Consumers Energy
Count on Us

A CMS Energy Company

William A. Schoenlein
Manager,
Hydro and Renewable Generation

December 15, 2015

Kimberly D. Bose, Secretary
Nathaniel J. Davis, Sr., Deputy Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, D.C. 20426

FERC PROJECT NO. 2680-108
LUDINGTON PUMPED STORAGE PROJECT
RE: DECEMBER 8, 2015 INITIAL STUDY MEETING SUMMARY

Dear Ms. Bose:

This letter provides Consumers Energy Company and DTE Electric Company (collectively, "Licensees") Initial Study Report ("ISR") meeting summary for the Ludington Pumped Storage Project, FERC Project No. 2680 ("Project"). Pursuant to 18 CFR § 5.15(c)(2) a meeting to discuss the initial study results with Relicensing Participants was held on Tuesday, December 8, 2015, in Pentwater, Michigan.

2015 work activities associated with the six FERC approved study plans were presented. The meeting agenda is shown below:

Agenda

1:00 pm	Introductions
	Overview of where we are at in the Licensing Process
	List Six Approved Study Plans
	Each study update will include an opportunity for questions and comments
1:15	Wildlife and Botanical Resources
2:00	Historical and Archaeological Resources
2:45	Recreation Resources
3:30	Fish and Aquatic Resources
4:30	Determine next steps
5:00	End meeting

Based on the sign-in sheets, the meeting was attended by representatives from the Michigan Department of Natural Resources, the Michigan Department of Environmental Quality, Pere Marquette Township, Mason County, The Little River Band of Ottawa Indians, FERC and the Licensees.

Attached are the PowerPoint slides presented for each study plan during the meeting. (Note: there were several slides removed from the Archaeological Study presentation that contained sensitive cultural resource site location information not intended for public disclosure.) At this time, based on the information provided in the December 2, 2015 Initial Year Study Report and the information presented in the meeting, there were no additional studies proposed or changes proposed to the approved study plans. In addition, no stakeholders at the meeting suggested to Licensees that any additional studies or changes to approved study plans should be considered. After the presentations by the Licensee, FERC's project manager, Shana Murray clearly identified all next steps including the schedule for comments by the interested parties. She discussed the comment and participation process through the finalization of the studies. Please contact David McIntosh of my staff at (231) 779-5506 if you have any questions.

Respectfully,

/s/ William A Schoenlein
William A Schoenlein

Copy to: Mailing List (attached)

ATTACHMENT 1

First Year Study Summary Presentation

Consumers Energy
Count on Us

DTE Energy

Ludington Pumped Storage (LPS)
First Year Study Report Meeting

December 8, 2015
Days Inn Pentwater

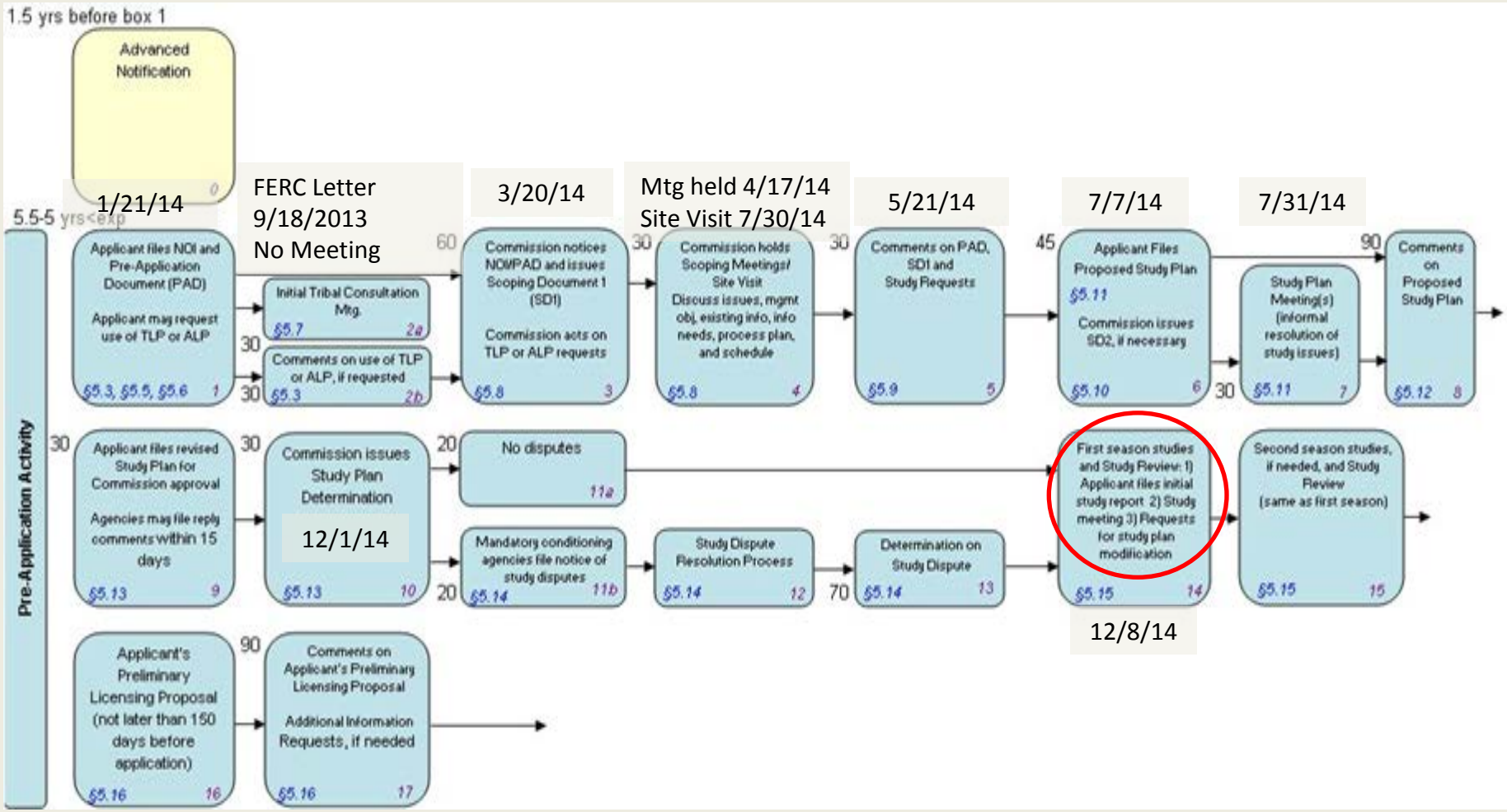
Agenda

1:00 pm	Introductions
	Overview of where we are at in the Licensing Process
	List Six Approved Study Plans
	Each study update will include an opportunity for questions and comments
1:15	Wildlife and Botanical Resources
2:00	Historical and Archaeological Resources
2:45	Recreation Resources
3:30	Fish and Aquatic Resources
4:30	Determine next steps
5:00	End meeting

Housekeeping Items

- Please Sign In
- Meeting Scheduled to end by 5:00 PM
- Speakers
  - Please state name and affiliation
  - Please speak clearly and one at a time

ILP Pre-filing Milestones



Six FERC Approved Study Plans

- Fish and Aquatic Resources
- Wildlife Resources
- Botanical Resources
- Recreation Resources
- Historical Resources Survey
- Archeological Resources Survey

Purpose of the First Year Study Plan Meeting

18 CFR 5.15 Conduct of Studies

- Within 15 days following the filing of the of the initial study report, the potential applicant shall hold a meeting with the participants and Commission staff to discuss the study results and the potential applicant's and or other participants proposals, if any, to modify the study plan in light of the progress of the study plan and data collected.

- First Year Study Plan Summary Filed on December 2, 2015

Next Steps:

- File Presentation notes with FERC
- Agency Review of Wildlife and Botanical Study Results
- SHPO /Tribe Review of Historical and Archaeological Report
- Complete the Fisheries Resource Study
- Complete the Recreation Resources Study

ATTACHMENT 2

Wildlife Resources Study Presentation

Wildlife Resources

John Vigna
King & MacGregor Environmental, Inc.
2520 Woodmeadow Drive SE
Grand Rapids, MI 49546

Wildlife Resources

Study Purpose

Scope of Work

Findings

Wildlife Resources

Cover Types/Land Use

- Beach/Low Dunes
- Bluff Slopes
- Forests
- Old Field/Shrub Thickets
- Reservoir Slope
- Maintained Recreational Areas

Wildlife Resources


HULL FIELD
HOME OF TWISTED STICKS R/C CLUB
SPECTATORS WELCOME · A.M.A. LICENSE REQUIRED TO FLY
ESTABLISHED THROUGH THE COOPERATION OF
PUMPED STORAGE • DETROIT EDISON • MASON CTY. PARKS
and CONSUMERS ENERGY

Wildlife Resources

Rare, Threatened, and Endangered Wildlife Species that Occur in the Project Vicinity

COMMON NAME	SCIENTIFIC NAME	STATUS[a]	COUNTY
Birds			
Bald eagle	*Haliaeetus leucocephalus*	SC	Mason
Marsh wren	*Cistothorus palustris*	SC	Mason
Piping plover	*Charadrius melodus*	FE	Mason
Rufa red knot	*Calidris canutus rufa*	FT	Mason, Ottawa
Fish			
Bigmouth shiner	*Notropis dorsalis*	SC	Ottawa
Cisco (lake herring)	*Coregonus artedi*	T	Ottawa
River redhorse	*Moxostoma carinatum*	T	Ottawa
Insects			
Karner blue butterfly	*Lycaeides melissa samuelis*	FE	Mason
Mammals			
Indiana bat	*Myotis sodalis*	FE	Mason, Ottawa
Northern long-eared bat	*Myotis septentrionalis*	FT	Mason, Ottawa
Reptiles and Amphibians			
Eastern box turtle	*Terrapene carolina carolina*	SC	Mason
Eastern massasauga	*Sistrurus catenatus*	PFT	Mason
Blanchard's cricket frog	*Acris crepitans blanchardi*	T	Ottawa

Wildlife Resources

Wildlife Species Encountered During Survey – Ludington Site

COMMON NAME	SCIENTIFIC NAME
Mammals	
Eastern chipmunk	*Tamias striatus*
Eastern coyote	*Canis Latrans*
Gray squirrel	*Sciurus carolinensis*
Striped skunk	*Mephitis mephitis*
White-tailed deer	*Odocoileus virginianus*
Birds	
American crow	*Corvus brachyrhynchos*
American goldfinch	*Carduelis tristis*
American tree sparrow	*Spizella arborea*
Bald eagle	*Haliaeetus leucocephalus*
Caspian tern	*Hydroprogne caspia*
Common raven	*Corvus corax*
Common tern	*Sterna hirundo*
Double-crested cormorant	*Phalacrocorax auritus*
Eastern bluebird	*Sialia sialis*
Herring gull	*Larus argentatus*
House wren	*Troglodytes aedon*
Northern cardinal	*Cardinalis cardinalis*
Pileated woodpecker	*Dryocopus pileatus*
Purple martin	*Progne subis*
Red-shouldered hawk	*Buteo lineatus*
Red-wing blackbird	*Agelaius phoeniceus*
Ring-billed gull	*Larus delawarensis*
Rock pigeon	*Columba livia*
Ruffed grouse	*Bonasa umbellus*
Tree swallow	*Tachycineta bicolor*
Turkey vulture	*Cathartes aura*
Wild turkey	*Meleagris gallopavo*
Reptiles	
Eastern garter snake	*Thamnophis sirtalis*
Insects	
Monarch	*Danaus plexippus*
Cabbage white	*Pieris rapae*

Wildlife Resources


NOTICE
Pigeon Lake
Entry permitted only
any other use is
fail to comply with
Alcoholic beverages prohibited
Users must remain on Boardwalk-Pathway and Pier
No bicycles, skateboards, scooters or skates permitted
No glass containers permitted
No motorized vehicles
All animals prohibited
No littering, destruction or defacing of facilities
No fires allowed

Wildlife Resources

Wildlife Species Encountered During Survey – Port Sheldon Site

COMMON NAME	SCIENTIFIC NAME
Mammals	
Meadow vole	*Microtus pennsylvanicus*
Birds	
American goldfinch	*Carduelis tristis*
Double-crested cormorant	*Phalacrocorax auritus*
Mallard	*Anas platyrhynchos*
Tree swallow	*Tachycineta bicolor*

Wildlife Resources

End

ATTACHMENT 3

Botanical Resources Study Presentation

Botanical Resources

John Vigna
King & MacGregor Environmental, Inc.
2520 Woodmeadow Drive SE
Grand Rapids, MI 49546

Botanical Resources

Study Purpose

Scope of Work

Findings

Botanical Resources

Invasive Plants Identified

Common Name	Scientific Name	Ludington Site	Port Sheldon Site
Invasive Plants			
Autumn olive	*Elaeagnus umbellate*	X	
Black locust	*Robinia pseudoacacia*	X	X
Bull Thistle	*Cirsium vulgare*	X	X
Common St. John's-wort	*Hypericum perforatum*	X	
Crown-Vetch	*Coronilla varia (Securigera v.)*	X	X
Garlic mustard	*Alliaria petiolata*		X
Glossy buckthorn	*Frangula alnus*	X	
Great mullein	*Verbascum thapsus*	X	X
Hedge-Parsley	*Torilis japonica*	X	
Japanese barberry	*Berberis thunbergii*	X	
Japanese hedge-parsley	*Torilis japonica*	X	
Japanese knotweed	*Fallopia japonica*	X	
Morrow's honeysuckle	*Lonicera morrowii*	X	X
Multiflora rose	*Rosa multiflora*	X	
Purple loosestrife	*Lythrum salicaria*		X
Reed canary grass	*Phalaris arundinacea*	X	X
Russian olive	*Elaeagnus angustifolia*	X	
Scotch pine	*Pinus sylvestris*	X	
Spotted knapweed	*Centaurea maculosa*	X	X
Wallflower Cabbage	*Coincya monensis*		X
Yellow-Rocket	*Barbarea vulgaris*	X	

Botanical Resources

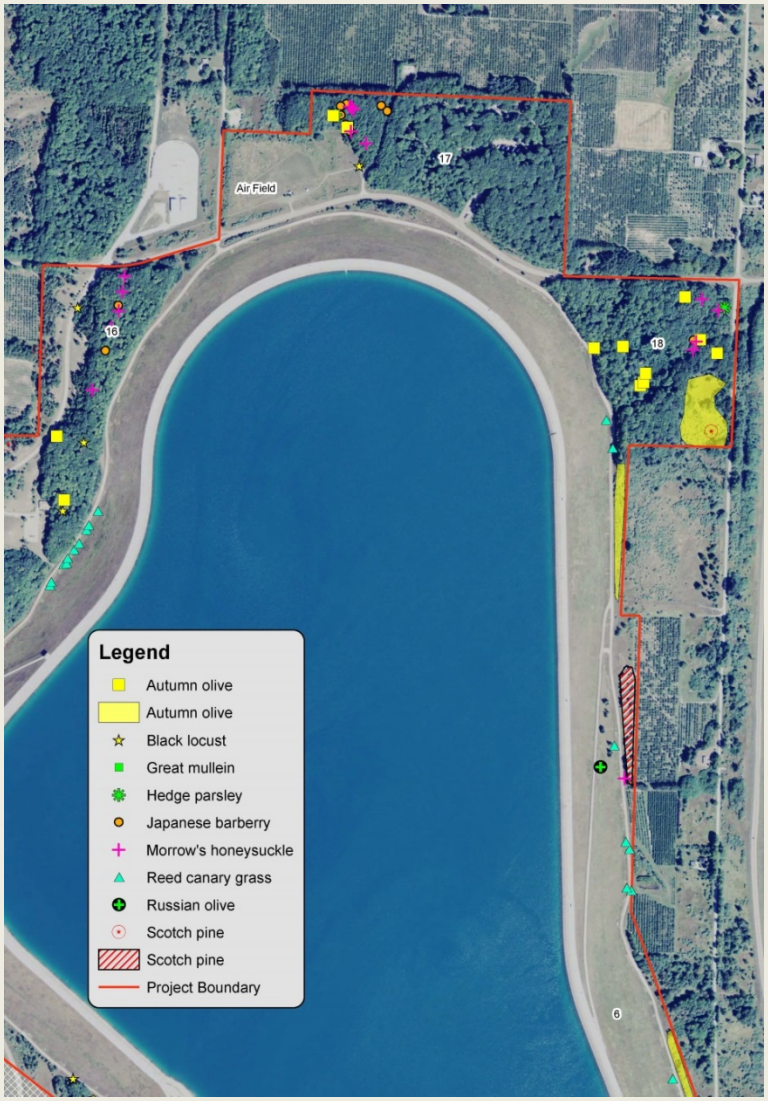
Rare, Threatened, and Endangered Plant Species that Occur in the Project Vicinity

Common Name	Scientific Name	Status	County
Ginseng	*Panax quinquefolius*	T	Mason
Pitcher's Thistle	*Cirsium pitcheri*	T, FT	Mason, Ottawa

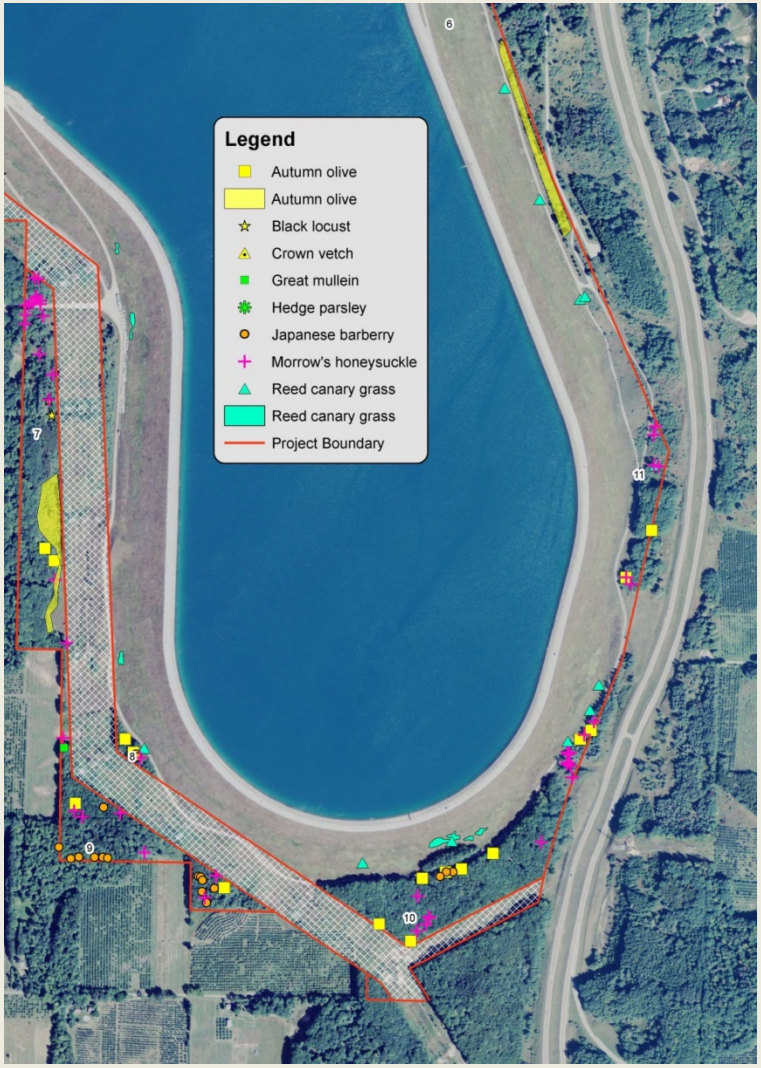
Botanical Resources

Botanical Resources

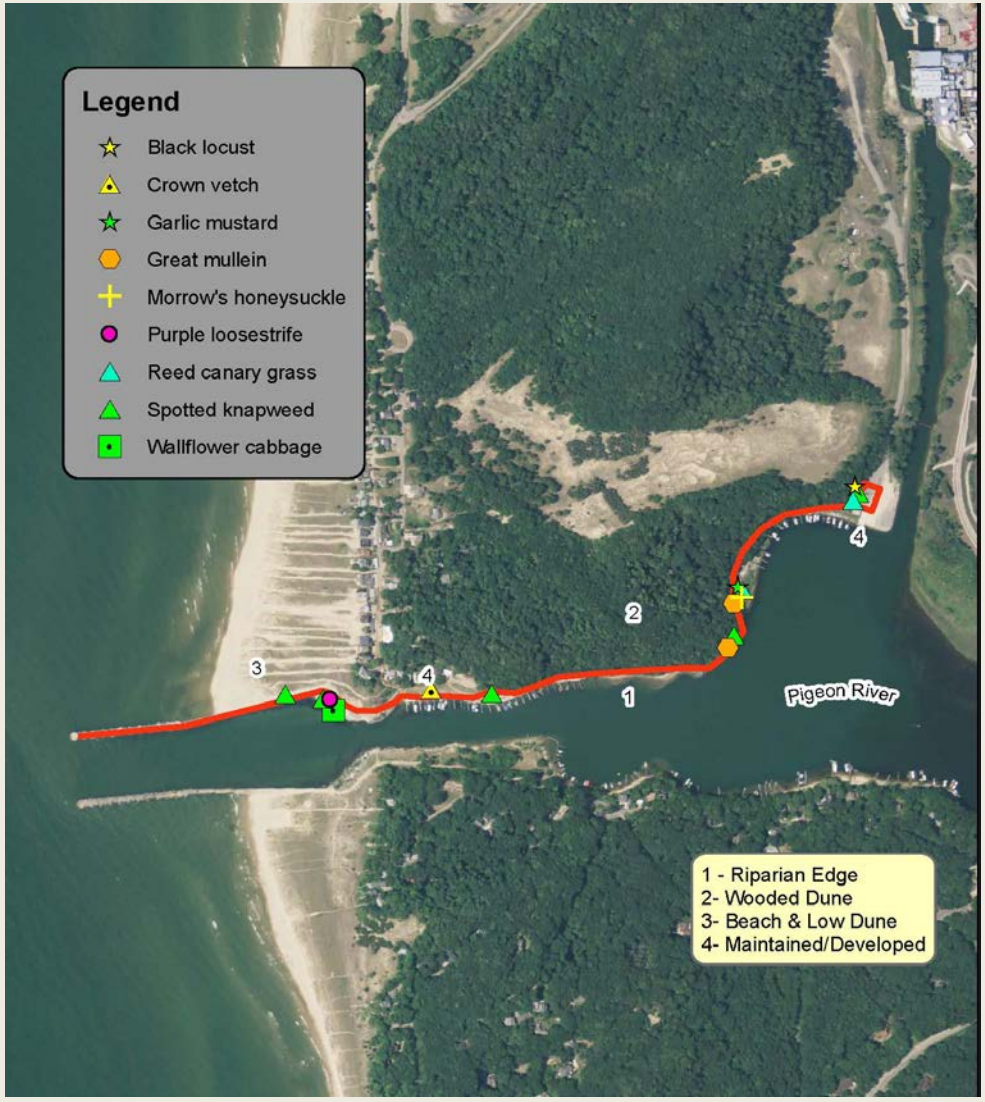
Botanical Resources



Botanical Resources



Botanical Resources



Botanical Resources

End

ATTACHMENT 4

Historical Resources Study Presentation

Historical Resources Study

Section 106 Compliance

Dr. Robert Chidester, RPA
Archaeology Team Leader
The Mannik & Smith Group, Inc.

Historical Resources Study

History/Architecture Study Plan

36 CFR PART 800 – Section 106 Process

Will historic resources be adversely affected by the license renewal (Project)?

- Determine the Area of Potential Effects (APE).
- Identify historic properties within the APE.
- Assess the impact of the Project on historic properties, if present.
- Owner will consult with SHPO and Native American Tribes.

Historical Resources Study

Determine the Area of Potential Effects (APE)

The geographic area or areas within which an undertaking may directly or indirectly caused alterations in the character or use of historic properties, if any such properties exist.

The APE is influenced by the scale and nature of an undertaking and may be different for different kinds of effects caused by the undertaking.

The undertaking in this case is the FERC license renewal. No change in operation or addition of facilities is proposed.

Historical Resources Study

To establish the APE, MSG travelled in and around the Project area and documented the buildings, structures and landscapes that may potentially be impacted by the re-licensing. Results were compiled in a photo log and mapped.

Historical Resources Study

Ludington Pumped Storage Facility (hydroelectric facility) APE

In this case, Project activities are limited to the property boundaries, as no physical, visual or auditory impacts are anticipated beyond those boundaries.

Pigeon Lake North Pier (recreation facility) APE

The recommended APE therefore corresponds to the current FERC Project Boundary, including both the LPSF site in Mason County and the satellite recreation site in Ottawa County.

No properties outside this Boundary will be affected by the FERC license renewal.

Historical Resources Study

Identify historic properties within the APE

Historic properties are buildings, structures, sites, objects or districts that are listed in or eligible for the National Register of Historic Places (NRHP).

A literature review was completed at the Michigan SHPO in July 2015. The lit review identified no previously recorded historic properties in or near the current Project APE.

Historical Resources Study

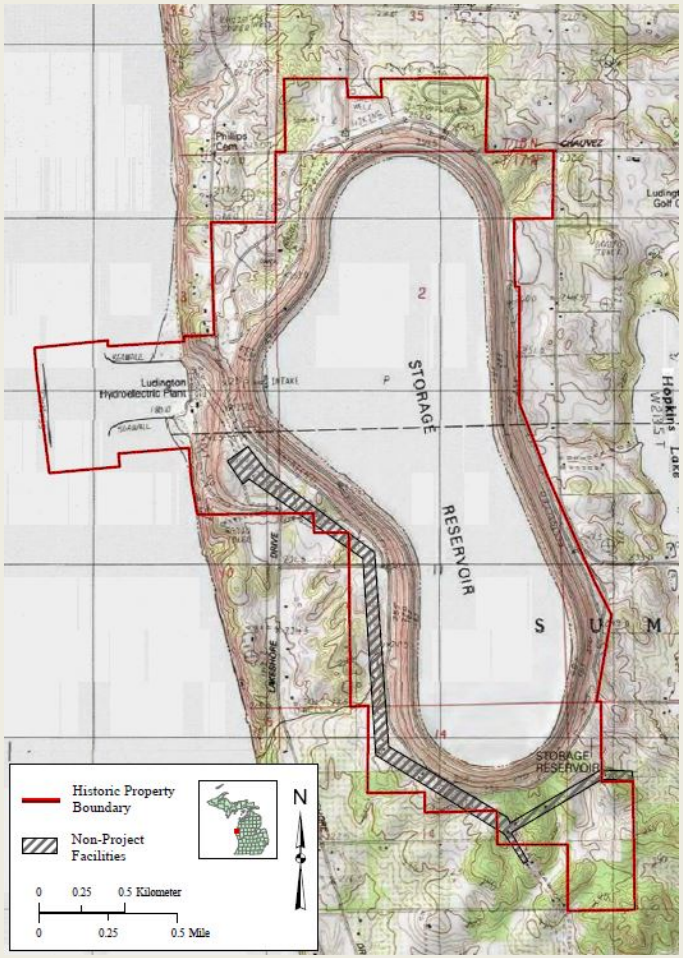
In August 2011, CCRG recommended the LPSF eligible for the NRHP under:

- *Criterion A* for its hydroelectric generating and transmitting capabilities;
- *Criterion C* for its significant design and engineering;
- *Criterion D* for its ability to answer research questions; and
- *Criteria Consideration D* for an exceptionally significant resource less than 50 years old.

In February 2012, the Michigan SHPO concurred with CCRG's recommendation of eligibility.

In May 2015, approximately 130 acres of the property depicted on the right were removed from the Project Boundary by FERC.

No historic/architectural resources are located within those 130 acres.



Historical Resources Study


MSG documented all architectural resources within the 1,500-acre APE at LPSF, including three recreational areas, a campground, and a model aircraft flying field.







Historical Resources Study

The APE for the Pigeon Lake North Pier facility is a 1.8 acre recreational corridor.

No historic/architectural resources were identified in or near the satellite APE.

Historical Resources Study

Impact Assessment for Historic/Architecture Resources

- The undertaking in this case is the FERC license renewal. No change in operation or addition of facilities is proposed.
- The SHPO has determined that the LPSF meets the criteria for listing in the NRHP.
- No other historic properties were identified by MSG in or near the Project APE.
- Given the scale and nature of the proposed Project, it is the opinion of MSG that the effects of the re-licensing do not meet the *Criteria of Adverse Effect* (36 CFR Part 800.5[a][1]) and the Project will have no adverse effect on the LPSF, which is eligible for NRHP listing.
- No further historic/architectural investigations are recommended.
- Report of findings and recommendations will be submitted to SHPO for review and comment.

Historical Resources Study

End

ATTACHMENT 5

Archaeological Resources Study Presentation

Archaeological Resources Study

Dr. Robert Chidester, RPA
Archaeology Team Leader
The Mannik & Smith Group, Inc.

Archaeological Resources Study

Archaeological Resources Study Plan

- No changes in land use are proposed; therefore, project effects on archaeological resources are unlikely

- No known, NRHP-eligible archaeological sites within the Project area, but 2 known sites within the Project area and 21 known sites within 2.0 miles, indicating archaeological sensitivity of Project area

Archaeological Resources Study

Archaeological Resources Study Plan

- Archaeological investigations required to identify all archaeological resources within the Project area and to identify adverse effects of continued Project operation

- Consultation with Michigan SHPO and Native American Tribes required

Archaeological Resources Study

Archaeological Resources Study Plan

- Project area includes both the LPS facility in Mason County and the Pigeon Lake North Pier (PLNP) facility in Ottawa County

- Information regarding potential adverse effects on NRHP-eligible archaeological sites will used to help develop a Historic Properties Management Plan (HPMP)

Archaeological Resources Study

Archaeological Resources Study

Project Timeline

- May-July 2015: Literature Review and Background Research
- August 2015: Field Survey
- September-October 2015: Laboratory Processing and Analysis
- October-November 2015: NRHP Eligibility Assessment, Preparation of Technical Report
- December 2015: Consultation with SHPO and Tribes

Archaeological Resources Study

Results of Literature Review

- 2 prehistoric archaeological sites located within LPS Project area
- 17 archaeological sites (both prehistoric and historic) located within 2.0 km of LPS Project area
- 6 archaeological investigations previously conducted within 2.0 km of LPS Project area

Archaeological Resources Study

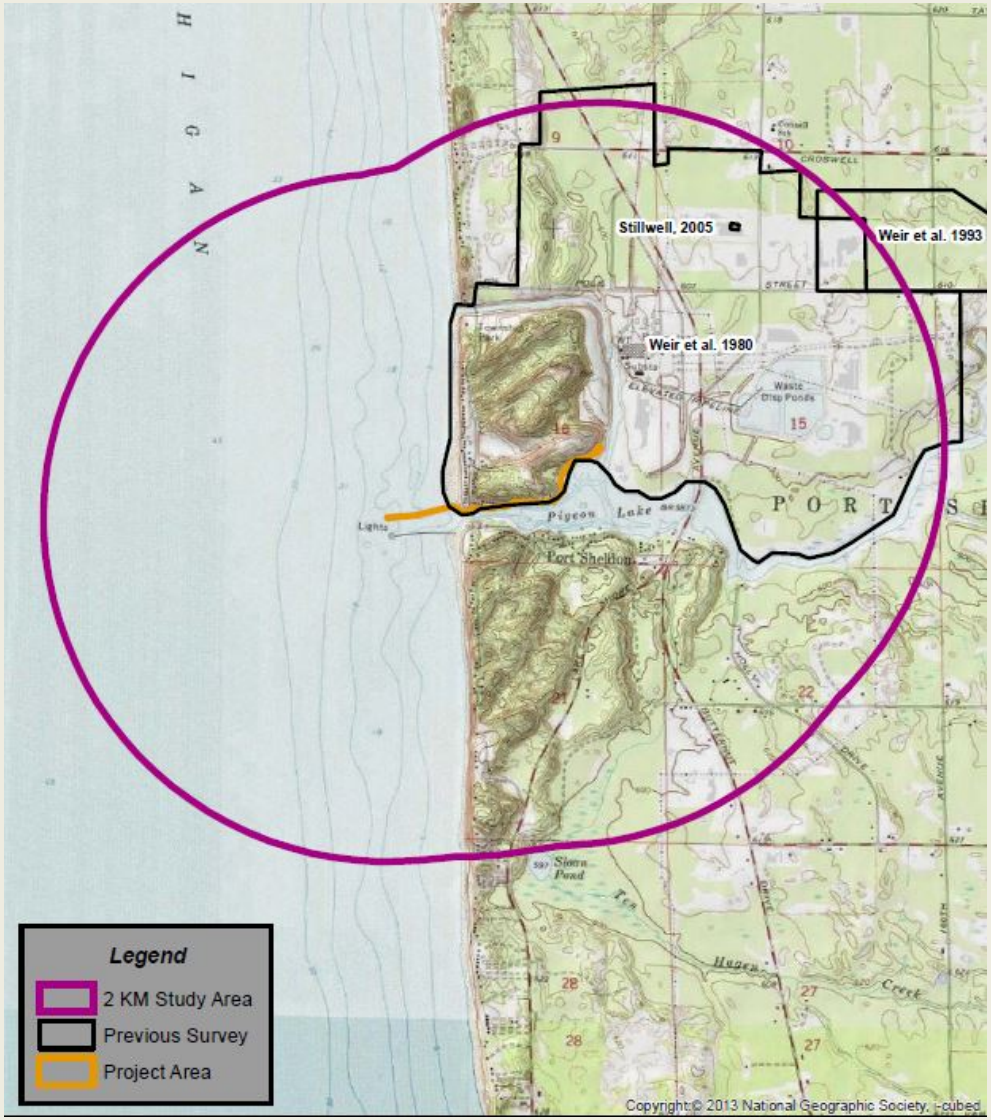
This slide contained sensitive cultural resource site information and was removed for filing as a public document.

Archaeological Resources Study

Results of Literature Review

- 0 archaeological sites located within PLNP Project area
- 0 archaeological sites located within 2.0 km of PLNP Project area
- 3 archaeological investigations previously conducted within 2.0 km of PLNP Project area

Archaeological Resources Study



Archaeological Resources Study

Archaeological Survey – Methods

- Aerial photographs (both current and historic) examined to determine previously disturbed areas
- Potentially undisturbed areas divided into 18 Survey Areas
- Survey Areas subjected to visual inspection and systematic shovel testing on a 15-meter grid
- Areas of excessive slope (>20%) noted but not shovel tested
- All soil from shovel tests screened for artifacts, then backfilled

Archaeological Resources Study

Archaeological Resources Study

Laboratory Processing and Analysis

- All artifacts recovered during survey were washed, sorted, counted and cataloged
- “Field Sites” combined into designated Archaeological Sites
- Basic analysis of site-specific assemblages to determine site age and function

Archaeological Resources Study

Survey Results

- 28 Field Sites identified representing both prehistoric and historic occupation of the LPS Project area
- 25 Field Sites distilled into 15 Archaeological Sites
- 3 Field Sites not designated as Archaeological Sites
- No archaeological sites identified in PLNP Project area

Archaeological Resources Study

This slide contained sensitive cultural resource site information and was removed for filing as a public document.

Archaeological Resources Study

Recommendations

- No further work recommended in PLNP Project area
- Previously recorded archaeological sites 20MN48-49 were destroyed by original construction of LPS
- None of the 5 prehistoric archaeological sites identified within the LPS Project area are NRHP-eligible
- 8 of the 10 historic archaeological sites identified within the LPS Project area are not NRHP-eligible

Archaeological Resources Study

Recommendations

- 2 of the 10 historic archaeological sites identified within the LPS Project area are *potentially* NRHP eligible, but will not be affected unless LPS operations expand into these areas

- Geomorphological investigation may be required to determine whether there is the potential for buried archaeological deposits in dune contexts within the LPS Project area

Archaeological Resources Study

This slide contained sensitive cultural resource site information and was removed for filing as a public document.

20MN324

20MN329

Archaeological Resources Study

Schedule for Remaining Work

- Report finalized by 12/31/2015
- Provided to SHPO and Tribes for review January 2016
- 45-day comment period ends in March 2016
- Artifacts recovered during field survey will be prepared and delivered to the Michigan SHPO for permanent curation following receipt of comments on technical report (January/February 2016)
- If SHPO concurs that geomorphological survey should be conducted, this can occur during the Phase II Survey and Reporting period (April-September 2016)

Archaeological Resources Study

End

ATTACHMENT 6

Recreation Resources Study Presentation

Recreation Resources Study

Angela Whelpley
TRC
14 Gabriel Drive
Augusta, ME 04330

Recreation Resources Study

Study Scope

The Recreation Resources Study includes:

- Recreation Site and Facility Inventory
- Condition Assessment and a Recreational Use Study.

The purpose of the study is to compile existing data and develop additional information to support a new FERC license application for continued operation of the Project.

Recreation Resources Study

Primary Goals

- Develop an inventory and condition assessment of the existing Project recreation facilities;
- Develop a survey/questionnaire;
- Estimate the existing level of daytime and nighttime recreational use occurring at the Project;
- Project future daytime and nighttime Project recreational use; and
- Identify entities that operate and maintain the existing Project recreation sites and facilities.

Recreation Resources Study

Schedule

- Field Data Collection
  - April 2015 - October 2015
- Consultation
  - To be completed in 4th quarter of 2015
- Statistical Analysis
  - Data entry will continue until all of the collected information has been complied.
  - Statistical Analysis will begin upon completion of data entry and be completed during the 4th quarter 2015
- Study Report
  - 2nd quarter 2016

Recreation Resources Study

Summary of Field Activities

Recreation Site and Facility Inventory and Condition Assessment

- TRC conducted the recreation site and facility inventory and condition assessment in May 2015

Recreation Use Study

- TRC conducted the recreation use study in April 2015 through October 2015
  - Visitor Counts (calibration, spot)
  - User Contact Surveys

Recreation Resources Study

Summary of Field Activities

Recreation Site and Facility Inventory and Condition Assessment

- At each recreation site, a standard recreational site/facility inventory and condition assessment form was completed
- Photos were taken and a GPS point was recorded for all FERC approved amenities.

Recreation Resources Study

Summary of Field Activities

Recreational Use Study

- TRC Staff conducted calibration counts at each Project recreation facility on four (4) days per month, which included two (2) randomly selected weekdays and two (2) randomly selected weekend days. For months containing a three-day holiday weekend (Memorial Day, Fourth of July, and Labor Day), an additional calibration count was conducted on one (1) holiday weekend day.
- Spot counts were conducted at each Project facility on four (4) days per month, which included two (2) randomly selected weekdays and two (2) randomly selected weekend days. For months containing a three-day holiday weekend, an additional spot count was conducted on one (1) holiday weekend day.
- User contact surveys were administered to one member of each recreation group encountered during the calibration counts.

Recreation Resources Study

Consultation

- Consultation with the municipal and county recreation departments and recreation/open space committees in those towns and counties located within the Project was initiated on October 22, 2015 via email (8 total).
- A phone conference was held with Pere Marquette Charter Township on November 2, 2015 to discuss their current Parks, Recreation & Open Space Plan 2015-2019.
- Email correspondence was received from Ottawa County Parks confirming that the Parks, Recreation and Open Space Plan dated 2011 was the current plan on file.
- User registration data for Mason County Campground and the Mason County Picnic Area was obtained to supplement field data.

Recreation Resources Study

Results

Recreation Site and Facility Inventory and Condition Assessment

- Mason County Campground (including Hull Airfield)
  - Owned by Licensees and Managed by Mason County (Campground)
  - Owned by Licensees and Managed by Twisted Stix (Hull Airfield)
- Mason County Picnic Area
  - Owned by Licensees and Managed by Mason County
- Upper Reservoir Observation Platform
  - Owned and Managed by Licensees
- Lake Michigan Overlook
  - Owned and Managed by Licensees
- Pigeon Lake North Pier
  - Owned and Managed by Licensees

- All of the recreation sites within the Project boundary were found to be meeting their intended function. All of the facilities were found to be in good condition.

Recreation Resources Study

Results

Recreational Use

- Results will be available upon completion of the study in the 2nd Quarter 2016.

ATTACHMENT 7

Fisheries and Aquatic Resources Study Presentation

Fish and Aquatic Resources

Greg Allen
Alden Research Laboratory, Inc.
30 Shrewsbury St.
Holden, MA 01520-1843

Fish and Aquatic Resources

Purpose

from Study Plan:

> *"…evaluate existing technologies available to protect fish from entrainment mortality and consider their applicability, feasibility, effectiveness and total cost…"*

Fish and Aquatic Resources
Consultation

Relicensing Consultation Group

Representatives from SAT and GFLT Member Organizations

Panel of Experts

Hydro Engineer, Fisheries Biologist, Fish Protection Engineer

Fish and Aquatic Resources
Phased Approach

- Phase 1 – Identify Entrainment Abatement and Engineering Alternatives (Study Plan Task 3)
- Phase 2 – Entrainment Abatement Evaluation (Study Plan Task 4)
- Phase 3 – Engineering Alternatives Evaluation (Study Plan Task 5)

Fish and Aquatic Resources
Schedule

- Phase 1
  - 6/30/2015 – Draft Phase 1 Report submitted to the LPSP Relicensing Consultation Group
  - 7/30/2015 – Phase 1 Report Review meeting with Relicensing Consultation Group
  - 12/1/2015 – Filed with FERC as part of Initial Study Report
- Phase 2
  - 10/13/2015 – Draft Phase 2 Report submitted to the LPSP Relicensing Consultation Group
  - 11/13/2015 – Phase 2 Report Review meeting with Relicensing Consultation Group
  - 12/1/2015 – Filed with FERC as part of Initial Study Report
- Phase 3
  - 5/17/16 – Draft Phase 3 Report due to the Relicensing Consultation Group
  - 7/12/2016 – Phase 3 Report Review meeting with Relicensing Consultation Group
  - 11/30/2016 – Updated Study Report Filed with FERC

Fish and Aquatic Resources

Consultations

- April 14, 2015 – Study kick-off meeting
- May 15, 2015 – Phase 1 Interim Review Teleconference
  - Received verbal comments regarding the progress of the Phase 1 study. Comments were addressed as part of the meeting minutes and the Phase 1 report.
- July 30, 2015 – Phase 1 Report Review Meeting
  - Written and verbal comments were received from the Phase 1 Draft Report. Comments were discussed and addressed during the face-to-face meeting and as part of the meeting minutes and Final Phase 1 report.
- August 14, 2015 – Phase 2 Interim Meeting
  - Received verbal comments regarding progress of Phase 2 evaluation during a face-to-face meeting. Comments were addressed as part of the meeting minutes and the Phase 2 report.
- November 13, 2015 – Phase 2 Report Review Meeting
  - Written and verbal comments were received for the Phase 2 Draft Report. Comments were discussed and addressed during the face-to-face meeting and as part of the meeting minutes and Final Phase 2 report.

Fish and Aquatic Resources

Results – Phase 1 Evaluation

Request for Fish Protection Technology Information

- Consultants, government agencies, non-profits, utilities, academia, technology vendors, and member representatives from the Scientific Advisory Group were solicited
- 70 individuals contacted
- 24 responses
- 14 supplied information

Request for Biological Information

- State and federal agencies, tribal entities, academia and non-profit organizations were contacted
- MDNR, NWF, USGS, University of Michigan and CEC provided data

Fish and Aquatic Resources

Results – Phase 1 Evaluation

Target Species and Species of Concern

Common Name	Life Stages Present	Barrier Net Monitoring Species Status	Barrier Net Trophic Category	Representative Species
Lake sturgeon	A	Nontarget	--	--
Alewife	I, J, A	Target	Forage Fish	X
Rainbow smelt	I, J, A	Target	Forage Fish	--
Walleye	J, A	Target	Game Fish	X
Yellow perch	I, J, A	Target	Game Fish	--
Brown trout	J, A	Target	Game Fish	--
Rainbow trout (steelhead)	J, A	Target	Game Fish	X
Lake trout	J, A	Target	Game Fish	--
Chinook salmon	J, A	Target	Game Fish	--
Coho salmon	J, A	Target	Game Fish	--
Lake Herring	I, J, A	Nontarget	--	--
Chub (Bloater)	I, J, A	Target	--	--
Lake whitefish	I, J, A	Nontarget	--	X

Fish and Aquatic Resources

Results – Phase 1 Evaluation

Technology List

Mode of Protection	Technology	Near Shore	Off Shore
ENTRAINMENT ABATEMENT TECHNOLOGIES			
Behavioral deterrence/guidance	Sound (infrasonic, sonic, ultrasonic, impulsive/high impact)	X	
	Light (strobe, continuous)	X	
	Chemicals	X	
	Air bubble curtain, (including CO_2)	X	
	Water jet curtain	X	
	Hanging chains	X	
	Visual keys	X	
	Multi-technology behavioral system	X	X
	Modified flow systems (current inducers; FVES™)	X	
Physical barrier/guidance	Barrier net	X	
	Aquatic filter barrier	X	
Physical barrier and/or diversion	Multi-technology physical system	X	X

Fish and Aquatic Resources

Results – Phase 1 Evaluation

Technology List (continued)

Mode of Protection	Technology	Near shore	Off shore
ENGINEERING ALTERNATIVES			
Physical barrier	Fixed screens	X	
	Narrow-spaced bar racks	X	
	Infiltration intakes	X	X
	Porous dike	X	
	Filtrex filter system	X	
	Perforated pipe screens	X	X
	Cylindrical wedgewire screens	X	X
Physical diversion	Angled louvers and bar racks	X	
	Angled screens (fixed or traveling)	X	
	Angled rotary drum screens	X	
	Inclined-plane screens	X	
	Eicher screen	X	
	Modular inclined screen (MIS)	X	
	Submerged traveling screens	X	

Fish and Aquatic Resources

Results – Phase 1 Evaluation

Technology List (continued)

Mode of Protection	Technology	Near shore	Off shore
ENGINEERING ALTERNATIVES			
Behavioral deterrence/guidance	Velocity Cap		X
	Veneer Intake	X	X
Mechanized physical barrier w/collection	Modified (Ristroph) traveling screens	X	
	Bilfinger Multi-Disc™ Screening System	X	
	Hydrolox™ Screens	X	
	Beaudrey Water Intake Protection (WIP) Screen	X	
Mechanized physical barrier	Standard traveling water screens (without fish collection)	X	

Fish and Aquatic Resources

Results – Phase 2 Evaluation

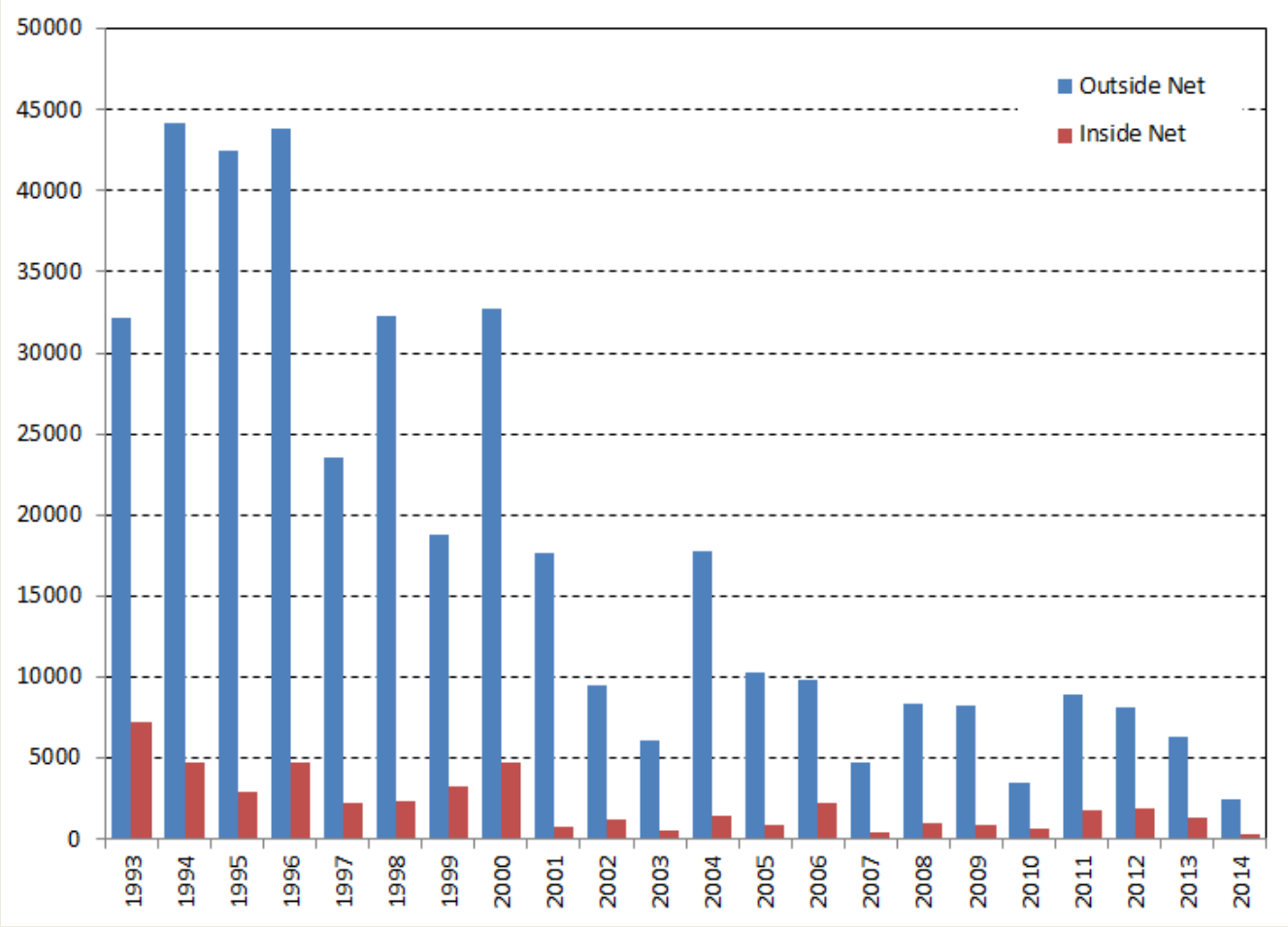
Entrainment and Abatement Alternatives

- Barrier net design and effectiveness summary
- Biological information and fish species matrix
- Barrier net effectiveness
- Technology screening criteria
- Feasibility assessment of entrainment abatement alternatives

Fish and Aquatic Resources

Results – Biological Information

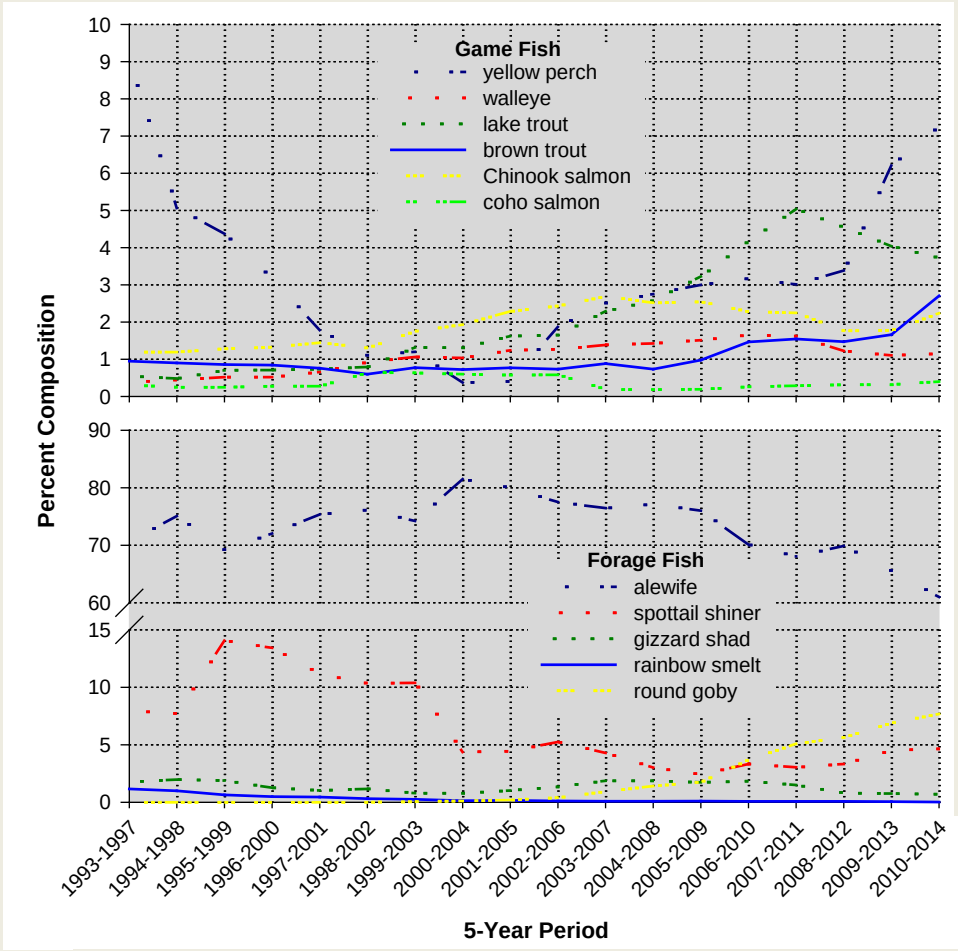
Species Abundance – Barrier Net Monitoring

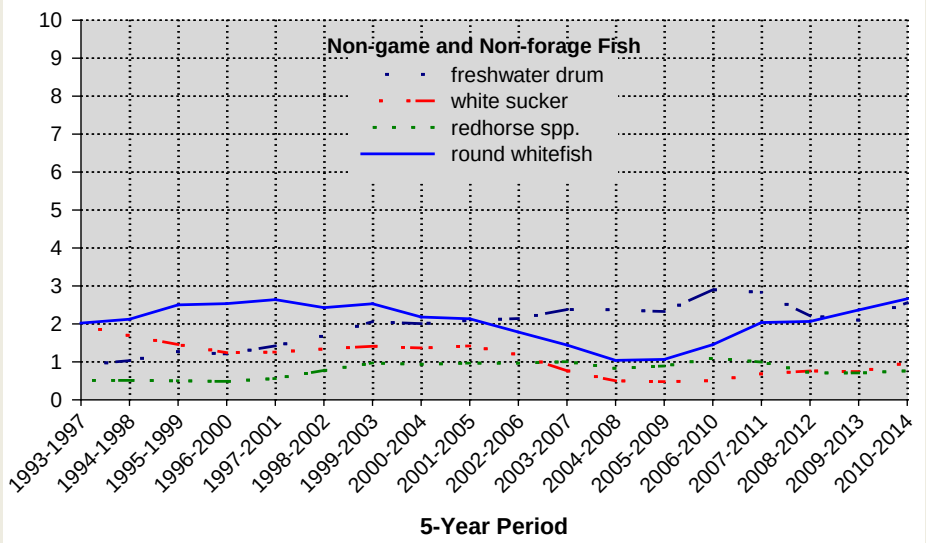


Fish and Aquatic Resources

Results – Biological Information

Species Composition – Barrier Net Monitoring





Fish and Aquatic Resources

Results – Phase 2 Evaluation

Fish Species Matrix

- Review biological information for species and life stage composition, abundance, diurnal and seasonal presence, and habitat preference (general depth and offshore vs nearshore)
- Species grouped as follows:
  - Target species Game and Forage Fish (as defined for barrier net monitoring)
  - Species of concern identified by licensing parties
  - Non-target Game and Forage Species
  - Non-target Non-game/Non-Forage Species

Fish and Aquatic Resources

Fish Species Matrix – Barrier Net Target Species (FERC settlement)

Family	Common Name	Scientific Name	Life Stages	Occurence			Abundance Reported by SWM (1988)	Current Abundance	Primary Habitat Relative to Shore	Depth	Entrain-ment Risk
				Seasonal	Monthly	Diurnal					
Game Species											
Salmonidae	Brown trout	*Salmo trutta*	J	SP-FA	May-Nov	N>D	C	C	NS	S	**M**
			A	SP-FA	Apr-Nov	N>D	C	C	NS	S	**M**
	Chinook salmon	*Oncorhynchus tshawytscha*	J	SU-FA	Jun-Oct	N>D	C	C	OS	S	**M**
			A	SU-FA	Jun-Oct	N>D	C	C	OS	S-B-M	**M**
	Coho salmon	*Oncorhynchus kisutch*	J	FA	Sep-Nov	N>D	C	R	OS	S-M	**L**
			A	FA	Sep-Nov	N>D	C	R	OS	S-M-B	**L**
	Lake trout	*Salvelinus namaycush*	A	SU-FA	Jun-Oct	N>D	C	C	NS	S-B-M	**M**
	Rainbow trout (Steelhead)	*Oncorhynchus mykiss*	J	FA-SP	Oct-May	N>D	C	R	NS	S-B	**L**
			A	FA-SP	Oct-May	N>D	C	R	NS	S-B	**L**
Percidae	Yellow perch	*Perca flavescens*	I	SP-SU	May-Jul	D/N	A	C	OS	B	**M**
			J	SP-SU	Apr-Aug	D/N	A	C	OS	B	**M**
			A	SP-SU	Apr-Aug	D/N	A	C	OS	B	**M**
Forage Species											
Clupeidae	Alewife	*Alosa pseudoharengus*	I	SU/FA	Jun-Sep	N>D	VA	VA	OS	S-M	**H**
			J	SP/SU	May-Aug	N>D	VA	VA	OS	S-M-B	**H**
			A	SP/SU	May-Aug	N>D	VA	VA	OS	S-M-B	**H**
Osmeridae	Rainbow smelt	*Osmerus mordax*	I	SP/FA	May	N>D	VA	R	OS	S-B-M	**L**
			J	SP/FA	May/Oct	N>D	VA	R	OS	S-B-M	**L**
			A	SP/FA	May/Oct	N>D	VA	R	OS	S-B-M	**L**
Other Species											
Salmonidae	Bloater (Chub)	*Coregonus hoyi*	J	SU	Jun-Aug	N>D	VA	R	OS	B	**L**
			A	SU	Jun-Aug	N>D	VA	R	OS	B	**L**

Life Stages: I, ichthyoplankton; J, juvenile; A, adult
Seasonal: SP, spring; SU, summer; FA, fall
Diurnal: D, day; N, night
Abundance: VA, very abundant; A, abundant; C, common; R, rare
Habitat: NS, nearshore; OS, offshore
Depth: S, surface; M, mid; B, bottom
Entrainment Risk: L, low; M, moderate; H, high

Fish and Aquatic Resources

Fish Species Matrix – Species of Concern identified by licensing parties

Family	Common Name	Scientific Name	Life Stages	Occurence			Abundance Reported by SWM (1988)	Current Abundance	Primary Habitat Relative to Shore	Depth	Entrain-ment Risk
				Seasonal	Monthly	Diurnal					
Forage Species											
Salmonidae	Lake Herring	*Coregonus artedi*	I	FA-WI	Oct-Dec	D/N	NR	R	NS	S-M-B	**L**
			J	FA-WI	Oct-Dec	D/N	NR	R	OS	S-M-B	**L**
			A	FA-WI	Oct-Dec	D/N	NR	R	OS	S-M-B	**L**
	Lake whitefish	*Coregonus clupeaformis*	I	SP	Apr-May	N	R	R	NS	B	**L**
			J	FA	Oct-Nov	N	C	R	OS	B-S	**L**
			A	FA	Oct-Nov	N	C	R	OS	B	**L**
Other Species											
Acipenseridae	Lake sturgeon	*Acipenser fulvescens*	A	SP-FA	Apr-Nov	D/N	R	R	OS	B	**L**

Life Stages: I, ichthyoplankton; J, juvenile; A, adult
Seasonal: SP, spring; SU, summer; FA, fall
Diurnal: D, day; N, night
Abundance: VA, very abundant; A, abundant; C, common; R, rare
Habitat: NS, nearshore; OS, offshore
Depth: S, surface; M, mid; B, bottom
Entrainment Risk: L, low; M, moderate; H, high

Fish and Aquatic Resources

Fish Species Matrix – Non-target game and forage species

Family	Common Name	Scientific Name	Life Stages	Occurence: Seasonal	Occurence: Monthly	Occurence: Diurnal	Abundance Reported by SWM (1988)	Current Abundance	Primary Habitat Relative to Shore	Depth	Entrain-ment Risk
Game Species											
Centrarchidae	Black crappie	*Pomoxis nigromaculatus*	I	SU	Aug	N	R	R	NS	B	**L**
			J	SU-FA	Jul-Sep	D/N	R	R	NS	S-B	**L**
			A	SU-FA	Jul-Sep	D/N	R	R	NS	S-B	**L**
	Largemouth bass	*Micropterus salmoides*	J	SU-FA	Jun-Sep	D/N	NR	R	NS	S	**L**
			A	SU-FA	Jun-Sep	D/N	NR	R	NS	S	**L**
	Pumpkinseed	*Lepomis gibbosus*	J	SU-FA	Jun-Sep	D/N	NR	R	NS	S	**L**
			A	SU-FA	Jun-Sep	D/N	NR	R	NS	S-M	**L**
	Rock bass	*Ambloplites rupestris*	J	SU-FA	Jun-Sep	D/N	NR	R	NS	B-S	**L**
			A	SU-FA	Jun-Sep	D/N	NR	R	NS	S-B	**L**
	Smallmouth bass	*Micropterus dolomieu*	J	SU-FA	Jun-Sep	D/N	NR	R	NS	S-B	**L**
			A	SU-FA	Jun-Sep	D/N	NR	R	NS	S-B	**L**
	Bluegill	*Lepomis macrochirus*	I	SU-FA	Aug-Nov	D/N	R	R	NS	B	**L**
			J	SU-FA	Jun-Sep	D/N	R	R	NS	M-B	**L**
			A	SU-FA	Jun-Sep	D/N	R	R	NS	M-B	**L**
Esocidae	Northern pike	*Esox lucius*	A				NR	R	NS	B-M	**L**
Salmonidae	Brook trout	*Salvelinus fontinalis*	A				NR	R	NS	S	**L**
Forage Species											
Clupeidae	Gizzard shad	*Dorosoma cepedianum*	I	FA	Oct	D/N	R	C	NS	S	**M**
			J	SP-FA	April-Oct	D/N	R	C	NS	S-B-M	**M**
			A	SP-FA	April-Oct	D/N	R	C	NS	M	**M**
Moronidae	White perch	*Morone americana*	A	SU-FA	Jul-Sep	D/N	NR	R	NS	S-B	**L**
Salmonidae	Round whitefish	*Prosopium cylindraceum*	A	SP-FA	Apr-Nov	N	C	C	OS	B-S	**M**

Life Stages: I, ichthyoplankton; J, juvenile; A, adult
Seasonal: SP, spring; SU, summer; FA, fall
Diurnal: D, day; N, night
Abundance: VA, very abundant; A, abundant; C, common; R, rare
Habitat: NS, nearshore; OS, offshore
Depth: S, surface; M, mid; B, bottom
Entrainment Risk: L, low; M, moderate; H, high

Fish and Aquatic Resources

Fish Species Matrix – Non-target species not classified as game/forage (1 of 2)

Family	Common Name	Scientific Name	Life Stages	Occurence			Abundance Reported by SWM (1988)	Current Abundance	Primary Habitat Relative to Shore	Depth	Entrain-ment Risk
				Seasonal	Monthly	Diurnal					
Other Species											
Amiidae	Bowfin	*Amia calva*	A	No Data	No Data	D/N	NR	R	NS	S	**L**
Catostomidae	Black buffalo	*Iciobus niger*	A	No Data	No Data	D/N	NR	R	NS	S-B	**L**
	Longnose sucker	*Catostomus catostomus*	A	SP-FA	Apr-Nov	N>D	C	R	NS	S-B-M	**L**
	Quillback	*Carpiodes cyprinus*	A	SU-FA	Jul-Sep	D/N	NR	R	NS	S	**L**
	Redhorse spp.	*Moxostoma spp.*	J	SU-FA	Jul-Sep	D/N	NR	C	NS	S-B	**M**
			A	SU-FA	Jul-Sep	D/N	NR	C	NS	S	**M**
	White sucker	*Catostomus commersoni*	J	SP-FA	Apr-Nov	N>D	C	C	OS	S-B	**M**
			A	SP-FA	Apr-Nov	N>D	C	C	OS	B	**M**
Cottidae	Mottled sculpin	*Cottus bairdi*	J	SU	Jun-Aug	N	NR	R	OS	B	**L**
			A	SU	Jul-Aug	N	NR	R	OS	S-B	**L**
	deepwater sculpin	*Myoxocephalus thompsonii*	I	SP-SU	April-Aug	N	C	R	NS	B	**L**
			J	FA	Nov	N	C	R	NS	B	**L**
			A	FA	Nov	N	C	R	NS	B	**L**
	Slimy sculpin	*Cottus cognatus*	A	SP-SU	May-Aug	N	NR	R	OS	B	**L**
Cyprinidae	Common carp	*Cyprinus carpio*	A	SP-FA	Jul-Aug	D/N	NR	R	NS	S-B-M	**L**
	Lake chub	*Couesius plumbeus*	A	No Data	No Data	D/N	NR	R	OS	B	**L**
	Common Shiner	*Notropis cornutus*	A	SP-FA	Apr-Nov	D/N	NR	R	NS	S-B-M	**L**
	Longnose dace	*Rhinichthys cataractae*	I	SP-FA	May-Sep	D/N	NR	R	NS	B	**L**
			J	SP-FA	May-Sep	D/N	NR	R	NS	B	**L**
			A	SP-FA	May-Sep	D/N	NR	R	NS	B	**L**
	Spottail shiner	*Notropis hudsonius*	I	SU	June-Aug	N	A	A	NS	S	**M**
			J	SP-FA	Apr-Nov	D/N	A	A	NS	S-B	**M**
			A	SP-FA	Apr-Nov	D/N	A	A	NS	S-B	**M**
	Lake emerald shiner	*Notropis atherinoides*	I	SU	June-Aug	N	R	UNK	OS	S	**L**
			J	SU	May-Aug	D/N	R	UNK	OS	S	**L**
			A	SU	May-Aug	D/N	R	UNK	OS	S	**L**

Life Stages: I, ichthyoplankton; J, juvenile; A, adult
Seasonal: SP, spring; SU, summer; FA, fall
Diurnal: D, day; N, night
Abundance: VA, very abundant; A, abundant; C, common; R, rare
Habitat: NS, nearshore; OS, offshore
Depth: S, surface; M, mid; B, bottom
Entrainment Risk: L, low; M, moderate; H, high

Fish and Aquatic Resources

Fish Species Matrix – Non-target species not classified as game/forage (2 of 2)

Family	Common Name	Scientific Name	Life Stages	Occurence			Abundance Reported by SWM (1988)	Current Abundance	Primary Habitat Relative to Shore	Depth	Entrain-ment Risk
				Seasonal	Monthly	Diurnal					
Other Species (continued)											
Gasterosteidae	Threespine stickleback	*Gasterosteus aculeatus*	J	No Data	No Data	D/N	NR	R	NS	S-B	**L**
			A	No Data	No Data	D/N	NR	R	NS	S-B	**L**
	Ninespine stickleback	*Pungitius pugitius*	I	SU-FA	Jun-Sep	N	C	UNK	NS	B	**M**
			J	SP-SU	Apr-Aug	D/N	C	UNK	NS	B	**M**
			A	SP-SU	Apr-Aug	D/N	C	UNK	NS	B	**M**
Gobiidae	Round goby	*Neogobius melanostomus*	J	SP-SU	May-Jul	D/N	NR	C	OS	S-B	**M**
			A	SP-SU	May-Jul	D/N	NR	C	OS	S-B	**M**
Ictaluridae	Black bullhead	*Ictalurus melas*	A	SU-FA	Aug-Sep	D/N	NR	R	NS	B	**L**
	Channel catfish	*Ictalurus punctatus*	A	SU-FA	Aug-Sep	D/N	NR	R	NS	B	**L**
Lepisosteidae	Longnose gar	*Lepisosteus osseus*	A	SP-FA	May-Sep	D/N	NR	R	NS	S-B	**L**
Lotidae	Burbot	*Lota lota*	I	SP-SU	Apr-Jun	N	C	R	OS	B	**L**
			J	SP-FA	Apr-Nov	N	C	R	OS	S	**L**
			A	SP-FA	Apr-Nov	N	C	R	OS	S	**L**
Percidae	Johnny darter	*Etheostoma nigrum*	I	SU-FA	July-Sept	N	C	UNK	NS	B	**M**
			J	SP-FA	May-Oct	N>D	A	UNK	NS	B	**M**
			A	SP-FA	May-Oct	N>D	A	UNK	NS	B	**M**
	Walleye	*Sander vitreus*	J	SP-FA	May-Oct	N	R	C	OS	B-S-M	**M**
			A	SP-FA	May-Oct	N	R	C	OS	S-B-M	**M**
Percopsidae	Trout-perch	*Percopsis omiscomaycus*	I	SU	Aug	N	R	R	NS	S-B	**L**
			J	SP-FA	May-Sept	N	C	R	NS	S-B	**L**
			A	SP-FA	May-Sept	N	C	R	NS	S-B	**L**
Petromyzontidae	Sea lamprey	*Petromyzon marinus*	A	No Data	No Data	D/N	NR	R	OS	S-B	**L**
Sciaenidae	Freshwater drum	*Aplodinotus grunniens*	A	SP-FA	May-Oct	D/N	NR	C	OS	S-B-M	**M**

Life Stages: I, ichthyoplankton; J, juvenile; A, adult
Seasonal: SP, spring; SU, summer; FA, fall
Diurnal: D, day; N, night
Abundance: VA, very abundant; A, abundant; C, common; R, rare
Habitat: NS, nearshore; OS, offshore
Depth: S, surface; M, mid; B, bottom
Entrainment Risk: L, low; M, moderate; H, high

Fish and Aquatic Resources

Results – Barrier Net Effectiveness

Barrier Net Effectiveness

				Game Fish > 5 inches				Forage Fish > 5 Inches		
Year	All Species	All Target Species	All Non-target Species	Salmonids	Yellow Perch	Walleye[1]	All Game Fish	Alewife	Rainbow Smelt	All Forage Fish
1993	77.5	80.4	60.1	80.1	76.1	95.8	76.6	80.7	77.0	80.7
1994	89.4	90.6	77.5	74.3	95.1	93.3	90.7	90.2	91.0	90.3
1995	93.1	95.4	76.8	86.2	99.3	96.5	96.3	96.3	93.1	96.3
1996	89.1	95.6	47.7	74.0	98.5	94.6	91.6	97.4	78.3	97.2
1997	90.5	95.8	64.5	72.4	96.4	95.4	83.1	97.6	87.6	97.5
1998	92.7	96.3	67.8	86.1	99.0	95.6	89.3	96.8	90.5	96.7
1999	82.5	96.0	58.5	89.3	99.6	97.6	94.3	99.2	78.4	98.9
2000	85.7	86.5	71.9	86.3	90.3	99.3	86.7	96.4	100.0	96.4
2001	95.6	96.5	84.4	79.3	100.0	98.8	81.1	97.2	80.5	97.2
2002	87.0	90.9	69.5	84.5	100.0	98.5	85.0	90.8	--	90.8
2003	91.0	93.9	76.8	78.9	100.0	96.6	80.0	98.3	--	98.2
2004	91.6	93.9	69.3	69.6	80.0	95.8	70.1	95.5	--	95.4
2005	91.4	92.1	85.0	89.8	100.0	96.7	90.3	92.6	88.9	92.6
2006	76.9	78.3	67.7	74.2	95.4	92.3	79.8	89.5	--	89.5
2007	91.2	91.9	88.7	80.5	80.0	88.5	80.4	94.3	--	94.3
2008	88.1	88.5	85.4	81.7	86.1	96.5	82.7	92.2	--	92.2
2009	89.3	91.4	65.6	75.1	89.3	73.1	77.1	97.0	--	97.0
2010	82.2	89.2	64.4	77.4	100.0	89.7	78.9	94.5	--	94.5
2011	79.5	81.7	69.4	77.3	92.6	92.0	82.1	96.2	--	96.2
2012	76.4	77.8	67.0	70.7	81.1	58.1	76.5	95.3	--	95.2
2013	78.4	81.2	68.6	76.6	96.2	94.4	91.4	94.3	--	94.1
2014	88.6	92.1	73.3	71.9	92.9	87.9	78.7	97.3	--	97.3
Mean	86.7	89.8	70.9	78.9	93.1	92.1	83.8	94.5	86.5	94.5
Range	76.4 - 95.6	77.8 - 96.5	47.7 - 88.7	69.6 - 89.8	76.1 - 100.0	58.1 - 99.3	70.1 - 96.3	80.7 - 99.2	77.0 - 100.0	80.7 - 98.9

[1] Walleye estimates include all fish greater than 4 inches in length.

Barrier Net Effectiveness

	Target Species									Species of Concern			Non-Target (>1000 fish collected over all years)							
Year	BNT	CHIN	COHO	LT	RBT	AW	RSM	YP	CHUB	LS	LW	LKH	FD	GSD	REDH	RGY	RWF	STSH	WEYE	WS
1993	71.5	82.2	85.2	85.5	0.0	82.1	76.5	76.2	0.0	--	90.0	--	75.6	91.0	82.1	--	43.4	26.7	95.8	97.9
1994	69.5	81.2	62.3	83.0	61.1	90.6	91.0	94.7	--	--		--	91.9	80.5	91.0	--	22.8	66.2	93.3	95.6
1995	76.9	81.6	90.2	95.9	87.5	96.0	93.1	90.5	--	--	--	--	98.5	95.5	91.7	--	57.2	38.5	96.5	96.5
1996	82.5	73.6	64.7	86.8	0.0	97.3	78.5	86.9	--	--	--	--	97.4	76.9	91.4	--	4.4	30.6	94.6	95.3
1997	89.4	62.2	44.2	91.8	58.3	97.5	87.6	92.2	--	--	--	--	97.7	93.9	98.3	--	27.8	54.7	95.4	94.1
1998	72.4	84.0	100.0	94.1	--	96.6	90.5	99.0	0.0	--	--	--	96.7	90.2	89.8	--	6.3	52.0	95.6	96.6
1999	93.7	86.1	87.7	92.0	50.0	97.3	78.4	89.6	--	--	--	--	99.5	100.0	99.1	--	0.0	53.0	97.6	99.5
2000	82.1	89.5	76.7	87.2	--	86.5	100.0	90.3	--	--	--	--	99.5	84.0	99.5	--	62.1	10.0	99.3	97.8
2001	80.8	74.0	70.0	85.9	--	97.2	80.5	100.0	--	--	--	--	96.7	47.2	97.9	--	81.8	33.5	98.8	96.9
2002	68.9	75.8	93.5	84.8	--	91.4	--	100.0	--	--	--	--	89.4	96.0	96.9	--	12.7	32.8	98.5	96.8
2003	82.7	71.4	--	86.9	--	95.5	--	90.6	--	--	--	72.2	99.5	95.8	93.6	--	90.9	28.1	96.6	97.2
2004	83.3	53.3	16.7	85.7	--	95.0	--	80.6	--	--	--	29.4	96.9	96.6	87.0	72.5	59.1	34.3	95.8	95.7
2005	81.5	89.1	68.8	93.0	--	92.3	88.9	94.7	--	--	--	--	98.7	87.5	84.6	81.1	85.1	58.8	96.7	94.6
2006	72.7	72.6	0.0	87.6	--	77.9	--	83.7	--	--	0.0	--	99.6	88.7	96.6	70.4	--	28.6	92.3	97.0
2007	88.4	63.6	--	90.2	--	94.2	--	75.0	--	--	--	--	100.0	87.4	96.6	86.6	82.9	52.7	88.5	--
2008	72.5	66.9	--	88.2	--	91.2	--	82.2	33.3	--	100.0	--	97.8	100.0	94.6	74.5	82.9	0.0	96.5	93.8
2009	73.3	79.8	--	75.0	--	94.4	--	83.9	0.0	--	94.7	--	95.8	90.3	90.7	59.1	35.9	1.2	73.1	85.4
2010	73.5	22.9	0.0	90.2	--	91.7	--	78.0	--	--	--	--	98.3	0.0	74.5	69.9	87.0	14.6	89.7	60.0
2011	54.0	54.7	78.6	87.1	--	84.2	--	60.6	--	--	--	--	98.8	--	35.3	79.7	50.5	46.7	92.0	22.5
2012	67.1	58.9	46.4	85.6	--	78.2	--	77.4	--	--	--	--	93.5	100.0	73.1	78.4	76.2	0.0	58.1	67.3
2013	81.0	60.3	--	91.2	18.2	77.3	--	94.0	--	--	--	82.8	97.2	--	90.5	81.6	28.3	24.8	94.4	--
2014	75.3	64.2	--	84.2	45.5	96.9	--	92.5	--	--	--	63.3	99.0	--	76.2	84.0	40.0	0.0	87.9	82.9
Mean	77.0	70.4	61.5	87.8	40.1	91.0	86.5	86.9	8.3	--	71.2	61.9	96.3	84.3	87.8	76.2	49.4	31.3	92.1	88.2
Range	54.0-93.7	22.9-89.5	0.0-100.0	75.0-95.9	0.0-87.5	77.3-97.5	76.5-100.0	60.6-100.0	0.0-33.3	--	0.0-100.0	29.4-82.8	75.6-100.0	0.0-100.0	35.3-99.5	59.1-86.6	0.0-90.9	0.0-66.2	58.1-99.3	22.5-99.5
N (all years)	3781	6061	1338	5146	641	324403	2958	24635	644	70	211	192	5815	6393	2596	3479	8136	32025	2878	6165
% Collected	0.86	1.38	0.30	1.17	0.15	73.83	0.67	5.61	0.15	0.02	0.05	0.04	1.32	1.46	0.59	0.79	1.85	7.29	0.66	1.40

SPECIES CODES: AW, alewife; BNT, brown trout; CHIN, chinook salmon; CHUB, bloater (chub); COHO, coho salmon; FD, freshwater drum; GSD, gizzard shad; LKH, lake whitefish; LS, lake sturgeon; LT, lake trout; LW, lake whitefish; RBT, rainbow trout; REDH, redhorse spp.; RGY, round goby; RSM, rainbow smelt; RWF, round whitefish; STSH, spottail shiner; WEYE, walleye; WS, white sucker; YP, yellow perch.

Fish and Aquatic Resources

Results – Phase 2 Evaluation

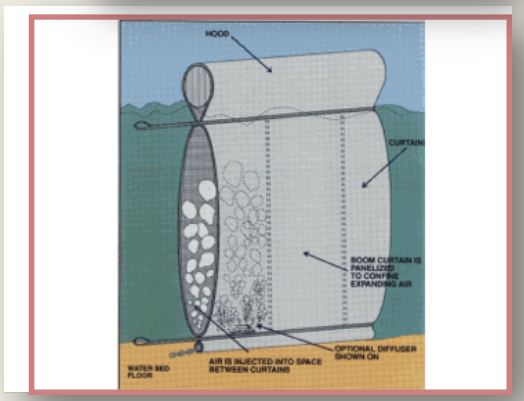
Screening Criteria Review

Biological Criteria

- Proven Biological Effectiveness
- Seasonal Performance
- Comparison to Existing Barrier Net

Engineering Criteria

- Commercially Availability
- Design Performance
- Regulatory Approval
- Adequate Space



Fish and Aquatic Resources

Results – Phase 2 Evaluation

Technology List

Mode of Protection	Technology
ENTRAINMENT ABATEMENT TECHNOLOGIES	
Behavioral deterrence/guidance	Sound (infrasonic, sonic, ultrasonic, impulsive/high impact)
	Light (strobe, continuous)
	Chemicals
	Electric barriers
	Air bubble curtain
	Water jet curtain (current inducers; FVES™)
	Hanging chains
	Visual cues
	Multi-technology behavioral system
Physical barrier/guidance	Barrier net
	Aquatic filter barrier

Fish and Aquatic Resources

Results – Phase 2 Evaluation

Preliminary Screening

Technology	Proven Biological Effectiveness	Commercially Available Alternative	Advantages Over The Existing Barrier Net	Potential for Application at LPSP
Behavioral Deterrents				
Sound (infrasonic, sonic, and ultrasonic)	**LIMITED**	**YES**	**NO**	**YES**
Light (strobe, continuous)	LIMITED	YES	NO	NO
Chemicals	NO	YES	NO	NO
Electrical barriers	**LIMITED**	**YES**	**NO**	**YES**
Air bubble curtain	NO	YES	NO	NO
Water jet curtain (current inducers; FVES™)	LIMITED	YES	NO	NO
Hanging chains	NO	YES	NO	NO
Visual cues	NO	YES	NO	NO
Multi-technology behavioral system	LIMITED	YES	NO	NO

Fish and Aquatic Resources

Results – Phase 2 Evaluation

Preliminary Screening

Technology	Proven Biological Effectiveness	Commercially Available Alternative	Advantages Over The Existing Barrier Net	Potential for Application at LPSP
Physical Barriers				
Barrier net	**YES**	**YES**	**YES**	**YES**
Aquatic filter barrier (Gunderboom)	**YES**	**YES**	**NO**	**YES**

Fish and Aquatic Resources

Feasibility Assessment of Alternatives

Alternative	Advantages	Disadvantages	Selected for Detailed Evaluation
Alternative 1 **Existing Barrier Net**	➢ Does not require modifications to the net or current O&M practices ➢ Currently meets established effectiveness criteria for target species	➢ Does not protect smaller organisms, ➢ Does not provide year round protection,	**Yes** ➢ Baseline for other alternatives
Alternative 2 **Potential Modifications to the Existing Barrier Net**	➢ Increases integrity of the existing net ➢ Potential reduction in O&M	➢ Does not protect smaller organisms, ➢ Does not provide year round protection,	**Yes** ➢ Increased net integrity with the same footprint ➢ Reduced submergence
Alternative 3 **Longer Barrier Net with 1/2-inch Bar Mesh over Entire Net Length**	➢ Increased exclusion of smaller fish (less than 4 inches in length)	➢ New net anchors, ➢ Increased O&M, ➢ Uncertain O&M performance, ➢ Greater visual impact, ➢ Greater navigational hazard, ➢ Does not provide year round protection	**Yes** ➢ Excludes smaller organisms
Alternative 4 **Existing Barrier Net with a Full-Scale Ultrasonic Deterrent System (ensonification of entire net length)**	➢ Does not require modifications to the existing net or current O&M practices ➢ Increased exclusion of juvenile and adult alewife over entire net length	➢ Only enhances exclusion effectiveness for alewife, ➢ Does not provide year round protection, ➢ No existing installations of comparable scale, ➢ Requires installation of permanent support structures, ➢ Requires power to operate ➢ Increased O&M	**Yes** ➢ Alewife are the dominant fish found within the barrier net

Fish and Aquatic Resources

Feasibility Assessment of Alternatives

Alternative	Advantages	Disadvantages	Selected for Detailed Evaluation
Alternative 5 Existing Barrier Net with an Electrical Barrier	Potential for increased exclusion of smaller fish	➢ No existing installation of comparable scale	**No**
		➢ Unknown effect on range of fish sizes present	
		➢ Requires installation of permanent anchoring system	➢ May not be effective on wide range of fish sizes
		➢ Requires power to operate	➢ Not proven to repel fish when flow is directed towards an intake
		➢ Worker and public safety concerns	
		➢ Does not provide year round protection	
		➢ Increased O&M	
Alternative 6 Aquatic Filter Barrier	Reduces entrainment of ichthyoplankton and smaller fish (less than 4 inches in length)	➢ Approximately 15 mile length required to meet AFB flow rate design specifications	**No**
		➢ Potential navigation hazard	
		➢ Impacts to recreation and shoreline access and use	➢ Extreme navigation hazard
		➢ Substantial cleaning effort required	➢ Permitting issues
		➢ Does not provide year round protection	
		➢ No existing installation of comparable scale ➢ Uncertain O&M performance	

Fish and Aquatic Resources

Results – Phase 2 Evaluation

Detailed Evaluation of Alternatives

Alternative 1 – The existing barrier net

Alternative 2 – Potential modifications to the existing barrier net

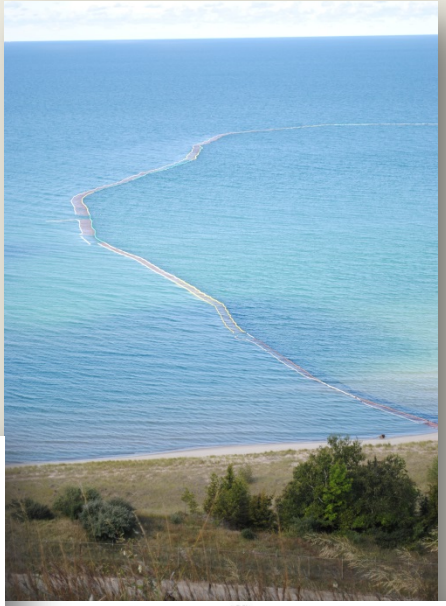
Alternative 3 – A longer barrier net with 1/2-inch bar mesh

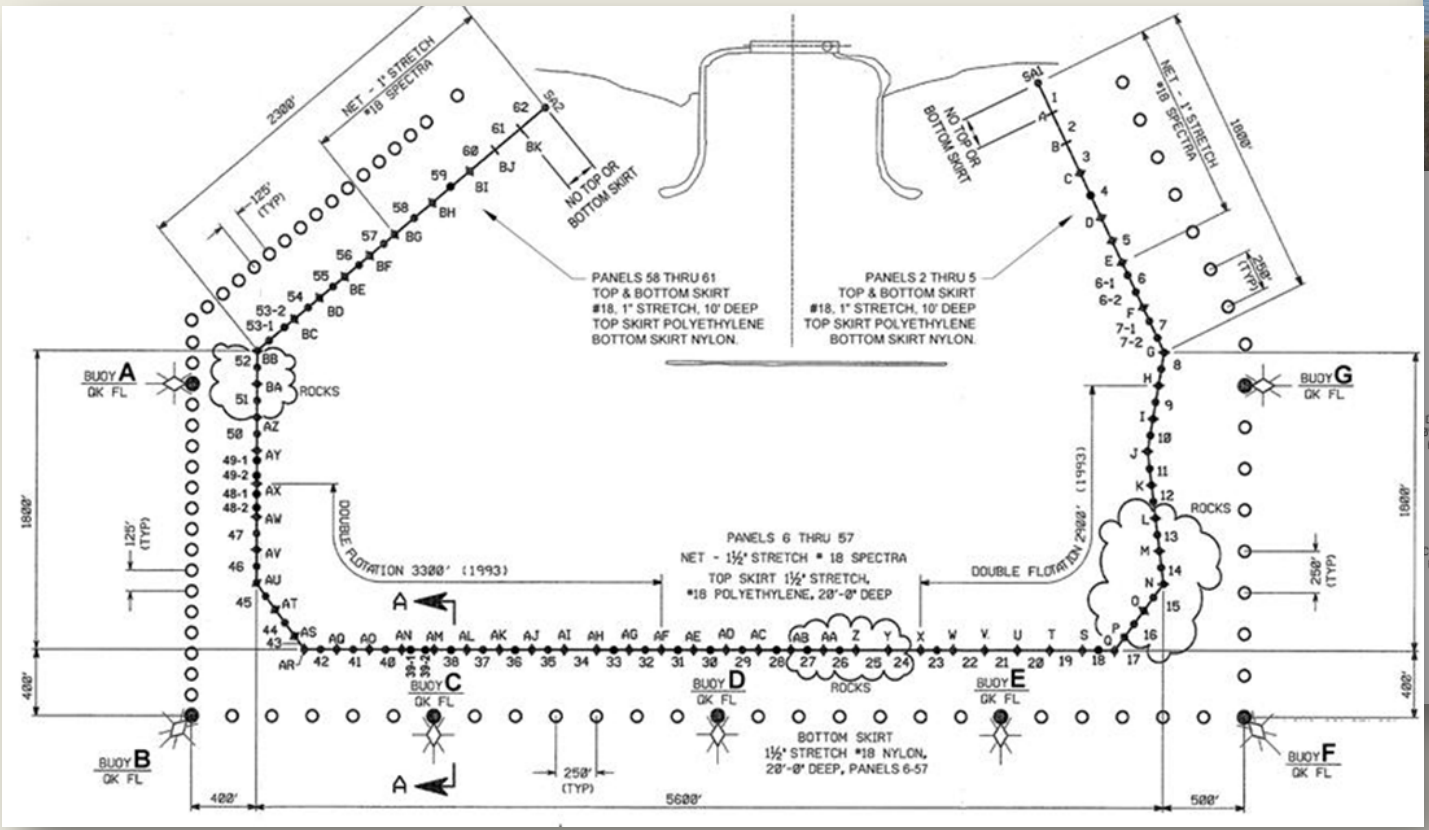
Alternative 4 – The existing barrier net with a full-scale ultrasonic deterrent system

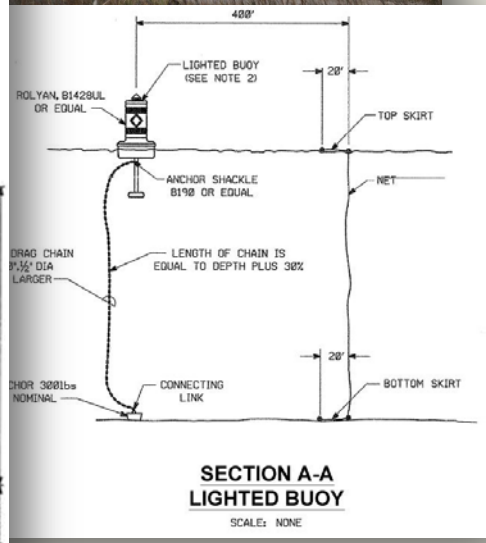
Fish and Aquatic Resources

Results – Phase 2 Evaluation

Alternative 1 – Existing Barrier Net

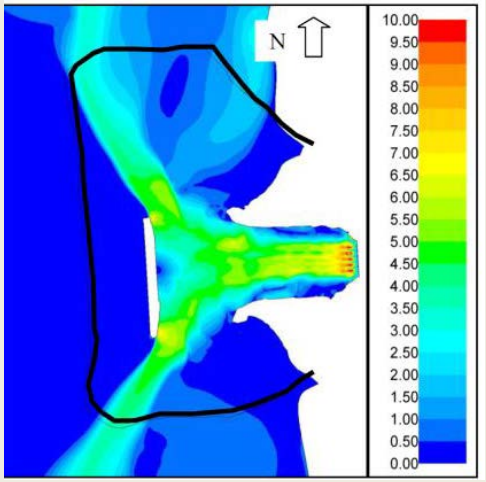




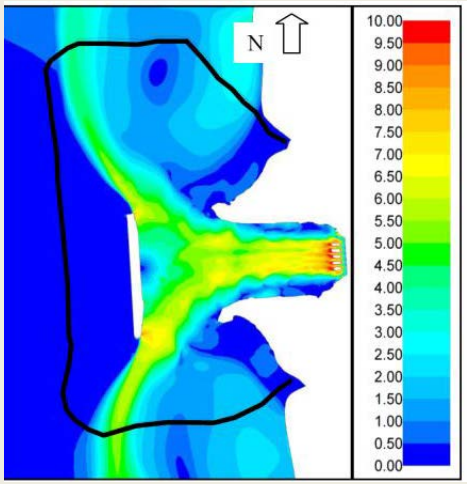


Fish and Aquatic Resources

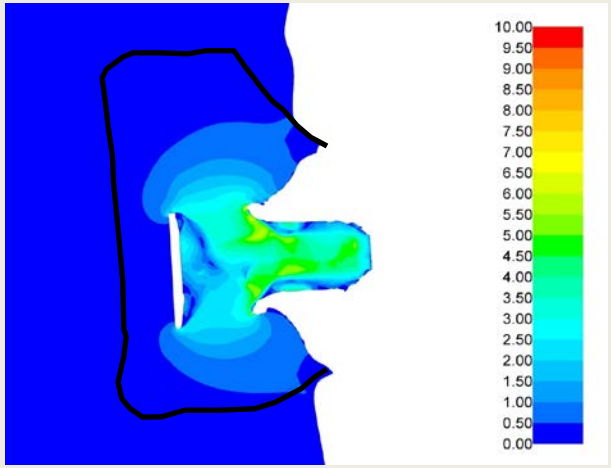
CFD Estimated Surface Velocities



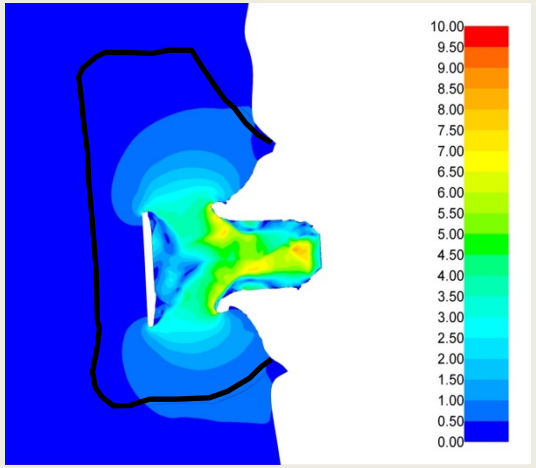
Generating – Original Capacity



Generating – Upgrade Capacity



Pumping – Original Capacity



Pumping – Upgrade Capacity

Fish and Aquatic Resources

Results – Phase 2 Evaluation

Alternative 2 – Potential Modifications to Existing Barrier Net

Adaptive management – monitor and evaluate incremental modifications

- Additional floatation
- Increased top skirt width
- Modified bottom skirt (width and connections)
- Additional bottom anchors
- Increased cleaning frequency
- Ultrasonic anti-fouling system in NW and SW corners

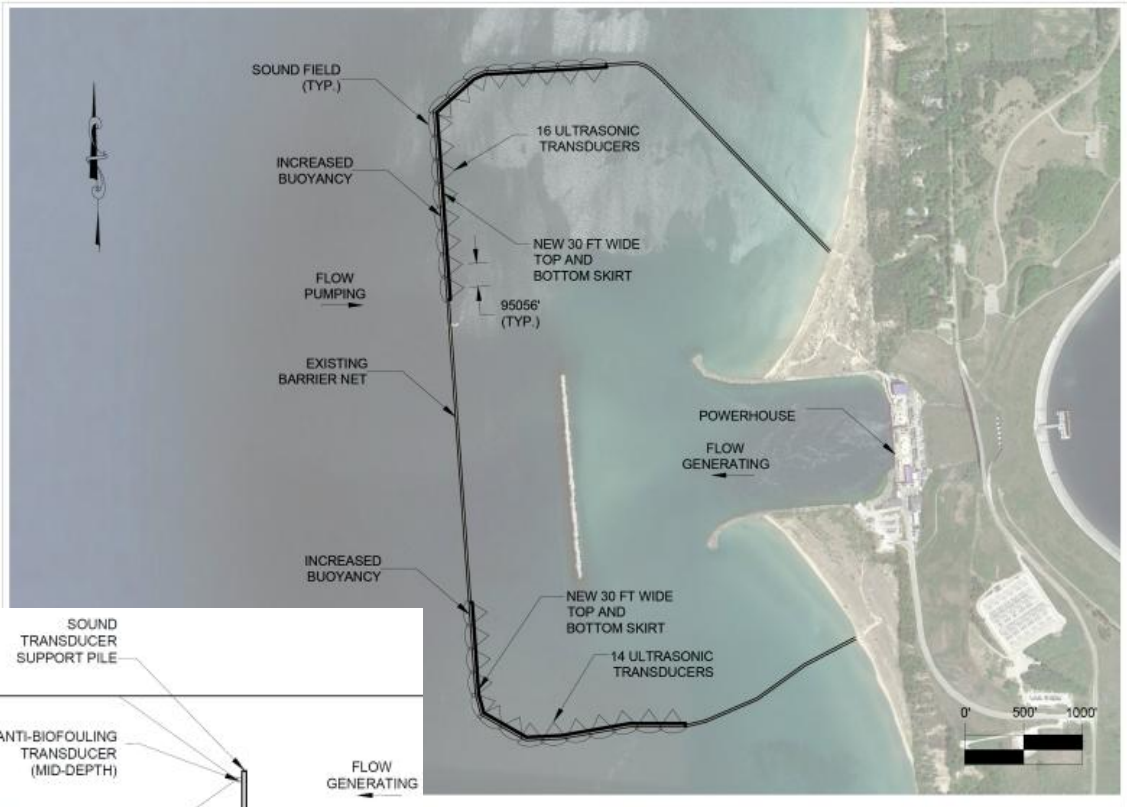
Fish and Aquatic Resources

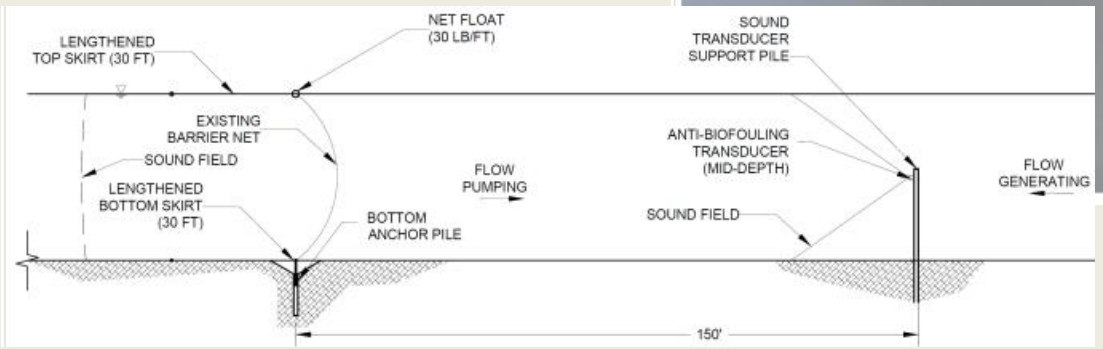
Results – Phase 2 Evaluation

Alternative 2 – Potential Modifications to Existing Barrier Net

Uncertainty and Risks

- Lack of data indicating breach events decrease barrier net performance
- Increased stress on net panels may lead to unforeseen failures.
- Anti-biofouling ultrasonic system untested on barrier nets





Fish and Aquatic Resources

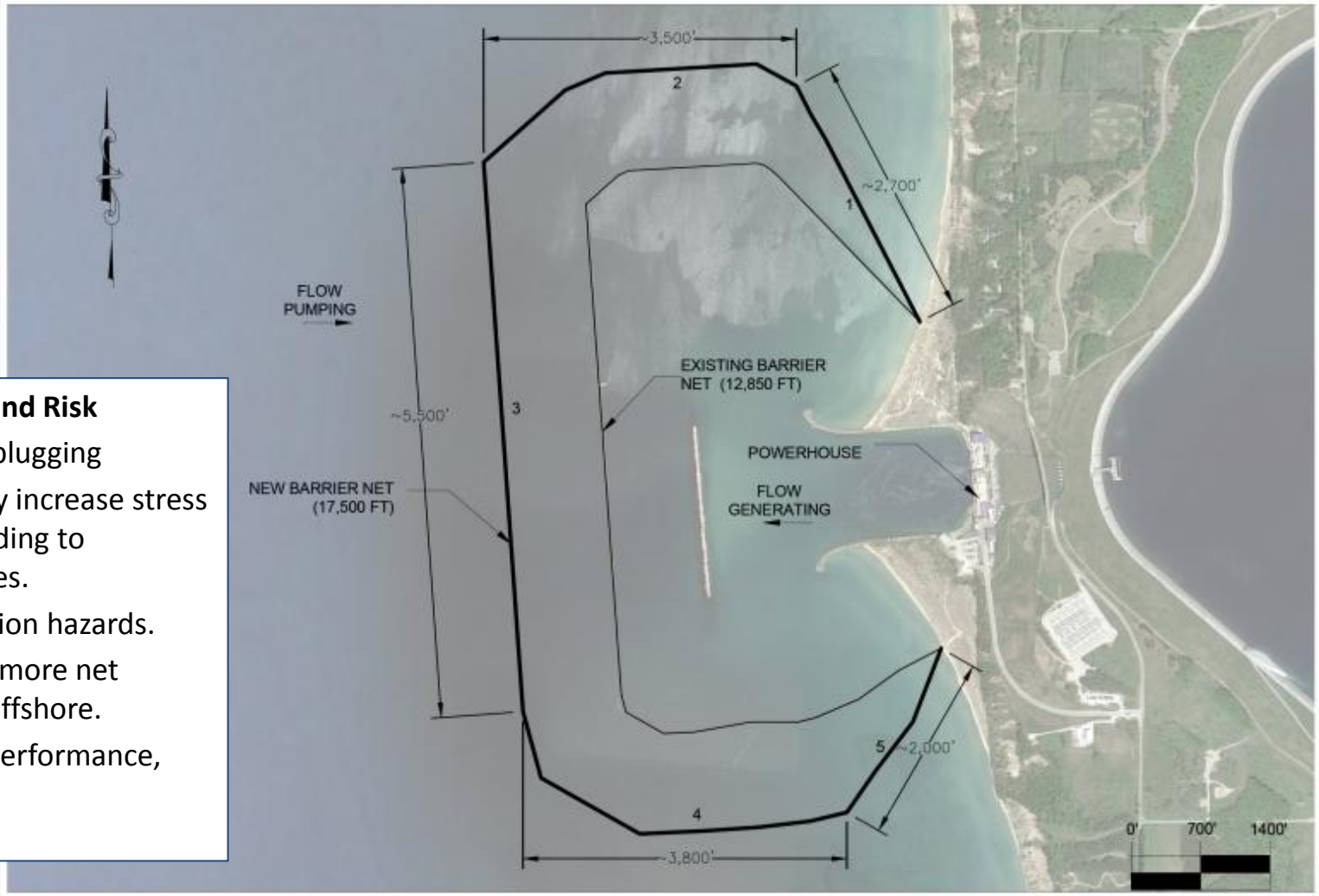
Results – Phase 2 Evaluation

Alternative 3 – Larger Barrier Net with ½-inch Bar Mesh

- Provides greater protection for fish < 4 inches
- Reduction of velocity and drag forces acting on the net
- ~1,000 feet further offshore
- 17,500 ft (3.3 miles) long

Fish and Aquatic Resources

Alternative 3 – Larger Barrier Net with ½-inch Bar Mesh



Uncertainty and Risk

- Increased risk of plugging
- Smaller mesh may increase stress on net panels leading to unforeseen failures.
- Increased navigation hazards.
- O&M issues with more net material farther offshore.
- Uncertain O&M performance,

Fish and Aquatic Resources

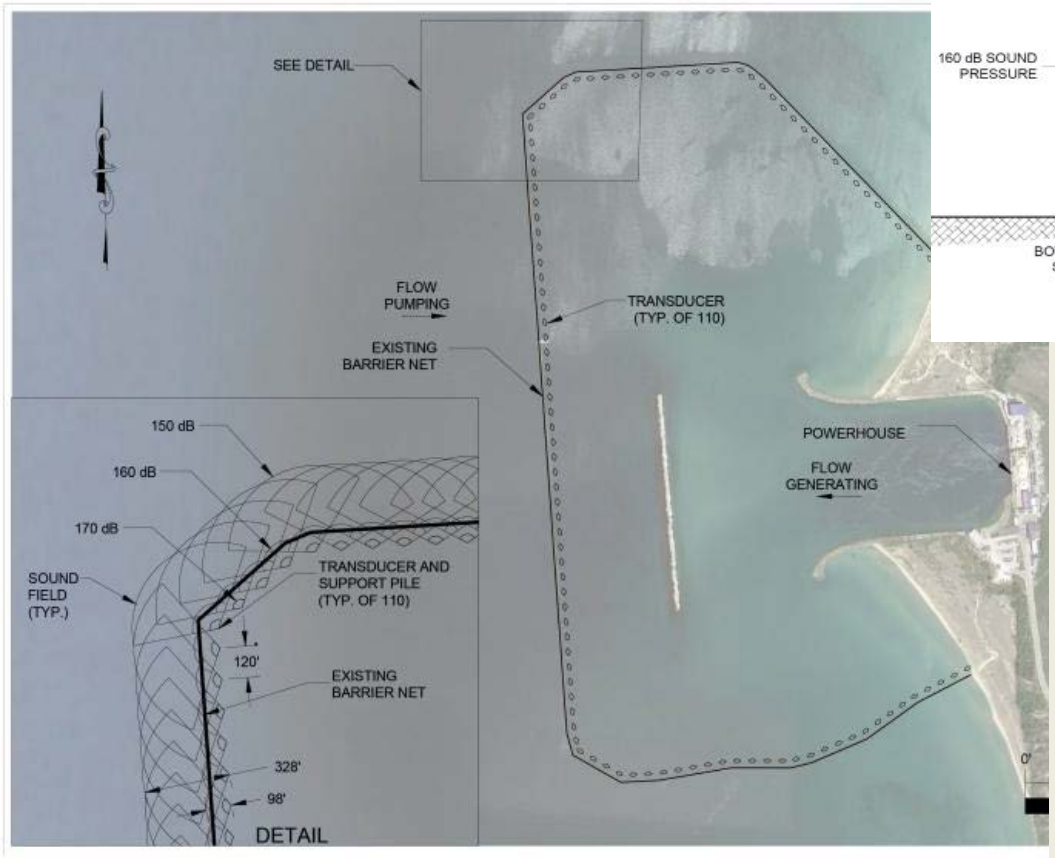
Results – Phase 2 Evaluation

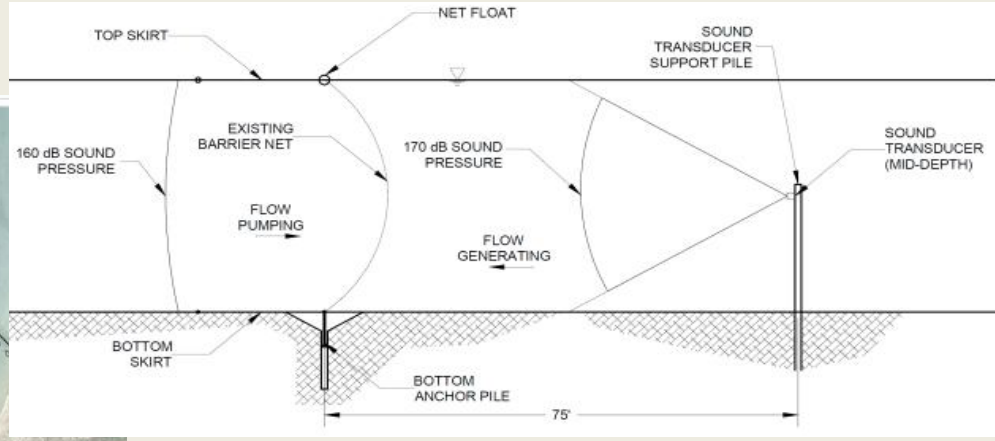
Alternative 4 – Existing Net with Full-scale Ultrasonic Deterrent System

- Enhance performance for alewife
- Alewife account for 74% of gill net catch
- Ultrasonic field (122 – 128 kHz) of entire net
- Deployed seasonally April to October

Fish and Aquatic Resources

Alternative 4 – Existing Net with Full-scale Ultrasonic Deterrent System





Uncertainty and Risk

- Only effective on Alewife (population in decline)
- Never used on this scale
- Acoustic mapping needed to ensure compete ensonification
- Uncertain O&M performance

Fish and Aquatic Resources

Results – Phase 2 Evaluation

Estimated Costs of Alternatives

Alternative	Initial Capital Costs			Annual Costs				
	Total Project Construction Costs (2015 $)	Replacement Power During Construction (2015 $) [1]	Total Capital Costs (2015 $)	Energy (2015 $)[1,2]	Labor (2015 $)[2]	Component Replacement (2015 $)[2,3]	Total Annual Costs (2015 $)[2]	Incremental Annual Costs (2015 $)
Alternative 1, Existing Barrier Net	NA	NA	NA	$440,000	$2,053,000	$324,000	$2,817,000	$0
Alternative 2, Modified Barrier Net	$3,767,000	$2,200,000	$5,967,000	$660,000	$2,258,000	$357,000	$3,275,000	$458,000
Alternative 2a, Modified Barrier Net with Ultrasonic Anti-biofouling	$6,200,000	$4,400,000	$10,600,000	$1,326,000	$2,274,000	$400,000	$4,000,000	$1,183,000
Alternative 3, Longer Barrier Net with ½-inch Bar Mesh	$10,578,000	$4,547,000	$15,125,000	$0	$4,200,000	$442,000	$4,642,000	$1,825,000
Alternative 4, Existing Barrier Net with a Full-Scale Ultrasonic Deterrent System	$15,921,000	$2,933,000	$18,854,000	$885,000	$2,143,000	$662,000	$3,690,000	$873,000

1. Assumes $55 per MWh.
2. Includes existing O&M effort required to maintain the barrier nets when applicable.
3. Barrier net replacement costs are treated as a capital investment by the project owners.

Fish and Aquatic Resources

End