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Eels III: Evaluation of Behavioral Cues for Guiding Silver Eels at Hydro Projects

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Evaluation of Behavioral Cues for Guiding Silver Eels at Hydro Projects



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ALDEN

Solving flow problems since 1894

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BLUE LEAF
ENVIRONMENTAL

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Project Participants

Eel Passage Research Center

Technical Committee – Member Affiliations

- Electric Power Research Institute
- Ontario Power Generation
- Hydro-Québec
- USFWS, FEMRF
- Duke Power
- New York Power Authority
- Ontario Ministry of Natural Resources
- Fisheries and Oceans Canada
- Québec Ministry of Sustainable Development, Environment Wildlife and Parks
- NYS Department of Environmental Conservation

Alden Team

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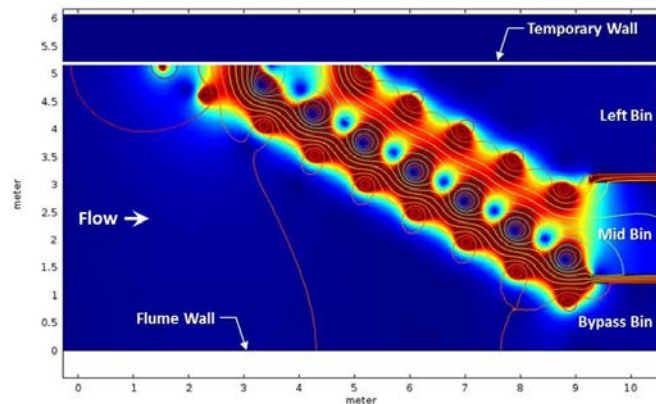
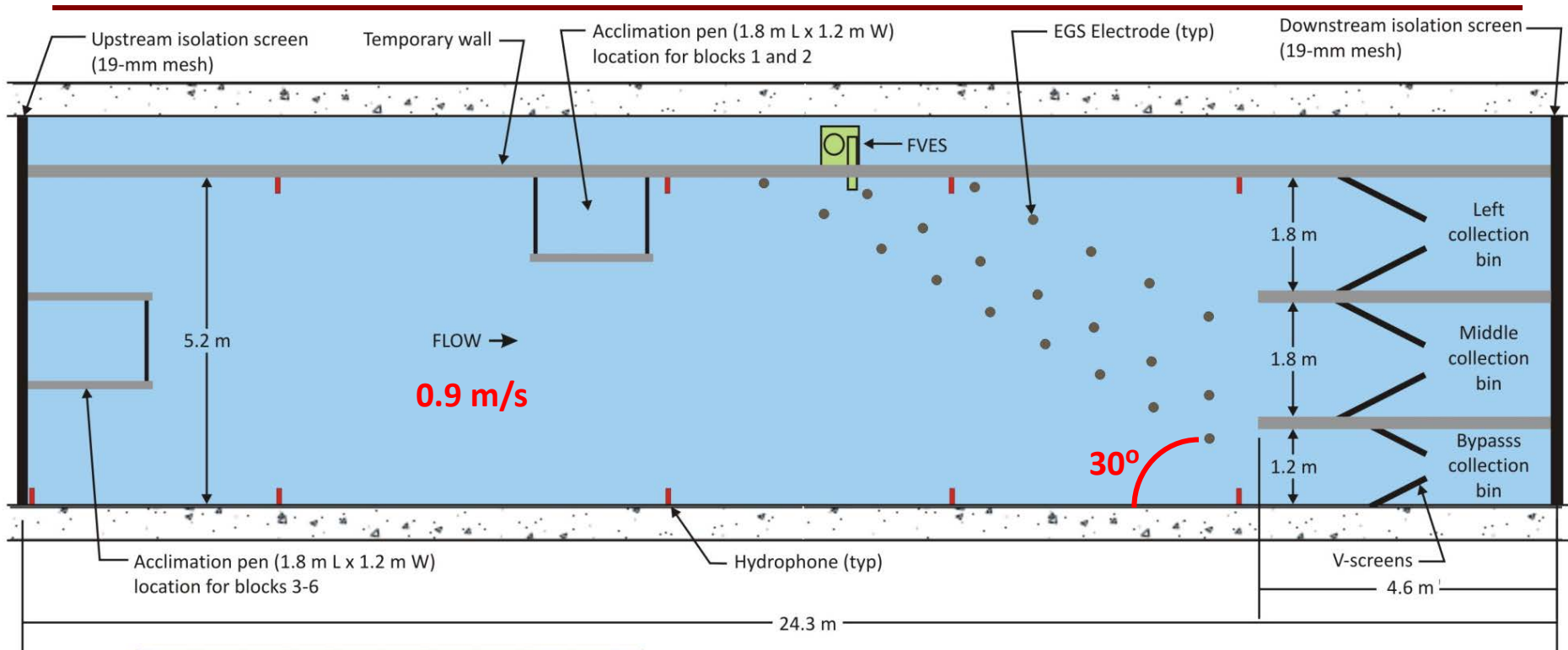
Evaluation of Behavioral Cues for Guiding Silver Eels at Hydro Projects

- Electrical Guidance System (EGS)
- Flow Velocity Enhancement System (FVES)



Large Flume Testing with EGS and FVES

Test Facility Design



Experimental Design

- Test Conditions: EGS, FVES, combined stimuli, control
- 5 replicate trials conducted with each condition; 30 eels per trial
- 2-hr trial duration
- Track each eel with 3D acoustic telemetry system
- Record number of eels downstream of stimulus field, in bypass collection bin, and that remain upstream.



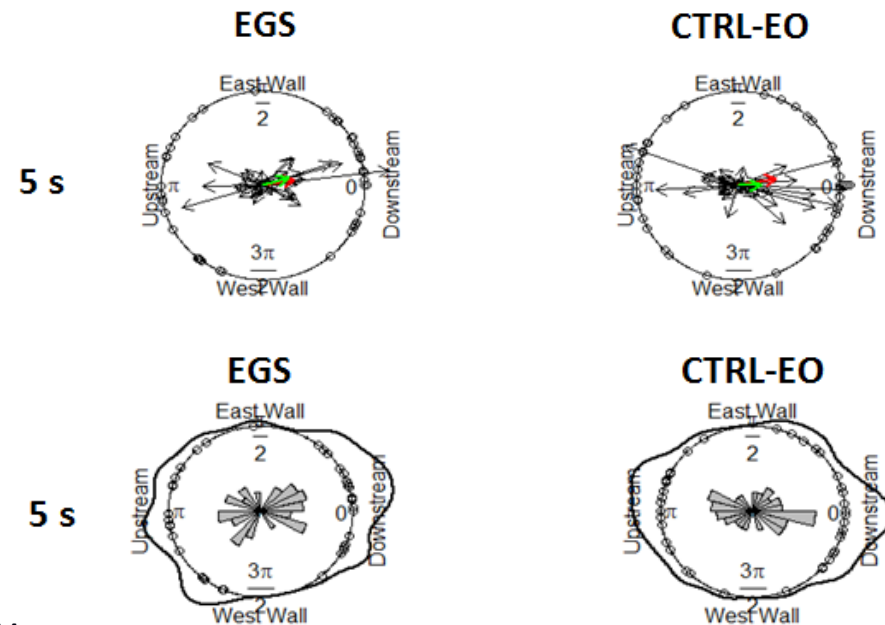
Test Conditions

Block	Trials	Dates	Flume Water Temp Range (C°)	Acclimation Pen Location	Number of Electrodes	Electrode Position for Control/FVES Trials
1	4	10/13-14	13.9 - 14.2	mid/wall	20	above water
2	4	10/15-16	15.6 - 16.7	mid/wall	20	above water
3	4	10/23-24	15.6 - 16.0	upstream/center	20	above water
4	4	10/27-28	14.7 - 15.1	upstream/center	21	above water
5	4	10/29-30	15.3 - 15.9	upstream/center	21	above water
6	2 (C)	11/18	10.2 - 10.3	upstream/center	21	in water

Eel Movement Statistical Analysis

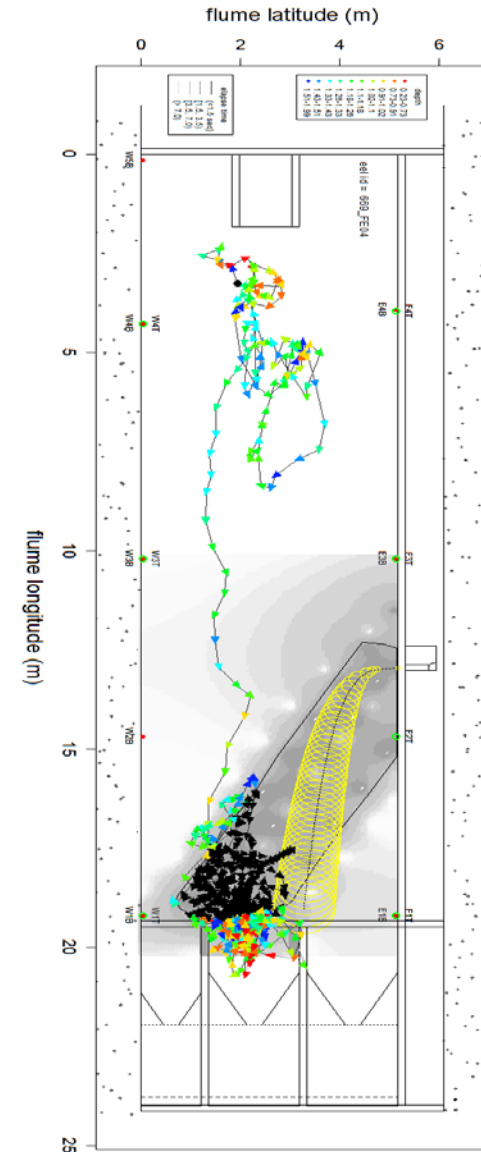
Calculation of Eel Movement and Direction

- The position where an eel first entered a stimulus zone of coverage was determined.
- For intervals of 5, 10, 20, 60, 300, and 600 seconds, the last observation of each time period was established.
- Using the first and last positions observed, differences were computed for x, y, and z coordinates and time.
- Direction was computed as an angle in the x-y plane and speed was calculated as the Euclidean distance in three dimensions between the first and last position divided by the difference in time.



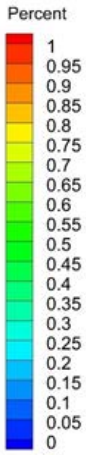
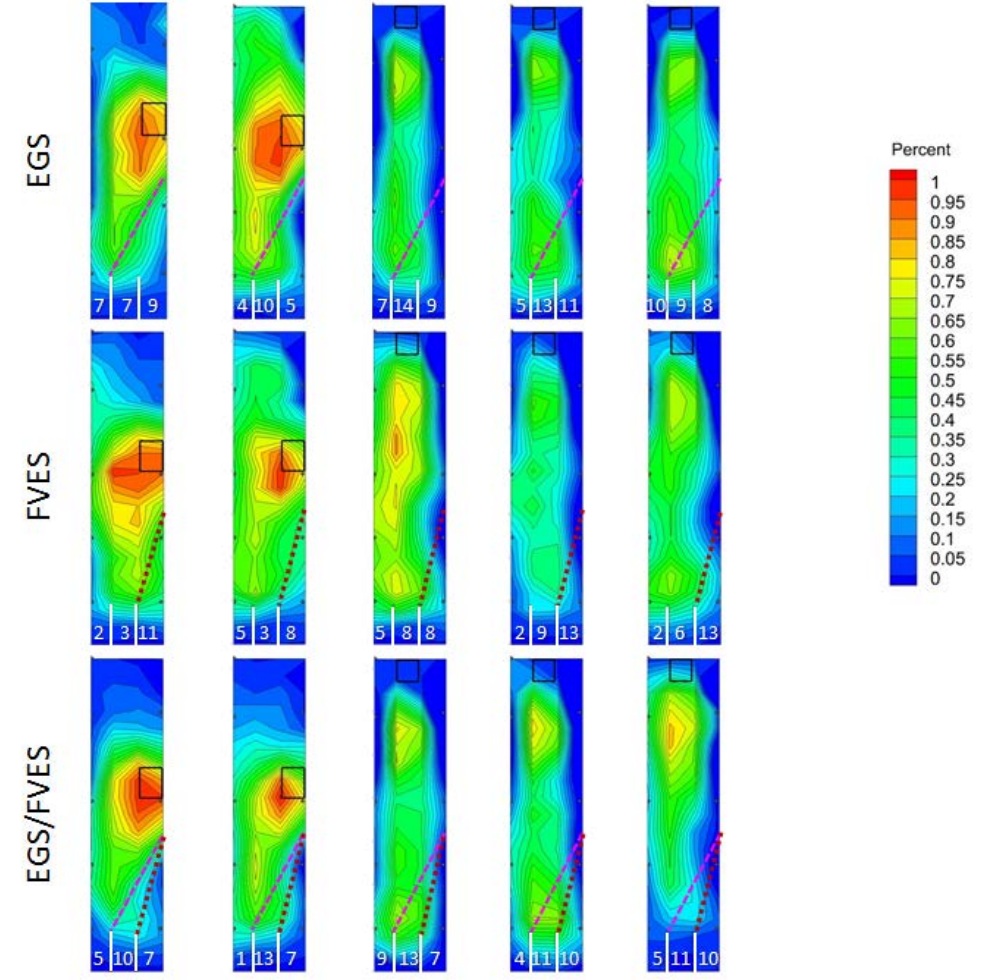
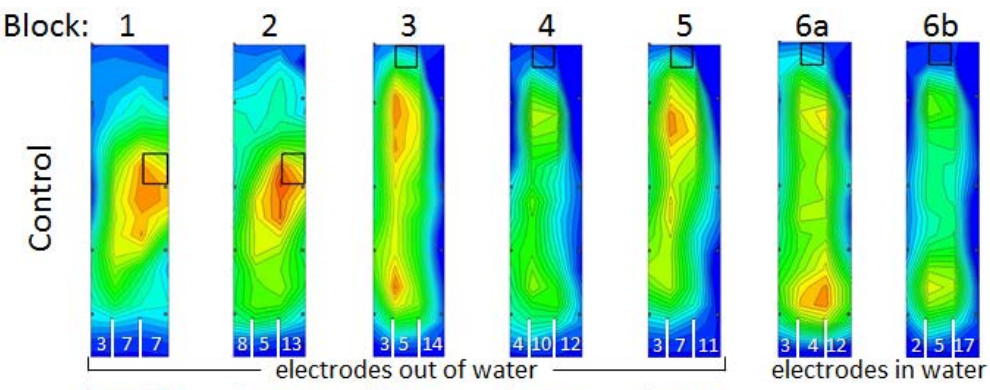
Results

- Recollection Bin Data (insufficient for determining avoidance/guidance)
- 1-hr Density Plots
- 10-min Density Plots
- Eel Track Examples
- Analysis of Eel Direction and Speed after Stimulus Encounter



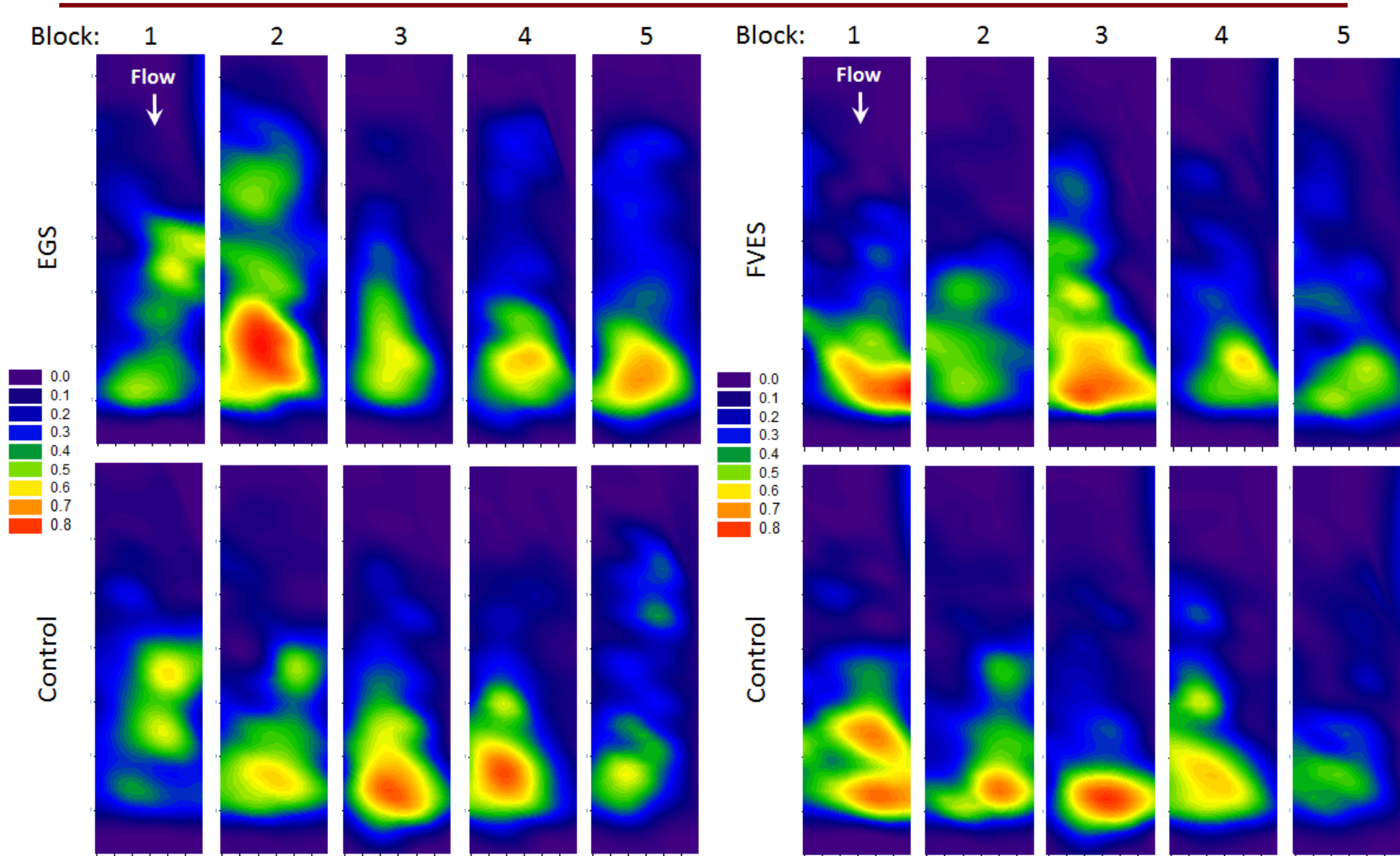
Telemetry Density Plots

First Hour of Each Trial



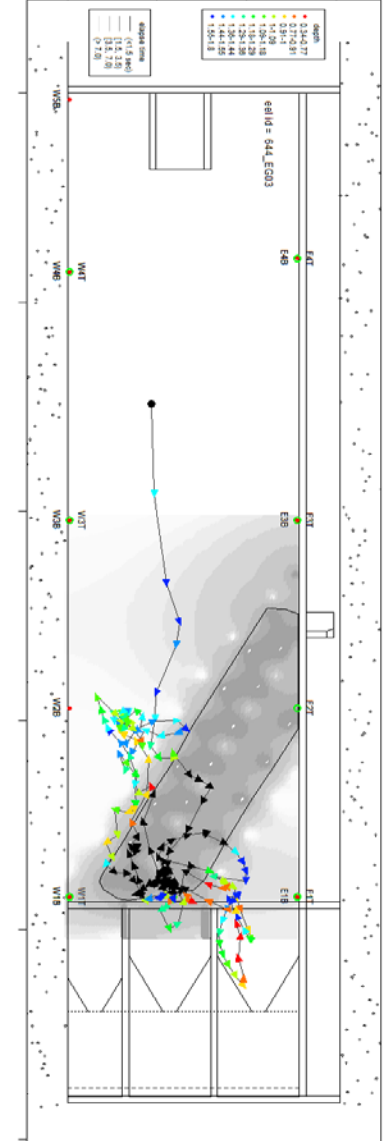
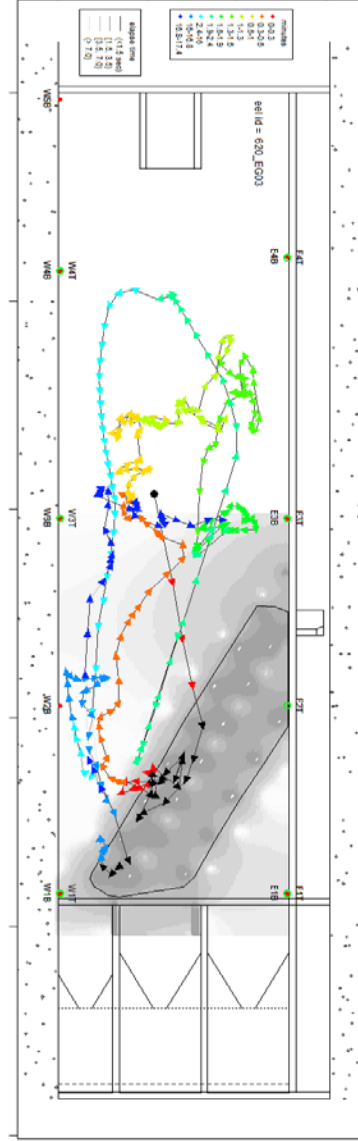
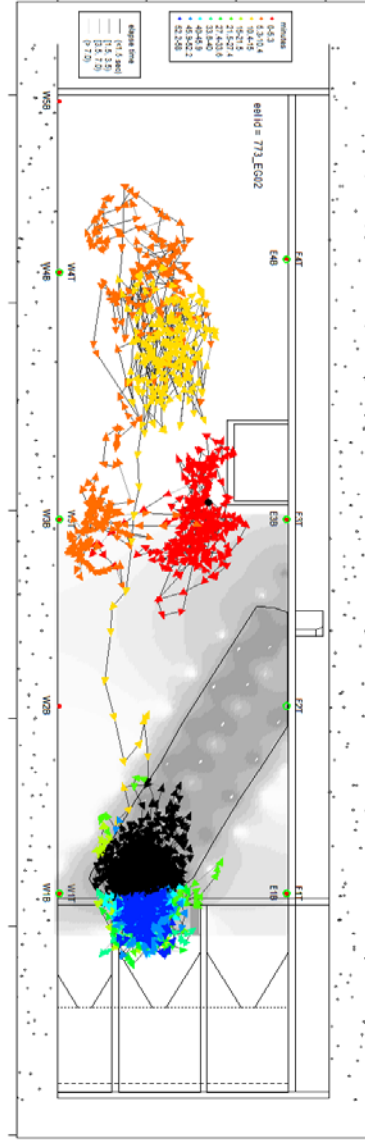
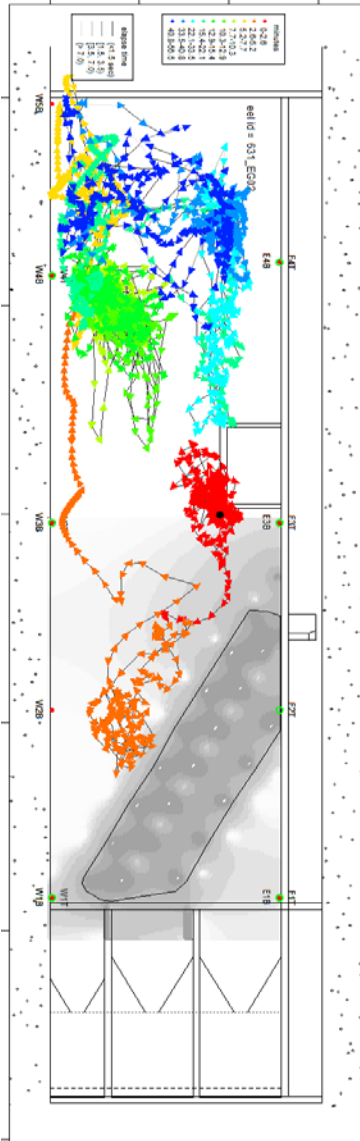
Telemetry Density Plots

30 sec Pre/10 min Post Stimulus Encounter



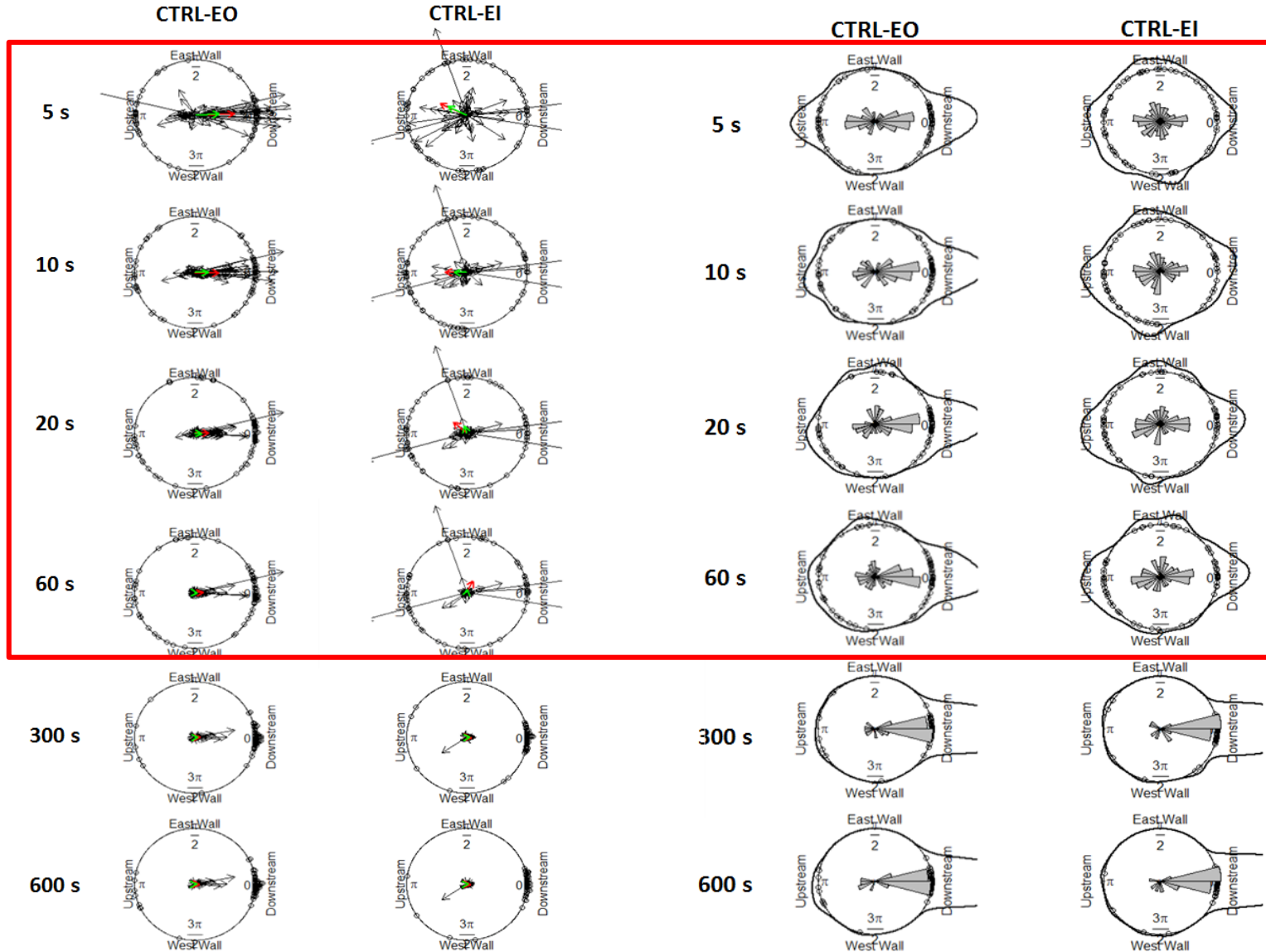
Example Eel Tracks

EGS Trials



Analysis of Eel Movement

Control Blocks 3-5 (electrodes out) vs. 6 (electrodes in)



Analysis of Eel Movement

Stimulus Treatments vs. Controls

- Few statistical differences in mean direction and directional distribution between stimulus and control trials for any of the time intervals evaluated (5 – 600 seconds).
- Eel movement direction for each stimulus and control trials was typically non-uniform and in the downstream direction, particularly after the acclimation pen was moved upstream.
- Analysis of control data with and without electrodes in water indicated physical presence of electrodes initially influenced eel behavior but this effect was not evident after 60 seconds.

Summary and Conclusions

- Recollection data (i.e., proportion of fish removed from each bin) could not be used to calculate guidance efficiency.
- 1-hr eel tracking density plots indicated differences in eel distributions between blocks with different test facility configurations.
- 10-min density plots did not demonstrate any consistent differences in eel distributions between treatment and control trials.
- Statistical analysis of eel movements (speed and direction) did not demonstrate any consistent differences between treatment and control trials.
- There appeared to be an initial avoidance reaction of eels to the physical presence of the electrodes during control trials when they were suspended in the water.
- Supplemental analyses of tracking data being considered to further explore potential avoidance and guidance responses to each stimulus.
- In hindsight, several changes could be made to study methods and test facility design to improve ability to detect behavioral responses.

QUESTIONS?

