

Field Investigation of American Eel Response to a Light Guidance Array

Jonathan Black

Technical Executive, Electric Power Research Institute

First International Fish Impingement and Entrainment Conference, Liverpool, UK

July 11-13, 2023



Special Thanks to Paul Jacobson (EPRI)
and Dave Stanley (OPG)

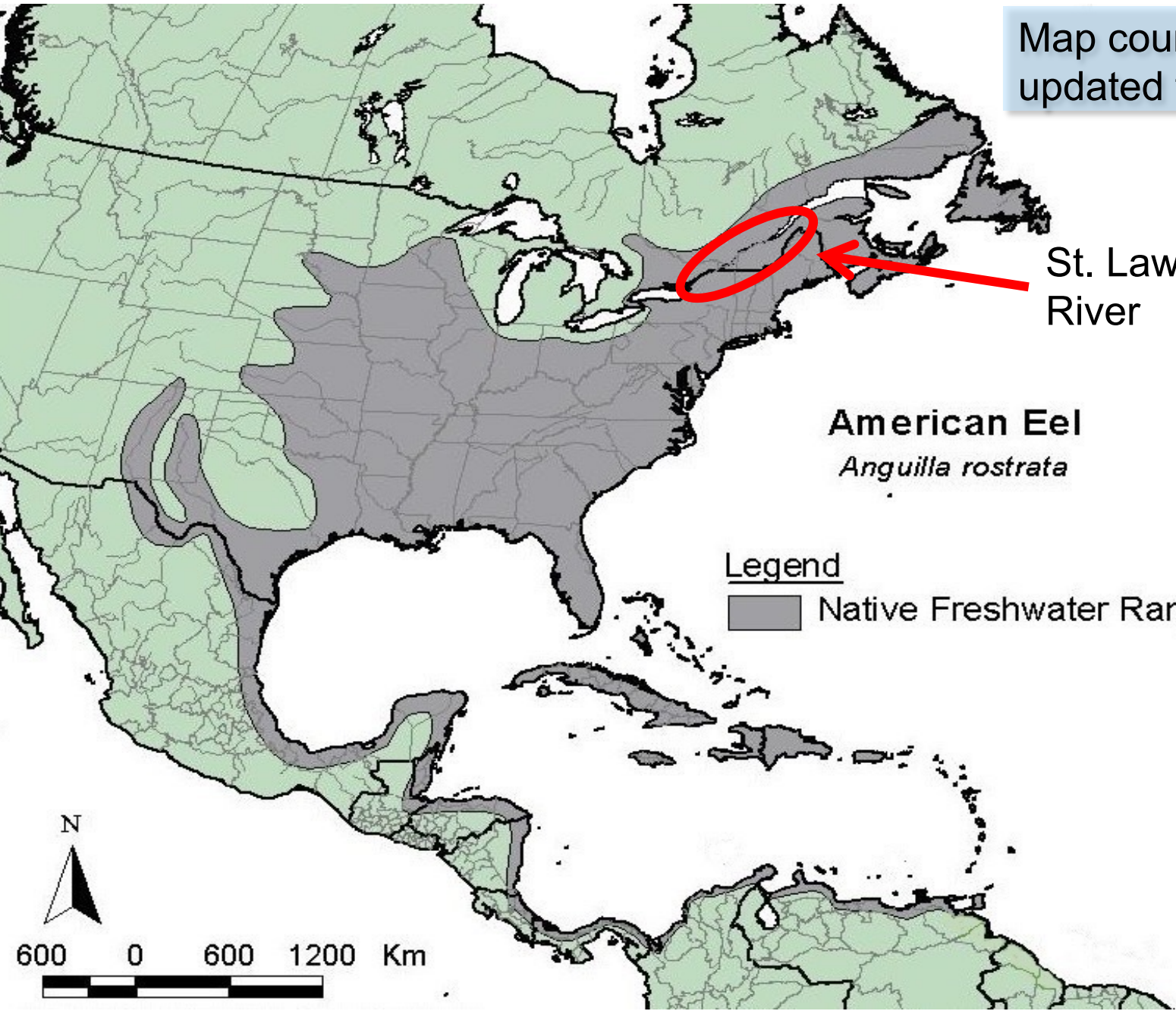
Map courtesy of USFWS,
updated from Natureserve



St. Lawrence
River

American Eel
Anguilla rostrata

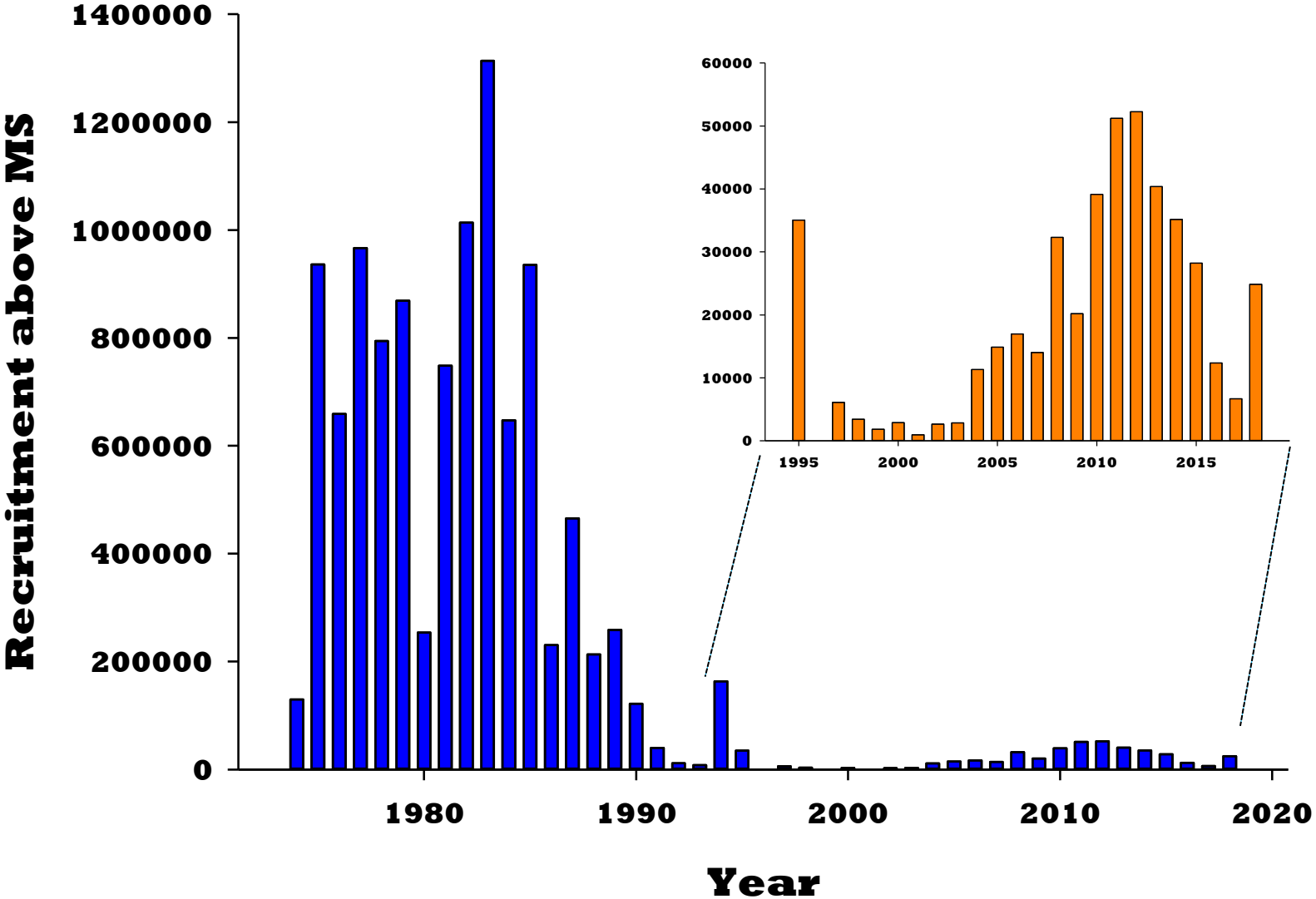
Legend
■ Native Freshwater Range



- Endangered (IUCN Red List)
- Endangered (Ontario)
- Vulnerable (Newfoundland and Labrador)
- Candidate for Listing (US and Quebec)

Eel recruitment to the upper St. Lawrence River

(1974-2018)



Eel Passage Research Centre

Upper St. Lawrence River and Selected Hydropower Project Facilities



- An EPRI-managed, bi-national collaboration to address downstream passage of eels at large hydroelectric power stations
- **Goal:** Maximize survival rate of eels that would otherwise pass through turbines at Moses-Saunders and Beauharnois without significantly reducing power production

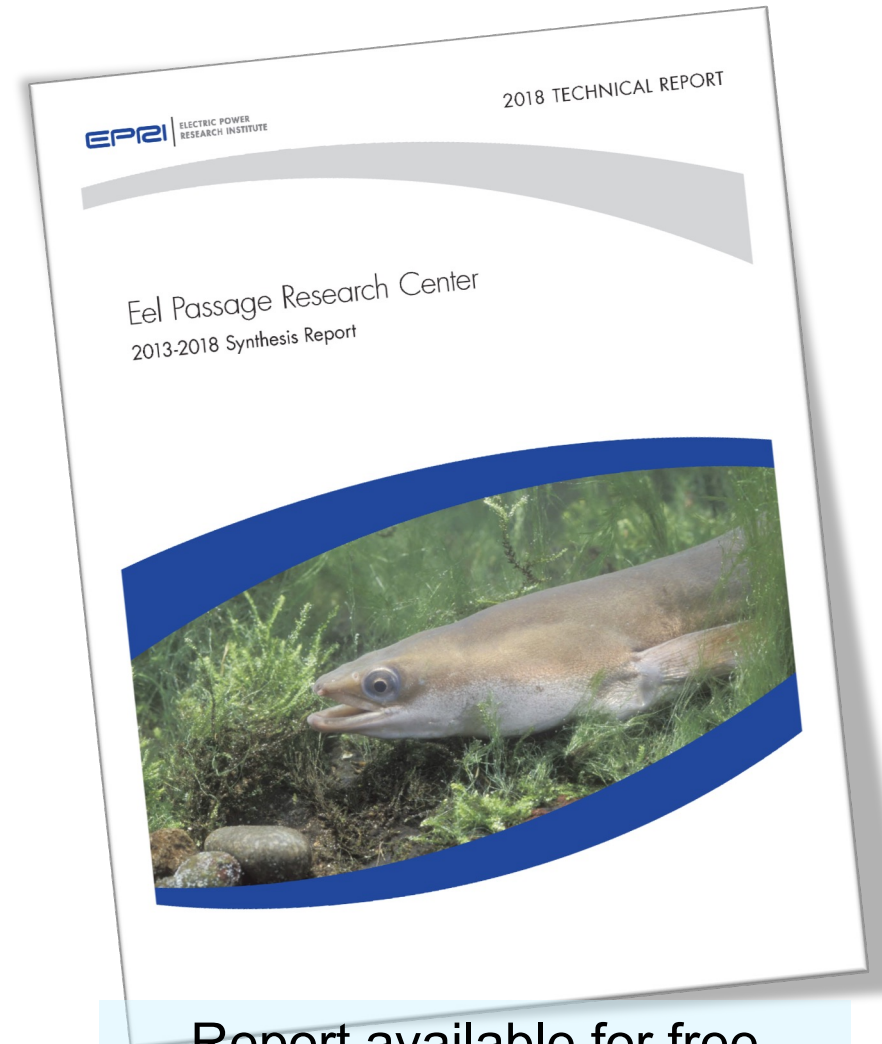
The Saint Lawrence is BIG

River	Approx Average Discharge (m ³ /s)
St. Lawrence	16,800
Volga River	8,220
River Tay	100
Mersey River	20

Key Findings to Date

2013-2018 Synthesis Report

- Light shows promise for guidance in the St. Lawrence
 - LEDs (recent) provide many advantages over previous light technologies
- Low frequency sound merits further investigation as secondary stimulus
 - Sound pressure level vs. particle motion
- EMF is unlikely to be useful for guidance in the river
- Velocity plume and electricity not suitable for guidance in St. Lawrence River, but could facilitate entry and capture at collection structures
- 1.1 MHz multibeam sonar (ARIS, DIDSON) can identify eels, 500 kHz multibeam sonar (Mesotech M3) can track known eels
- Laboratory studies are of limited value for investigating eel guidance
 - Context
 - Scale



Report available for free download at: www.epri.com

Report ID: 3002014733



Field Investigation of American Eel Response to a Light Guidance Array

Collaborators



NY Power Authority



Fisheries and Oceans Canada

Pêches et Océans Canada

*Environnement,
Lutte contre
les changements
climatiques,
Faune et Parcs*



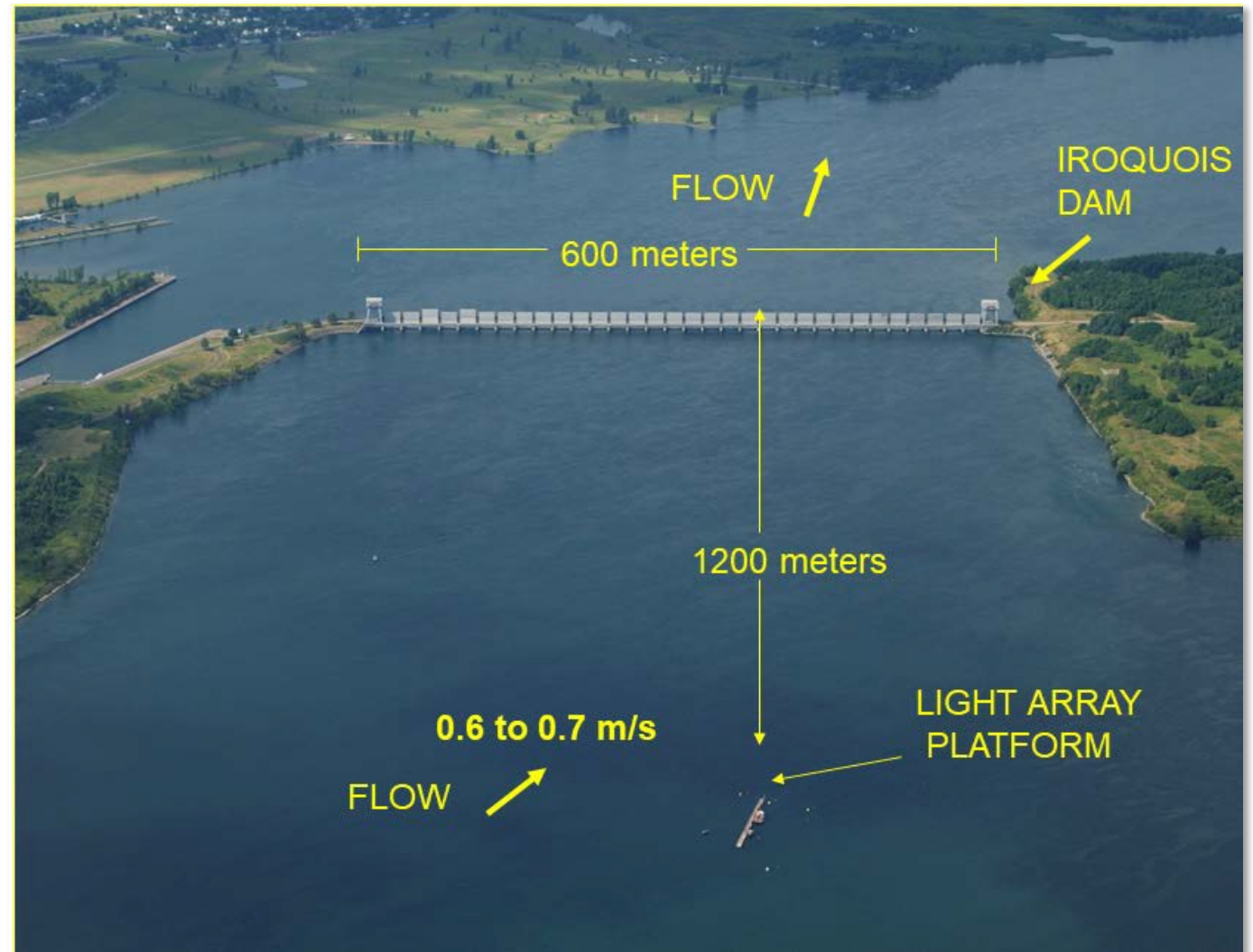
Light Array Background

Goal: Perform a proof-of-concept study on the feasibility of a floating LED light array system that will concentrate eels for capture and transport around hydro stations to address turbine mortality for downstream migrating eels



Light Array Background

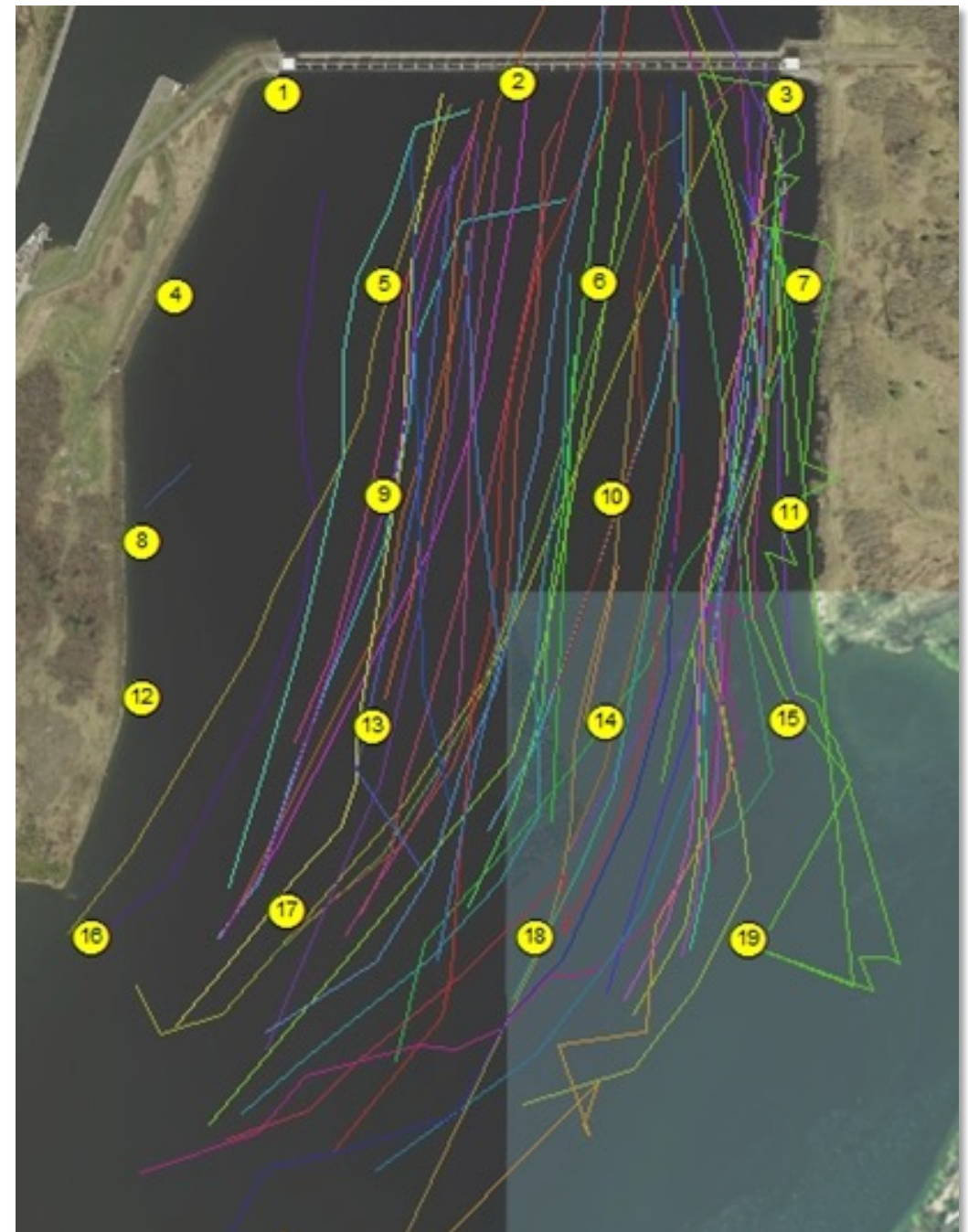
- American eel negatively phototaxic, migrate downstream at night
- NYPA conducted a preliminary evaluation of a light array for relicensing
- Light guidance has been used for migrating eels on smaller rivers



Light Array Background

Eel Movement

- American eel movement at Iroquois Water Control Dam based on telemetry of silvering eels from 2017 and 2018
 - Majority of eels migrate on the east side of the river
 - 66% of eels pass 44% of gates
 - Flow velocity approx. 1 m/s near Iroquois Water Control Dam
 - St Lawrence River flow at Iroquois –
~8,000 m³/s



Light Array

- Deployed 3rd week of August, removed 1st week of December 2022
- Floating light boom – 216 m (708 ft); secured with anchors/chain
- Shrouded LED lights angled downward – wall of light
- Randomized lights on/off trials
- Light field measured



Eel Movement Evaluation

- 400 eels tagged; implanted with Innovasea 180 kHz with pressure sensors, ping rate 3 sec, battery life >6 months
- Eel source – OPG Trap & Transport Program, Ontario Ministry of Natural Resources and Forestry managed eel selection, Carleton Univ. performed transmitter implantations
- Eels >950mm selected, increased probability of migrating
- Eel released approximately 250 km upstream of Iroquois Water Control Dam in May (199) and Sept (201)

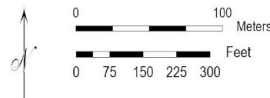
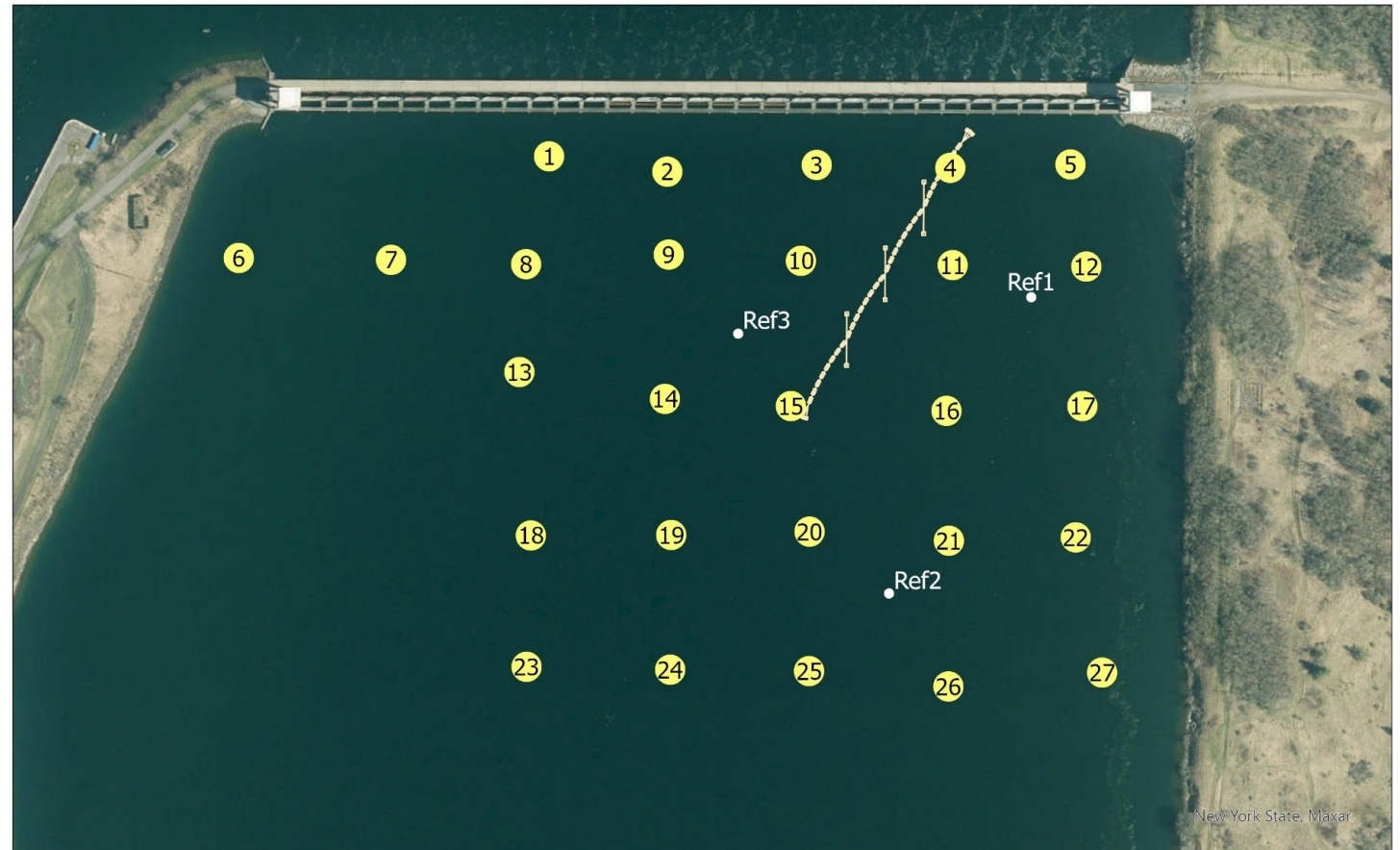


Eel Movement Evaluation

- Fine-scale positioning array – 27 receivers
- Receivers deployed on substrate and reference tags used to ensure receivers were synced
- XYZ positioning approximately 1 m
- Detection range ~300 m upstream and downstream of the receivers (USFWS)

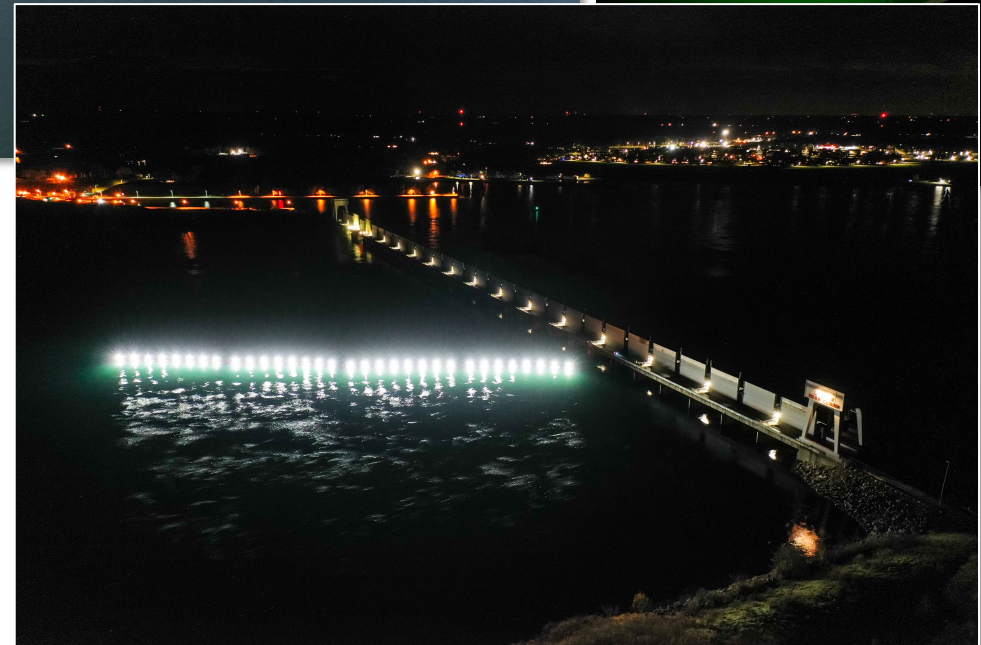
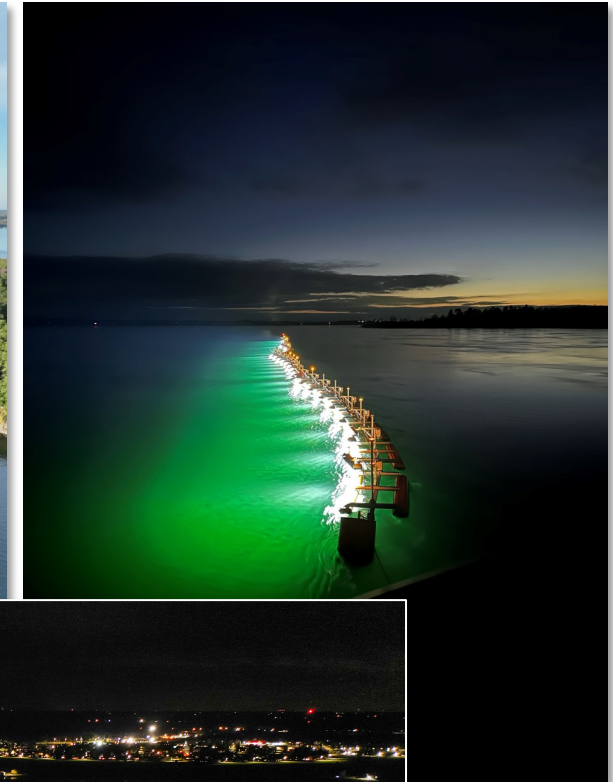


U.S. Fish & Wildlife Service

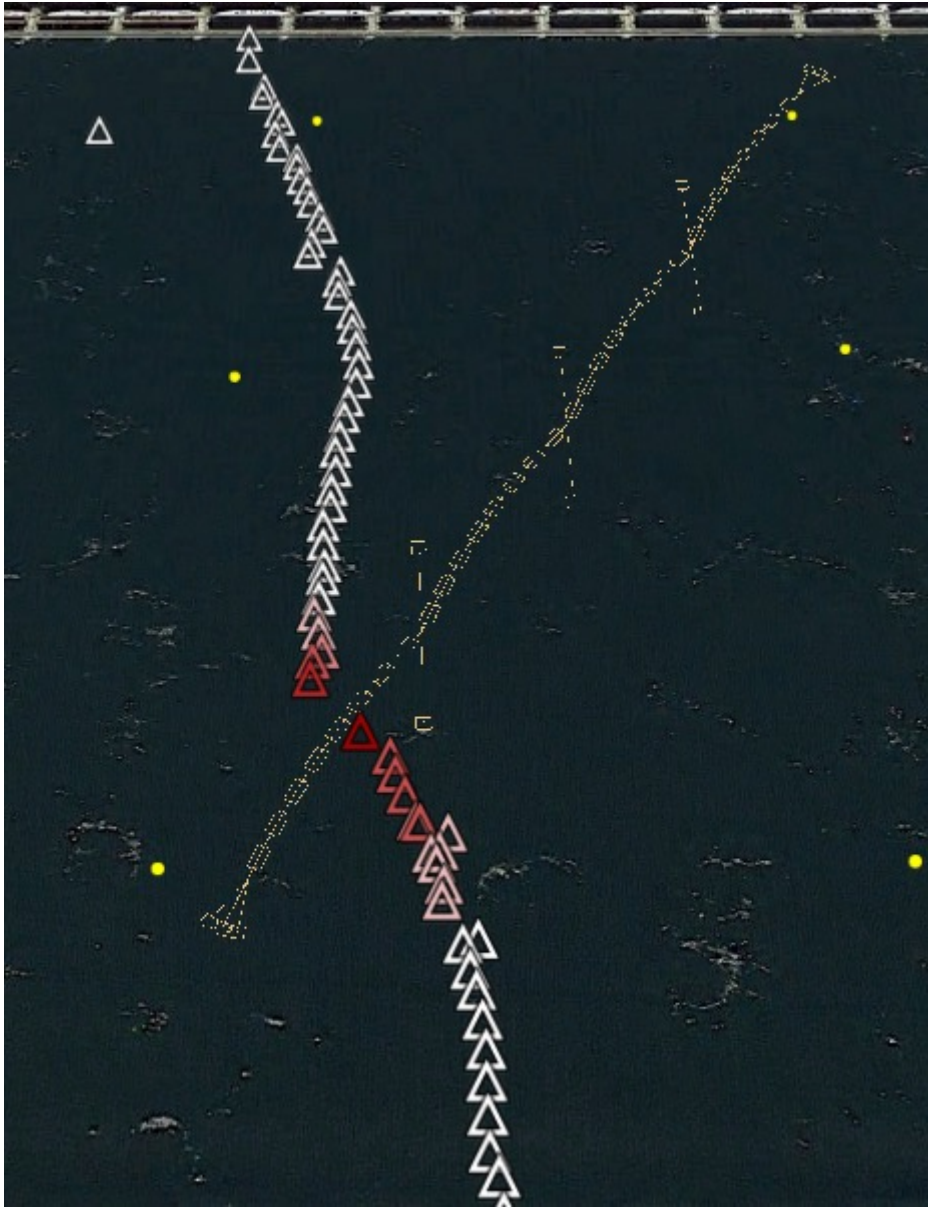


2022 Light Guidance Preliminary Results

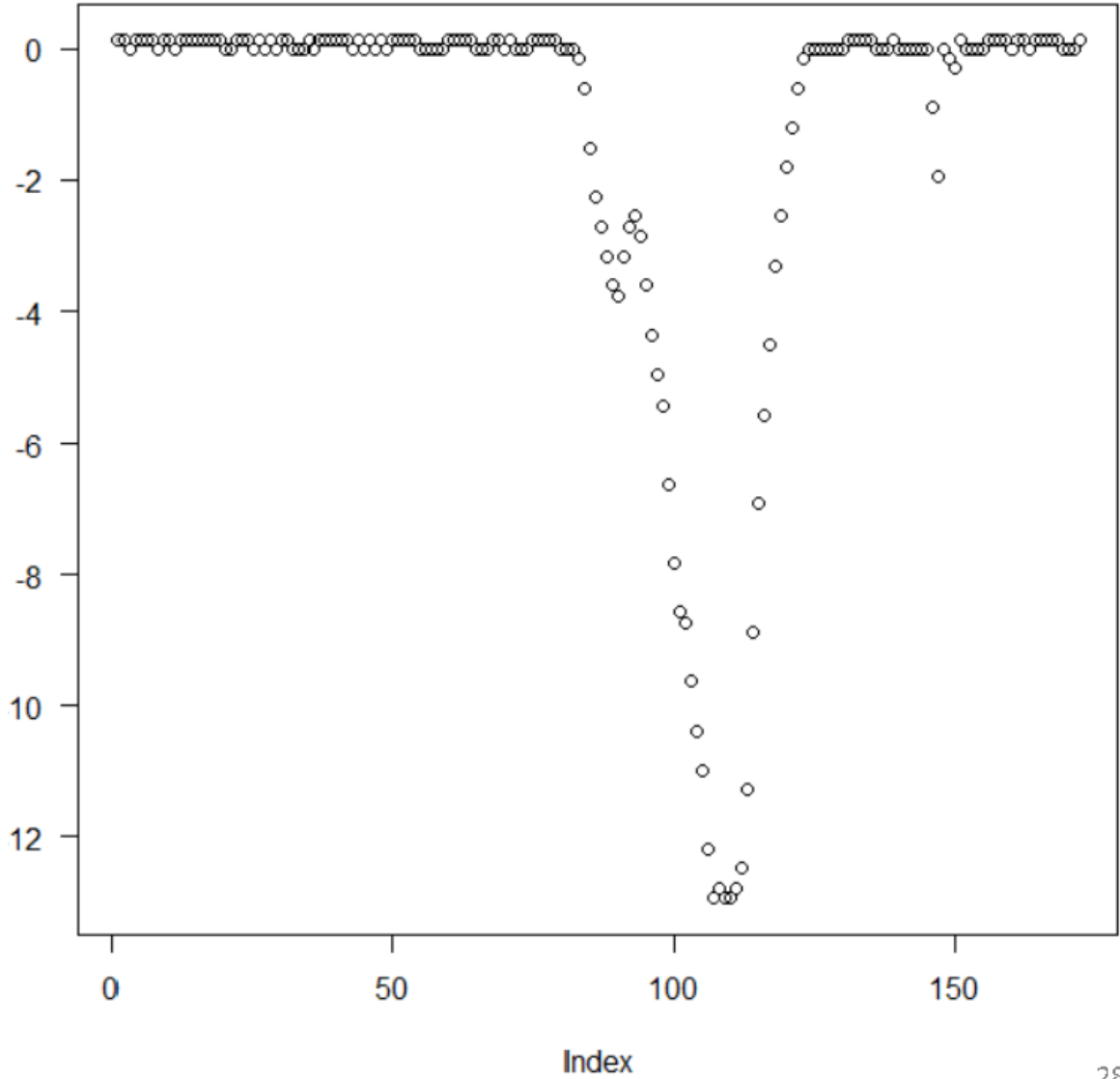
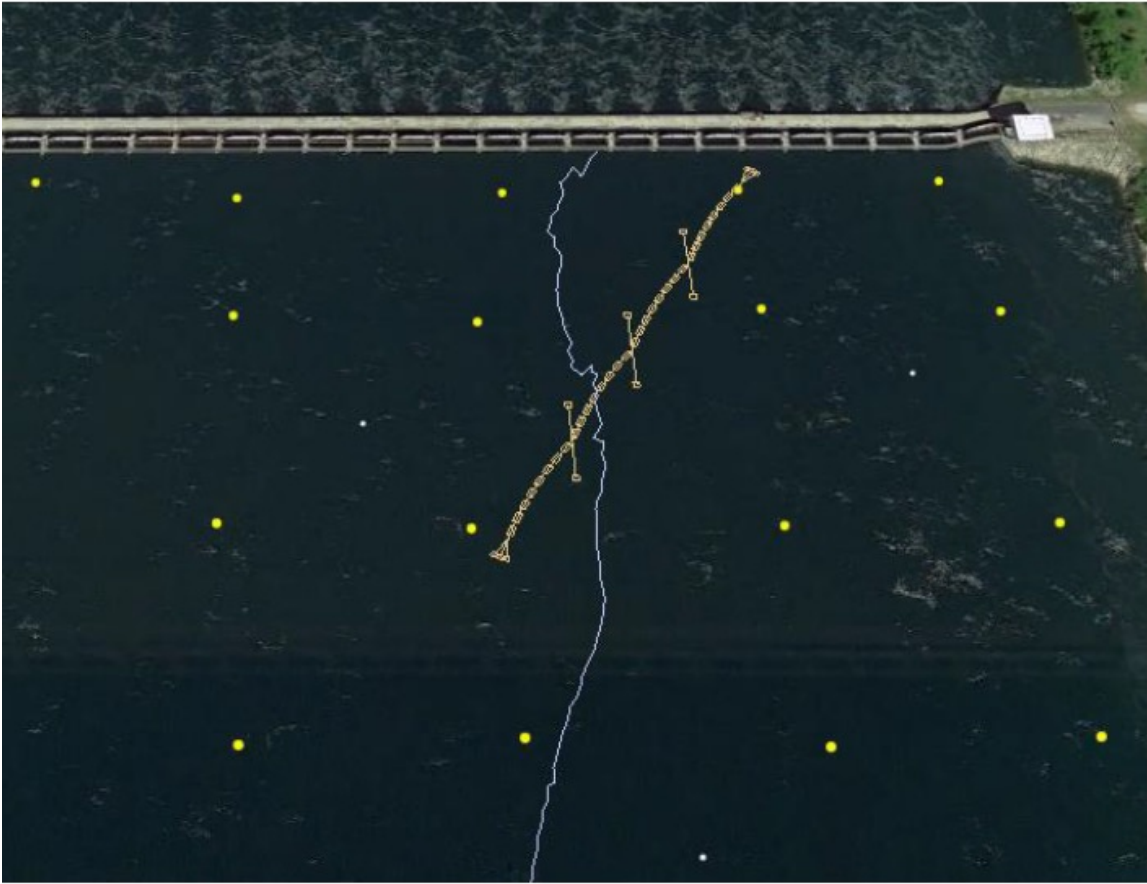
- Fine-scale positioning data processed – Innovasea – Spring 2023
- One row of receivers across river downloaded and results are:
 - 200 of the 400 tagged eels passed
 - 41 eels passed during “lights OFF” condition
 - 159 eels passed during “lights ON” condition
 - Each receiver – 3.5M–7.5M detections – include sync tag transmissions
- Lots more to come



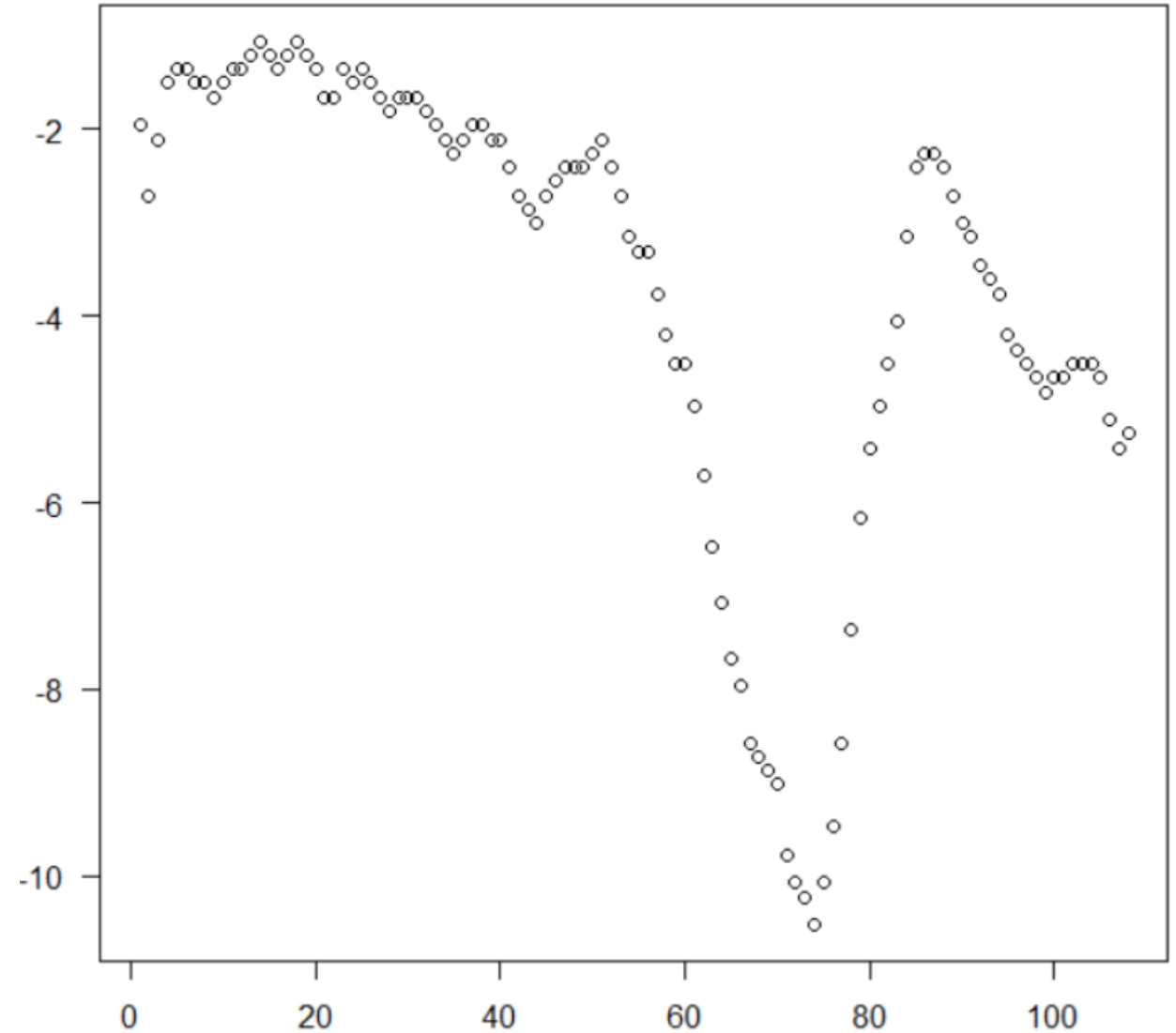
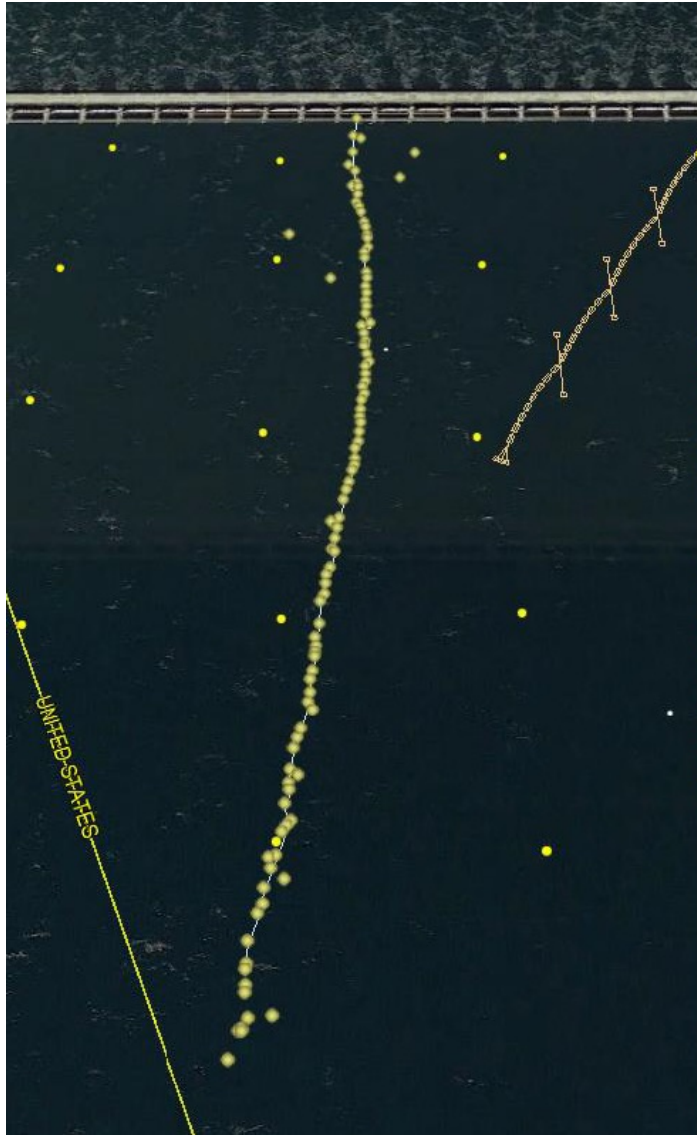
Eel Passing Under Light Array



Eel Passing Under Light Array

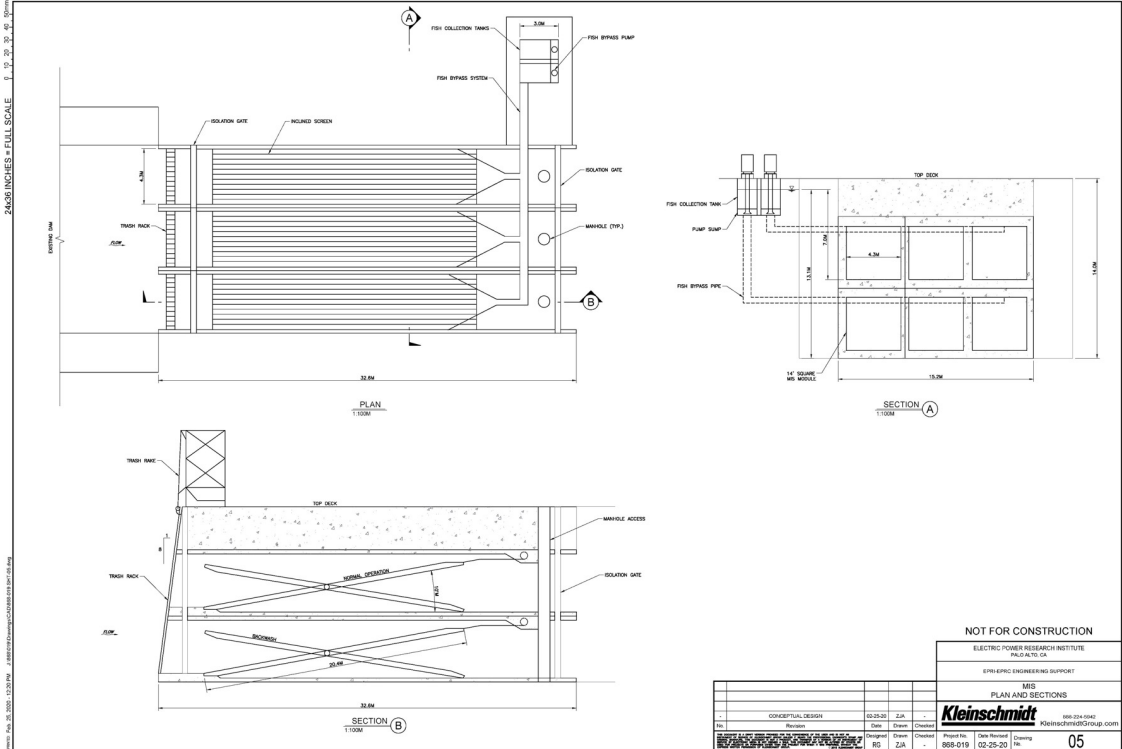


Avoidance without Guidance



Next Steps

- Evaluate results of 2022 study (process remaining receiver data)
- Develop capture methods if eels can be diverted
- Develop and deploy full scale light array and capture method
- Develop light array and capture methods for Beauharnois Canal





Together...Shaping the Future of Energy[®]

