

Hydraulics of the Vianney-Legendre vertical slot fishway near St. Ours, Quebec

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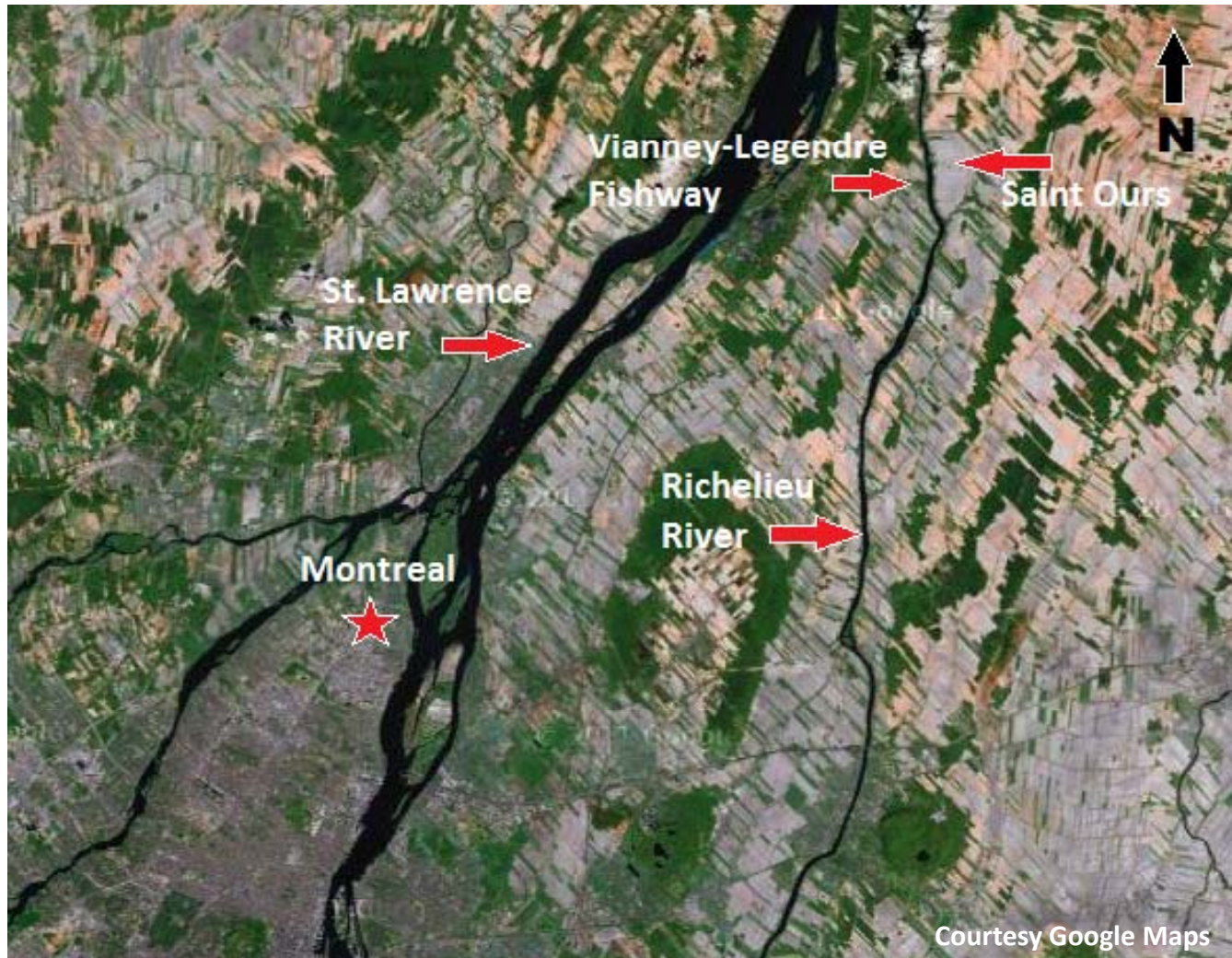
Overview

- Summer 2011 field results
 - Introduce field study site
 - Velocity Measurements
 - Flow patterns
 - Velocity field diagrams
 - Water Levels
- Project's next steps

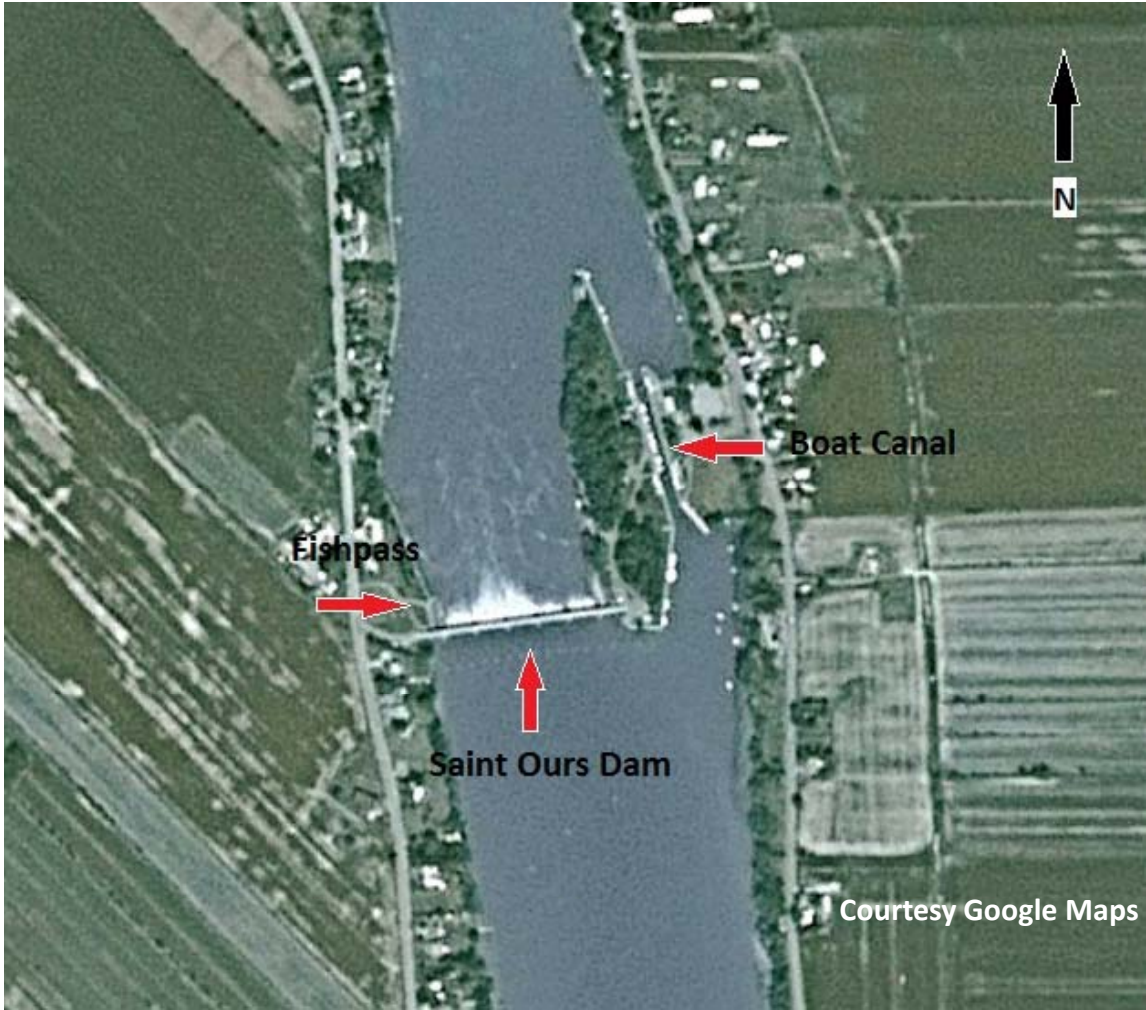
Research Goals

Combine fish ecology and hydraulic engineering research in order to improve our understanding of fish passage at the study site. A focus will be placed on improving upstream fish passage and developing a set of design guidelines to be followed for future fishways passing sturgeon species.

Area Map



Site Map



Spillway Open



Photo by Adam Marriner

Spillway Closed



Photo by Adam Marriner

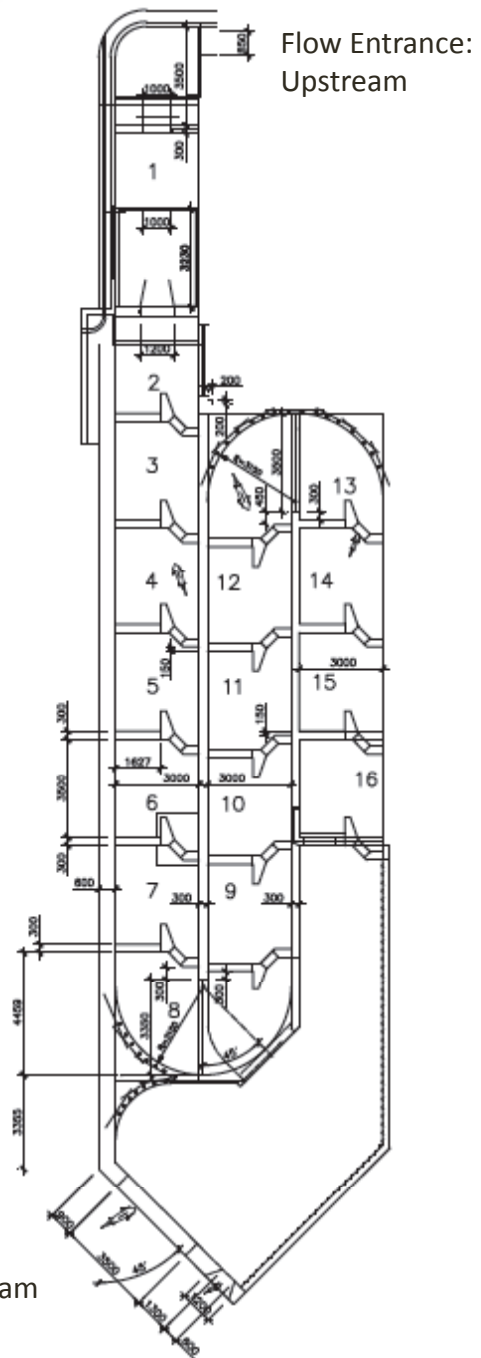
Fishway Information



- Constructed in 2001– 02
- Vertical Slot Fishway (staircase style)

Design Details

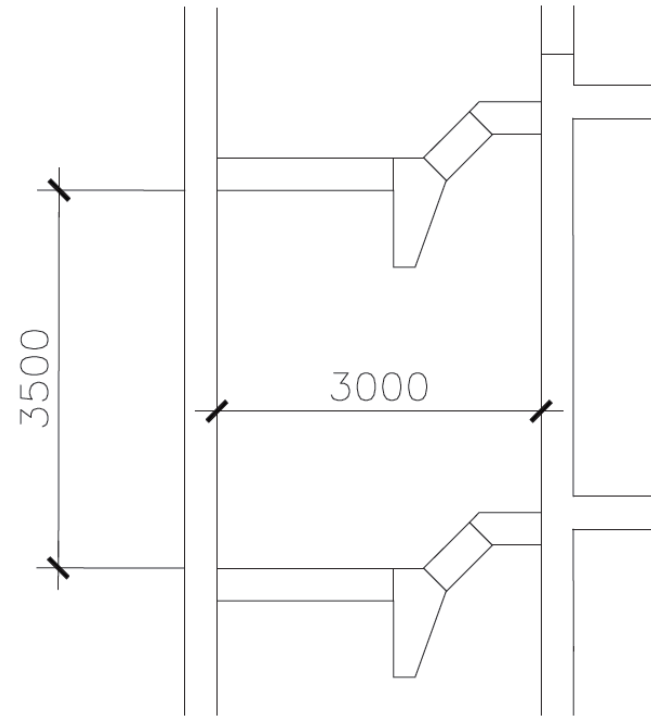
- Staircase style vertical slot fishway
 - Overcome a greater elevation change
- 89 m in length
 - Fish swimming distance > 89 m
- 17 pools
 - 13 standard pools
 - 2 turning pools
 - entrance & exit pools
- Total elevation change of 2.55m
- Overall slope = 2.8%
- flow rate = $1.60 \text{ m}^3/\text{s}$ + attraction flow = $6.5 \text{ m}^3/\text{s}$



Standard Pools



$L = \text{pool length} = 3.500 \text{ m} = 5.83 b_0$
 $W = \text{pool width} = 3.000 \text{ m} = 5.00 b_0$
 $b_0 = 0.609 \text{ m}$
 $S = 3.95\%$



Turning Pools

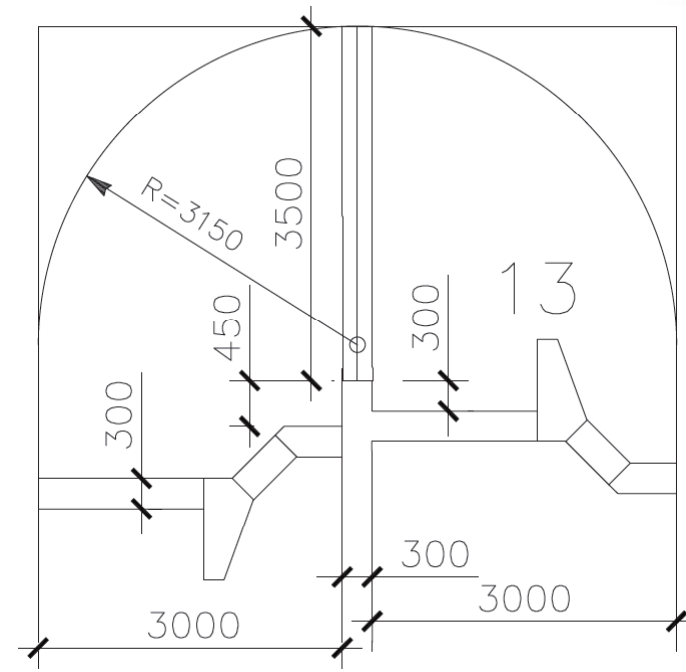


Photo by Adam Marriner

$L = 3.50 \text{ m}$

$W_T = \text{Turning pool width} = 6.30 \text{ m}$

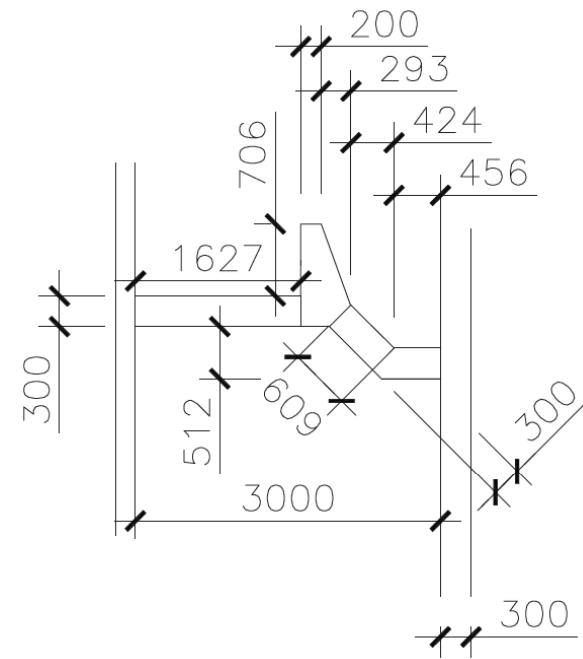
$R_T = \text{Turning pool radius} = 3.15 \text{ m}$



Slot



Slot width = $b_0 = 0.609$ m



Entrance Pool



Fieldwork Focus

- Standard Pools
 - Extensive research
 - Detailed understanding of hydraulics
 - Design guidelines⁵
 - $L = 10 b_0$, $W = 8 b_0$
- Turning Pool
 - Little pre-existing research²
 - No design guidelines
 - High passage failure in two turning pools¹

Fieldwork Outline

- Water Level
 - 5 pools
 - 2 turning pools
 - 1 pool in each standard row
 - Upstream & downstream
- Velocity
 - 2 turning pools
 - 2 standard pools

Water Levels

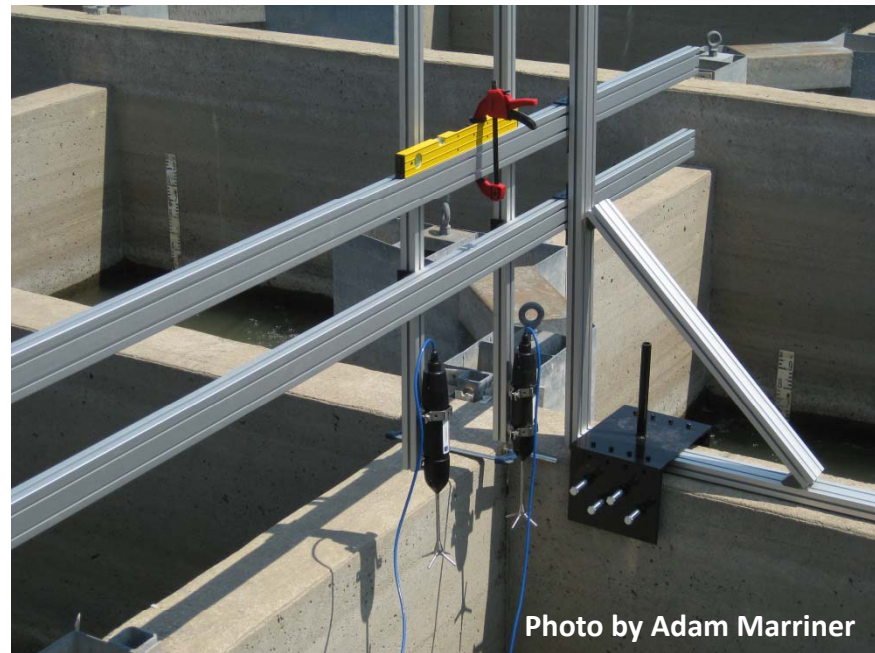


- Data Divers
- Measurement frequency of 1 minute

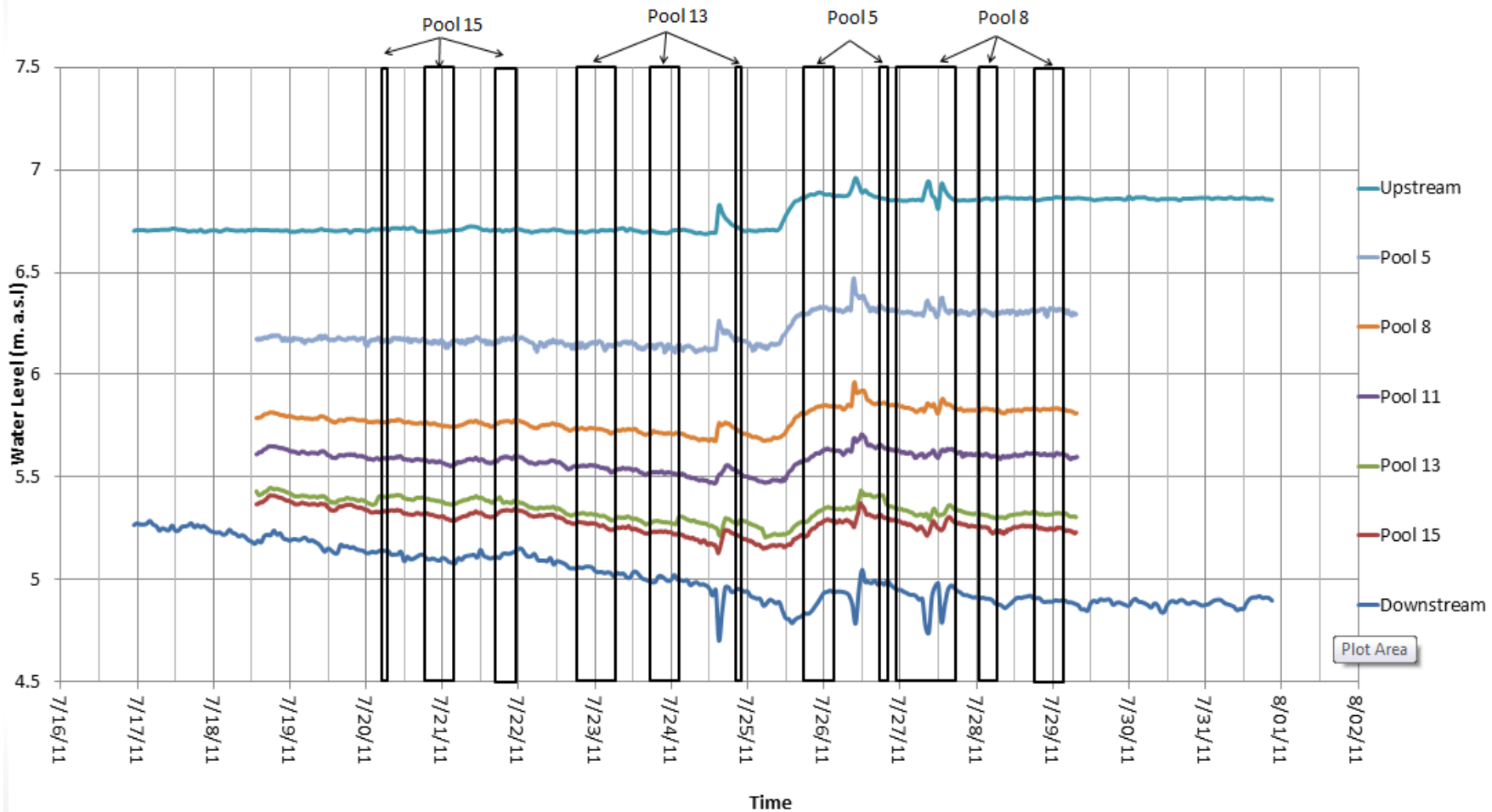
Velocity Measurements



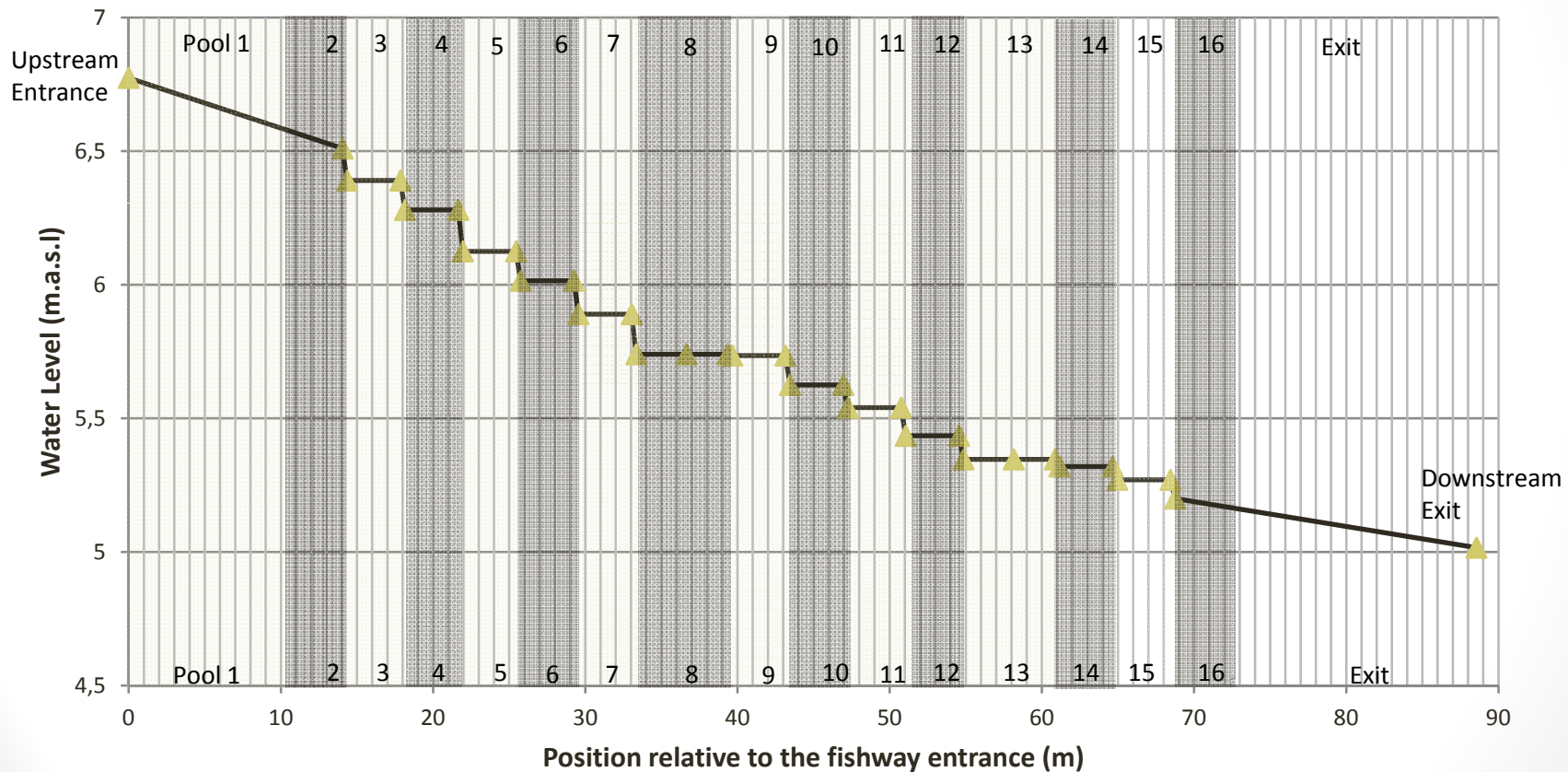
- MiniTec aluminum framing
- Nortek Vectrino field ADVs
- Approximate water depth = 50 cm



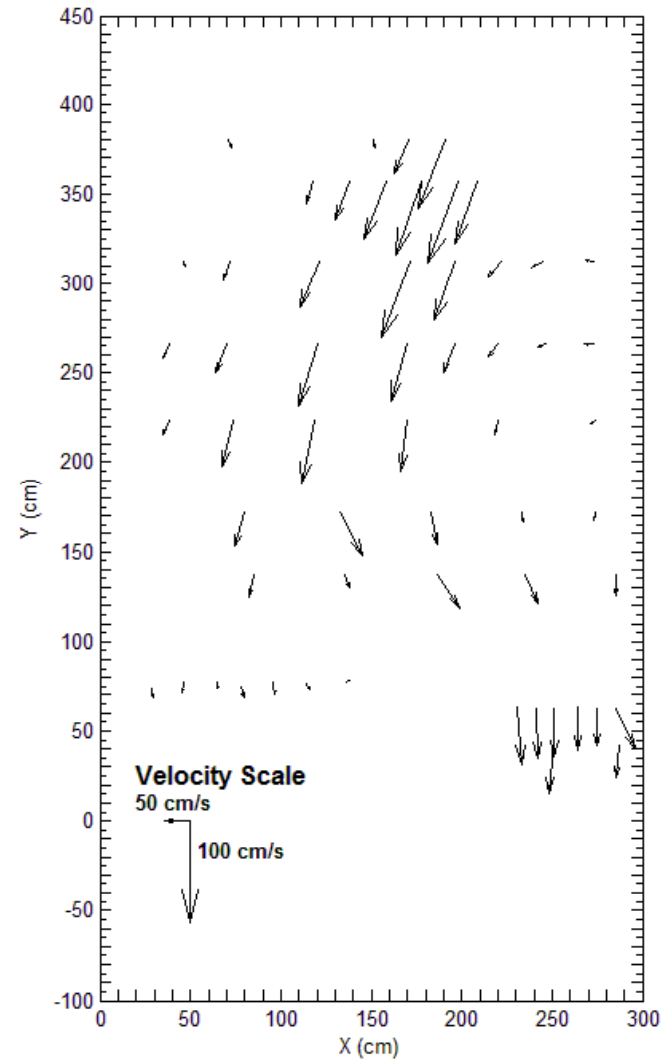
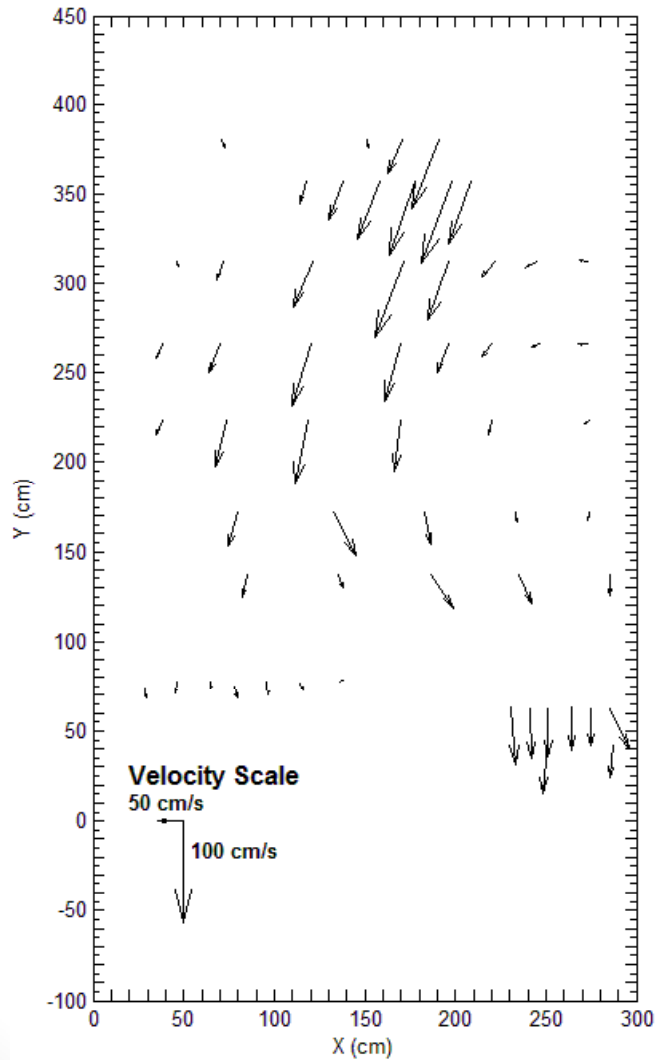
Water Levels: Metres above Sea Level



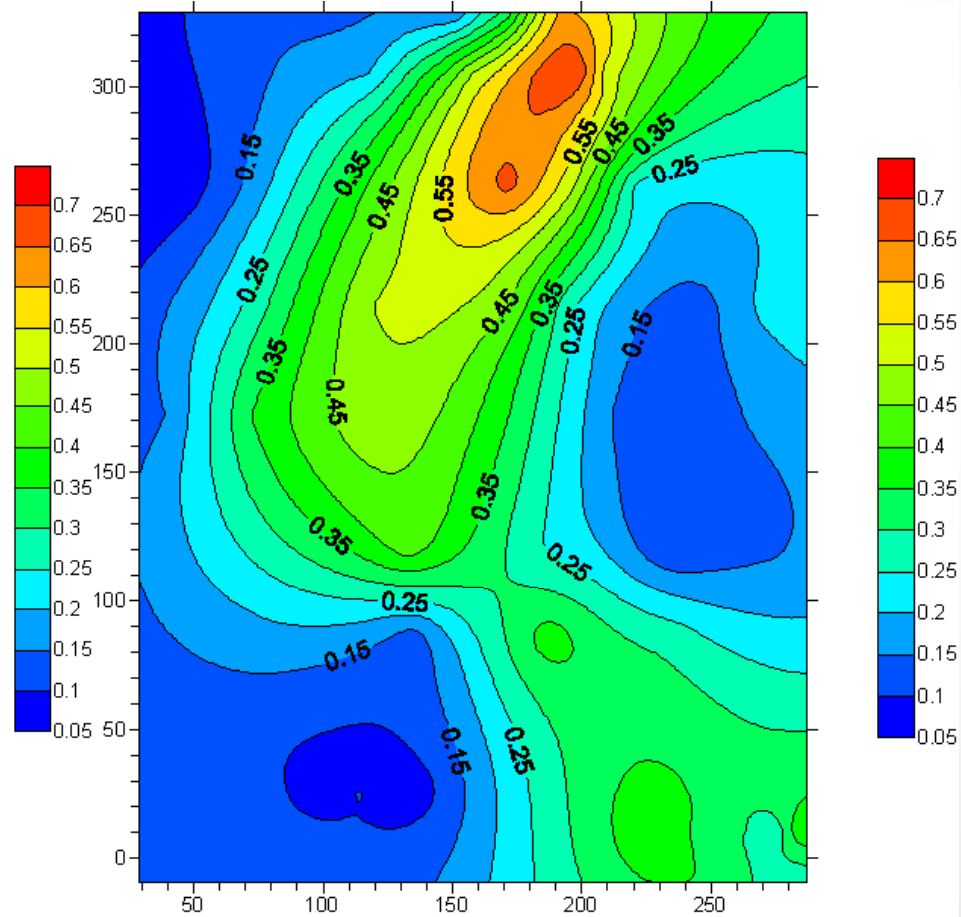
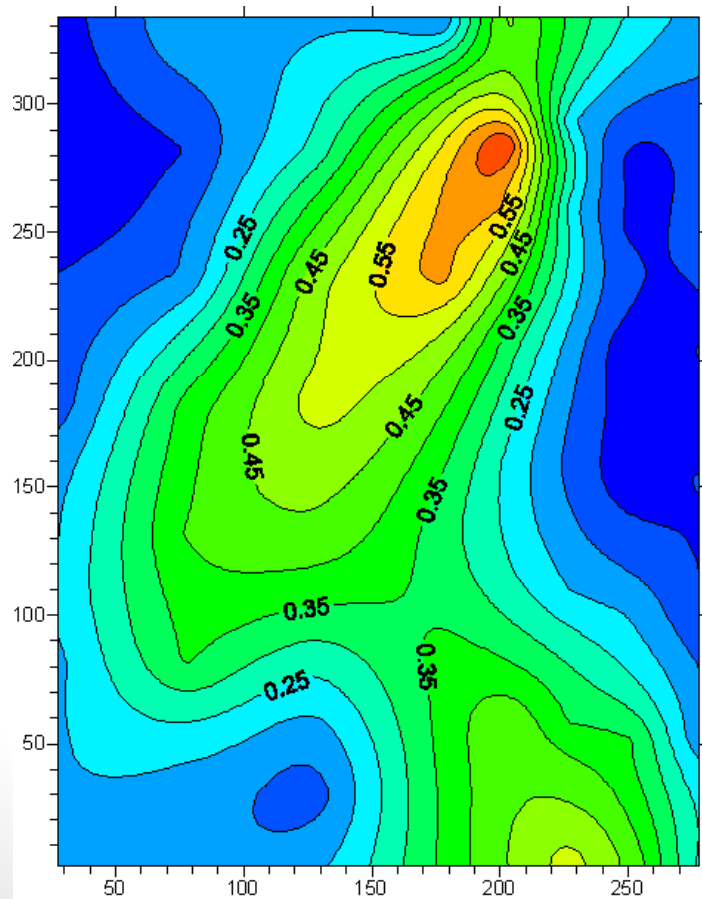
Fishway Elevation Changes



Velocity Field Diagrams: Pools 5 & 15



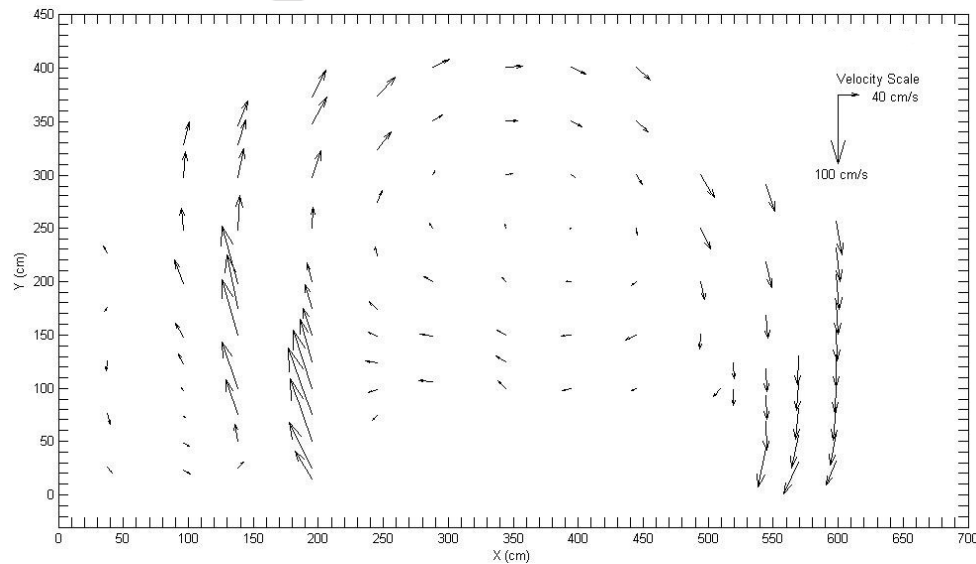
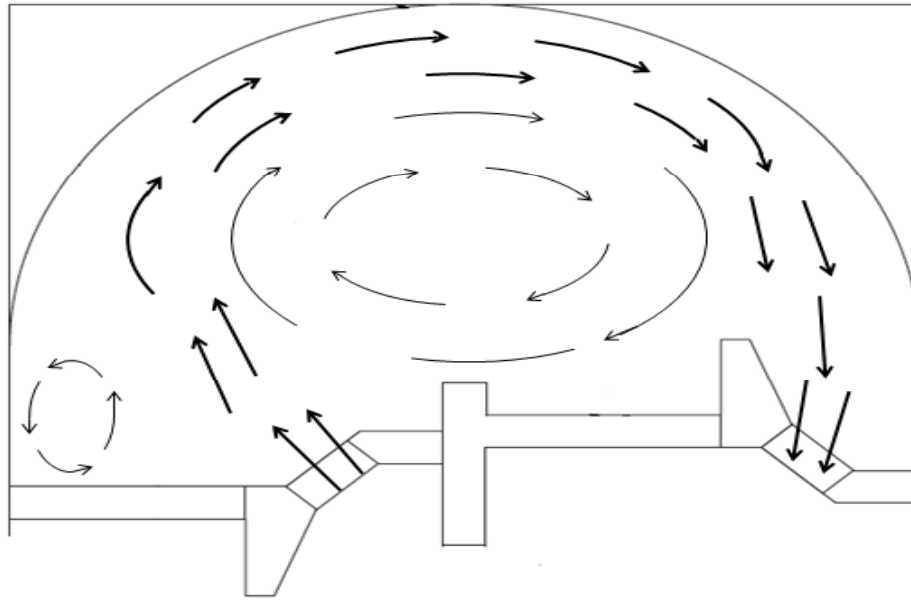
Kinetic Energy Diagrams: Pools 5 & 15



Standard Pool Hydraulics

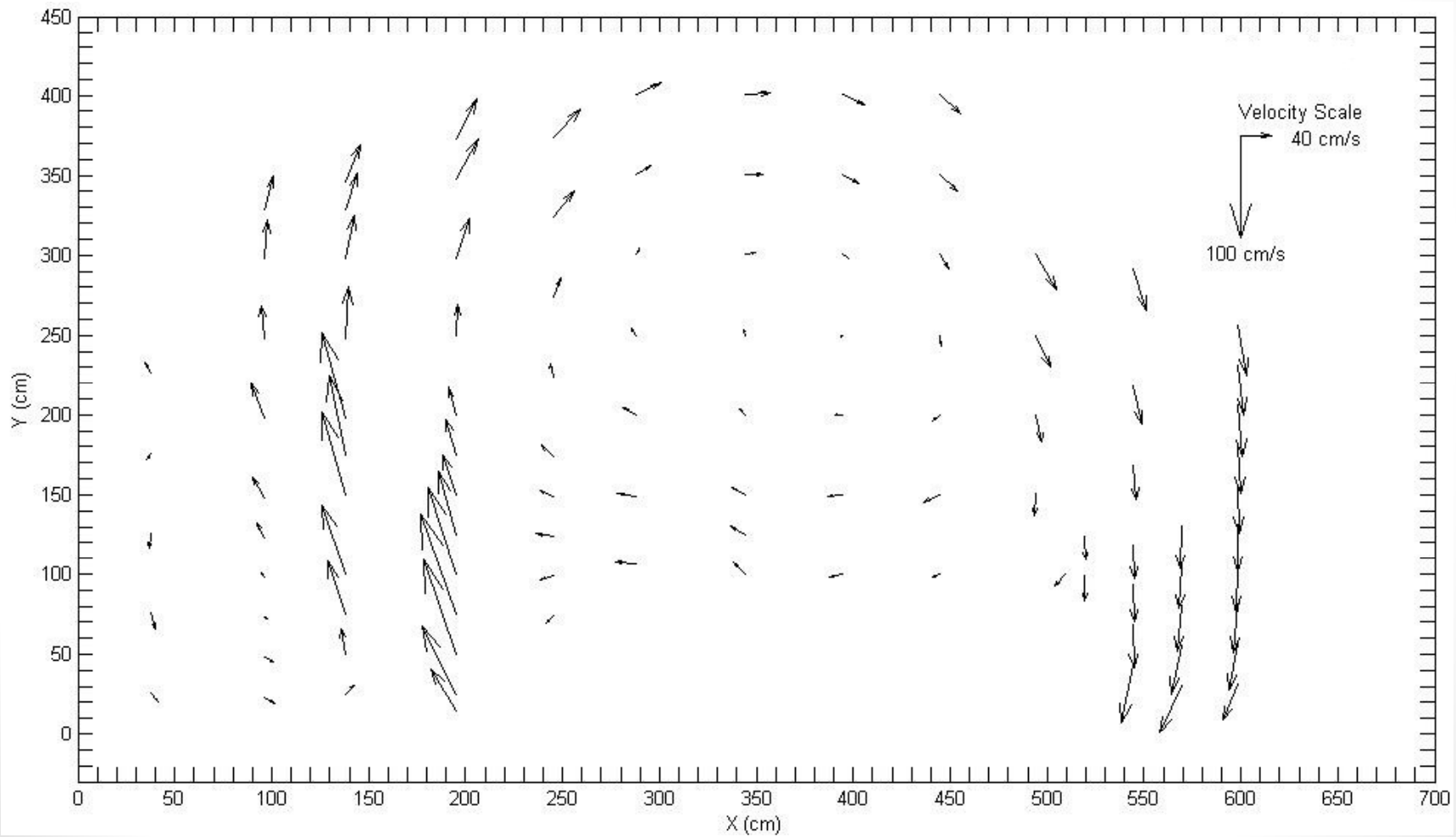
- Similar to Type 2³ flow pattern
- Kinetic Energy measurements consistent with previous laboratory study⁴
- Pool 5 velocities greater than Pool 15

Turning Pool Flow Pattern



Pool 13

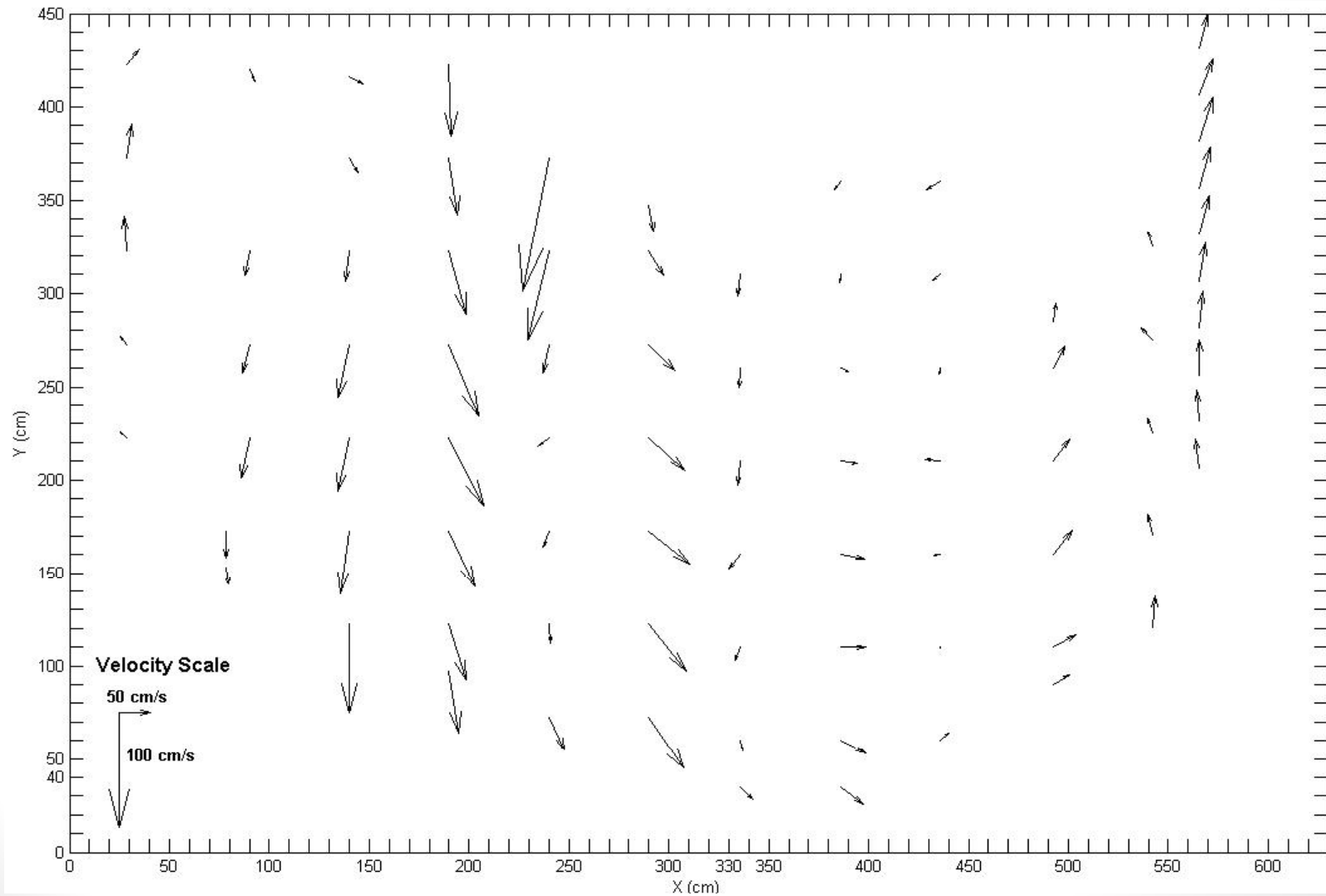
Velocity Field Diagram



Pool 8

- $V_{sm} = 1.23 \text{ m/s}$
- 82 data points

Velocity Field Diagram



What is causing the ascension difficulties in turning pools ?

- 180° direction change
- Large recirculation zones or eddies
 - greater than fishes body size
- Suggestions?

Upcoming Project Options

- Velocity measurements
 - Reinforced measurement set- up
 - Data points at multiple depths
- Attraction flows
 - ADCP measurements of downstream fish 'entrance'
- Water levels
- Study with a biomechanical fish.

References

- Thiem J, et al (2011) Behaviour and passage success of upriver-migrating lake sturgeon *Acipenser fulvescens* in a vertical slot fishway on the Richelieu River, Quebec, Canada. *Endangered Species Research* Vol. 15: 1—11.
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- Lui, M., Rajaratnam, N., & Zhu, D. (2006). Mean Flow and Turbulence Structure in Vertical Slot Fishways. *Journal of Hydraulic Engineering*, 765-777.
- Rajaratnam, N., Katopodis, C., & Solanki, S. (1992). New designs for vertical slot fishways. *Canadian Journal of Civil Engineering*, 402-414.

Acknowledgements

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Thank You / Questions

