Otter Tail River Project (FERC No. 10853)
Otter Tail Power Company

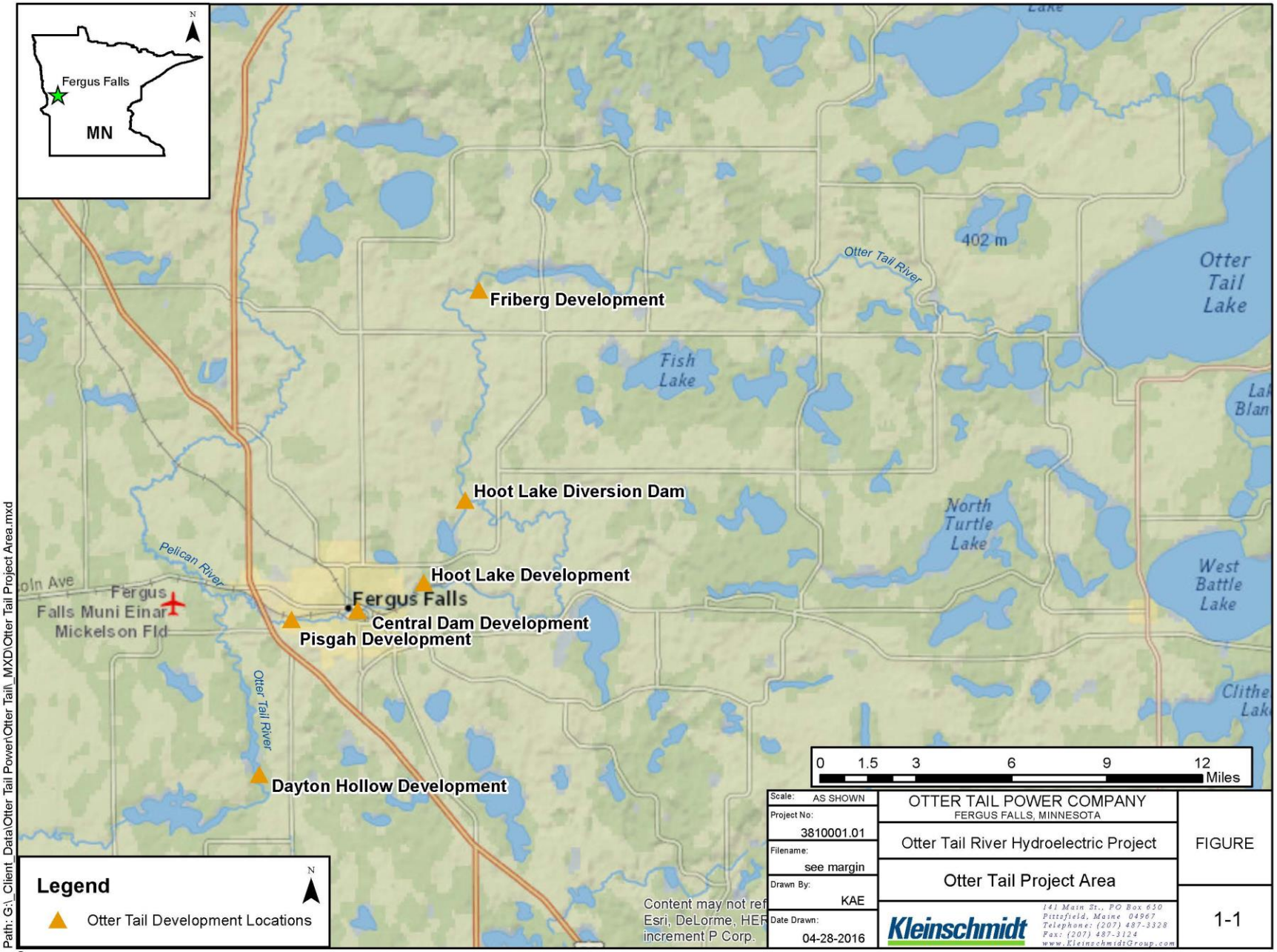
Initial Study Report

2017 Aquatic Studies

April 26, 2018

Study List

Study Name	Status
Baseline Fisheries	Completed June-August 2017
Lake Sturgeon Sampling	Initial Survey Completed Oct 2017
Friberg Instream Flow	Completed late-August 2017
Hoot Diversion Reach Instream Flow	Completed October 2017
Fish Passage Feasibility	Completed Fall 2017


Fergus Falls
MN
Friberg Development
Hoot Lake Diversion Dam
Hoot Lake Development
Fergus Falls
Central Dam Development
Pisgah Development
Dayton Hollow Development
Fergus Falls Muni Einar Mickelson Fld
Pelican River
Otter Tail River
Otter Tail River
402 m
Otter Tail Lake
Fish Lake
North Turtle Lake
West Battle Lake
0 1.5 3 6 9 12
Miles
Legend
Otter Tail Development Locations
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Drawn By: KAE
Date Drawn: 04-28-2016
OTTER TAIL POWER COMPANY
FERGUS FALLS, MINNESOTA
Otter Tail River Hydroelectric Project
Otter Tail Project Area
FIGURE
1-1
Kleinschmidt
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Pittsfield, Maine 04967
Telephone: (207) 487-3328
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Path: G:_Client_Data\Otter Tail Power\Otter Tail_MXD\Otter Tail Project Area.mxd
Source:

Baseline Fisheries

Goals / Methods

- Goal – provide current information about the composition, relative abundance, and size/age structure of fish species in the Otter Tail River Project area.
- Studies completed by the Midwest Biodiversity Institute
- Field methods (e.g., sampling locations, access, biosecurity) developed in consultation with MNDNR
- Standard MNDNR protocols
  - Early Summer Sampling (trap nets, EFISH, gill nets)
    - Central and Pisgah
  - August Near Shore Sampling (seining, EFISH)
    - Central, Pisgah, Friberg Lake, Hoot Lake, Wright Lake, Dayton Hollow
  - August Sampling (Boat EFISH - riverine)
    - Otter Tail River between Friberg dam and Hoot Diversion dam;
    - Hoot Diversion Reach
  - 111 sampling locations (gill nets, trap nets, seining, electrofishing)
  - Minor modifications to protocols based on field conditions (i.e., shallow areas, heavy vegetation)

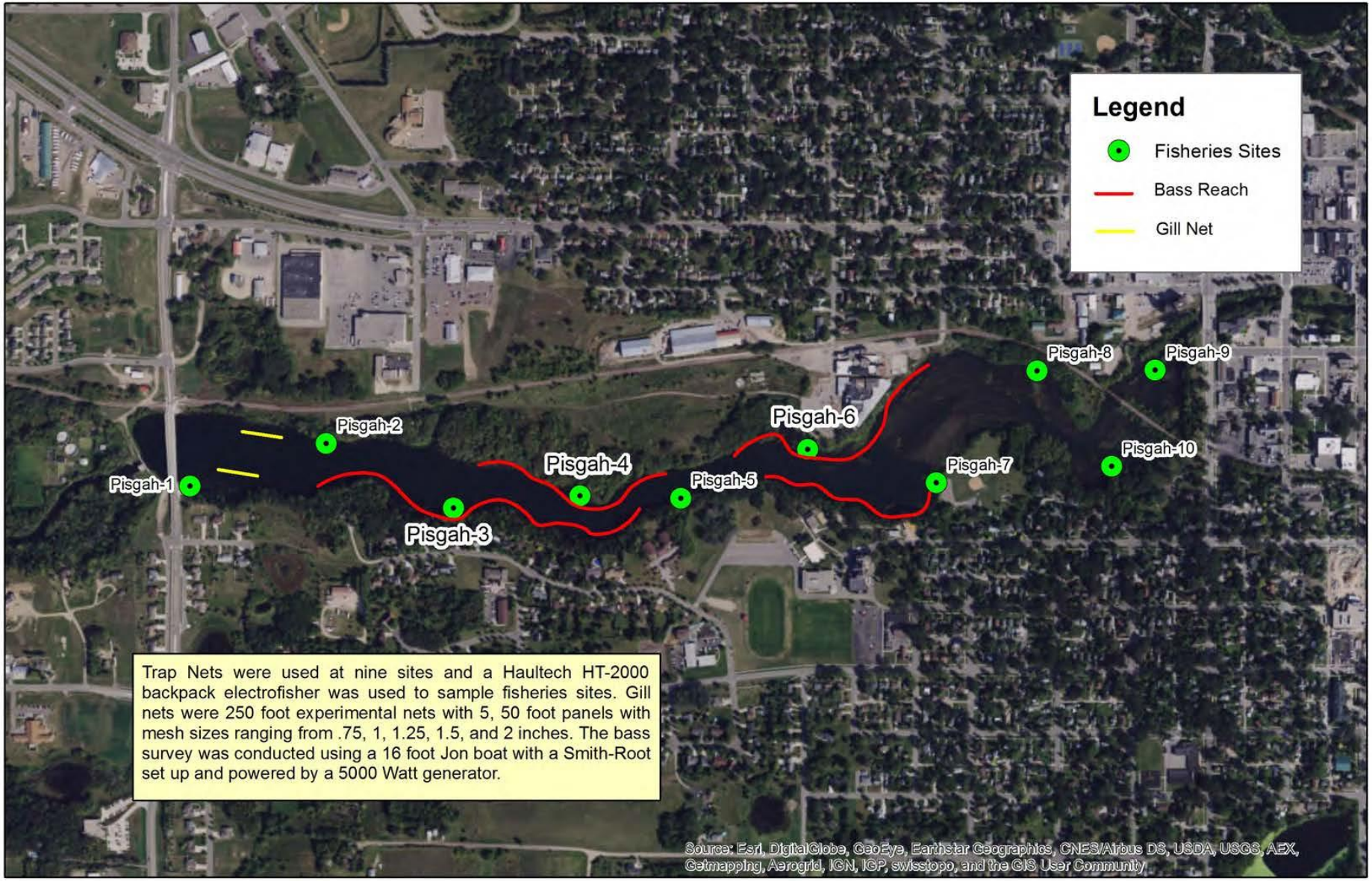
Baseline Fisheries

Goals / Methods

Method	General Description of Gear and Sampling Protocols
Gill Nets	Experimental; 250-feet-long, 6-feet-deep; five 50-foot panels with varying mesh size (0.75, 1.0, 1.25, 1.5 and 2.0 inches); nets fished overnight at two sites for 1 night
Trap Nets	40-foot-long leads/wings approximately 3.5-feet deep; six 30-inch hoops; mesh size 0.75-inch nylon; nets fished overnight in each impoundment at nine sites for 1 night
Beach Seines	5-foot by 50-foot opening with a 0.25-inch nylon mesh bag seine; where vegetation allowed; one to two seine pulls parallel to shore across 100-foot e-fishing site at trap net locations
Boat Electrofisher	18-foot Jon boat outfitted with a 5000-Watt generator; 500-meter sites, sampling in direction of upstream to downstream
Backpack Electrofisher	Haultech HT-2000; 100 feet of shoreline was sampled at same location as trap net sets

Water Body	Survey type	Number of sites/nets	2017 Sampling Timeframe
Central Impoundment	Seining (too much vegetation) Shoreline backpack and boat electrofishing	1 site 10 sites	August August
	Trap netting (too shallow for gill nets)	9 trap nets	June
	Boat electrofishing	3 sites	June
Pisgah Impoundment	Shoreline backpack and boat electrofishing	10 sites	August
	Gill and trap netting	2 gill nets; 9 trap nets	June
	Boat electrofishing	4 sites	June
Friberg Lake	Seining (too much vegetation) Shoreline backpack and boat electrofishing	1 site 10 sites	August August
Hoot Lake	Seining Shoreline backpack electrofishing	4 sites 10 sites	August August
Wright Lake	Seining Shoreline backpack electrofishing	5 sites 10 sites	August August
Dayton Hollow Impoundment	Seining Shoreline backpack electrofishing	1 site 10 sites	August August
Otter Tail River (between Friberg dam and Hoot Diversion dam)	Boat electrofishing	4 sites	August/October
Otter Tail River (Hoot Diversion Reach)	Boat electrofishing	4 sites	August

Pisgah Dam Impoundment Baseline Fishery Study Sites



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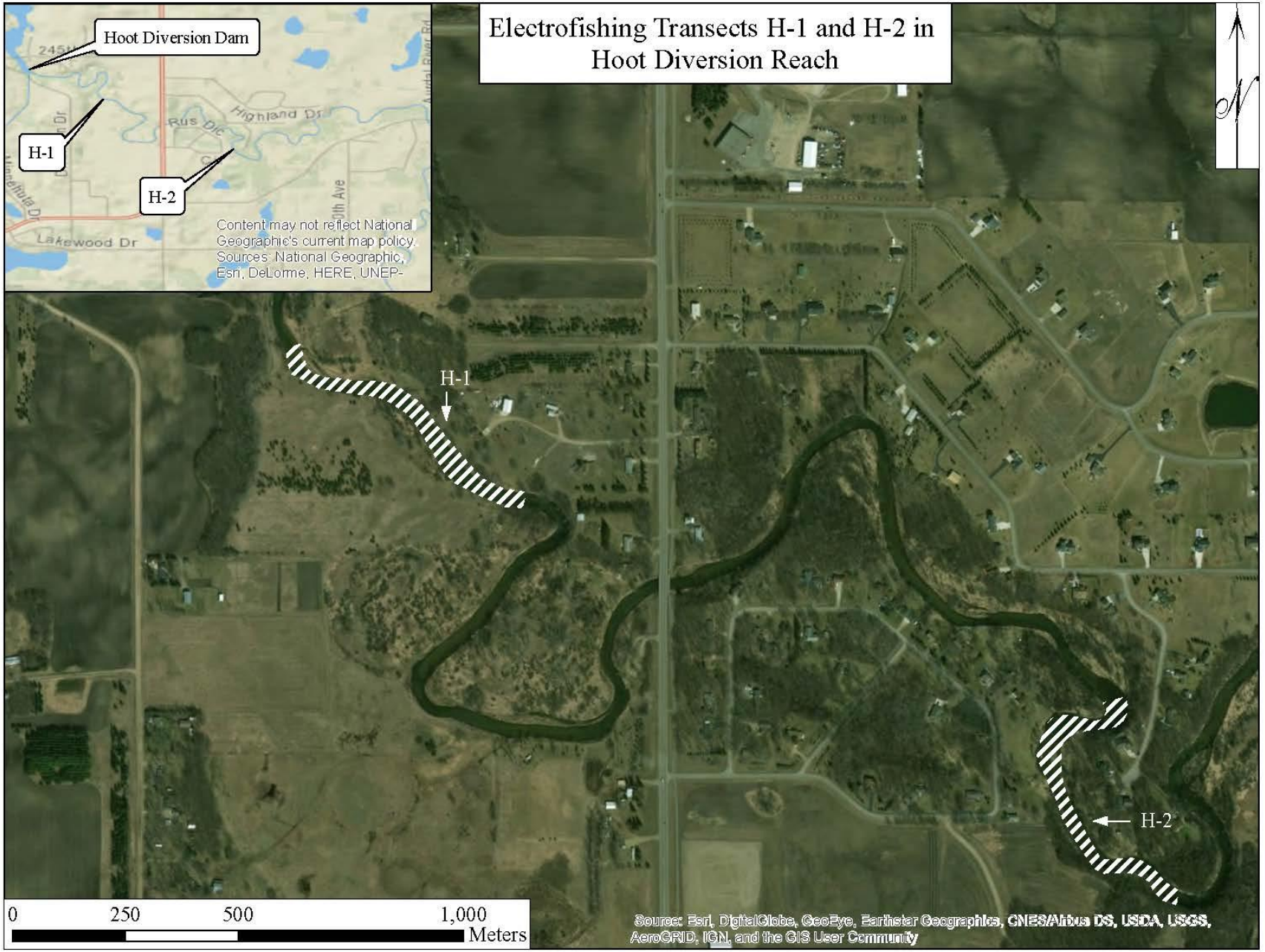
Electrofishing Transects H-1 and H-2 in Hoot Diversion Reach
Hoot Diversion Dam
H-1
H-2
Highland Dr
Lakewood Dr
Content may not reflect National Geographic's current map policy. Sources: National Geographic, Esri, DeLorme, HERE, UNEP-
H-1
H-2
N
0
250
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Meters
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Catch/Results

Sampling Location	No. Fish Collected	No. Species Collected	Dominant Species
Dayton Hollow Impoundment	219	19	green sunfish (26%); Johnny darter (16.9%); blackside darter (15.5%); smallmouth bass (11.9%)
Pisgah Impoundment	455	30	green sunfish (25.6%); bluegill (10.5%); common shiner (8.8%); smallmouth bass (8.6%)
Central Impoundment	475	32	hornyhead chub (14.5%); smallmouth bass (13.7%); common shiner (13.1%); green sunfish (10.9%); rock bass (10.5%)
Hoot Lake	176	14	bluegill (39.2%); green sunfish (15.3%); largemouth bass (11.4%)
Wright Lake	128	12	rock bass (21.9%); bluegill (16.4%); Johnny darter (16.4%); green sunfish (14.8%)
Friberg Impoundment	97	17	bluegill (24.7%); largemouth bass (24.7%); weed shiner (20.6%)
Friberg (Riverine)	369	27	smallmouth bass (37.9%); golden redhorse (10.8%)
Hoot Diversion Reach (Riverine)	688	23	common shiner (25.6%); hornyhead chub (21.7%); northern hogsucker (15.1%); smallmouth bass (15.1%)
Total Catch	2,607	47	smallmouth bass (12.7%); common shiner (11.9%); green sunfish (9.2%); and hornyhead chub (8.4%)

Catch/ Results

Fish Species Composition – 5% or more of total			
Species	**Scientific Name**	**Total collected**	**% of Total**
Smallmouth bass	*Micropterus dolomieu*	330	12.66%
Common shiner	*Luxilus cornutus*	310	11.89%
Green sunfish	*Lepomis cyanellus*	298	11.43%
Hornyhead chub	*Nocomis biguttatus*	219	8.40%
Bluegill	*Lepomis macrochirus*	184	7.06%
Largemouth bass	*Micropterus salmoides*	130	4.99%

Fish Species Composition – 1% to 5% or more of total			
Species	**Scientific Name**	**Total collected**	**% of Total**
Golden redhorse	*Moxostoma erythrurum*	121	4.64%
Northern hogsucker	*Hypentelium nigricans*	113	4.33%
Bluntnose minnow	*Pimephales notatus*	102	3.91%
Rock bass	*Ambloplites rupestris*	93	3.57%
Johnny darter	*Etheostoma nigrum*	91	3.49%
Notropis spp.	-	68	2.61%
Weed shiner	*Notropis texanus*	55	2.11%
Blackside darter	*Percina maculata*	51	1.96%
Nocomis spp.	-	50	1.92%
White sucker	*Catostomus commersonii*	47	1.80%
Northern pike	*Esox lucius*	43	1.65%
Iowa darter	*Etheostoma exile*	33	1.27%

Catch/Results – Impoundment

Species	YOY	Juvenile	Adult	Total
Black crappie	0	7	10	17
Bluegill	103	44	31	178
Bowfin	0	0	10	10
Channel catfish	0	0	1	1
Largemouth bass	63	4	1	68
Northern pike	0	1	17	18
Pumpkinseed	2	5	12	19
Rock bass	30	37	67	134
Smallmouth bass	67	16	68	151
Walleye	0	0	1	1
Yellow perch	0	6	4	10
Total	265	120	222	607
Relative Percent	43.7%	19.8%	36.6%	100.0%

Species	Weight (pounds)	Length (inches)	Sample Method	Impoundment
Common carp	10.26	26.6	Gill Net	Pisgah
Bowfin	5.03	24.0	Trap Net	Pisgah
Smallmouth bass	3.64	18.8	Boat	Central
Northern pike	2.91	22.7	Trap Net	Central
Walleye	1.74	15.6	Gill Net	Pisgah
Black crappie	1.37	12.7	Trap Net	Central
Bluegill	0.88	9.4	Boat	Pisgah
Rock bass	0.82	9.9	Trap Net	Pisgah
Pumpkinseed	0.49	7.7	Trap Net	Pisgah
Channel catfish	0.15	7.4	Trap Net	Central
Yellow perch	0.11	6.0	Trap Net	Pisgah
Largemouth bass	0.04	4.5	Boat	Pisgah

Baseline Fisheries

Summary

- Fisheries survey completed in accordance with study plan
  - minor adjustments due to vegetation and water depth (too shallow)
- Otter Tail Project Area provides:
  - Diverse assemblage of game, non-game, and native fish species and habitats
  - Multiple life stages (nursery, rearing, spawning)
  - Littoral shorelines, pelagic habitats, riverine habitats

Baseline Fisheries

Fall Lake Sturgeon

Goals / Methods

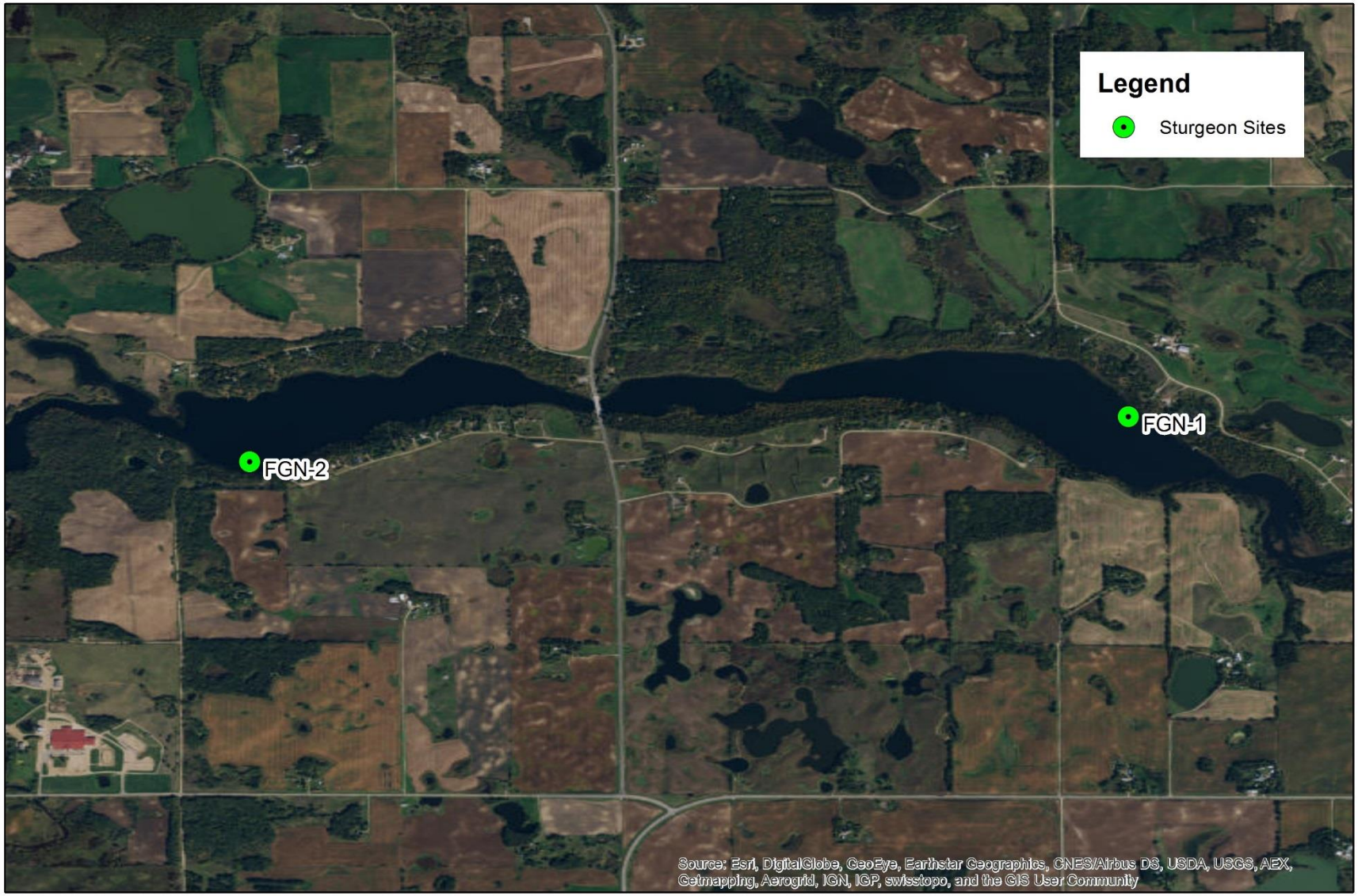
- Goal – obtain information about the distribution, size, and age structure of lake sturgeon in 4 waterbodies:
  - Orwell Lake
  - Dayton Hollow Reservoir
  - Hoot Lake
  - Friberg Lake
- Field methods (logistics, sample locations) developed in consultation with MNDNR/USFWS prior to survey work
- Sampling from October 17 – October 23 with assistance from USFWS/MNDNR

Fall Lake Sturgeon

Methods

- Two 200-foot-long experimental nets set in each waterbody for 3 consecutive nights
- Net soak times of 15 to 17 hours; checked each morning
- Biological data: length, weight, girth, presence of tags
- PIT-tagged with syringe applicator
- Sampling depth: 10 to 40 feet

Friberg Dam Impoundment Sturgeon Study Sites



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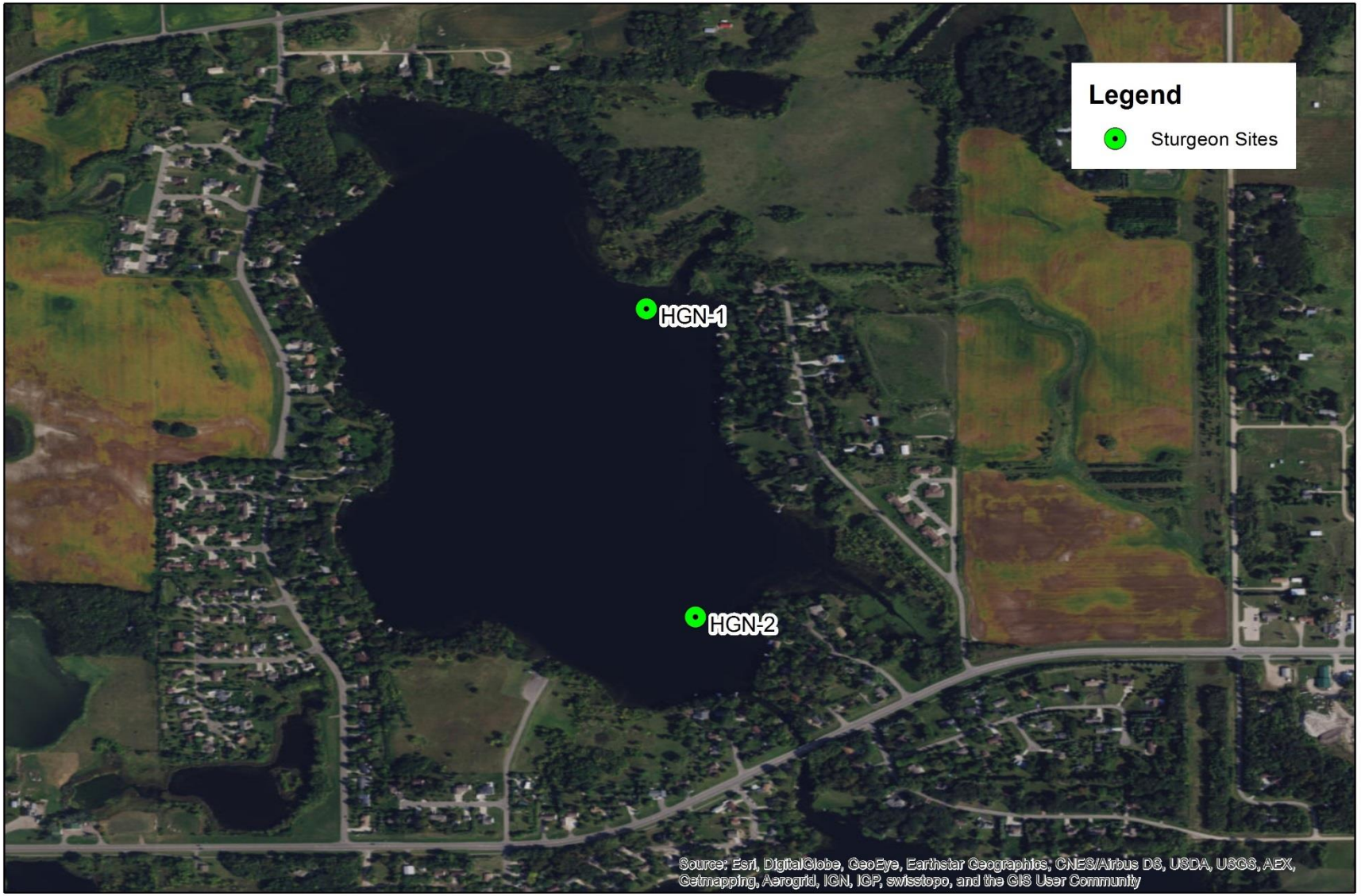
Hoot Lake Sturgeon Study Sites



Dayton Hollow Sturgeon Study Sites

0 0.125 0.25 0.5 Miles

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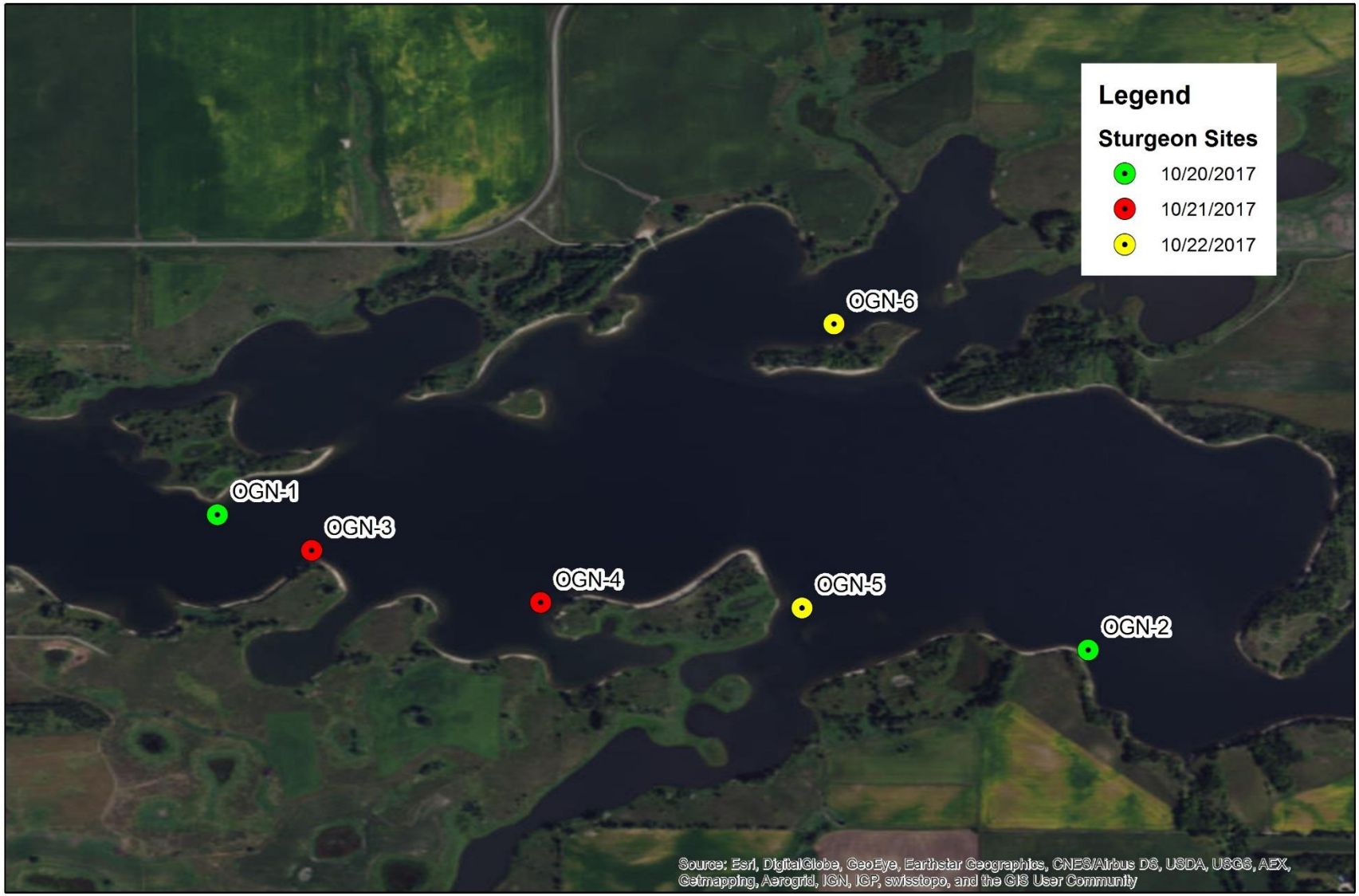
Orwell Lake Sturgeon Study Sites



Fall Sturgeon

Kleinschmidt

Results

Location	No. Collected	Percent Total Catch
Friberg Reservoir	9	23.5%
Hoot Lake	17*	50.0%
Dayton Hollow Reservoir	8*	26.5%
Orwell Lake	0	0.0%
Total	34	100.0%

* plus 2 recaptured fish at each site

Length Class	Number Collected	Percent Collected
< 24 inches	0	0.0%
25 to 36 inches	2	6.1%
37 to 48 inches	22	66.7%
> 48 inches	9	27.3%
Total	**33**	**100.0%**

Fall Sturgeon

Summary

- Fall sampling survey completed in accordance with study plan; no fin samples
- Spring sampling scheduled for the week of May 7; planning to collect pectoral fin samples
- 3 of 4 impoundments provide habitat for rearing lake sturgeon

Fall Sturgeon

Friberg Instream Flow Study

- Study Goal – assess the relationship between aquatic habitat, boating activities, and river flow in the reach at existing conditions up to 250 cfs.

Friberg Development

- 1 turbine with capacity of ~245 cfs
- Study area ~ 2,200-ft of Otter Tail river between dam/powerhouse
- OTPC opens a gate ~ 3 inches during non-spill conditions (~16 cfs) to maintain aquatic habitats
- natural hydrology sustains river flow considerably higher than capacity of the turbine, which results in additional water to the reach

Field Methods (Late August 2017)

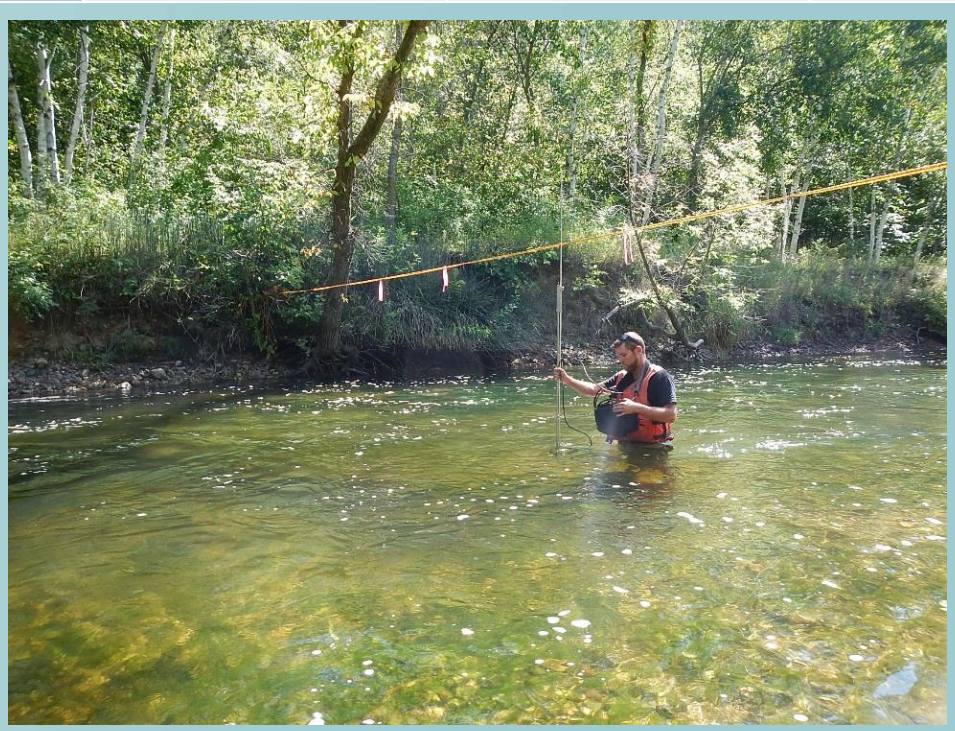
- Identification / establish 7 transects with MNDNR (prior to study)
- Engineering weir/orifice calculations to determine gate settings at dam for 5 releases
- Gauge river flow at each release and installed temp. staff gauges to verify stable flows
- Measure depth and velocity (microhabitat data) from the dam at all transects at all releases
- Classify substrates across each transect; measured wetted channel width
- Photographed each transect at each flow release
- Canoed reach at each flow release; qualitative assessment of boat navigability

Source: ESRI, Kleinschmidt, Otter Tail

Kleinschmidt

Flow Releases From the Friberg Dam During the 2017 Instream Flow Study

Release No.	Target Release	Gate Opening (weir calcs)	Measured Discharge at Transect 2 (cfs)
1	existing	3 inches	16
2	60	10.5 inches	54
3	110	22.25 inches	113
4	175	37.25 inches	185
5	250	50 inches	242



Analysis Methods

- Selected representative species/lifestages (12) with MNDNR using habitat guilds, based on fisheries catch, and study plan

Species and Lifestages Evaluated for the Friberg Instream Flow Study

Species/Lifestage	Riffle	Raceway/ Run	Medium Pool
Smallmouth bass (spawning)	-	-	X
Golden redhorse (juvenile)	-	-	X
Channel catfish (juvenile)	-	-	X
Longnose dace (spawning)	X	-	-
Smallmouth bass (juvenile)	X	-	-
Longnose dace (adult)	X	-	-
Golden redhorse (young-of-year)	X	-	-
Lake sturgeon (spawning)	-	X	-
Northern hogsucker (adult)	-	X	
Channel catfish (young-of-year)	-	X	-
Creeper (mussel)	-	X	-
Threeridge (mussel)	-	X	-

Analysis Methods

- Field data entered into MS Excel; QC data entry
- Excel-based suitability assessment tool to compare flows/habitat and calculate a habitat suitability index
- Habitat Suitability Curves (MNDNR 2006); species-specific Poisson or Arctangent formulas that show micro-habitat (depth, velocity, substrate) preference

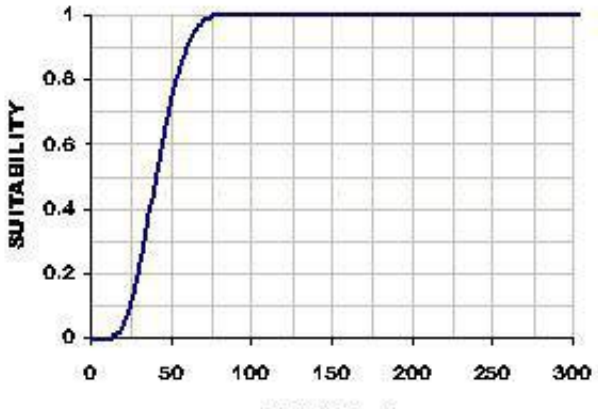
  *SI =(((453694000-DEPTH)/(453694000-9.036))^8594488.372) *2.718^((8594488.372/236434000)*(1-(453694000-DEPTH)/(453694000-9.036))^236434000))* (**Adult Longnose Dace – Depth)**

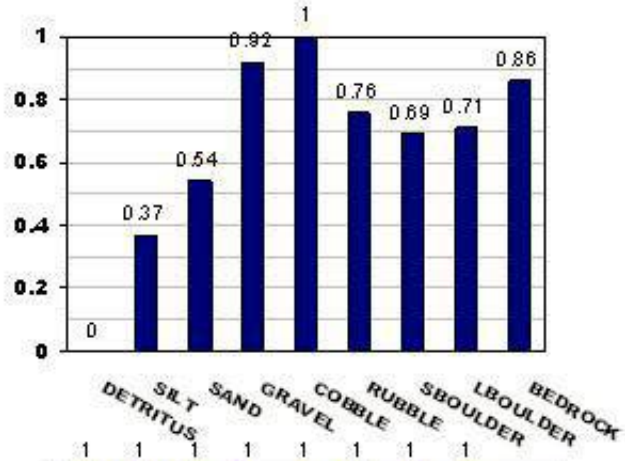
- Product of 3 suitability values (depth, velocity, and substrate) at each station on transect
- Summed across each transect at each flow release to calculate a unitless suitability index
- Graphed against discharge; incremental gain or loss; percent of the highest value observed

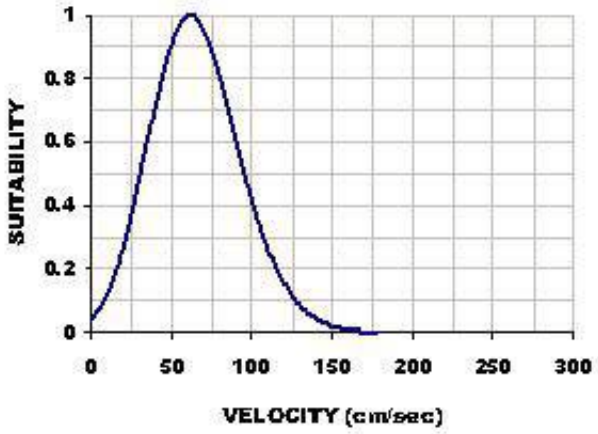
Analysis Methods – Habitat Suitability Criteria

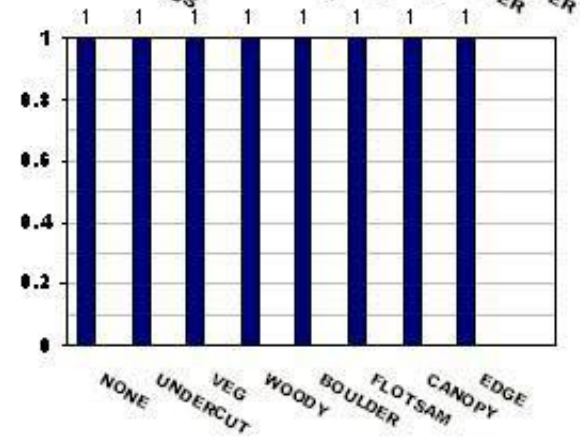
Kleinschmidt

NORTHERN HOGSUCKER ADULT









Analysis Methods

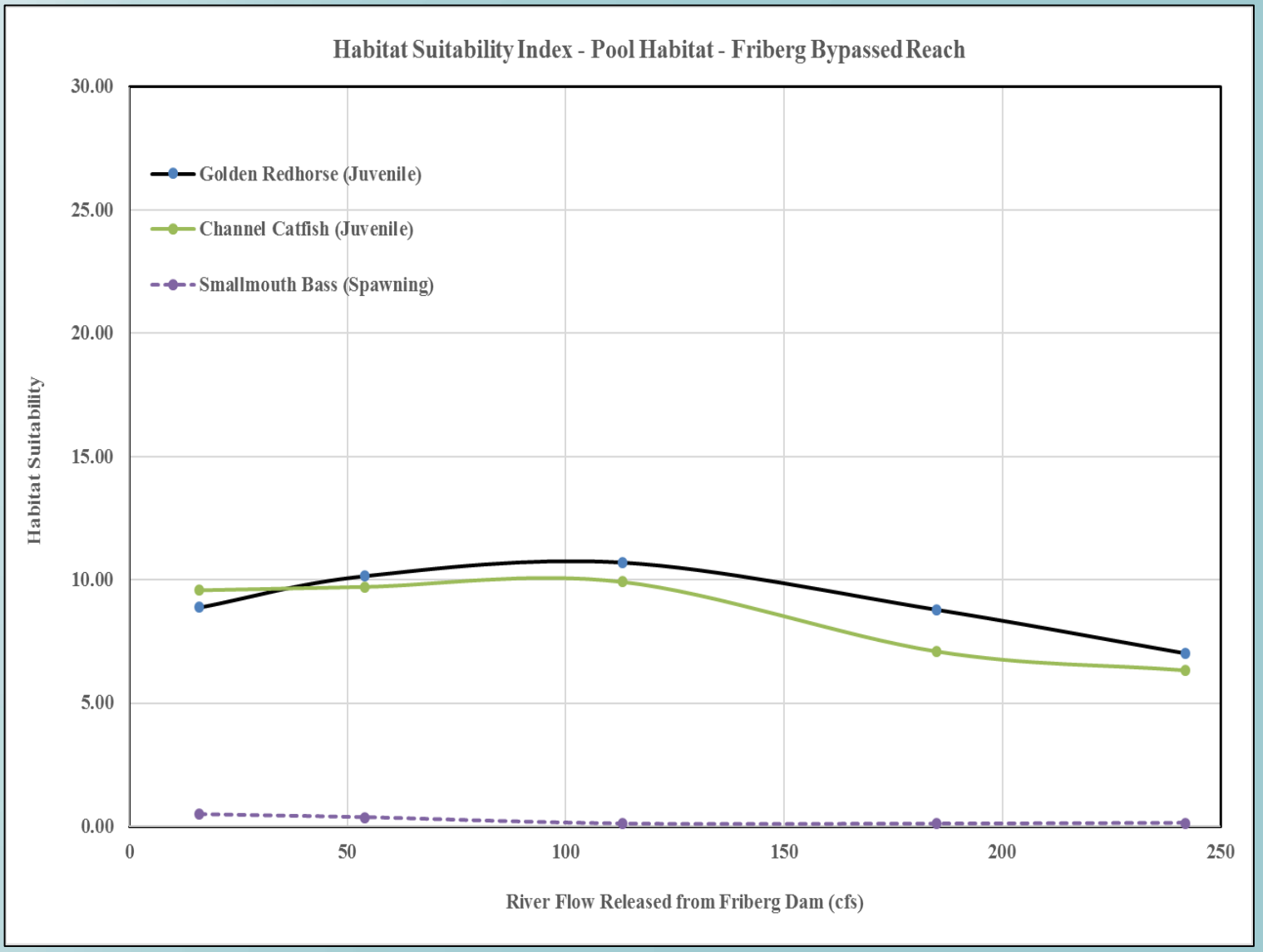
Kleinschmidt

Transect 2 (Raceway / Run Habitat)

Habitat Data						Northern Hogsucker (Adult)				Creeper (Mussel)				Threeridge (Mussel)			
Release 2 (54 cfs)																	
Station		*Depth (ft)*	*Depth (cm)*	*Velocity (fps)*	*Velocity (cmps)*	Depth SI	Velocity SI	Substrate SI	Composite SI	Depth SI	Velocity SI	Substrate SI	Composite SI	Depth SI	Velocity SI	Substrate SI	Composite SI (*)
3.5																	
5																	
7																	
9	Small gravel	1.9	57.9	-0.04	-1.2	0.88	0.04	0.92	0.03	0.83	0.02	1.00	0.02	0.29	0.16	1.00	0.05
11	Small gravel	1.1	33.5	0.49	14.9	0.31	0.18	0.92	0.05	0.00	0.88	1.00	0.00	0.00	0.28	1.00	0.00
13	Small gravel	1.55	47.2	0.76	23.2	0.69	0.33	0.92	0.21	0.35	1.00	1.00	0.35	0.00	0.37	1.00	0.00
15	Small gravel	1.85	56.4	0.73	22.3	0.86	0.31	0.92	0.24	0.78	1.00	1.00	0.78	0.21	0.36	1.00	0.08
17	Large gravel	2.25	68.6	0.74	22.6	0.97	0.31	0.92	0.28	1.00	1.00	1.00	1.00	0.84	0.36	1.00	0.30
19	Large gravel	2.55	77.7	0.75	22.9	1.00	0.32	0.92	0.29	0.96	1.00	1.00	0.96	0.99	0.37	1.00	0.36
21	Large gravel	2.8	85.3	0.77	23.5	1.00	0.33	0.92	0.30	0.88	1.00	1.00	0.88	0.99	0.37	1.00	0.37
23	Large gravel	2.9	88.4	0.90	27.3	0.99	0.42	0.92	0.38	0.85	0.97	1.00	0.83	0.98	0.42	1.00	0.41
25	Large gravel	3.1	94.5	0.92	27.9	0.98	0.43	0.92	0.39	0.78	0.97	1.00	0.75	0.95	0.43	1.00	0.41
27	Large gravel	3.2	97.5	0.94	28.7	0.97	0.45	0.92	0.40	0.74	0.96	1.00	0.71	0.93	0.44	1.00	0.41
29.1	Small boulder	3	91.4	0.79	24.1	0.99	0.35	0.69	0.23	0.81	1.00	0.77	0.62	0.97	0.38	0.28	0.10
31	Cobble	2.8	85.3	0.83	25.3	1.00	0.37	1.00	0.37	0.88	0.99	0.22	0.19	0.99	0.40	0.50	0.20
33	Cobble	2.6	79.2	0.71	21.6	1.00	0.30	1.00	0.30	0.95	1.00	0.22	0.21	1.00	0.35	0.50	0.18
35	Small boulder	1.85	56.4	0.62	18.9	0.86	0.24	0.69	0.15	0.78	0.98	0.77	0.59	0.21	0.32	0.28	0.02
37	Large gravel	2.1	64.0	0.62	18.9	0.95	0.24	0.92	0.21	0.97	0.98	1.00	0.94	0.65	0.32	1.00	0.21
39	Small gravel	1.8	54.9	0.48	14.6	0.84	0.18	0.92	0.14	0.72	0.87	1.00	0.63	0.14	0.28	1.00	0.04
41	Small gravel	1	30.5	0.17	5.2	0.22	0.07	0.92	0.02	0.00	0.29	1.00	0.00	0.00	0.20	1.00	0.00
43	Small gravel	0.35	10.7	-0.04	-1.2	0.00	0.04	0.92	0.00	0.00	0.02	1.00	0.00	0.00	0.16	1.00	0.00
45.5																	
							Total SI		3.99		Total SI		9.47			Total SI	3.13
Release 3 (113 cfs)																	

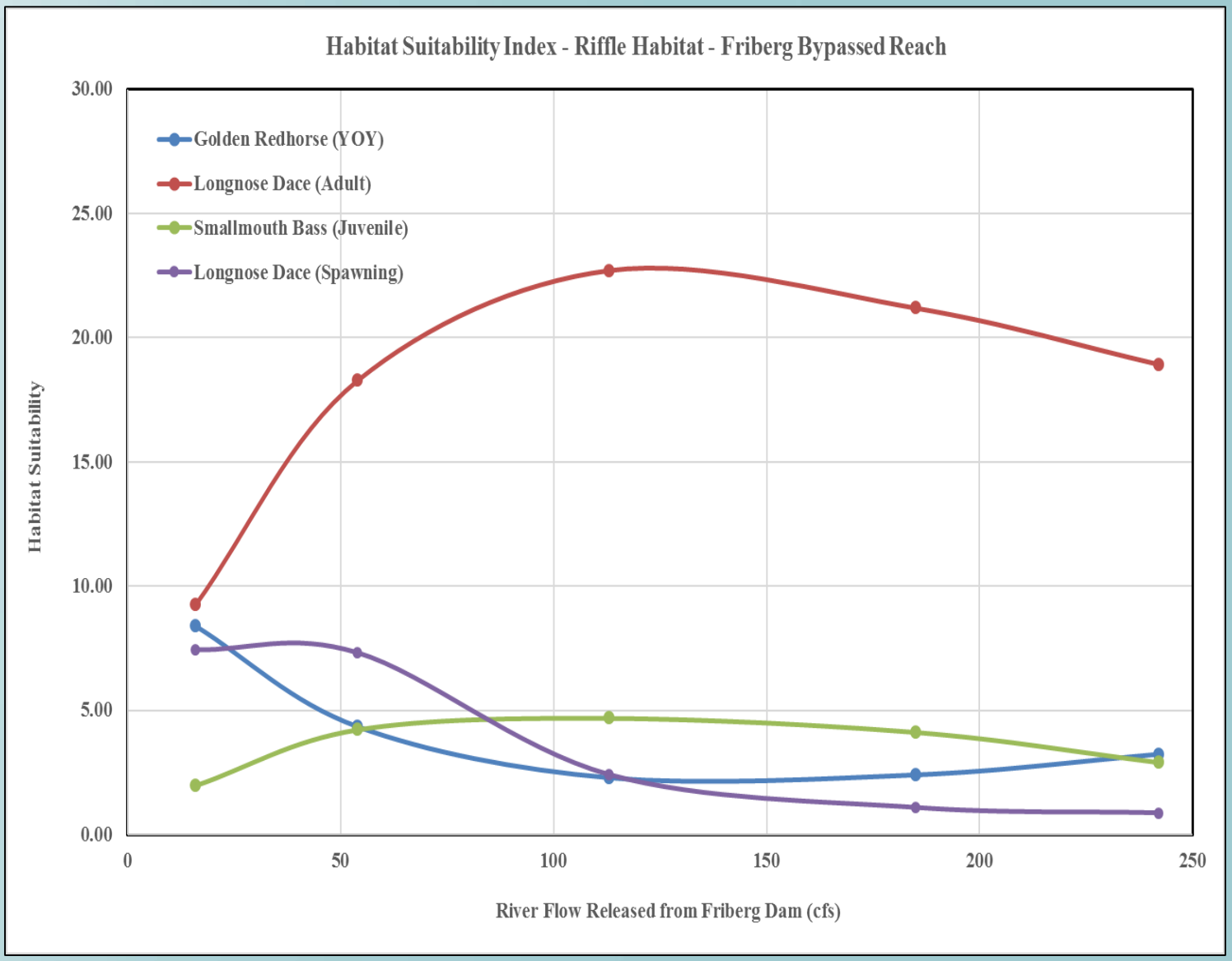
RESULTS

Habitat Suitability Index Value
Pool Species



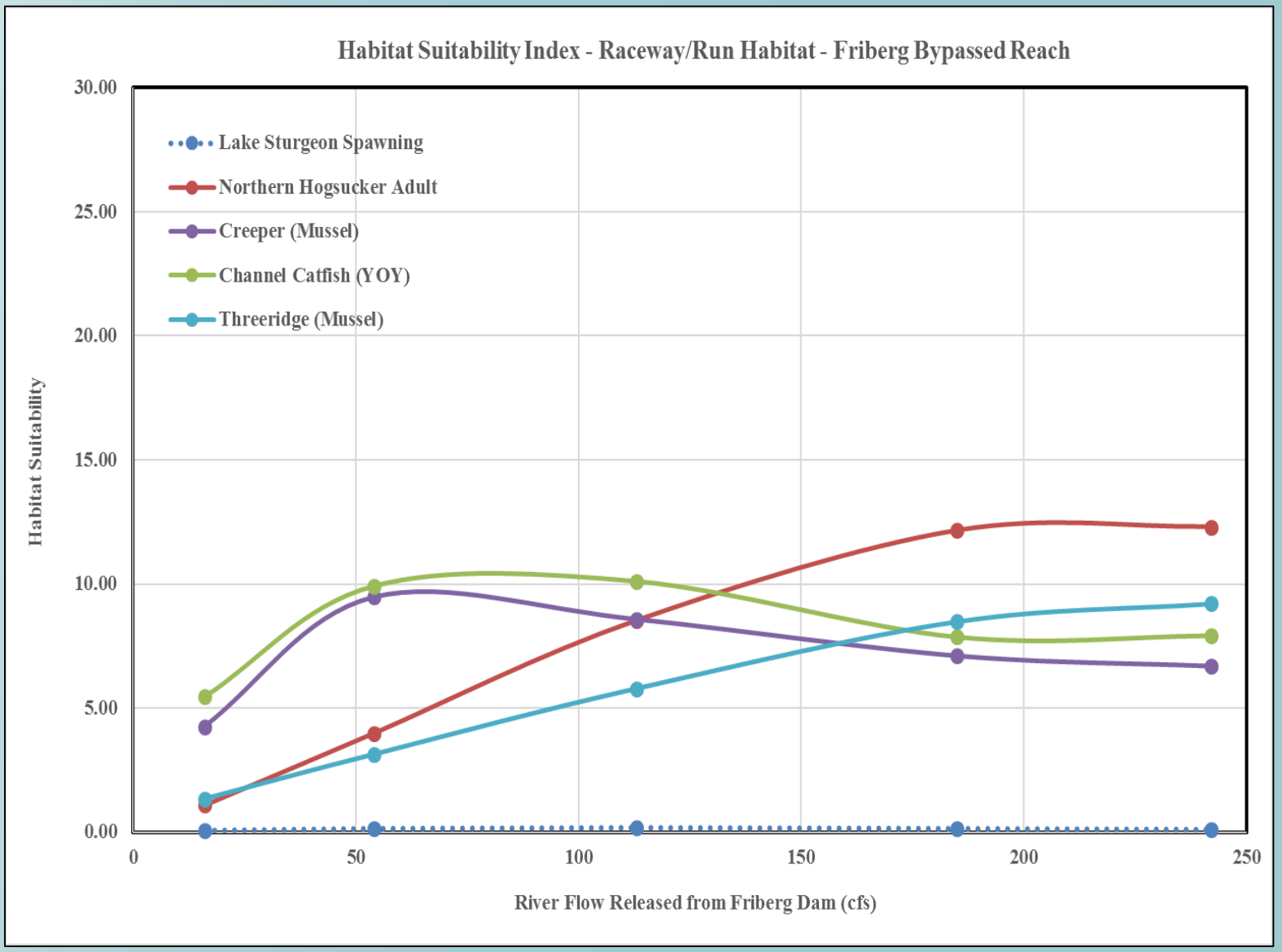
RESULTS

Habitat Suitability Index Value
Riffle Species

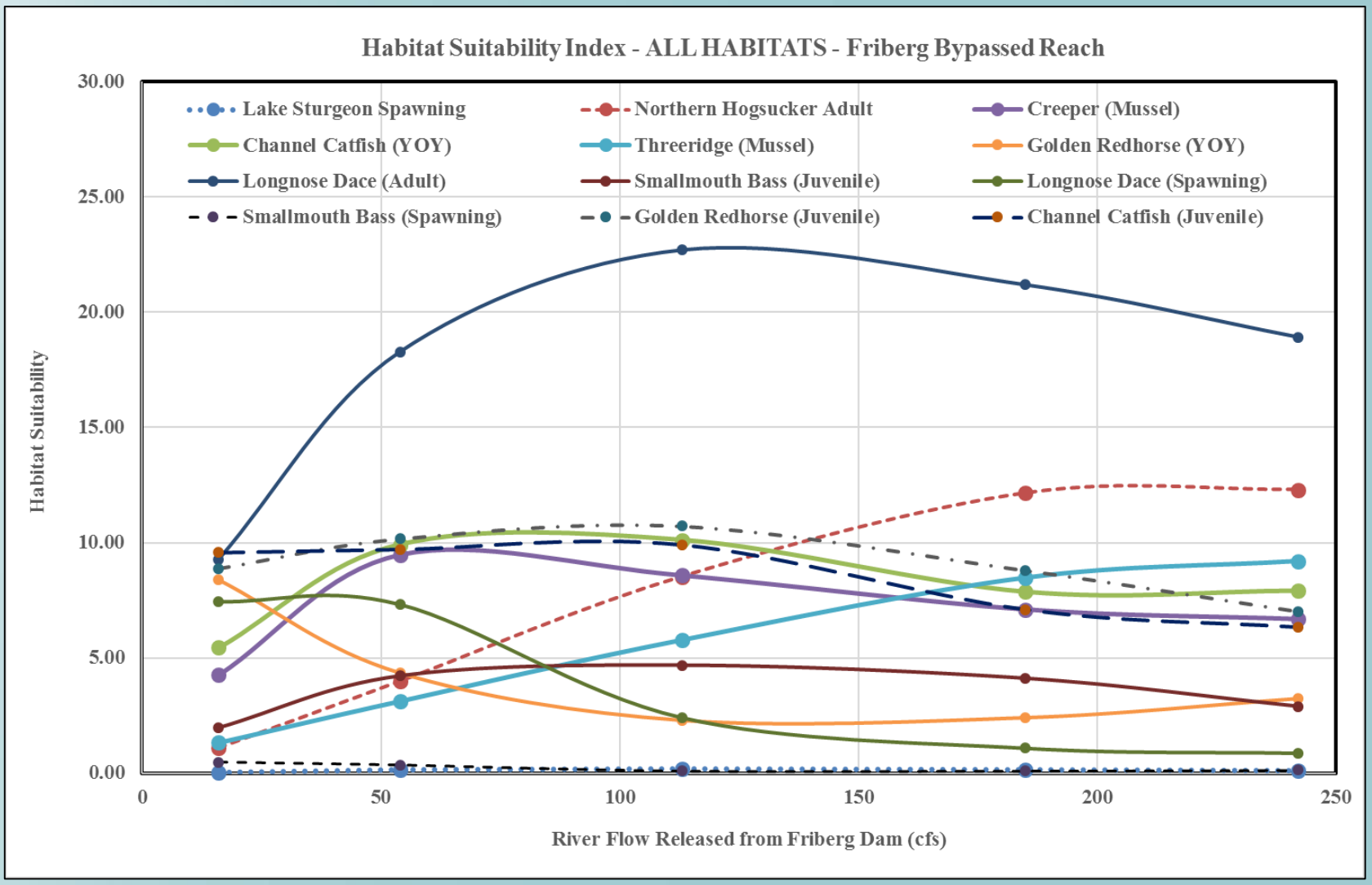


RESULTS

Habitat Suitability Index Value
Raceway Species



Habitat Suitability Index Value for ALL Species



Release	Approx. Flow	Boater Rating	Portage Required	Whitewater Features	Impediments to Boating	Overall Comment	Overall Ranking
1	16 cfs	Beginner	Yes, shallow reaches with several obstructions	None	Log jams, obstacles, and metal break wall	Not navigable by canoe at this release, carried the boat more than floated; may be ok with kayak	1
2	54 cfs	Beginner-Intermediate	Only 1 shallow area to portage	Not quite whitewater but very fast runs; must maneuver to stay in deeper water	Able to float over log jams	Fast water throughout, still some shallow areas with boulders	3
3	113 cfs	Intermediate	None required	Yes, several fast runs with some whitewater over boulders	None - able to float whole reach	Fast water throughout reach, some boulders to maneuver around; fast water results in increased tipping hazards to less experienced boaters	4
4	185 cfs	Intermediate	None required	Fast water over boulders forms small white caps.	None - able to float whole reach	Very fast runs, easily floated middle of the reach; fast water results in increased tipping hazards to less experienced boaters	4
5	242 cfs	Did not paddle - too much water advanced or expert only					

SUMMARY

Kleinschmidt

- Existing operational protocol (16 cfs) provides suitable habitat for several species and lifestages of freshwater fish and mussels
- Biggest gains (inflection) in habitat suitability for creeper (mussel), YOY channel catfish, juvenile smallmouth bass, juvenile golden redhorse occur with release of 54 cfs
- Inflection at 113 cfs for adult longnose dace and spawning lake sturgeon
- Inflection at 185 cfs for threeridge mussels and northern hogsucker adults
- Flow releases of 54, 113, 185 provide quality boating; intermediate to advanced

Hoot Diversion Flow Study

Kleinschmidt

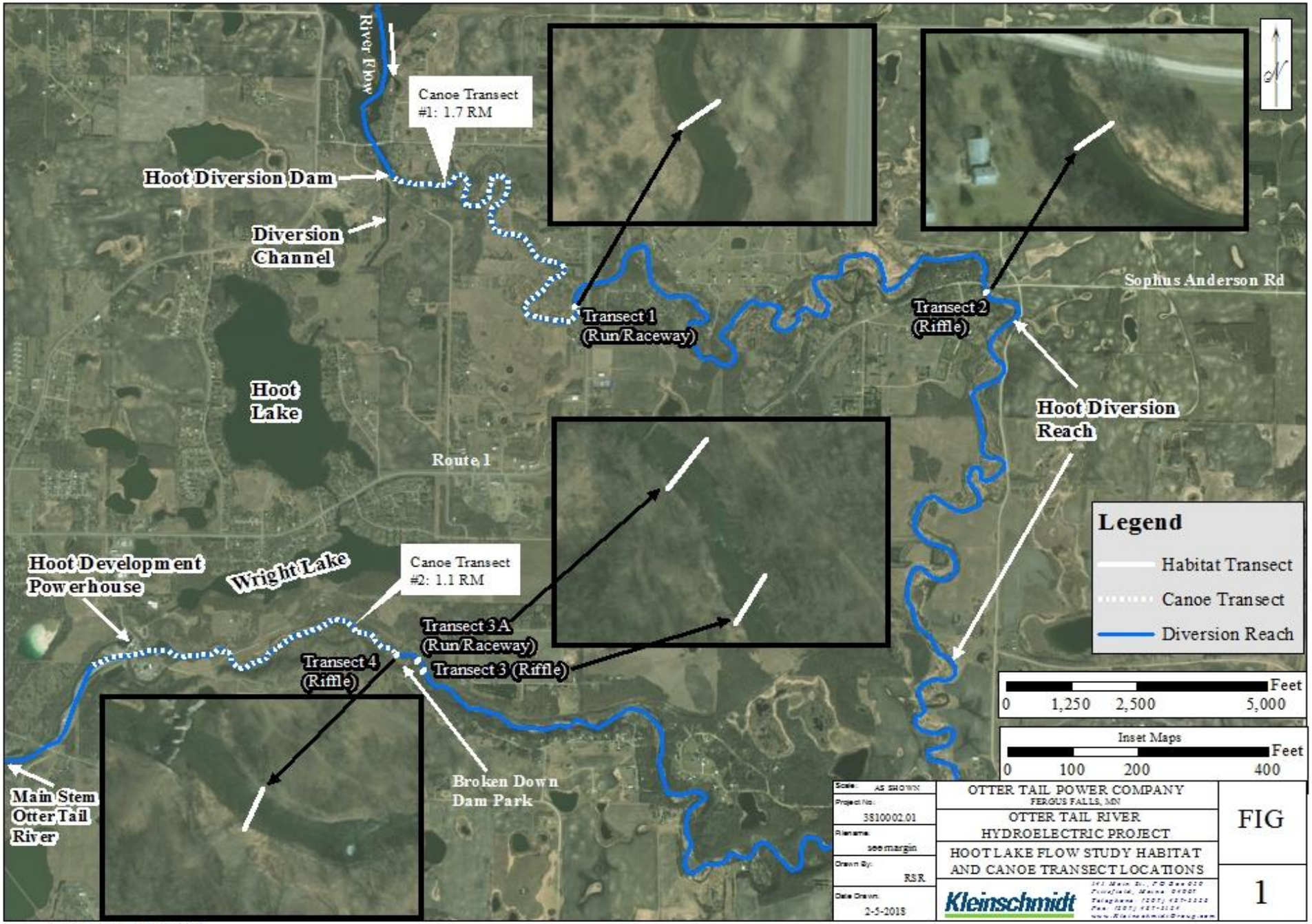
- Goal – assess existing minimum flow requirements; quantify relationship between aquatic habitat, boating, and river flow

- Hoot Development
  - 1 turbine with capacity of ~300 cfs

  - Study area - 12.8 mile reach of Otter Tail river between diversion dam/powerhouse

  - current flow requirements:
    - 30 cfs (or inflow, whichever is less) from the day after Labor Day through March 31
    - 110 cfs (or inflow, whichever is less) from April 1 to May 31
    - 60 cfs (or inflow, whichever is less) from June 1 through Labor Day

- Methods – very similar/identical to Friberg



Source: ESRI, Kleinschmidt, Otter Tail

Kleinschmidt

Flow Releases From the Hoot Diversion Dam During the 2017 Instream Flow Study

Release No.	Target Release	Gate Opening	Measured Discharge at Transect 1 (cfs)
1	30	1 gate open 2.75 inches plus leaks through fishway and gates	36
2	60	0 gates open, fishway flow at full pond plus leaks from dam gates	52
3	110	1 gate open 7.25 inches plus fishway flow and leaks from dam gates	109
4	175	1 gate open 16.25 inches plus fishway flow and leaks from dam gates	154
5	250	1 gate open 12 inches; 1 gate open 14.5 inches plus fishway flow and leaks from dam gates	221

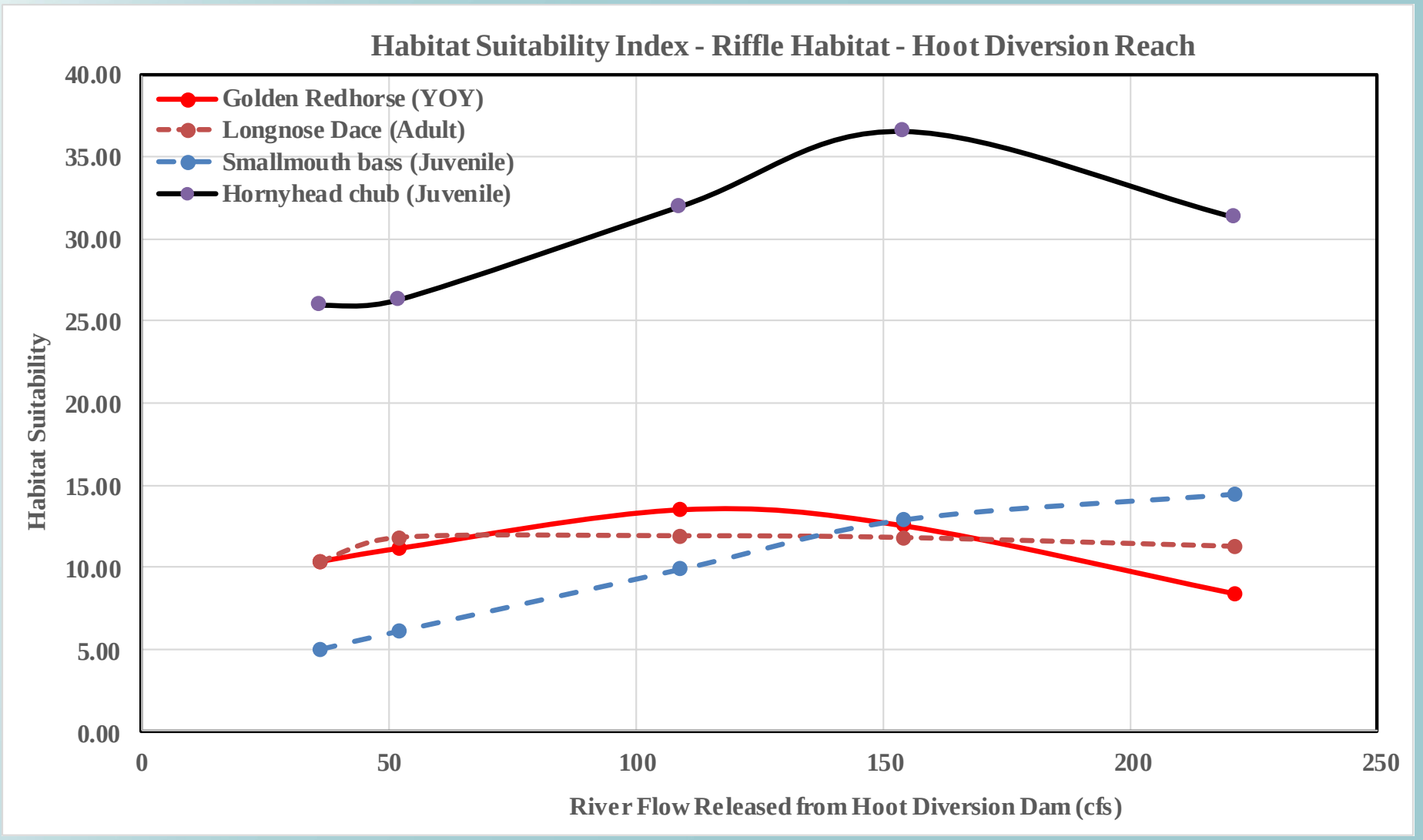
Analysis Methods (same as Friberg)

- Selected representative species/lifestages (8) with MNDNR using habitat guilds, baseline fisheries data, and study plan

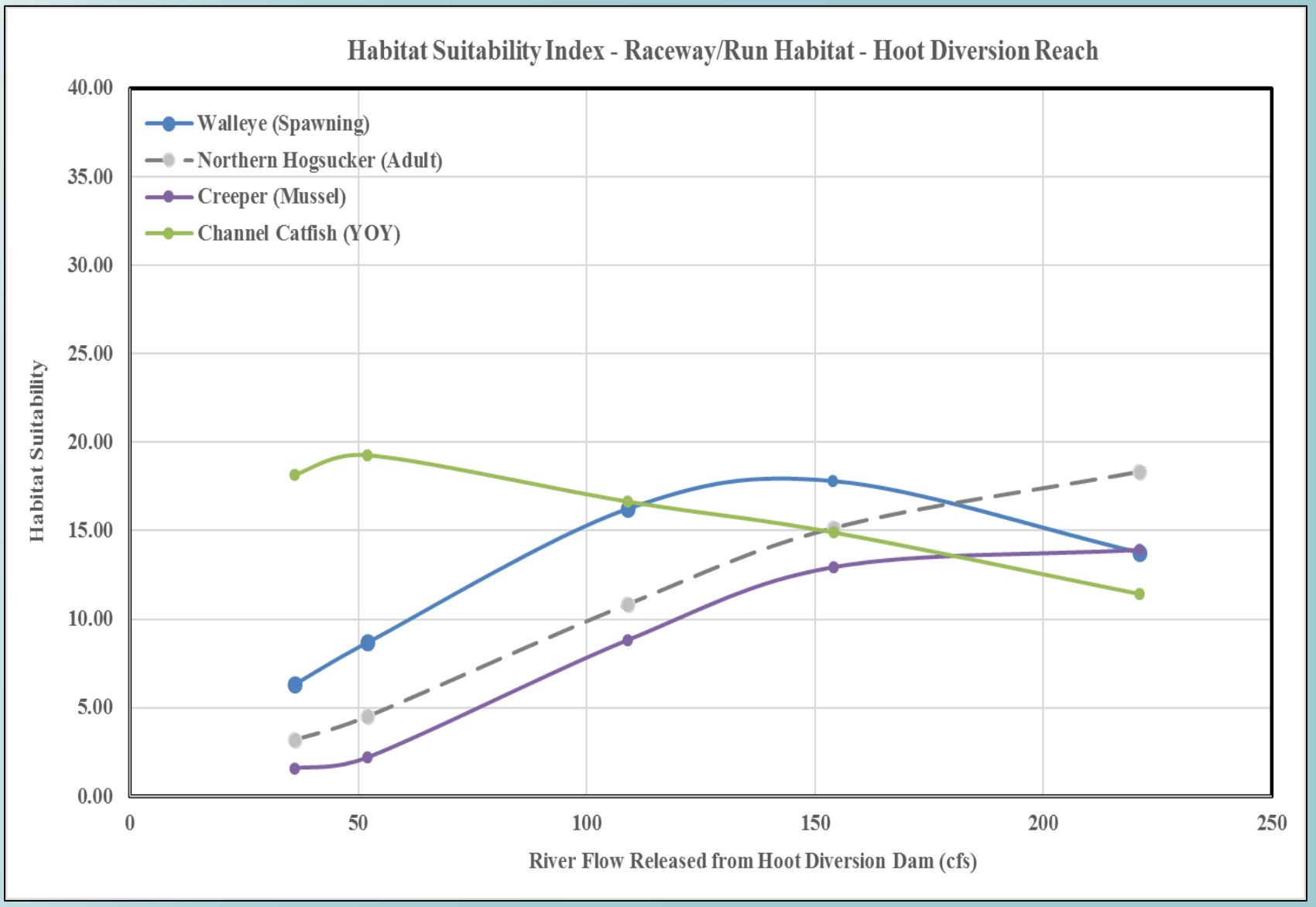
Species and Lifestages Evaluated for the Hoot Diversion Instream Flow Study

Species/Lifestage	Riffle	Raceway/Run
Hornyhead chub (juvenile)	X	-
Smallmouth bass (juvenile)	X	-
Longnose dace (adult)	X	-
Golden redhorse (young of year)	X	-
Walleye (spawning)	-	X
Northern hogsucker (adult)	-	X
Channel catfish (young-of-year)	-	X
Creeper (mussel)	-	X

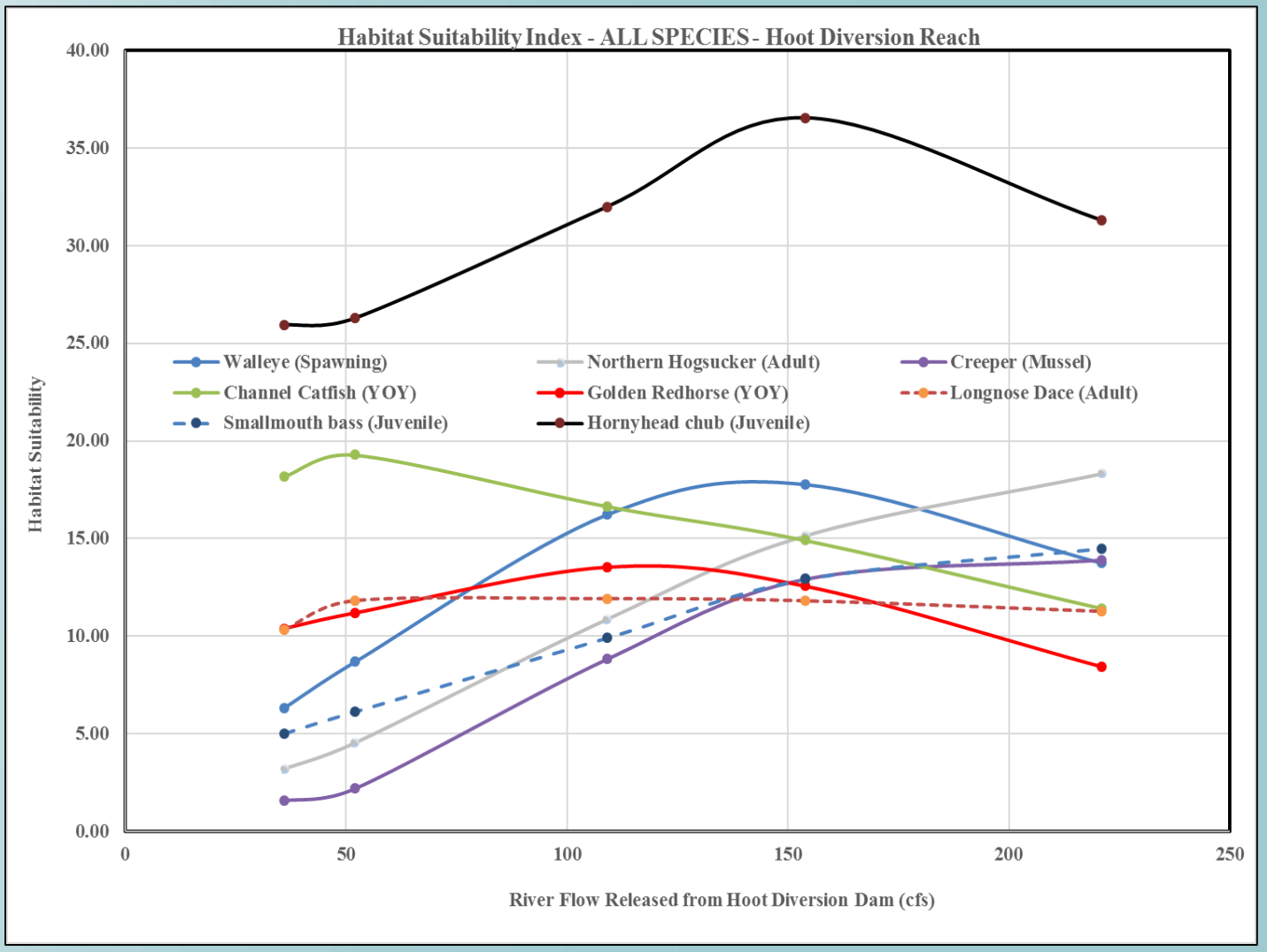
Habitat Suitability Index Value
Riffle Species



Habitat Suitability Index Value
Raceway Species



Habitat Suitability Index Value for ALL Species



BOATER NAVIGABILITY

Release	Approx. Flow	Boater Rating	Portage Required?	Whitewater features*	Impediments to boating	Overall comment	Overall ranking**
1	36 cfs	Beginner	Yes, shallow in areas, 4 portages, upper reach more challenging than lower reach	None	Shallow water at artificial rapids; shallow areas below the diversion dam	Carried the boat more than floated; may be ok with kayak. Lower reach generally navigable with 1 portage; many scrapes and arduous paddling	2.5
2	52 cfs	Beginner	Yes, shallow in areas, 2 portages, upper reach more challenging than lower reach	None	Shallow water at artificial rapids; shallow areas below the diversion dam	Easy to navigate, not excessively fast in upper reach; adequate flow except near artificial rapids in lower reach (portage required)	4.5
3	109 cfs	Intermediate	Yes, 1 at artificial rapids	None	Shallow water at artificial rapids; shallow areas below the diversion dam	Easy to navigate, not excessively fast in upper reach; adequate flow except near artificial rapids in lower reach (portage required)	4.5
4	154 cfs	Intermediate	Yes, 1 at artificial rapids	None	Shallow water at artificial rapids	Some fast areas in upper reach, easy to navigate, not excessively fast in upper reach; adequate flow except near artificial rapids (portage required); lower reach has some fast water that requires skill	5
5	221 cfs	Intermediate	None	None	Shallow water at artificial rapids	Some fast areas in upper reach, easy to navigate, not excessively fast in upper reach; adequate flow except near artificial rapids (portage required); lower reach has some fast water that requires skill	5

SUMMARY

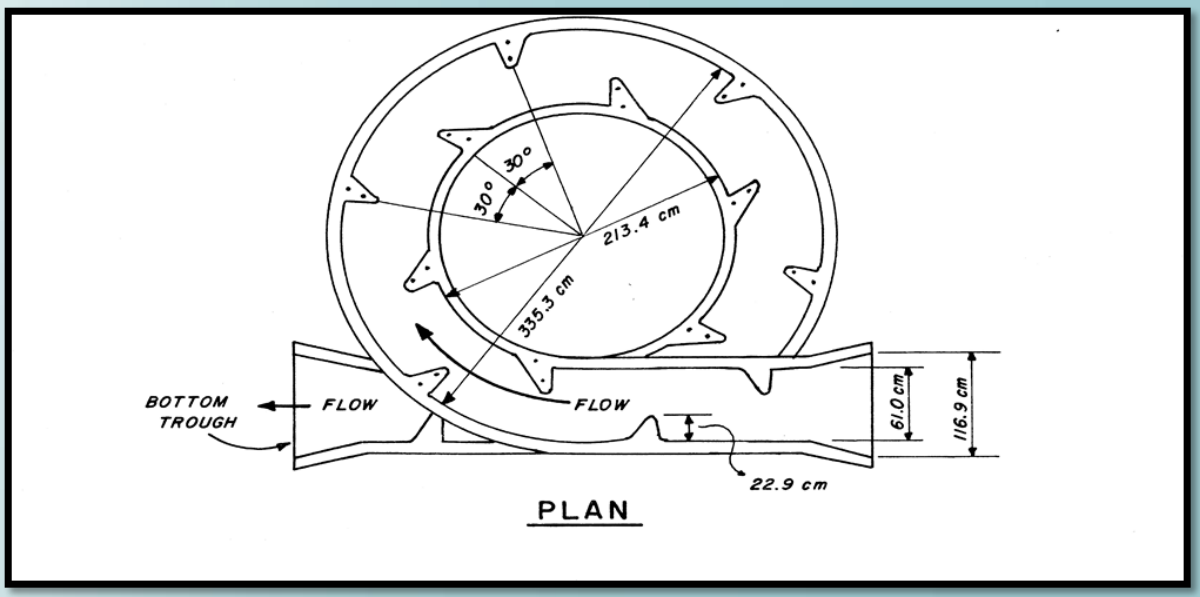
- Existing minimum flows (30, 60, 110) provide suitable habitat for several species and lifestages of freshwater fish and mussels
- Existing flow regime keeps a large percentage of the channel wetted, though in areas, it is shallow, especially during a release of approximately 30 cfs
- Suitable habitat remained consistent or decreased for young-of-year golden redhorse, young-of-year channel catfish, adult longnose dace at higher flow releases (154 and 221 cfs)
- Habitat suitability decreased or there was an inflection (*i.e.*, notable decrease in rate of increase of habitat suitability) at 154 and 221 cfs for all of organisms
- Releases of 52, 109, 154, and 221 provide quality boating; beginner to intermediate
- Study plan implemented; met objectives; provided quantitative assessment to determine instream flow

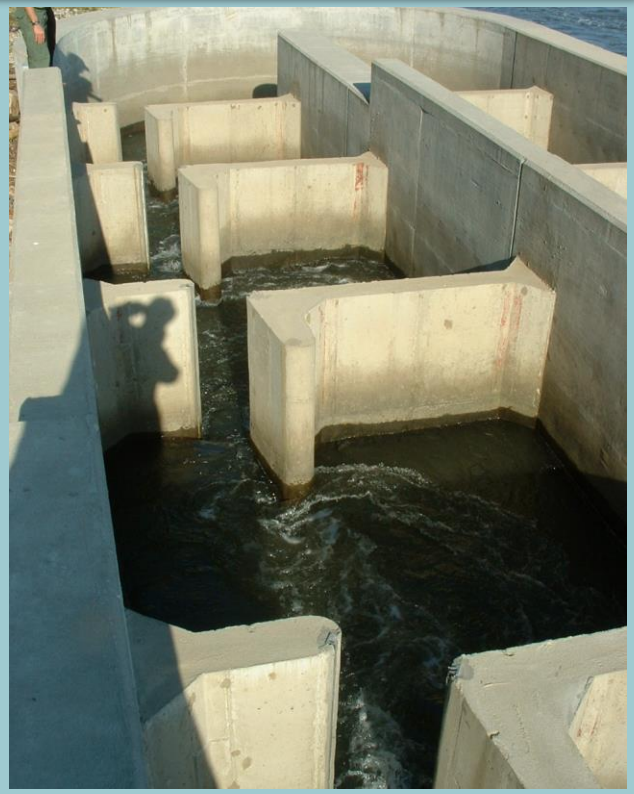
Fish Passage Feasibility

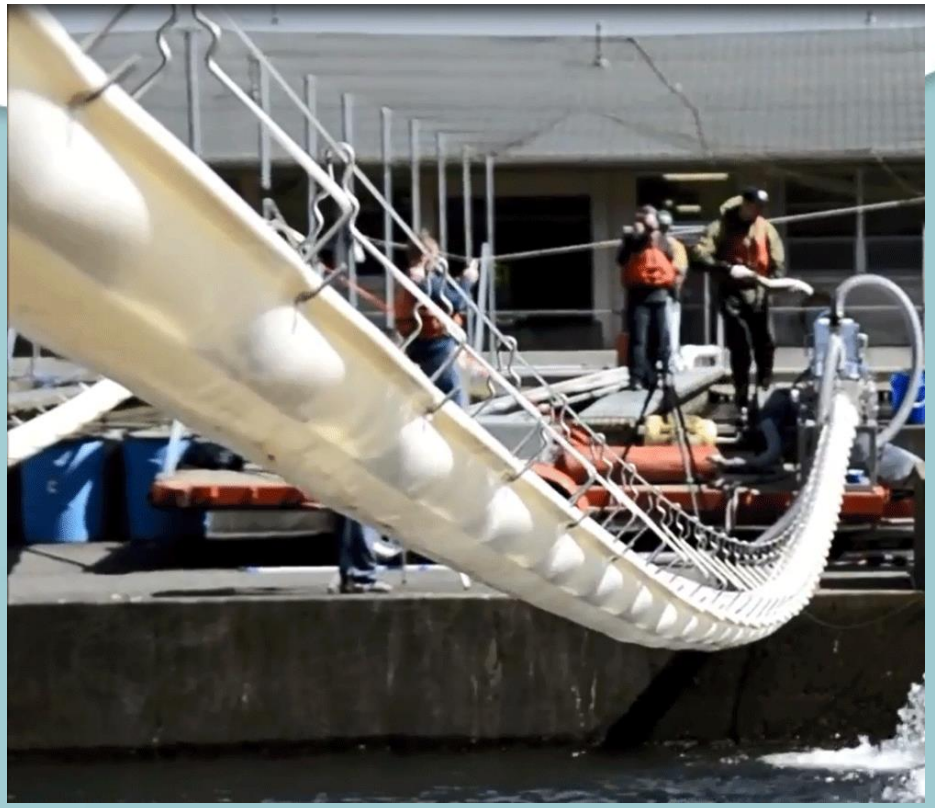
- Study Goal – evaluate whether there are cost-effective and practical means to provide fish passage at the Friberg, Hoot, Central, Pisgah, and Dayton Hollow dams

Methods

- Consultation with agencies (tele-conference Nov. 2017) to identify systems for review
- Review of biological effectiveness with focus on lake sturgeon and initial screening of alternatives
- Develop conceptual designs of up to two alternatives for upstream and downstream passage
- Opinion of probable construction cost estimates (order of magnitude; more review recommended)
- General advantages/disadvantages and operational issues
- Identification of alternative mitigation techniques


30°
30°
213.4 cm
335.3 cm
BOTTOM TROUGH
FLOW
FLOW
61.0 cm
116.9 cm
22.9 cm
PLAN






Juvenile Fish
Transportation

RESULTS – BIOLOGICAL

- Fish passage for sturgeon experimental and challenging due to poor swimming ability and morphology (large body size and high drag)

- Limited literature

- Richelieu River (2010)
  - vertical slot; low-head dam (8.5-feet)
  - eighty-eight lake sturgeon (88.2 percent) entered volitionally
  - 32 (36.4 percent) passed

- USGS Conte Fish Lab (2011)
  - spiral-slot prototype; two 360-degree loops around a 20-foot diameter circle
  - 125-feet-long, 3.3-feet-wide; total rise 6.3 feet
  - 10 adults (90.9 percent) and 16 juvenile (72.2 percent) captive reared lake sturgeon ascended the fishway in a lab setting

Results – Biological

- Parsley et al. (2007)
  - Pool and weir style on the Columbia River
  - Limited passage of white sturgeon (8 percent; 8 of 90 fish)

- Fish Lifts (designed for sturgeon)
  - Full depth entrance
  - Applicable for higher heads or where space is limited.
  - Less energy expenditure, which may result in less fall back and better effectiveness
  - Some success on Menominee River and Holyoke

- Nature-like Fishways
  - Limited information regarding success but gaining popularity
  - Shovelnose sturgeon twice as likely to pass via nature-like then slotted fishways (White and Mefford 2002)
  - Require low-gradient channel (3%) so land/space can be an issue
  - Provides upstream and downstream passage

Results – Initial screening

- Eliminated Whooshh - species-specific and experimental; need tubes for multiple species/lifestages
- Eliminated Trap and Truck due to handling / labor requirements
- Eliminated vertical slot fishways, Denil fishways, and Alaskan steeppasses; limited effectiveness at passing lake sturgeon; area constraints
- Included fish lifts given height of dams, space constraints, and possible improved performance as compared to other measures
- Included nature-like fishways (upstream and downstream), where practical
- Included downstream bypass orifices

Results

Site	Upstream Passage Alternative 1 and Cost Opinion	Upstream Passage Alternative 2 and Cost Opinion	Downstream Passage Alternative 1 and Cost Opinion	Downstream Passage Alternative 2 and Cost Opinion
Dayton Hollow	Nature-like Fishway - $2M to $3M	Fish Lift – $5M to $6M	Nature-like Fishway – N/A	Submerged Bypass – $1M to $2M
Pisgah	Nature-like Fishway – $1.5M to $2.5M	Fish Lift – $4M to $5M	Nature-like Fishway – N/A	Submerged Bypass – $1M to $2M
Central	Spiral-slot Fishway – $3M to $4.5M	Fish Lift – $3.5M to $4.5M	Submerged Bypass – $1M to $2M	N/A
Friberg	Nature-like Fishway – $1.5M to $2.5M	Fish Lift – $4M to $5M	Nature-like Fishway – N/A	Submerged Bypass – $1M to $2M

SUMMARY

- Passage for sturgeon experimental and challenging
- Construction / design costs throughout Otter Tail River Project area range as much as $30 million
- Substantial additional costs likely for land acquisition; structural modifications; administrative; lost generation
- Alternatives may include: conservation easements, watershed restoration plans, TMDLs, off site mitigation or stream restoration

QUESTIONS/COMMENTS