Tide Gates and Floodgates:

All you wanted to know but never dared to ask

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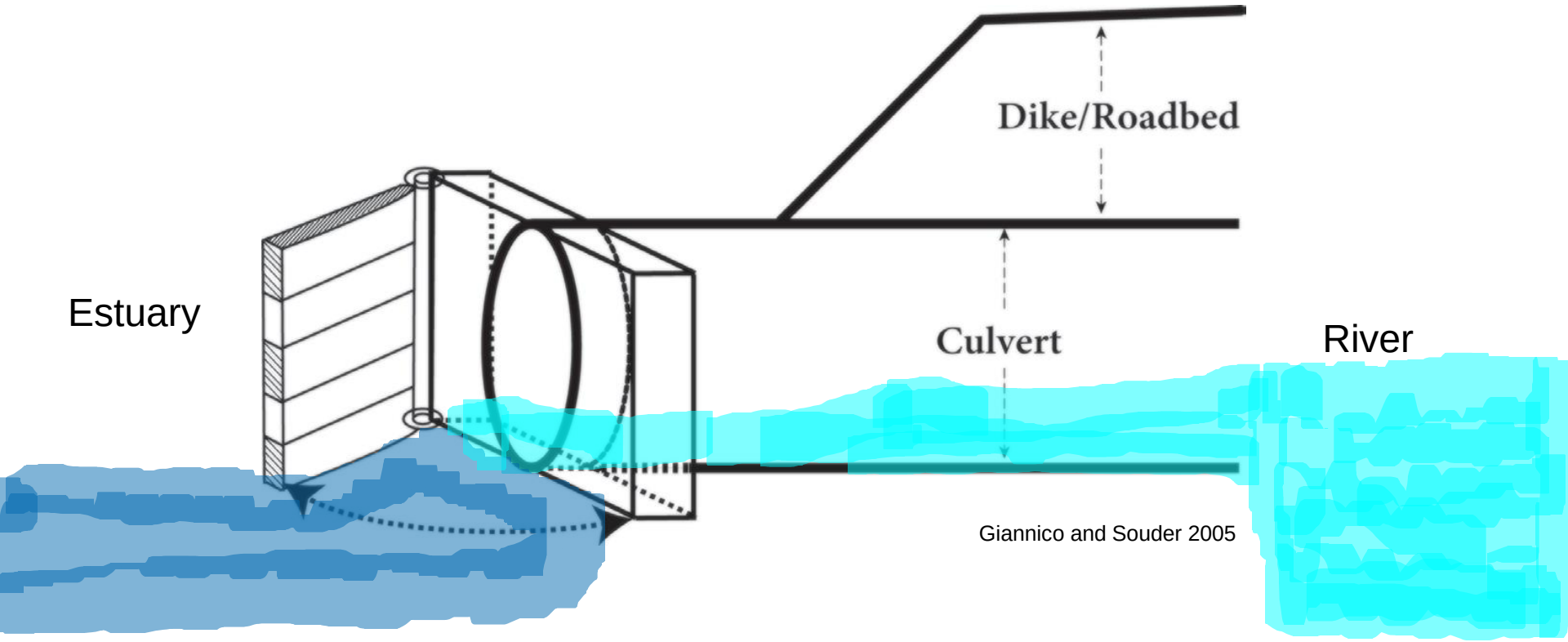
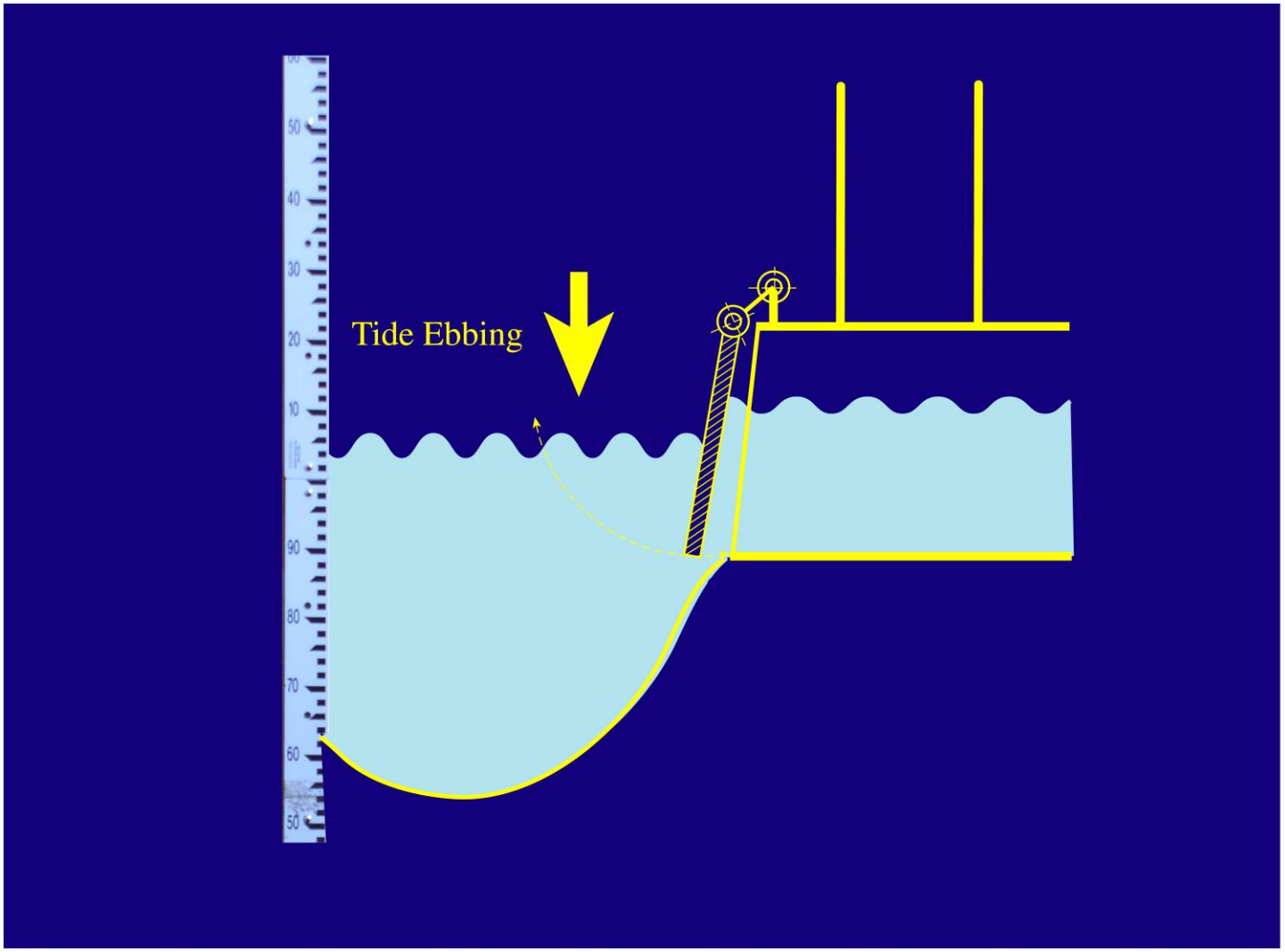
What is a Tide Gate or Flood Gate



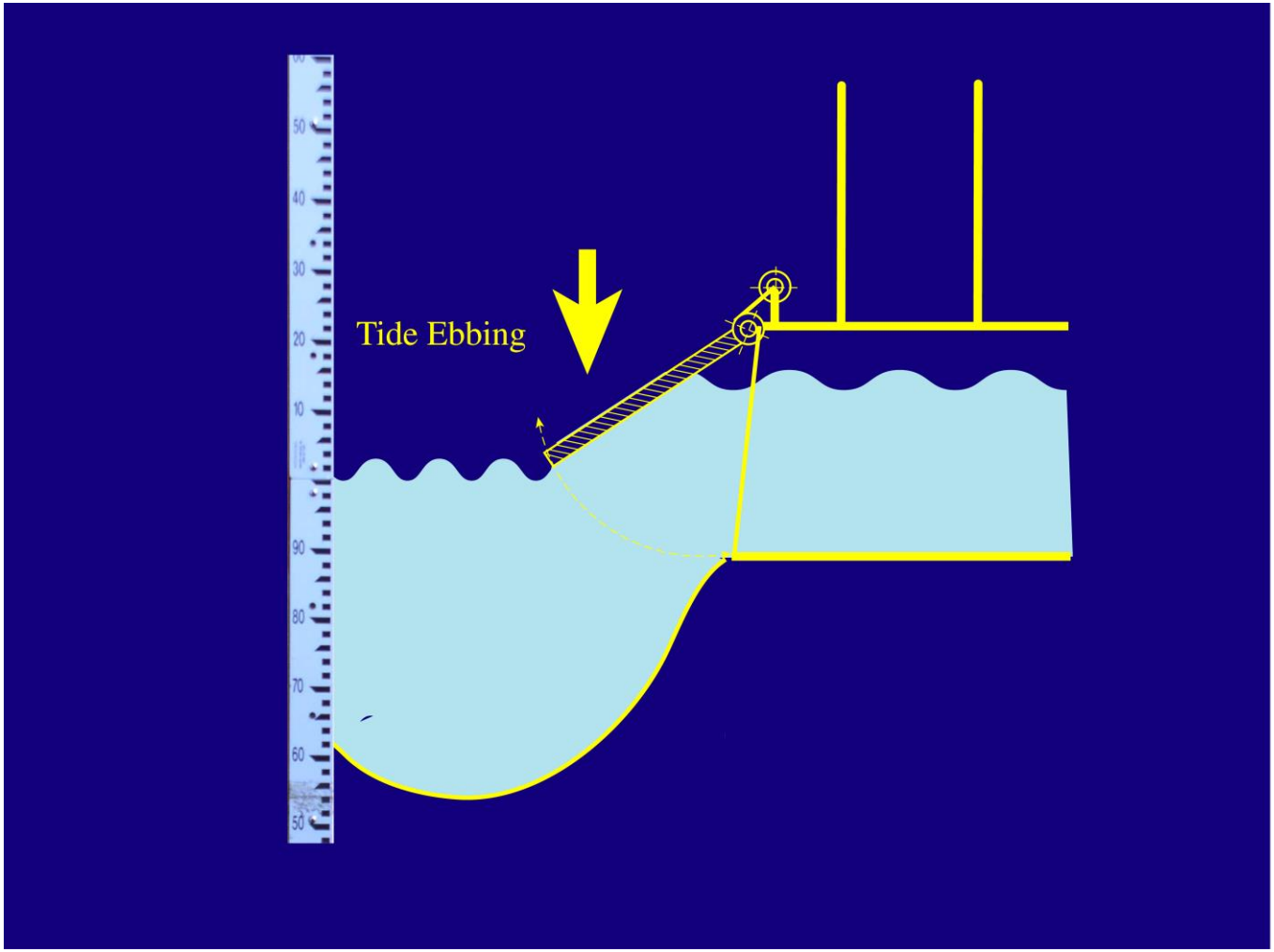
Giannico and Souder 2005

Tide Gate Opening



By Jon Souder

Tide Gate Fully Open



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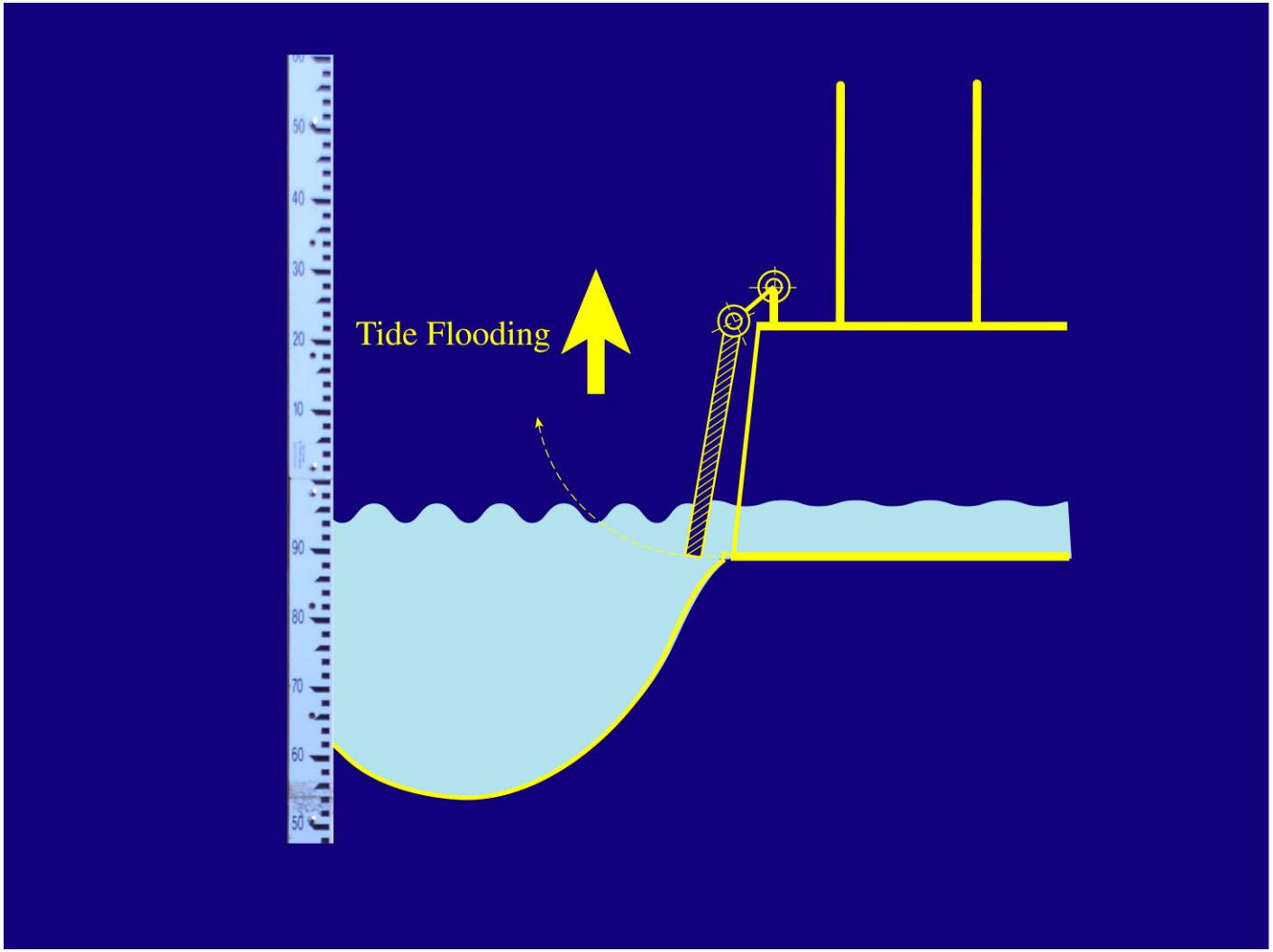
Tide Gate Closing



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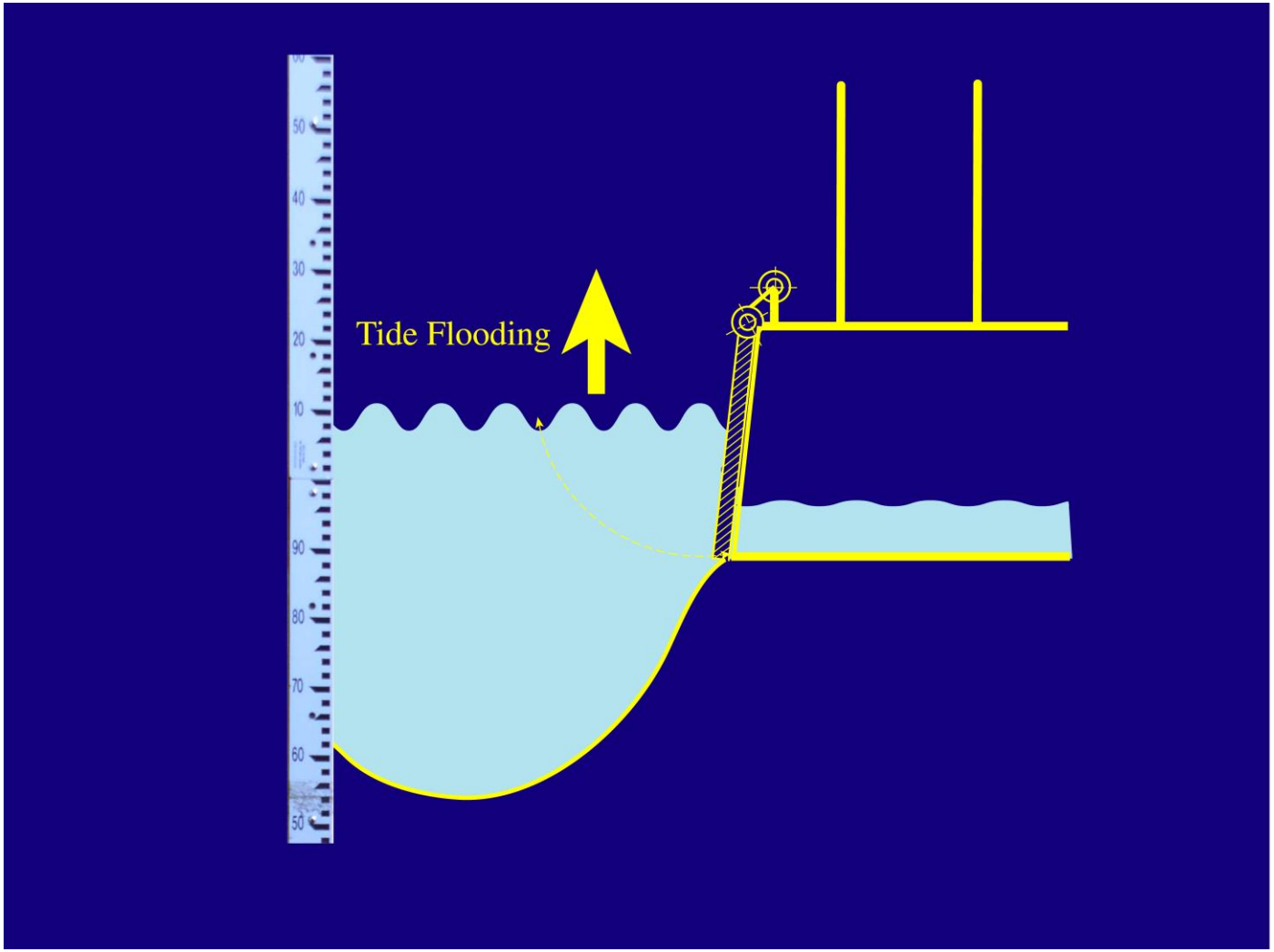
Tide Gate Fully Closed



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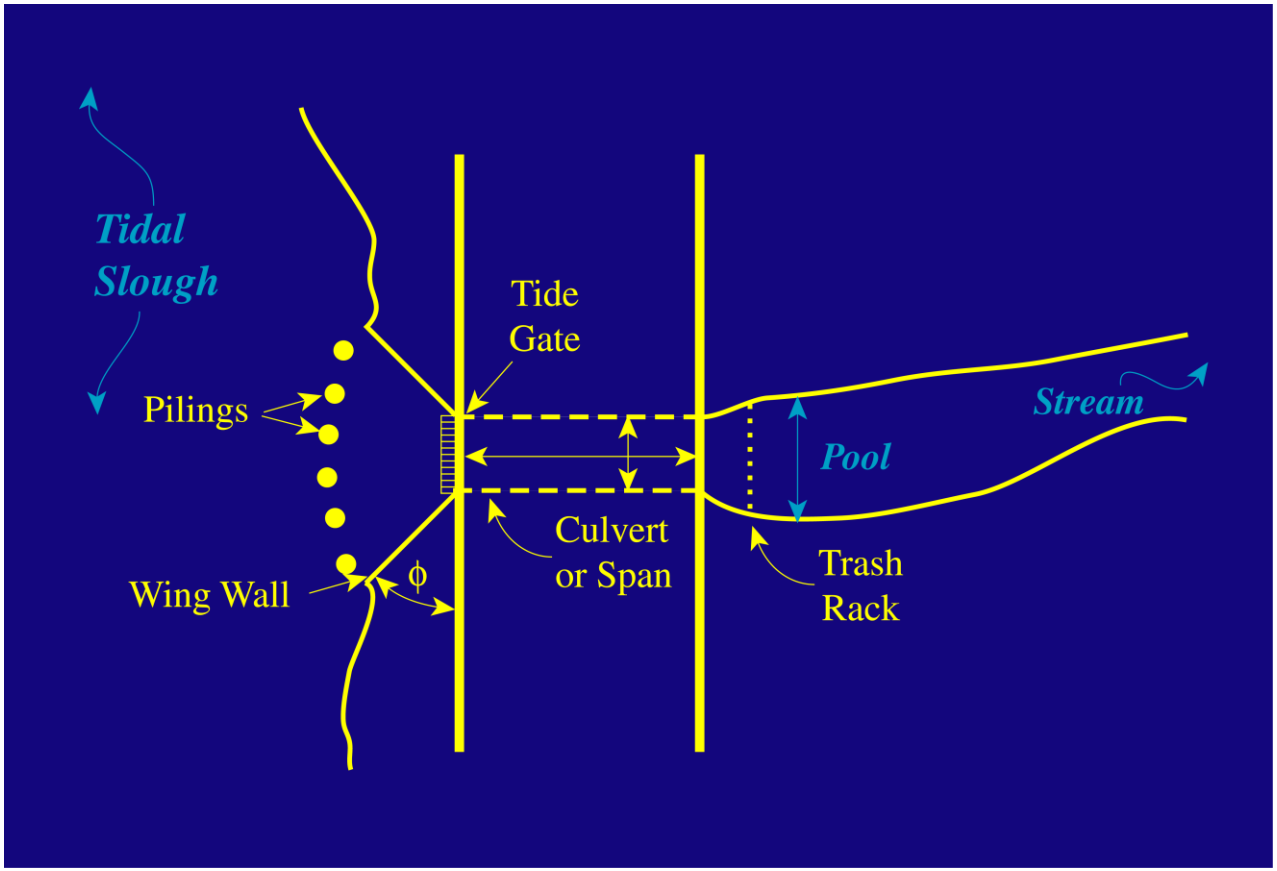
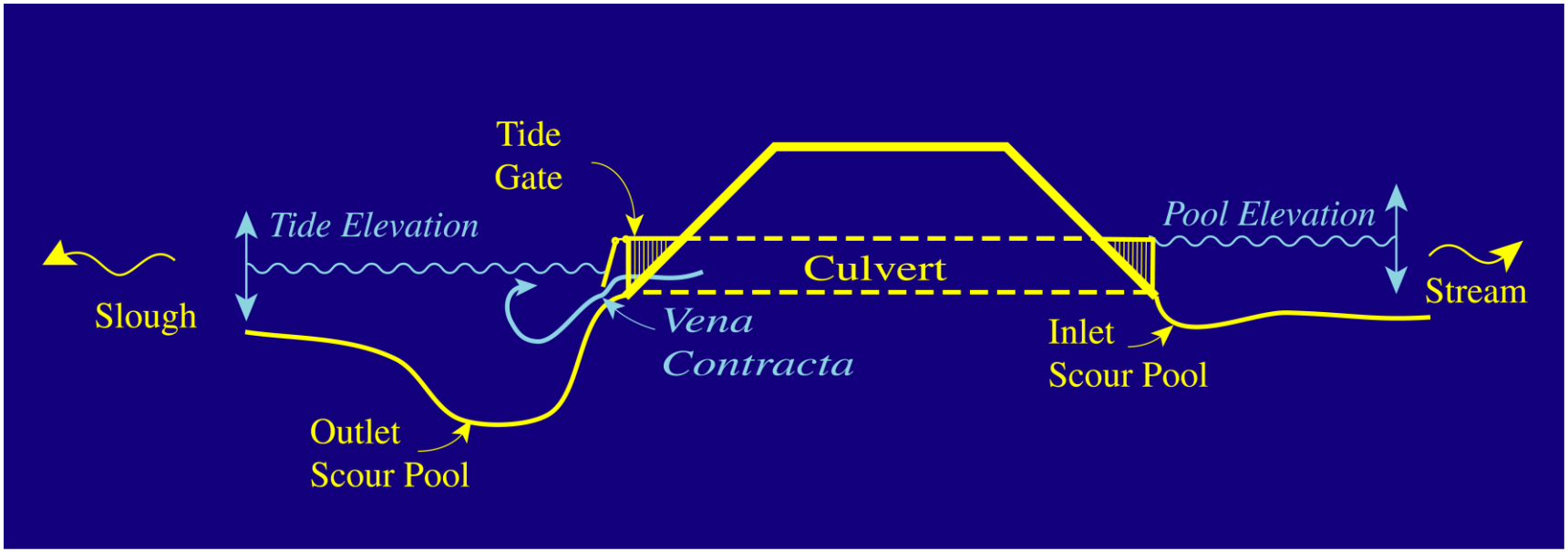
Tide Gate and “Box” — Plan View



Giannico and Souder 2005

Tide Gate — Elevation View



Giannico and Souder 2005

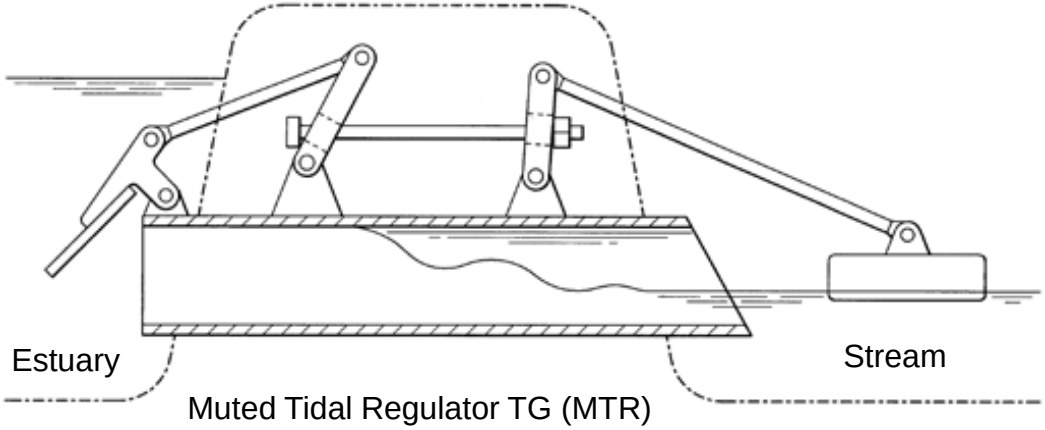
Common types of tide gates

Top Hinged

Side Hinged

Where are tide gates used?

Side-hinged TG



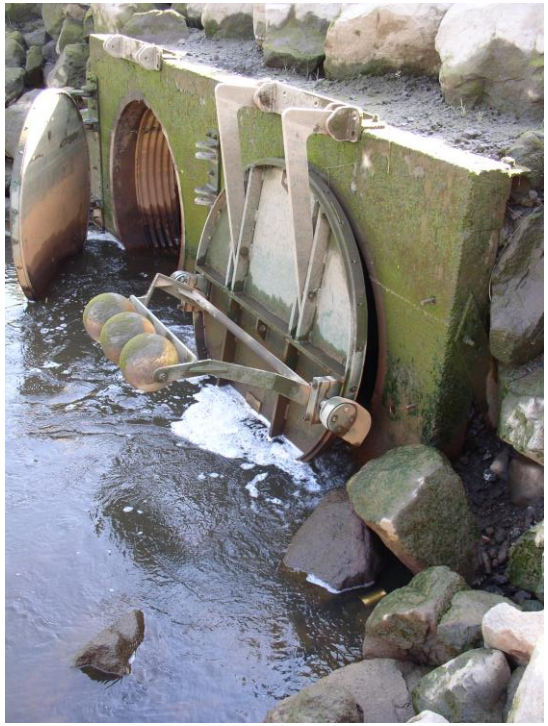
Muted Tidal Regulator TG (MTR)

Giannico and Souder 2005

A variety of tide gate designs are in use.

Top-hinged Self-regulating TG

Top-hinged TG



Top-hinged TG with Mitigator Device

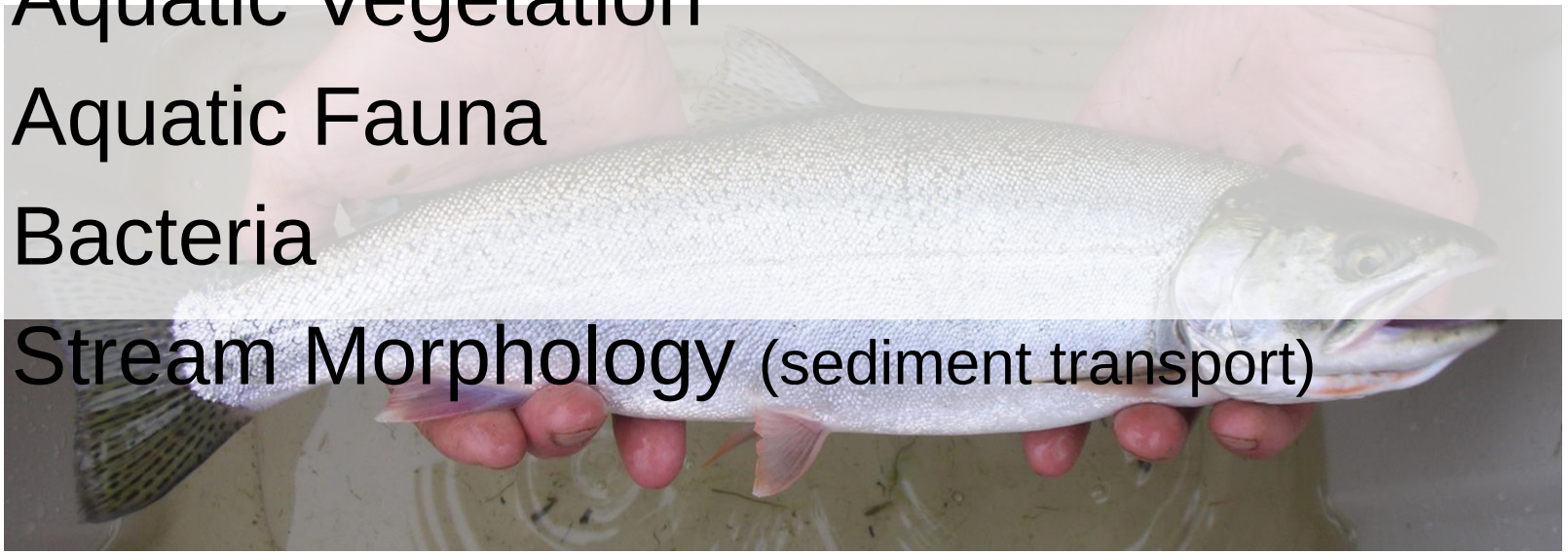
Giannico and Souder 2004

Common Goals Of Tide Gate Projects

Souder, J. et al. 2018

Main impacts of tide gates

- Physical Barrier to Fish Migration
- Water Quality (salinity, temperature and DO)
- Aquatic Vegetation
- Aquatic Fauna
- Bacteria
- Stream Morphology (sediment transport)



Water Velocity as Barrier to Passage

- Adult Salmon Passage Criteria: Water velocity less than 4 feet per second.

Palouse Creek

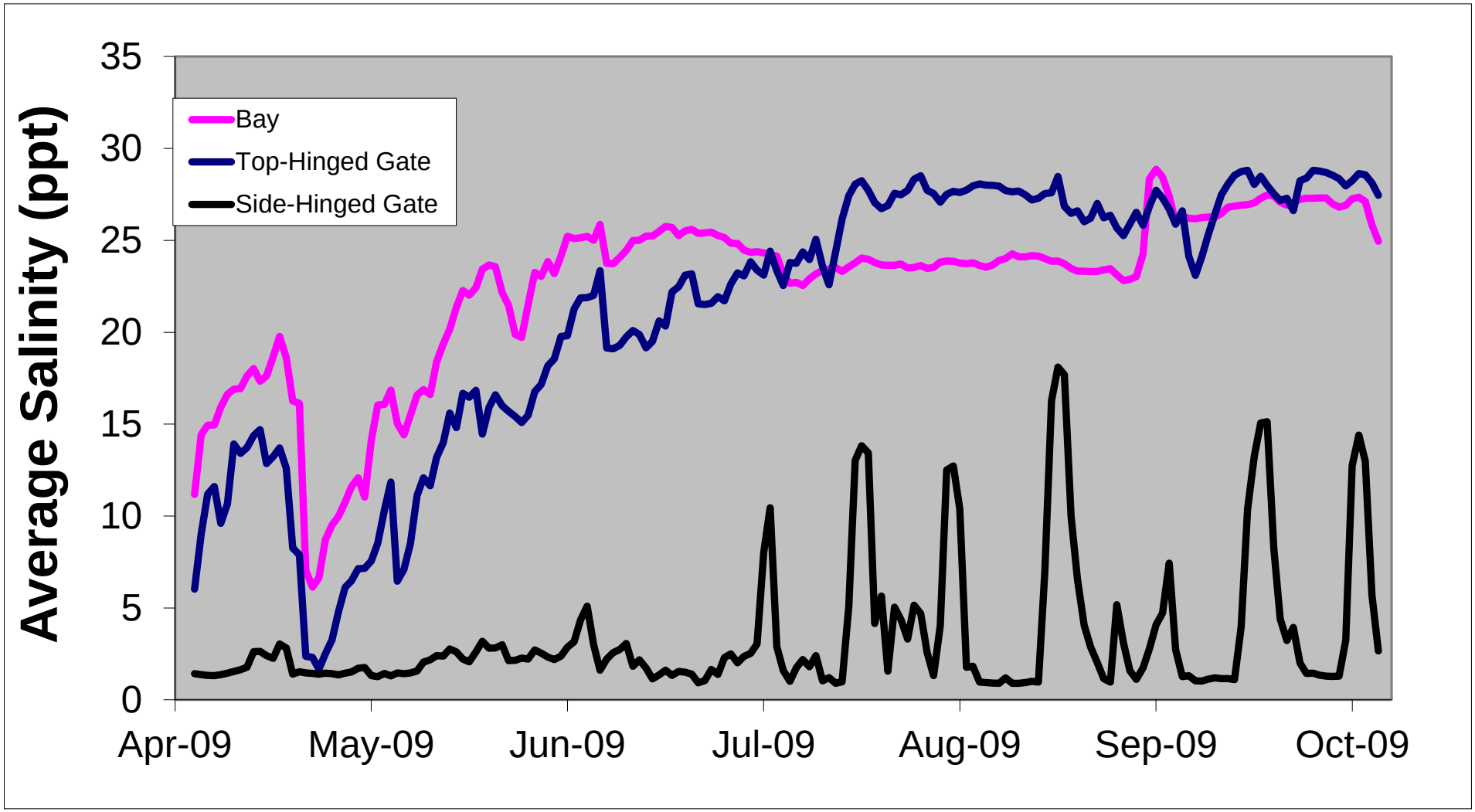
- Juvenile Salmon Passage Criteria: Water velocity less than 2 feet per second.

Larson Creek

Altered Salinity Gradients

- Salinity gradients in tidal systems range between 24 ppt seawater and 0 ppt freshwater.
- Juvenile salmon like to have a range of salinities available to choose among during their smoltification (adjustment from fresh to sea water) process.

Water Quality: Salinity



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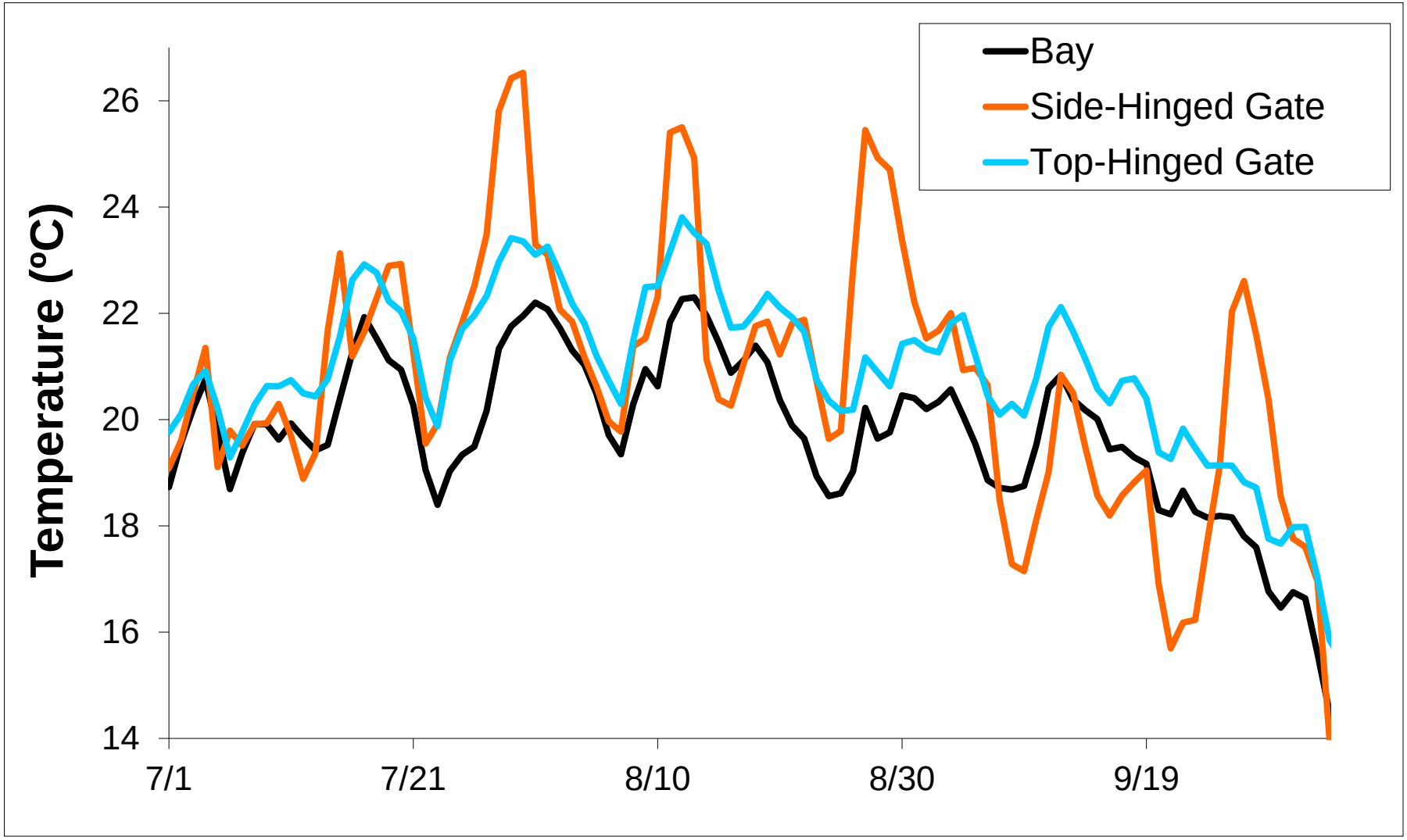
Water Quality: Temperature



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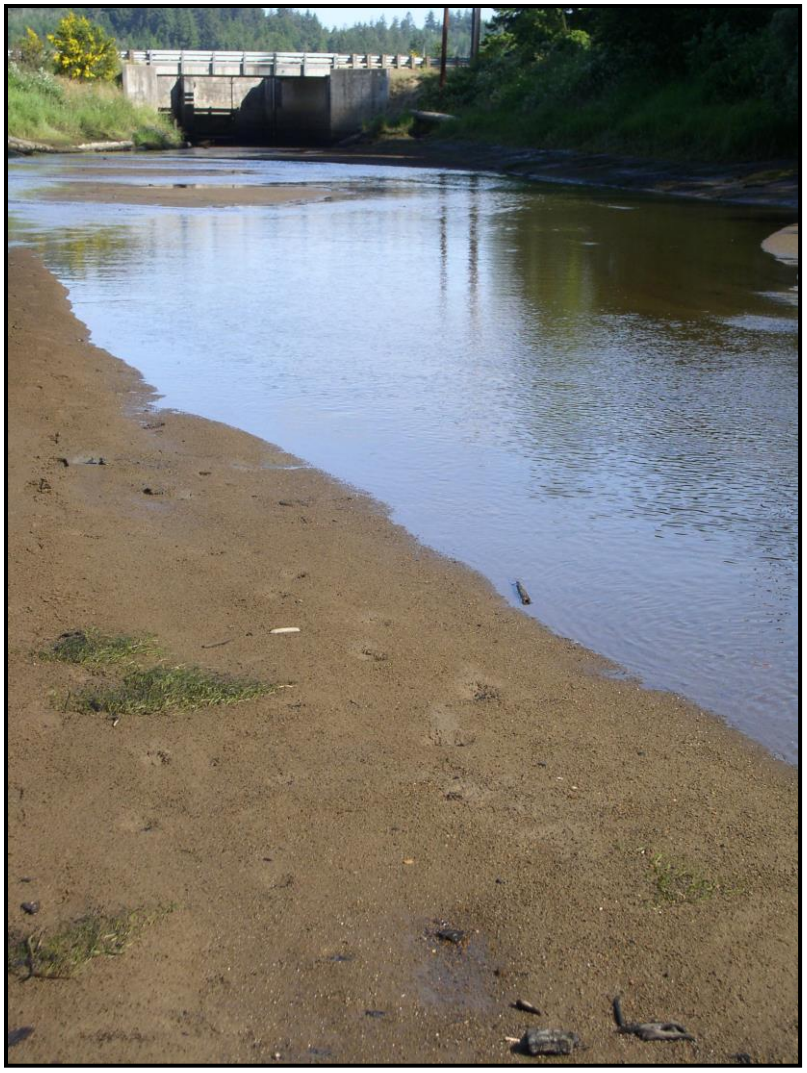
Plant Community

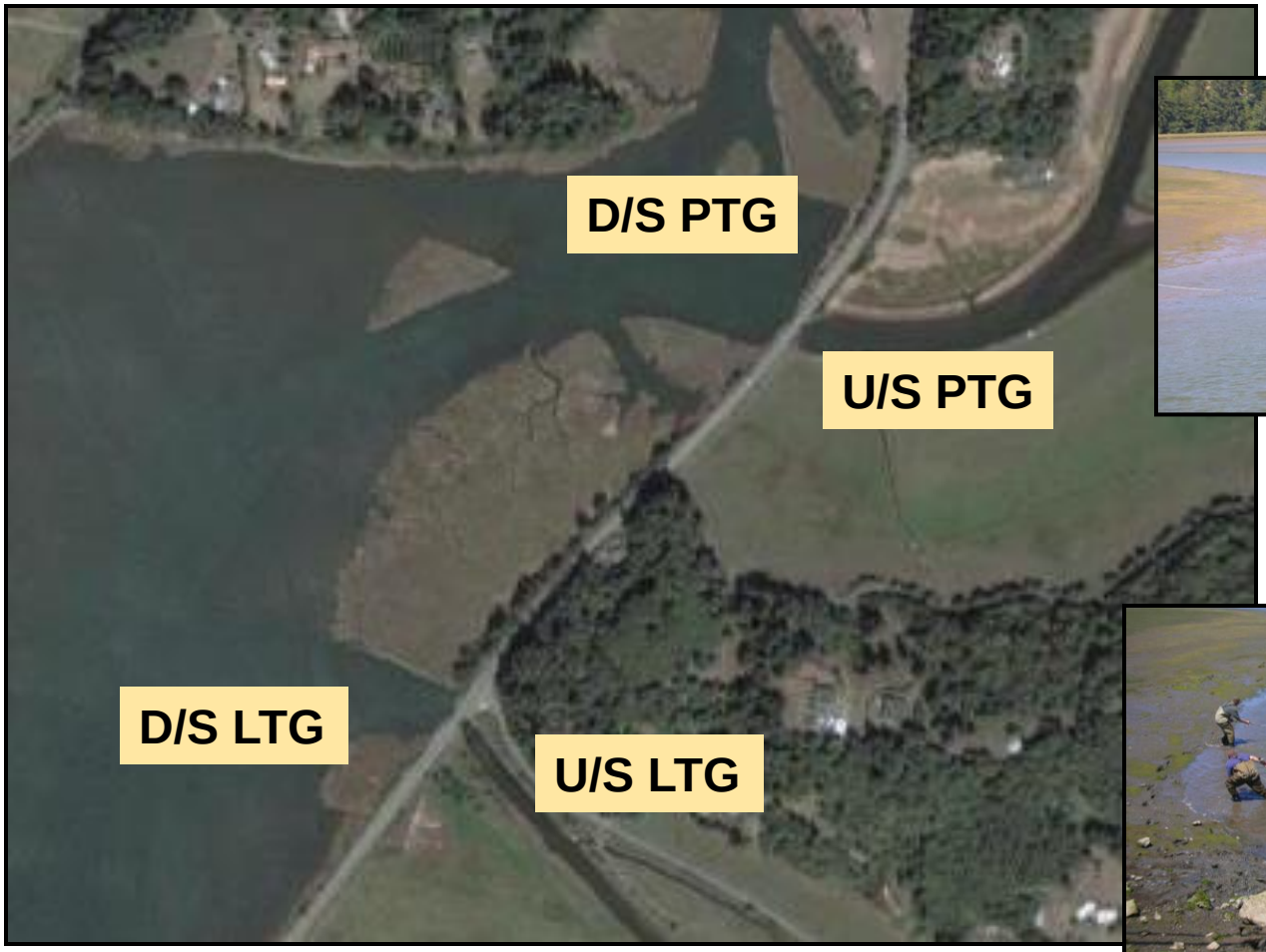


Aquatic Vegetation

- Most tide gates (especially large and old ones) leak!
- Salinity inflows allowed by leaky gate in Palouse Creek sustained eelgrass, Ulva, and *Enteromorpha*.

Palouse Creek Behind Tidegate

Animal Community



Animal Community

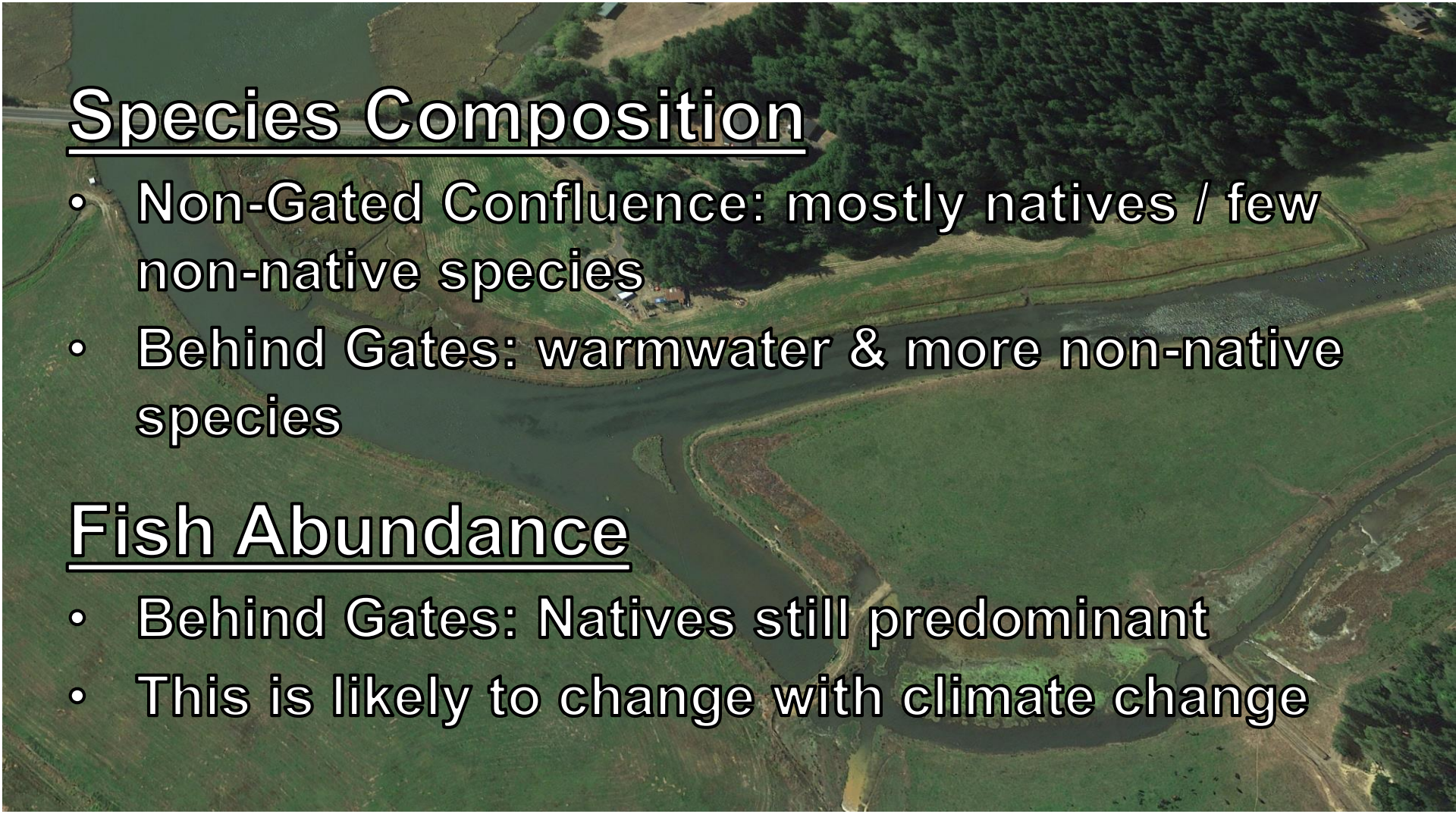
Species	D/S PTG	D/S LTG	U/S PTG	U/S LTG
Chinook salmon	X	X	X	
Coho salmon	X	X	X	X
Cutthroat trout	X	X	X	X
Rainbow trout		X		X
Stickleback	X	X	X	X
Bay Anchovy	X	X	X	
Shiner Surf Perch	X	X	X	X
Bay Pipefish	X	X	X	
Saddleback Gunnel	X	X	X	X
Eulachon	X	X	X	
American Shad	X	X	X	
Cottiddae spp.	X	X	X	X
Pleuronectidae spp.	X	X	X	
Jack silverside.	X		X	
Total species	**13**	**13**	**13**	**7**
Total Samples	**18**	**13**	**15**	**17**

Pleuronectidae spp.

Stream Habitats & Geomorphology

- Pools provide cover, cooler water, and aquatic vegetation.
- Lower invert elevations of culverts allow for sediment transport and expose channel bottom to sunlight (reducing bacteria => columnaris disease, vibriosis, furunculosis)
- Higher invert elevations alter sediment transport and form large and warm upstream pools.

Ecological Effects: Fish Assemblages



Species Composition

- Non-Gated Confluence: mostly natives / few non-native species
- Behind Gates: warmwater & more non-native species

Fish Abundance

- Behind Gates: Natives still predominant
- This is likely to change with climate change

Souder, J. et al. 2018

Juvenile Coho Salmon Movement Through Tide Gates

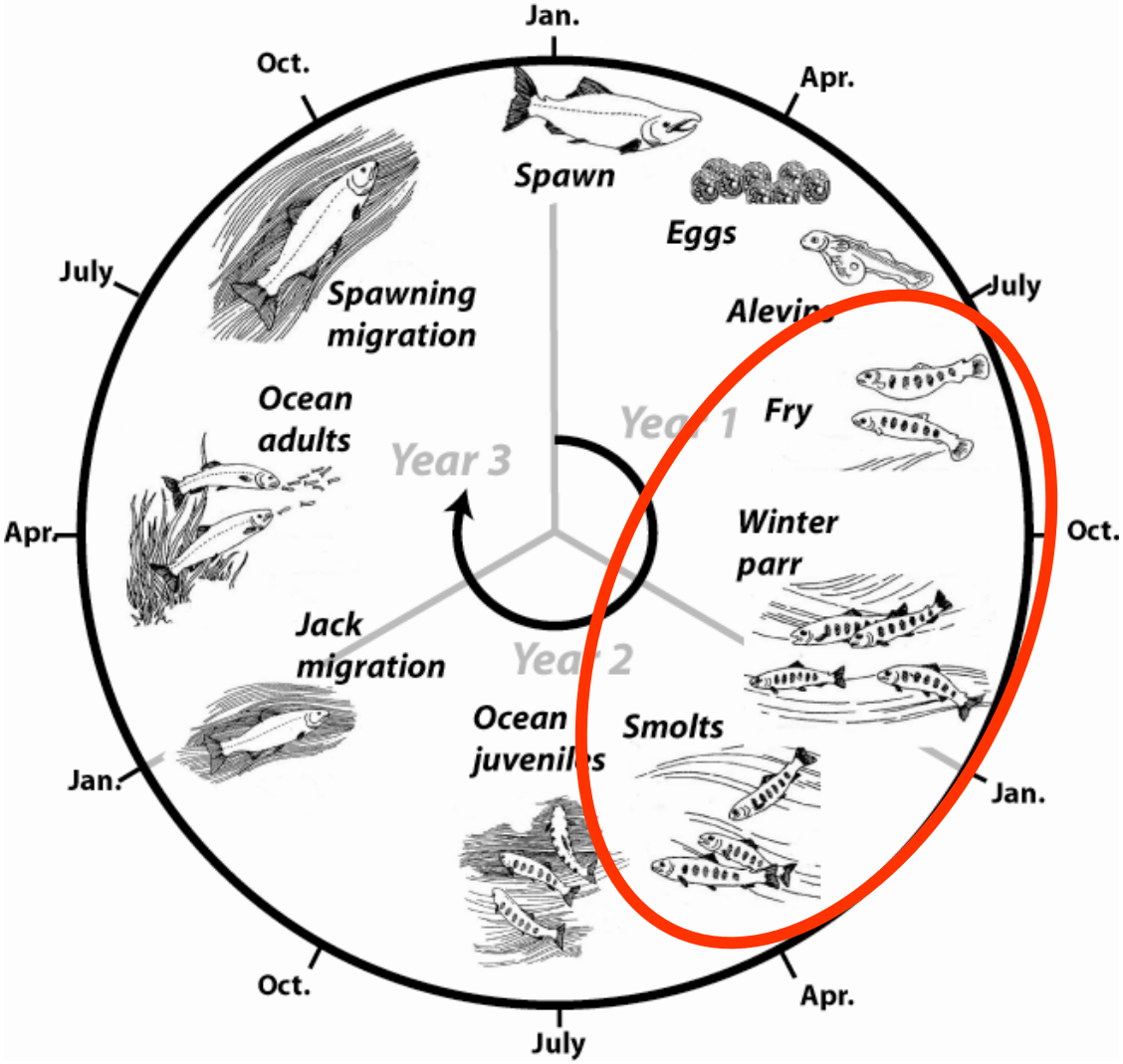
(Arthur Bass, MS Thesis, 2010)

1. Describe coho salmon smolt movements in ungated estuarine channels,

2. Compare migration rate and behavior of smolts in ungated channel with gated channel, and

3. Identify tide gate conditions associated with greater smolt passage rate.

Coho Salmon Life Cycle



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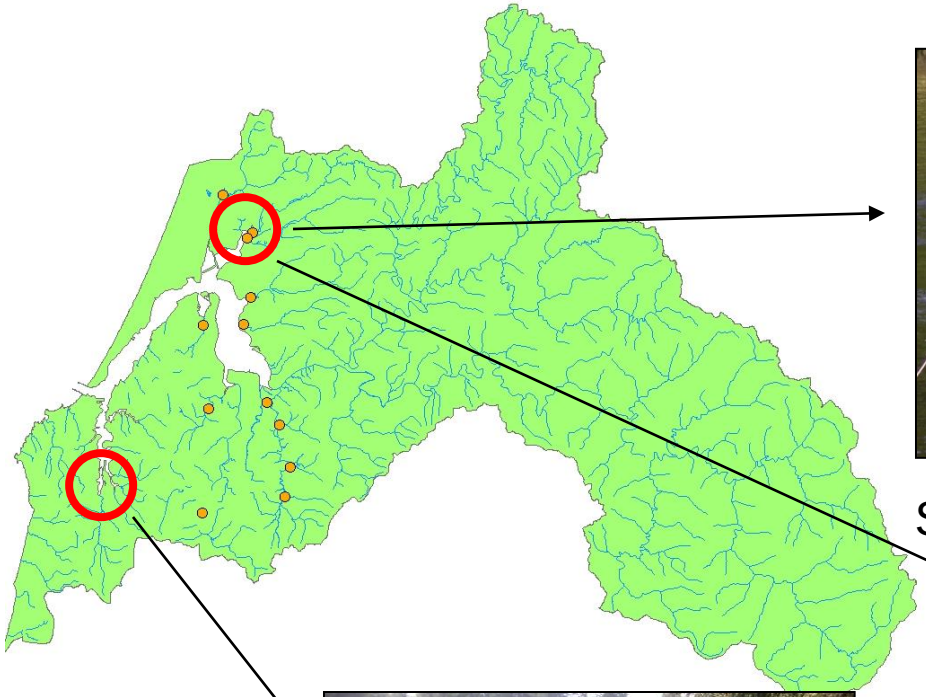
Methods: Field Sites



Side Hinged (Larson)

No tide gate
- reference
(Winchester)

Top Hinged
(Palouse)

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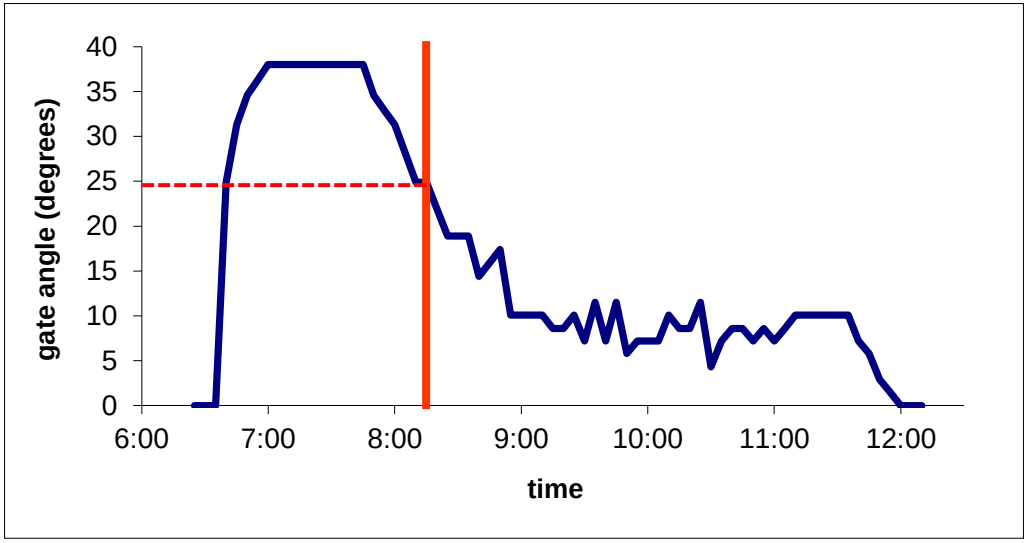
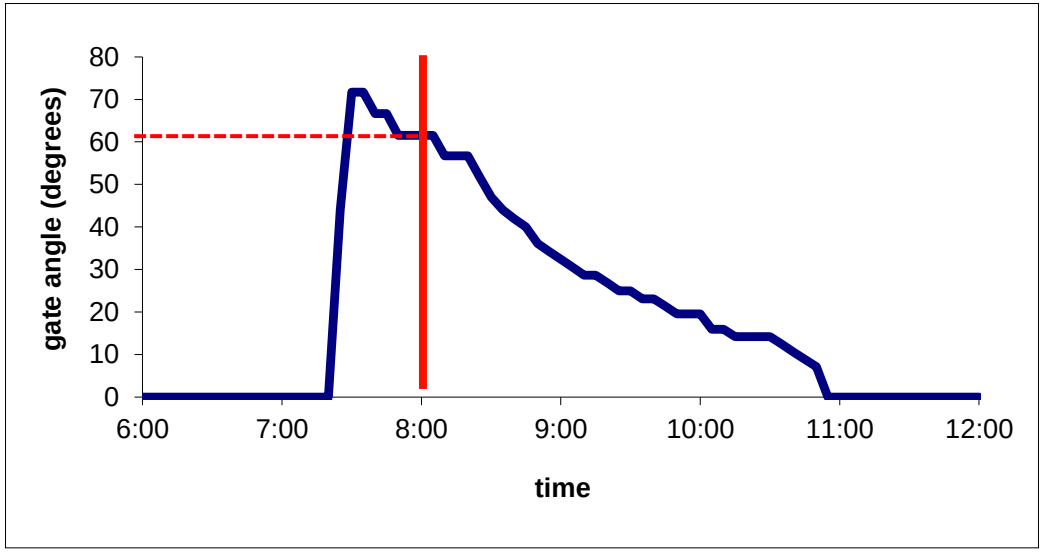
Top Hinged vs Side Hinged

Palouse 5/27/09 8:14



Larson 5/27/09 8:01



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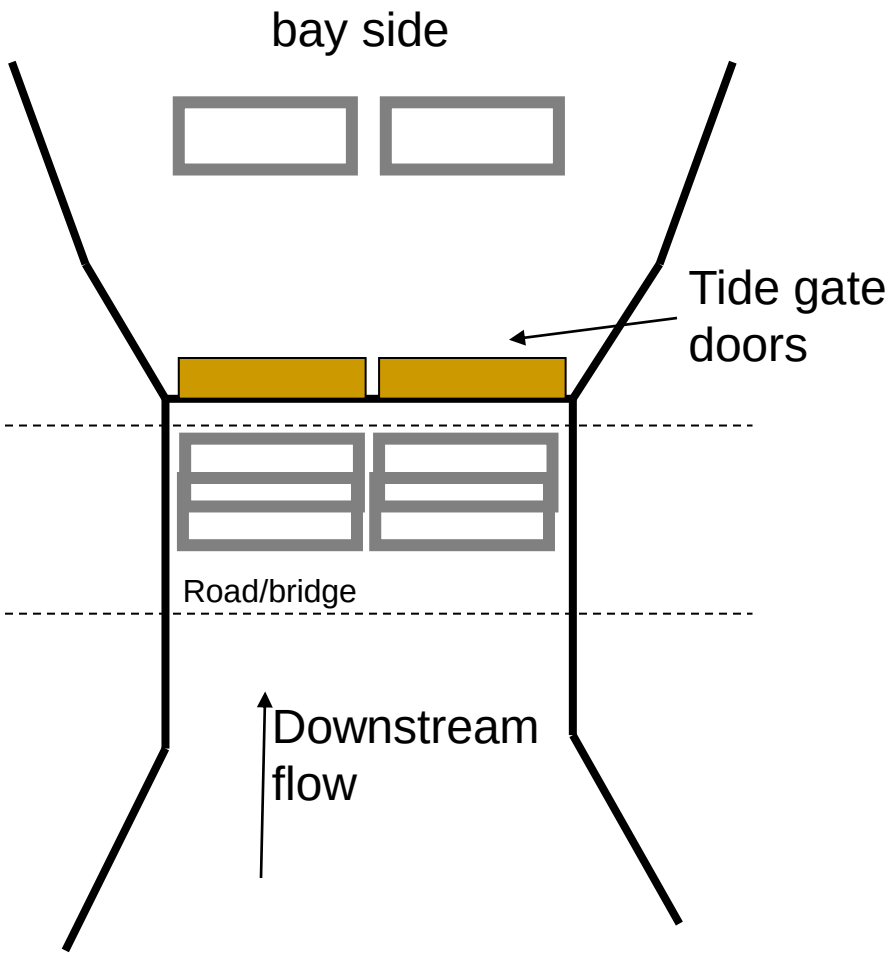
Trapping Methods

Methods: Stationary PIT Antennae



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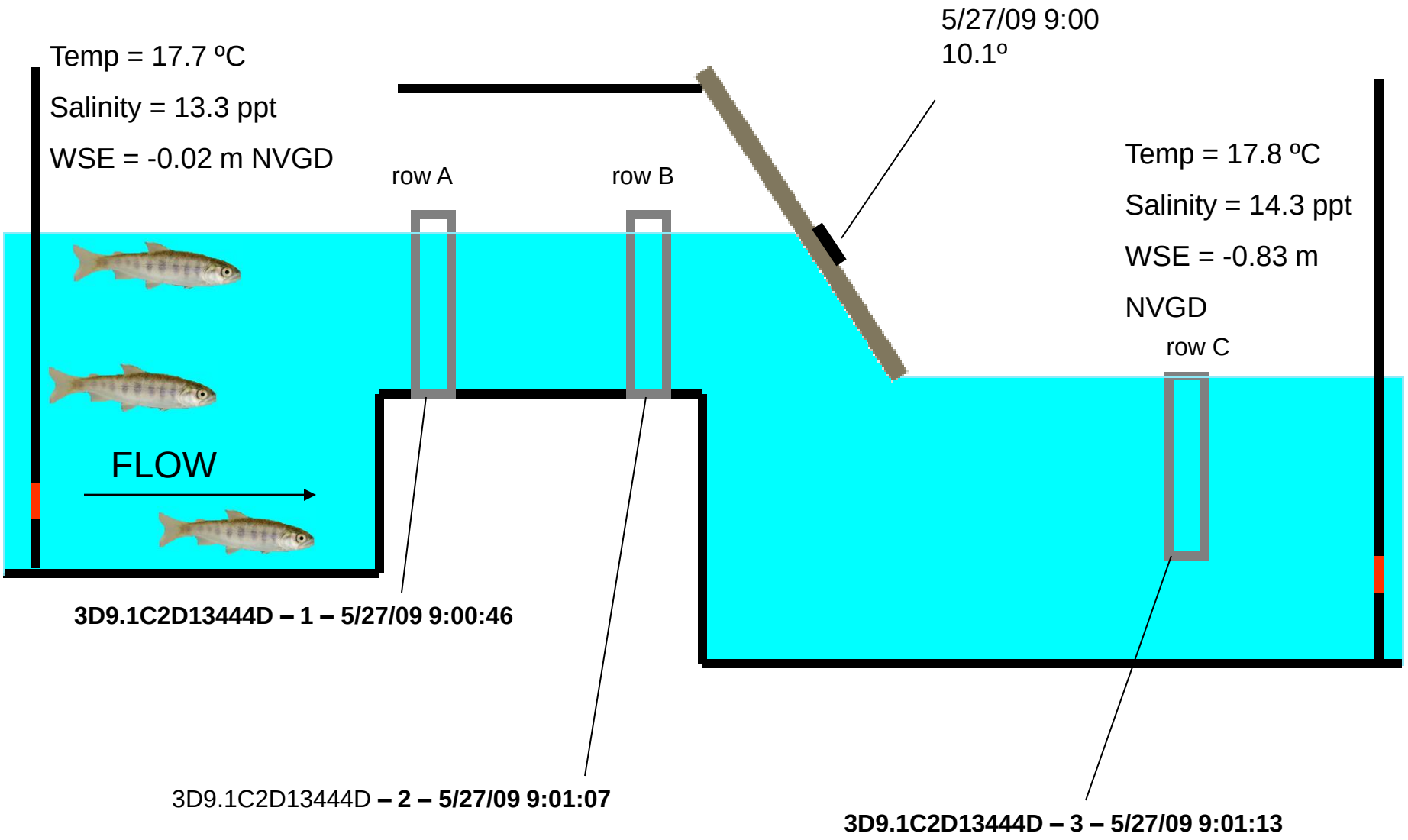
Methods: Data Collection at Tide Gates



3D9.1C2D13444D = coho, 5/18/09, Palouse Reservoir, FL = 108 mm, W = 16.4 g

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Palouse – top hinge

Stream side

Bay side

by Art Bass

Larson – side hinge

Stream side

Bay side

Winchester – reference

Fish Passage Study: Conclusions

1. Ungated channel: 47% of tagged coho smolts performed repeated upstream/downstream movements

2. Salmon smolts do no emigrate passively, many downstream movements occurred during flood tides and were tightly coordinated with sunset

3. Downstream movement = dusk

   Upstream movement = dawn

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Fish Passage: Conclusions

4. Down/upstream movement difficult in gated stream (only 4% of individuals did pass upstream)

5. Gated stream: smolts passed downstream during daylight hours (when fish sheltered in tide gate box and gate opened)

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Fish Passage: Conclusions

6. Greater gate angle = higher proportion of smolts passing downstream (however, some “premature” passage = entrainment in high water velocities)

7. Larger smolts = lower tendency to mill around antennas and emigrated more swiftly (more prepared to enter brackish waters)

References

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