Tidal Slough “Geometry” Filters Estuarine Drivers, Mediates Transport Processes, and Controls Variability of Ecosystem Gradients

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DWR

Calfed Science Conference
October 22, 2008

Key ideas

- Estuaries generate <u>variability</u> by interaction of physical drivers and “geometry as filter” at the land-water-air interface.
- Geometry filters drivers at a variety of time scales
- Natural tidal creek systems have more complex land-water-air interfaces.
- More complex geometry begets more variable scalar gradient response.
- The “why does variability matter?” corollary:

✓ Native plants/fishes evolved in a more variable environment.

DRERIP Hydrodynamics Conceptual Model:

Geometry “filters” estuarine drivers

Drivers

(forcing mechanisms)

- Meteorology
- Tides
- River inputs

Linkages

(hydrodynamic processes)

- Advection
- Dispersion
- Gravitational Circulation

Outcomes

(Chemical/Biological Habitat Characteristics)

Gradients of

- Residence time
- Salinity
- Temperature
- Sediment
- Biota
- Toxics
- etc.

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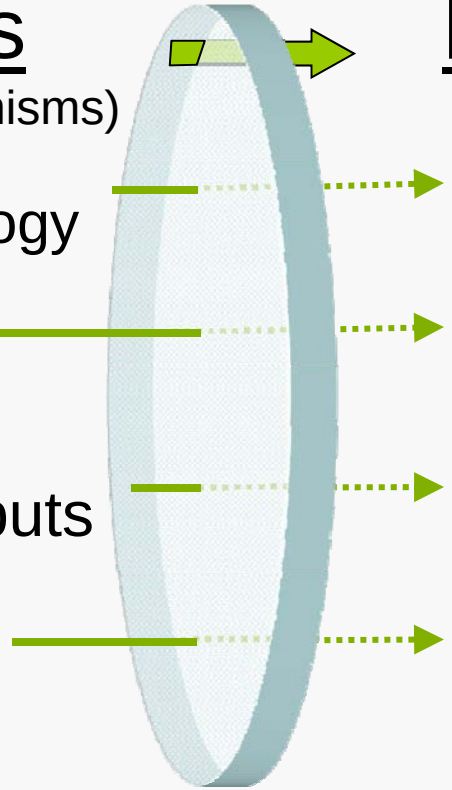
Geometry
(Like a Filter)



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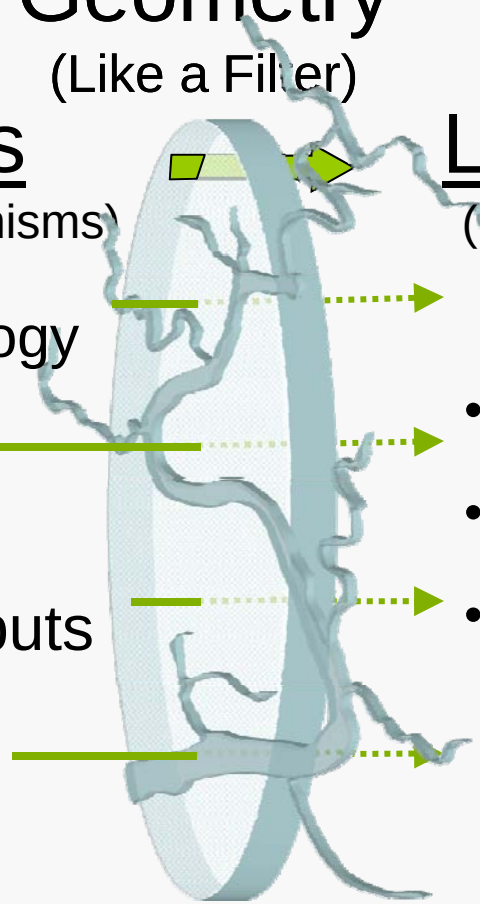

First Mallard Branch

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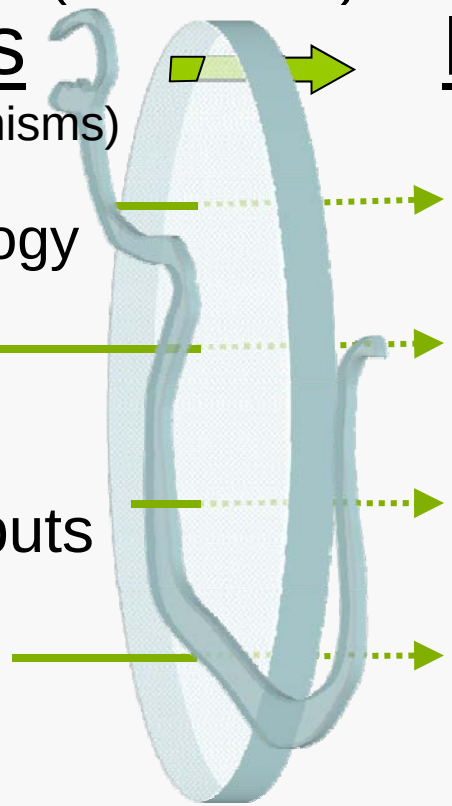

Sheldrake Slough

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What do we mean by “variability?”

- Concentration gradients in space and time (“Outcomes”).

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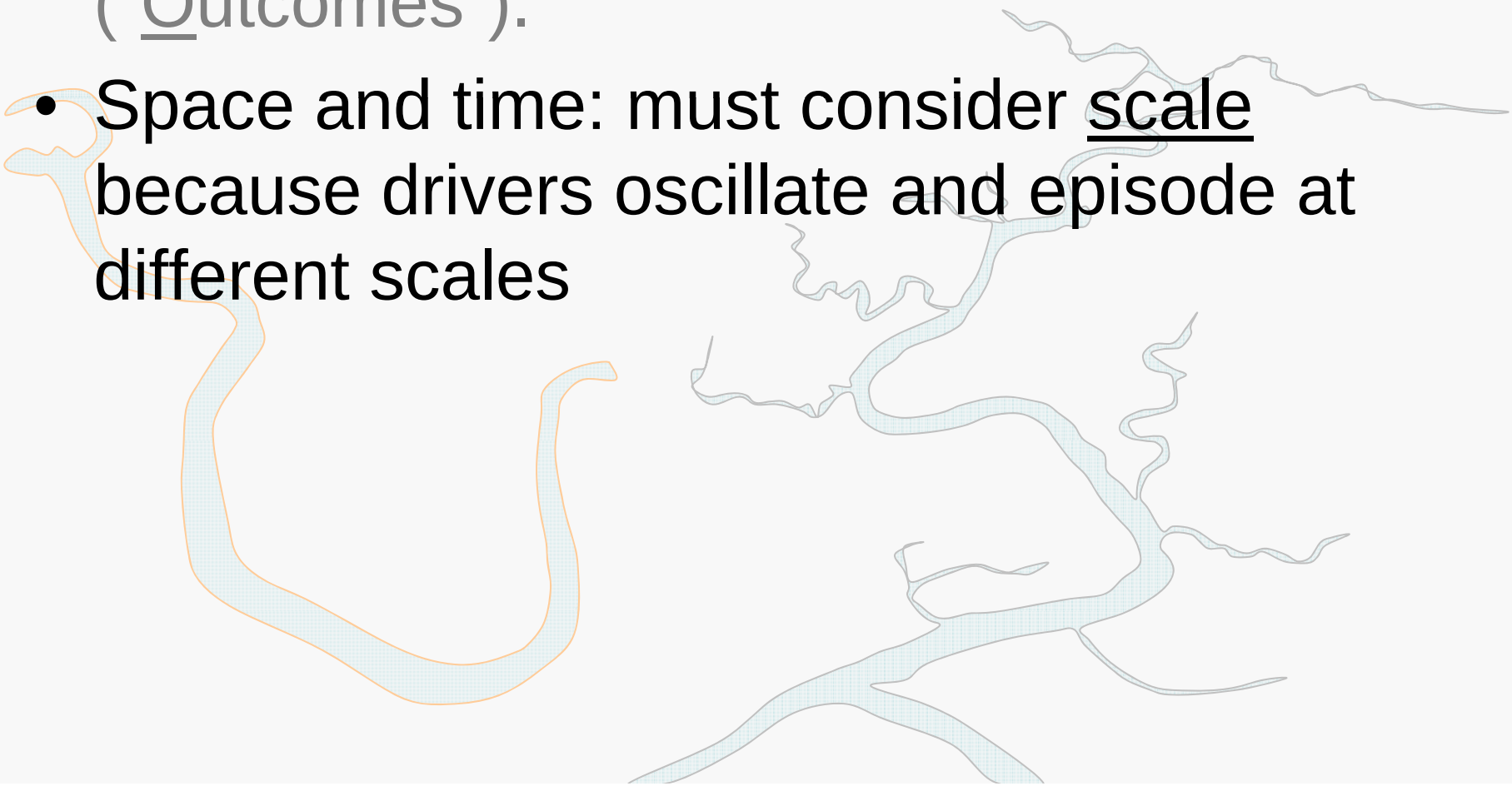
- Space and time: must consider scale because drivers oscillate and episode at different scales



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- Drivers of variability in *time* (dC/dt):

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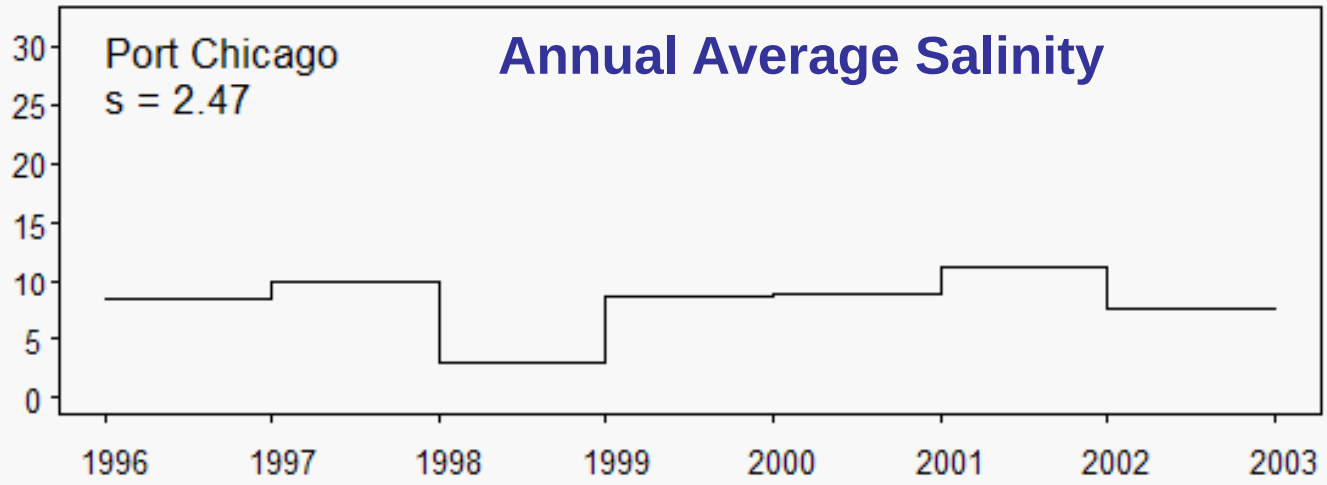

DRIVERS:

1. ENSO status
2. Delta Outflow

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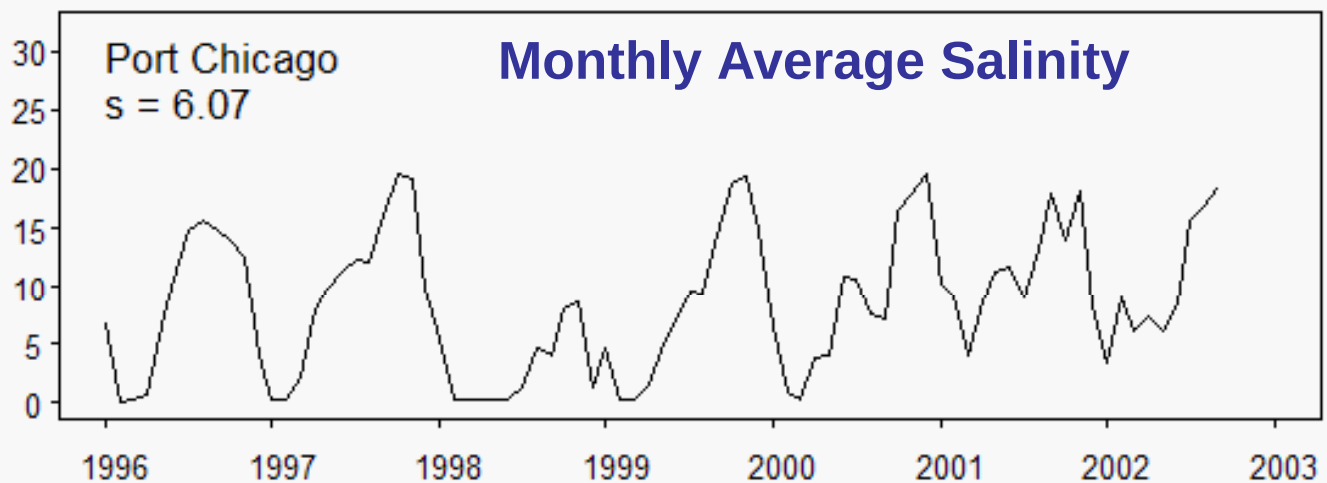

DRIVERS:

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2. Seasonal climat
3. ENSO Status

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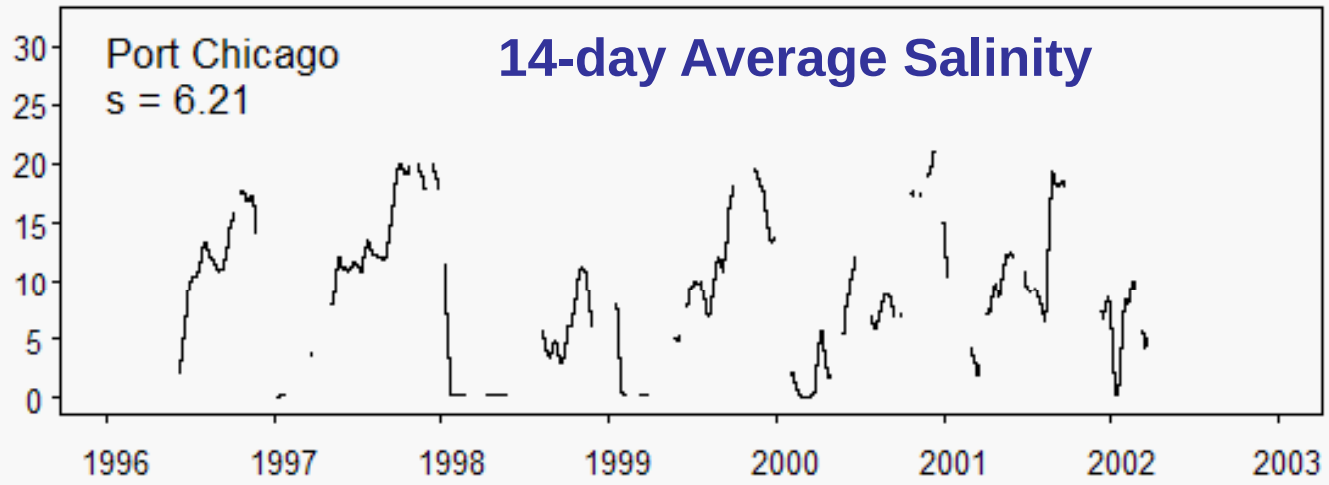

DRIVERS:

1. Spring-Neap
2. Delta Outflow
3. Semi-drnl Tide

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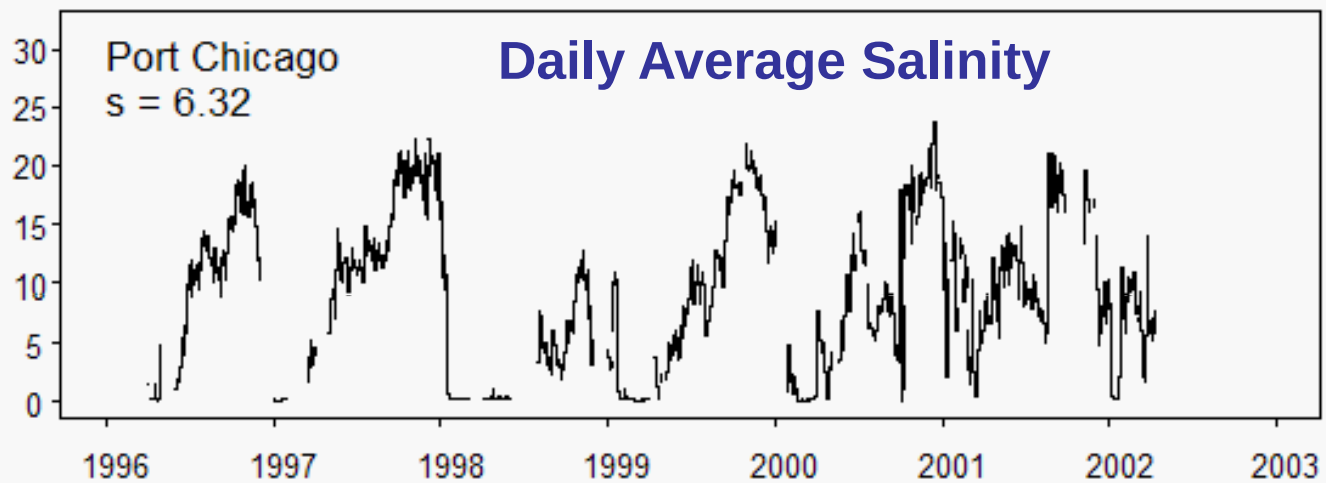

DRIVERS:

1. Semi-drnl tide
2. Delta outflow
3. Wind
4. Bar. pressure

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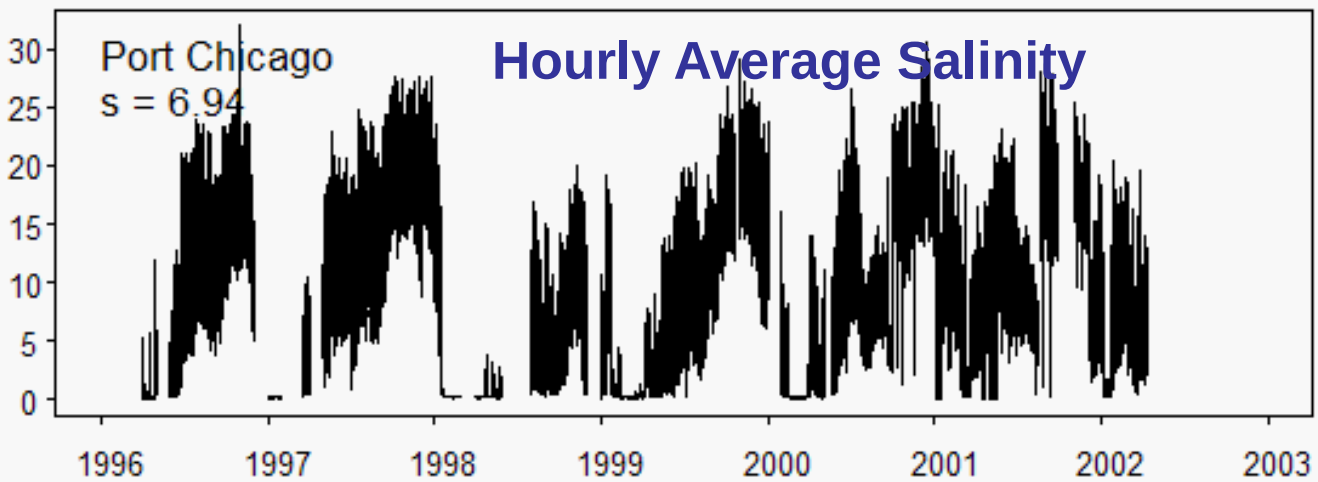

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1. Wind
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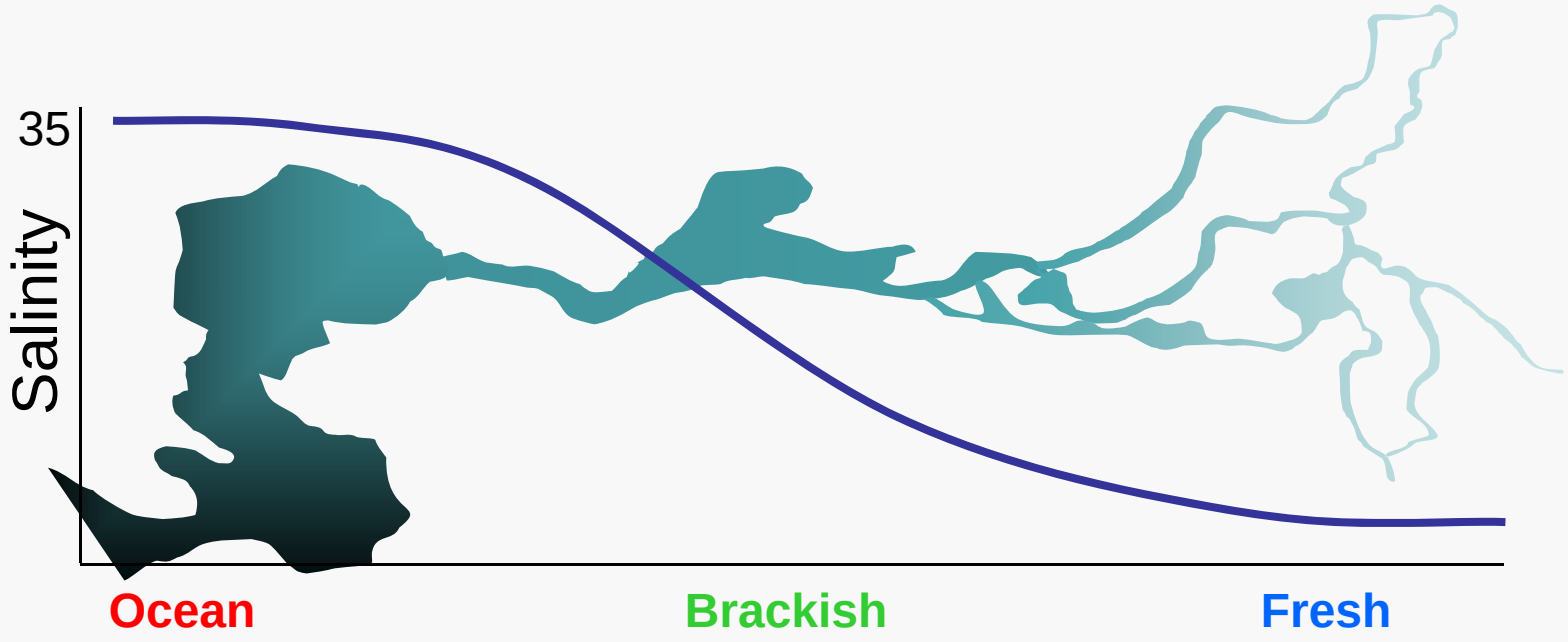

DISPERSION of salt upstream = **ADVECTION** of salt downstream

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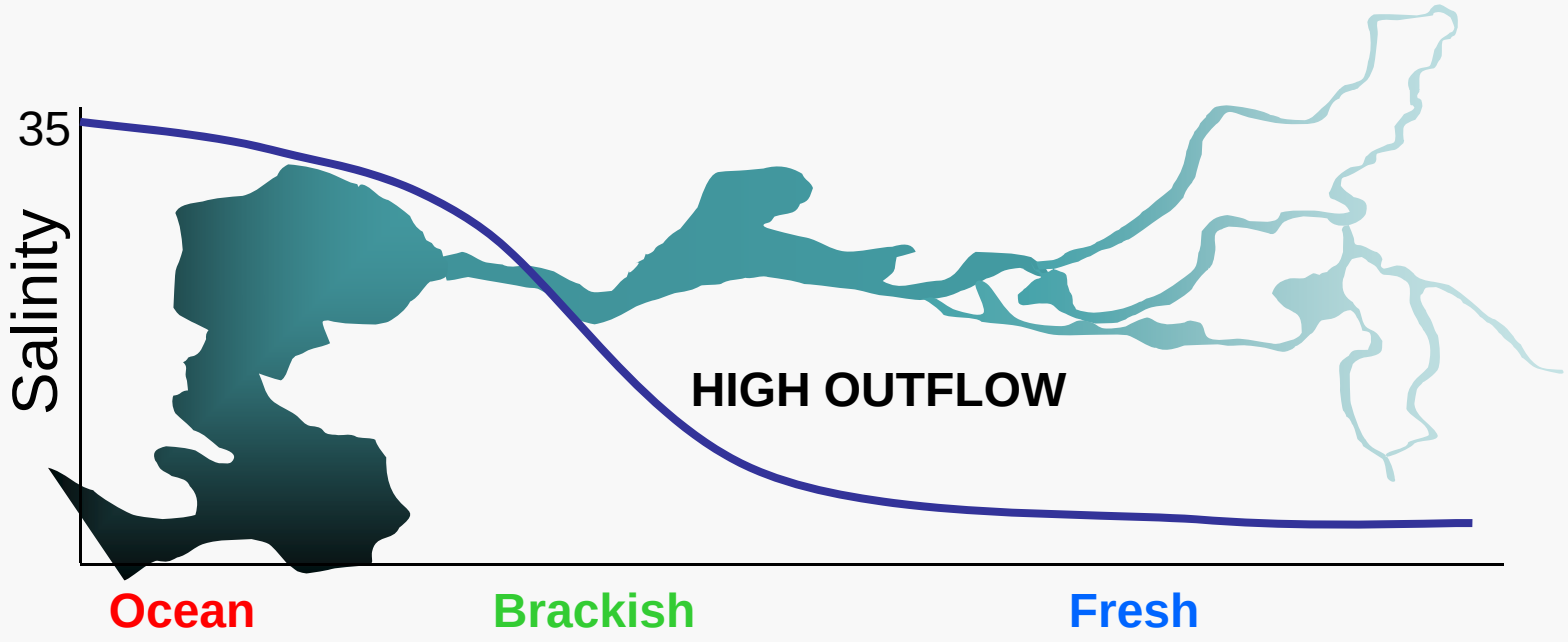

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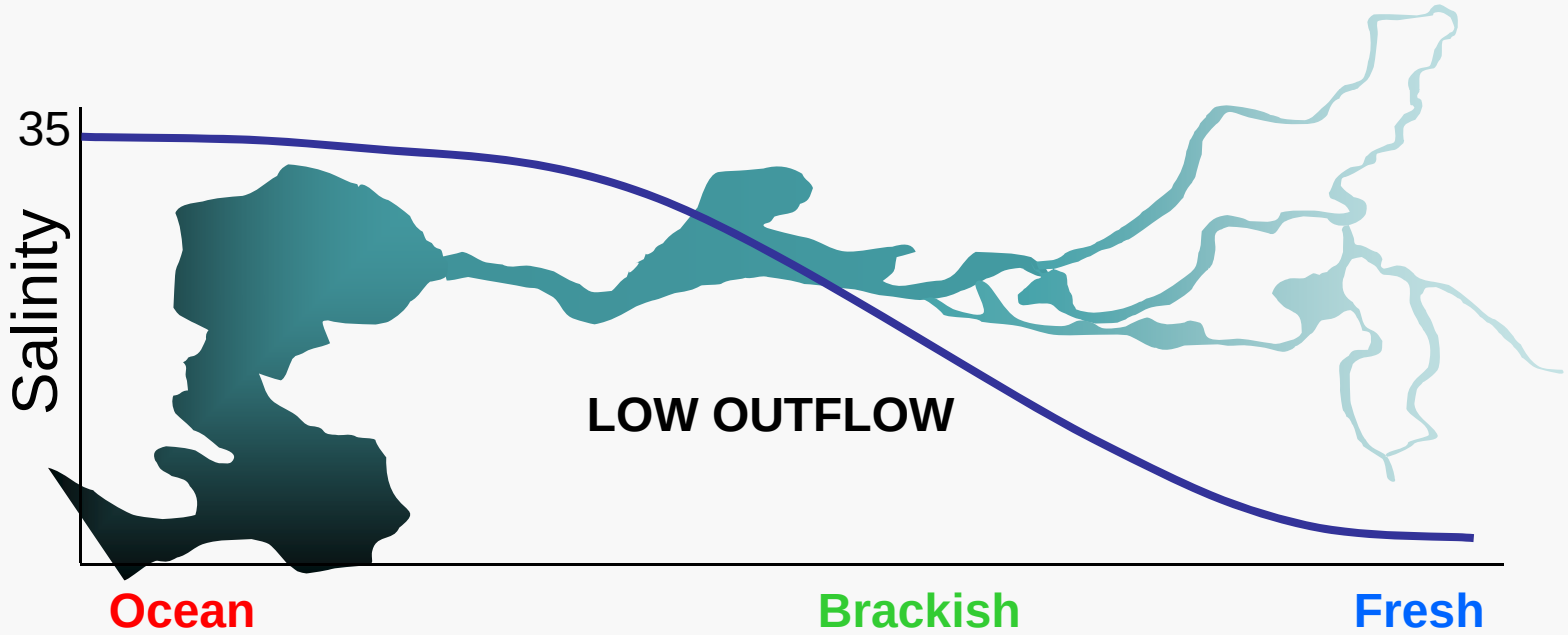
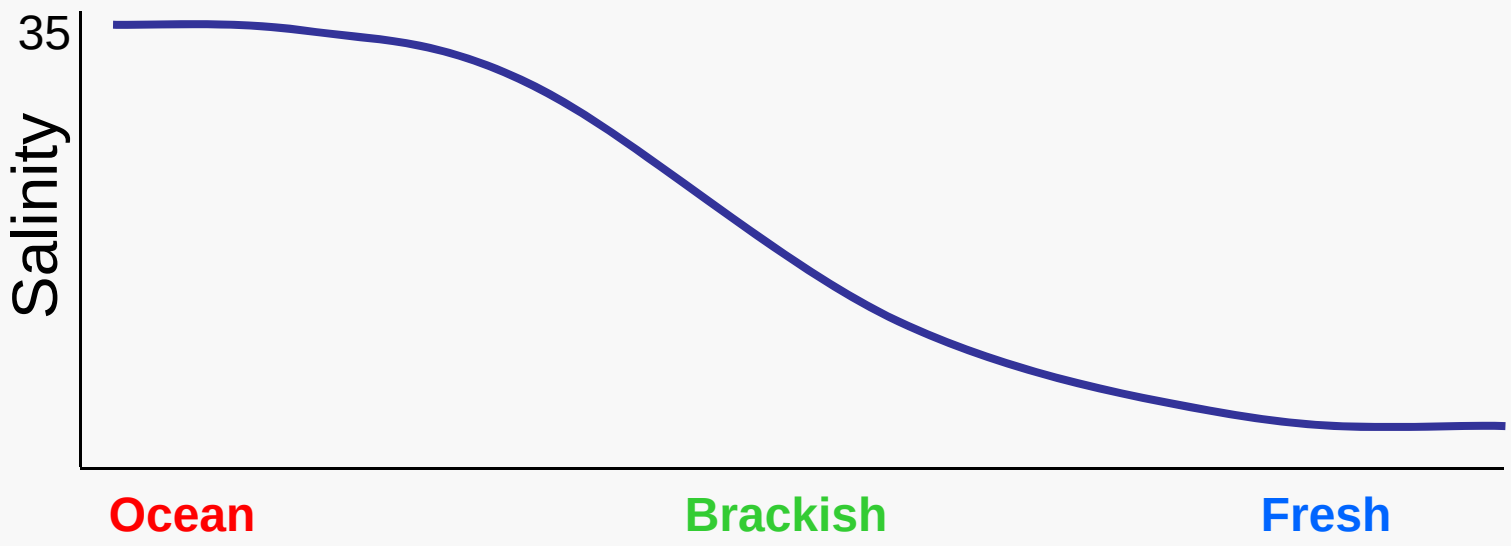


DISPERSION of salt upstream = **ADVECTION** of salt downstream

The salt balance also depends on



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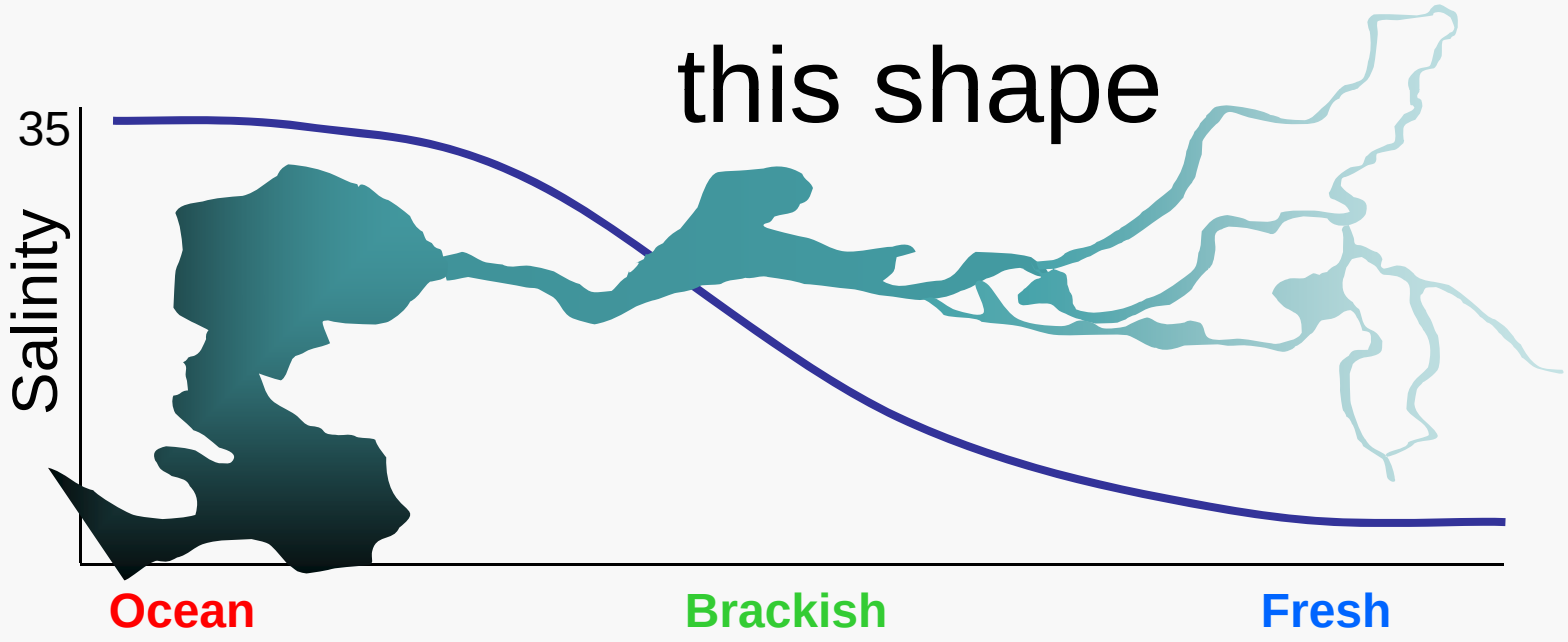

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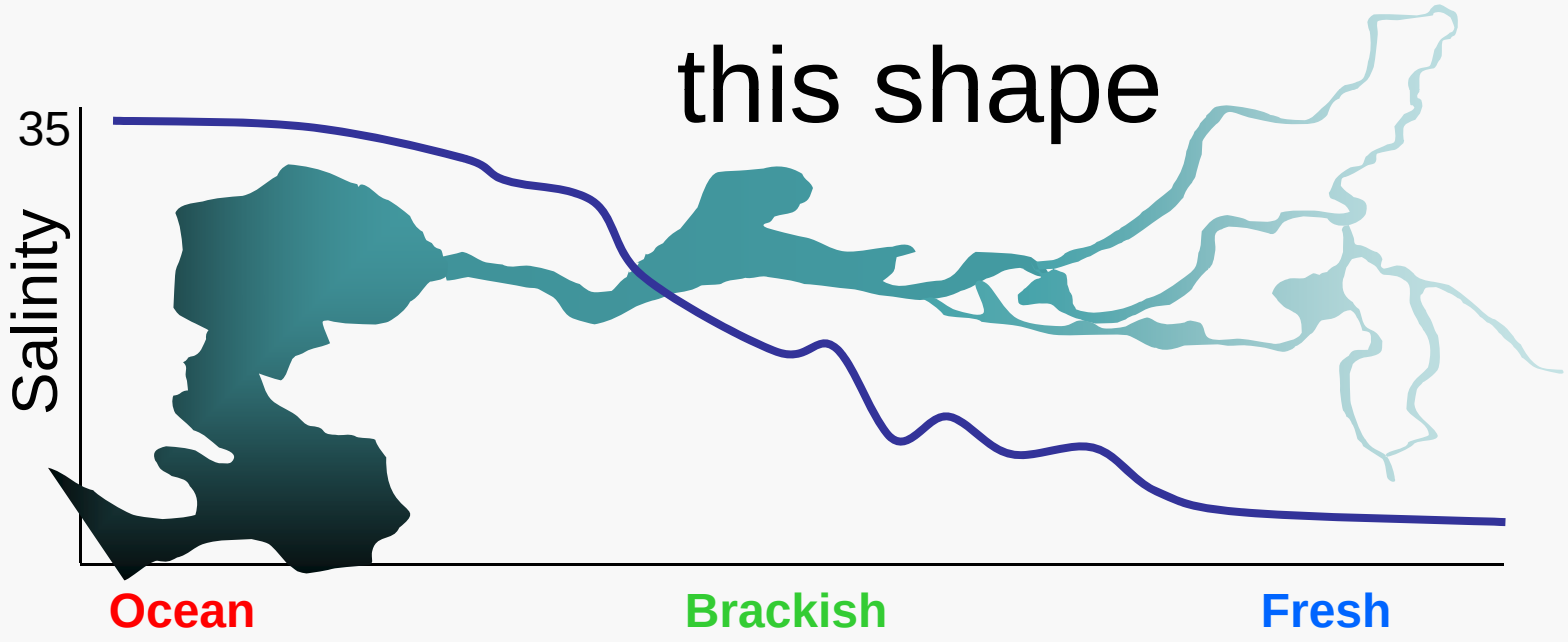
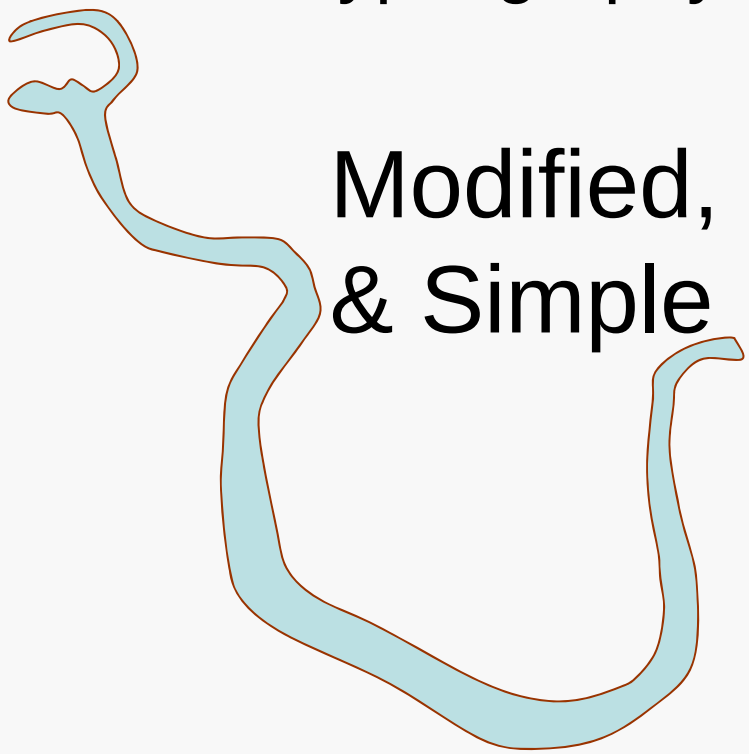


DISPERSION of salt upstream = **ADVECTION** of salt downstream

Scaling down, geometry really matters

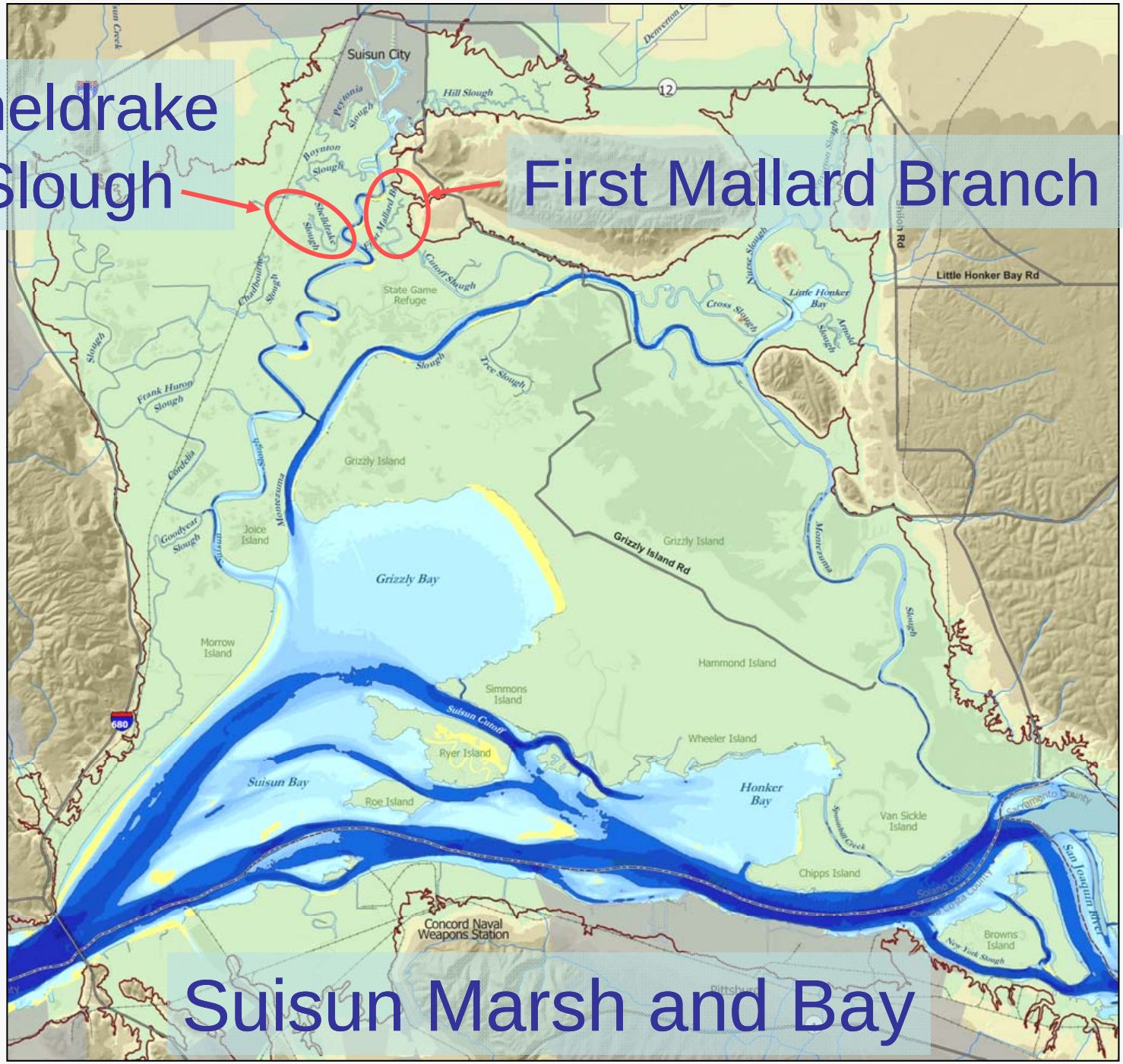
"Geometry"

- Hydro-geomorphology
- Connectivity across scales
- Ratio of tide excursion-to-channel bifurcation
- Hypsography



Sheldrake Slough

First Mallard Branch


Sheldrake Slough
First Mallard Branch
Suisun Marsh and Bay
Suisun City
Hill Slough
Peytonia Slough
Boynton Slough
Sheldrake Slough
First Mallard Br
Cutoff Slough
State Game Refuge
Chadbourne Slough
Frank Huron Slough
Cordelia
Goodyear Slough
Suisun Slough
Montezuma Slough
Tree Slough
Grizzly Island
Joice Island
Grizzly Bay
Morrow Island
Grizzly Island Rd
Little Honker Bay Rd
Little Honker Bay
Cross Slough
Nurse Slough
Arnold Slough
Hammond Island
Simmons Island
Suisun Cutoff
Ryer Island
Wheeler Island
Suisun Bay
Roe Island
Honker Bay
Van Sickle Island
Chipps Island
Concord Naval Weapons Station
Browns Island
New York Slough
San Joaquin River
Sacramento County
Solano County
Contra Costa County
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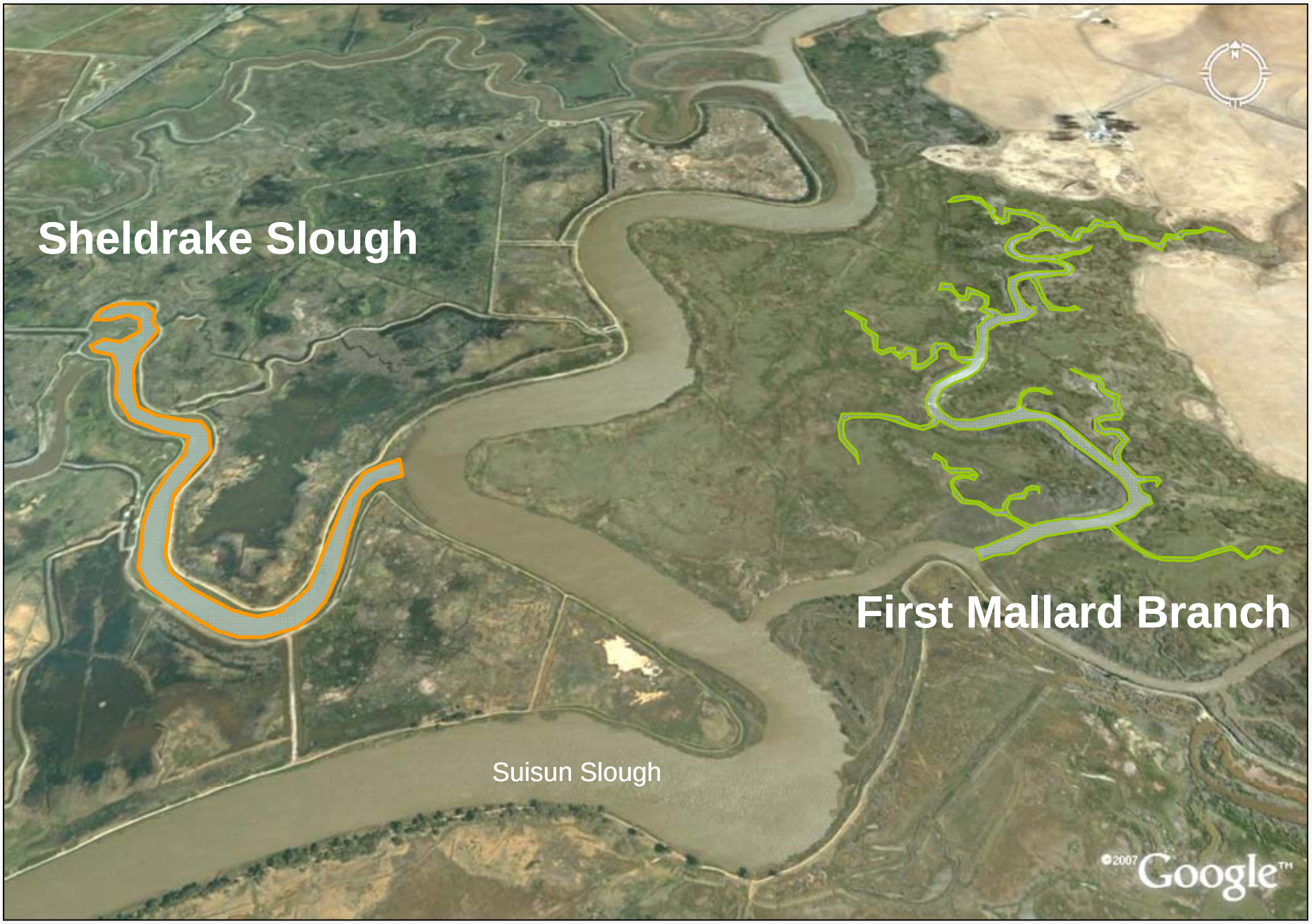
Different Physiography and Land-Water Interface



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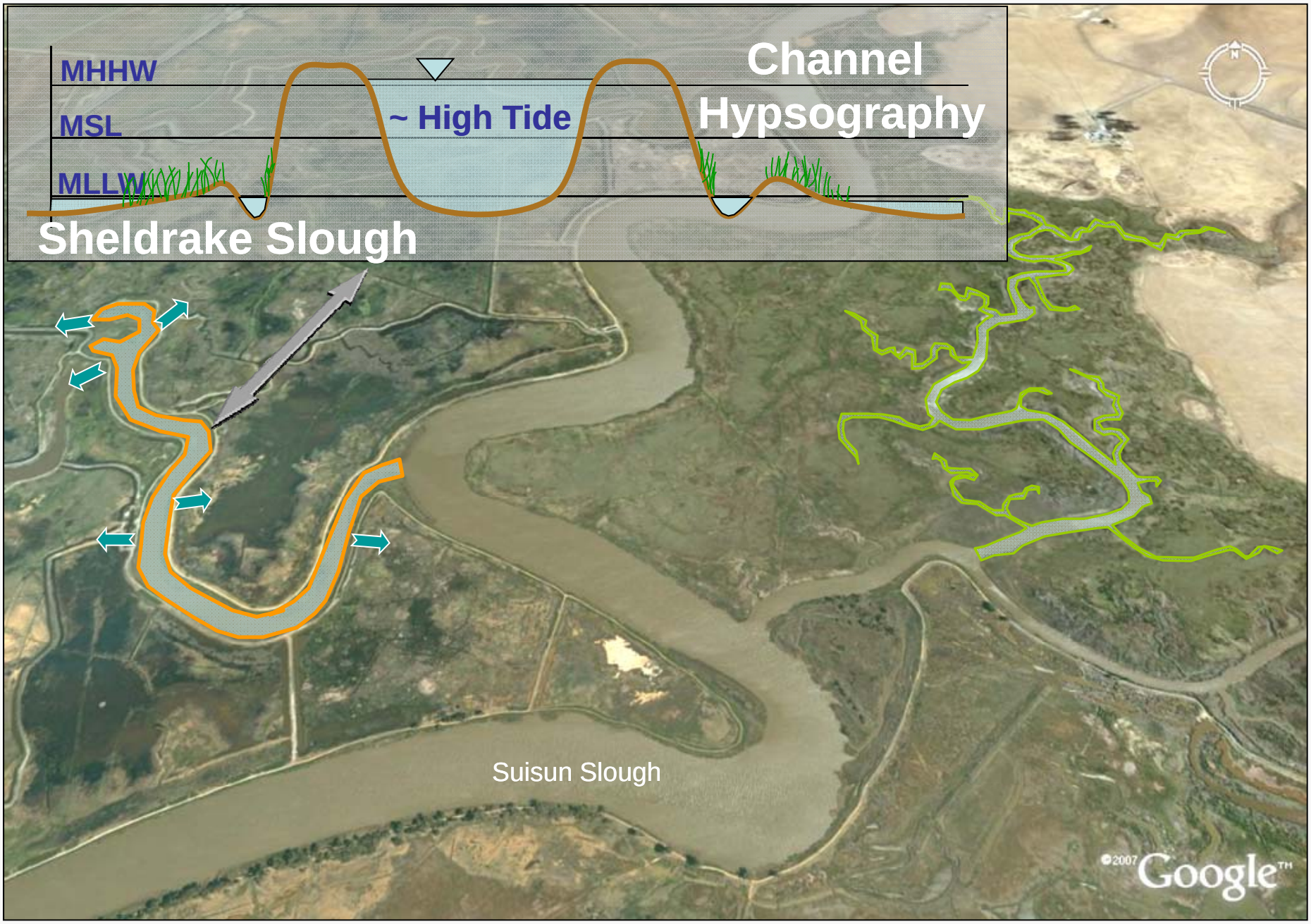

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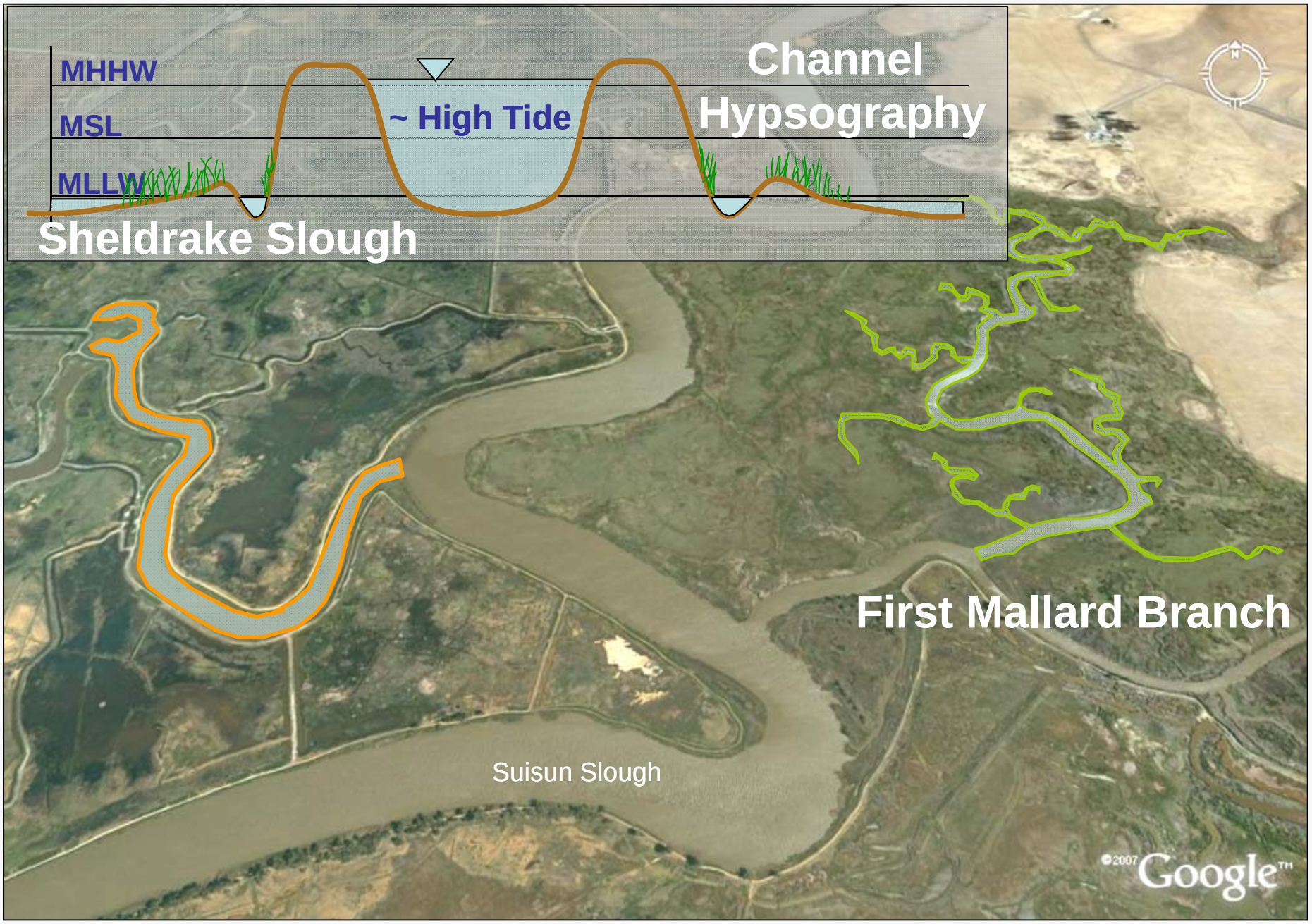

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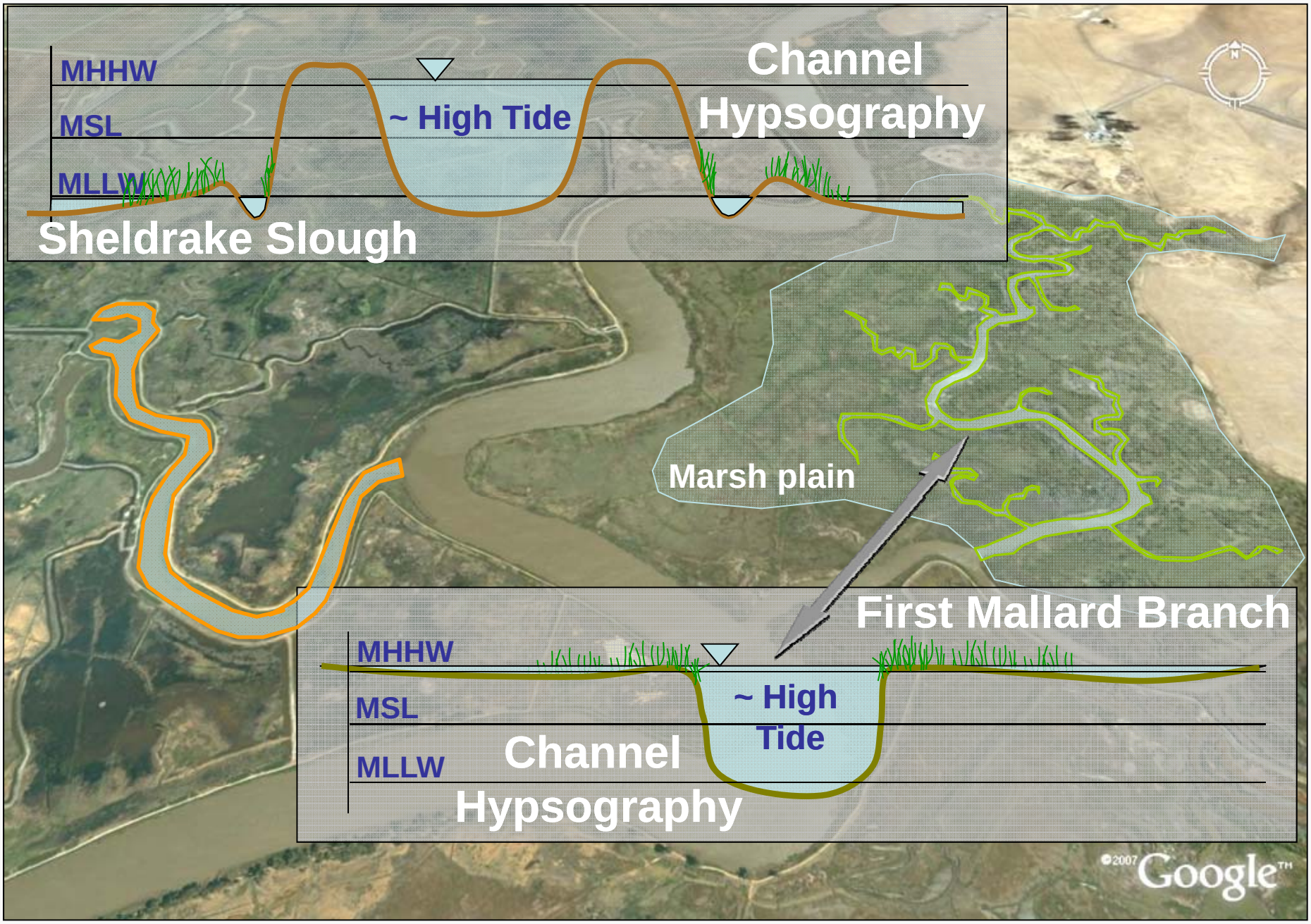

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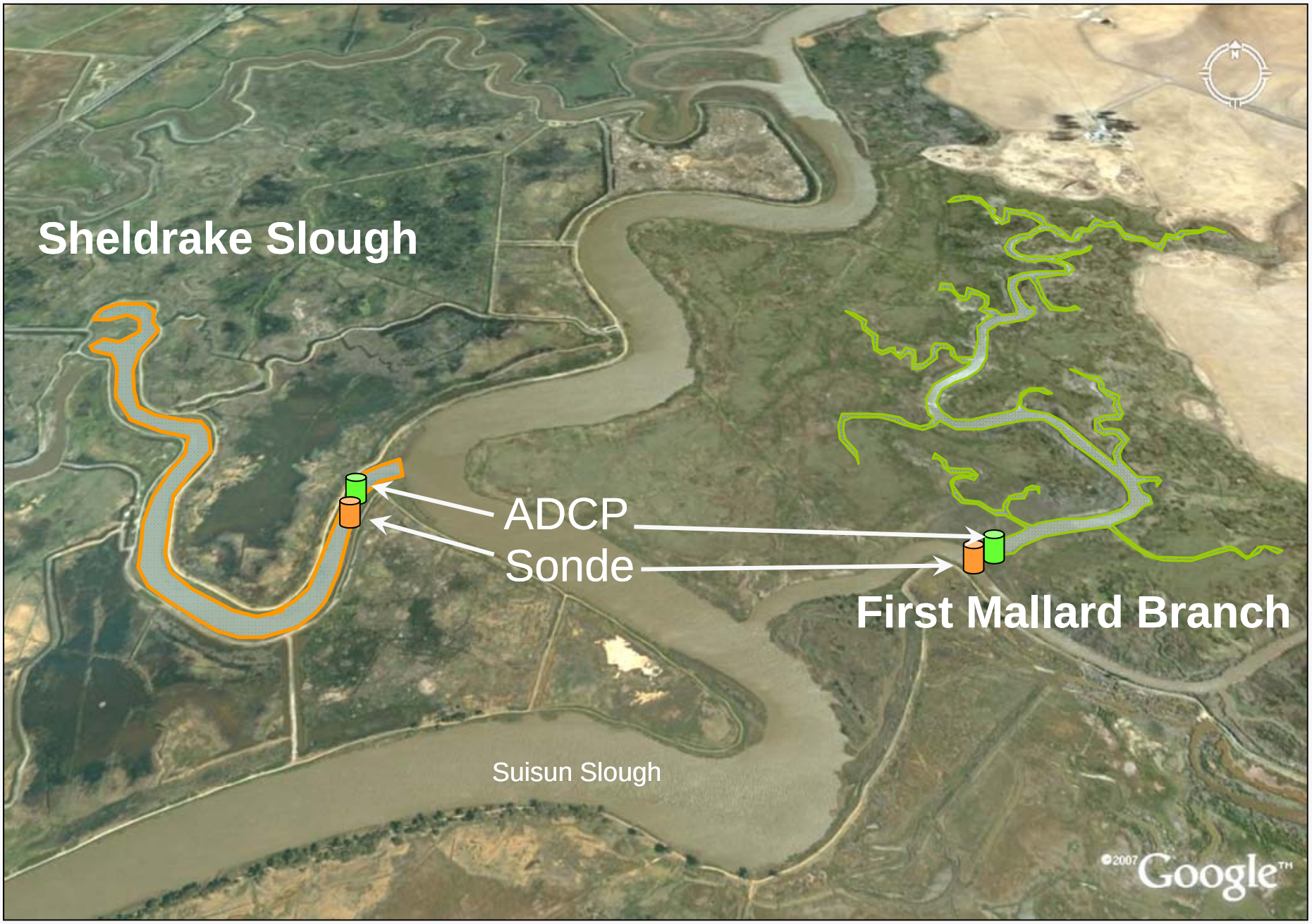
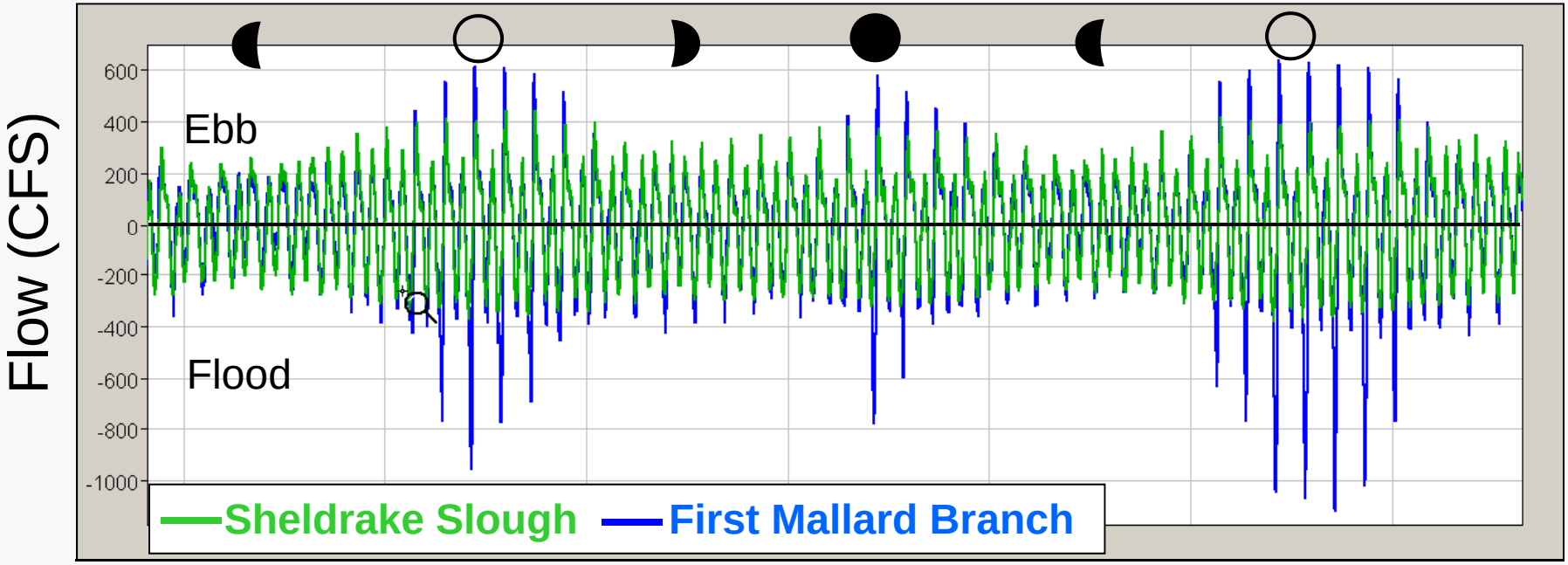
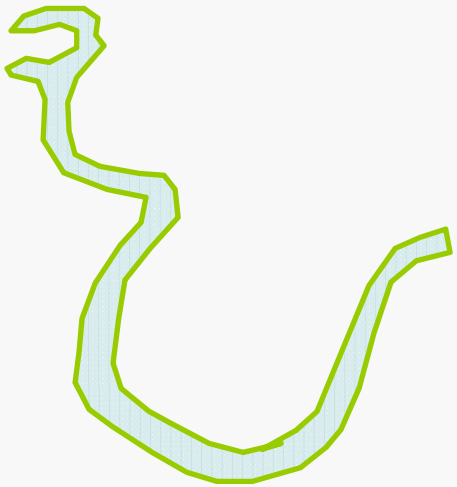
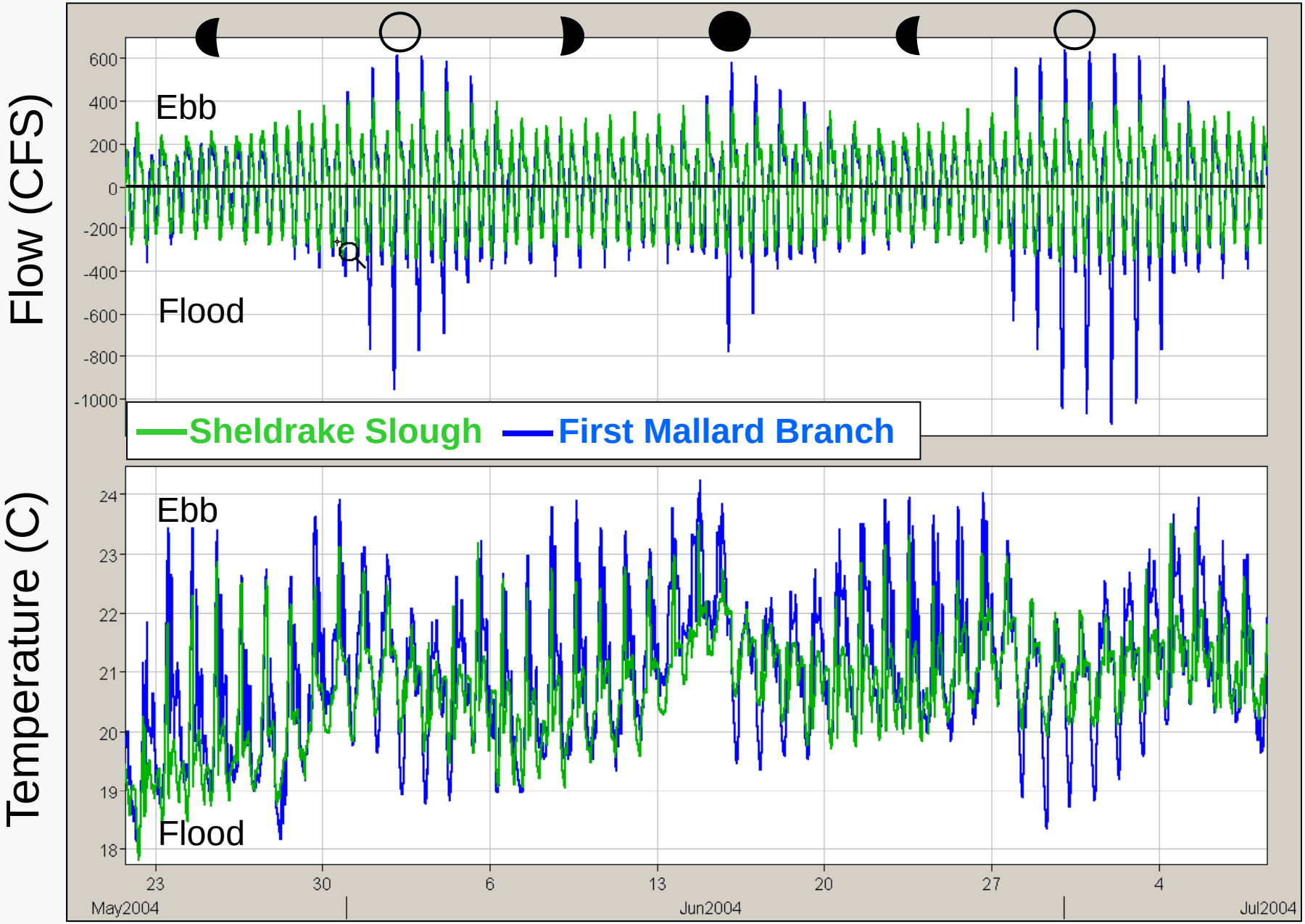


Flow Variability





Flow and Temperature Variability



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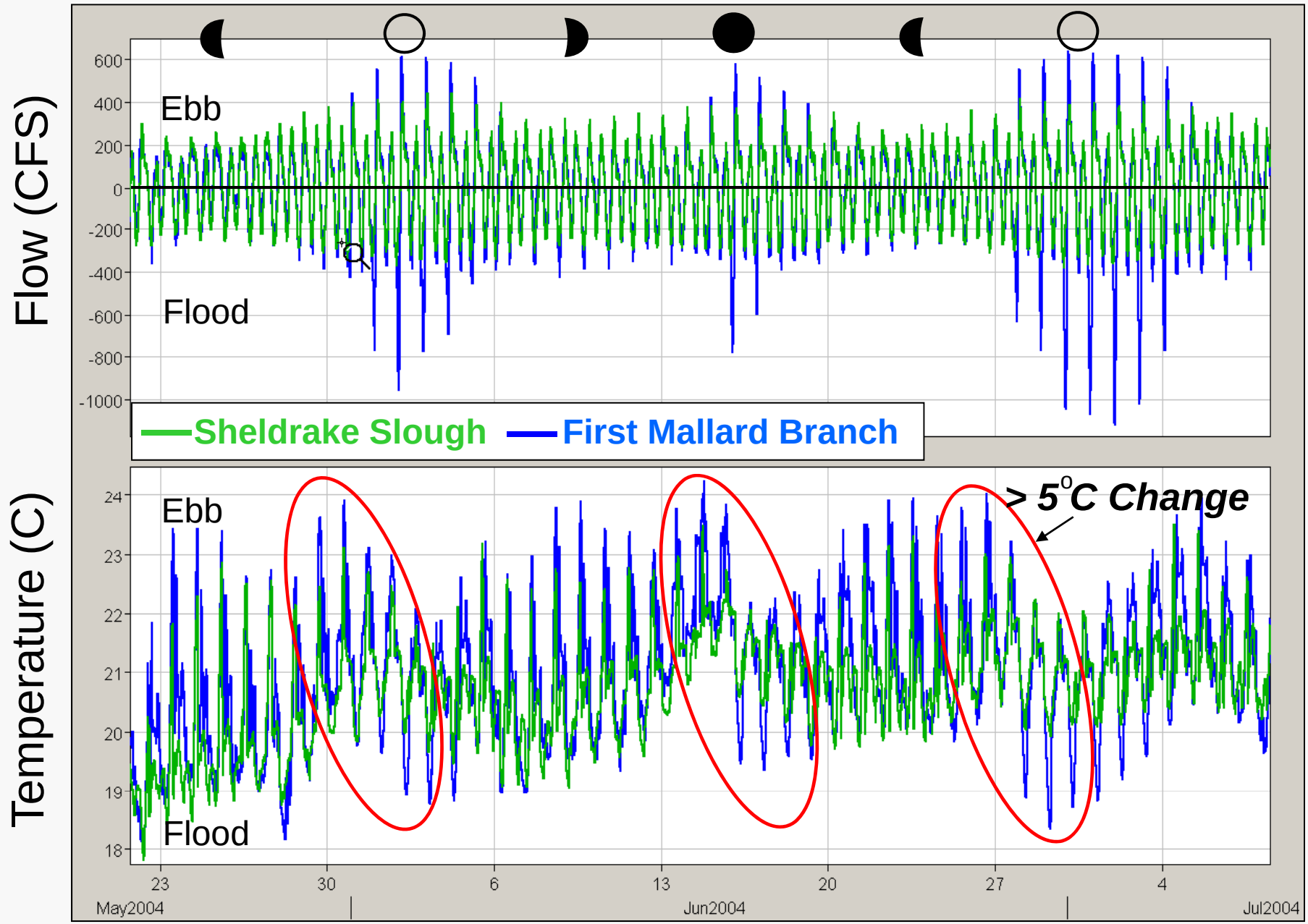

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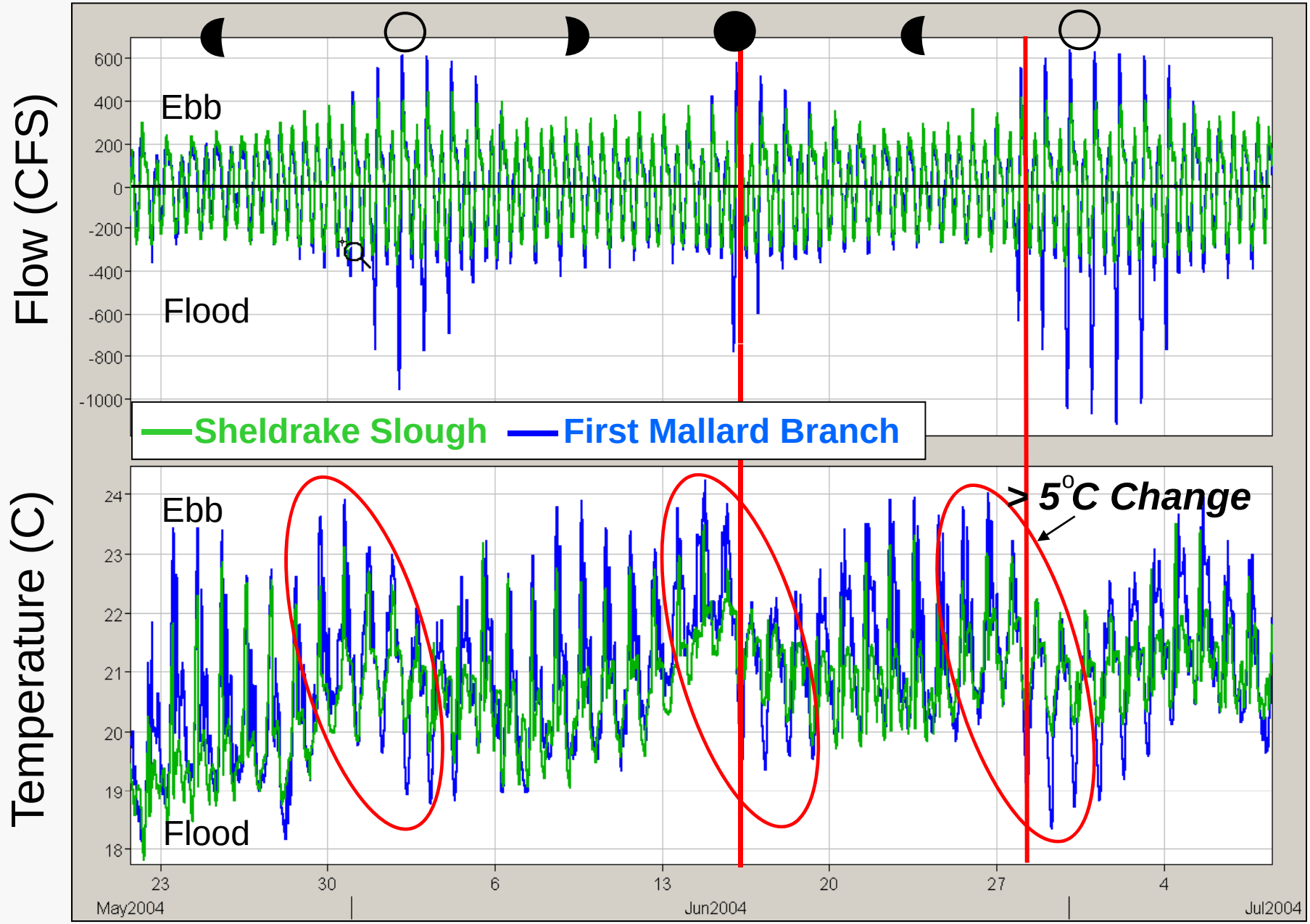

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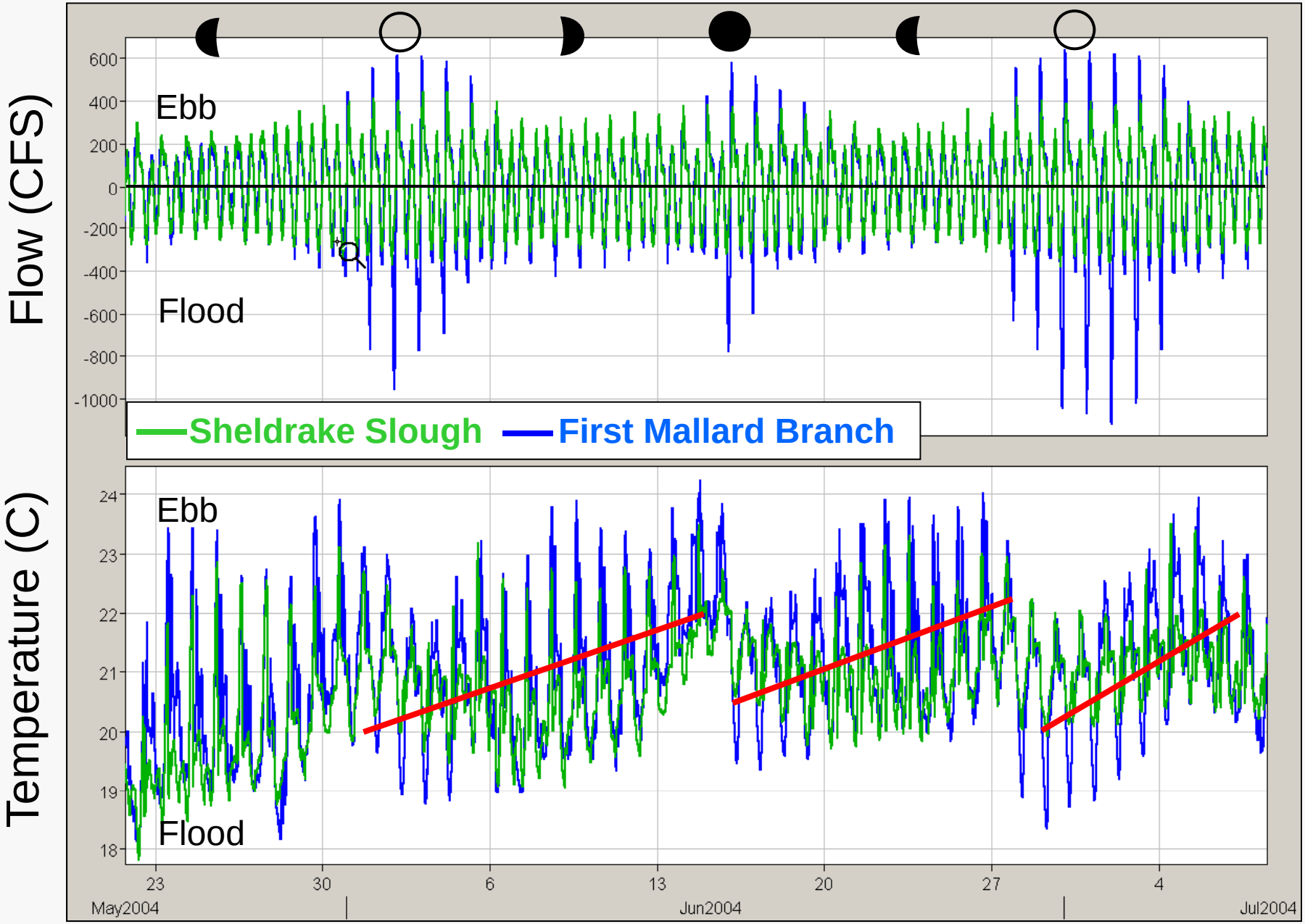
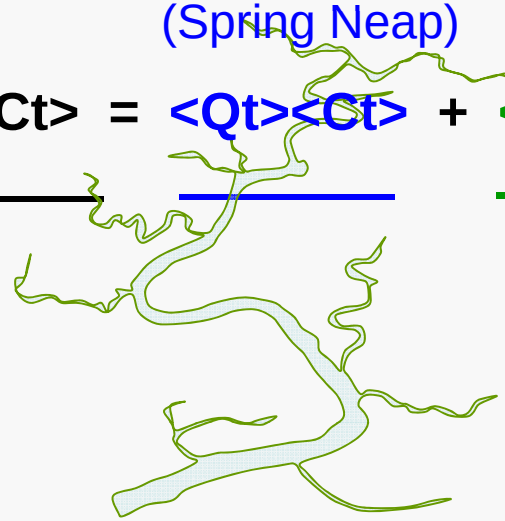
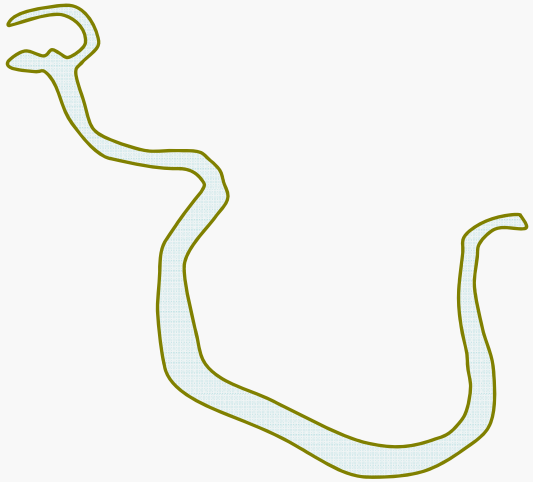


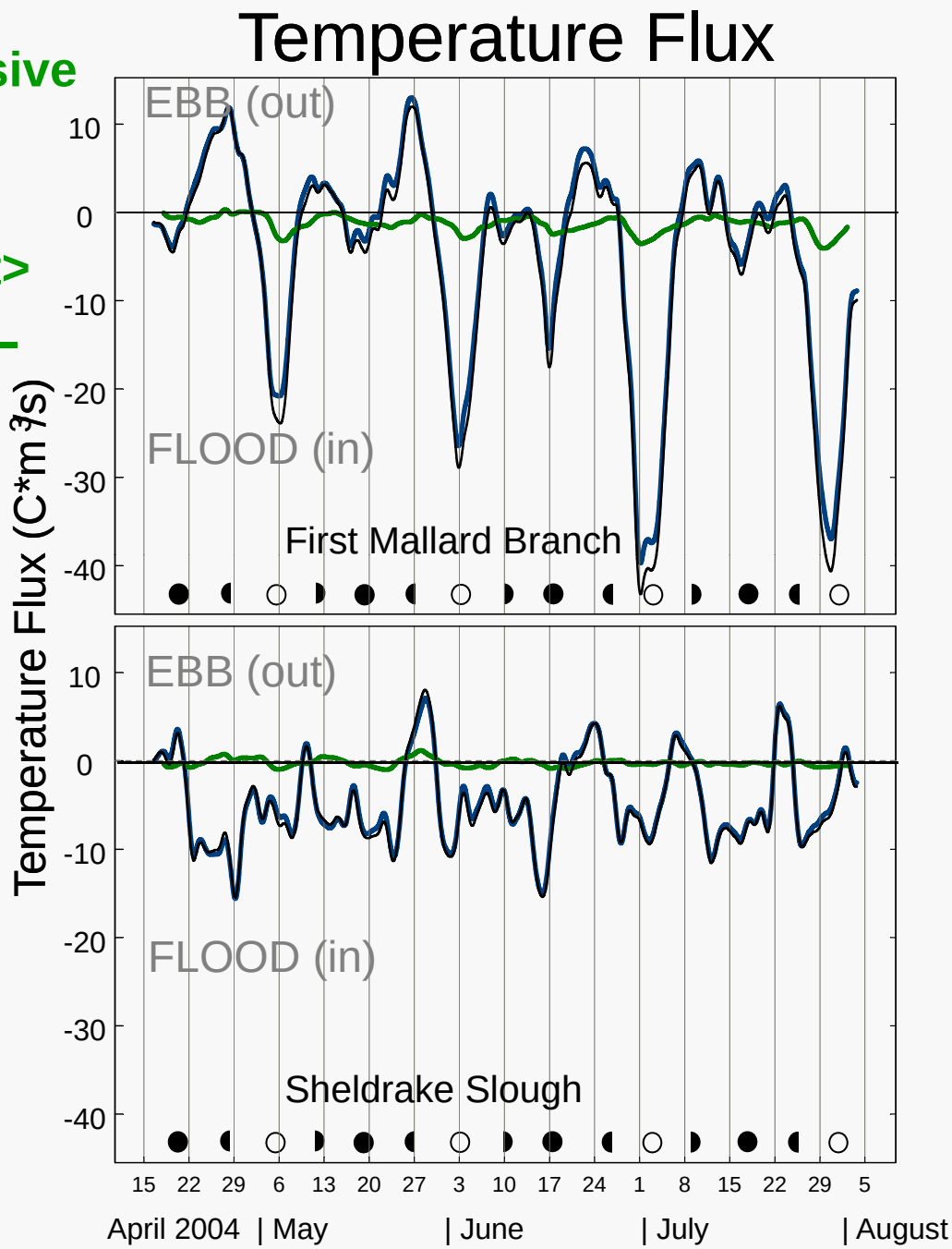
Total Flux = Advective Flux + Dispersive Flux

(Spring Neap) (Tides)

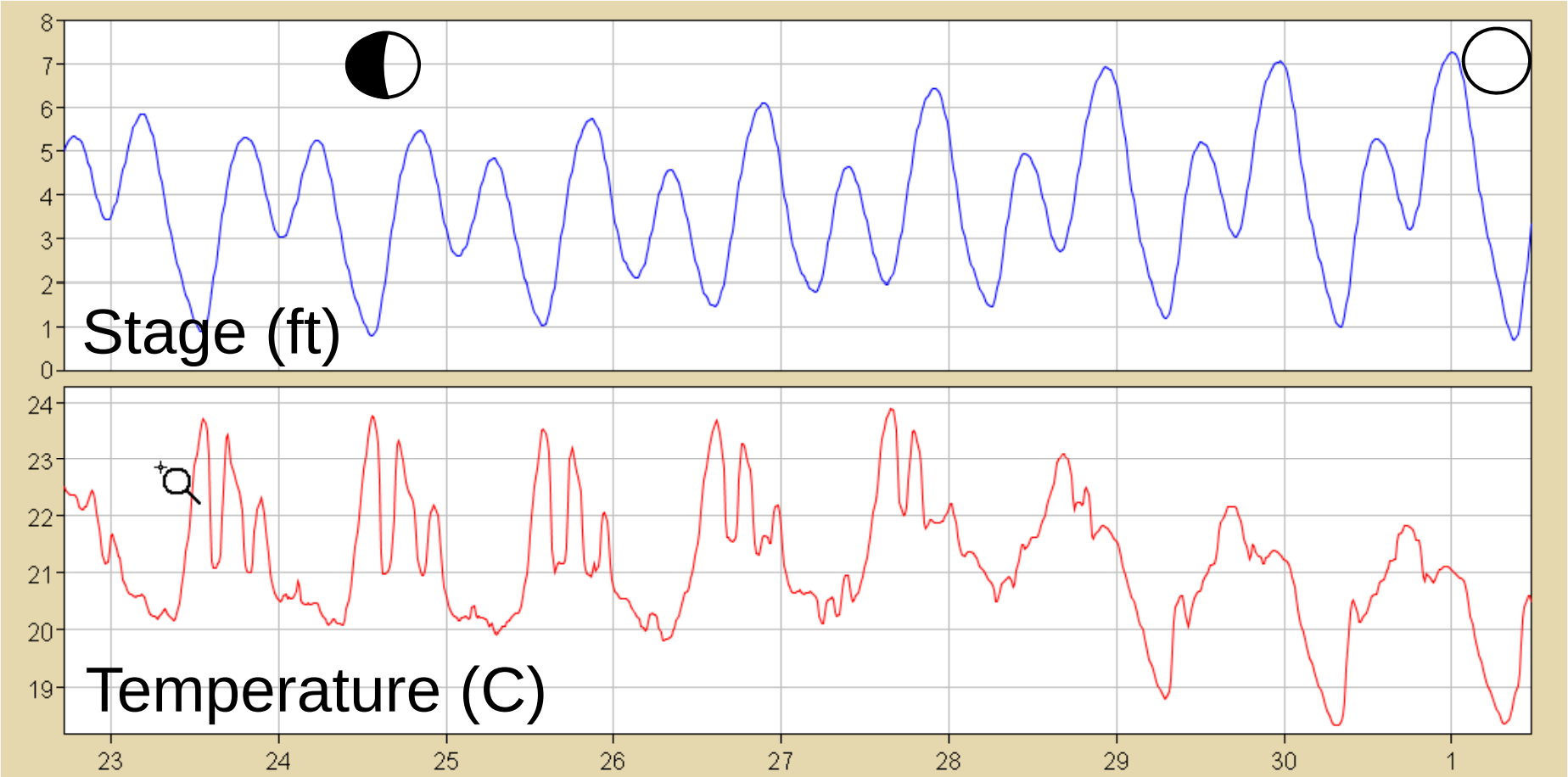
<Qt*Ct> = <Qt><Ct> + <Q't*C't>





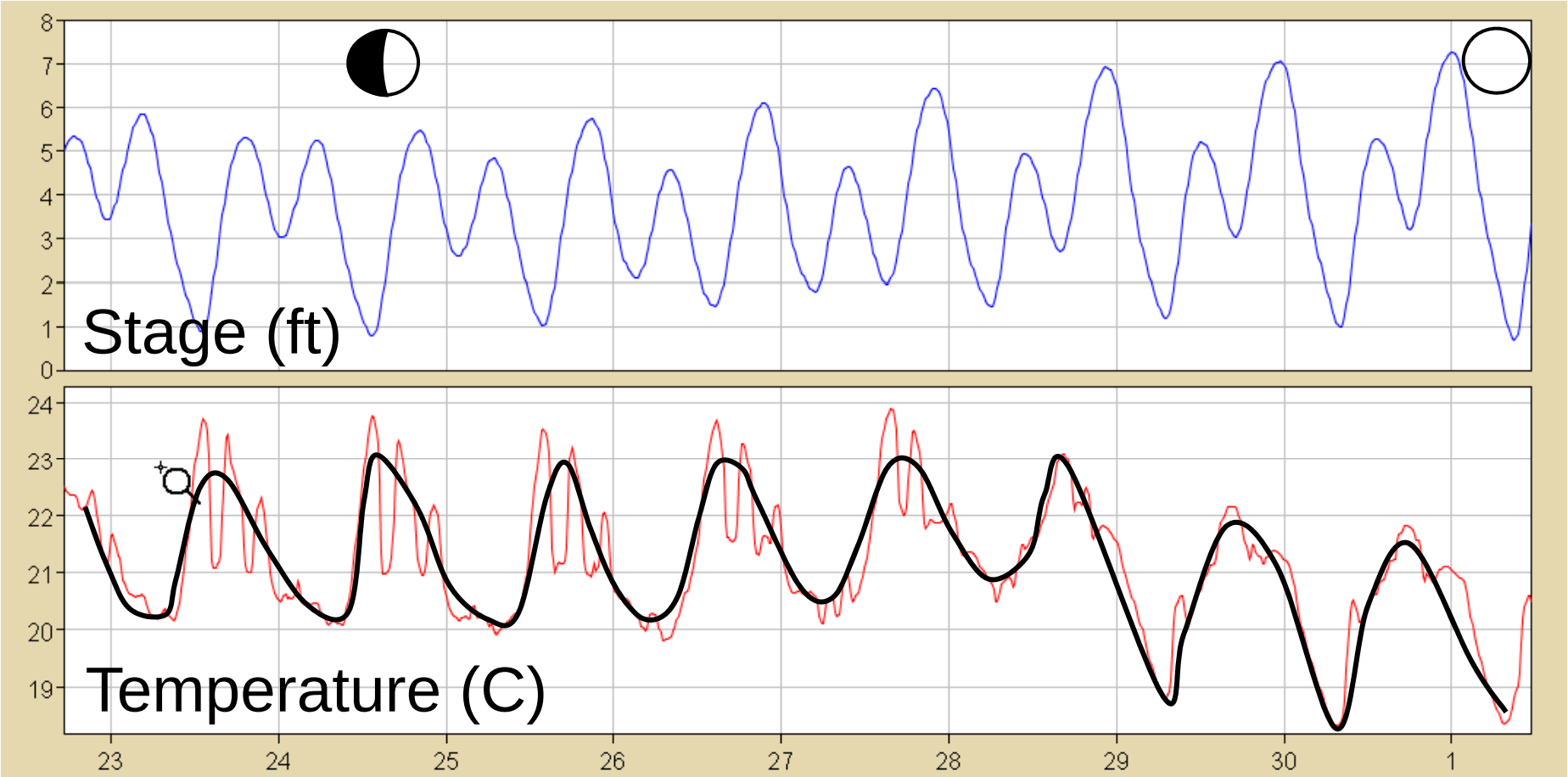


Consider some variability drivers on First Mallard temperature



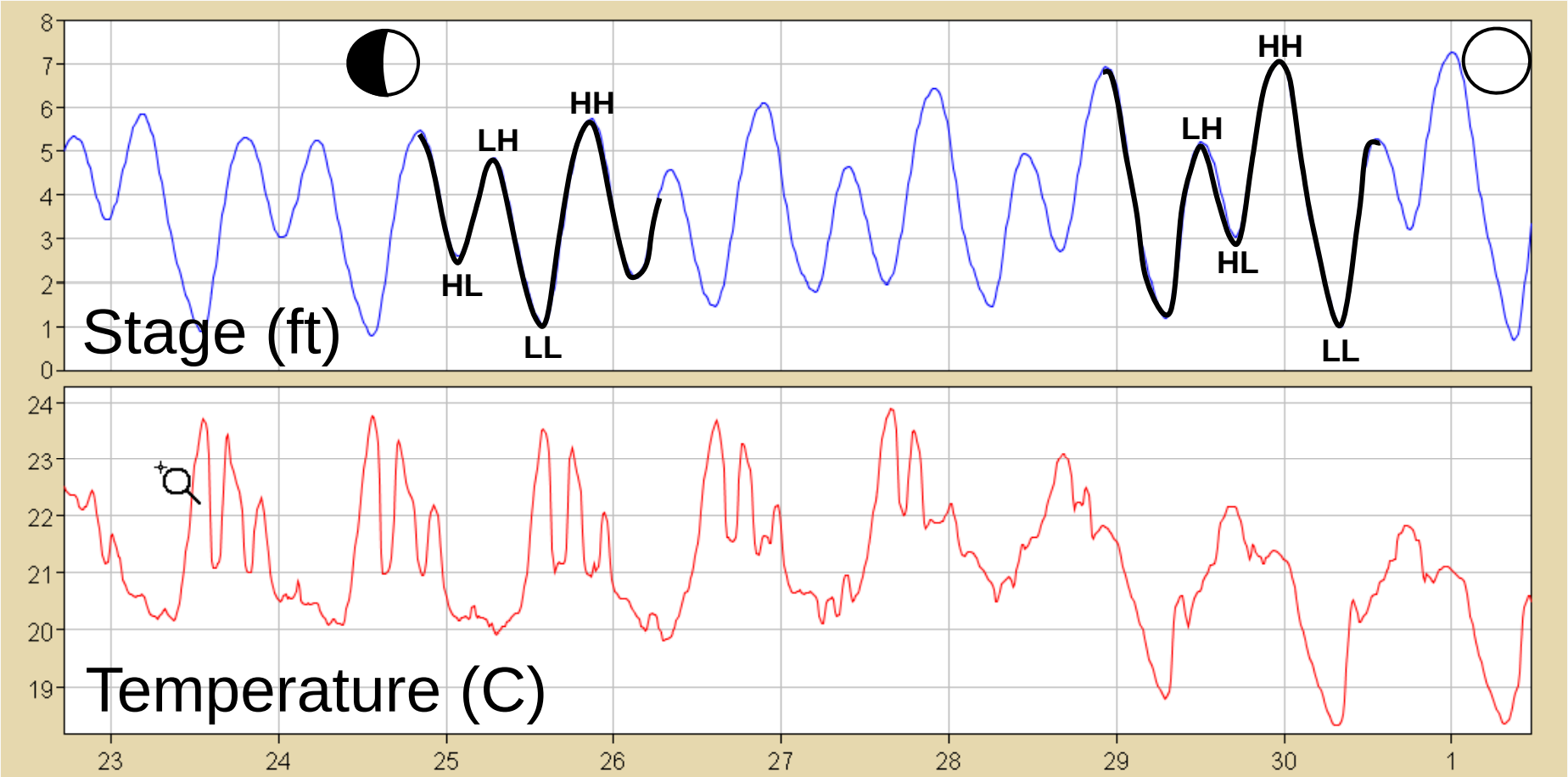
End of June 2004

Variability Drivers: Diel heating/cooling



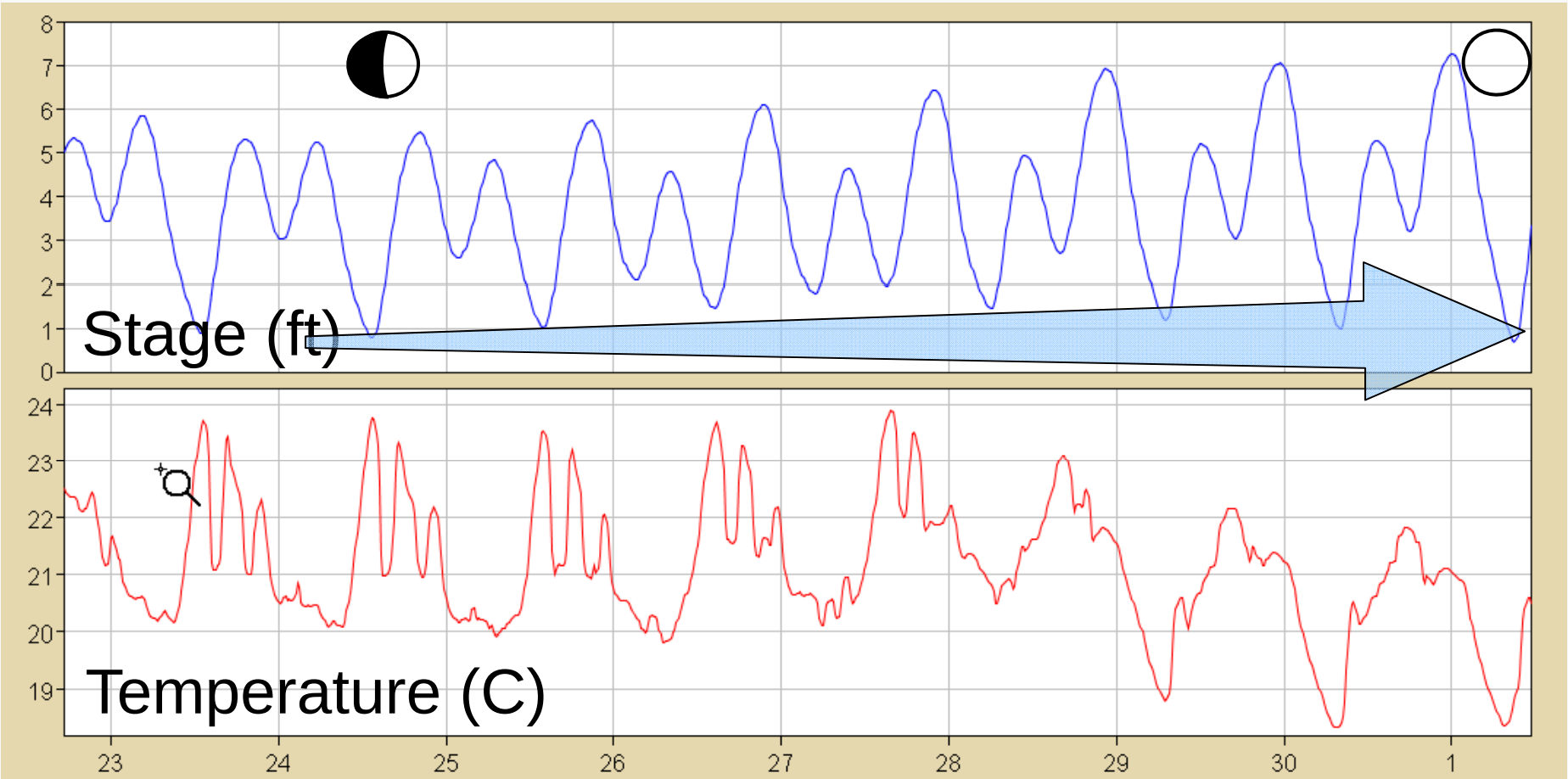
End of June 2004

Variability Drivers: Mixed semi-diurnal tidal asymmetry



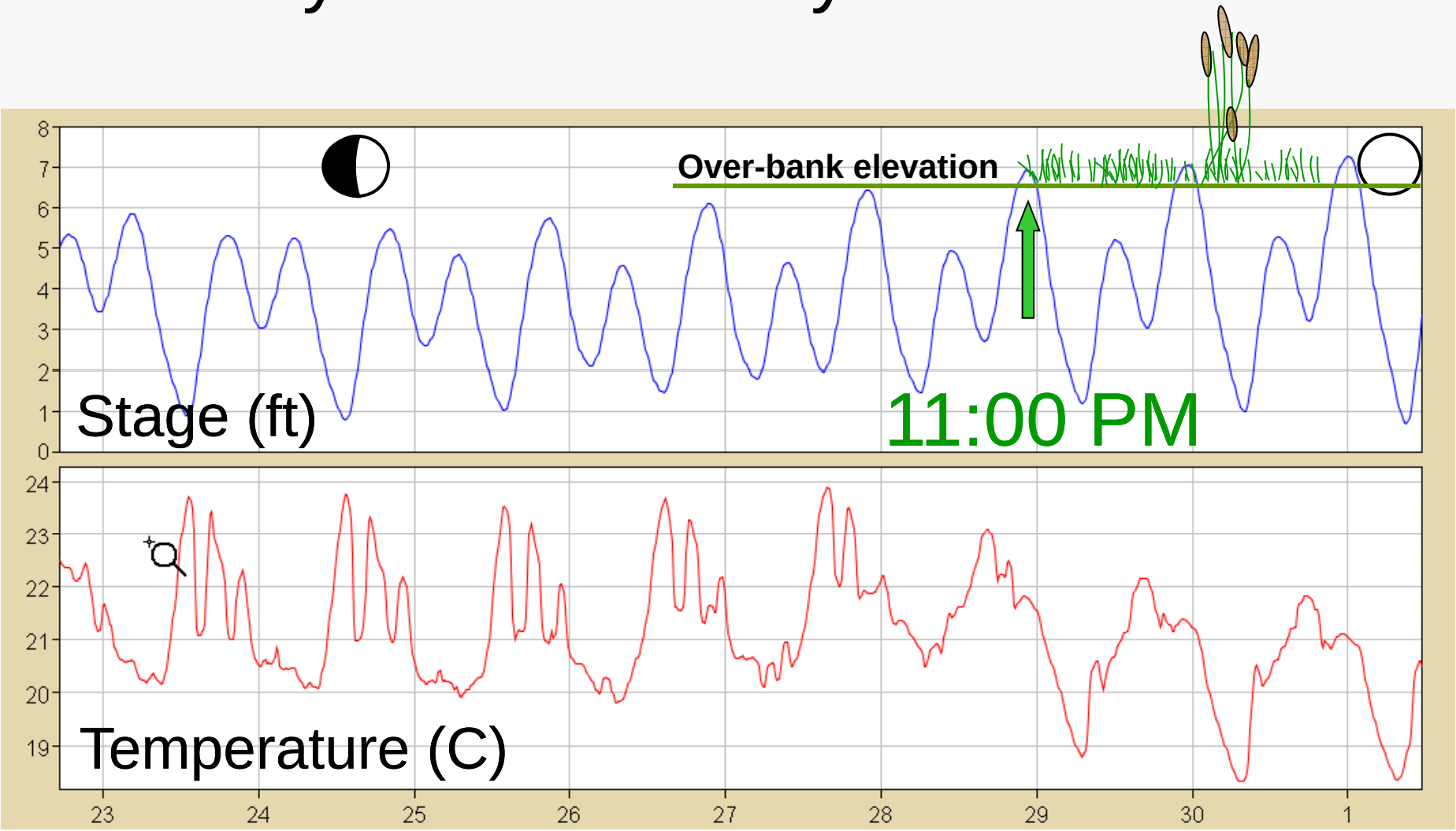
End of June 2004

Variability Drivers: Tide strength



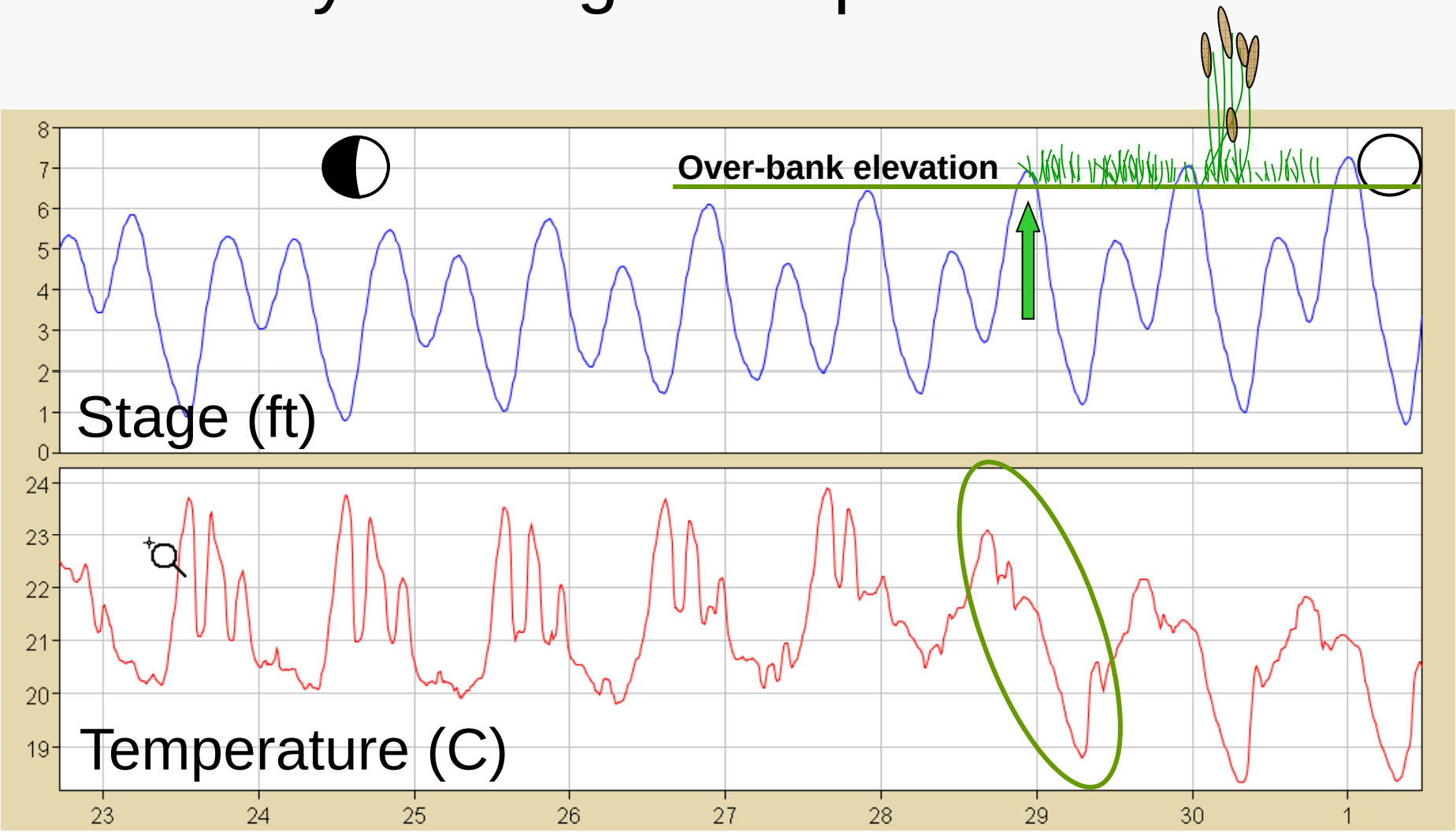
End of June 2004

Variability Drivers: 335 yr HT Precession



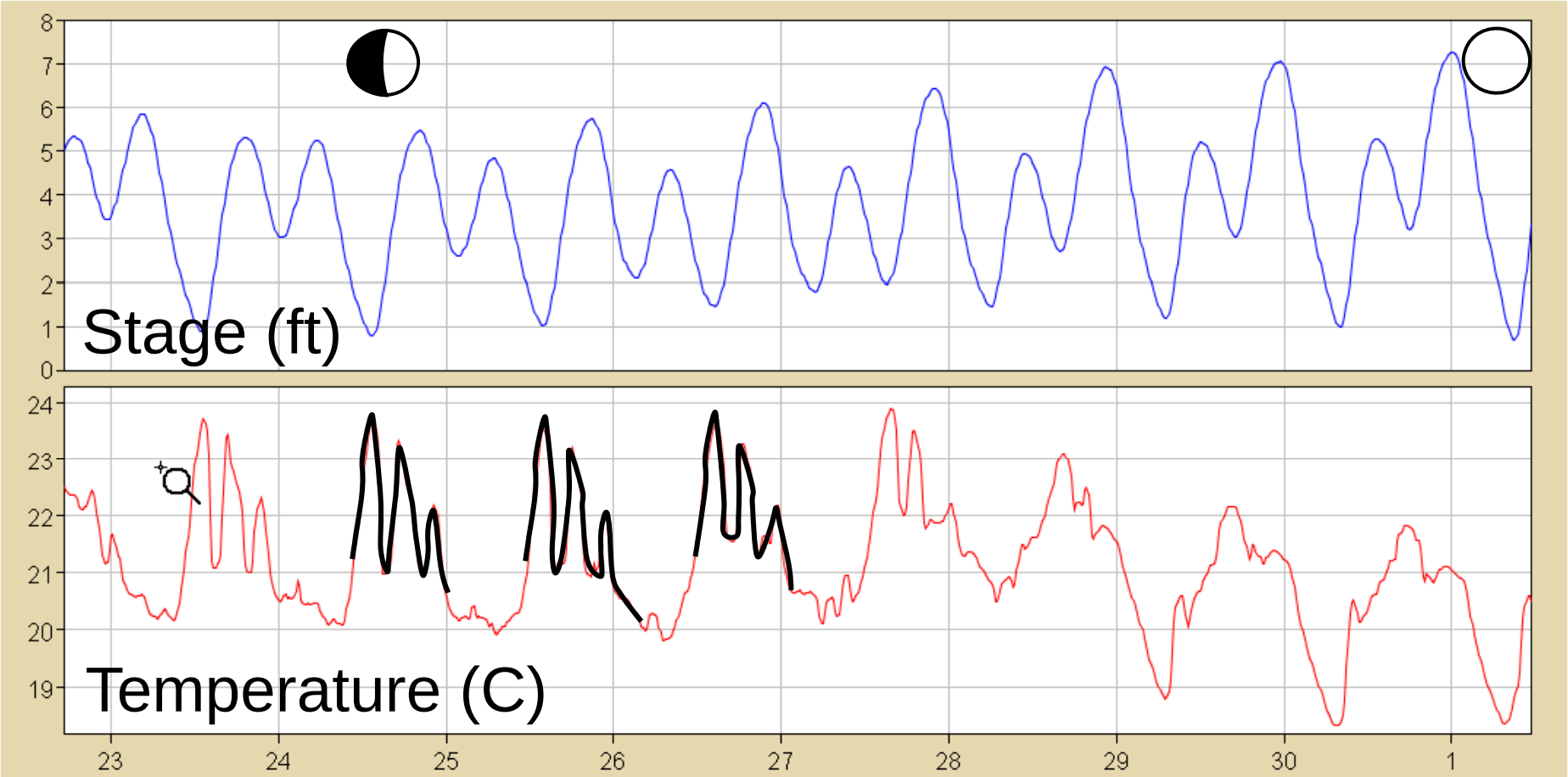
End of June 2004

Geometry filter: geomorphic thresholds



End of June 2004

Geometry filter: slough connectivity and tidal excursion



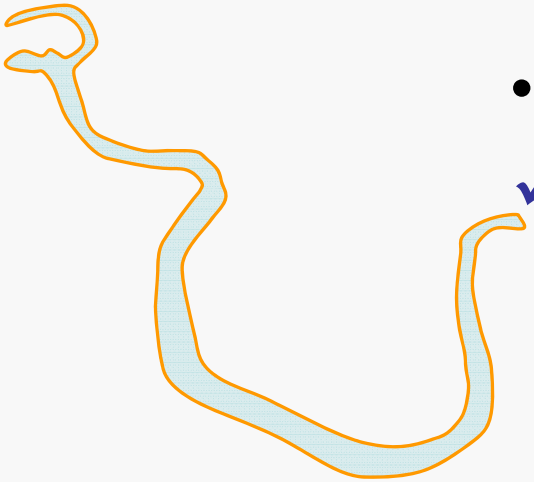
End of June 2004

Connectivity lost:
Tidal creeks systems are now “Lakes”

Key ideas

- Estuaries generate variability by interaction of physical drivers and “geometry as filter” at the land-water-air interface.
- Geometry filters drivers at all time scales
- Natural tidal creek systems have more complex land-water-air interfaces
- More complex geometry begets more variable gradient response.
- The “why does variability matter?” corollary:

✓ Native plants/fishes evolved in a more variable environment.



Thank you

- Steve Culberson
- Jon Burau
- Paul Massera
- Brad Tom
- Kate Le
- Terri Fong

Additional slides