

Research on Up- and Downstream Passage of Lake Sturgeons at S. O. Conte Anadromous Fish Research Center

Boyd Kynard, Don Pugh, Erika Henyey, Tim Parker, and
Martin Horgan

S.O. Conte Anadromous Fish Research Center (Leetown
Science Center, USGS)

Turners Falls, MA 01376



DEVELOP A FISH LADDER FOR STURGEONS & RIVERINE FISHES

1. STUDY FISH BEHAVIOR in response to various fish PASSAGE OPENINGS and SELECT BEST OPENING for Sturgeons (1994-1998)

Funding: Conte AFRC (Lake Sturgeon) and US COE (Pallid Sturgeon)

2. BUILD & TEST A PROTOTYPE LADDER (1999-2003)

Funding: Great Lakes Fishery Trust, Conte AFRC, Menominee Indian Tribe of Wisconsin



TWO STURGEONS TESTED:

Acipenser

Wolf River Lake Sturgeon

n = 27; Age = 6-8 Years

TL = 71-98 cm (mean, 87 cm)

Tested: Sep - Nov 1998

Scaphirhynchus

Missouri R. Pallid sturgeon

n = 22; Age = 4 Years

Shovelnose sturgeon

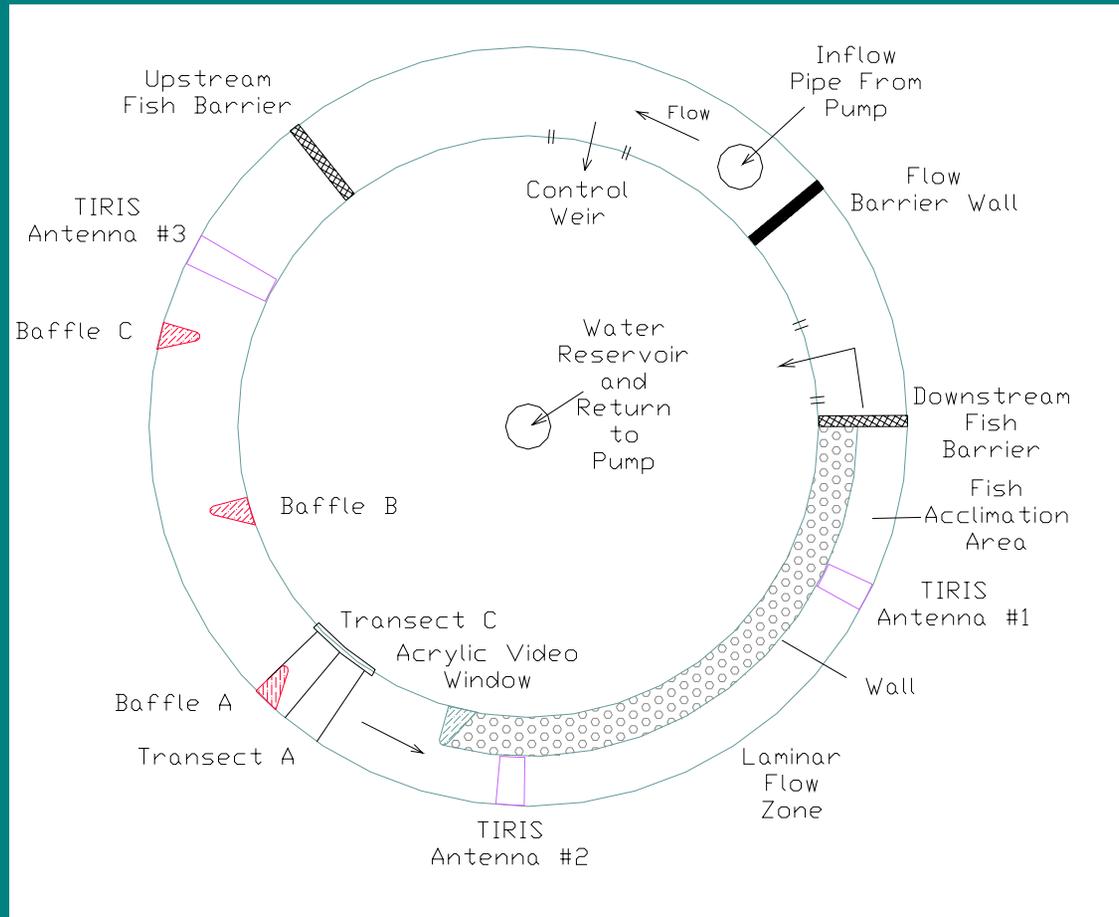
n = 3; Age = 3 Years

Tested : Sep - Nov 2001



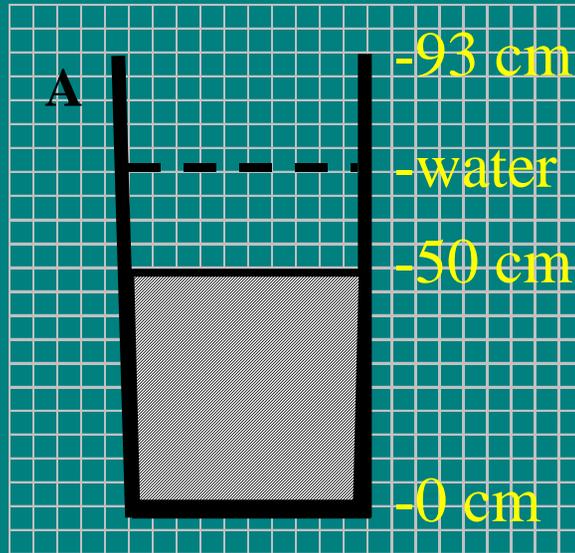
EXPERIMENTAL FLUME to OBSERVE FISH BEHAVIOR

Channel Width = 52cm; Test Arena = 4.3 m long

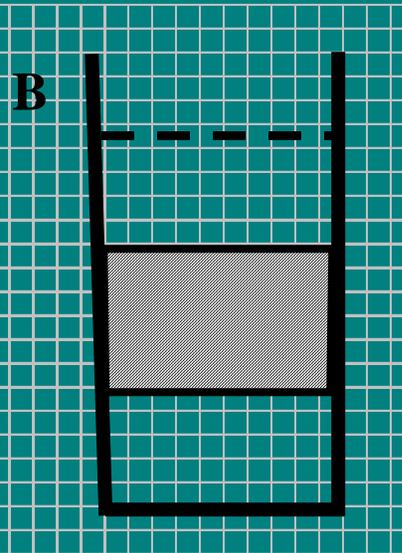


Horizontal & Vertical Openings

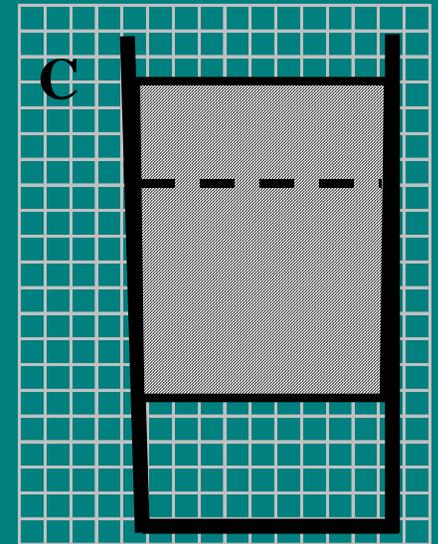
Surface Weir



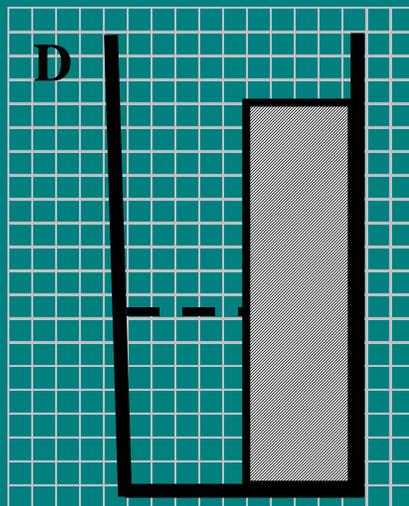
Weir & Orifice



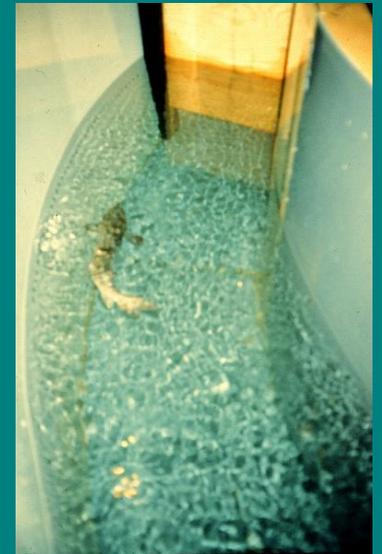
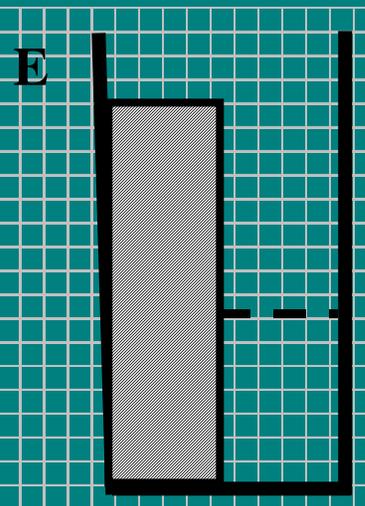
Bottom Orifice



Inside Side Baffle



Outside Side Baffle



LAKE STURGEON RESULTS (n=15)

(Bold White = Best Fish Use)

	% Passing	% Failed	Mean TB/S ¹	% Contact
	<u>First Run</u>	<u>Attempts</u>	<u>At Opening</u>	<u>w/ Structure</u>
Surface Weir	35	57	2.8	96
Weir & Orifice	19	49	2.6	85
Bottom Orifice	85	31	2.2	37
Baffle I (55 cm)	42	3	2.5	4
Baffle II (90 cm)	77	7	2.7	0

¹ TB/s = Tail-beats/s



DOWNSTREAM MOVEMENT OF STURGEONS

Lake Sturgeon

Pallid Sturgeon

Design

Moved Tail-first

Moved Tail-first

Surface Weir

0 of 1

Weir & Orifice

0 of 1

Bottom Orifice

1 of 2

Baffle I

10 of 11

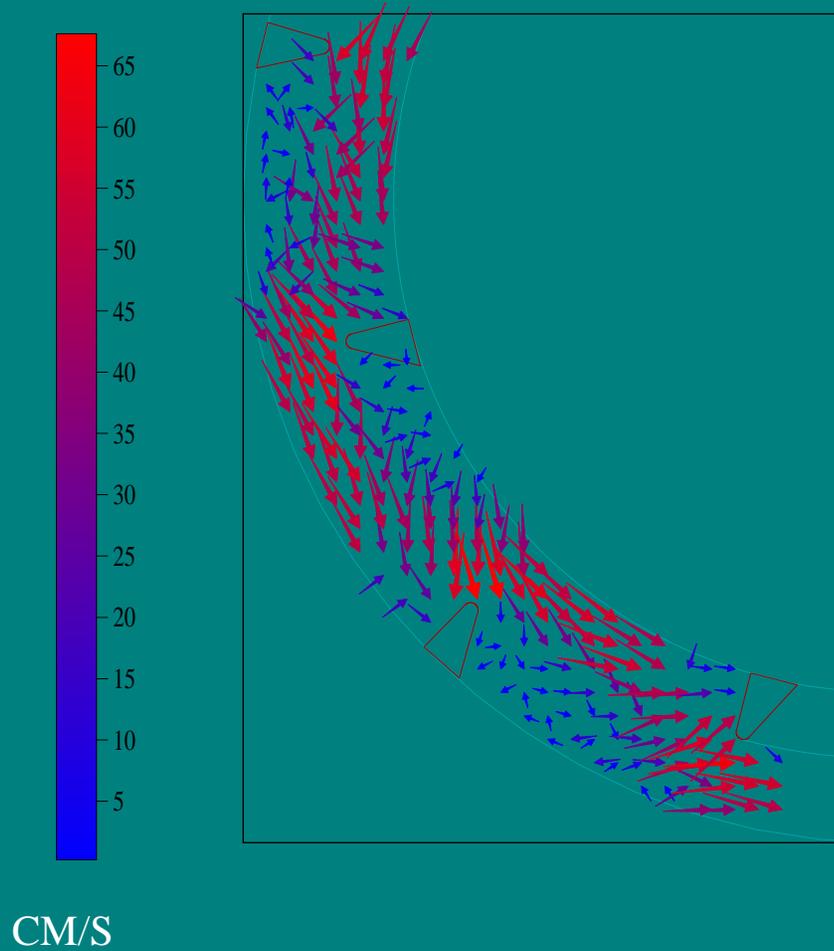
Baffle II

7 of 7

30 of 47 (68 %)



VELOCITY VECTORS IN SIDE-BAFFLE DESIGN



SUMMARY

- Non-Migratory Juvenile Sturgeons OK for Studying Behavioral Responses to Structure and Flow Important to Passage
- Opening Type – Slot is Best Because of High Success Rate, Low Fish Contact, and Clearly Best for Passing Down-running Fish.
- Swim Mode – Sturgeons Should Have No Problem Passing Slot Velocities of a Prolonged Swim Speed (1.0-1.5 BL/s)

Side-Baffle Ladder

- 6 % Slope & Suitable Baffle Spacing – OK for 4.3 m (Short Distance)
- ✓ Resting Areas – Fish Rest Behind Outside Baffles
- ✓ Downstream Movement - Sturgeons Move Downstream Tail-first



PROTOTYPE SPIRAL FISH LADDER

6 % Slope (1:16 ft) ; 6.1 m (20 ft) Diameter Loop; 1 m Wide Channel;
One Spiral = 50 Lineal Feet; One Loop Rise (vertical) = 100 cm (39 inches)

The bottom of the 2nd loop shown is 8 ft (2.4 m) high.



1 Loop Spiral

*11 Baffles

*30–35 cm water depth

*CFS = 6–7

*Velocity at slots = 0.8–1.3 m/s

(NO VELOCITY INCREASE TOP –
BOTTOM of SPIRAL)

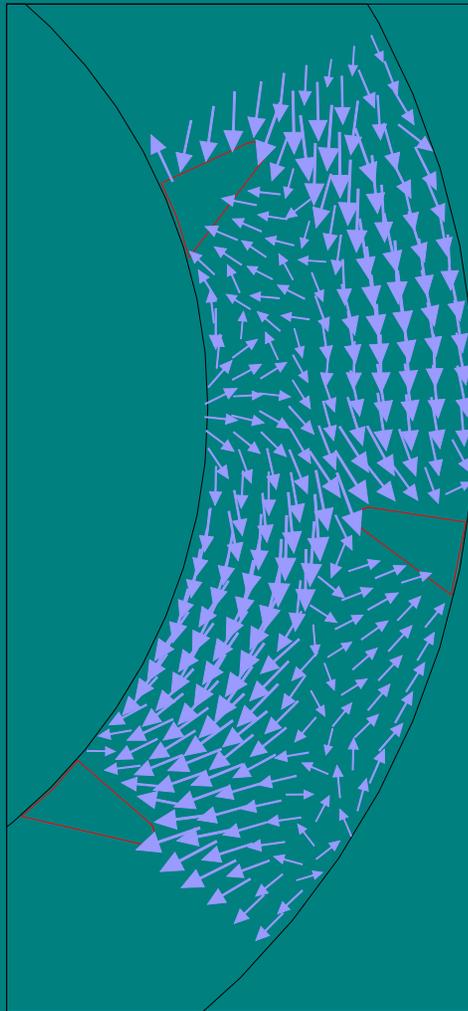
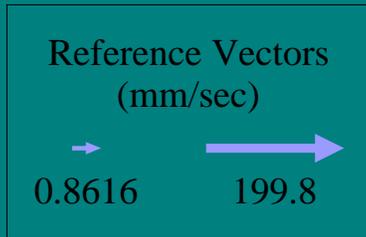
2 Loop Spiral

•12 Baffles in 1 loop

• Slot opening = inside baffle (61 cm = 24"); outside baffle (48 cm = 19")

• Baffle–Baffle Distance = 122 cm = 48"

• Mean velocity at slots = 0.9–1.2 m/s





Lake Sturgeon Performance

Test*	# Trials	Mean TL (cm)	# Top / # Tested	% Passed	# Passes	Mean time to top (min)
Spr-02	4	102	9 / 23	39	20	2
Fall-02	7	105	10 / 23	43	14	44
Spr-03	3	105	16 / 23	73	87	56
Fall-03	1	108	10 / 22	45	12	44

* 2-h trials in Spr 02, 24-h trials in Fall 02, 72-h trials in 03

Notes: 5 sturgeon never swam to top

Usual swim styles: swim-pause-swim or swim directly to top

Diel behavior: Many fish were Nocturnal, moving after sunset

UPSTREAM MOVING STURGEON

<u>% Fish with fins erect (n=100)</u>			<u>Hold time</u>	<u>Passage</u>
1 fin	2 fins	none	at baffle(n=20)	route (n=124)
30	61	9	10 min	fast water

DOWNSTREAM MOVING STURGEON

<u>Orientation (n=95)</u>		<u>% Contact (n=79)</u>		
<u>% head-first</u>	<u>% tail-first</u>	<u>miss</u>	<u>glance</u>	<u>hit</u>
13.7	86.3	32	66	2



Riverine Fish Performance

	Spiral			% to	Mean #	Mean time
Test	loops	Species	N	Top	trips to top	to top (min)
Spr-02	1	W.Sucker	25	100	5.8	< 30
		SMB	11	90	1.9	< 90
Sum- fall 02	2	Channel C.	4	100	2.8	< 60
		Walleye	3	100	3	< 30
Spr-03	2	Walleye	12	92	3.1	80
		W.Sucker	82	92	3.5	48
		SMB	6	66	2.5	51
		LMB	1	100	1	80

Note: Most movement was Nocturnal, except for SMB & LMB

DOWNSTREAM PASSAGE FOR STURGEONS

GUIDANCE BY BAR RACKS AND LOUVERS –Shortnose & Pallid Tests – 1998 (Funding: Conte AFRC)

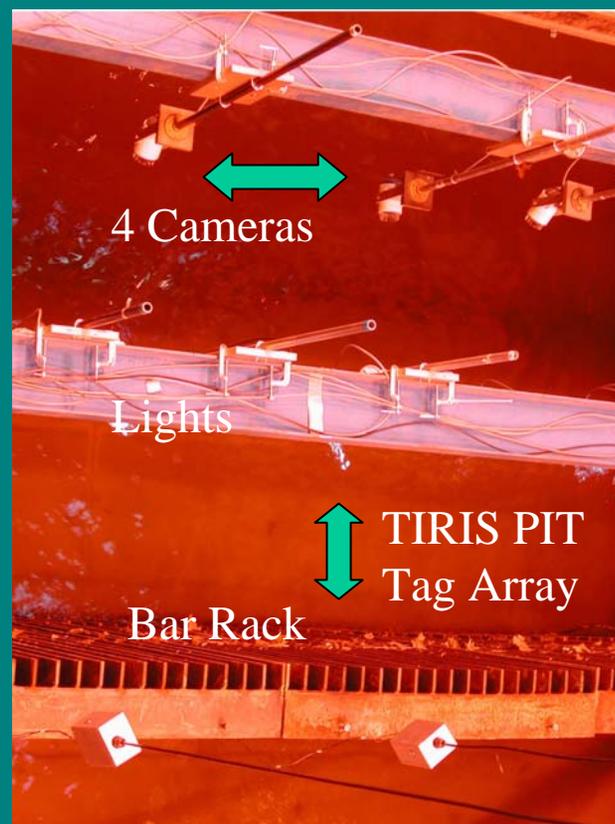
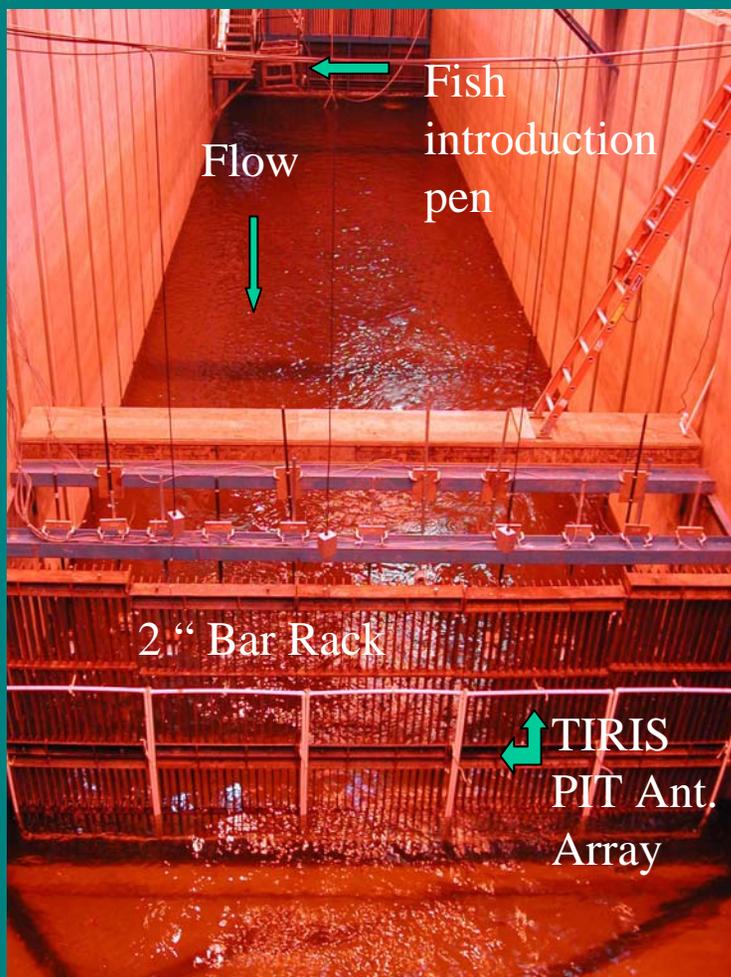
- Louvers guide well, racks guide poor unless oriented like louvers
- Yearlings (27 cm TL) avoid impingement at 40 cm/s velocity (1.5 BL/S)
- Guidance best in day, lowest at night (fish using vision to avoid structure)



Development of Downstream Passage for Sturgeons : Fall 2004

(Funding: City of Holyoke)

1. Determine swimming depth
2. Determine impingement on bar racks at natural velocities





18 mo old sns

Ready for testing

Don Pugh working the digital video system



PRELIMINARY RESULTS

1. **Swimming Depth** – Within 1.5 m of bottom (90% within 0.5 m)
2. **Guidance at Bar Rack**

1 FT/S APPROACH VELOCITY

- * Adults-Yearlings guided, avoid impingement

2 FT/S APPROACH VELOCITY

- * Adults & Large Juveniles guided, avoid impingement
- * Yearlings - ?

3 FT/S APPROACH VELOCITY



