2017

Interactions between channel geometry, tidal flow, and water quality in Damariscotta Estuary (3.4b)

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SEANET

Changing Environment Theme

Introduction

Project goals:

- Gain a better understanding of how tides transport material and influence water quality important to aquaculture in the Damariscotta Estuary.
- Provide considerations for future aquaculture by predicting how present day conditions will alter from environmental changes.

Research objectives:

1. Characterize tidal behavior throughout estuary
2. Investigate how tides affect water quality
3. Determine how a storm event will change those water quality patterns

The dynamics of the estuary are governed by several interacting physical systems, and this project studies the influences from **morphology**, to **hydrodynamics**, to **biochemistry**, from analytical and statistical perspectives.

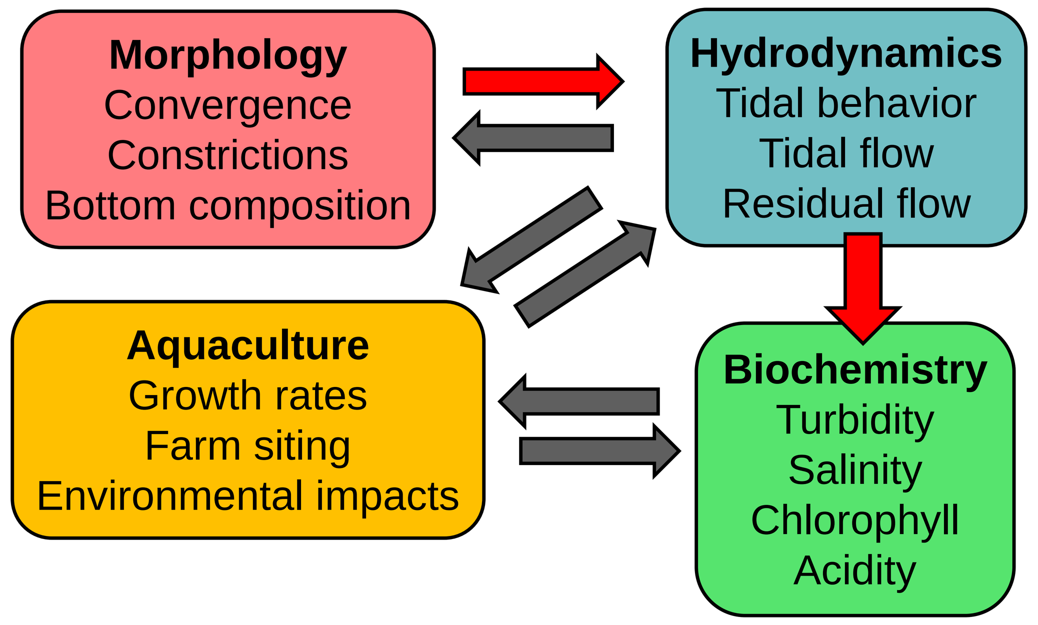


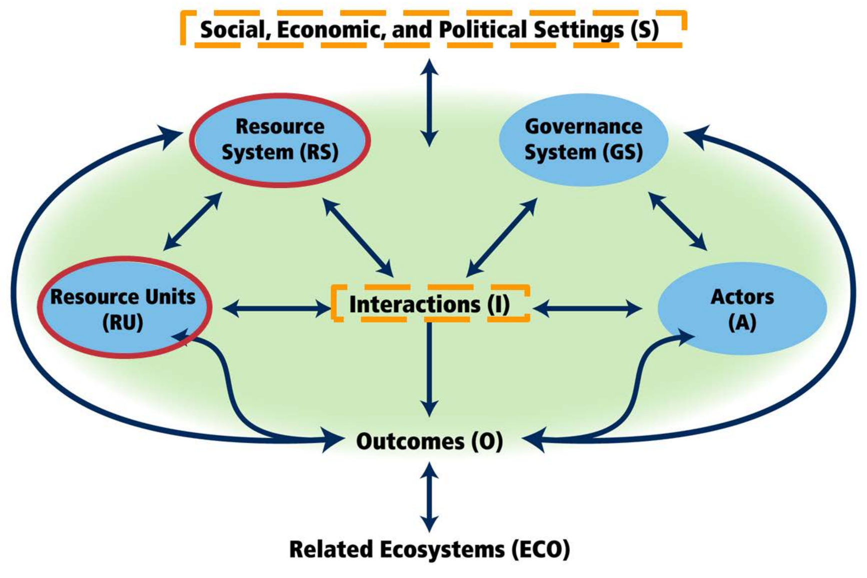
Figure 1: The mechanisms that govern the dynamics of an estuary and its relevance to aquaculture health.

SES Framework

RS5: Productivity of system
RS7: Predictability of system dynamics
RU1: Resource unit mobility
RU7: Spatial and temporal distribution

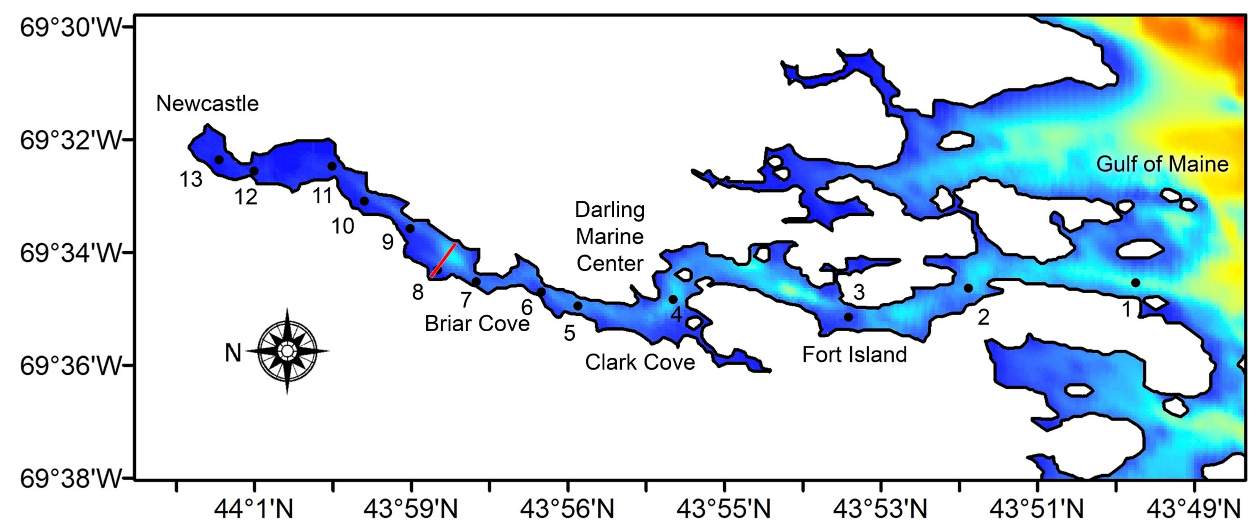
Implications for or Relevance to:

S1: Economic development
O1: Ecological performance measures



Data Collection

- Water level loggers deployed at thirteen sites from July to November of 2016.
- Two LOBO buoys and the Outer buoy were used for surface current and water quality data.
- During neap and spring tide in September 2016, transect data was collected over a cross-section just north of Glidden Ledges, and CTD data was collected at four stations across the estuary.



	Location	Distance (km)	Data Collected
1	Coast	0	Tides, Currents, Water Quality
2	South Bristol	4.4	Tides
3	Fort Island	7.1	Tides
4	Clark Cove	11.5	Tides, Currents, Water Quality
5	Salt Marsh Cove	13.7	Tides
6	Mears Cove	14.7	Tides
7	Briar Cove	16.5	Tides
8	Dodge Lower Cove	17.4	Tides, Transects
9	Wiley Cove	18.8	Tides
10	Dodge Upper Cove	20.1	Tides
11	Hog Island	21.4	Tides, Currents, Water Quality
12	Dino Peninsula	23.3	Tides
13	Newcastle	24.1	Tides

Figure 2: Map of the Damariscotta Estuary, with sampling sites marked.

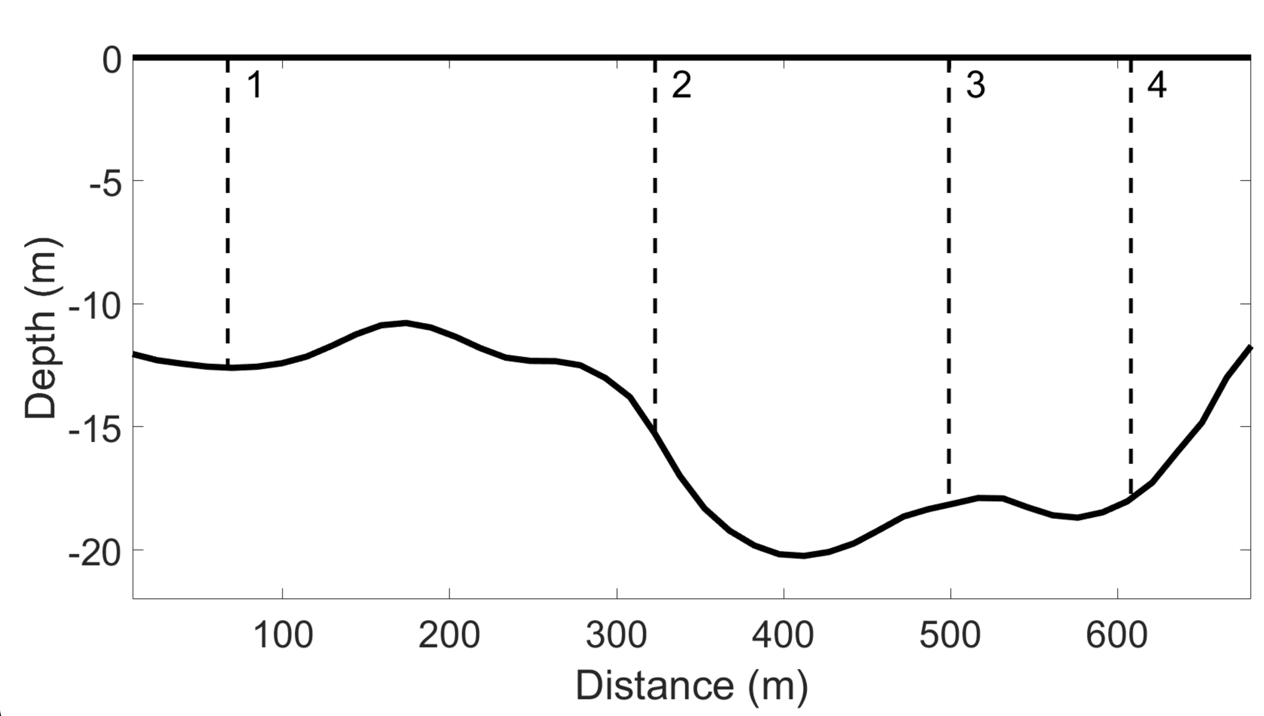


Figure 3: MicroCTD stations across estuary near Dodge Cove

Results

- Tides are **semi-diurnally dominant**, with strong diurnal and spring/neap components.
- **M4 and M6 overtides** are apparent north of Fort Island

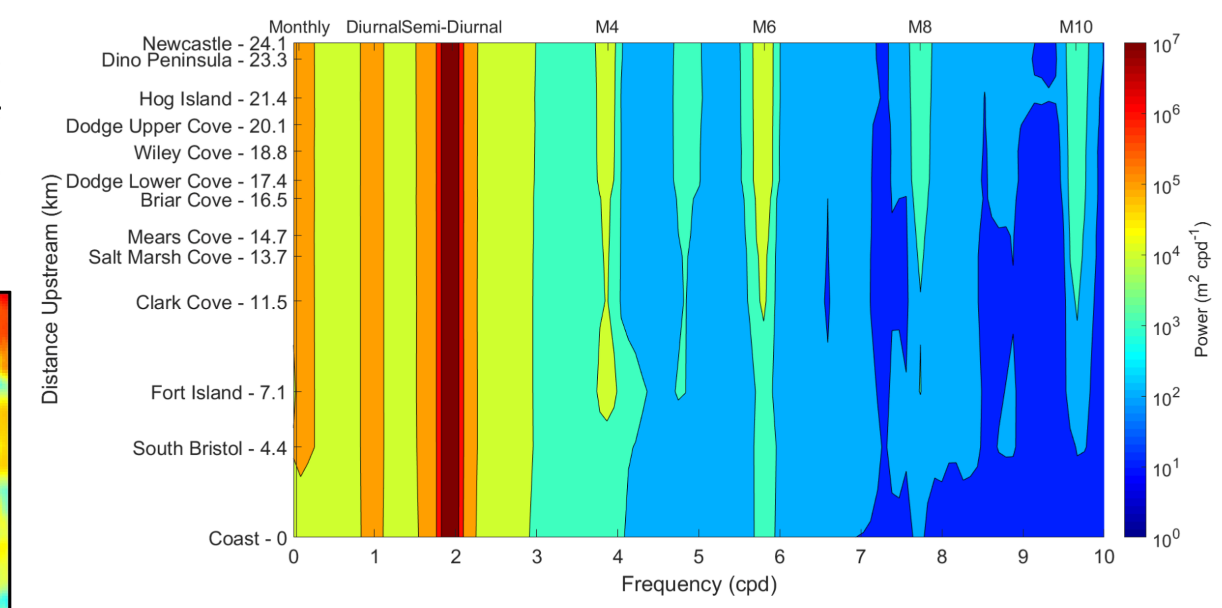


Figure 4: Water elevation power spectral density contour plot

- Overtides amplify upstream due to converging estuary, with stronger spikes near constrictions
- Phase differences between M2, M4, and M6 tides cause the estuary to be **ebb dominant** north of Clark Cove

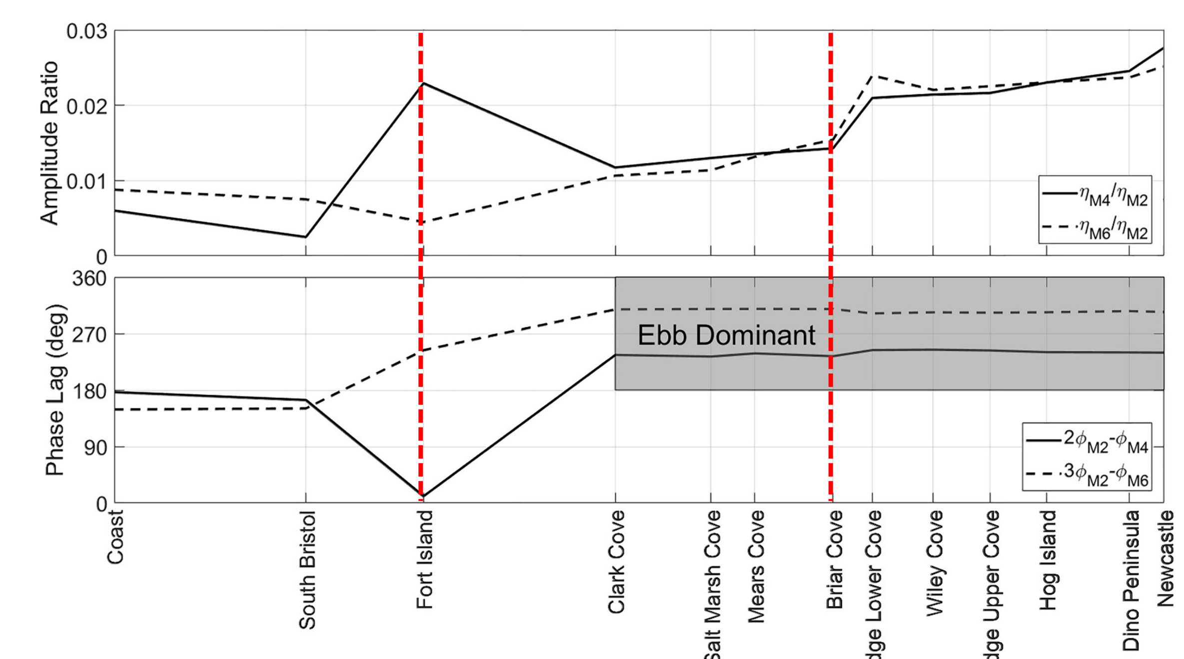


Figure 5: Overtide amplitudes and phases, relative to M2, along the estuary

- Turbidity and other water quality metrics show extremely strong quarter-diurnal and spring/neap variance

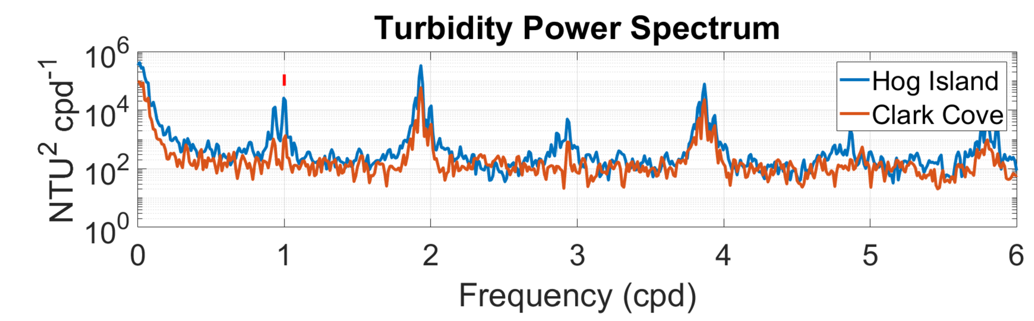


Figure 6: Turbidity power spectrum at Hog Island and Clark Cove

Conclusions

- Irregular bathymetry and multiple constrictions contribute to amplification and phase lag of overtides upriver
- These overtides, although small in magnitude, have important effects on water quality and material transport relevant to aquaculture

Next Steps

- Observing cross-sectional data to find links between currents, eddy viscosity, and turbidity
- We are determining that overtides are caused by **lateral circulation** near the surface and **bottom friction** near the bottom
- Understanding links between eddy viscosity, vertical turbulent momentum flux, and turbidity will uncover connections between overtides and water quality

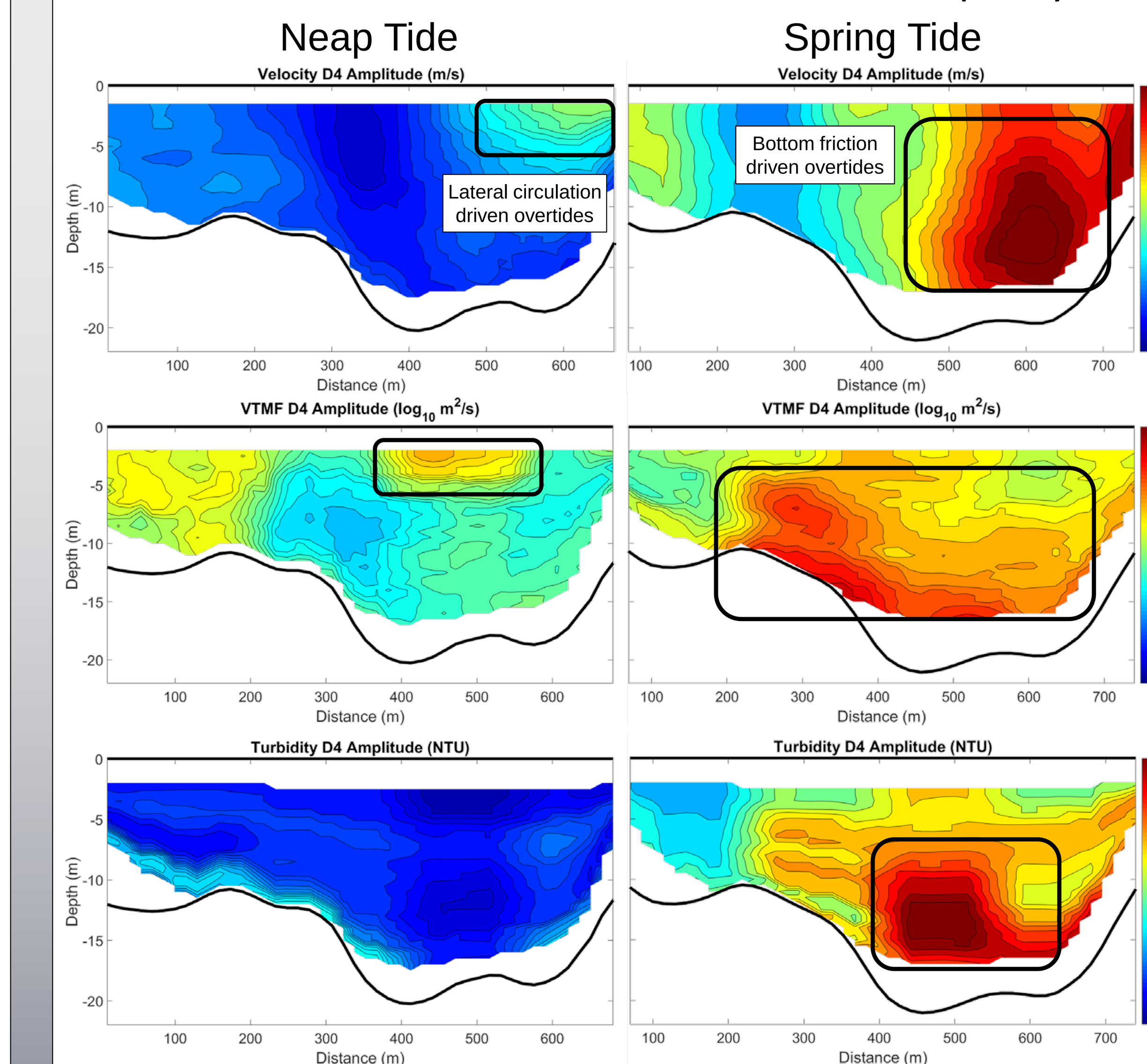


Figure 7: Preliminary data from cross-section analysis

Acknowledgements

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MAINE EPSCoR

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