Appendix I
Aquatic Ecological Resource Characterization and Impact Assessment

Aquatic Ecological Resource Characterization and Impact Assessment

Icebreaker Wind

Prepared for:

Icebreaker Windpower, Inc.

Prepared by:

LimnoTech

January 24, 2017

LimnoTech

Water | Scientists
Environment | Engineers

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1 Executive Summary

This document summarizes the relevant ecological issues affecting offshore wind development in Lake Erie that have been identified by experts. The report characterizes the site chosen by Icebreaker Windpower, Inc. (Icebreaker Windpower) for Icebreaker Wind, the six turbine demonstration project 8 to 10 miles off the shore of Cleveland, Ohio and assesses the potential aquatic ecological impact of the project on Lake Erie. This assessment was done utilizing a weight of evidence approach based on information presented from the following sources:

- Review of risk factor maps created by Ohio Department of Natural Resources (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.
- 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.
- 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 (OSW) turbines have been installed in freshwater.
- 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.

A project team led by LimnoTech with support from Ohio State University and Cornell University identified relevant potential impact categories from ODNR and GLWC documents. These major impact categories included:

- Aquatic habitat alteration during and after construction
- Noise impacts during and after construction
- Electromagnetic field impacts from electric cables
- Sediment disturbance
- Physical changes to wind, waves, and currents on the lake

The primary receptors for these potential impacts would include the following:

- Fish, which includes all growth stages including larval, juvenile, and adult
- Zooplankton and phytoplankton
- Benthic macroinvertebrates
- Humans that use the lake's resources for fishing, boating, swimming, and a source of drinking water

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.
- Degradation of habitat by sediment resuspension during electric cable installation is expected to only last several hours and extend no further than a few hundred meters or less 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.

The 2016 aquatic data collection by LimnoTech was conducted under the guidance of ODNR with review by the US Fish and Wildlife Service (USFWS). A comprehensive sampling plan was developed to guide the 2016 monitoring and characterization effort and to meet the requirements of the submerged lands lease from ODNR (ODNR, 2013). The sampling plan was first drafted in May 2016, but has undergone minor revisions after review with ODNR and USFWS. The latest version is dated January 23, 2017 (LimnoTech 2017). ODNR, USFWS and Icebreaker Windpower are finalizing a Memorandum of Understanding (MOU), which details the annual level of sampling and analysis that Icebreaker Windpower will be required to perform during all pre-, during-, and post- construction phases of the project. ODNR and USFWS will review monitoring data and address any discrepancies between the assessment of potential impacts and results from monitoring data.

It is our assessment that the scientific weight of evidence presented here shows that Icebreaker Wind presents minimal risk to the aquatic ecosystem. Ongoing engagement with regulators through ecosystem monitoring, adaptive management, and stakeholder engagement will address any other concerns.

2 Introduction

Offshore wind and other renewable energy sources within the Great Lakes have the potential to reduce carbon dioxide and other air emissions, water usage by power plants and associated fish mortality within the Great Lakes. However, decision makers require knowledge of the potential impacts, both physical and biological, to evaluate the extent to which offshore wind development might impact the fishery and aquatic ecosystem of the Great Lakes to recommend appropriate measures to protect critical habitat and preserve self-sustaining fish populations. The subject of this report is the Icebreaker Windpower project, which includes six 3.45 megawatt turbines and a transmission cable, proposed to be built in an area 8 to 10 miles off-shore of Cleveland, Ohio.

Based on workshops conducted by the GLWC, the ODNR developed the Lake Erie Open Water Aquatic Sampling Protocol for Securing Submerged Land Leases Offshore Windpower Siting (ODNR, 2013). This protocol is used to determine potential impacts, both physical and biological, of offshore wind development in the Great Lakes. The Aquatic Ecological Resources Characterization plan was designed to meet the requirements of the ODNR protocol and was developed in consultation with the ODNR and USFWS. The plan addressed all of the issues raised by the ODNR and USFWS related to Icebreaker Wind's potential impact on aquatic resources.

The purpose of this report is to document the aquatic ecological resources of Lake Erie near the proposed project and review and assess potential impacts that it might have on these resources. The study was completed by reviewing available information from recent offshore wind energy workshops held in the Great Lakes, ODNR documents assessing the potential risk of offshore wind energy to ecological resources, and site specific data collected in 2016 by LimnoTech (under contract to Icebreaker Windpower) to assess the present condition of the ecosystem. The workshops and ODNR documents are discussed in further detail in Section 3 and the 2016 site characterization is discussed in Section 4.

The remainder of this report provides the following information:

- Project background information (Section 2)
- A summary of relevant information on previous offshore wind studies (Section 3)
- A summary of results from the 2016 study (Section 4)
- A summary of the major ecological resources that might be impacted (Section 5)
- References (Section 6)
- Appendices

2.1 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 constructed on the Lake Erie lake bed, on leased submerged state land. These rights were obtained through a Submerged Land Lease with the State of Ohio. 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 bathymetry contours.

The Mono Bucket (MB) will be utilized as the foundation for the turbines. The MB combines the benefits of a gravity base, a monopile, and a suction bucket. In essence, it is a Suction Installed Caisson (SICA) or an "all-in-one" steel foundation system designed to support offshore wind turbines. The MB foundation is comprised of three sections: a steel skirt that will be embedded in the lakebed, a lid section, and a shaft that above the mudline resembles the elements of a standard offshore wind foundation (Figure 2). The Mono Bucket is installed using both gravity and a suction pump system including skirt nozzles and internal pressure chambers. Details of the foundation and shaft diameters are presented in Table 1. The Mono Bucket (MB) installation process includes two phases of installation. During the first phase, the MB is lowered onto the lakebed and self penetrates into the lake sediment due to its weight (500-600 tons). It self penetrates between 1 to 2 m (3 to 6 feet) into the lakebed, depending on soil stiffness at the site. At that point the MB ceases to self-penetrate. In order to continue the downward penetration, pressure is applied to the bucket lid. This is accomplished by sucking water out of the bucket using a pump, creating a higher pressure on the lid (compared to inside the bucket). This installation method eliminates the need for pile driving or dredging, thereby eliminating noise and soil disturbance.

Table 1. Details of foundation and shaft.

Foundation	Bucket Diameter	Shaft Diameter	Foundation Overall Height
Mono Bucket	17.0 meters (55.8 feet)	4.5 meters (13.8 feet)	36.9 meters (121 feet)

When compared with conventional monopile or jacket foundations, the MB foundation completely eliminates the need for pile driving, which is a significant contributor to underwater noise during installation. Similar installations with large diameter Mono Buckets have shown that fine-grained sediments can become dislodged and captured in the discharge water during the final stage (approximately the last meter) of the penetration process. During this final stage, when the turbulence created by the pump dislodges particles of sediment from the lakebed, these particles can become suspended in the water being pumped back into the Lake. For Icebreaker, an analysis of the geotechnical results from 2015 indicate that the particles in the top 0.1 – 0.3 m (1/3 to 1 feet) of the lake bed could possibly become dislodged and sucked into the pump. A more thorough review of the MB technology and installation methods is found at http://universal-foundation.com/technology/.

2.2 Project Site

As shown in Figure 1, the project site is located offshore of Cleveland, Ohio in the Central Basin of Lake Erie. Lake Erie, being the shallowest and warmest Great Lake, has the highest primary production, biological diversity and fish production of all the Great Lakes (Allinger and Reavie 2013). Specifically, Lake Erie's biological and physical processes are strongly influenced by the lake's topography and the division of the three basins (Ludsin and Hook 2013, Munawar and Munawar 2000). The Central Basin, the location of the project area, is the intermediate of the three basins in terms of temperature, productivity and depth (Ludsin and Hook 2013), and is dominated by cool-water species (e.g. yellow perch and walleye) with warm and colder water species present to some degree.

The Lake provides a valuable commercial and sport fishery, including walleye and yellow perch and is used for a variety of other uses including boating, sailing, swimming, commercial transport, swimming, and a source of drinking water.

2.3 Approach

This document reviews several key datasets to make a determination of the potential risk that Icebreaker Wind might have on the aquatic ecological resources of Lake Erie. These include the following:

- Review of risk factor maps created by the ODNR to specifically map out key aquatic habitats and areas of low and high potential impact from off shore wind across the Ohio Waters of Lake Erie.
- Review of recent reports authored by experts from around the Great Lakes region as part of the GLWC to identify potential areas of impact from offshore wind in the Great Lakes, including review of other studies and literature sources relevant to this project.
- Collection of site specific ecological data in 2016 at the project site to validate the impact assessments made by experts at the workshops and in ODNR's risk analysis maps.

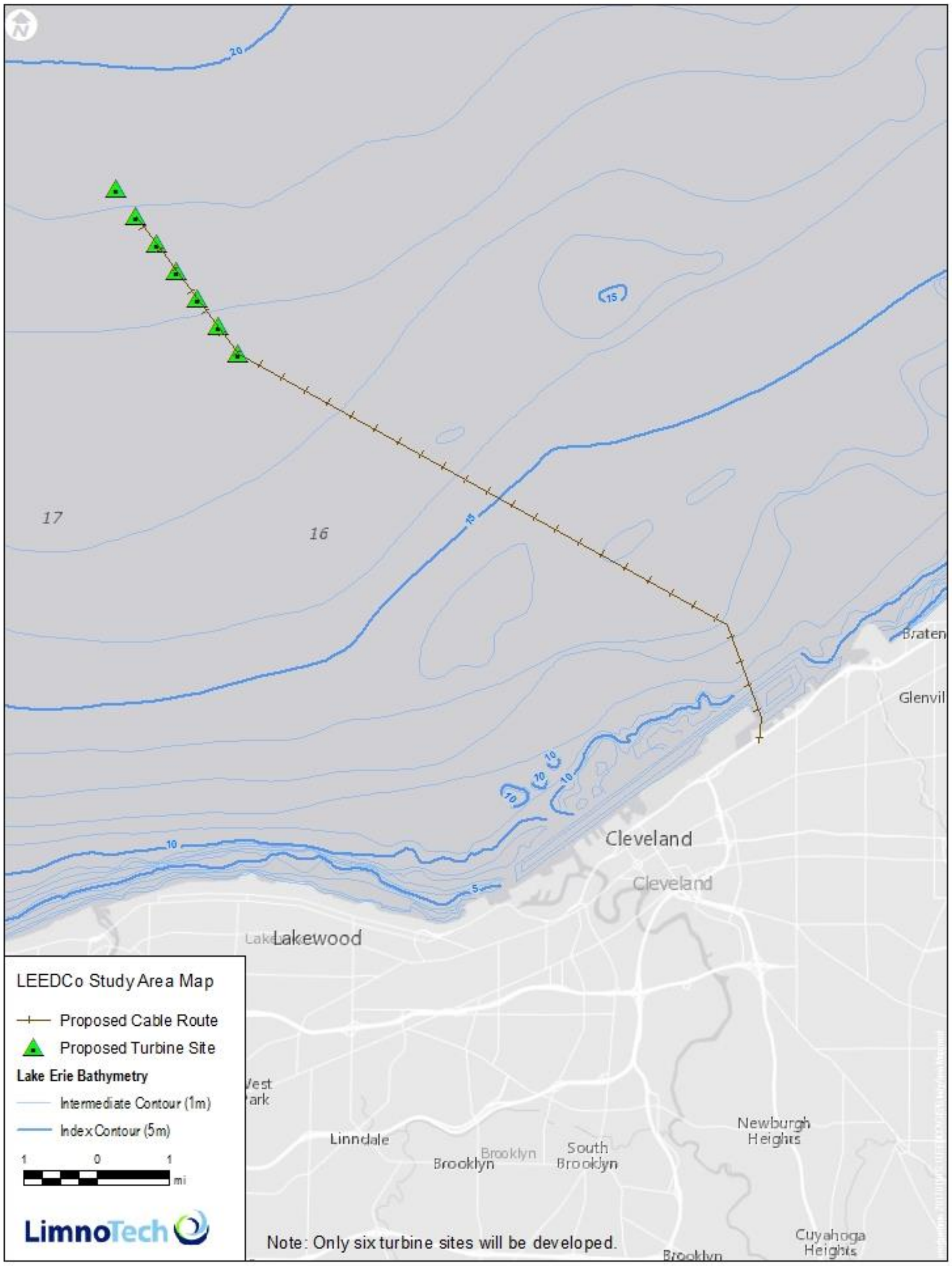

Figure 1. Project location map.

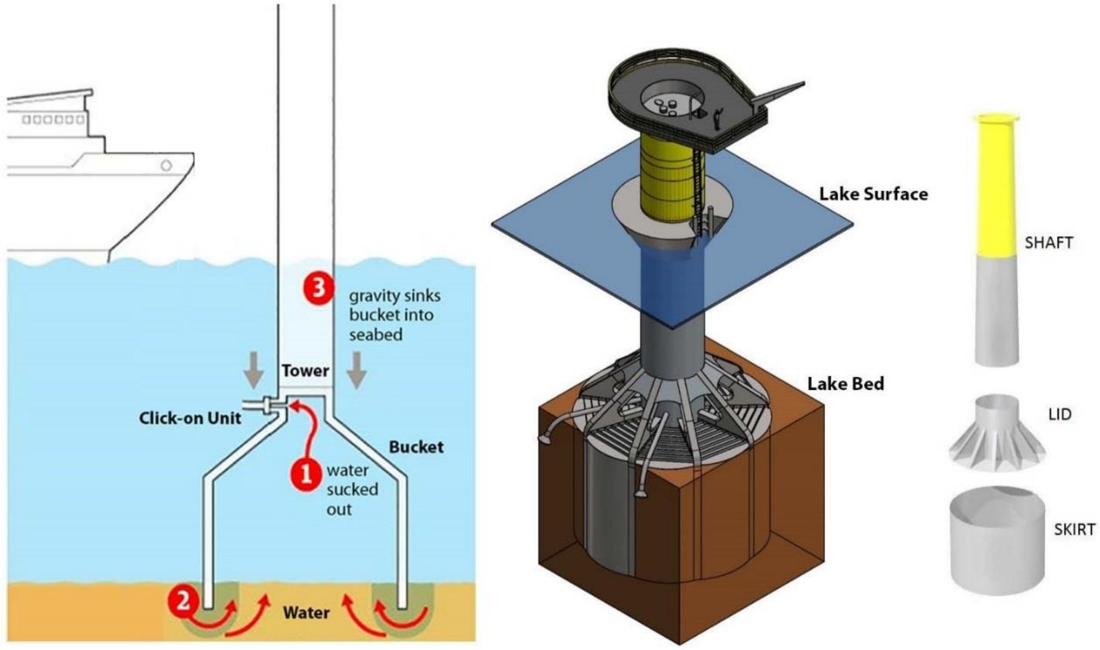

Figure 2.Mono bucket installation method.

A multi-disciplinary team, led by LimnoTech, included other experts from the Ohio State University, Cornell University, and BSA Environmental Services. The team worked to compile existing datasets and conduct a 2016 baseline ecological characterization of the Central Basin of Lake Erie off shore of Cleveland. The project team consulted with ODNR and USFWS on sampling plan design, leading up to a multi-year agreement, which forms a science based consensus for monitoring relevant components of the aquatic ecosystem.

2.4 Project Team

This section describes the project team in further detail. LimnoTech is 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 – 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 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 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.

2.5 Agency coordination

Throughout the last several years Icebreaker Windpower consulted with ODNR and the USFWS to identify an area of Lake Erie offshore of Cleveland appropriate for siting a small demonstration wind project in an area that is least likely to impact the ecological resources of Lake Erie. The coordination with these agencies continued in 2016 as Icebreaker Windpower and LimnoTech worked to develop a 2016 monitoring program to assess ecological resources at the proposed project site and initiate the baseline characterization monitoring. In 2016 Icebreaker Windpower and LimnoTech met with ODNR and USFWS on the following dates to discuss the proposed project and the 2016 characterization study:

- 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 sampling plan and finalize key monitoring objectives for the Icebreaker Windpower 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 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 LimnoTech (2017), Monitoring Plan. The 2016 sampling plan (LimnoTech, 2017) 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. ODNR and Icebreaker Windpower are also working towards a formal MOU, which will lay out the specific multi-year monitoring plan that Icebreaker Windpower will complete to meet its obligations included in its Submerged Lands Lease and to support its Application for a Certificate of Environmental Compatibility and Public Need to the OPSB. The MOU will describe the multi-year monitoring plan, which will cover pre-, during-, and post- construction phases of the proposed project. The MOU is expected to be finalized in early 2017.

3 Review of Previous OSW Studies

This chapter reviews previous studies of risk of offshore wind (OSW) development in Lake Erie from the ODNR, GLWC, Deepwater Wind, and ITC Lake Erie Connector project. This section highlights the relevant issues from each source.

3.1 Ohio Department of Natural Resources

ODNR worked in parallel and in cooperation with the GLWC to develop its own specific guidance for the development of offshore wind in the Lake Erie waters of Ohio. In 2009, ODNR published its analysis of various aquatic ecological resources and associated levels of risk posed by offshore wind development in “Wind Turbine Placement Favorability Analysis” (ODNR 2009). In addition, in 2013 ODNR finalized its “Aquatic Sampling Protocol for Offshore Wind Development for the Purpose of Securing Submerged Land Leases” (ODNR 2013). Both of these documents present a detailed review of the potential ecological resources that might be impacted by offshore wind development and identify areas where projects can be sited for minimal impact.

3.1.1 Overall Favorability Analysis

The favorability analysis involved creating a series of maps that show the various ecological resources of Lake Erie and then integrating them into a comprehensive potential impacts and OSW favorability map. The final favorability map was generated by applying weighted values to numerous potential indicators, or limiting factors, and then by calculating the total sum of weights for each one minute grid size cell. As a result, the comprehensive scores of summed weighted values provide an illustration showing the most favorable and least favorable locations in Lake Erie for wind turbine placement. The map takes into account a variety of factors including fish habitat, lakebed substrate, commercial and sport fishery effort, and location of reefs. For this report a small clip of several of the key maps are shown in this section, however the full page version of each map is attached as Appendix A.

The two grid cells from the mapping exercise that cover the turbine area are shown in Figure 3. The grid cells are light green, which has a moderate-low number of limiting factors. This rating is favorable for offshore wind development and balances many of the potential impacts associated with the project. The area selected is far from shore and well away from any commercial shipping channels.

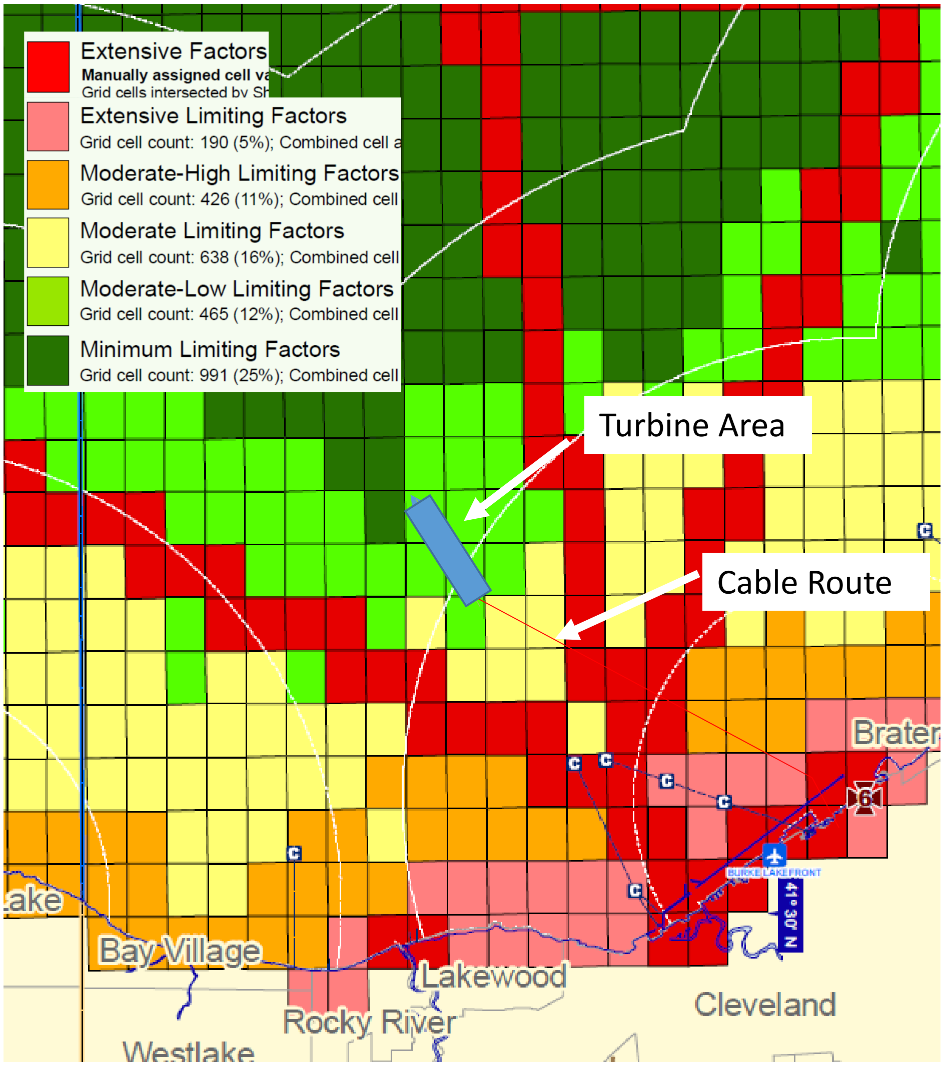

Figure 3. Overall project risk potential as rated by ODNR.

3.1.2 Fish habitat analysis

ODNR specifically assessed the quality of fish habitats across Lake Erie and identified key areas in the lake for reefs, shoals, artificial reefs, spawning areas for walleye, and adult walleye and perch habitat as well as areas that are in the Dead Zone. The area selected by Icebreaker Windpower has poor aquatic habitat due to its location in the Dead Zone and is well away from any fish spawning reefs or key habitat. Figure 4 shows that the turbine sites are primarily within the Dead Zone, with a small area shown connecting to the walleye/perch habitat area.

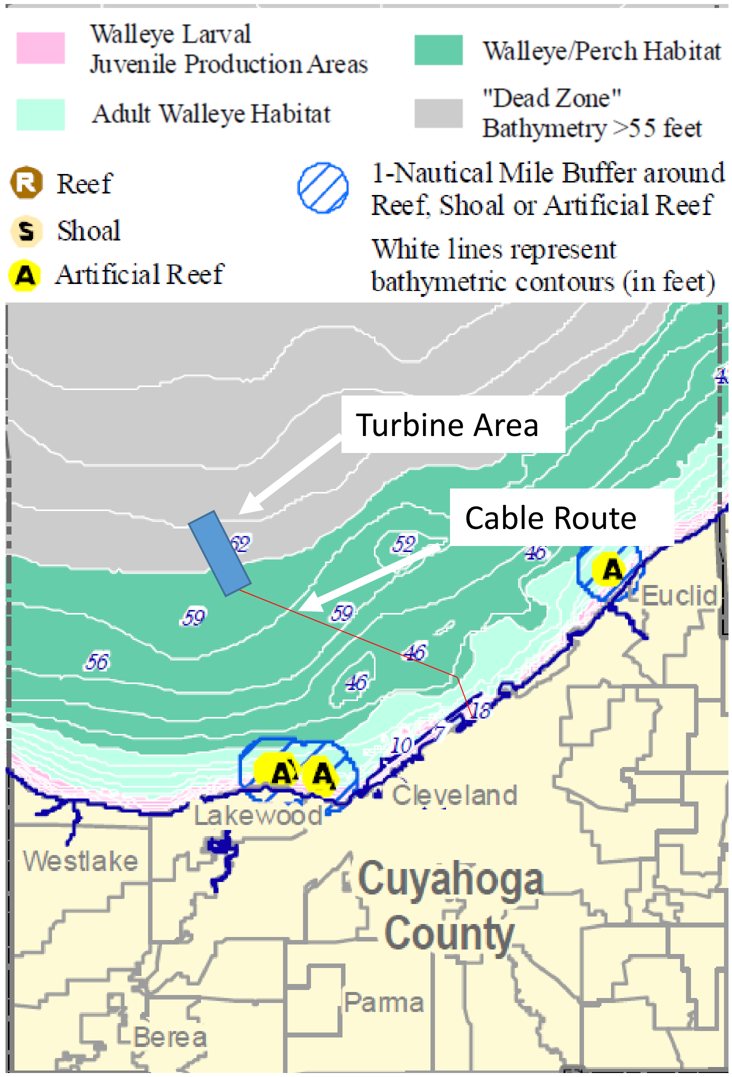

Figure 4. Habitat map of Lake Erie and turbine site.

3.1.3 Aquatic ecological favorability analysis

An aquatic specific potential impact map was generated by ODNR, which only focuses on factors related to habitat and lake bed substrate. Figure 5 shows that Icebreaker Wind is in the moderate-low and moderate-high impact zones. The moderate-high rating is partially driven by the estimated commercial and recreational fishing effort maps that is predicted for the site by ODNR. When investigating the factors that went into the creation of the fishing effort maps it was discovered that only very coarse information was available regarding the exact locations of sport and commercial fishery effort in Lake Erie. Data is only available in 10-minute quadrangle blocks (Figure 6), which cover an area of over ~100 sq miles. The ODNR map reproduced below in Figure 6 predicted a very high level of fish effort in the survey block that covers the project site, which also extends all the way to Cleveland Harbor. A more accurate assessment of fishing effort was done by LimnoTech in 2016, which is presented in Section 4.5.2.

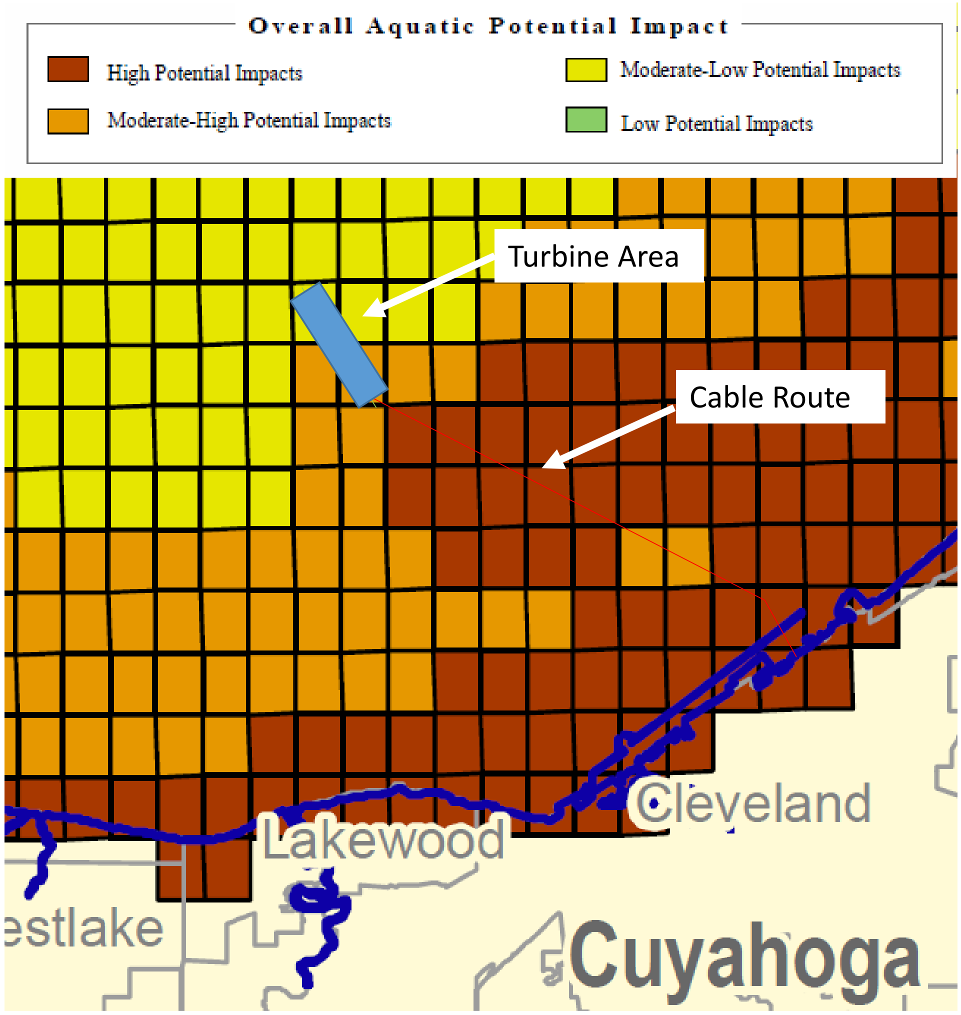

Figure 5. Aquatic ecological risk potential as rated by ODNR.

Based on the favorability analysis ODNR listed the potential impacts that OSW could have on Lake Erie. These include the following:

- Proximity to reefs, shoals, and artificial reefs for use in fish spawning and nursery areas
- Intensity of sport and commercial fishing effort in the region
- Lakebed substrate as habitat for invertebrates
- Fish habitat and community structure

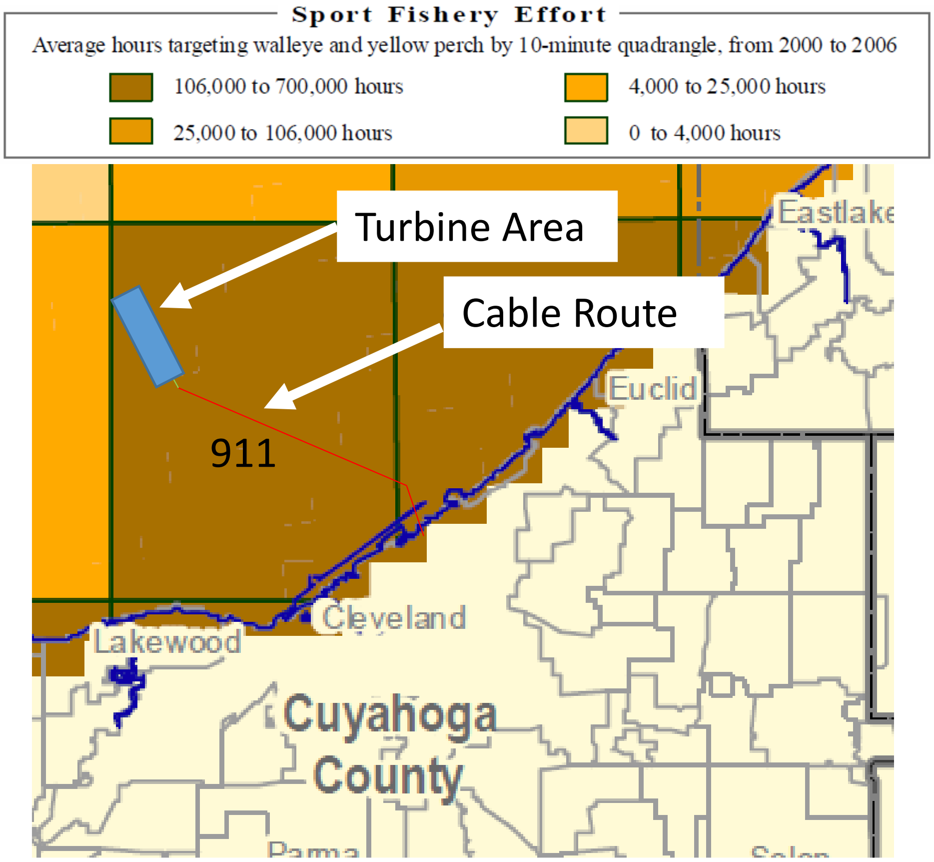

Figure 6. Map of sport fishing effort from ODNR and turbine locations.

3.1.4 ODNR Sampling Protocol

The ODNR developed sampling protocol (ODNR, 2013) identified the level of monitoring required of any OSW developer seeking a submerged lands lease. The protocol begins by identifying the major components of the Lake Erie ecosystem that should be monitored, which include:

- Fish community/lower trophic level
- Physical habitat
- Fish behavior
- Boating usage

Potential impact areas were drawn from the protocol for an analysis of the project risk for this report. Data were collected for one pre-construction monitoring year by LimnoTech (as detailed in Section 4) that followed the protocol's recommendations to develop an informed scientific assessment of the potential project impacts. A summary of the data is discussed in Section 4 and how the data relates to the identified impacts is in Section 5 of this report.

3.2 Great Lakes Wind Collaborative

The GLWC published a report in 2011 titled "State of the Science Report: An Assessment of Research on the Ecological Impacts of Wind Energy in the Great Lakes Region" and also conducted a workshop in 2012 titled "Offshore Wind Energy: Understanding Impacts on Great Lakes Fishery and Other Aquatic Resources". These two reports contain input from multiple federal and state agencies as well as scientists from across the Great Lakes region about key ecological resource impacts to consider when reviewing and permitting offshore wind facilities.

3.2.1 Review of 2011 Workshop

The "State of the Science Report: An Assessment of Research on the Ecological Impacts of Wind Energy in the Great Lakes Region" was crafted after a March 2011 workshop in Indianapolis. It was attended by over 120 people with representation from provincial and federal governmental agencies, consulting firms, nongovernmental organizations (NGOs), academic institutions, electrical utilities and the wind industry. This review will focus on the aquatic resources section of the report. At the workshop the following issues were raised that could impact the aquatic ecological resources:

- Habitat alteration in sensitive spawning areas
- Noise impacts on fish from construction and operation activities
- EMF emanating from transmission lines

The workshop participants concluded that offshore wind power generation within the Great Lakes has the potential to be implemented with minimal impacts on the aquatic ecosystem.

3.2.2 Review of 2012 Workshop

On November 28-29, 2012 the Great Lakes Commission and the GLWC hosted a workshop in Ann Arbor, Michigan, which was meant to be a follow-up to the 2011 workshop, with a specific emphasis on offshore wind. A summary of the workshop was published in 2013 (GLWC, 2013). The workshop's goal was to identify potential impacts that offshore wind might have on the Great Lakes fishery and other aquatic resources. Approximately 40 people attended the workshop from a range of public and private sector organizations. The workshop had several key discussion points and findings:

- Potential impacts on fish, both positive and negative
    - Noise impacts from construction activities and turbine operation
    - EMF impacts on behavior
    - Turbidity impacts from construction activities during spawning season
    - Altering fish behavior and migration patterns
    - Lakebed habitat disruption during construction, especially in spawning or nursery habitats
    - Behavior of fishermen as they adapt to changing fish movements or new artificial reefs that attract fish
    - Artificial reefs (turbine foundations) can attract fish
- Other potential impacts
    - Ice characteristics near turbines
    - Local scour around turbine foundation
    - Wind, waves, and circulation patterns could be affected by turbines

The workshop identified three key research areas that are needed to better understand the potential impact that offshore wind might have on the aquatic ecosystem. These include: 1) detailed knowledge of substrate types and location of spawning reefs; 2) potential impacts to fish behavior on migratory species; and 3) best practices to avoid spawning areas and migrating fish.

3.3 Deepwater Wind

The nation's first offshore wind farm was recently constructed offshore of Block Island in Rhode Island, which also had to go through an extensive review of potential aquatic impacts. The 30 MW project with five turbines completed an Environmental Report in 2012 as part of its permitting process with state and federal regulators (Deepwater Wind 2012). The executive summary identified key aquatic resources that could be impacted from the project. Table 2 lists each aquatic resource category and the identified potential impact. The table is produced here as the Deepwater Wind project has conducted similar extensive studies of potential impacts associated with developing OSW in the United States.

Table 2. Review of key aquatic issues from Deepwater Wind environmental report.

Resource	Potential Impacts
Physical Oceanography and Meteorology	No effect to surrounding physical processes including circulation, flow patterns, stratification or possible long term rise in sea level.
Water Quality and Water Resources	No effect to groundwater or surface water resources are anticipated from onshore facilities. Temporary sediment disturbance during construction activities will result in minor, short-term, and localized increases in total suspended solids (TSS) near wind turbine generator (WTG) foundations and along submarine cable corridors. Low risk of hazardous spill during construction and operation. Low risk of frac-out during HDD activities.
Benthic Resources	Minor, short-term, localized disturbance to benthic habitat from WTG installation and cable laying activities. Minimal permanent alteration of habitat associated with the five WTGs and the targeted use of additional cable protection (max of 2.25 acres [0.99 hectares]). WTG foundations may provide a minor beneficial impact by providing artificial hard substrate that may attract some sessile benthic encrusting species. No impacts from electromagnetic fields (EMF) due to cable design and burial depth.
Fish Resources	Minor, short-term, localized disturbance to benthic habitat used by finfish from WTG installation and cable laying activities. Minimal permanent alteration of habitat associated with the five WTGs and the targeted use of additional cable protection (max of 2.25 acres [0.99 hectares]). Temporary sediment disturbance during construction activities will result in minor, short-term, and localized increases in total TSS near WTG foundations and along submarine cable corridors. WTG foundations may provide a minor beneficial impact by providing additional habitat for some structure-oriented species. Minor short-term impacts from underwater noise generated during pile driving. No impacts from EMF due to cable design and burial depth.

3.4 ITC Lake Erie Connector

ITC Lake Erie Connector, LLC is proposing to construct a 72 mile 1,000 megawatt electric transmission interconnection cable between Ontario and Pennsylvania across Lake Erie. As part of the project a water quality modeling study was completed as the project crossed a range of sediment types and water depths (HDR, 2015). The underwater portion of the cable is 65 miles in length and will be buried in the sediments using a jet-plow installation method, which is the same method to be employed by Icebreaker Windpower. The jet-plow installation method provides a trench to lay the cable and uses water jets to fluidize the sediment in the trench before cable laying. The jet-plow fluidizes the sediment in front of the installation plow and the cable slides into the trench from the back, then settles to the bottom of the trench and is buried with the resuspended sediment. Results from the study are summarized below:

> “The results from the water quality modeling show that minimal water quality impacts are associated with the cable installation in Lake Erie and they are limited to temporary impacts that would occur locally within a four hour timeframe. At all five of the representative locations, the model calculated TSS concentration increases due to the cable installation are <3 mg/L above observed background lake TSS levels at a distance of 100 meters from the point of installation and within five to eleven meters of the lake bottom. The model calculated TSS concentration increases reach a temporary peak concentration at the point of installation and then decrease rapidly. The time to reach a TSS concentration increase of <100 mg/L is on the order of one hour and to reach <3 mg/L above background TSS levels is on the order of one to four hours.”

In addition, the environmental report conducted as part of a comprehensive environmental assessment found that recovery for benthic communities varies, ranging from several months to several years, depending on the type of community and type of disturbance (DOE, 2013).

4 2016 Site Characterization

This section presents results from data collected in 2016 to support an assessment of the aquatic ecological resources of Lake Erie and the potential impacts Icebreaker Wind could pose to those resources. The 2016 dataset serves two main objectives, 1) to validate and review assessments of potential impacts to the ecosystem from previous workshops and ODNR offshore wind favorability analysis and 2) to serve as a baseline dataset to compare subsequent construction and post construction datasets to assess any changes to the pre-construction characterization. This analysis focuses on the first objective, as the second objective will be completed in cooperation with ODNR and USFWS during and after construction.

4.1 Summary of 2016 monitoring program

The 2016 in-lake monitoring was designed to collect extensive physical, chemical, and biological data at the proposed project site on a monthly basis between May and October. Table 3 summarizes the sampling elements that were conducted each month. As noted, the methods to perform each type of sampling were approved by ODNR during several meetings and email exchanges as summarized in Section 2.5.

Table 3. Review of 2016 sampling events.

Sampling Category		May	Jun	Jul	Aug	Sep	Oct	ODNR Review Status
Fish Community								
	Hydroacoustic	s	s	s	s	s	s	Finalized
	Larval Fish	s	s	s				Finalized
	Juvenile	s			s		s	Finalized
	Zooplankton	s	s	s	s	s	s	Finalized
	Phytoplankton	s	s	s	s	s	s	Finalized
	Benthos	s					s	Finalized
Physical								
	Chemistry (discrete)	s	s	s	s	s	s	Finalized
	Chemistry (continuous)	d	m	m	m	m	r	Finalized
	Substrate Mapping	s						Finalized
	Hydrodynamic	d	m	m	m	m	m	Finalized
Fish Behavior								
	Acoustic Telemetry						d	Finalized
	Fixed Acoustic				s	s	s	Finalized
	Noise	d	m	m	m	m	r	Finalized
	Aerial Surveys	s	s	s	s	s	s	Finalized

d=deploy, m=maintain, r-retrieve, s=sample

A map of the stations sampled in 2016 is provided in Figure 7. Review of the data is divided into five sections including biological data, water chemistry, physical habitat, noise monitoring, and other monitoring.

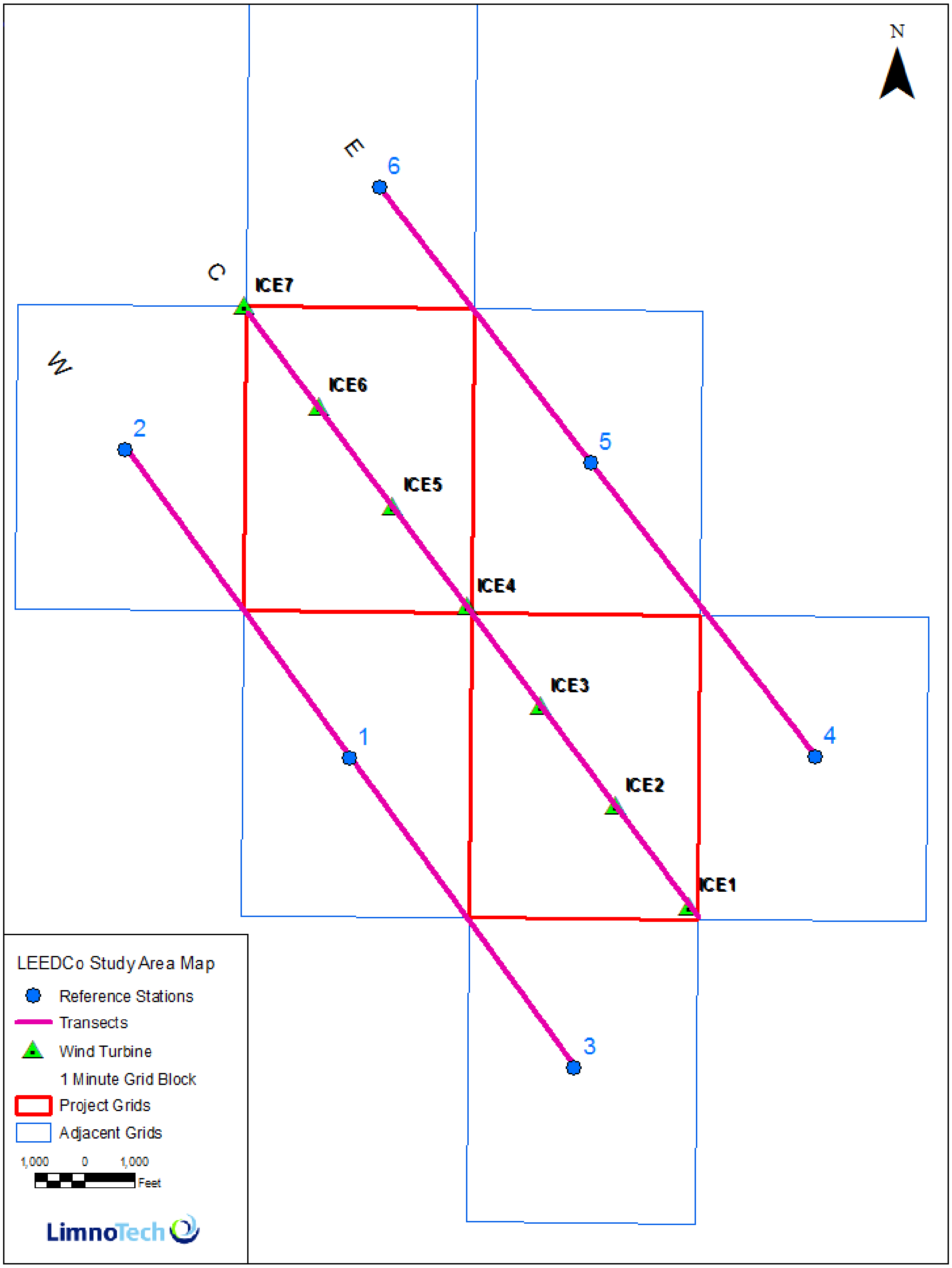

Figure 7. Map of monitoring stations.

4.2 Biological monitoring

The 2016 sampling included a characterization of the fish, zooplankton, phytoplankton, and benthic macroinvertebrates at the proposed project site. The characterization was completed through monthly sampling of all of these components and identification of organisms present. The structure of the aquatic food web and population dynamics of its member species determine how energy flows throughout the food web. The components of a food web are closely linked, such that changes to a single component can affect the entire food web (Ludsin and Hook 2013). It is critical to understand both the upper food web components (i.e., fish) as well the lower trophic levels (e.g., benthos, zooplankton, phytoplankton), as changes at the lower levels can have a significant impact on both the composition and productivity of fisheries communities within Lake Erie (LEC 1998).

The central basin, the location of the project study area, is the intermediate of the three basins of Lake Erie in terms of temperature, productivity and depth (Ludsin and Hook 2013), and is dominated by cool-water species (e.g. yellow perch and walleye) with warm and colder water species present to some degree. The current conditions of the central basin are generally considered mesotrophic (a moderate range of dissolved nutrients) with respect to the other two basins; the preferable range for perch and walleye. A food web, modified by the NOAA Great Lakes Research Environmental Research Laboratory is presented in Figure 8.

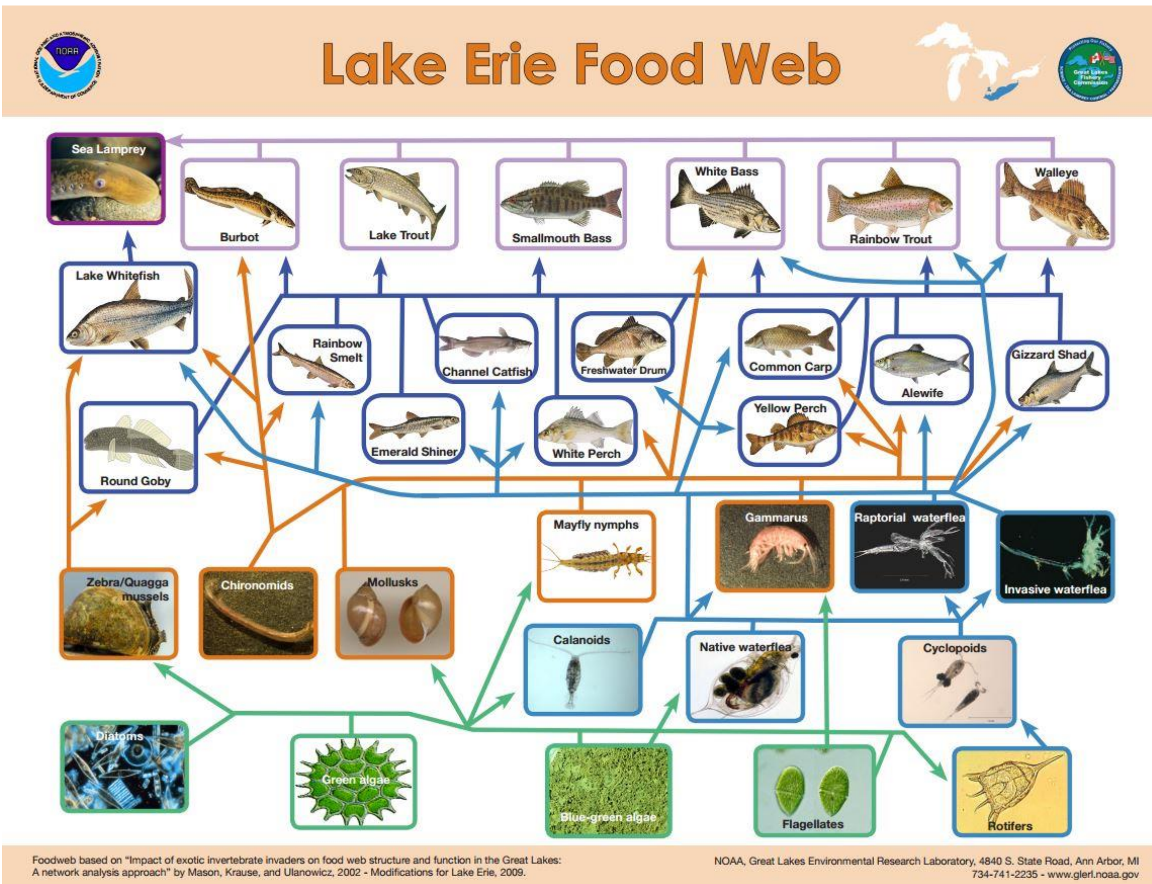

Figure 8. Example food web of the Lake Erie biological community. Photo taken from the NOAA, Great Lake Environmental Research Laboratory.

4.2.1 Upper food web

Lake Erie supports a species rich and diverse composition of approximately 90 fish (ODNR 2015), including commercial and recreational fisheries for important fish stocks such as walleye and yellow perch, as well as several other species (e.g., white bass, white perch, and lake whitefish). Other fish groups present in the Central Basin include trout, bass, smelt, catfish, carp, herring, drum, minnows and sunfish (Figure 8). Although Lake Erie has been extensively studied over the past several decades, biological data are a key component of the overall environmental baseline information used to assess any potential effects of the turbines. For this study, we used several collection methods to assess the fish species found within the project vicinity, to provide a better understanding of the upper food web, as well as any potential impacts on it as a result of Icebreaker Wind. The following sections include results from the larval and juvenile fish sampling as well as the hydroacoustics surveys. Larval and juvenile fish are the most vulnerable growth stages of the upper food web, which is why they were the focus of the 2016 study.

Larval Fish

Larval fish contribute both to recruitment and to the food base of adult fish population as they age and mature. The composition of Lake Erie's larval fish community has shifted in the last several decades, due in part to the introduction of invasive species and a general shift in the food web structure. Larval fish sampling was conducted on May 24, June 26 and July 20, 2016. Three replicate, five minute tows were completed at three locations during each sampling event. These included two turbine locations (Turbine station ICE2 and Turbine station ICE6) and one reference site (Reference 1). A 1X2m frame, 500 micron Neuston net was used to collect the fish according to the ODNR ichthyoplankton sampling protocols. The results from these collections are summarized Table 4. 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 completed a single trawl near the Cleveland intake crib in June, in order to compare the offshore results to a more nearshore location (~4 miles from shore) (Table 4).

The lack of larval fish in the project area is not surprising given the project area is far offshore, where there are no preferred spawning habitat grounds, and minimal near-shore mixing. A recent paper by Ludsin et al. (2014), presented the spawning habitats for 24 Lake Erie fish species, including the most harvested commercial and/or recreational fish as well as important prey species, and none of these fish had a preferred spawning habitat offshore, except lake trout which preferred a near-offshore habitat. The 2016 survey results indicate very low larval abundance, therefore based on this observation Icebreaker Wind is likely to present a minimal impact. An ongoing monitoring program will continue to monitor larval fish levels through all phases of the project.

Table 4. Ichthyoplankton results from the May, June and July 2016 sampling events.

Site	Date	Average (SD)
Turbine 2	5/24/2016	0 (0)
Reference 1	5/24/2016	0 (0)
Turbine 6	5/24/2016	0 (0)
Turbine 2	6/26/2016	< 1 (1)
Reference 1	6/26/2016	< 1 (1)
Turbine 6	6/26/2016	< 1 (1)
Turbine 2	7/20/2016	0 (0)
Reference 1	7/20/2016	0 (0)
Turbine 6	7/20/2016	0 (0)
Nearshore	*6/26/2016*	*16 (NA)*

Juvenile Fish

Juvenile fish sampling was conducted on May 21, August 8 and October 3, 2016. Three replicate, ten minute tows were completed at the two turbine locations (Turbine station ICE2 and Turbine station ICE6) and one reference site (Reference 1), during each event. A flat-bottom otter trawl with a 7.7 meter head rope and 12-mm bar mesh in the cod end was used. Trawl catches were sorted by species and age-category (e.g., age-0, age-1, age-2+) and then enumerated. A subsample of 30 individuals per species and age category was measured for total length (nearest mm) and weight (nearest 0.1 g). The combined results from the three replicate surveys at each location across the three events are summarized in Table 5.

Table 5. Summary of the juvenile fish sampling results from the 2016 spring, summer and fall events (Mean ± SD of individual fish).

	Turbine 2			Turbine 6			Reference 1		
Fish Species	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)

In the 2016 spring 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 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 Turbine 1 measured 0.45 mg/L and Turbine 7 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 thermocline and associated bottom hypoxia had dissipated for the October 3rd 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.

Monthly bottom trawl surveys, on the U.S. side of the central basin of Lake Erie are conducted regularly from May through October across four depth strata (5-10m, 10-15m, 15-20m and >20m) (Ohio Division of Wildlife (ODW), 2016). Bottom trawling is generally conducted before, during and after lake stratification at three stations, for 10 minutes per trawl with depths greater than 10m, similar in structure to our study design. Comparable to our study, yellow perch, white perch and rainbow smelt, amongst others dominated the ODNR trawls across the central basin surveys. Walleye, white bass, goby, shiners, freshwater drum, trout-perch, gizzard shad, alewife and silver chub were also present in variable numbers (ODW, 2016). None of the fish collected during these surveys are threatened or endangered. The results of this study are consistent with basin wide trends in composition and abundance. An ongoing monitoring program will continue to monitor juvenile fish populations through all phases of the project.

Mobile and fixed acoustic surveys

Hydroacoustics utilizes sonar technology for the detection, assessment and monitoring of underwater objects. Active hydroacoustics sensing involves listening for the echo from sound via an echo sounder. This method can determine the range and size of an object and is used for the assessment of fish size, distribution and abundance in an area. Acoustic monitors were used to assess whether there are any unique fish densities at the project location and to later compare whether the turbines and cable have had any impact on fish distribution, abundance, and movement in the project area. Hydroacoustic monitoring to assess fish size, distribution, and abundance in an area was performed once monthly in the months of May through October 2016 on multiple transects.

To assess the stock size, a density estimate based on area was calculated according to the Standard Operating Procedures for Fisheries Acoustic Surveys in the Great Lakes (Parker-Stetter et al 2009). The results from the mobile hydroacoustic surveys are summarized in Table 6.

Table 6. Summary of the mobile hydroacoustics across 6 months in 2016 for total density, individuals (#) per m^2 (Mean ± SD).

Month	Density (m^2±SD)
May	1.82 (0.35)

June	1.15 (0.38)
July	4.36 (0.89)
August	0.14 (0.01)
September	0.20 (0.01)
October	3.20 (2.00)

Overall, the 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. 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 lack 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. The limited presence of fish near the turbine sites in the summer and early fall months minimizes impacts on fish during these months. An ongoing monitoring program will continue to monitor fish populations using acoustics through all phases of the project.

4.2.2 Lower food web

The 2016 site characterization assessed the phytoplankton, zooplankton and benthos communities, to provide a better understanding of the lower food web within and near the project location, as well as any potential impacts as a result of the Icebreaker Windpower project. The following sections include the results from the phytoplankton, zooplankton and benthos surveys.

The lower Lake Erie food web includes the zooplankton, phytoplankton and benthic communities. These lower trophic levels are critical to sustaining and maintaining healthy food webs, and were an important component to the site characterization. In 1999, the Forage Task Group (FTG) of the Great Lakes Fisheries Commission (GLFC) initiated a Lower Trophic Level Assessment (LTLA) program within Lake Erie (FTG, 2016). The program conducts yearly monitoring of nine key variables including zooplankton, phytoplankton and benthos to characterize ecosystem change through time. The lower trophic level biomass varies amongst basins and years (FTG, 2016). Additionally, other continuous monitoring programs such as the US Environmental Protection Agency (USEPA) Great Lakes National Program Office's (GLNPO) Open Lake Water Quality Survey of the Great Lakes have provided multi-year data that can be used to establish and compare biological trends. The USEPA monitoring program includes phytoplankton, zooplankton and benthos results.

Phytoplankton

The Lake Erie Central Basin phytoplankton biovolumes have generally increased over the last decade (Allinger and Reavie 2013). High spring biovolumes are mostly attributed to diatoms (e.g. *Aulacoseira islandica*), whereas a more mixed phytoplankton sample is common during summer sampling events. Phytoplankton are primary producers that form the base of many food webs. Phytoplankton sampling was conducted once per month from May through October, in conjunction with the zooplankton, benthos and water chemistry samples. Samples were collected at six reference locations and three turbine stations monthly from May through September. Due to inclement weather during the October event, samples were only collected from three reference stations (Reference 1, 3 and 6) and two turbine stations (Turbine 4 and Turbine 6). Field collection methods were based on the Lake Erie Coordinated Lower Trophic Level Assessment (FTG, 2016). Briefly, an integrated tube/hose sampler was lowered to just above the lake bottom to complete the sampling. Sub-samples were removed for plankton identification to taxonomic genus and then enumerated. The results from each event are summarized in Table 7, including the numerical metrics, including number of genus, cells/L and the total biovolume for each month and station.

Table 7. 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.

	Turbine 2						Turbine 4					
	May	June	July	August	September	October	May	June	July	August	September	October
Number of Genus	15	12	21	15	19		-	10	14	25	21	32
Cells/L	9.7E+06	5.0E+05	9.98E+06	6.31E+06	3.46E+06		-	7.5E+06	1.54E+07	2.64E+07	1.27E+07	5.18E+07
Total Biovolume (um^3/L)	7.0E+09	3.5E+08	3.90E+08	5.06E+08	6.64E+08		-	7.9E+08	3.48E+08	3.06E+08	3.93E+08	1.96E+09
	Turbine 6						Reference 1					
	May	June	July	August	September	October	May	June	July	August	September	October
Number of Genus	12	14	15	22	13	17	18	12	17	18	22	21
Cells/L	9.9E+06	1.9E+06	4.68E+06	8.78E+06	6.80E+07	2.86E+07	9.3E+06	2.7E+06	8.13E+06	8.05E+06	8.76E+06	3.74E+07
Total Biovolume (um^3/L)	2.5E+09	7.7E+07	2.94E+08	4.58E+08	8.61E+08	2.78E+09	1.9E+09	2.5E+08	4.35E+08	7.04E+08	1.78E+08	4.03E+09
	Reference 2						Reference 3					
	May	June	July	August	September	October	May	June	July	August	September	October
Number of Genus	15	9	16	21	24		18	9	15	12	16	18
Cells/L	8.3E+06	3.1E+06	8.12E+06	4.78E+06	1.66E+07		1.2E+07	5.0E+05	6.39E+06	3.68E+07	6.49E+06	5.00E+07
Total Biovolume (um^3/L)	2.8E+09	7.1E+08	1.93E+08	1.41E+09	3.17E+08		8.7E+09	3.5E+07	4.71E+08	2.00E+09	4.80E+08	2.40E+10
	Reference 4						Reference 5					
	May	June	July	August	September	October	May	June	July	August	September	October
Number of Genus	15	9	21	17	19		22	13	18	15	13	
Cells/L	1.1E+07	4.7E+05	1.17E+07	9.37E+06	8.94E+06		7.8E+06	4.6E+05	6.61E+06	1.45E+07	1.44E+07	
Total Biovolume (um^3/L)	3.5E+09	1.2E+08	1.46E+09	5.29E+08	2.96E+08		2.2E+09	1.4E+08	5.39E+08	6.60E+08	8.11E+08	
	Reference 6						**All Sites**					
	May	June	July	August	September	October	**May**	**June**	**July**	**August**	**September**	**October**
Number of Genus	13	11	17	16	14	28	16 (3)	11 (2)	17 (3)	18 (4)	18 (4)	23 (7)
Cells/L	1.5E+07	1.8E+06	9.80E+06	6.46E+06	1.15E+07	2.23E+07	1.04E+07	2.10E+06	8.98E+06	1.35E+07	1.68E+07	3.80E+07
Total Biovolume (um^3/L)	4.3E+09	1.7E+08	4.28E+08	3.71E+08	3.51E+08	7.70E+08	4.11E+09	2.94E+08	5.07E+08	7.71E+08	4.83E+08	6.71E+09

A summary of the composition of Genus across all months is found in Table 8. 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. The species composition was typical of most Lake Erie samples, which are made up of mostly diatoms, green algae, dinoflagellates and blue-green algae (NOAA 2009). Allinger and Reavie (2013) summarized the USEPA-GLNPO biovolume and species composition of algal groups from 2001 through 2011. They found similar trends to the 2016 data, with a spring dominance of the diatoms, likely due to the winter sub-ice growths (McKay et al. 2011; Twiss et al. 2012) trending to a more mixed biovolume in the summer. The results of this study are consistent with basin wide trends in composition and abundance. Alterations to the phytoplankton community composition and structure are not anticipated as part of the construction or operation of the Icebreaker Windpower project. An ongoing monitoring program will continue to monitor phytoplankton levels through all phases of the project.

Table 8. 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	

Zooplankton

Zooplankton are heterotrophs that are a vital component of freshwater food webs. According to the most recent FTG 2016 report, from 1999 through 2015 across all stations (8 stations, including those on the Canadian side) (FTG, 2016), zooplankton biomass ranged on average from <100 ug/L to greater than 300 mg/L (excluding rotifers and veligers). In general, the Central Basin is made up of mostly water fleas, calanoid and cyclopod copepods, rotifers, and to a lesser extent the larval crustaceans (nauplii) (NOAA, 2009).

Zooplankton sampling was conducted once monthly from May through October, in conjunction with the phytoplankton, benthos and water chemistry samples. Samples were collected at six reference locations and three turbine stations monthly from May through September. Due to inclement weather during the October event, samples were only collected from three reference stations (Reference 1, 3 and 6) and two turbine stations (Turbine 4 and Turbine 6). Field collection methods were based on the Lake Erie Coordinated Lower Trophic Level Assessment (FTG, 2016). A weighted zooplankton net (0.5 m in diameter, 64 micron mesh), with a flow meter was lowered to the lake bottom and then pulled up so the plankton were collected along the way down and up. Sub-samples were removed for plankton identification to taxonomic genus (species when available) and then enumerated.

The results from each event are summarized in Table 9, 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 9. The number of species, number of organisms/L and the biomass for all zooplankton in each sample - May through October 2016.

	Turbine 2						Turbine 4					
	May	June	July	August	September	October	May	June	July	August	September	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
	Turbine 6						Reference 1					
	May	June	July	August	September	October	May	June	July	August	September	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
	Reference 2						Reference 3					
	May	June	July	August	September	October	May	June	July	August	September	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
	Reference 4						Reference 5					
	May	June	July	August	September	October	May	June	July	August	September	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	-
	Reference 6						**All Sites**					
	May	June	July	August	September	October	May	June	July	August	September	October
Number of Species	16	16	8	13	13	13	16±2	14±1	10 (1)	11 (3)	11 (2)	15 (3)
Number/L	1613	953	821	2374	2230	998	1644±620	897±693		2174 (1236)	1198 (554)	847 (86)
Biomass (ug d.w./L)	580	974	157	323	205	392	643±311	741±333	223 (160)	495 (469)	344 (252)	307 (82)

The species composition across each month is summarized in Table 10. 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 10. 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 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 Windpower project. An ongoing monitoring program will continue to monitor zooplankton populations through all phases of the project.

Benthic macroinvertebrates

Benthic macroinvertebrates are organisms without backbones that live on the lake bed (rocks, sediments, debris, logs, plants, etc.). Unlike fish, they are relatively immobile and are continuously exposed to their environments, making them sensitive to water quality. Many reside in the project area long enough (months to years) to reflect changing environmental conditions and serve as an important food source for fish species. Seasonal hypoxia is a regular event in the Central Basin and can influence the ecosystem structure of these lower trophic levels. Given the seasonal trends in oxygen (Section 4.3) measured at the project location, with extended hypoxic and anoxic periods, the benthic community is expected to be made up of more tolerant taxa such as the oligochaetes, sphaeriid clams and midges (Krieger, 1984). While the invasive Dreissena have changed the structure of most Lake Erie benthic communities, certain pockets of the Central Basin are completely devoid of the species due to regular hypoxic events in the Dead Zone (Conroy et al. 2011, Matzinger et al. 2010, Burakova et al. 2014).

Samples were collected in 2016 at one reference station and two turbine stations in spring (May) and fall (October). Field methods were based on the Lake Erie Coordinated Lower Trophic Level Assessment (FTG, 2016). Three replicate grabs of bottom sediment were collected during each sampling event. 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 std. dev. (in parentheses) are presented of each taxa across three replicate at each location for the May and October events.

Taxa	May			October		
	Turbine 2	Turbine 6	Reference 1	Turbine 2	Turbine 6	Reference 1
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. Species that were abundant in the study area, such as the oligochaetes, sphaeriid clams, and chironomids, are more tolerant to the oxygen depletion and/or can readily re-populate areas (Burakova et al. 2014). The samples collected at the site indicated the benthic macroinvertebrate population at the proposed turbine locations is typical for this region of Lake Erie. Alterations to benthic community composition and structure are not anticipated as part of the construction or operation of the Icebreaker Windpower project.

4.3 Water column

This section reviews relevant data from the water column in Lake Erie from two main sources, 1) a nearby station that is monitored by USEPA GLNPO on a regular basis, and 2) stations monitored by LimnoTech at the proposed Icebreaker Windpower project site in 2016. Typical parameters measured during limnological studies of lakes include nutrients and DO (Wetzel, 2001). These two components were also suggested to be monitored by ODNR in their aquatic sampling protocol (ODNR 2013). A review of typical levels of each one of these parameters can give insight into its relevance for assessing potential impacts by Icebreaker Windpower on the aquatic ecosystem. For example, areas with low levels of DO offer poor quality fish habitat.

4.3.1 Nutrients

Historically, nutrient enrichment (i.e. eutrophication) has been an ongoing problem in Lake Erie, causing algal blooms and resulting in subsequent oxygen depletion. From the 1950s to the 1970s, oxygen depletion was recorded throughout the hypolimnion of the central basin (USEPA 2014). The eastern basin also experiences oxygen depletion (Lake Erie LaMP 2009).

GLNPO has been conducting water chemistry sampling within the Central Basin of Lake Erie since 2000. The closest long-term sampling location, station ER43, is located 13 miles WNW of the purposed turbine location (41.788 °N and 81.944 °W) at a water depth of 66 feet. GLNPO generally samples once in April and August each year at station ER43 and provided data through 2015. Integrated water column samples of nitrate-nitrite, and total phosphorous were obtained from GLNPO to compare to samples taken from the monitoring site in 2016. Typical nitrate and nitrite concentration as shown in Figure 9 at the GLNPO site ranged from <0.050 mg/L to over 0.500 mg/L, which are within the range for a medium to low productivity lake (Wetzel 2001). The 2016 data collected by LimnoTech, shown in Table 12, in the project area showed nitrate-nitrite levels varied between 0.052 mg/L to 0.884 mg/L. The highest values were recorded in May and the lowest in October.

Table 12. Monthly average nutrient concentration.

	Monthly Average Concentration (mg/L)					
Parameter	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Oct**
Phosphorus	0.013	0.008	0.005	0.006	0.007	0.021
Nitrate-nitrite	0.884	0.471	0.489	0.084	0.061	0.052

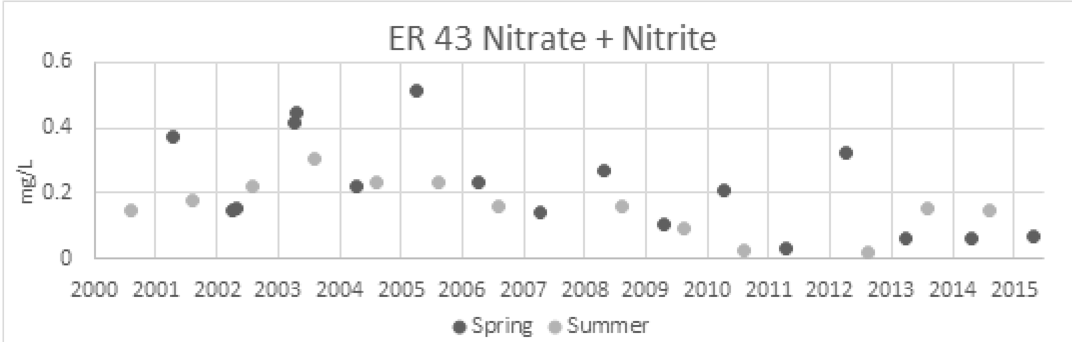

Figure 9. GLNPO integrated nitrate-nitrite samples in April and August at station ER43 from 2000 to 2015.

Typical total phosphorus concentrations as shown in Figure 10 are 1 µg/L to 6 µg/L, which are within the range for a medium to low productivity lake (Wetzel 2001). The 2016 data collected by LimnoTech, shown in Table 12, in the project area showed total phosphorus concentrations ranged from 5 ug/L to 21 ug/L. The highest values were seen in the months of May and October, with the lowest values found in July.

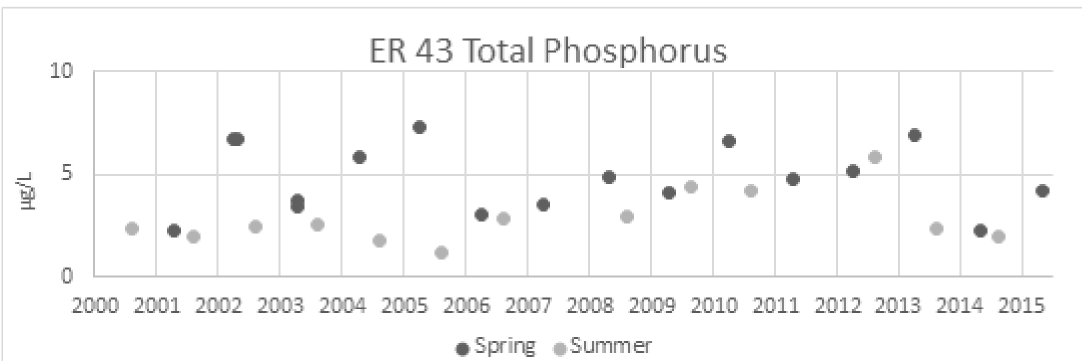

Figure 10. GLNPO integrated total phosphorus samples in April and August at station ER43 from 2000 to 2015.

Alterations to nutrient levels are not anticipated as part of the construction or operation of the Icebreaker Windpower project. An ongoing monitoring program will continue to monitor nutrient levels through all phases of the project.

4.3.2 Dissolved oxygen

Dissolved oxygen levels in Lake Erie vary dramatically throughout the year and can remain hypoxic for weeks to months in the summer and early fall. DO was measured at several locations throughout the region by LimnoTech in 2016. This includes by buoys located approximately 10 miles northeast of the study area at a water depth of 72 feet (Station 45165) and 4 miles to the southeast of the study area at a water depth of 45ft (Station 45176). The buoys provide a continuous time-series of DO and a water temperature profile from May to October, 2016. A plot of data from this buoy is shown in Figure 11. The plot shows DO dropped below 2 mg/L in early August at the far offshore location and in mid-July closer to shore.

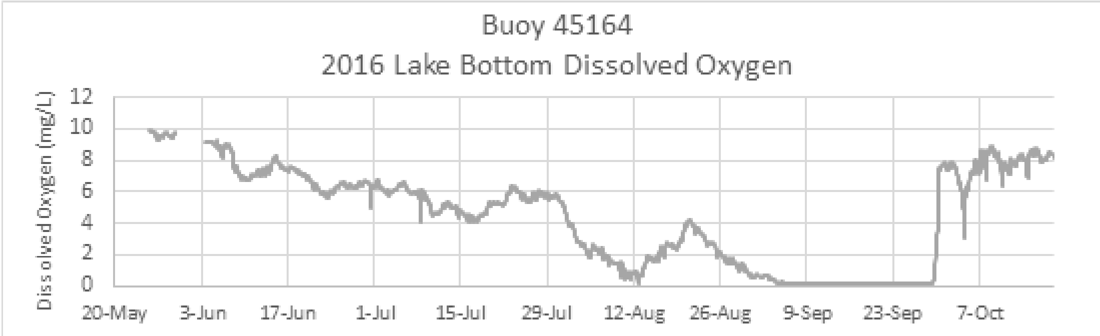

Figure 11. Dissolved oxygen measured from buoy 45154.

Bottom DO was also measured in 2016 at proposed turbine sites 1, 2, 4, and 7, as well as Reference 1. All sites had DO levels that were hypoxic in August and September and were not re-oxygenated until the lake mixed completely in late-September (Figure 12).

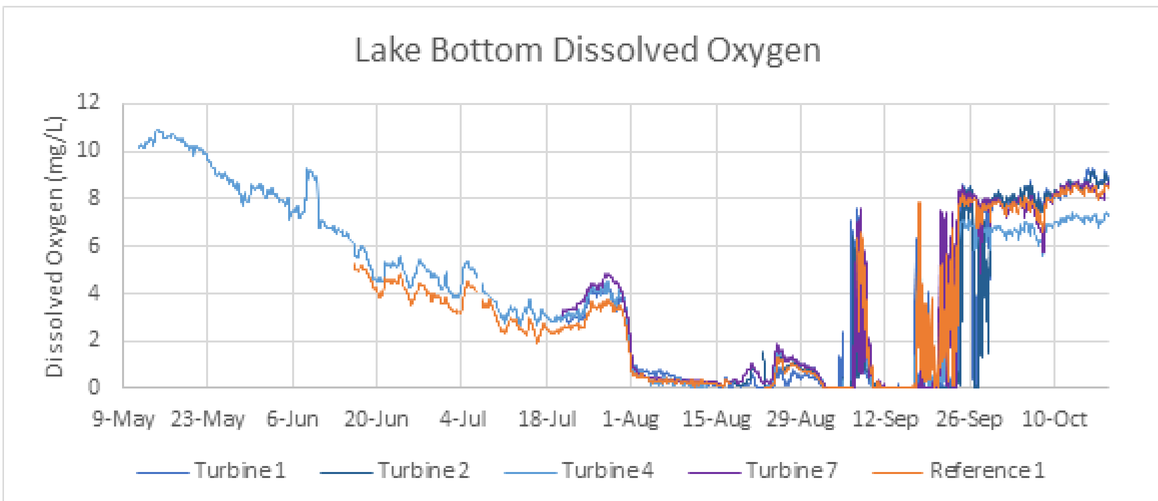

Figure 12. 2016 lake bottom dissolved oxygen at Turbine sites 1, 2, 3, 7, and Reference 1.

This data shows that hypoxia extends from far offshore, past the project site, towards the Cleveland water intake crib. This regional DO trend is not likely to be impacted by the Icebreaker Windpower project, however the presence and movement of this hypoxic zone can rapidly affect the presence or absence of fish within the region. An ongoing monitoring program will continue to monitor DO levels through all phases of the project.

4.4 Physical habitat

A subsurface geophysical study was conducted in 2016 by Canadian Seabed Research Ltd. (CSR 2016) to map the surficial geology of the study area near the turbines and along the export cable route. Maps of the surficial sediment type are included in Appendix A. The surficial sediments near the turbines are all composed of a silt/clay mixture with no appreciable change in sediment character until approximately a third of the way down the export cable route. Figure 13 shows a simple representation of the side scan mosaic. The proposed turbine sites are all located along the upper left arm of the survey track while the export cable route extends along the center of the mosaic and finally turns towards the shoreline near the Cleveland break wall. The darker brown color indicates a silt/clay mixture, while lighter brown indicates a sand or sand/gravel mixture. ODNR also mapped surficial sediments in Lake Erie as part of their favorability analysis (ODNR 2009). ODNR shows that mud comprises the area near the turbines and transitions to sand/mud mixture in the nearshore region. ODNR ranks mud as the most favorable sediment type for wind turbine placement as it is a poor substrate to sustain aquatic biodiversity and offers little to no value for spawning.

Figure 13. Side scan sonar mosaic of sediment type (dark brown= silt/clay, lt. brown =sand).

4.5 Other aquatic resources

4.5.1 Waves and Circulation

Research on currents and circulations in Lake Erie have shown that surface currents are driven by wind and bottom currents by topography and boundary geometry (Gedney, R. and Lick, W. 1972; Saylor, J. and Miler, G., 1987). Beginning in 2005, NOAA's Great Lakes Environmental Research Laboratory (GLERL) in collaboration with researchers from the U.S. and Canada conducted a study on Lake Erie called International Field Years on Lake Erie (IFYLE) to investigate hypoxia and harmful algal blooms. Station C06 for IFYLE was installed in 2005, 10 miles northeast of Icebreaker Windpower's monitoring site at a water depth of 21 meters to measure water currents from the bottom of Lake Erie to the surface. Collocated with C06, station W06 was also installed in 2005 to measure wave heights. Data from September 1 to October 15 is shown in Figure 14 and available wave heights from W06 are shown in Figure 15. An ongoing monitoring program will continue to monitor wind, waves, and currents through all phases of the project.

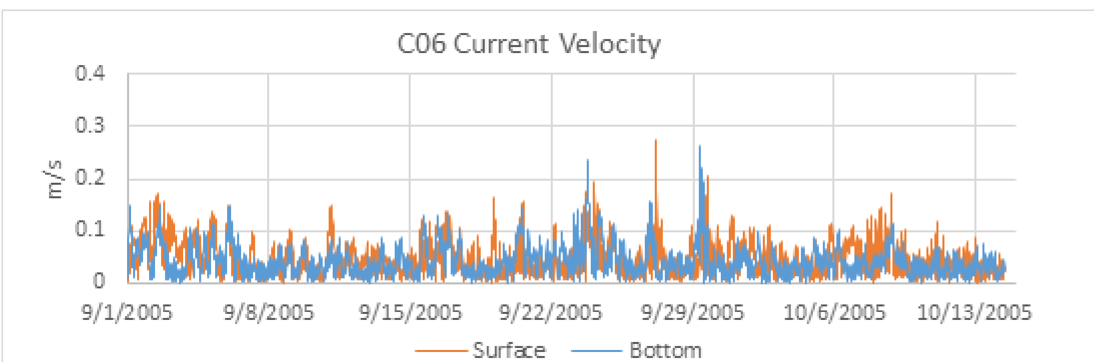

Figure 14. 2005 IFYLE current velocity from the lake surface and bottom at station C06.

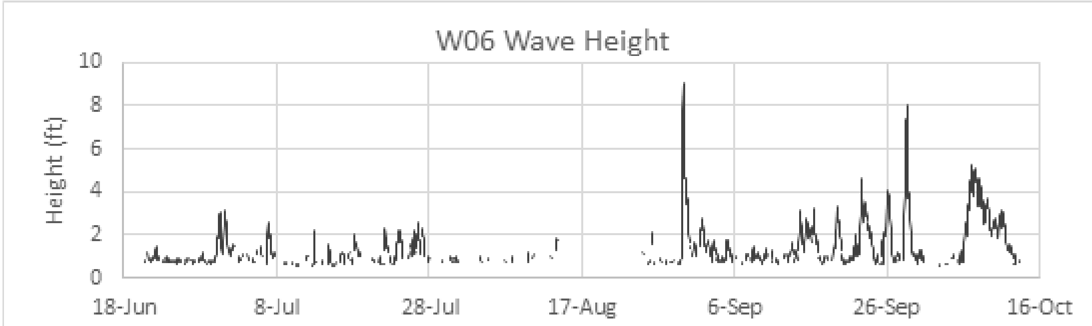

Figure 15. 2005 IFYLE wave height at station C06.

Current meters were deployed at Reference 1 and Turbine station ICE4 on May 11, 2016 and were retrieved on October 19, 2016. Water velocity and direction data were logged hourly for each meter of the water column at both locations and additional wave height data were recorded at Turbine 4. Figure 16 shows the water velocity at the surface at bottom at the proposed location of turbine 4. The average the surface currents were higher than the bottom currents and velocity was generally below 0.3 m/s throughout the water column. Wave heights during the summer were generally below four feet and wave heights reached almost eight feet during the fall (Figure 17). At the surface at Turbine 4 currents were moving towards the south-west for a majority of the deployment as shown in Figure 18.

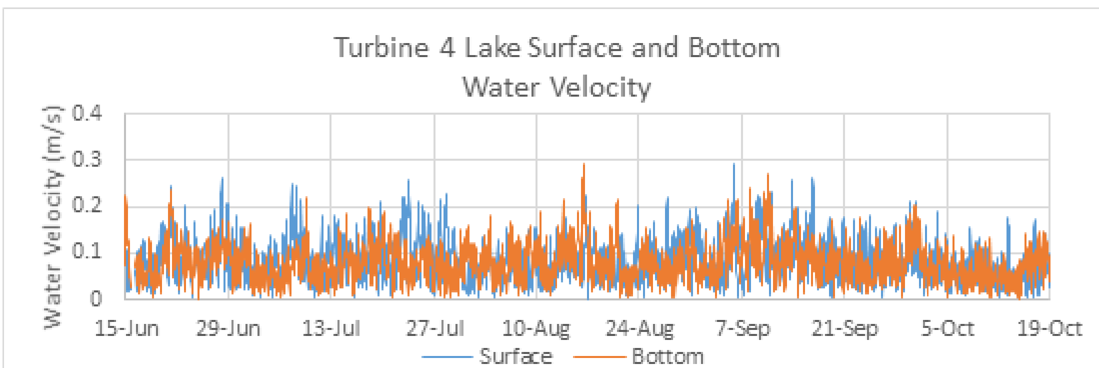

Figure 16. 2016 lake surface and bottom water velocity at Turbine 4.

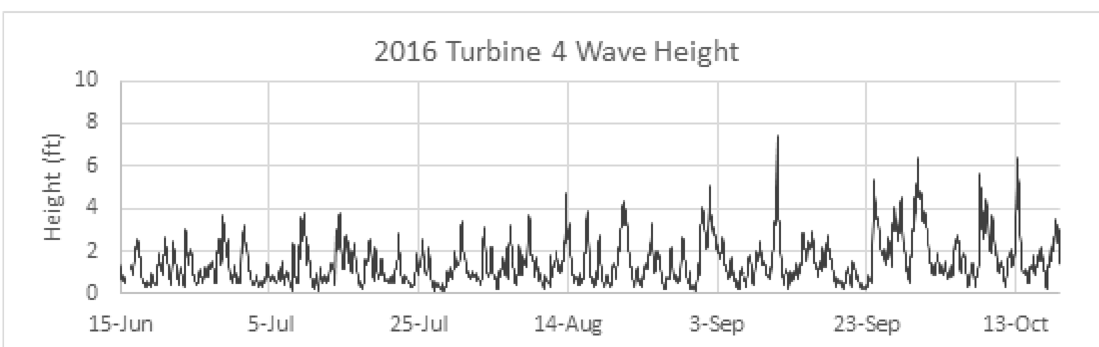

Figure 17. 2016 wave heights at Turbine 4.

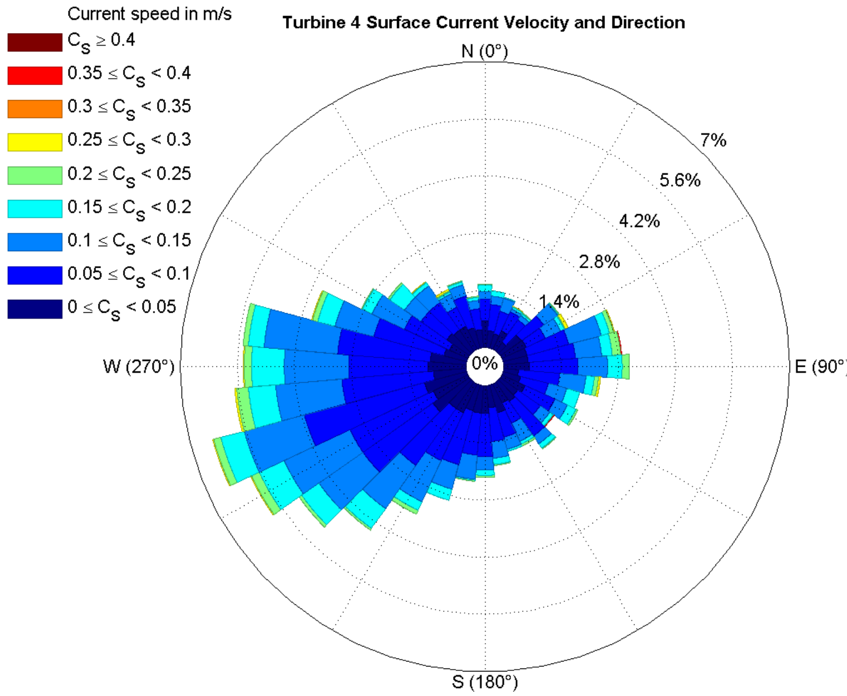

Figure 18. 2016 surface current velocity and direction at Turbine 4. Spokes represent the frequency of currents moving towards a particular direction.

4.5.2 Recreational Boating and Fishing

In 2016 LimnoTech contracted with Aerial Associates to conduct aerial surveys of the Cleveland area to count boats on 12 different days between May and October. An example of the results from a flyover conducted on July 3, 2016 is shown below in Figure 19. The boat count data shows the presence of boats within a given 5-minute geographic area offshore of Cleveland. Results from all of the boat surveys by 5-minute survey block are summarized in Table 13 below. 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 than is depicted in the ODNR developed sport fishery maps shown in Figure 6. The ODNR sport fishery effort maps are based off of data from 10-minute survey grids, which are too coarse to evaluate expected fishing effort in the immediate vicinity of the turbines.

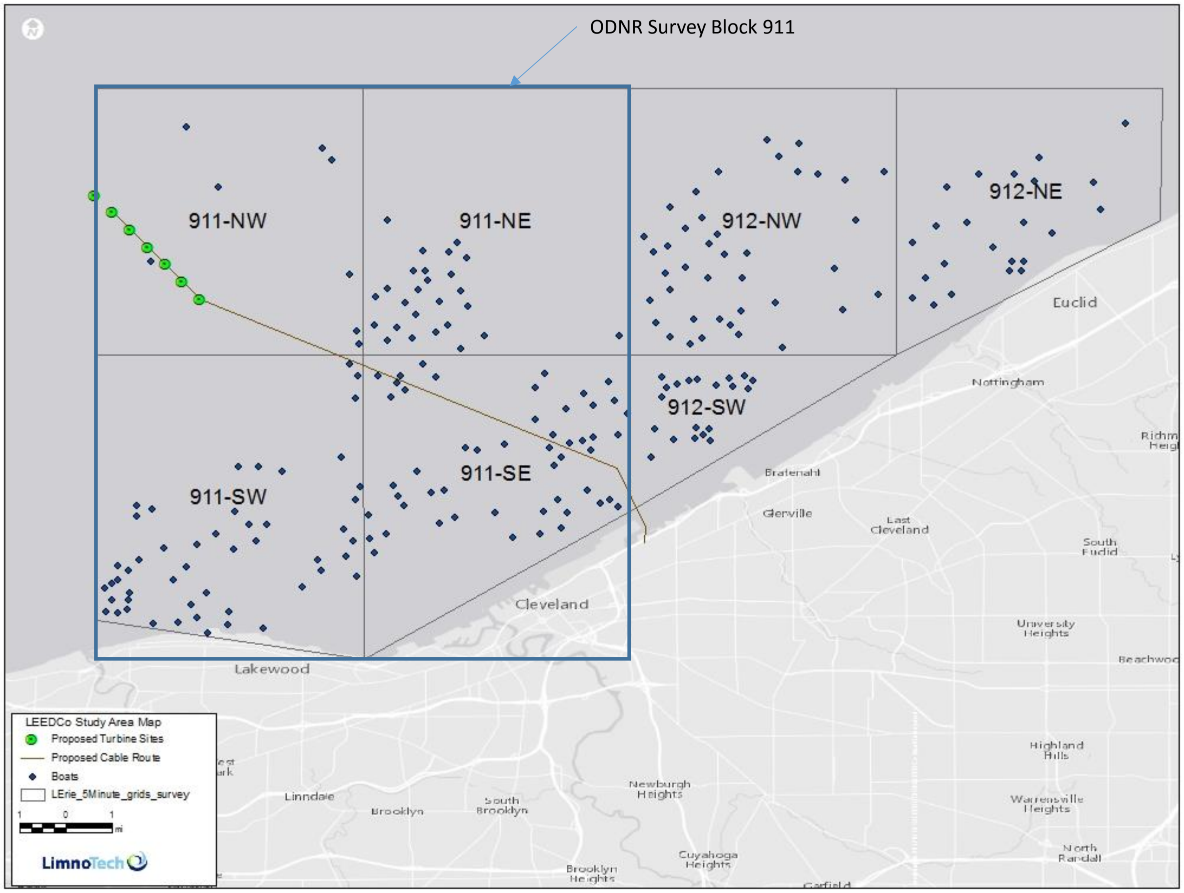

Figure 19. Map of recreational boats (dots) as counted by plane and turbine location (green dots) on July 3, 2016.

Table 13. 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

In 2016 LimnoTech also performed a recreational boat slip assessment for Cleveland area marinas. The September 26, 2016 analysis used aerial imagery collected via plane on August 3, 2016 to identify power and sail boats present at 16 marinas in Lorain, Cuyahoga, and Lake Counties. A total of 6,057 boat slips were inventoried. A total of 812 sailboats and 3,252 power boats were present (Table 14). A summary of the boat lengths is presented in Table 15. The summary shows that 99% of the sailboats have a mast height of less than 65 ft.

Table 14. Summary of boat slip counts by marina.

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 15. Summary of boat lengths and estimated mast height.

Percentile of boats counted	Power Boat Length (ft)	Sailboats		
		Length (ft)	# of boats > or =	Min. Mast Height (ft)
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

5 Review of Impact Categories

This section summarizes the major ecological resources that might be impacted by a given offshore wind project in the Great Lakes and within each subsection is a brief discussion of how Icebreaker Windpower is addressing this potential impact.

5.1 Aquatic habitat alteration

The workshops highlighted the need to have an understanding of the substrate at the site and identify the location of key spawning reefs, shoals, and artificial habitat. The study also noted the potentially beneficial ecological impacts that could result from creating artificial structures to enhance fish habitat.

LimnoTech has reviewed aquatic habitat alteration associated with the project as follows:

- 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 and sediment type. Sediment type interpreted from side scan sonar surveys and grab samples are presented in Section 4.4 and a review of ODNR fish habitat maps are presented as an inset in Figure 3 and in full in Appendix A (Figure 21).
- Dissolved oxygen (DO) data collected in 2016 shows the proposed turbine sites were all within the Lake Erie Dead Zone and therefore offer poorer habitat for fish and macroinvertebrates. The DO data at the site is presented in Figure 11.
- Only very tolerant benthic macroinvertebrates species were found within the project site. This information is presented in Section 4.2.2.
- 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 due to the presence of hypoxic waters. This information is presented in Section 4.2.1.
- 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.
- Icebreaker Windpower has committed to substantial ongoing monitoring of potential impacts to aquatic habitat alteration. The ongoing monitoring is being conducted with oversight and input from ODNR and USFWS.

5.2 Sediment disturbance

The workshops highlighted the need to have an understanding of sediment disturbance during turbine foundation installation and buried cable installation.

LimnoTech has reviewed sediment disturbance associated with the project as follows:

- Construction related sediment resuspension and enhanced turbidity near the turbines are mitigated by the chosen mono bucket foundation, which has minimal impact on surrounding sediments during installation. The caisson of the mono bucket turbines acts as a scour protection in the vicinity of the shaft. Stroescu et. al (2016) monitoring of three projects installed in the North Seas to survey multi-year scour development found scouring was insignificant.

- Degradation of habitat by sediment resuspension during electric cable installation is expected to only last several hours and extend no further than a few hundred meters or less 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. The ITC Lake Erie Connector project did a comprehensive study of resuspension potential during the installation of a proposed buried electric cable line that extends 72 miles across Lake Erie from Pennsylvania to Ontario (HDR 2015). The installation method, jet plow, is the same as the method chosen by Ice WP and sediment type and ambient currents are similar in magnitude. The HDR study found that elevated suspended sediment concentrations extended 100 m beyond the installation location for several hours.
- Icebreaker Windpower has committed to substantial ongoing monitoring of potential impacts due to sediment disturbance. The ongoing monitoring is being conducted with oversight and input from ODNR and USFWS.

5.3 Noise

The magnitude of noise effects is dependent on project location, construction timing and species sensitivity to various types of disturbance.

LimnoTech has reviewed noise impacts associated with the project as follows:

- Although, the disturbance of operational noise and boat traffic varies between fish species, in general, studies indicate that the effect on most species is low (Bergstrom et al. 2012). If fish are nearby excessive noise levels, they would likely move away from the area in response to their flight reactions (Bergstrom et al. 2012, Nedwell and Howell 2003, Mueller-Blenkle et al. 2010, Andersson 2011). Studies have shown that early life stages of fish have a limited flight ability, and likely at least as sensitive as adults to acoustic noise (Wahlberg and Westerberg 2005). Very few larval fish were collected in the study area (4.2.1), which would reduce impacts to these life stages. Additionally, the sound from operating wind turbines, is not likely strong enough to cause any immediate hearing damage in fish, even when the fish are right next to the foundations (Bergstrom et al. 2012, Wahlberg and Westerberg 2005, Mueller-Blenkle et al. 2010, Anderson 2011). Bergstrom et al. (2012) summarized that certain fish species, (i.e. young salmonids; Sand et al. 2001) have the ability to detect and move away from high intensity low-frequency noises (Wahlberg and Westerberg 2005, Mueller-Blenkle et al. 2010, Andersson 2011). These noises would likely only be heard within a few meters away from the sound source (Bergstrom et al. 2012).
- Icebreaker Windpower will utilize a suction bucket foundation for the turbines, which will significantly minimize construction noise during turbine foundation installation. The driving of steel piles is not required for foundation installation, which can generate significant noise (TetraTech 2012; Deepwater Wind 2012).
- Ship generated noise levels during turbine and cable installation will be similar in nature to the noise emitted by passing lake freighters, which frequent the shipping channels offshore of Cleveland. Sound from passing ships can generate noise levels up to 180 dB (Deepwater Wind 2012). Close to 1,000 ships frequent the Port of Cleveland annually (portofcleveland.com).
- Icebreaker Wind is sited in a location identified by ODNR that is far from spawning reefs and key nursery areas, where increased noise levels could impact fish recruitment and spawning migration. The chosen site is also within the Dead Zone of Lake Erie, which has low species

diversity and minimal fish populations in the summer and fall months, which minimizes the presence of potential receptors of enhanced construction noise.

- Icebreaker Windpower is working with ODNR to monitor underwater noise levels during construction and after construction. The noise monitoring plan follows the direct guidance of ODNR and was developed with researchers at Cornell University.

5.4 Fish movement/behavior

Both workshops brought up the issue of wind turbine foundations and associated transmission lines that could affect fish behavior and movement. Turbine foundations could create artificial reefs, which could attract fish. EMF generated by transmission lines or electrical collection cables could deter and alter fish migration patterns. Sport and commercial fishing could be affected if fish movements are affected. Each of these issues is discussed in further detail below.

Artificial reef

The creation of artificial reefs around the turbine foundations could impact local fish species and attract fish and other invertebrates.

LimnoTech has reviewed fish behavior and artificial reefs associated with the project as follows:

- 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 in Figure 22.
- The mono bucket foundations chosen for Icebreaker Wind limits sediment disturbance during installation and covers a limited area as cited previously.
- Icebreaker Windpower has committed to substantial ongoing monitoring of potential impacts due to sediment disturbance. The ongoing monitoring is being conducted with oversight and input from ODNR and USFWS.

Electromagnetic fields

The 2011 and 2012 workshops noted that fish migration and movements could be impacted by EMF generated by electrical transmission lines that will be installed between turbines and to a shoreline power station.

LimnoTech has reviewed fish behavior and EMF associated with the project as follows:

- The selected cable route is not located on any ODNR mapped reefs or shoals that could attract fish as identified in Figure 4.
- A detailed literature review of EMF impacts on fish was conducted. The summary of the literature review is included as Appendix B. The literature review 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 collection cables will be buried below the sediment surface to minimize or eliminate any electromagnetic impacts in the water column. In addition, the cable will be encapsulated within a polymer and shielded covering.
- The project team conferred with other state and federal agencies regarding a similar nearby project in Lake Erie where a much larger and higher capacity electric transmission line is being buried across all of Lake Erie to determine how EMF is being considered for that project. The ITC Lake Erie Connector project (http://www.itclakeerieconnector.com/) has not raised EMF as an issue despite it crossing the entire lake and carrying up to 1,000 MW of power.

- Icebreaker Windpower has committed to monitoring fish behavior and movements during and after construction to monitor for any changes. Data collected in 2016 will be used as a baseline. This sampling plan is detailed in LimnoTech 2017.

Fishing Effort and Boating

If fish movements are affected in any way by Icebreaker Wind, it is possible that sport and commercial fishing efforts and recreational boating patterns in general could be affected indirectly.

LimnoTech has reviewed fish behavior and potential impacts on fishing and boating associated with the project as follows:

- The project is sited in a location that is 8 to 10 miles from shore in an area sited by ODNR and shown in Figure 22 to contain poor fish habitat quality.
- 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 2% of the boats counted in all of the surveys were within 3 miles of the project site. Additional information on the 2016 boating data is found in Section 4.4.
- The turbines will be designed to locate the turbine blades sufficiently off the surface of the water to minimize/limit any potential interaction rotating blades might have with tall sailing boats. The turbine blades will be a minimum of 65ft above the water's surface. A LimnoTech sailboat survey of all harbors in Cleveland found that 99% of sailboats have masts lower than this height and Icebreaker Windpower is closely consulting with the US Coast Guard and local marinas to ensure sufficient warnings and chart markings are in place.
- Icebreaker Windpower has committed to monitor boating activity during and after construction to track any changes in boating behavior. This sampling plan is attached as Appendix B.

5.5 Physical lake conditions

At the 2012 workshop, a number of other relatively minor potential areas of impact were discussed including sediment scour around turbines that could affect local bathymetry, local wind and wave patterns, and circulation. The workshop participants concluded no overall impact of sediment scour, wind, and waves from offshore wind development is likely and only a small impact of turbidity/sediment transport is likely during construction. The workshop participants indicated that changes in lake circulation patterns could be possible, but it would depend on the scale and location of any proposed project.

LimnoTech has reviewed the physical impacts associated with the project as follows:

- 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 of 17 meters in diameter (0.05 ac) and a combined footprint from all six turbines of 0.3 ac.
- Installation of the buried electric cables will follow a jet plow installation method, which represents the industry standard for minimal impact to surrounding method 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.
- Icebreaker Windpower has committed to substantial ongoing monitoring of potential impacts due to changes in wind speed, wave height, or currents. The ongoing monitoring is being conducted with oversight and input from ODNR and USFWS.

6 Conclusion

This document reviews several key datasets to make a determination of the potential risk the Icebreaker Windpower project might have on the aquatic ecological resources of Lake Erie. After a review of documents from ODNR, GLWC, Deepwater Wind, and the ITC Lake Erie Connector project a list of potential impact categories was developed. Each major category was reviewed with respect to data available from others as well as a 2016 site specific evaluation of aquatic resources. It is our assessment that the scientific weight of evidence presented here shows that Icebreaker Wind presents minimal risk to the aquatic ecosystem. Icebreaker Windpower has taken significant steps to select a site that ODNR has identified as being favorable to OSW development and chosen best available technologies to install the turbines and cables in a manner that minimized impact on the aquatic ecosystem. An MOU between Icebreaker Windpower and ODNR and USFWS will detail the specific monitoring actions that will be required through the construction and post construction phases of the project. This monitoring plan and agreement ensures assumptions made by ODNR and USFWS about the aquatic risk potential are continually evaluated as the project progresses.

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Appendix A –Maps

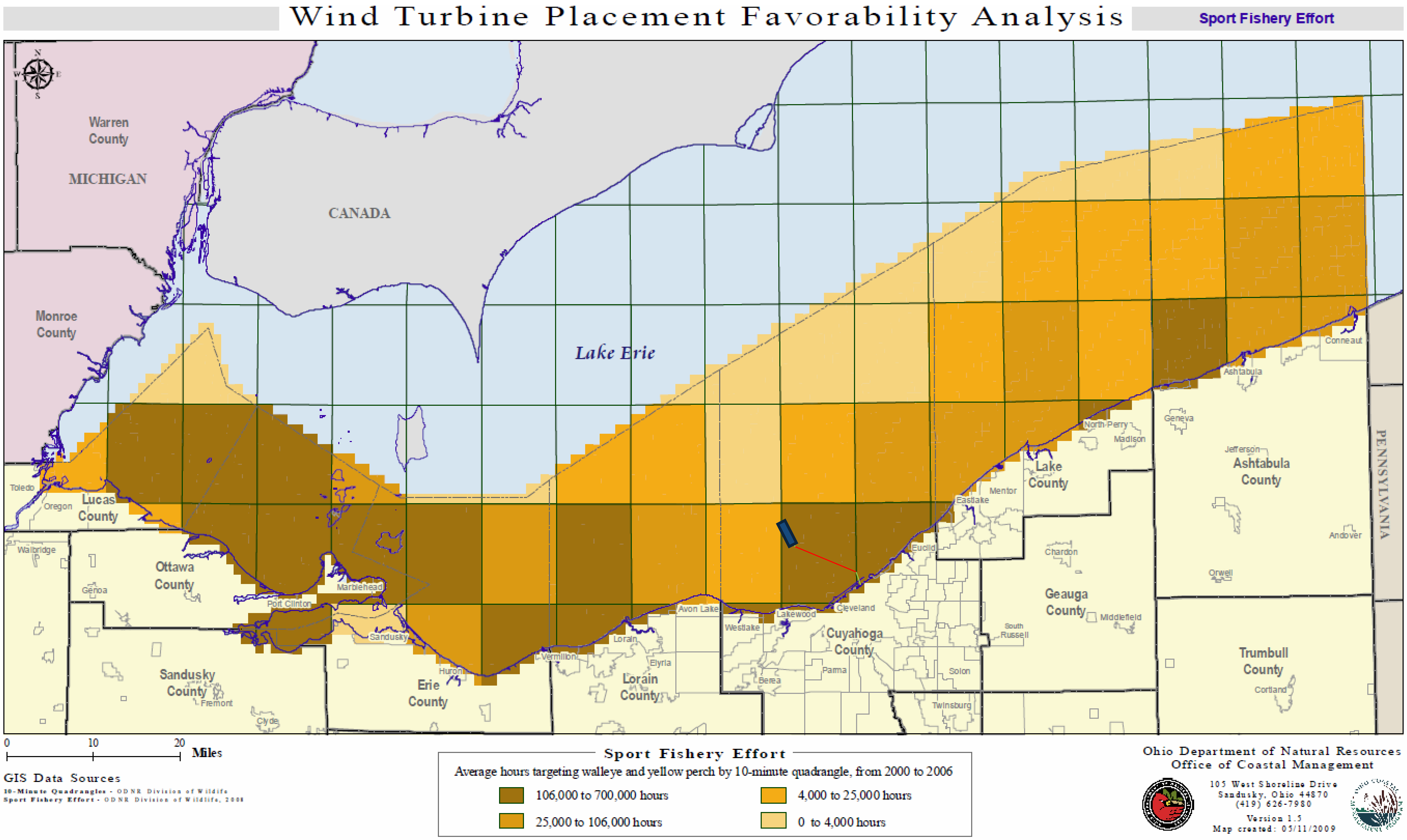

Figure 20. ODNR sport fishery effort map

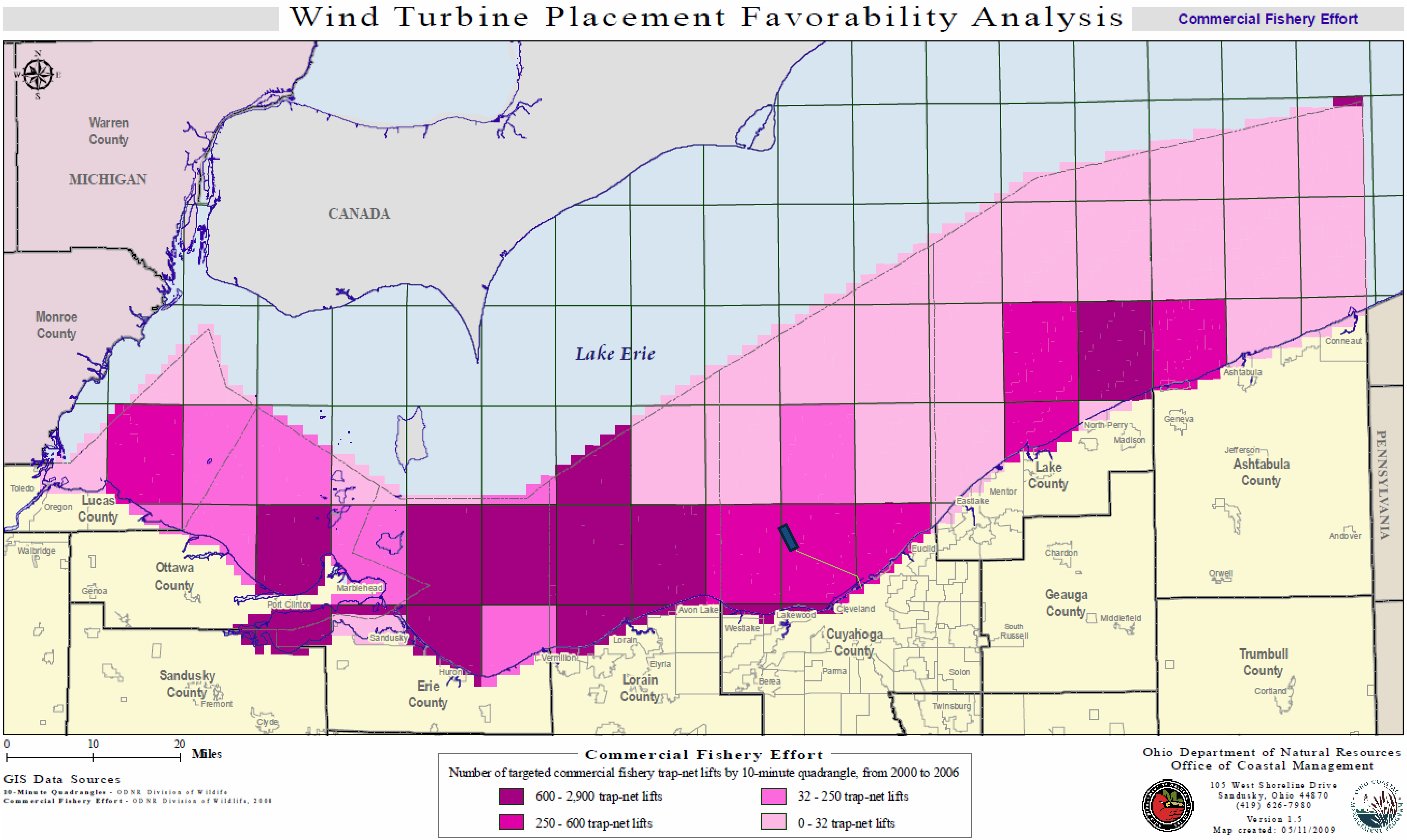

Figure 21. ODNR commercial fishery effort map

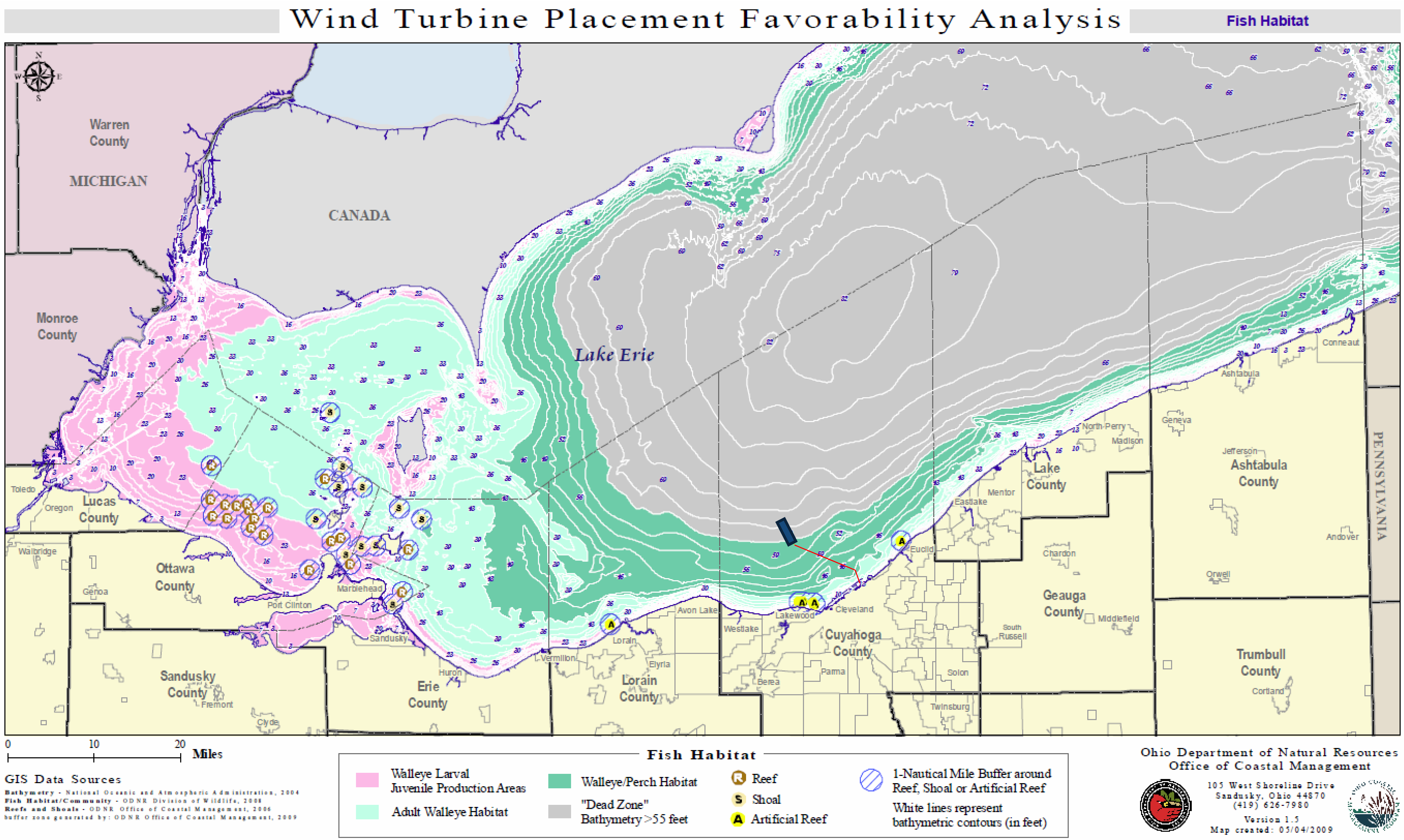

Figure 22. ODNR fish habitat map.

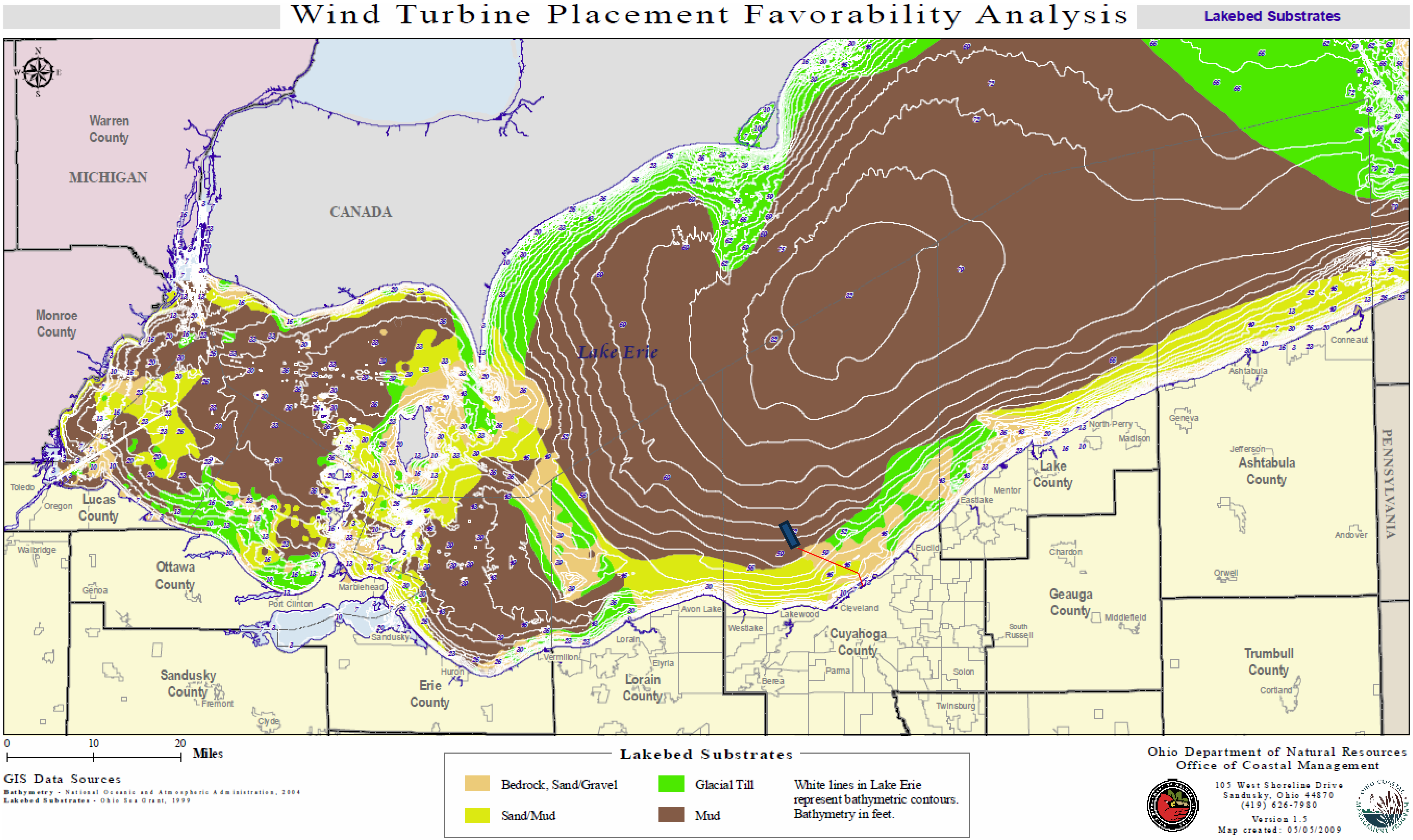

Figure 23. ODNR lakebed substrates map

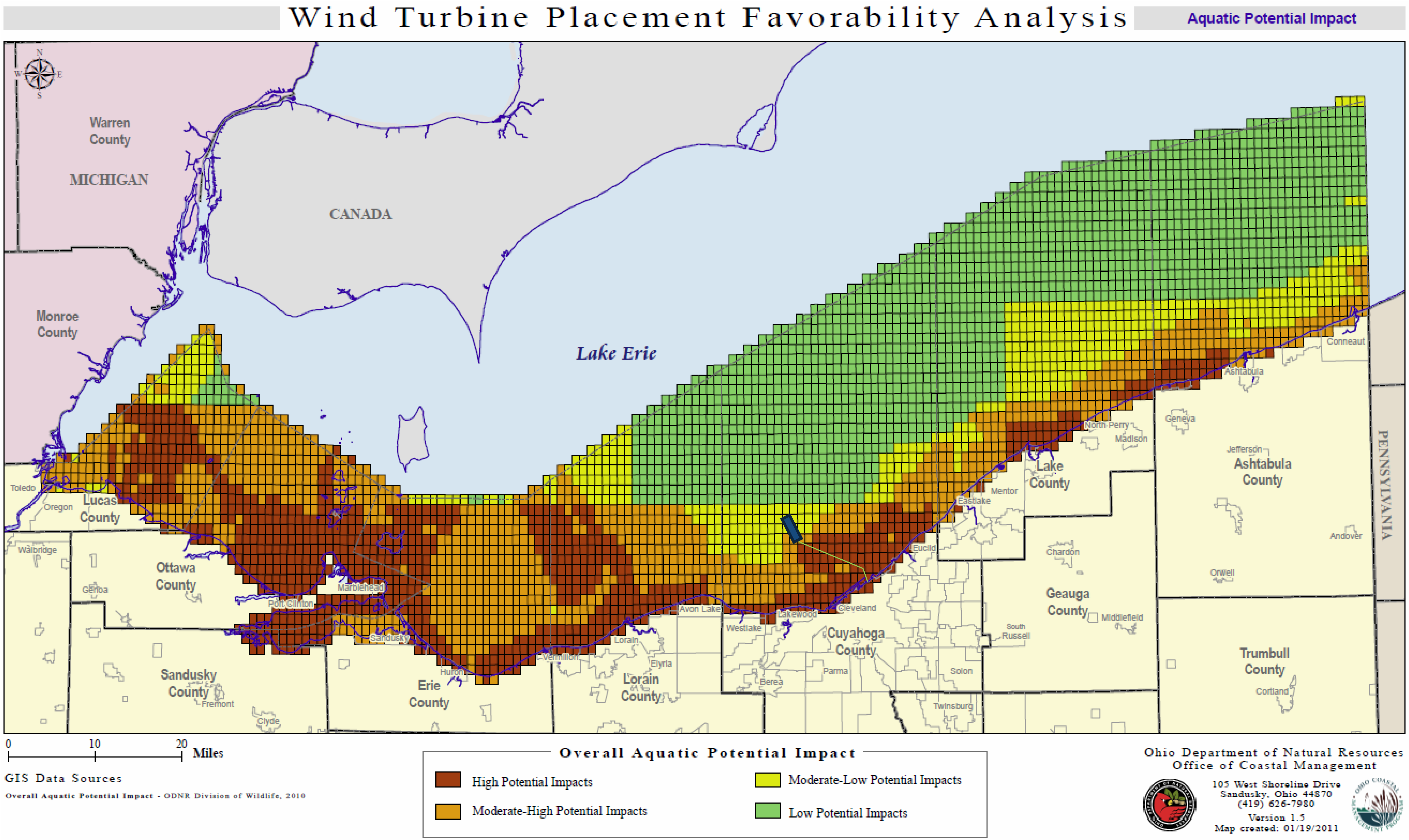

Figure 24. ODNR overall aquatic potential impact map.

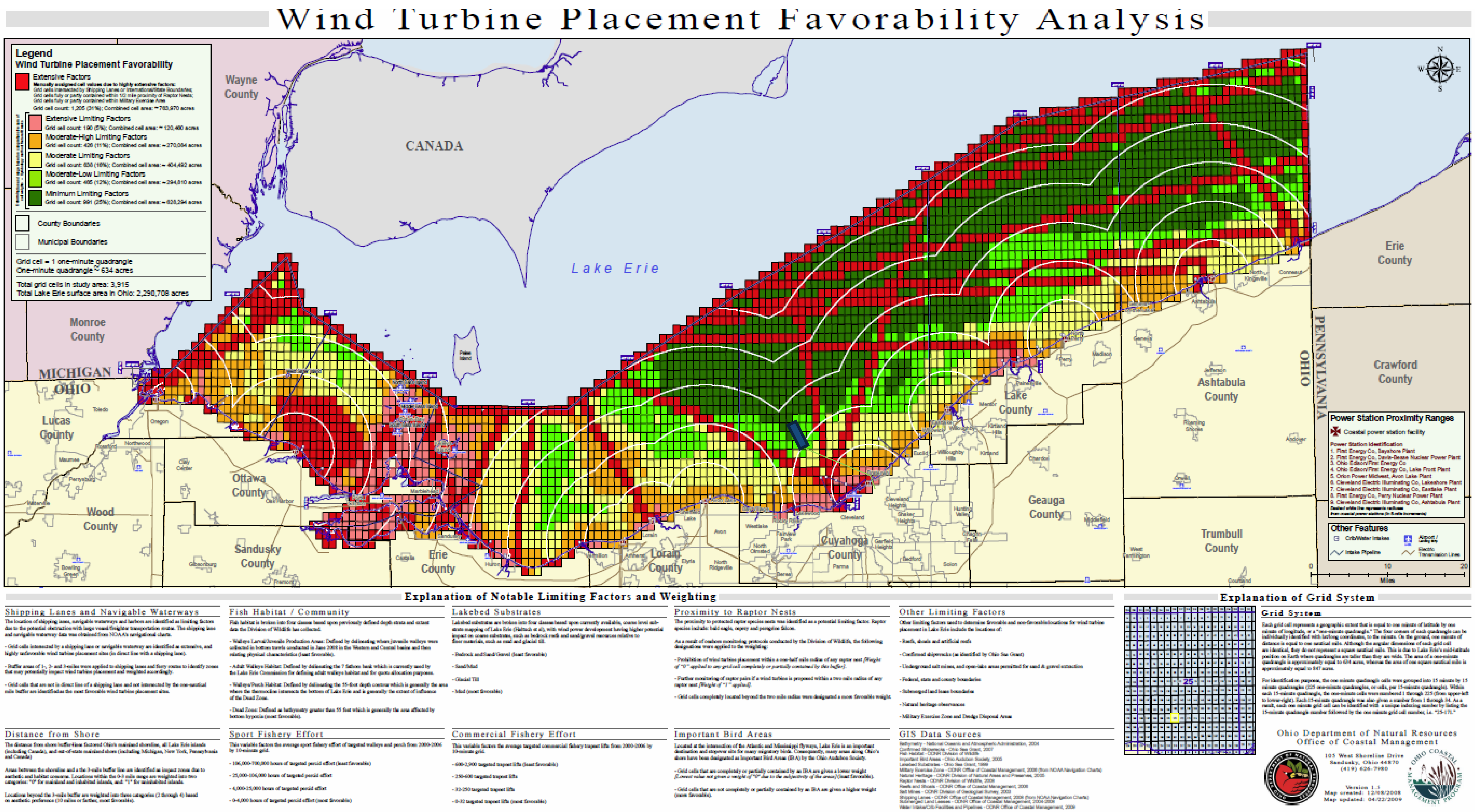

Figure 25. ODNR wind turbine placement favorability analysis.

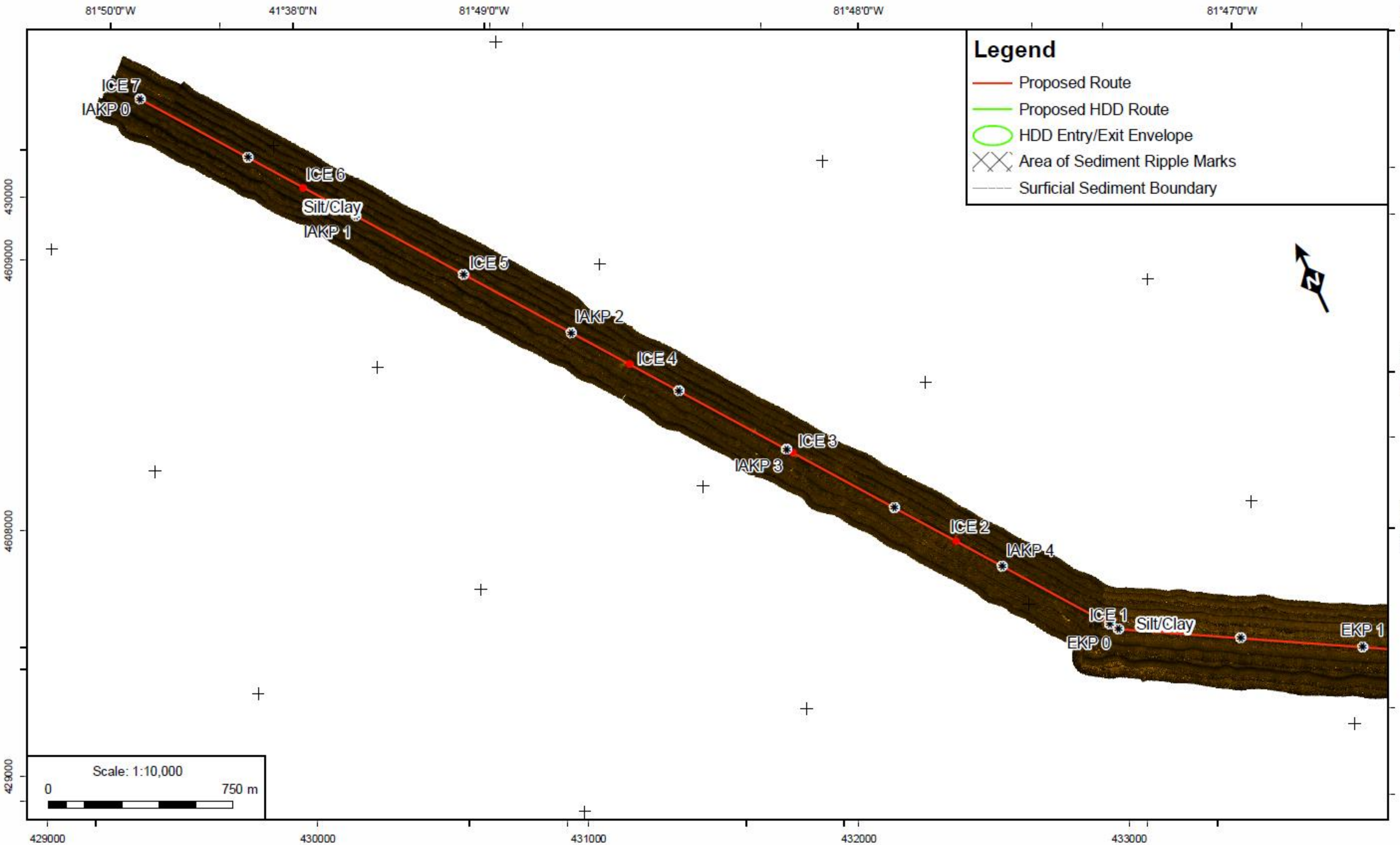

Figure 26. Sediment type at turbine locations.

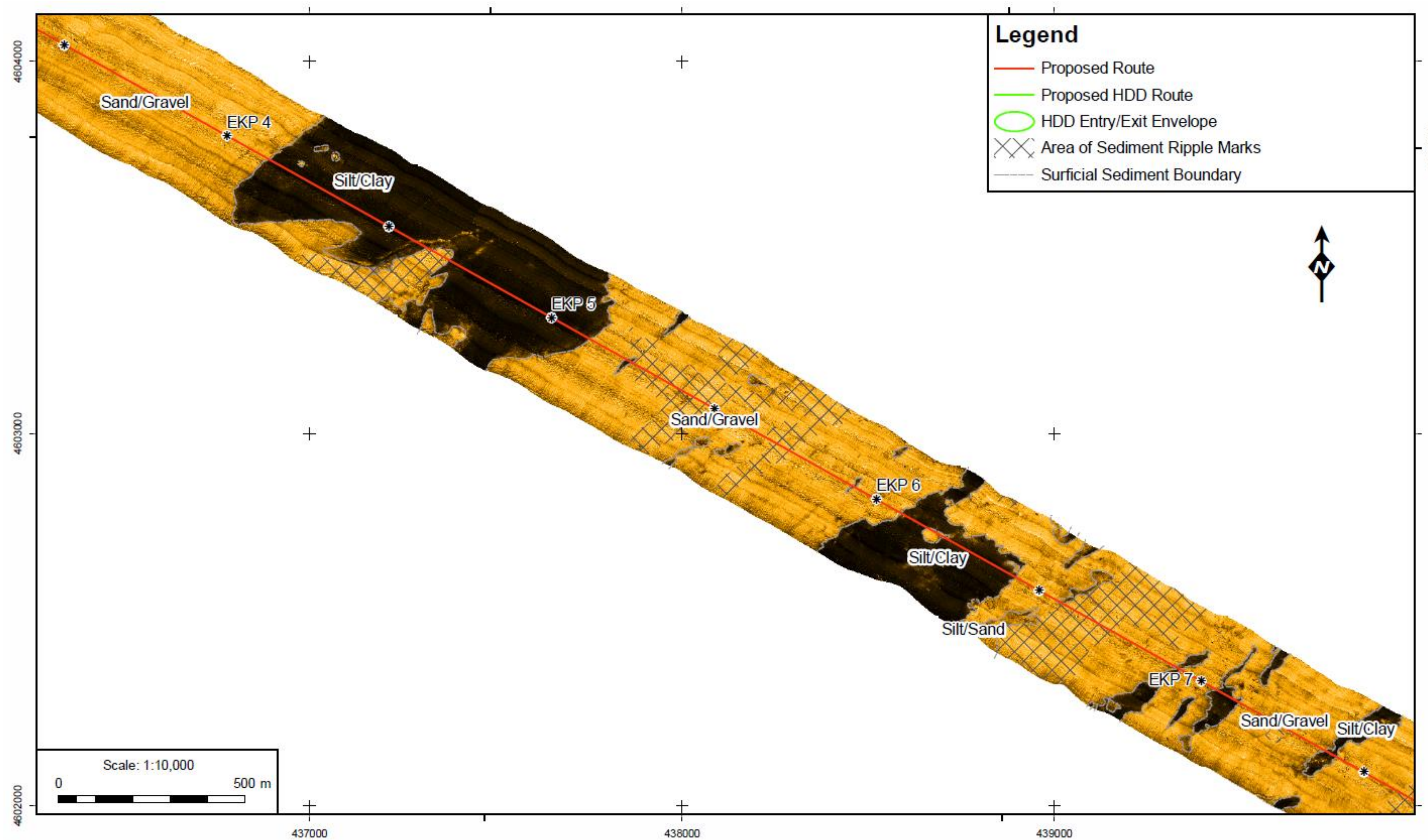

Figure 27. Surficial geology over the proposed export cable route.

Appendix B – EMF Memo to ODNR (6/29/16)

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Memorandum

From:	Ed Verhamme Jen Daley, PhD Greg Peterson	**Date:**	June 29, 2016
		Project:	LEEDCo
To:	Scudder Mackey, PhD, ODNR Jennifer Norris, ODNR Jeff Tyson, ODNR	**CC:**	Stuart Siegfried, OPSB Grant Zeto, OPSB

SUBJECT: Summary of Current Information Related to Electromagnetic Field Impacts on Fish and LEEDCo Proposed Transmission Cable.

Introduction

The Lake Erie Energy Development Corporation (LEEDCo) is proposing to develop the first offshore freshwater wind project in the Great Lakes – planned to be located in Lake Erie offshore of Cleveland. As part of the project, an eight mile long, three-phase, 34.5kV, AC transmission cable will be buried below the sediment surface along the bottom of Lake Erie to transmit electricity from the turbines to the mainland transformer station. During recent discussions regarding the LEEDCo project, the Ohio Department of Natural Resources (ODNR) expressed an interest in the potential impacts of the electric transmission cable on fish in the project area; particularly with respect to electromagnetic field (EMF) impacts. In addition, the ODNR Aquatic Sampling Protocol for Offshore Wind Development requires acoustic telemetry studies to monitor fish behavior and the ODNR has suggested that LEEDCo's study should also include monitoring near the transmission line to evaluate its effects on fish behavior. This memorandum is intended to summarize current research and information regarding the impact of EMFs on fish and provide our assessment of the likely impact to fish in the vicinity of the proposed transmission line. Based on the current research and existing EMF fish impact studies that have been done in the Great Lakes the expected EMF to be generated by the LEEDCO electric transmission line will not have an adverse impact on fish behavior and habitat.

Background

When considering the impact of submarine cables on aquatic environments there are two major concerns –the electric field and the magnetic field. The electric field is produced by stationary charges, and the magnetic field is produced by moving charges (currents). Both of these issues are described in more detail below.

Electric Field

Electric fields are caused by electric charges and are associated with the positive and negative electrons in the cable conductors. The electric field impacts are not a concern for the LEEDCo project because the cable conductors are shielded and jacketed with an insulator, which is designed to virtually eliminate any electric field losses outside the cable, thus maximizing the power delivered by the cable to its final destination on shore (Hampton et al., 2007). In addition, the electric field effects of electric transmission cables should not be confused with electric barrier/deterrent system designs. For example, large fish deterrents/barriers, such as those used at the Chicago Ship Canal, are electrical systems designed to transfer as much energy into the water as possible, using exposed bare electrodes in the water to be effective as a fish deterrent. The impact on fish habitat and behavior from electric transmission lines is not comparable to the impact from electric deterrent systems; one system is designed to transfer as much energy as possible into the water, while the other, as is the case for the LEEDCo project, is designed to prevent as much of this energy loss as possible. More information on the Chicago Ship Canal electric barrier can be found at
http://www.lrc.usace.army.mil/Missions/CivilWorksProjects/ANSPortal/Barrier.aspx.

Magnetic Field Levels near Submarine Transmission Cables

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. As summarized in Figure 1, Cada et al. (2011, 2012) found that even at 1 meters from the cable, the EMF levels were near background levels (50 micro tesla units (µT)). In a personal communication with Verdant Power Inc., the researchers found that three additional Verdant alternative energy projects had underwater transmission cables that were estimated to generate magnetic fields ranging from 20-100 micro tesla units (µT), one meter away from the surface of the cables. For context, the naturally occurring earth magnetic field is approximately 50 µT in the United States (Bochert and Zettler 2004, Normandeau et al., 2011). Normandeau et al. (2011) evaluated ten AC projects with standard cable specifications in marine environments. Of the ten projects 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 naturally occurring earth magnetic field. For comparison purposes and as discussed below, the estimated magnetic field from the proposed LEEDCo transmission cable, at 1 meter from the cable, is approximately 2 µT (See Figure 1). Therefore, the estimated magnetic field from the LEEDCo transmission line is much less than background levels and the average magnetic fields measured for other underwater transmission line projects.

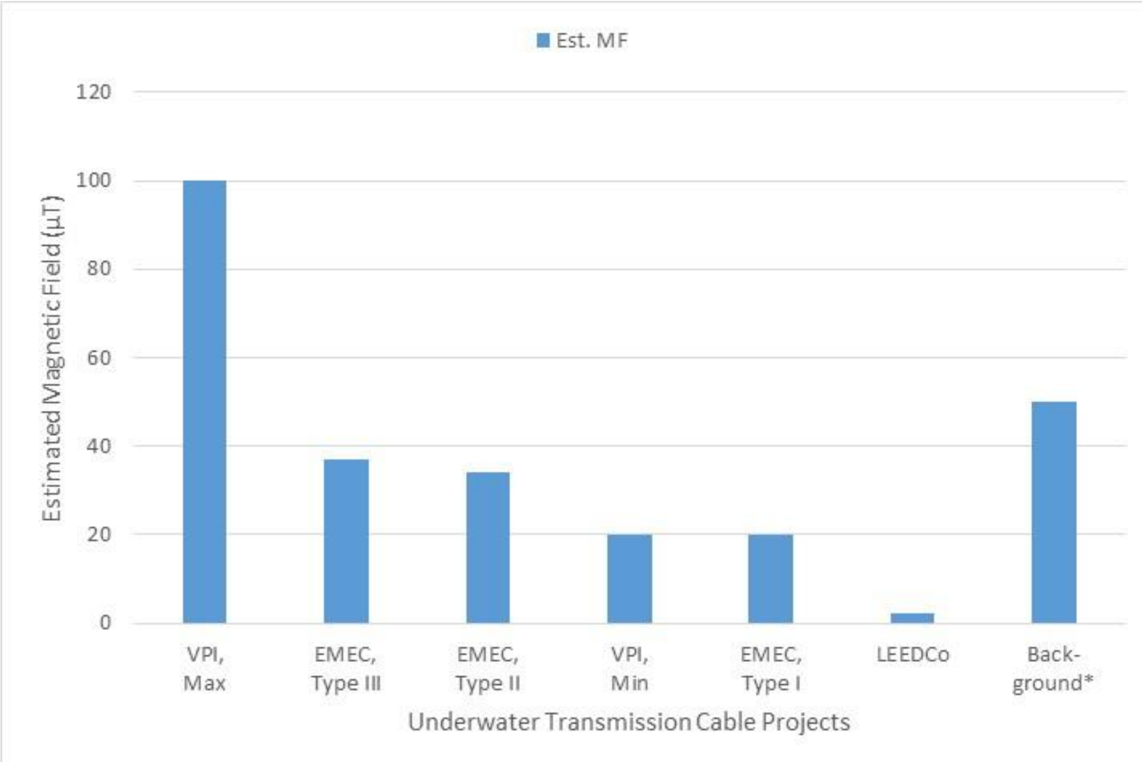

Figure 1. EMF levels for various underwater transmission cable projects (VPI and EMEC) are summarized in Cada et al. (2012). Note for comparison purposes, the insertion of the estimated LEEDCo transmission line EMF at 1m above the buried cable (JDR, 2013) and the inclusion of the naturally occurring earth magnetic field (*) as background.

In addition to demonstrating that the magnetic fields generated by transmission lines are small relative to background, research has also shown that the strength of magnetic field decreased exponentially with distance from the cable center and that burying the cables further diminishes the impacts of magnetic fields (Bevelhimer et al. 2013). For example, a study by Cada et al. (2011, 2012) at the Oak Ridge National Laboratory, found that the strength of the magnetic field decreased as a function of the distance from the source. Based on their calculations, the researchers also found that the strength of the magnetic field decreased exponentially as the distance from the electric transmission cable increased. Using a similar method, Cada et al. (2011) estimated expected magnetic fields based on electric transmission cable characteristics. As part of their experiment, Cada et al. measured the magnetic field at the source of the magnetic field and at several locations away from the source. Even when operating the electromagnet at maximum strength (165,780 µT), they found that the strength of the magnetic field returned to background levels (~100-200 µT) eleven inches away from the source of the field. Preliminary results from ongoing research on in situ cables have corroborated the conclusion that transmission line generated, magnetic fields diminish significantly with distance to near background levels (Bull, 2015; Thomsen, 2015).

LEEDCo Transmission Cable

The electric transmission cable specifications chosen by LEEDCo operates at a voltage of 34.5kV, alternating current (AC), and is made with crosslinked polyethelene (XLPE) insulation. The cable has three inner conductors, and an outer armored steel jacket (Figure 2). For the LEEDCo pilot project the cable will carry a maximum load of 20.7MW (3.45 MW per turbine). This translates to a current of 345 amps. The cable has an approximate total diameter of 100 mm (~4”). The cable will be buried below the surface using a cut and fill approach. Crosslinked polyethylene (XLPE) has become the globally preferred insulation for power cables, both for distribution and transmission system applications. Semiconducting screens are extruded over the three individual conductors and the insulation outer surface to maintain a uniform electric field, and to contain the electric field entirely within the cable jacket (Hampton et al., 2007). The construction of the electric transmission cable for the LEEDCo project is intended to reduce or eliminate any electric field losses outside the jacket of the cable. Any electric fields that escape the jacket decrease the efficiency of the cable and therefore, decrease the amount of power delivered by the cable to its final destination onshore. The proposed LEEDCo cable was specifically chosen to reduce or eliminate electric field losses, and thus reduce or eliminate effects of the electric field to surrounding biota or habitats.

Although a manufacturer has not been chosen, the magnetic field generated by the line is governed by the voltage and current of the transmission cable and not the cable design. Calculation of the estimated magnetic field from the LEEDCo cable was done by one of the transmission cable contractors, JDR Cable Systems in 2013 (JDR, 2013). A maximum magnetic field density of 2 µT was calculated for a load of 379 amps at a distance of 1 meter from the cable center. Note that this calculation was carried out at a slightly higher amperage than the LEEDCo proposed 345 amps. Even at 0.5m above the cable the magnetic field strength is only 8.5 µT, which is considerably less than the earth’s magnetic field strength (~50 µT). An estimate of the magnetic field strength at various distances from the cable center is shown below is Figure 3.

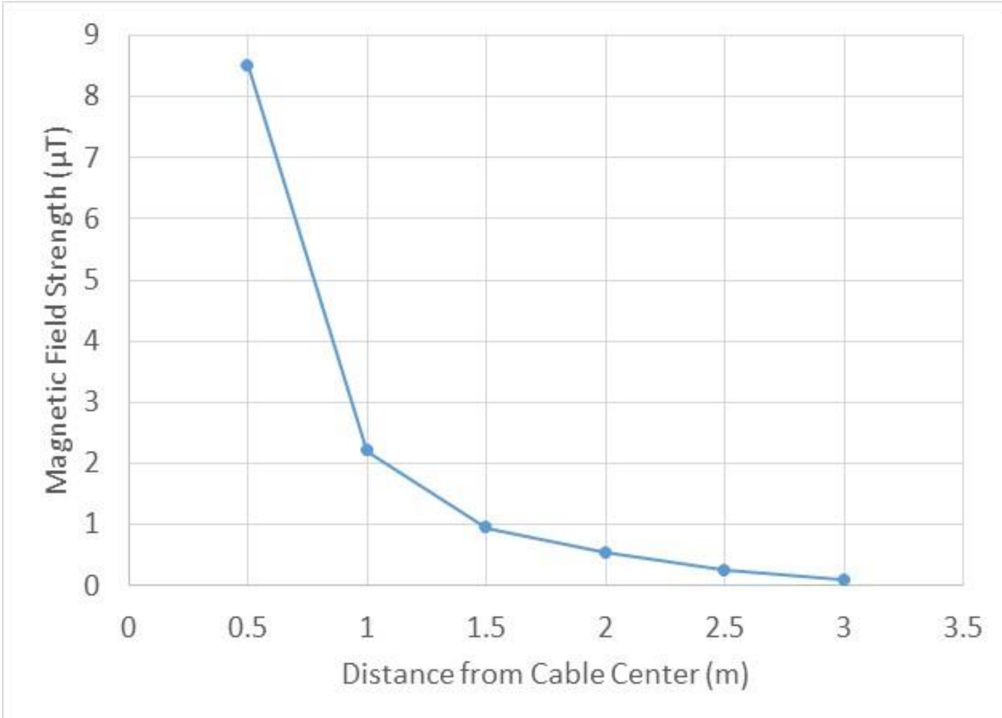

Figure 3. Magnetic field strength at various distances (estimated from JDR, 2013)

Current Research and Information: Electromagnetic Fields and Fish

It is important to understand the spatial scale when assessing the impacts of magnetic and induced electric fields on fish. Although behavioral and physiological effects on fish from electromagnetic fields have been documented in small scale laboratory experiments with embryos, larger scale experiments on juvenile and adult fish, both show little to no impact.

Fish, other aquatic organisms, and even currents can induce electric fields when passing through magnetic fields. The strength of an induced electric field varies depending on the speed and orientation of the object passing through the field. For example, perpendicular movement through a magnetic field will induce an electric field of maximum strength while parallel movement through the same field will not induce an electric field. So induced electric field strength depends on the distance from the field as well as on the speed of the organism (or current) and the orientation of the organism relative to the field. (Gill, 2005; OSPAR, 2009; Normandeau et al., 2011; Bergstrom, 2014; Thomsen et al., 2015; Copping, 2016).

Negative effects related to EMFs have mostly been observed in laboratory settings involving fish embryos exposed directly to EMFs. Increases in mortality due to EMF exposure does not appear to be a major concern (Shultz et al., 2012), but some studies have demonstrated sub-lethal effects. In a recent literature review of EMF experiments on fish embryos, delays in hatching were observed in magnetic fields stronger than 1,000 µT for several species (Krylov et al., 2014). Exposure to even stronger fields (2,000 µT) has been reported to increase the exchange rate between the embryo and the surrounding water (Krylov et al., 2014). However these effects are not well understood (Thomsen et al., 2015). For example, when zebrafish embryos were exposed to 1,000 µT two hours after fertilization no significant developmental delay was observed, but when similar embryos received the same exposure 48 hours after fertilization a delay was detected (Skauli et al., 2000). Additionally, results from other sets of experiments on freshwater fish suggest that many of the observed effects in seen in EMF-exposed embryos were not statistically different from the control groups, even at higher exposure levels (up to 3,000 µT) (Schultz et al., 2012). Although sub-lethal effects were observed in these studies, the levels of magnetic fields were significantly higher than the levels that are estimated to result from the electric transmission cable for the LEEDCo project. Therefore, it is not anticipated that the LEEDCo electric transmission cable will have any adverse impact on fish embryos in Lake Erie.

One study, which saw effects at lower magnetic field strengths was conducted using Japenese rice fish. When exposing Japanese rice fish embryos to magnetic fields ranging between 15-60 µT, Lee et al. (2014) found that embryos exposed to 60 µT had higher levels of anxiety-like behavior and exhibited changes in morphology. The EMF-exposed embryos also developed faster than the control. Another experiment on roach embryos observed faster development in embryos, and a decrease in yearling size and weight (Chebotareva et al., 2009). Notably, the above studies were all completed with direct exposures of EMF on embryos, which tend to be the most sensitive life stage of a fish.

Cada et al. (2012) performed an experiment to evaluate the impact of magnetic fields generated by an instantaneous AC power source on juvenile freshwater fish. Juvenile paddlefish and juvenile lake sturgeon were placed in a circular tank, and an electromagnet was activated when the fish approached. The experiment was repeated at a variety of electromagnet strengths. The magnetic fields created by the AC electromagnet used in the experiment produced a field at full power of approximately 165,780 µT, whereas the control (background) level was 100-200µT. Even at 1% of the field strength of the maximum value the field was as high as 3,510 µT, which is several fold higher than typical transmission lines (Figure 1). The paddlefish experienced no statistically significant changes in behavior when exposed to the instantaneous magnetic fields. In contrast, lake sturgeon reacted to the magnetic fields at all strengths. Control groups of lake sturgeon also exhibited some altered behavior patterns, but the fish exposed to the magnetic fields displayed longer reaction times. Overall, no long-term changes in sturgeon behavior were observed. A follow up study by Bevelhimer et al. (2013) found that the EMF strength threshold for no behavioral response in lake sturgeon was approximately 1,000-2,000 µT, located about 4 to 8 inches away from the full strength electromagnet producing the EMF. Below this average threshold short-term responses disappeared. Based on the results of this work, researchers suggested burying the cables in order to take advantage of the rapid decay in magnetic field strength and to position cables in a way that would minimize crossings with migratory pathways (Bevelhimer et al. 2013).

An unpublished study by Westerberg and Lagenfelt found that 60 migrating silver eels had significantly slower swimming speeds when in the vicinity of a 130 kV AC transmission cable in the Baltic Sea (Ohman et al., 2007) which Ohman et al. (2007) suggested was a relatively minor impact. Some fish (like eels) are known to be sensitive to EMFs, but this does not necessarily mean that transmission cables will have a significant impact on movement and behavior (Ohman et al., 2007; Bull, 2015; Dunlop et al., 2016). Additionally, as documented earlier, recent lab experiments support the importance of spatial scale in mitigating the ecological impact of electromagnetic fields.

To assess whether EMFs from the LEEDCo transmission line could have an adverse impact on fish species of concern in the Great Lakes, we looked at a study involving Lake Sturgeon (*Acipenser fulvescens*). Lake Sturgeon have both shallow and deep water life-history requirements associated with the substrates, and are benthic feeding. Lake Sturgeon are also considered an electro-sensitive species, having developed complex electroreceptors for the purpose of feeding and migration (Map of Life, 2016). Bevelhimer et al. (2013), studied EMF effects on Lake Sturgeon and found that the EMF strength threshold for no behavioral response in Lake Sturgeon was 1,000-2,000 µT, when located about 4 to 8 inches away from the full strength EMF. Figure 4 below shows the threshold level versus estimated EMF levels from Figure 1 above. If Sturgeon are in the vicinity of the LEEDCo transmission line, this large species could be exposed to EMFs however, the LEEDCo transmission cable is planned to be buried below the substrate, at a great enough depth so that any EMF from the transmission line will be well below the strength threshold for no behavioral response in Lake Sturgeon. (See Figure 4). Therefore, EMFs from the LEEDCo transmission cable are not expected to adversely affect Lake Sturgeon.

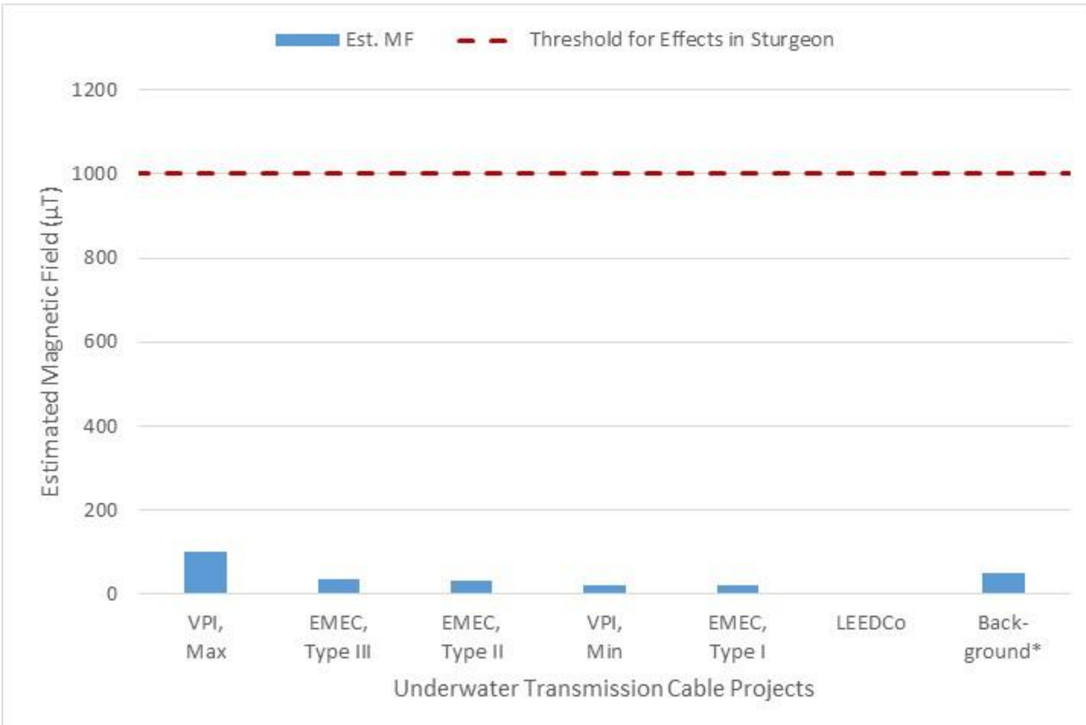

Figure 4. EMF levels (at 1m above buried cables) for various transmission lines (Cada et. al. 2012) and LEEDCo (JDR, 2013) estimate versus Sturgeon effects level.

Magnetic Field Studies

Electric transmission lines within Lake Erie, the Great Lakes or in coastal regions of the United States in general, are not unique and have been permitted and installed for many decades. Several large electric transmission lines are already in place not too far from the project site transiting from Port Clinton to Put-in-Bay, Catawba to South Bass Island, and over 25 miles of electric transmission cable from the Ontario mainland to Pelee Island. Other transmission cables are also in the proposal phase, such as a 73 mile Lake Erie cable, known as the ITC Lake Erie Connector, which will interconnect power grids in Pennsylvania and Ontario.

California Power Cable Observation Study

A study just 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 un energized 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 LEEDCo 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 LEEDCo 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 LEEDCo 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 1 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."

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 7.8km buried transmission line running from an island offshore to the mainland. The transmission line carries up to 200MW of power at a maximum of 170kV, which is much larger than the LEEDCo proposed transmission line voltage and power. The study involved nearshore electrofishing surveys and acoustic surveys paired with gill netting. Little difference between fish communities in transects near the cable and reference transects was detected. 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 1,000MW, 320kV, DC transmission cable to link the Ontario Independent Electric System Operator (IESO) with the Pennsylvania PJM Interconnetion (PJM). This cable would carry ten times the voltage and almost fifty times the power compared with the LEEDCo 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 permit 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.

Conclusion

Based on the expected low EMF levels to be generated by the LEEDCO project 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 transmission cable proposed by LEEDCo are not necessary and EMF generated by the LEEDCo electric transmission cable will not have an adverse impact on fish behavior and habitat. The ODNR required acoustic telemetry studies, as specified in the ODNR Aquatic Sampling Protocol for Offshore Wind Development, to monitor for transmission line effects on fish behavior would be of limited value given the evidence that no measureable EMF impacts are expected from the LEEDCo transmission line project and the abundant current research showing that EMFs from transmission cables similar to the one proposed by LEEDCo do not have a significant effect on fish behavior. Acoustic telemetry research has been widely used across the Great Lakes to understand general fish movement patterns and can be used to monitor local fish behavior within river mouths and channels, but it has limited value to monitor local fish behavior within the open waters of the Great Lakes and should not be a requirement of the pre-, during, and post-construction monitoring.

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