Hydrodynamics of Herring River:
Past, Present, and Restored

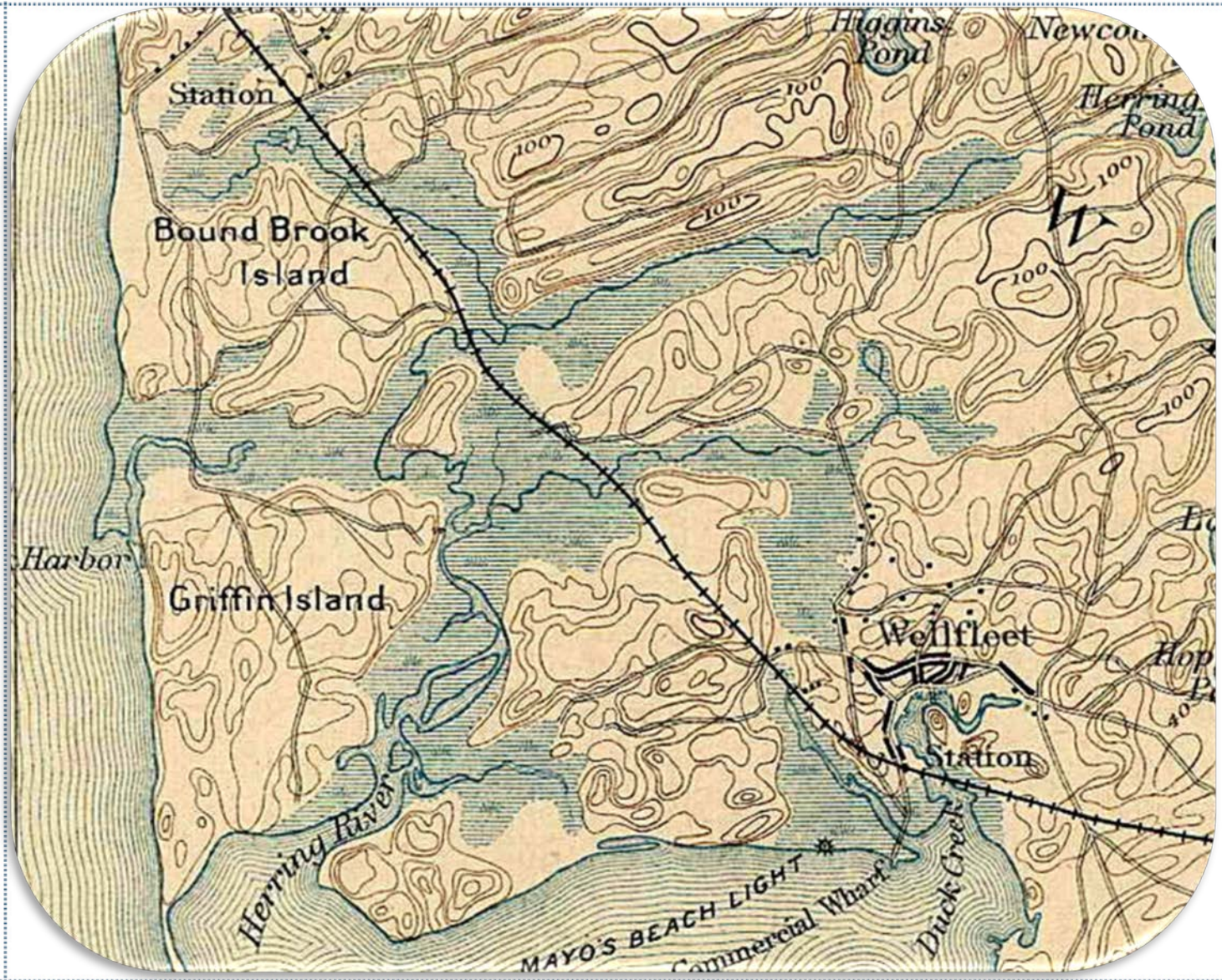
WOODS HOLE GROUP
FOR EARTH, FROM SPACE
A CLS COMPANY

TOWN OF WELLFLEET
1620
INCORPORATED 1763

NATIONAL PARK SERVICE

Kirk Bosma, Woods Hole Group
October 11, 2018

Herring River History

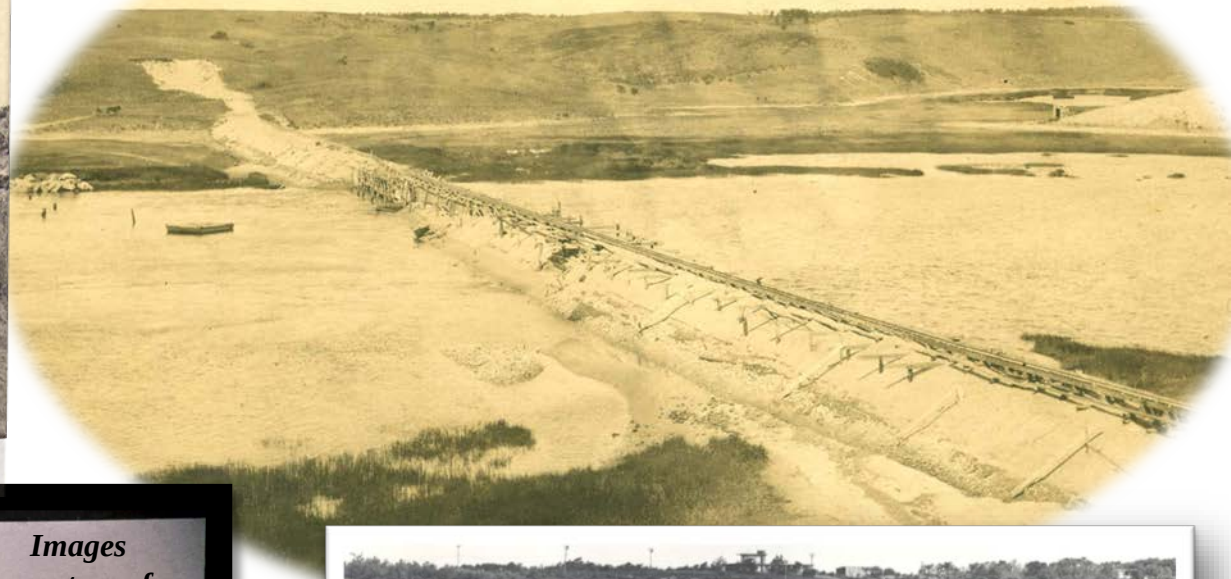


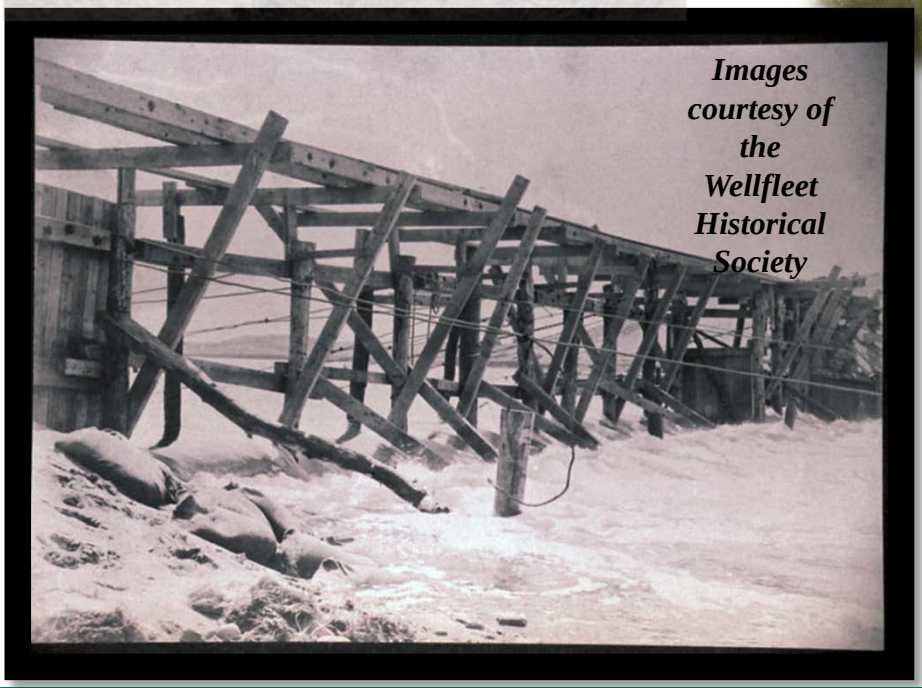
1887

Image courtesy of the Wellfleet Historical Society

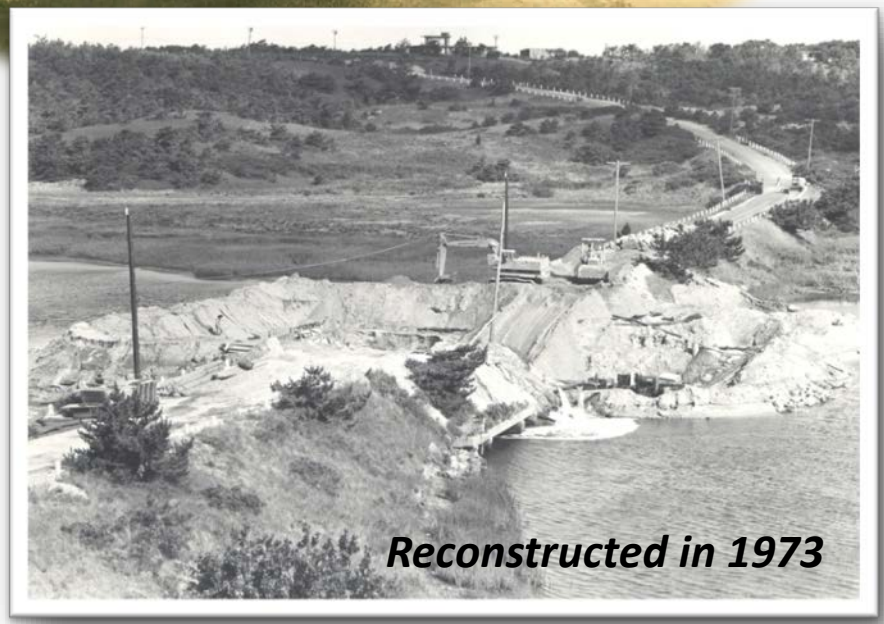
Herring River History

Winter 1908-09



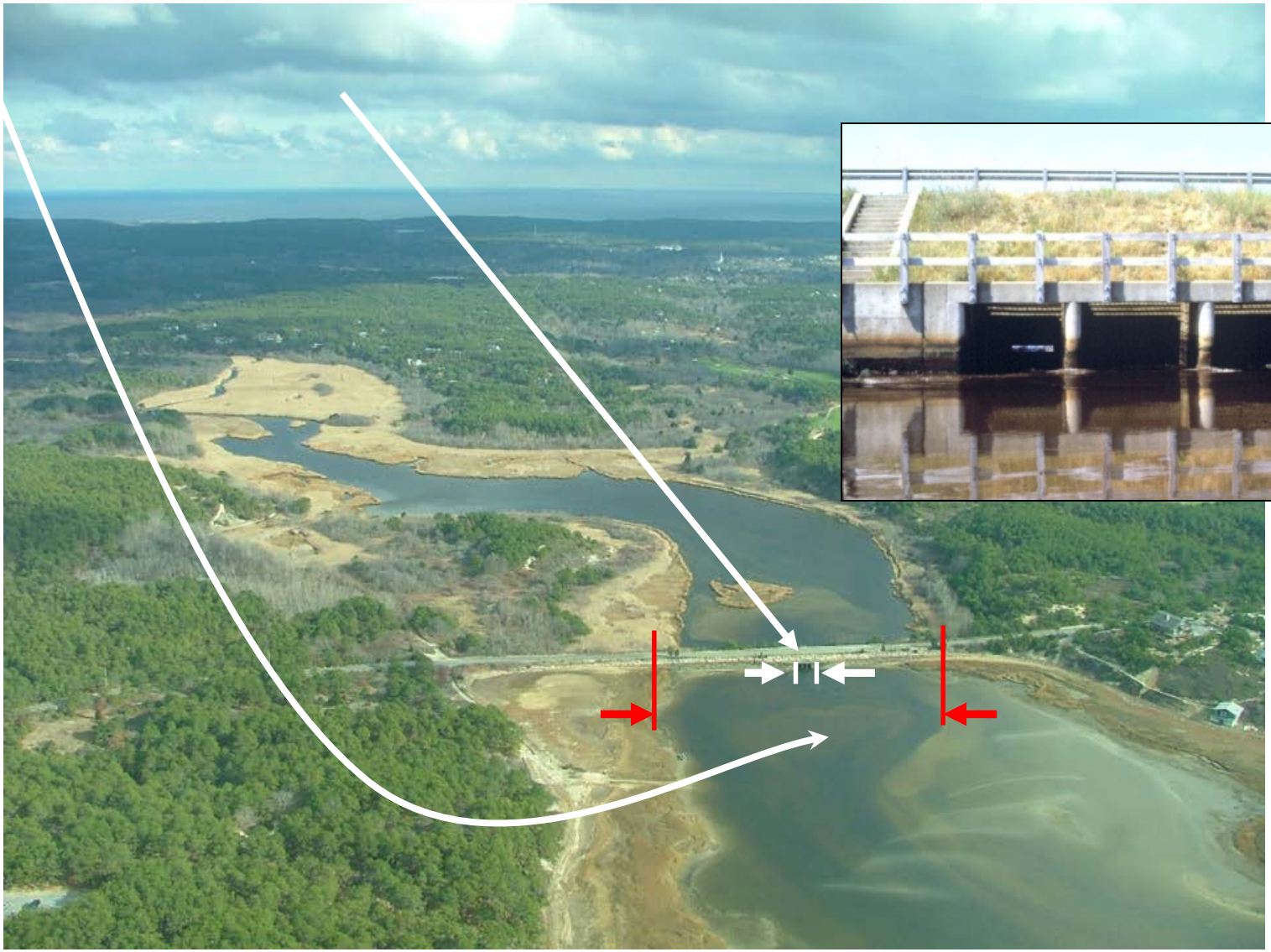


Images courtesy of the Wellfleet Historical Society

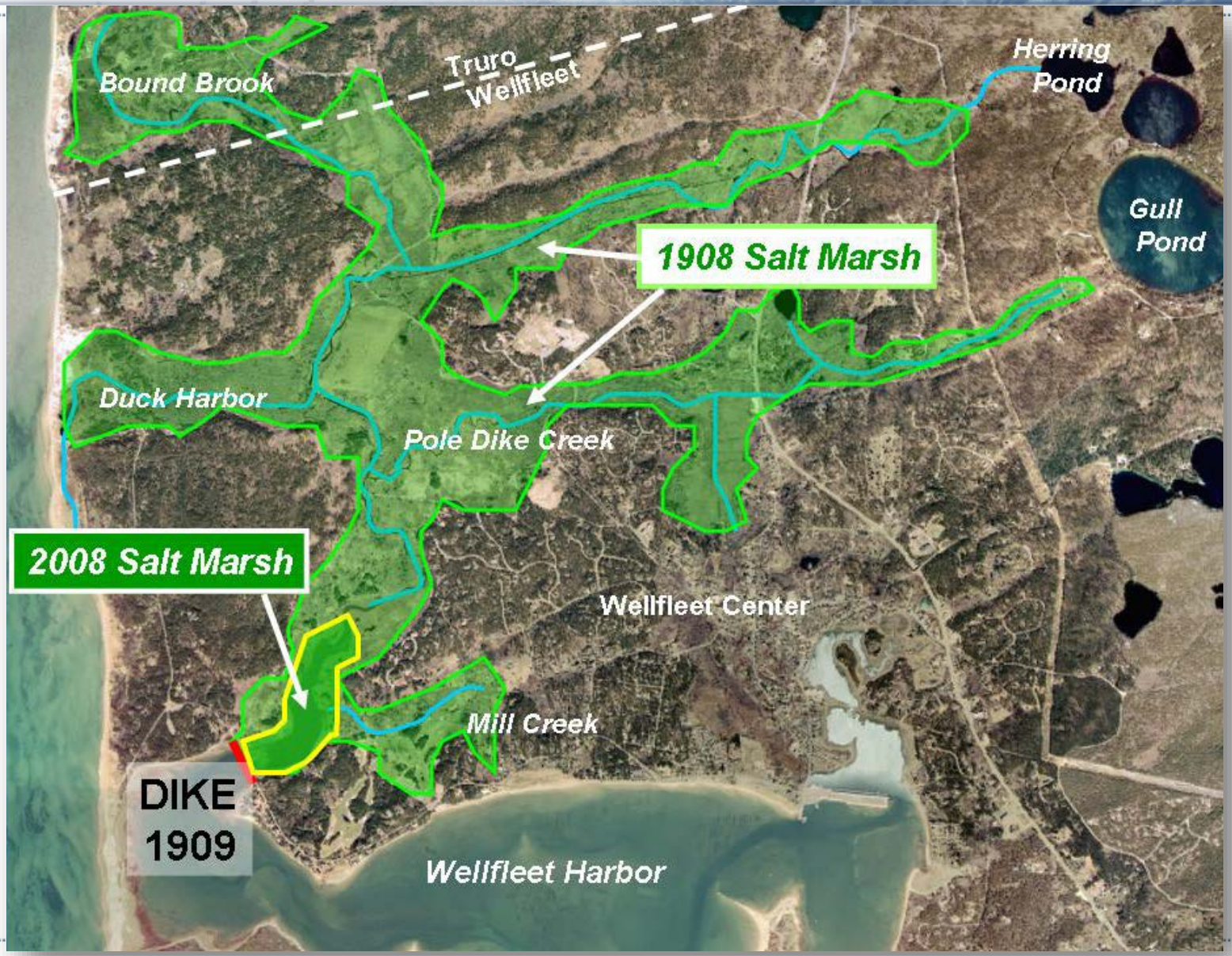


Reconstructed in 1973

Herring River History



Town of Wellfleet History



What were they thinking?

Following the Golden Years of Cape Cod…

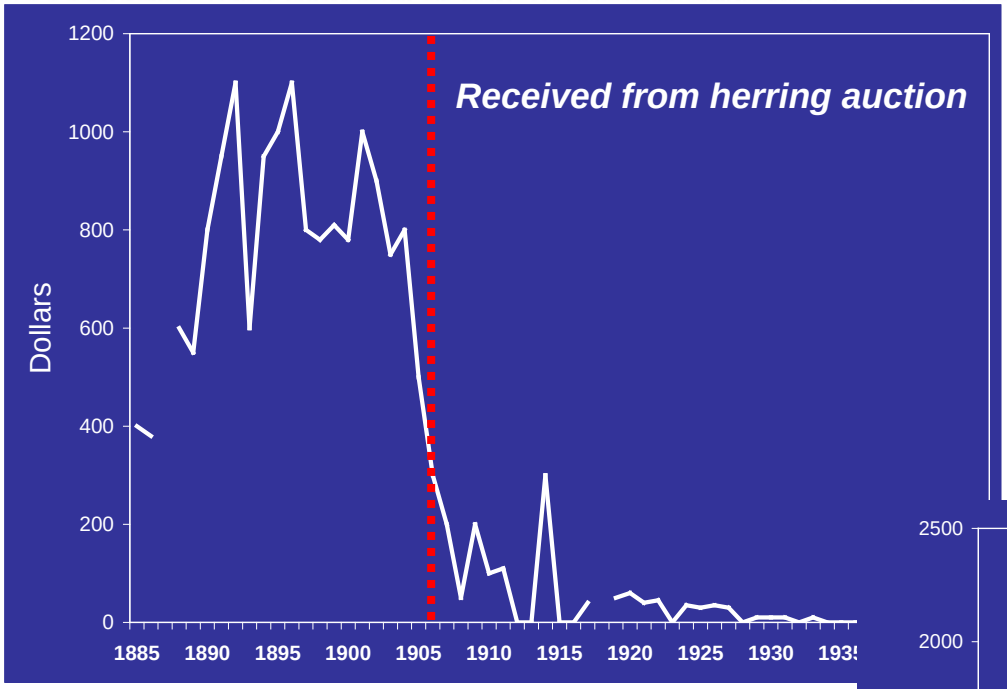
- **In 1906, Capt. Lorenzo Dow Baker went to argue for a dike**
  - **Declining fishing industry**
  - **Change in industry and development**
  - **Encourage development and tourism (Built Chequessett Inn)**
  - **Reduce mosquitoes, cost of oil on marsh plain**
- **Cost of $20,000 dike, total annual budget was $15,000**
- **Baker died in 1908, and as a tribute the dike was constructed despite significant opposition.**

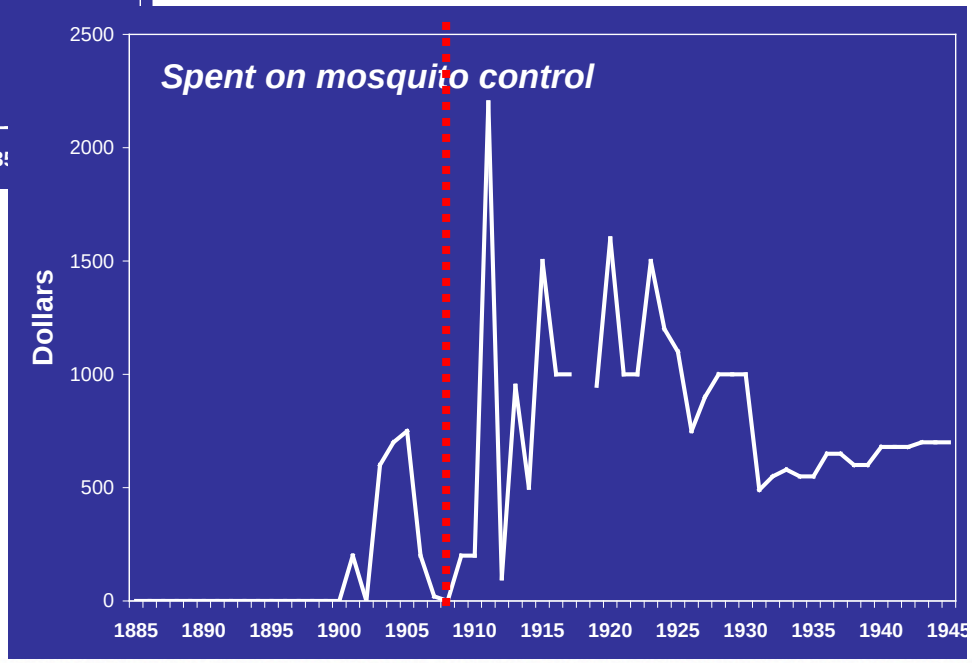
Intentions of the dike didn't work…

- **Development was a bust**
- **Loss of 1100-acre salt marsh estuary**
- **Acidification & metals toxicity**
- **Oxygen depletion & fish kills**
- **High mosquito production**
- **Exotic species (*Phragmites*, multiflora rose, etc.)**
- **Sediment subsidence**

Dr. John Cumbler, University of Louisville
History Professor

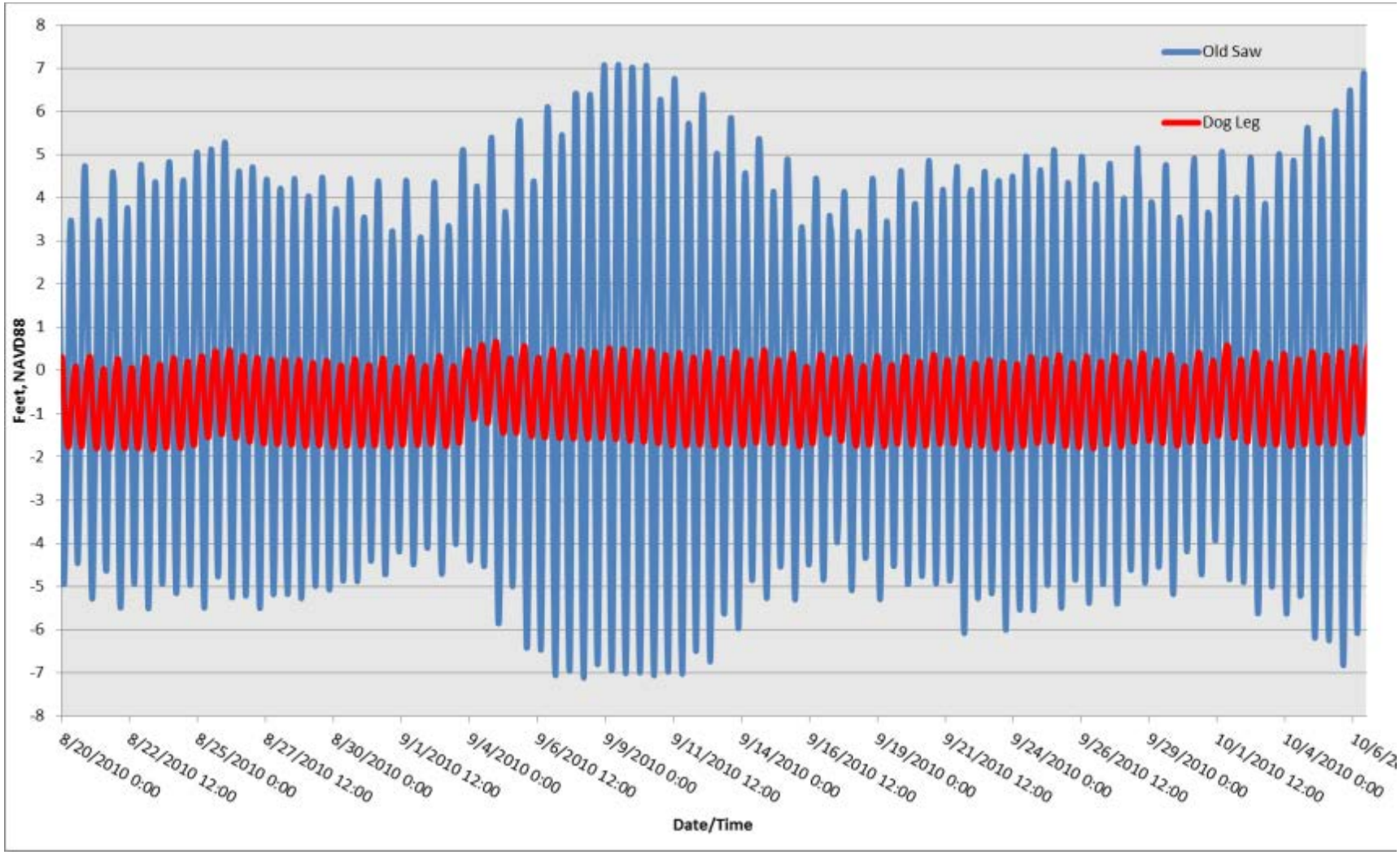
Herring River History



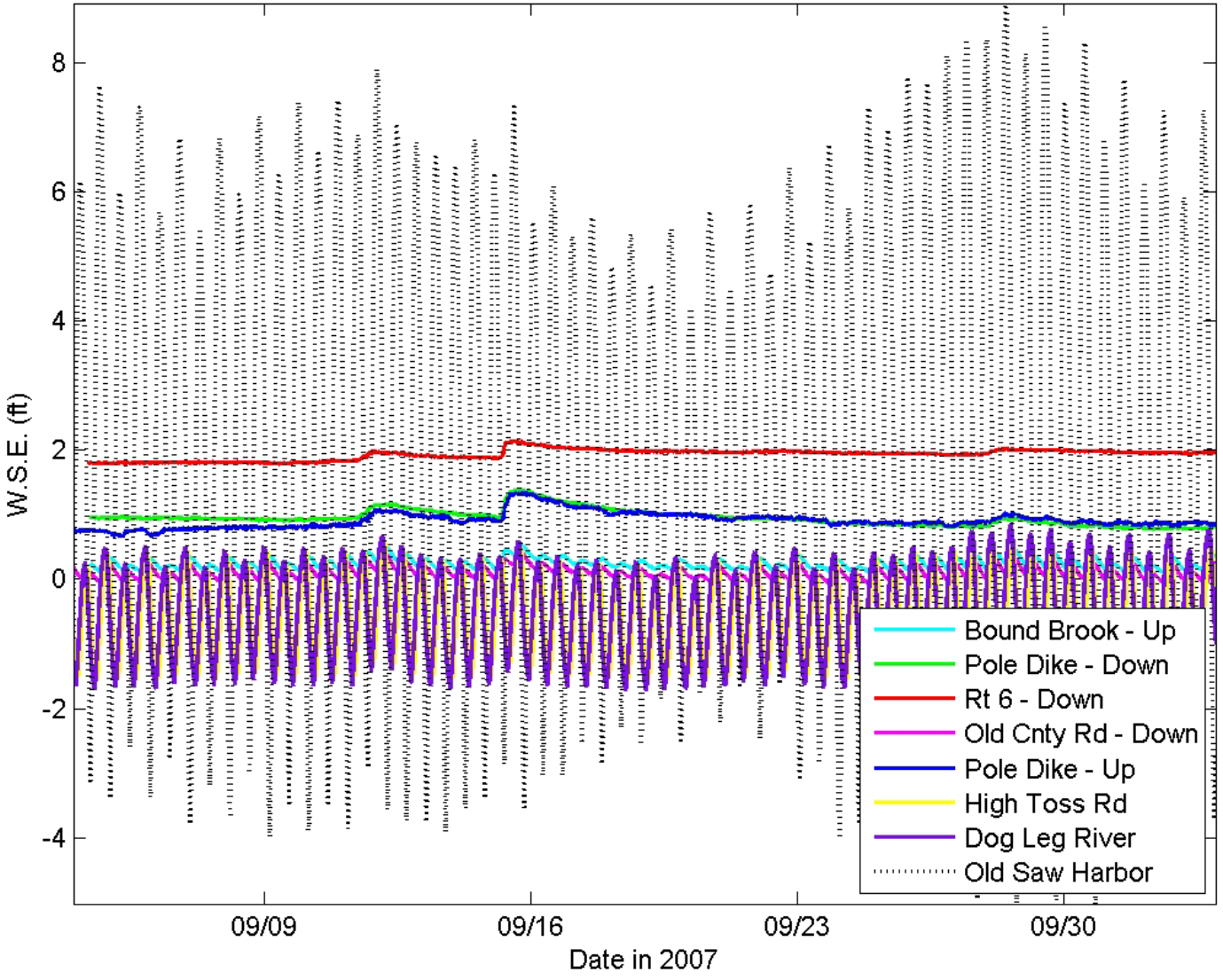


Herring River Present

Current Conditions of Herring River



Herring River Present



On-going effects of Tidal Restriction

Loss of Estuarine Productivity

Closed Shellfish Areas

Degraded Habitat and Acidification

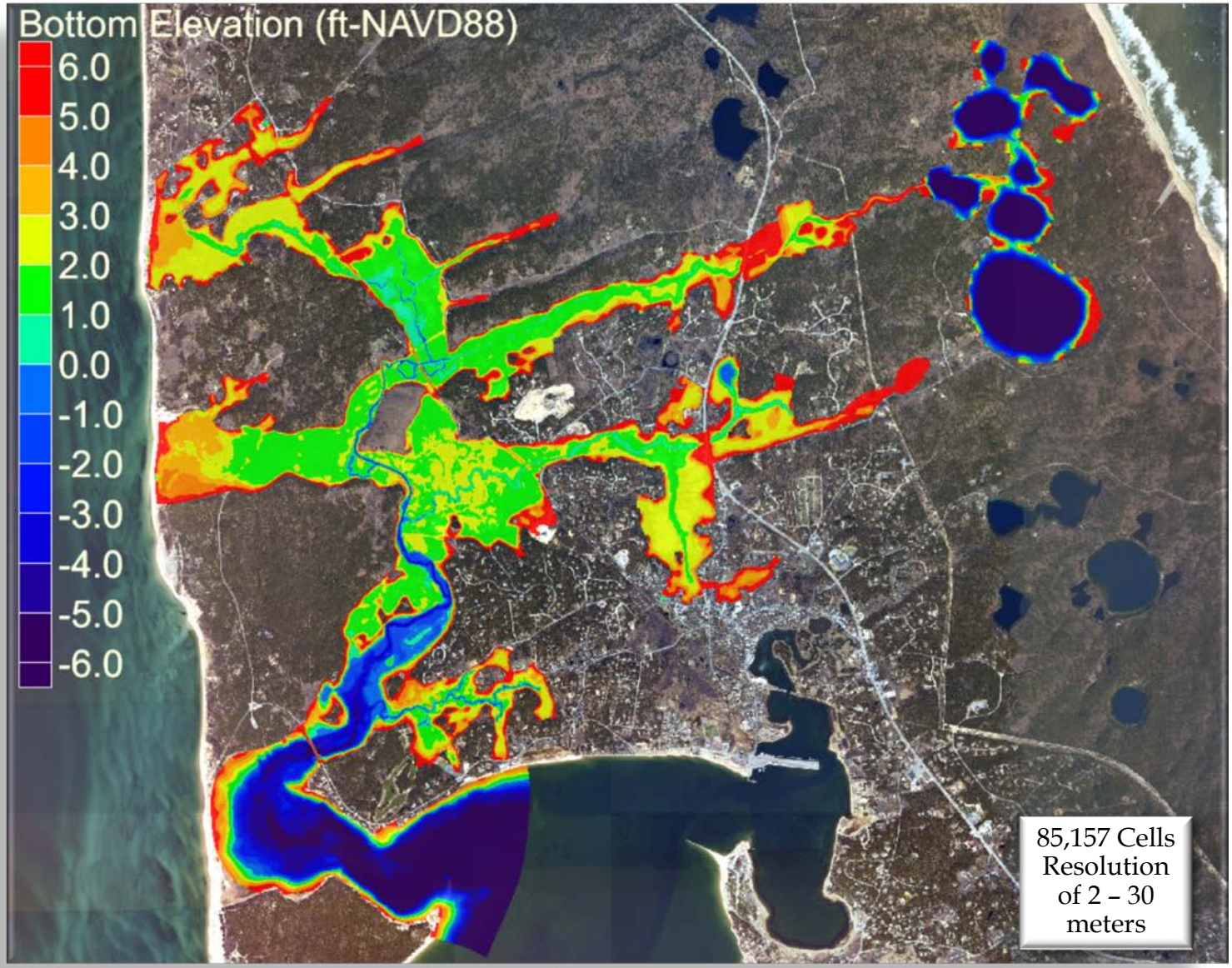
Poor Water Quality and Fish Kills

Project Benefits and Impacts

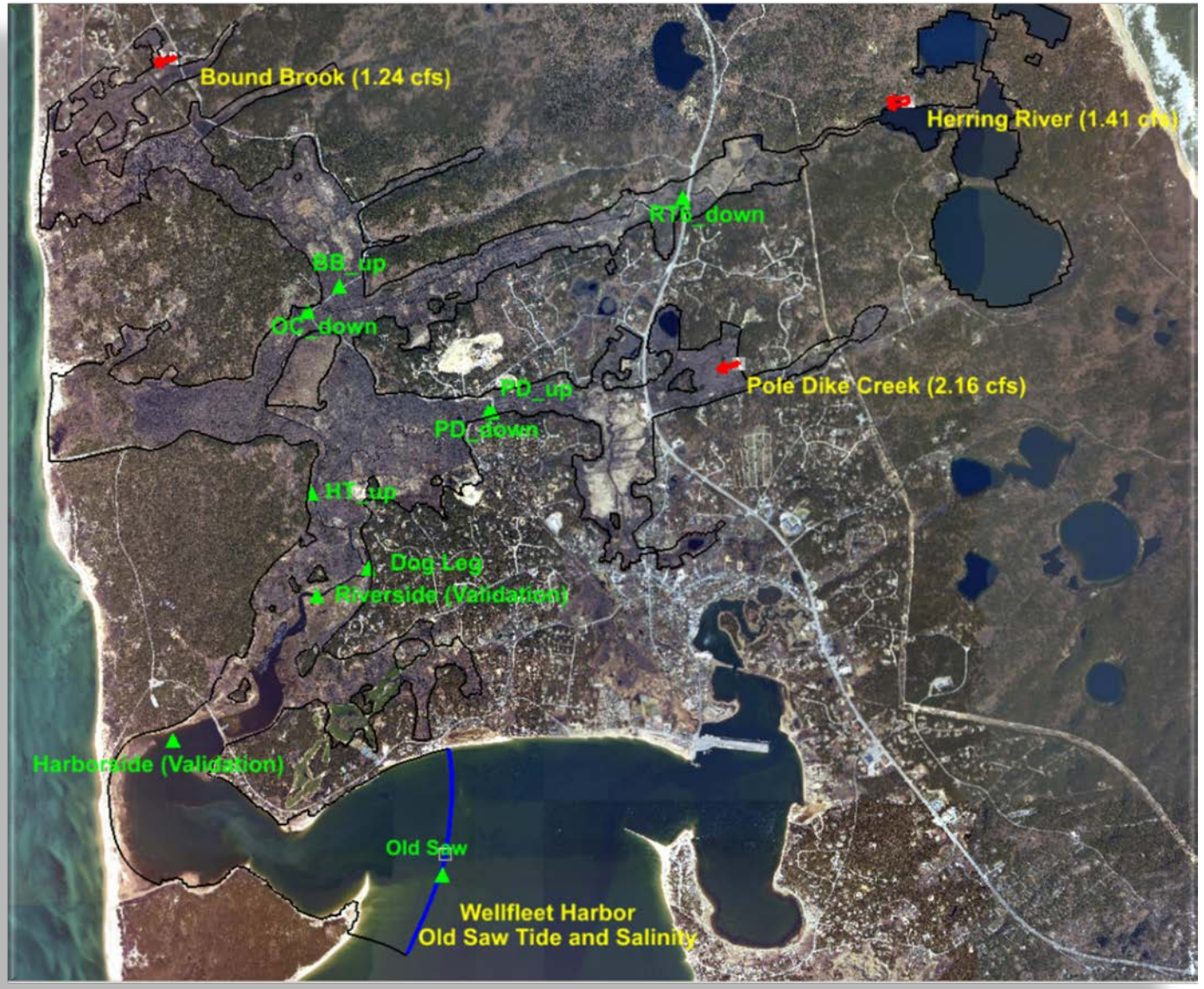
Restored Coastal Habitats

- ✓ 890 Acres of Intertidal Habitats
- ✓ 580 Acres of Salt Marsh
- ✓ 11+ River Miles for River Herring
- ✓ Access to 160 Pond Acres for Spawning
- ✓ Improved Water Quality
- ✓ 200+ Acres Clam and Oyster Habitat
- ✓ Increase and Sustain Declining Salt Marsh Habitat
- ✓ Habitat for Marine Species; Striped Bass, Winter Flounder, Diamond-back Terrapin
- ✓ Engine of Productivity for Near- and Off-Shore Marine Habitats

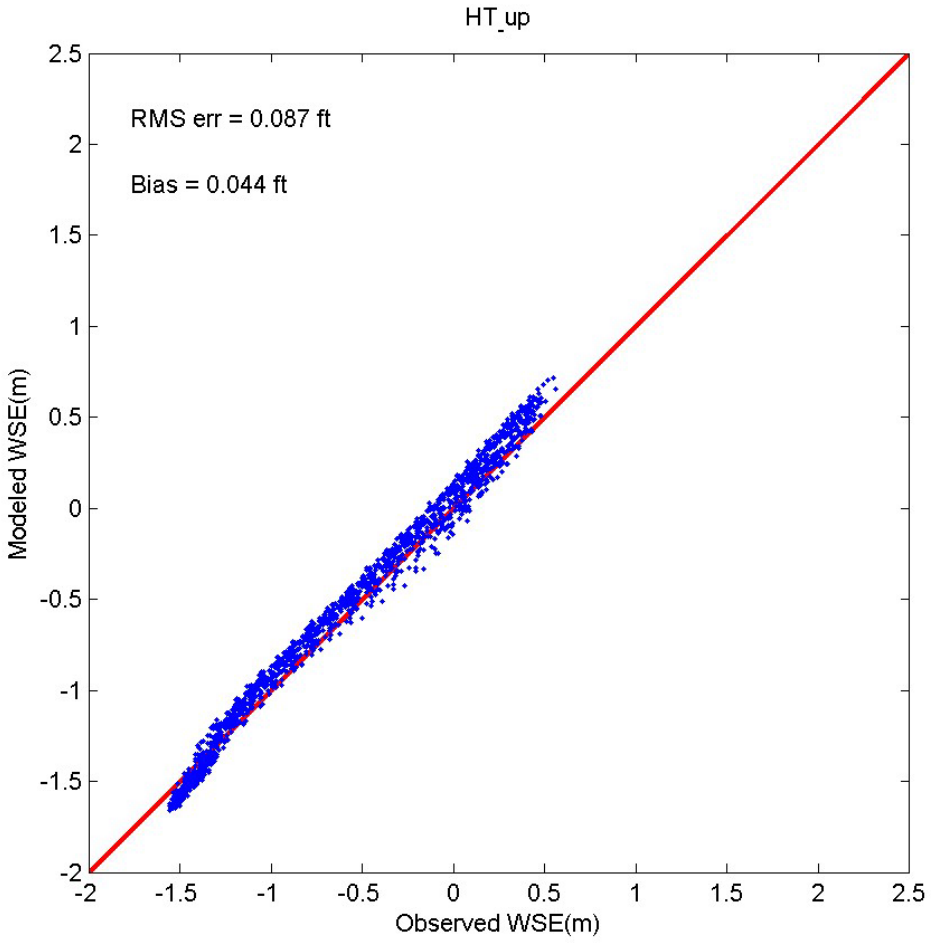
Topography and Bathymetry

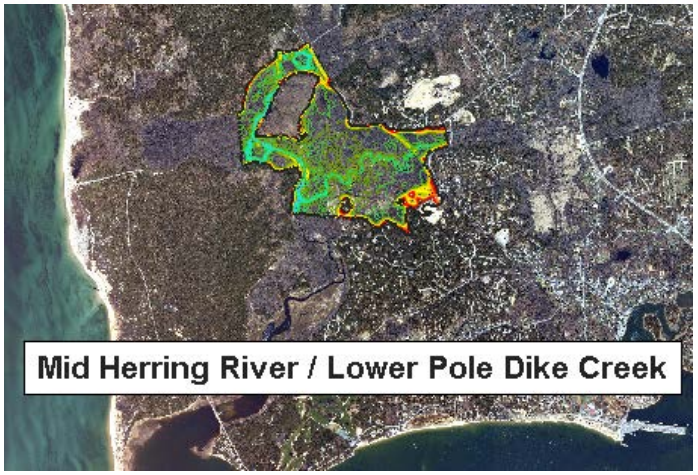


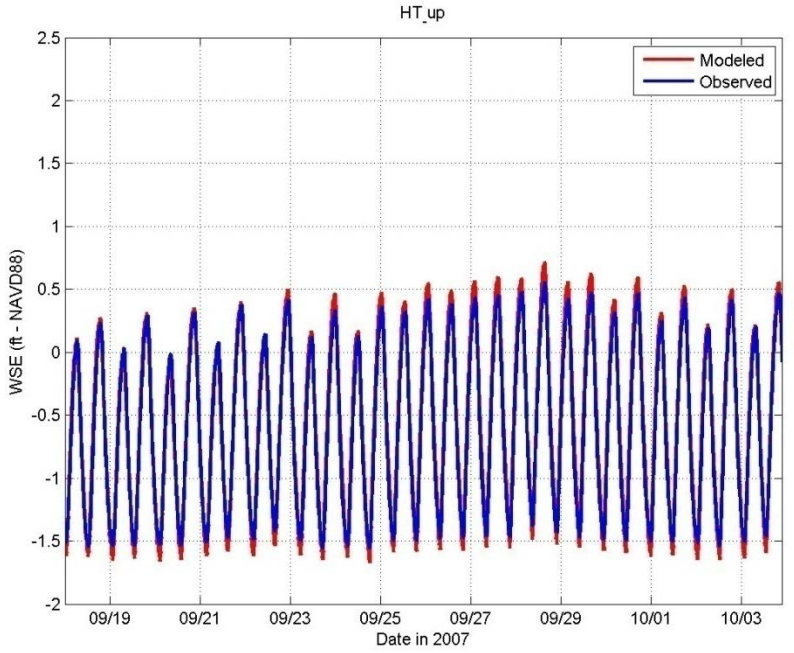
Gage Locations



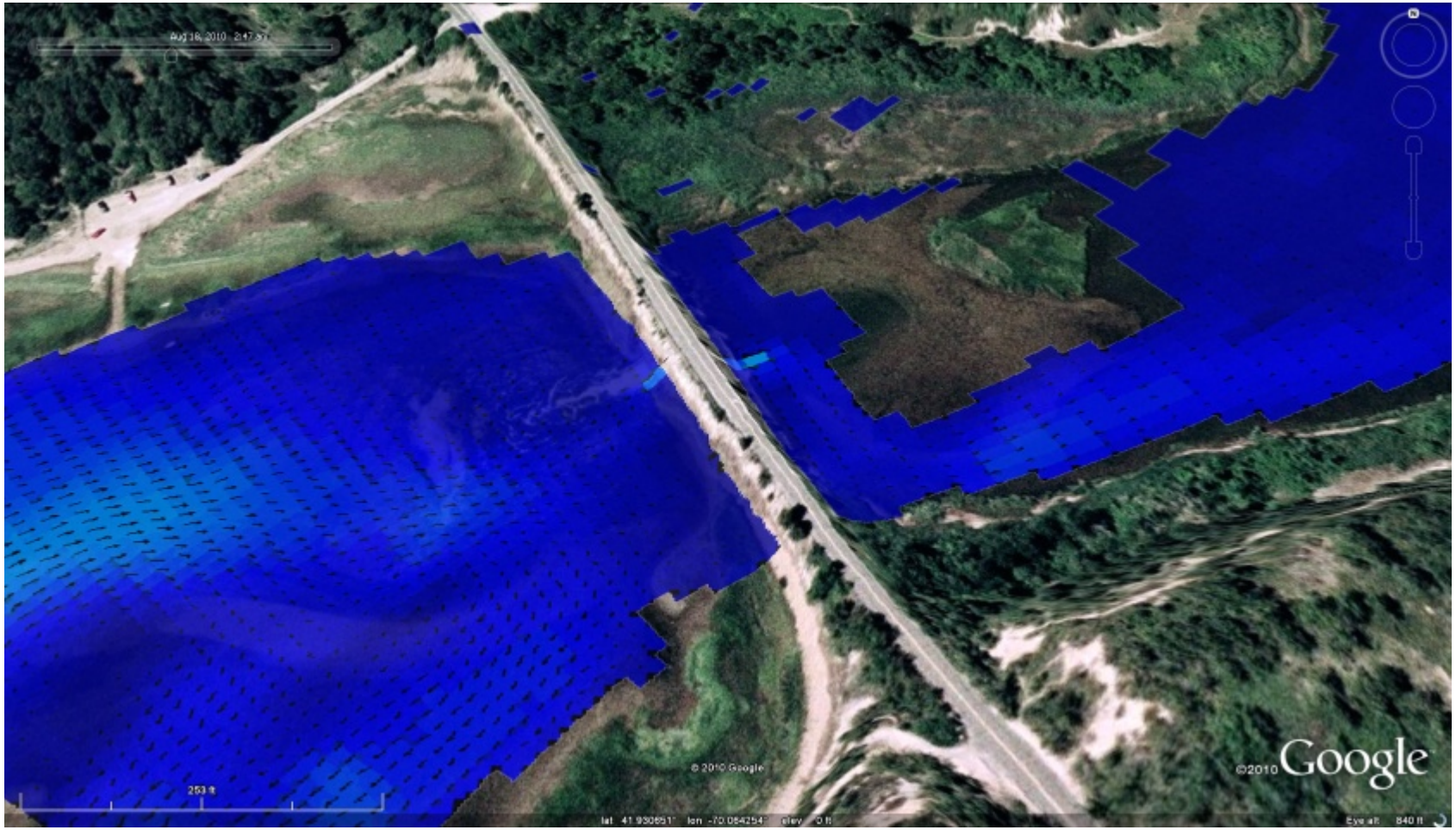
Model Calibration





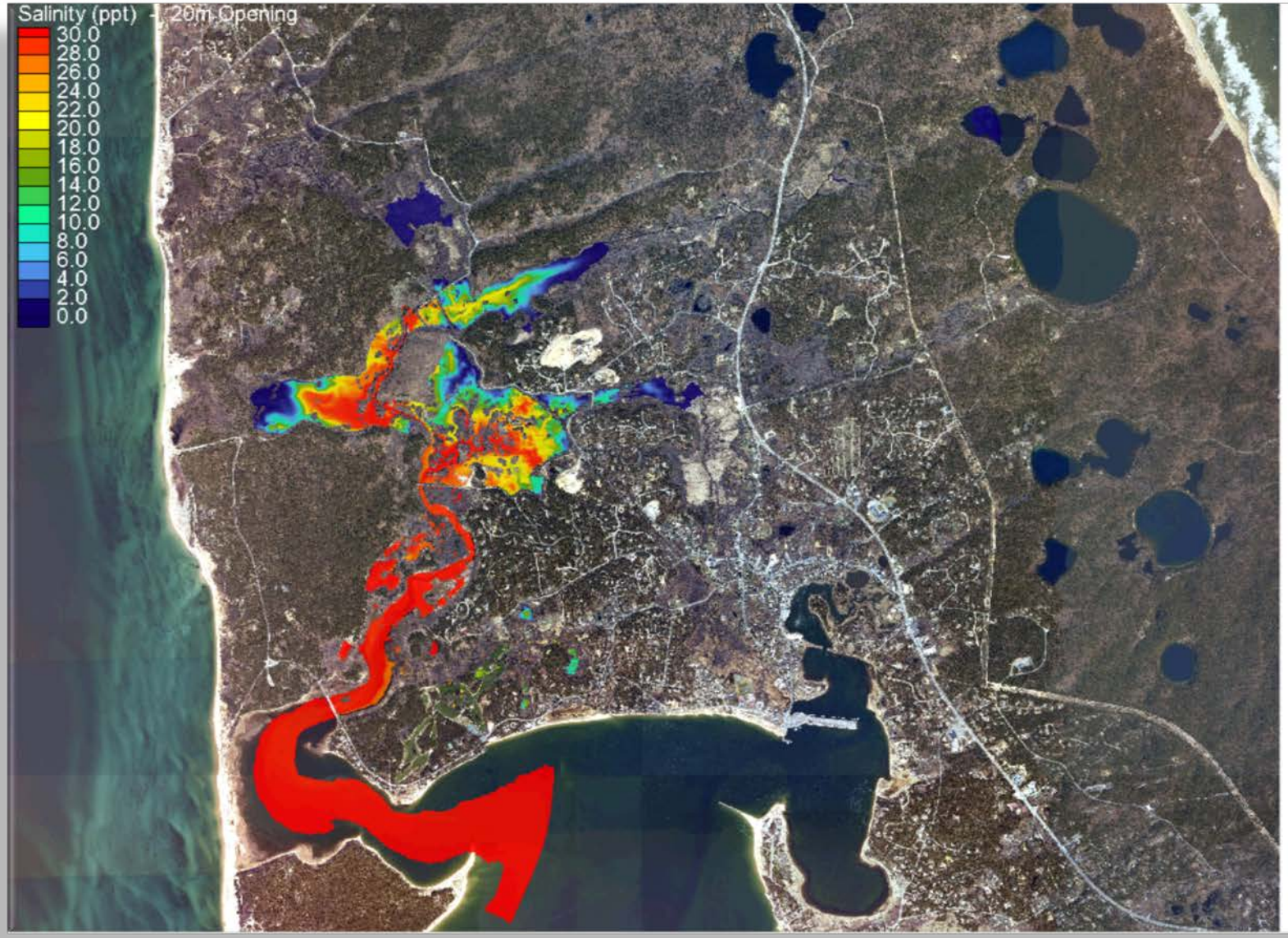


Velocities

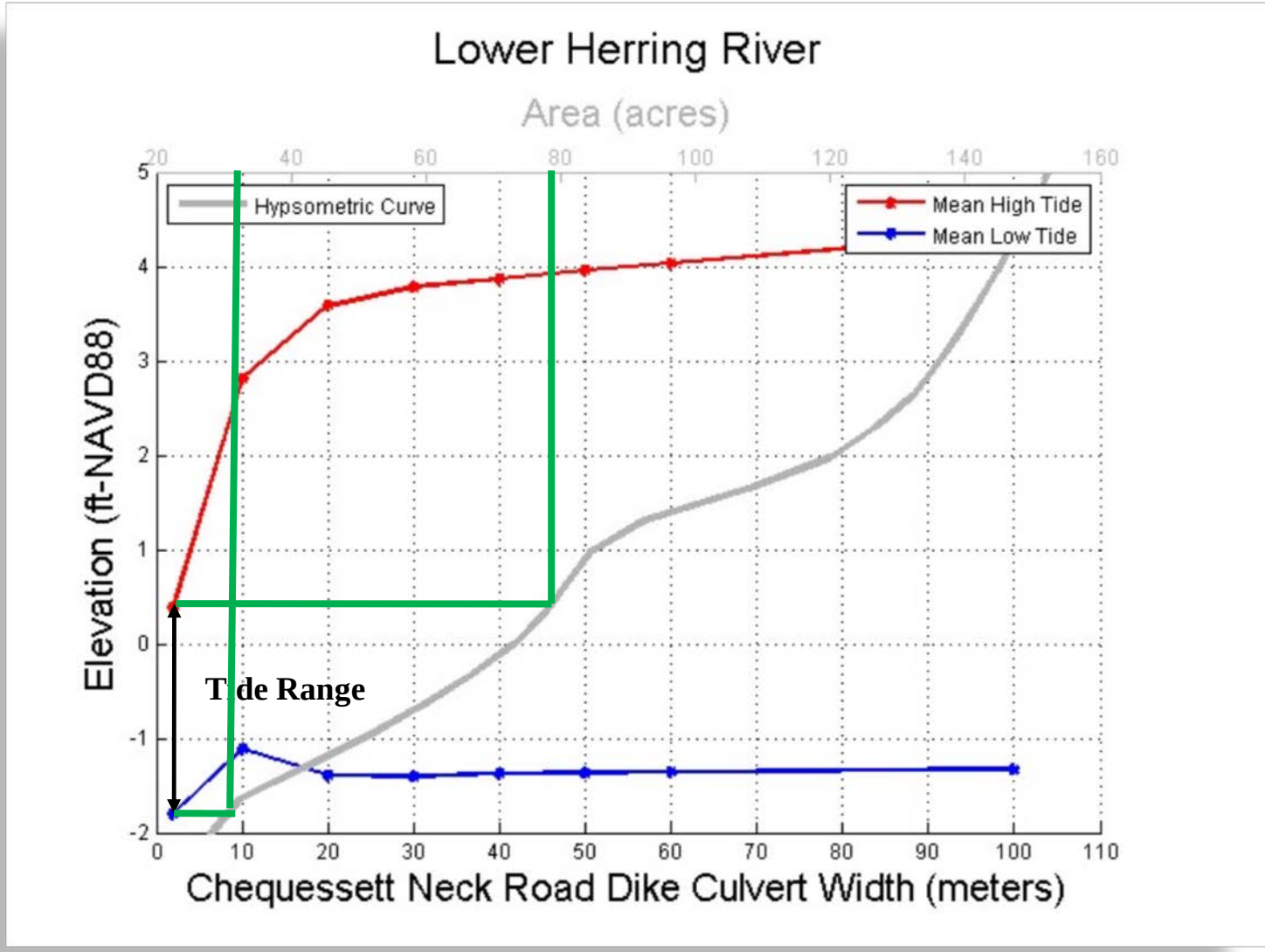


Existing Hydrodynamics

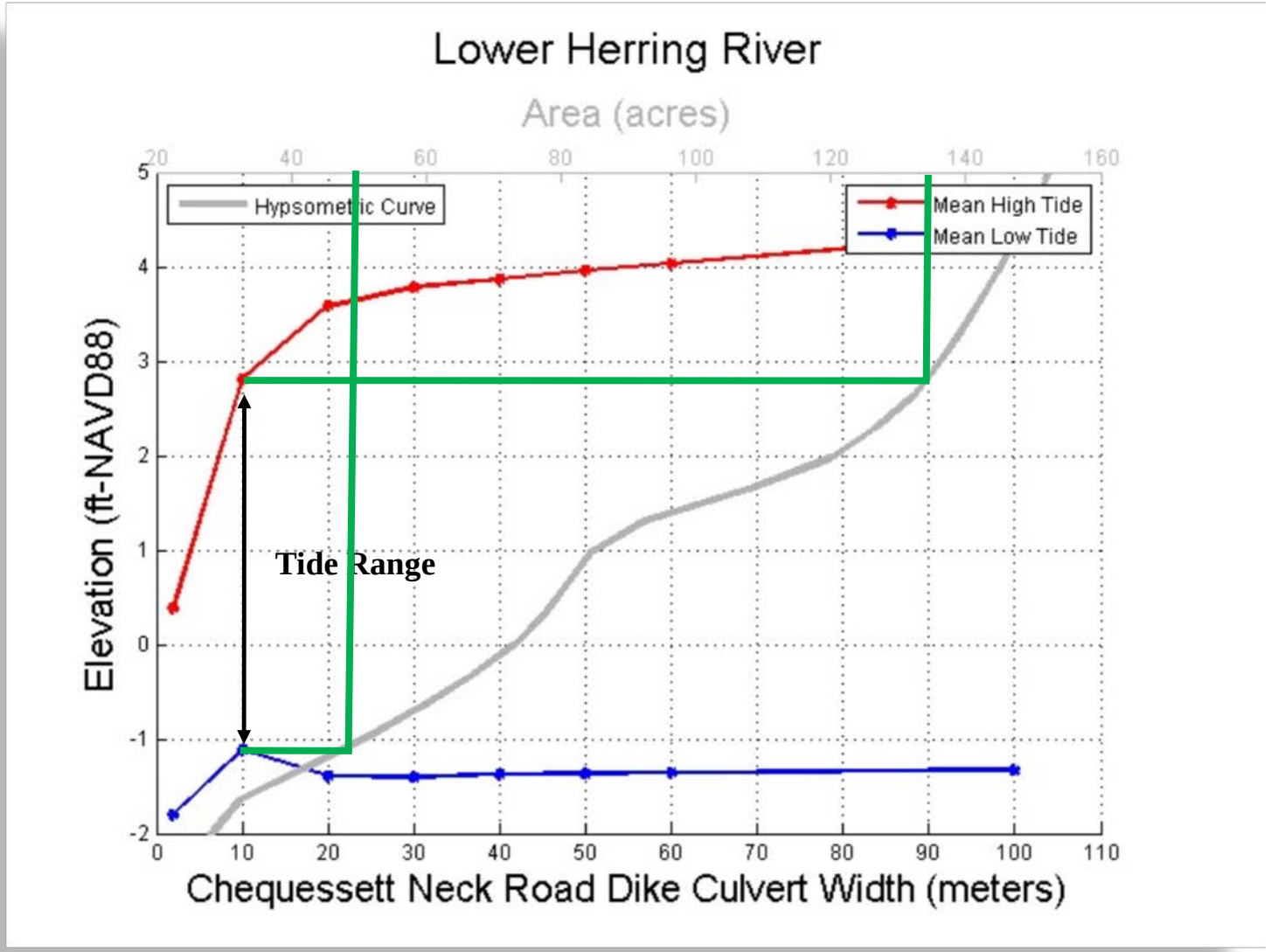
Alternative Simulations



Dike Opening



Dike Opening



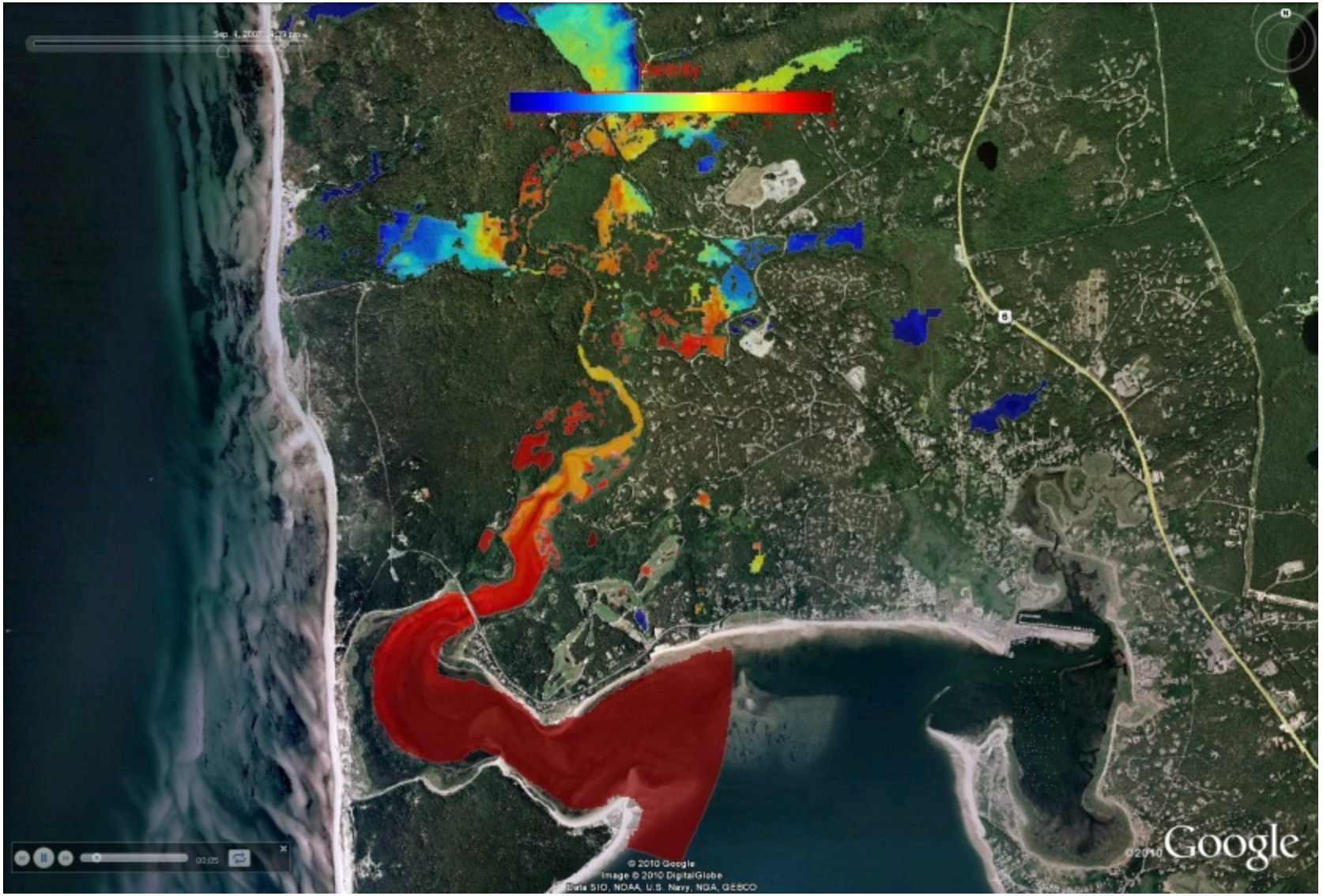
Alternative Simulations

Lower Herring River Sub Basin (elevations in NAVD88, feet) (salinity in psu)	Wellfleet Harbor	Existing Conditions	Fully Open	Chequesset Neck New Dike Opening — Adaptive Management Openings - Smaller Sizes — Increase in Number of Slide gates open --------->															
				1 slide, 2 flap	1 slide, 2 flap	1 slide, 2 flap	2 slide, 2 flap	2 slide, 2 flap	2 slide, 2 flap	3 slide, 2 flap	4 slide, 2 flap	4 slide, 2 flap	4 slide, 2 flap	5 slide, 2 flap	5 slide, 2 flap	6 slide, 2 flap	6 slide, 2 flap	7 slide, 2 flap	7 slide, 2 flap
Opening Height (feet)				1	2	8	1	2	6	10	1	6	8	2	6	2	6	1	10
Mean Low Water	-5.47	-2.20	-2.72	-2.87	-2.56	-2.08	-2.71	-2.52	-1.88	-2.16	-2.68	-2.46	-2.40	-2.75	-2.61	-2.78	-2.69	-2.75	-2.60
Mean Tide Level	-0.32	-0.98	0.96	-1.92	-1.42	-0.86	-1.49	-0.97	-0.03	0.18	-1.04	0.15	0.27	-0.40	0.21	-0.30	0.27	-0.66	0.52
Mean High Water	4.84	0.24	4.64	-0.96	-0.27	0.37	-0.27	0.59	1.81	2.51	0.60	2.76	2.94	1.95	3.03	2.19	3.23	1.43	3.63
Tide Range	10.31	2.44	7.36	1.91	2.29	2.45	2.44	3.11	3.69	4.67	3.28	5.22	5.34	4.70	5.64	4.97	5.92	4.18	6.23
Mean High Water Spring	6.22	0.36	6.22	-0.87	-0.15	1.27	-0.15	0.80	2.41	2.80	0.80	3.28	3.56	2.34	3.57	2.50	3.74	1.81	4.26
100-year Storm Event	9.31	0.91	8.78	-0.42	0.27	2.30	0.26	1.41	3.25	4.08	1.42	4.17	4.30	2.99	4.34	3.19	4.58	2.44	5.48
Mean Salinity (Dike^)	30*	26.1	28.7	21.1	22.6	24.2	22.6	23.4	25.1	25.0	23.4	25.4	25.6	24.0	25.8	24.2	26.1	23.6	26.6
Maximum Salinity (Dike^)	30*	29.9	30.0	29.9	29.9	29.9	29.9	29.9	29.9	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0
Mean Salinity (Dog Leg)	30*	1.4	27.1	1.9	7.6	12.2	7.7	13.4	18.0	19.4	13.4	20.7	21.2	17.6	21.9	18.1	23.0	16.2	24.2
Maximum Salinity (Dog Leg)	30*	14.7	30.0	14.7	26.8	29.3	26.9	29.3	29.4	30.0	29.4	30.0	30.0	29.8	30.0	30.0	30.0	29.9	30.0

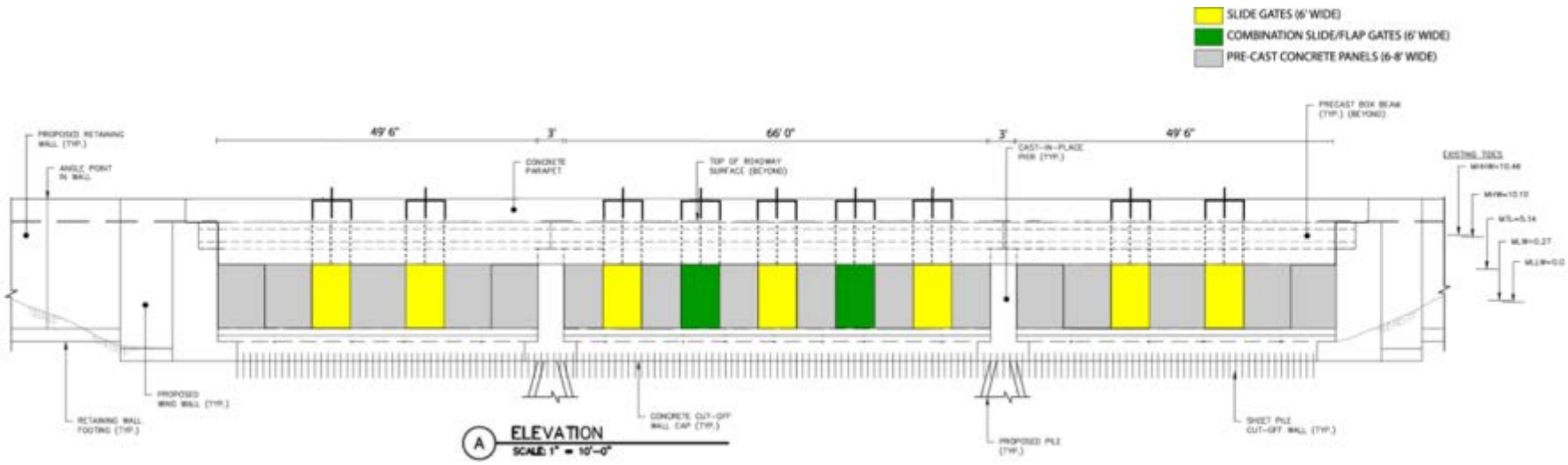
* = Salinity in Model within Wellfleet Harbor

^ = Just upstream of Dike

Interactive Exploration

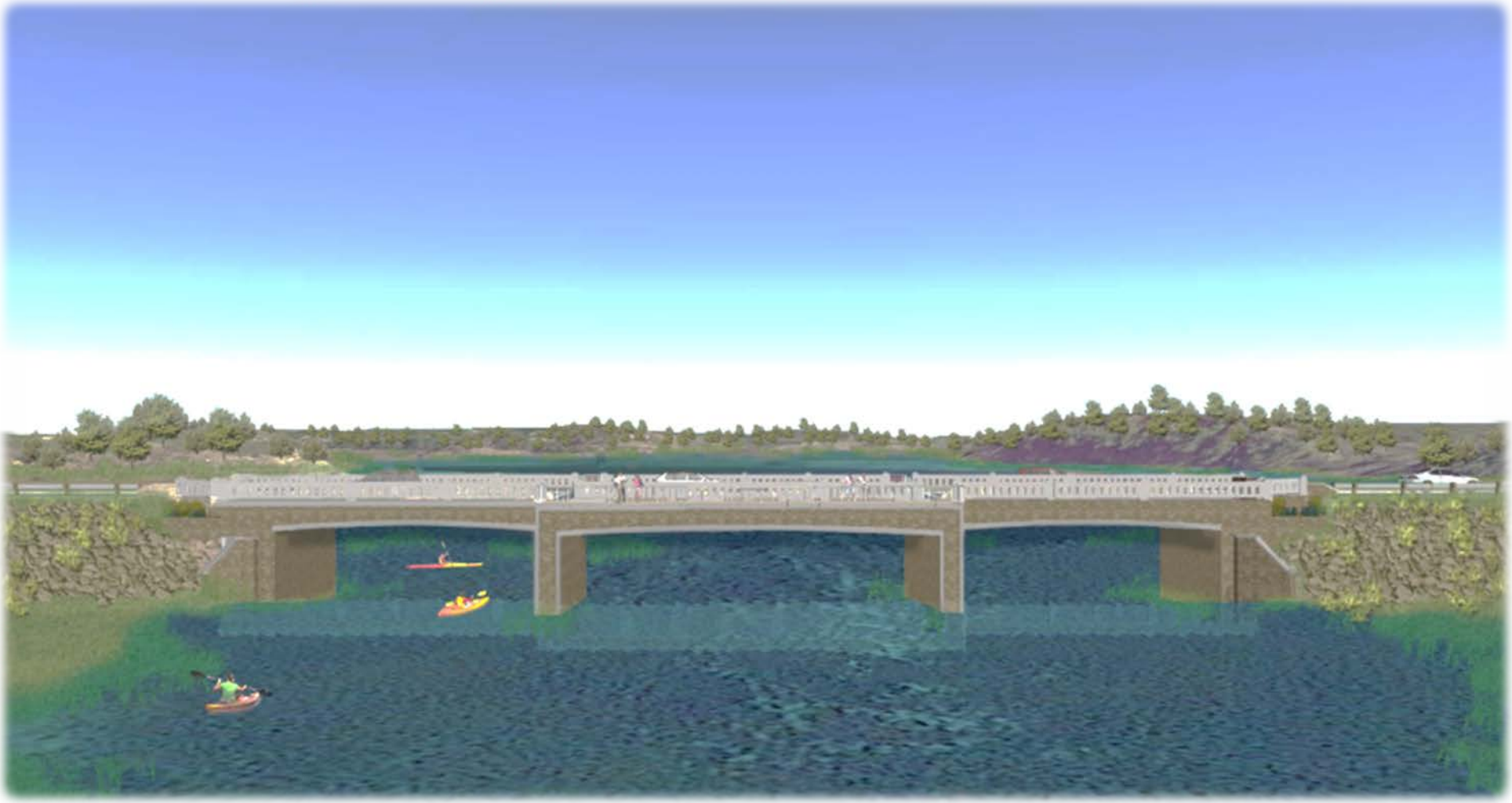


Engineering Design

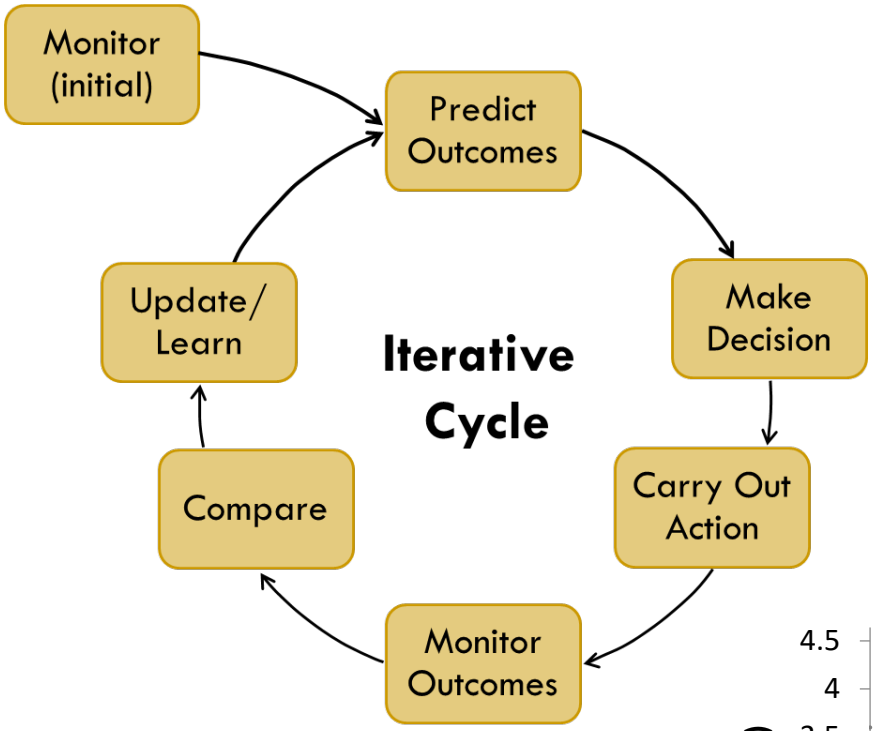


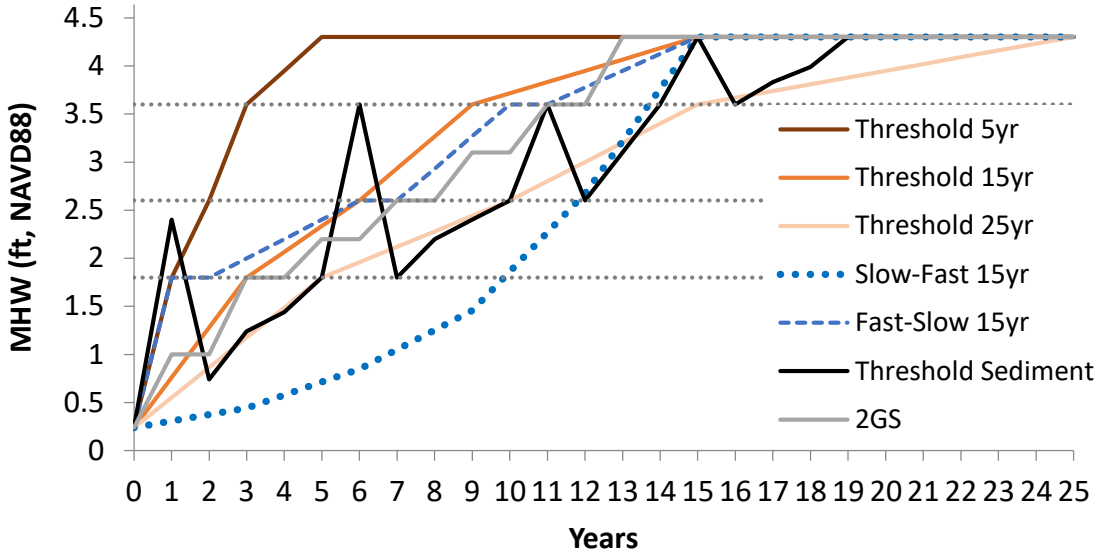
- 7 slide gates, 2 combination slide/flap gates, 16 pre-cast concrete panels
- Provides full operational control during all phases of the restoration
- In the early stages, the restoration process will rely on slide and combination gates and not full panel removal

Open Span Bridge with Tidal Control

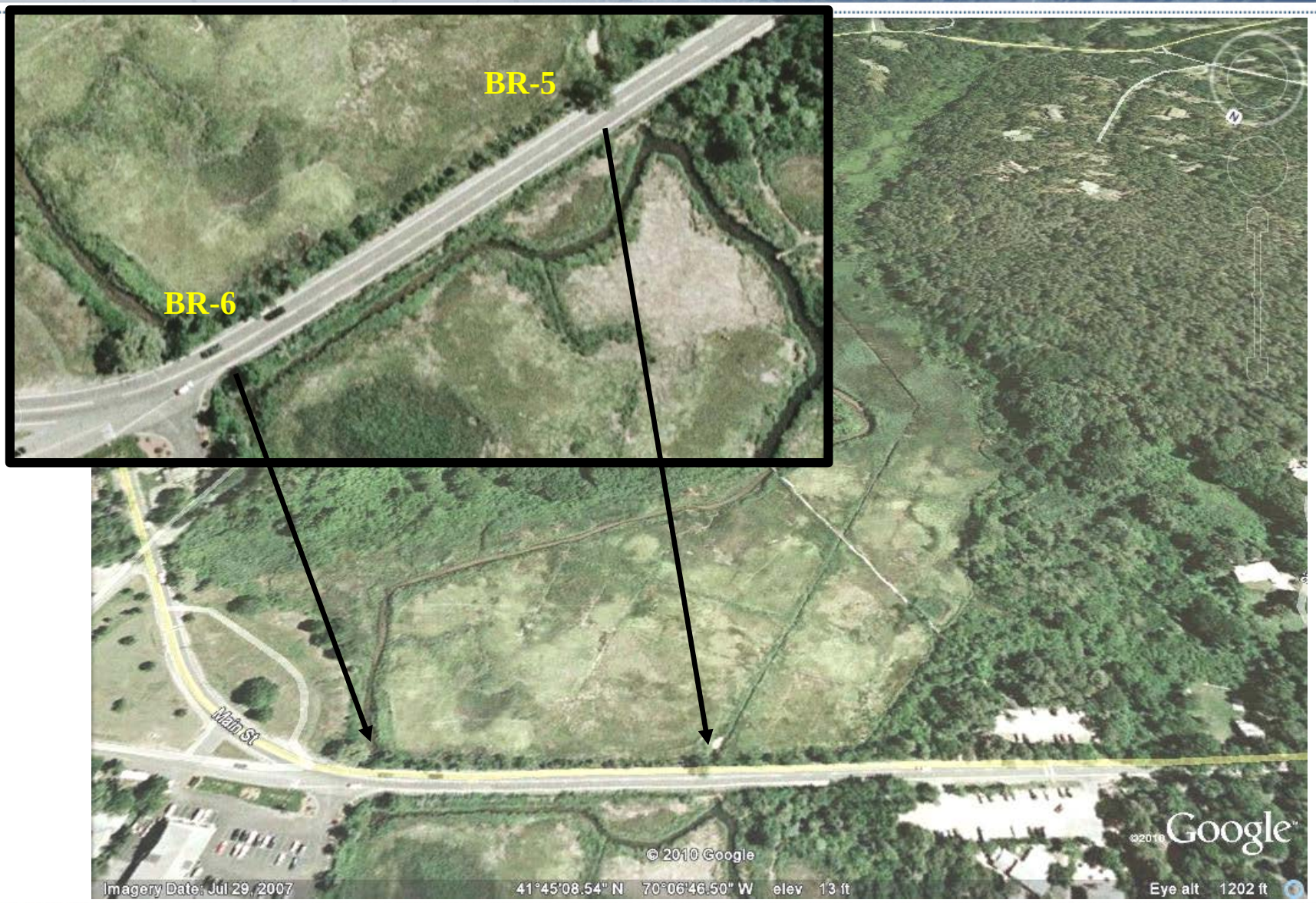


Adaptive Management





Stony Brook, Brewster



Stony Brook, Brewster

Winner of the Coastal America Partnership Award

Brides Brook, Connecticut

Pre-Construction - Anthropogenic restriction

During Construction - Expanded open channel and box culvert under coastal dune

Brides Brook, Connecticut

Post-Construction - Re-established dune and grass planting