

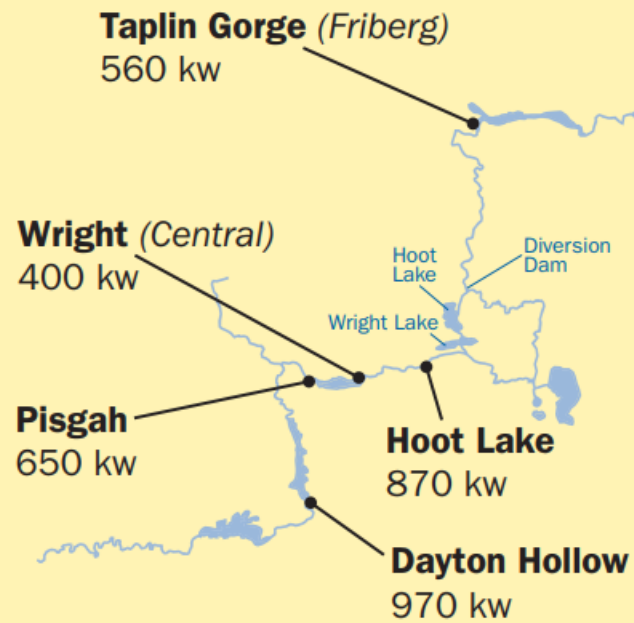


UPDATED STUDY REPORT MEETING

April 29, 2019

PROJECT MAP

Otter Tail River Hydroelectric Plants



AGENDA



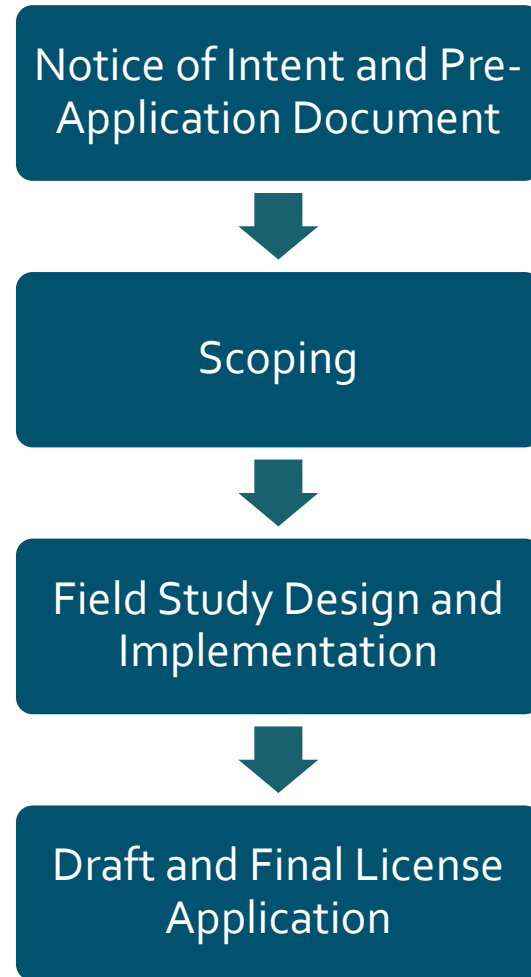
- Introductions
- Purpose of the Meeting
- Relicensing Overview
 - Process
 - Schedule
 - Second Year Studies
- Study Reports
 - Lake Sturgeon Survey
 - Fish Impingement, Entrainment, and Survival Study (Desktop)
 - Mussel Survey
- Additional Information Provided in USR
- Recap and Next Steps

PURPOSE OF THE MEETING

1. Review FERC licensing process
2. Discuss the Updated Study Report results
3. Discuss next steps in the FERC relicensing



RELICENSING PROCESS



RELICENSING PROCESS TO DATE



Milestone	Date
PAD and NOI	June 2016
Scoping Meeting	August 2016
Study Season 1	2017
Initial Study Report	April 2018
Study Season 2	2018
Updated Study Report	April 14, 2019
Updated Study Report Meeting	April 29, 2019

INITIAL STUDY REPORT EFFORTS



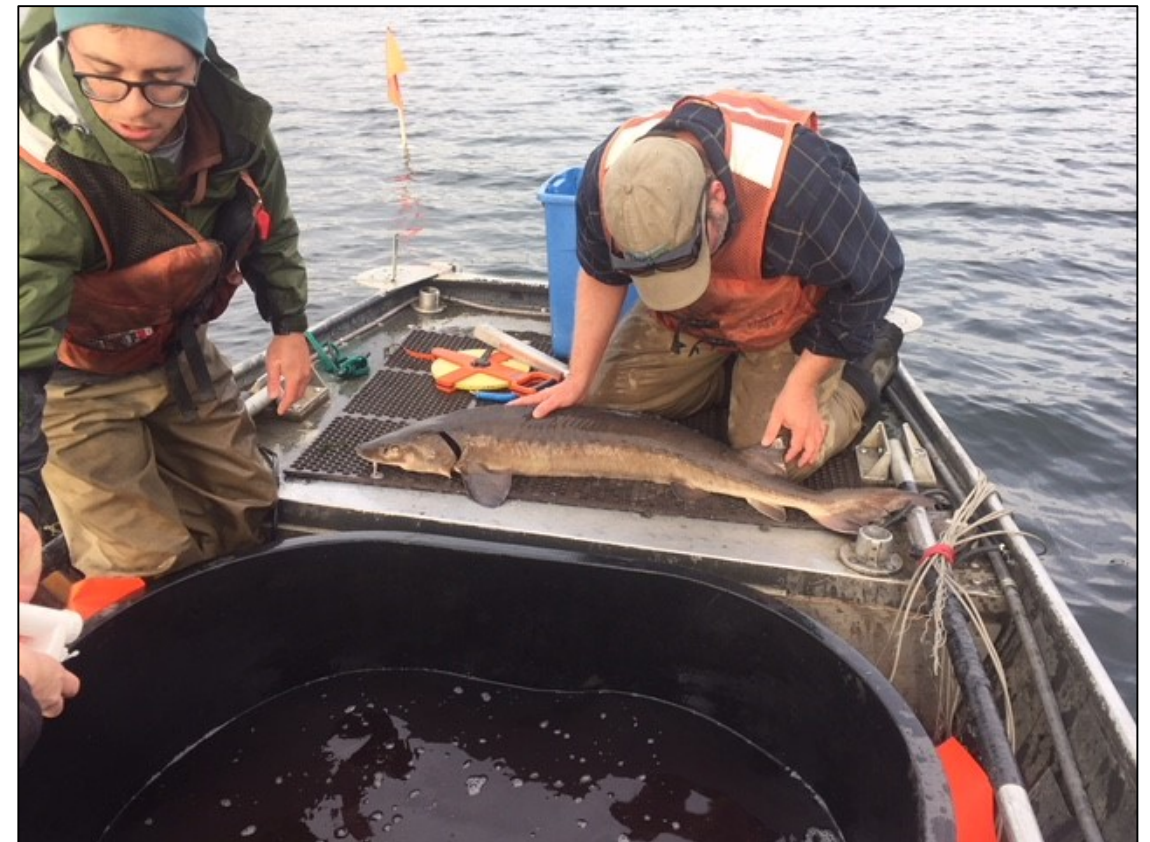
- Friberg Bypassed Reach Instream Flow Study
 - Hoot Diversion Reach Instream Flow Evaluation
 - 2017 Baseline Fisheries Survey
 - Fish Passage Feasibility Study
 - Wildlife Resource Survey
 - Botanical Resource Survey
 - Recreation Use and Facility Inventory Study
 - Cultural Resources Survey
-
- Initial study report meeting on April 26, 2018
 - Filed the summary of the meeting on May 5, 2018

UPDATED STUDY REPORT EFFORTS



- Lake Sturgeon Survey (Midwest Biodiversity Institute)
- Desktop Fish Impingement, Entrainment, and Survival Study (Normandeau Associates)
- Mussel Survey (Endangered Resource Services, LLC)
- Additional Information
 - Recreation Addendum
 - Boating Impediment Data

2018 LAKE STURGEON SURVEY



LAKE STURGEON SURVEY - METHODS

- Planned repeat of Fall 2017 survey
- Gill Nets (200-feet-long, 3 to 6 inch mesh size)
- Set 2 gill nets in each waterbody for 3 consecutive nights (May 7 to May 12)
 - ❖ Orwell Reservoir
 - ❖ Dayton Hollow Reservoir
 - ❖ Hoot Lake
 - ❖ Friberg Reservoir
- Collected length, weight, girth, photos, and presence of tags
- Tagged fish with syringe applicator



LAKE STURGEON – 2018 SPRING RESULTS

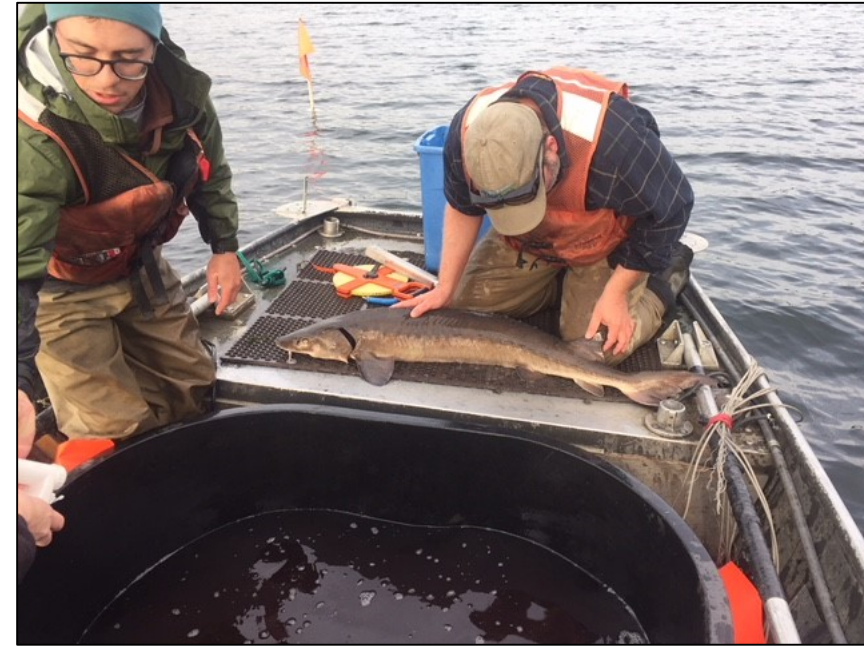


- 41 large-bodied sturgeon collected
- 54% (22) from Hoot Lake; 44% (18) from Friberg
- 1 from Dayton; 0 sturgeon from Orwell
- 4 recaps from fall 2017 survey (Hoot)



LAKE STURGEON – 2018 SPRING RESULTS

- Length range 30 inches to 56.9 inches
- Weight range 5.5 pounds to 34.2 pounds
- Like the fall 2017 survey, most sturgeon were 37 to 48 inches long (61 percent).
- 14 (34.1 percent) were longer than 48 inches.
- 2 (4.9 percent) were smaller than 36 inches.



LAKE STURGEON – SUMMARY

- Collected 75 individual lake sturgeon within the Otter Tail River Project area during the 2017 and 2018 surveys
- Aquatic habitats in the Otter Tail River Project area provide habitat for lake sturgeon to mature and grow



Location	No. Collected (2017)	Percent Total Catch (2017)	No. Collected (2018)	Percent Total Catch (2018)
Friberg Reservoir	9	23.5%	18	43.9
Hoot Lake	17	50.0%	22	53.7
Dayton Hollow Reservoir	8	26.5%	1	2.4
Orwell Lake	0	0.0%	0	0
Total	34	100.0%	41	100

DESKTOP FISH ENTRAINMENT, IMPINGEMENT, SURVIVAL



DESKTOP FISH ENTRAINMENT, IMPINGEMENT, SURVIVAL

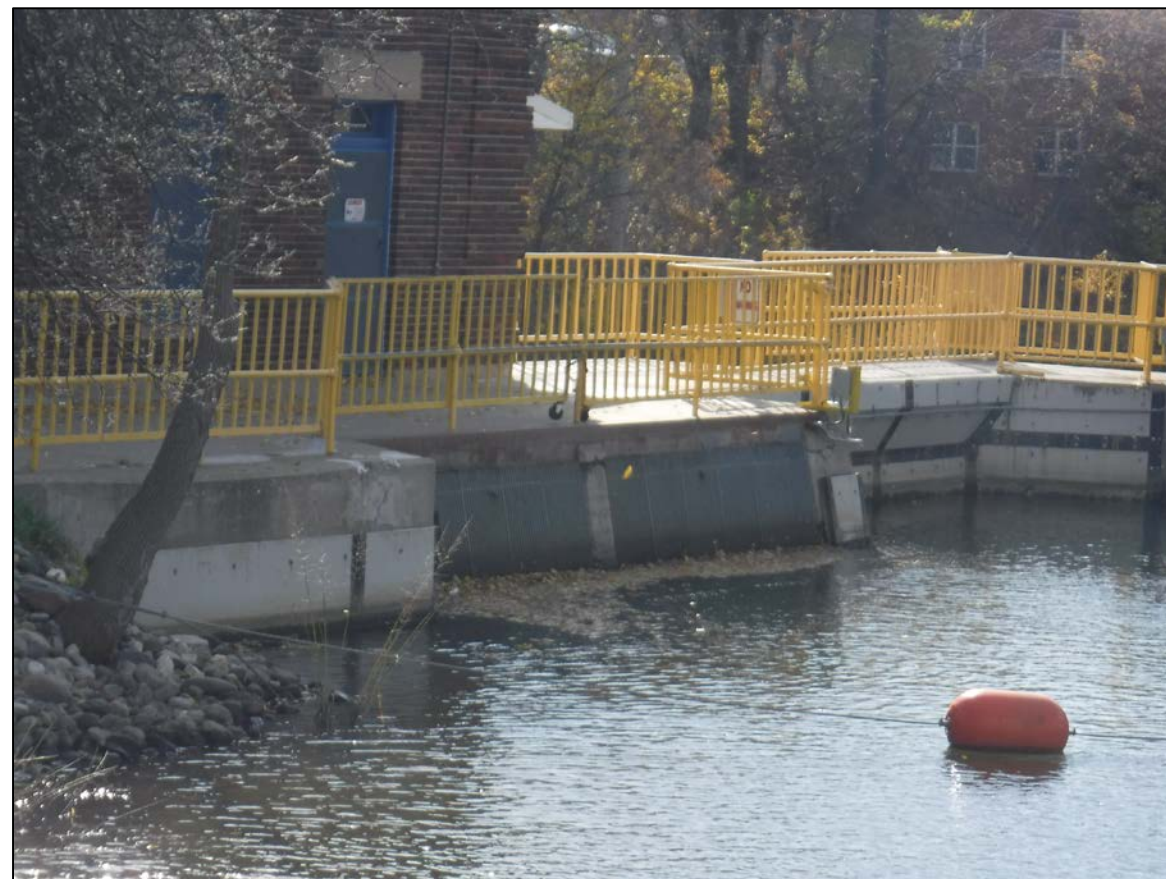
- Entrainment – involuntary passage of fish through the intake / hydro turbines
- Impingement – entrapment against intake racks resulting from increased water velocity
- Desktop Study - routinely used in FERC relicensing process
- Surrogate data from field studies/database of similar hydroelectric facilities/turbines
- Qualitative + Quantitative to Assess Overall Risk
- Blade Strike Models – empirical calcs to evaluate probability of blade strike / survival based on turbine characteristics



DESKTOP FISH ENTRAINMENT, IMPINGEMENT, SURVIVAL - METHODS



- Intake/Debris Rack Spacing
 - Hoot Lake - 1.0 inch
 - Friberg - 1.25 inches
 - Central - 1.25 inches
 - Dayton Hollow - 1.25 inches
 - Pisgah - 2.25 inches
- Calculated Water Velocities at intakes
 - Hoot Lake - 1.1 feet per second
 - Friberg - 1.1 fps
 - Central - 1.9 fps
 - Dayton Hollow - 2.7 fps
 - Pisgah - 2.5 fps



DESKTOP FISH ENTRAINMENT, IMPINGEMENT, SURVIVAL - METHODS

- Target Fish Species for Evaluation (based on management interest)



- Channel Catfish
- Northern Pike
- Lake Sturgeon
- Black Crappie
- Smallmouth Bass
- Walleye
- Yellow Perch



DESKTOP FISH ENTRAINMENT, IMPINGEMENT, SURVIVAL - METHODS

- Burst Swim Speeds

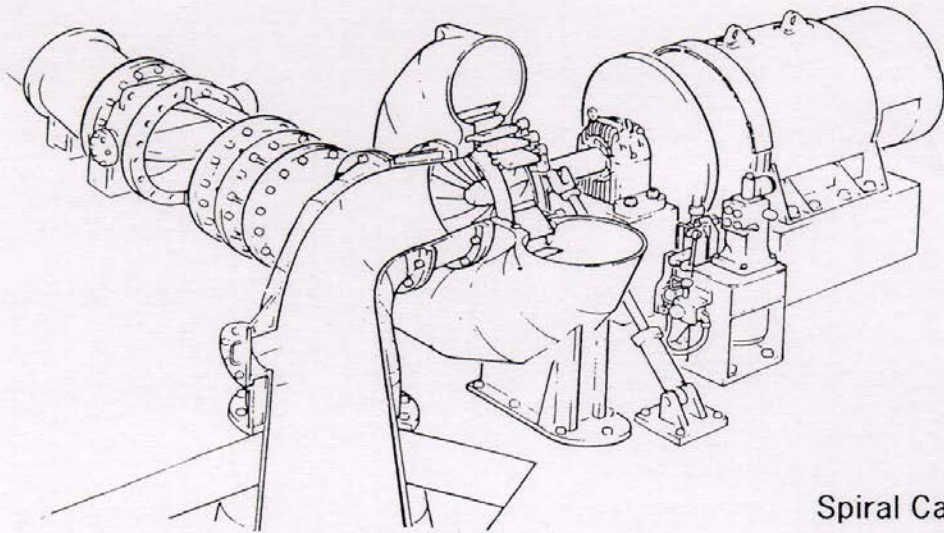
Species	Life Stage	Species Size (in)	Burst/Startle Speed (fps)
Channel Catfish	Juvenile	2	1.5-2.1
	Large Juvenile	6.3-8.3	3.9
Lake Sturgeon	Juvenile	6	1.2-1.7
	Large Juvenile	14	1.7-2.8
	Adult	47	4.5-6.3
Northern Pike	Juvenile/Adult	4.7-24.4	0.9-13.8
Black Crappie	Juvenile	2.0-4.0	1.0-1.5
Smallmouth Bass	Juvenile	3.6-3.7	1.9-3.6
	Adult	10.5-14.9	2.3-7.8
Walleye	Juvenile	3.2-6.3	1.8-6.0
	Adult	13.8-22.4	3.9-8.6
Yellow Perch	Juvenile	3.7-4.1	0.7-2.2
	Juvenile/Adult	Unknown	1.4-3.0



DESKTOP FISH ENTRAINMENT, IMPINGEMENT, SURVIVAL - METHODS



- Turbine Characteristics
 - Type of turbine / orientation / manufacturer
 - No. of turbine blades
 - Revolutions per minute
 - Head/Height
 - Water capacity (cfs)



Spiral Cased
Francis Turbine

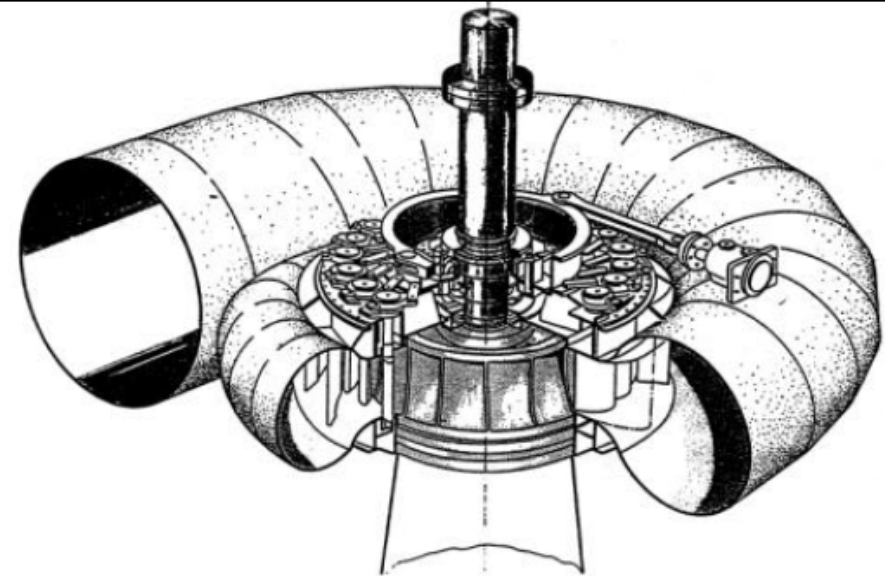


Figure 1 : General view of a Francis model turbine



- **Blade Strike Probability**

- Forces on a fish's body from contact with turbine components (e.g., rotating blades, draft tube, passage through gaps between the blades and hub)
- The model predicts the probabilities of leading edge strikes based on:
 - ✓ number of turbine blades (or buckets; N),
 - ✓ fish length (L), runner blade speed (rpm),
 - ✓ turbine type, runner diameter (D),
 - ✓ and total discharge (Q)

$$P = \lambda \frac{N \cdot L}{D} \cdot \left[\frac{\sin \alpha_t \cdot \frac{B}{D_1}}{2 Q_{\omega d}} + \frac{\cos \alpha_t}{\pi} \right]$$

DESKTOP FISH ENTRAINMENT, IMPINGEMENT, SURVIVAL - RESULTS

Site/Unit	Turbine Type	Operation	Discharge (cfs)	Efficiency (%)	Correlation Factor*	Predicted Survival (%) by Body Length (in)						
						4	8	12	16	20	24	28
Friberg	Vertical Francis	Max. Capacity	244	0.855	0.1	89.4	78.9	68.3	57.7	.	.	.
					0.2	78.9	57.7	36.6	15.4	.	.	.
		Peak Efficiency	195	0.924	0.1	89.7	79.3	69.0	58.7	.	.	.
					0.2	79.3	58.7	38.0	17.4	.	.	.
Hoot Lake	Horizon. Francis	Max. Capacity	220	0.824	0.1	79.6	59.3	38.9	.	.	.	.
					0.2	59.3	18.5	0.0	.	.	.	.
		Peak Efficiency	210	0.826	0.1	79.6	59.3	38.9	.	.	.	.
					0.2	59.3	18.5	0.0	.	.	.	.
Central	Vertical Francis	Max. Capacity	307	0.83	0.1	88.5	76.9	65.4	53.8	.	.	.
					0.2	76.9	53.8	30.7	7.6	.	.	.
		Peak Efficiency	262	0.87	0.1	88.7	77.3	66.0	54.7	.	.	.
					0.2	77.3	54.7	32.0	9.3	.	.	.
Pisgah	Vertical Francis	Max. Capacity	363	0.83	0.1	90.0	80.1	70.1	60.1	50.1	40.2	30.2
					0.2	80.1	60.1	40.2	20.2	0.3	0.0	0.0
		Peak Efficiency	310	0.87	0.1	90.2	80.3	70.5	60.7	50.8	41.0	31.2
					0.2	80.3	60.7	41.0	21.3	1.6	0.0	0.0
Dayton Unit 1	Horizon. Francis	Max. Capacity	570	0.85	0.1	92.8	85.7	78.5	71.3	.	.	.
					0.2	85.7	71.3	57.0	42.7	.	.	.
		Peak Efficiency	450	0.91	0.1	92.8	85.6	78.3	71.1	.	.	.
					0.2	85.6	71.1	56.7	42.2	.	.	.
Dayton Unit 2	Horizon. Francis	Max. Capacity	570	0.81	0.1	94.5	88.9	83.4	77.9	.	.	.
					0.2	88.9	77.9	66.8	55.8	.	.	.
		Peak Efficiency	450	0.88	0.1	94.3	88.6	82.9	77.3	.	.	.
					0.2	88.6	77.3	65.9	54.5	.	.	.



*** Correlation Factor** - individual fish may not lie entirely in the plane of revolution; an impact on a sensitive portion of the fish body may be more damaging than an impact to a less sensitive portion (head vs tail).

DESKTOP FISH ENTRAINMENT, IMPINGEMENT, SURVIVAL - RESULTS



- Impingement and Entrainment Potential
 - All 7 species able to avoid entrainment and impingement at Friberg and Hoot Lake (1.1 fps; narrow racks)
 - Intake velocities at Central (1.9 fps), Dayton Hollow (2.7 fps), and Pisgah (2.9 fps) are near the low end of reported burst speeds of channel catfish, smallmouth bass, walleye, lake sturgeon, and northern pike
 - Black crappie and small yellow perch have the highest potential to become impinged or entrained at Central, Dayton, Pisgah as a result of size, habitat preferences, and slower swim speeds
 - Lack of migration and small size of intakes relative to the total area of littoral zone suggests that operations are not likely to adversely affect black crappie at population level

2018 FRESHWATER MUSSEL SURVEY



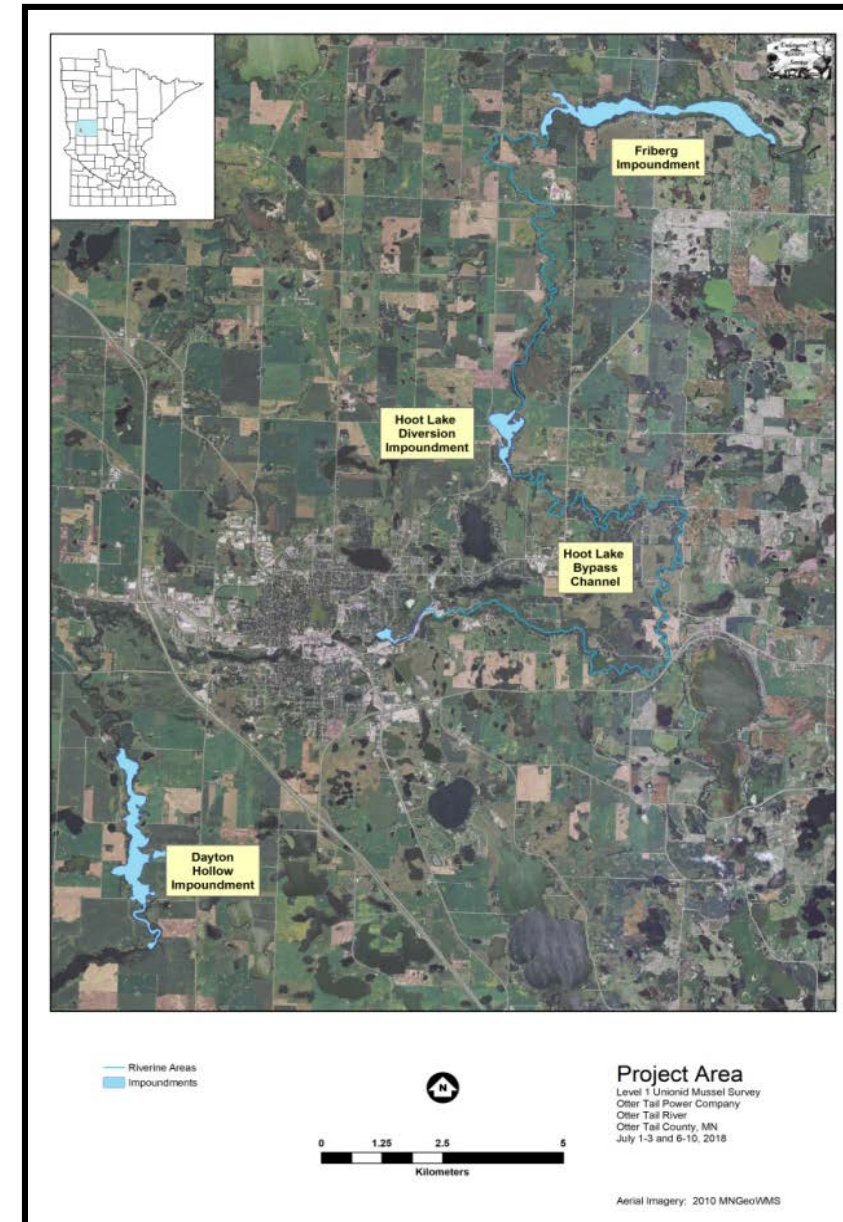
Wabash pigtoe



Plain pocketbook

MUSSEL SURVEY - METHODS

- Comprehensive inventory of species diversity, richness, abundance, and distribution
- Level 1 Qualitative Survey – designed with staff from MNDNR
- 4 survey sites per shoreline/river mile (159 total survey stations)
 - 31 stations in the Friberg Impoundment
 - 25 stations between the Friberg Dam and the Hoot Lake Diversion Impoundment
 - 13 stations in the Hoot Lake Diversion Impoundment
 - 53 stations in the Hoot Lake Diversion Channel
 - 6 stations in the Hoot Lake tailwater below Wright Lake
 - 27 stations in the Dayton Hollow Impoundment
 - 4 stations in the Dayton Hollow Tailwater



MUSSEL SURVEY - METHODS

Field Methods

- GPS waypoint at the upstream starting point
- One-person hour timed search
- Four to five surveyors depending on conditions
- Snorkelers focusing on areas <1m deep with low current
- SCUBA divers concentrating on areas >1m deep and/or with moderate to high current
- Individuals placed on sorting tables, photographed, separated, and identified by species
- Measured the smallest and largest juvenile (0-5 annular rings) and adult (>5 annual rings)
- Tallied the total number of live individuals



MUSSEL SURVEY - ANALYSIS



- Total number of sites with live mussels
- Total number of sites with live mussels or relict shells
- Frequency of occurrence (the percentage of locations that had live unionid mussels)
- Frequency of historical occurrence (the percentage of locations that had any evidence of unionid mussels)
- Frequency of historical survivorship (the percentage of locations with historical evidence that still had live unionid mussels)
- Simpson's Diversity Index (probability that two individuals will be different species; values range from 0.0 to 1.0)
- Average number of live species and individuals per site
- Total live individuals
- Species richness
- Historic species richness (live and relict shells)
- Historical species survivorship (the percentage of all species encountered that were represented by at least one live individual)

Species	Common Name	State Status	Number of Individuals	Number of Sites Where Found	Freq. of Occurrence at Sites with Live Mussels	Freq. of Occurrence at all Sites	Mean Number of Individuals at Sites Where Present	Mean Number of Individuals at All Sites with Live Mussels	Additional Sites with Relict Shells Only
<i>Amblema plicata</i>	Threeridge		18,279	145	98.64	91.19	126.06	121.86	3
<i>Lampsilis siliquoidea</i>	Fatmucket		714	99	67.35	62.26	7.21	4.76	18
<i>Fusconaia flava</i>	Wabash pigtoe		689	117	79.59	73.58	5.89	4.59	19
<i>Lasmigona costata</i>	Fluted-shell	THR.	505	85	57.82	53.46	5.94	3.37	9
<i>Pyganodon grandis</i>	Giant floater		159	41	27.89	25.79	3.88	1.06	13
<i>Quadrula quadrula</i>	Mapleleaf		153	39	26.53	24.53	3.92	1.02	1
<i>Strophitus undulatus</i>	Creeper		153	41	27.89	25.79	3.73	1.02	20
<i>Lasmigona complanata</i>	White heelsplitter		80	38	25.85	23.90	2.11	0.53	10
<i>Lampsilis cardium</i>	Plain pocketbook		69	19	12.93	11.95	3.63	0.46	13
<i>Pyganodon lacustris</i>	Lake floater		15	4	2.72	2.52	3.75	0.10	3
<i>Utterbackia imbecillis</i>	Paper pondshell		14	9	6.12	5.66	1.56	0.09	3
<i>Lasmigona compressa</i>	Creek heelsplitter	S.C.	1	1	0.68	0.63	1.00	0.01	9
<i>Ligumia recta</i>	Black sandshell	S.C.	1	1	0.68	0.63	1.00	0.01	14
<i>Dreissena polymorpha</i>	Zebra mussel	Exotic	*	59	40.14	37.11	*	*	0
<i>Corbicula fluminea</i>	Asian Clam	Exotic	*	1	0.68	0.63	*	*	0
<i>Anodontoides ferussacianus</i>	Cylindrical papershell		**	**	98.64	91.19	**	**	2
<i>Potamilus alatus</i>	Pink heelsplitter		**	**	67.35	62.26	**	**	1

* Exotic Species – Excluded from Unionid Community Analysis

** Relict Shell Only

Summary Statistics:	Project Area	Friberg Imp.	Friberg Dam to Hoot Div. Imp.	Hoot Lake Diversion Imp.	Hoot Lake Div. Chan.	Hoot Lake Tailwater	Dayton Reservoir	Dayton Tailwater
Total number of sites	159	31	25	13	53	6	27	4
Total number of sites - live mussels	147	26	24	9	51	6	27	4
Total number of sites - live mussels or relict shells	150	26	25	10	52	6	27	4
Frequency of occurrence	92.45	83.87	96.00	69.23	96.23	100.00	100.00	100.00
Frequency of historical occurrence	94.34	83.87	100.00	76.92	98.11	100.00	100.00	100.00
Frequency of historical survivorship	98.00	100.00	96.00	90.00	98.08	100.00	100.00	100.00
Simpson diversity index	0.23	0.34	0.22	0.12	0.26	0.13	0.17	0.23
Mean # of live species/site (live mussels only)	4.35	4.81	5.46	3.56	3.33	4.67	4.93	5.00
Mean # of live species/site (live or relict shells)	4.26	4.81	5.24	3.20	3.27	4.67	4.93	5.00
Mean # of live species/site (all sites)	4.02	4.03	5.24	2.46	3.21	4.67	4.93	5.00
Mean # of all species/site (live or relict shells)	5.18	5.31	5.68	3.60	4.63	6.50	5.56	7.75
Mean # of all species/site (all sites)	4.89	4.45	5.68	2.77	4.55	6.50	5.56	7.75
Mean # of live individuals/site (live mussels only)	141.71	108.65	276.38	96.33	89.71	268.50	138.44	145.75
Mean # of live individuals/site (live or relict shells)	138.88	108.65	265.32	86.70	87.98	268.50	138.44	145.75
Mean # of live individuals/site (all sites)	131.02	91.13	265.32	66.69	86.32	268.50	138.44	145.75
Total live individuals	20,832	2,825	6,633	867	4,575	1,611	3,738	583
Total live juveniles	370	54	94	7	46	26	134	9
% juveniles	1.78	1.91	1.42	0.81	1.01	1.61	3.58	1.54
Species richness	13	10	10	8	8	8	9	8
Species richness (including relict shells)	15	11	12	8	12	9	12	9

MUSSEL SURVEY - SUMMARY



- Level 1 surveys are a qualitative method with primary goal of defining the community assemblage
- Mussel density throughout much of the project area was exceptional and comparable to many high quality sites in MN
- Richness was high for the Red River of the North drainage with the majority of species known being present
- Conversely, species diversity index was classified as low
- Predominance of threeridge unique



ADDITIONAL INFORMATION PROVIDED IN USR



USR incorporated FERC's recommendations:

- Mapping of boating impediments
 - GPS coordinates of impediments to boating during the paddling portion of
 - Friberg Bypassed Reach Instream Flow Study
 - Hoot Diversion Reach Instream Flow Evaluation
- Recreation Use and Facility Inventory Study modifications
 - Include the City of Fergus Falls Riverwalk in the inventory assessment.
 - Include a description and photographs of existing safety signage, and address any lack of safety signage.
 - Included discussion of how facilities would provide recreational opportunities for persons with disabilities.
 - Included discussion of whether or not erosion is occurring at each recreation site and access area.

Recap and Next Steps

SCHEDULE

Milestone	Date
Otter Tail files Updated Study Report	4/14/2019
Otter Tail conducts Updated Study Report Meeting	4/29/2019
Otter Tail files meeting summary	5/14/2019
Stakeholders submit any disputes/Requests to Amend Study Plan	6/13/2019
Otter Tail submits responses to disputes/amendment requests	7/13/2019
FERC Director's Determination of Disputes/Amendments	8/12/2019
Otter Tail files Draft License Application	7/3/2019
Stakeholders submit responses to Draft License Application	10/01/2019
Otter Tail files Final License Application	11/30/2019

