Population Dynamics of Indicator Bacteria on Sediment Causing Shellfish Harvest Closures

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Acknowledgements & Contributing Sources

- Ambient water and sediment monitoring

  (Washington State Department of Health, Mason County and Squaxin Island Tribe)

- Department of Ecology Oakland Bay TMDL Report (www.ecy.wa.gov/pubs/1110039.pdf)

- Department of Ecology stream bacteria study (www.ecy.wa.gov/pubs/1103019.pdf)

- Microcosm die-off, biofilm growth and stream bacteria studies

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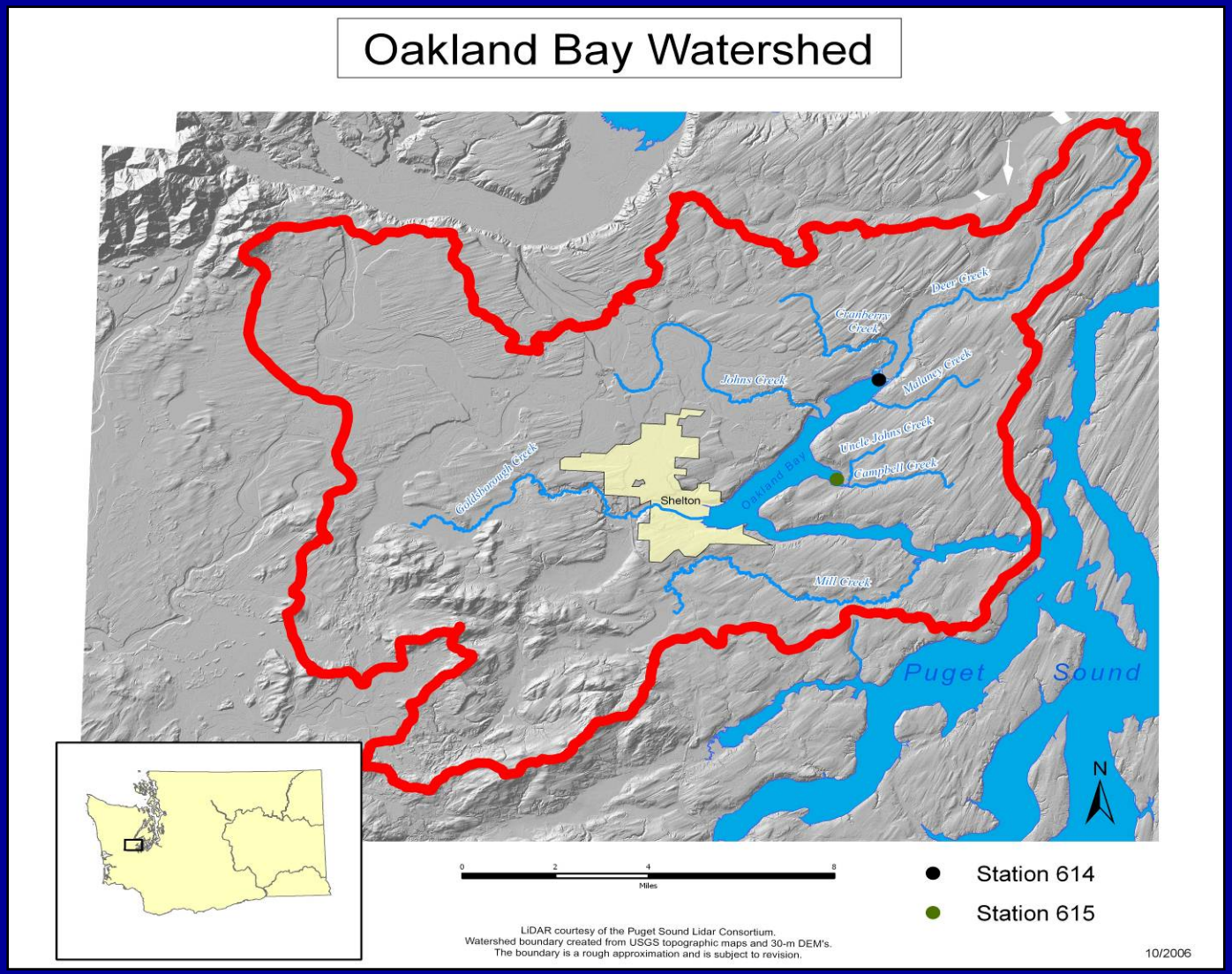
Closure & Research Location: extreme headwater of the Salish Sea



Oakland Bay Shellfish Resources

Commercial Harvest

Manila Clams
~3M lbs/yr

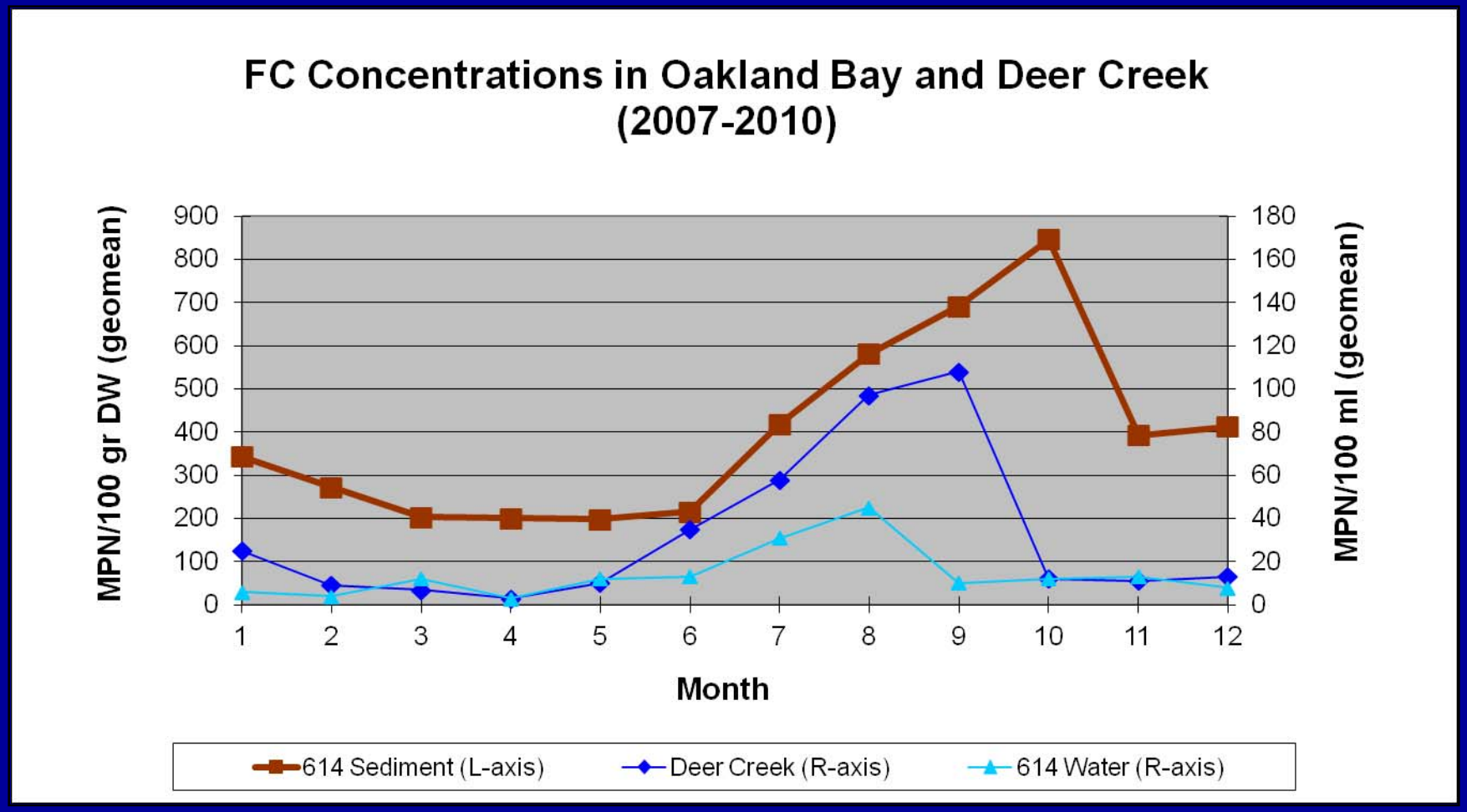
Kumamoto Oysters
~1.8M/yr

Product Value
>$10M/yr

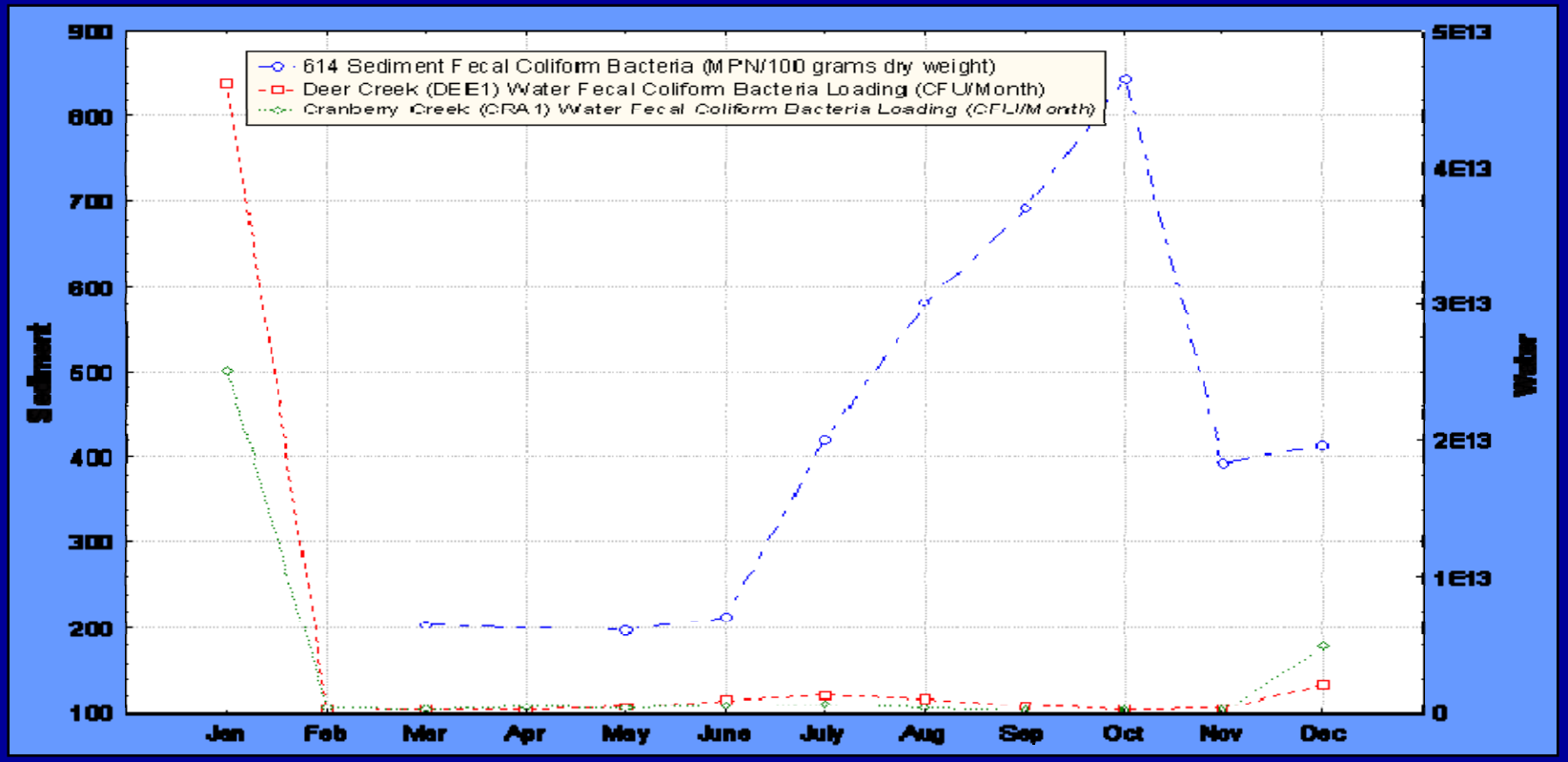
Tribal Harvest

Crime Scene: Upper Oakland Bay

Problem:
FC concentrations increase during summer



Cause: increase not from stream loading



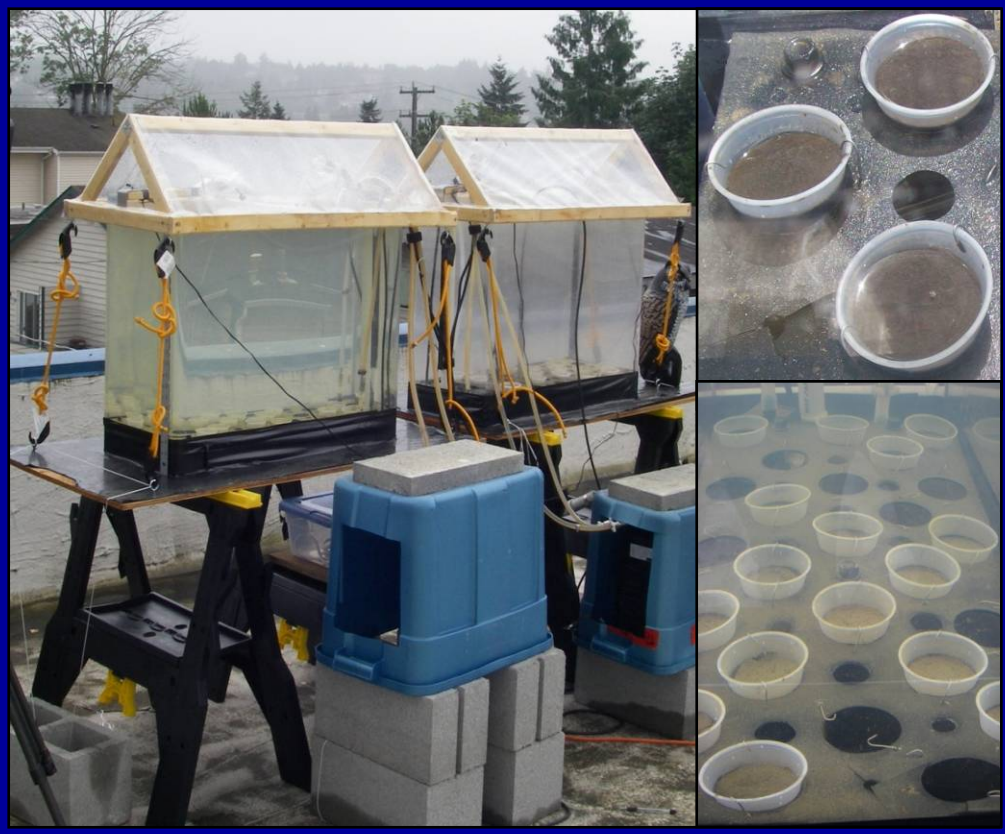
Alternate Hypothesis:
FC replicate rather than simply accumulate on marine inter-tidal sediment

Field Investigation Challenging

Microcosm Simulation Cheaper

Microcosm Die-off Study Design

- Simulated bay tidal exchange and water quality in duplicate aquaria on lab roof
- Inoculated with sediment from DOH 614
- Measured FC in 6 replicate sediment cups at Day 0, 3, 7, 14, 21 and 28
- Results are from one test run; two other test runs were unsuccessful

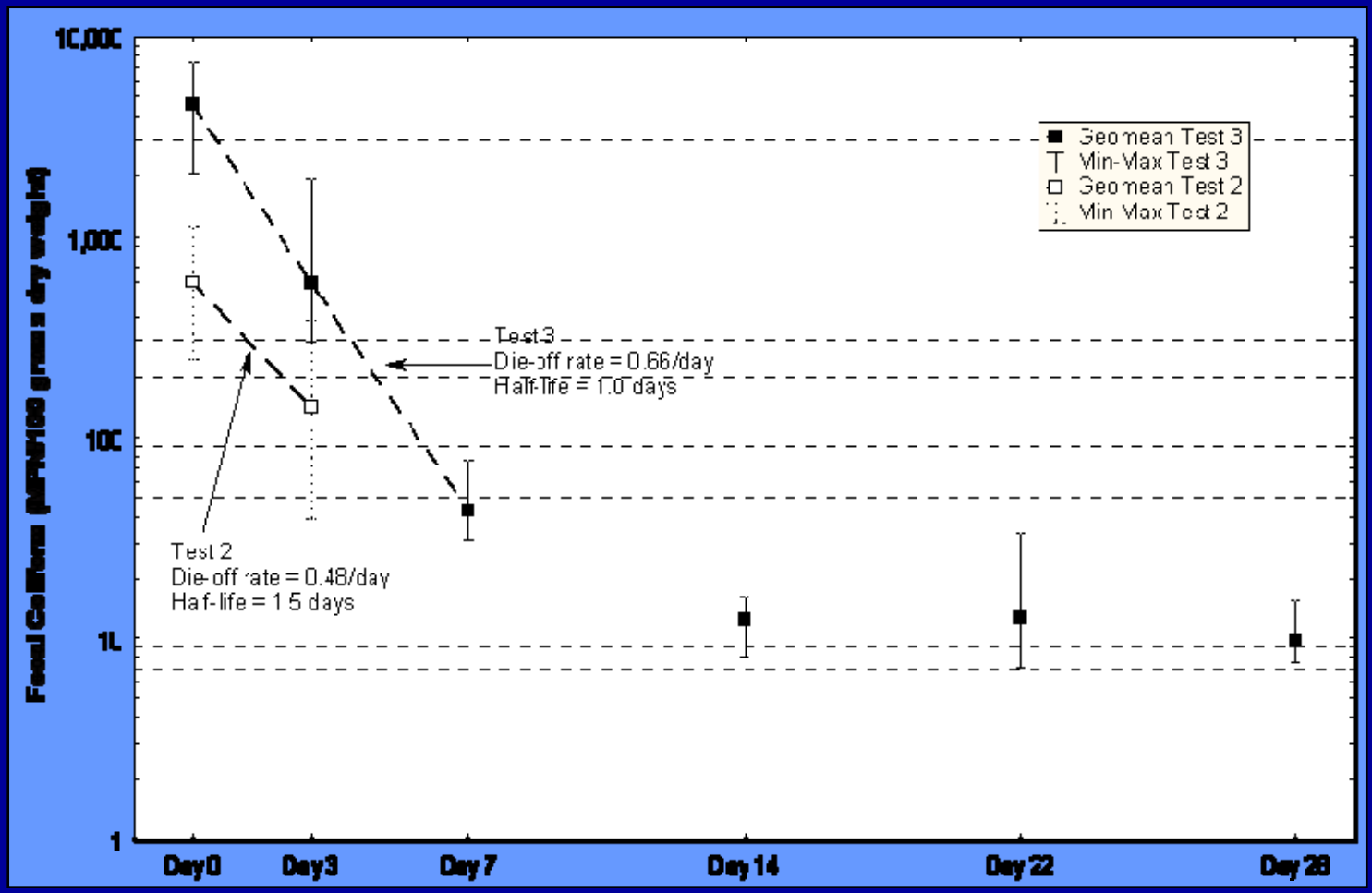


Microcosm Simulated Field Conditions

	Microcosms (Test 3)	Oakland Bay (summer)
Air temperature (°C)	25 (13-36)	17 (8-37, at Shelton)
Humidity (%)	42 (20-78)	15 (4-37, at Shelton)
Water temperature (°C)	20 (15-24)	19 (16-24)
Salinity (ppt)	27 (25-30)	26 (16-30)
pH	8.1 (8.0-8.3)	8.3 (7.7-9.0)
Dissolved oxygen (mg/L)	8.1 (7.2-9.4)	6.5 (5.6-9.6)
Dissolved oxygen (% sat.)	102 (88-118)	80 (58-120)
Turbidity (NTU)	2.8 (1.4-6.9)	26 (3.2-144)

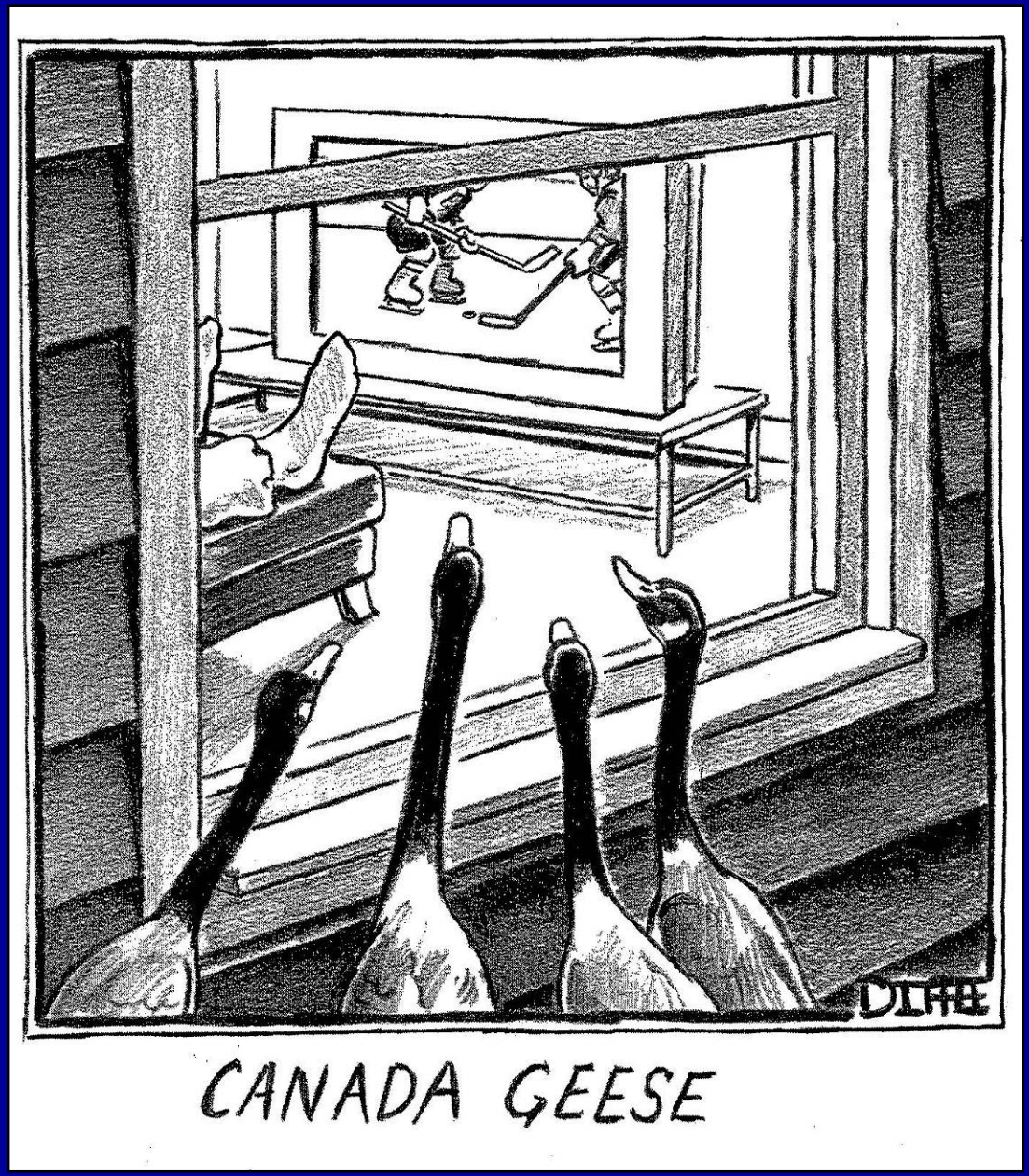
- Mean (range) values presented
- Six-hour tidal exchange with equal sun exposure in each aquarium
- Sediments drained and remained wet at low tide

Microcosm Results: no replication, classic die-off rate for sediment FC



Alternative Explanations

- Sediment FC accumulation rate increases during late summer months
  - Wildlife fecal deposits directly on inter-tidal sediment? (not supported by existing data)
- Sediment FC die-off rate decreases during late summer due to a more hospitable environment
  - Negligible loading rate a quandary, but
  - Less sunlight exposure (both day length & tidal timing shifts)
  - Cooler temperatures
  - More nutrients & marine snow
  - Less osmotic shock & better pre-conditioning
- Microcosm simulation overlooked some key variable
  - Free-floating vs. sediment-attached bacteria
  - Marine snow deposition
  - Nutrient levels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