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Fish Passage Studies II: Size-Related Turbine Passage Survival and Injury of Lake Sturgeon at the Shawano Project, Wolf River, Wisconsin

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Size - Related Turbine Passage Survival and Injury of Lake Sturgeon at the Shawano Project, Wolf River, Wisconsin

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Background

- Shawano Paper Mill Dam in Wisconsin is located on the Wolf River east of Green Bay in Shawano County.
- The city, county, and Shawano Lake are all named for Menominee Chief Sawanoh, whose tribal people lived, farmed, and fished the lake.
- Shawano Paper Mill Dam was built in 1892 to regulate the water levels in Shawano Lake.
- The Shawano Paper Mill Dam marks the end of the line for Lake Sturgeon and other migratory fish migrating from Lake Winnebago Pool up the Wolf River.

Background (continued)

- A natural barrier, Keshena Falls is located 11 miles upstream from the Shawano Paper Mill Dam.
- Keshena Falls was a historical spawning area.
- Sturgeon return every spring to the Shawano Paper Mill Dam to spawn in mass numbers; an environmental spectacle which attracts locals and tourists alike.
- Efforts are underway to return adult sturgeon to Keshena Falls historic spawning area.
- Progeny of these fish will have to pass the Shawano Project.

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OBJECTIVES

The objectives were to:

- Estimate 48h survival and injury rates (within ±5%, 90% of the time) of fingerling and yearling sized Lake Sturgeon passing through the turbines at Shawano Paper Mill Dam.
- Determine injury rates and types attributed to turbine passage.

Test Conditions

Technique - All fish tagged with HI-Z tags

Fish source – School of Freshwater Sciences at the University of Wisconsin Milwaukee

Specimens – Juvenile (two size groups) Lake Sturgeon

Fish length (TL in mm)

- Fingerlings range from 180 to 224, average 199
- Yearling sized range from 240 to 335, average 260
- Control fingerlings range from 180 to 220, average 197
- Control yearling sized range from 240 to 290, average 251

Sample size

- Fingerling: N = 150
- Yearling sized: N = 160
- Control: N = 87

Water temperature – 9.0 to 9.5°C (48.2 to 49.1°F)

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Turbine Characteristics and Test conditions

- Turbine type – 42 in Leffel-Z (Vertical Francis type)
- Maximum discharge 265 cfs (test at 260 cfs)
- Rotation 100 rpm
- Runner diameter size - 42 to 74 in (small unit)
- Number of buckets 18
- Number of wicket gates 20
- Width between wicket gates 7.4 in
- Operating head 10.5 ft
- Normal Headwater elevation 802.5 ft
- Normal Tailwater elevation 792 ft

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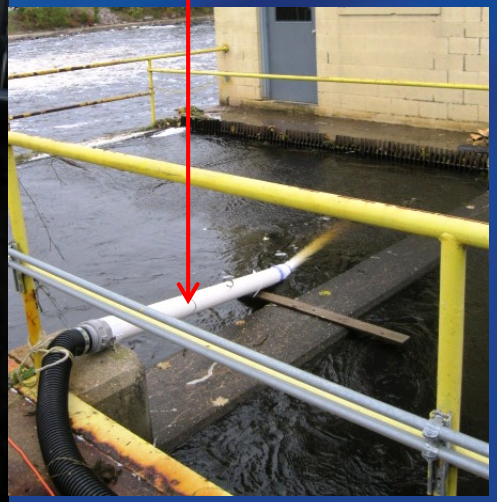
Methods
Release Locations

Control release hose

Treatment release hose

Treatment release pipe going through trash racks

Treatment release pipe



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Release Locations (continued)

Turbine

Release near the middle of turbine, approx. 1/2 ft upstream of wicket gates.

Control

The control fish groups were released downstream of Unit 2 turbine.

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HI-Z Tagging Sequence


Tagging


Fish with HI-Z, radio, and floy tags


Activating HI-Z tags


Fish released

- The HI-Z tag-recapture technique has been used to estimate survival/injury of more than 22 species of fish; this was the first study on Sturgeon.

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Fish Tracking and Recapture

Fish buoyed to surface

Netting fish

Fish holding tank

Fish held for 48h

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Statistical Analysis

- Passage survival and injury rates were estimated relative to controls.
- Chi-square tests performed to determine homogeneity (P=0.05) between daily trials with respect to recapture frequencies of dead, alive, and unknown fish.
- Calculated malady-free rates (fish without any passage related injuries or loss of equilibrium).

Results: Recapture Rates

- Recapture rates were 88.7 and 90.6% for the fingerling and yearling sized fish, respectively.
- Recapture rate for the control groups was 98.0% and 95.0% for the fingerlings and yearling sized, respectively.
- HI-Z tags only were recovered on 11 (7%) and 14 (9%) of the fingerling and yearling sized fish, respectively. Fish assigned dead.
- The average retrieval time for the treatment fish ranged from 8 to 10 minutes. Control retrieval time averaged 4 minutes.

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Survival Results

	Treatment				Control	
	Fingerling		Yearling		Fingerling	Yearling
Released	150		160		50	40
Recaptured Alive	133	(88.7%)	145	(90.6%)	49 (98.0%)	38 (95.0%)
Assigned Alive*	6	(4.0%)	1	(0.6%)	1 (2.0%)	2 (5.0%)
Assigned Dead**	11	(7.3%)	14	(8.8%)	0 (0.0%)	0 (0.0%)
Died in Holding	0	(0.0%)	1	(0.6%)	0 (0.0%)	0 (0.0%)
48h Survival	92.7%		90.6%			
90% CI (±)	3.5%		3.8%			

* Fish trapped were not recaptured ** Tags only recaptured

- No fish recovered dead
- Relatively high number of tags-only recaptured: fingerling 7.3%, yearling sized 8.8%, (worst case scenario assigned dead)
- Some fish trapped temporarily in underwater structures; others not recaptured assigned alive, fingerling 4.0%, yearling sized 0.6%, controls 2 and 5%

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Injuries

- Only one yearling recaptured with injuries.
- Injuries consisted of damaged gill, hemorrhaged left eye, and hemorrhaged brain;
- This fish died in holding, injuries were major and mechanical;
- Recapture of only one injured fish suggests that the actual survival estimates are likely higher than estimated herein;
- Minimal injuries may have been due to Sturgeon being cartilaginous and covered in scutes and a low Project head (10.5ft).

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Comparison to Other Studies

With Similar sized (177 – 213 mm) Juvenile Salmonids

	Box Canyon	Albeni Falls	Foster	Shawano	
Fish Released	400	209	1238	150	160
Fish Recaptured	99%	98%	96%	89%	91%
*HI-Z tags recaptured only (no fish)	1%	1%	2%	7%	9%
*Fish recaptured missing a HI-Z tag	5%	4%	11%	9%	16%
*Fish recaptured with injuries and missing a HI-Z tag	2%	0%	6%	0%	<1%
*Fish recaptured with injuries and all HI-Z tags present	2%	2%	15%	0%	0%

* Percent based on recaptured fish; not total released

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Comparison to Other Studies (continued)

- Physical recapture of fish typically higher 96-99% than that at Shawano (89 and 91%), which was due primarily to the lower recapture of tags only 1-2% versus 7 and 9% at Shawano.
- Fish recaptured missing a tag are generally lower 4-11% than at Shawano (9 and 16%).
- Typically more of these fish missing a tag are injured (0-6%) than that at Shawano (0 and <1%).
- Typically more fish with all tags intact are injured (2-15%) than that at Shawano (0%).
- The data on missing and detached tags indicate that the Sturgeon survival estimates are likely higher.

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Conclusions

- Survival estimate (48h) of fingerling and yearling passed fish were 92.7 and 90.6%, respectively.
- Malady-free estimates were 100.0 and 99.9% for the fingerling and yearling sized passed fish, respectively.
- Survival was not significantly different between the fingerling and yearling sized fish; malady rates were not significantly different.

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Conclusions (continued)

- Desired precision (ε) ≤ ± 5%; 90% of the time was met for all estimates.
- Only one fish was injured and dead at 48h.
- The recapture of only one injured fish and absence of injuries to recaptured fish missing a tag indicate the actual survival rates are likely higher.

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