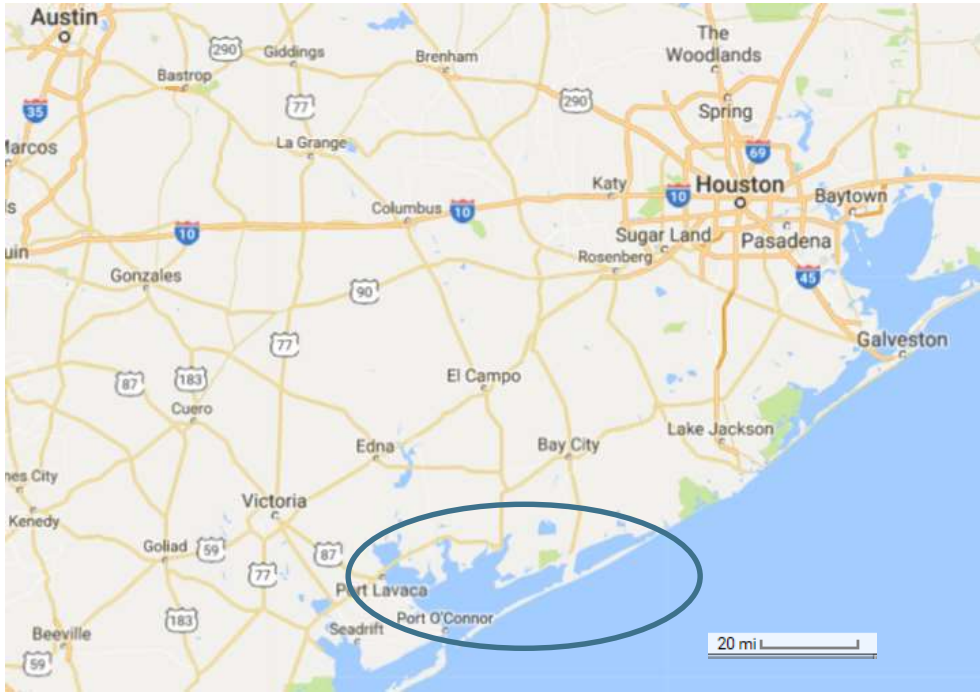
Development and Refinement of Freshwater Inflow Standards in Matagorda and Lavaca Bays, Texas, using Oysters and Dermo

Dan Opdyke, Ph.D., P.E., Deborah Chiavelli, Ph.D., and Elaine Darby, P.E.

December 12, 2016

Matagorda and Lavaca Bays

- 350 square miles
- 2nd largest bay system in Texas
- Significant commercial and recreational fishing
- Fisheries depend on suitable salinity values, which in turn depend on adequate freshwater inflows
  - In Texas, too little freshwater is a key concern



Texas Environmental Flows Legislation

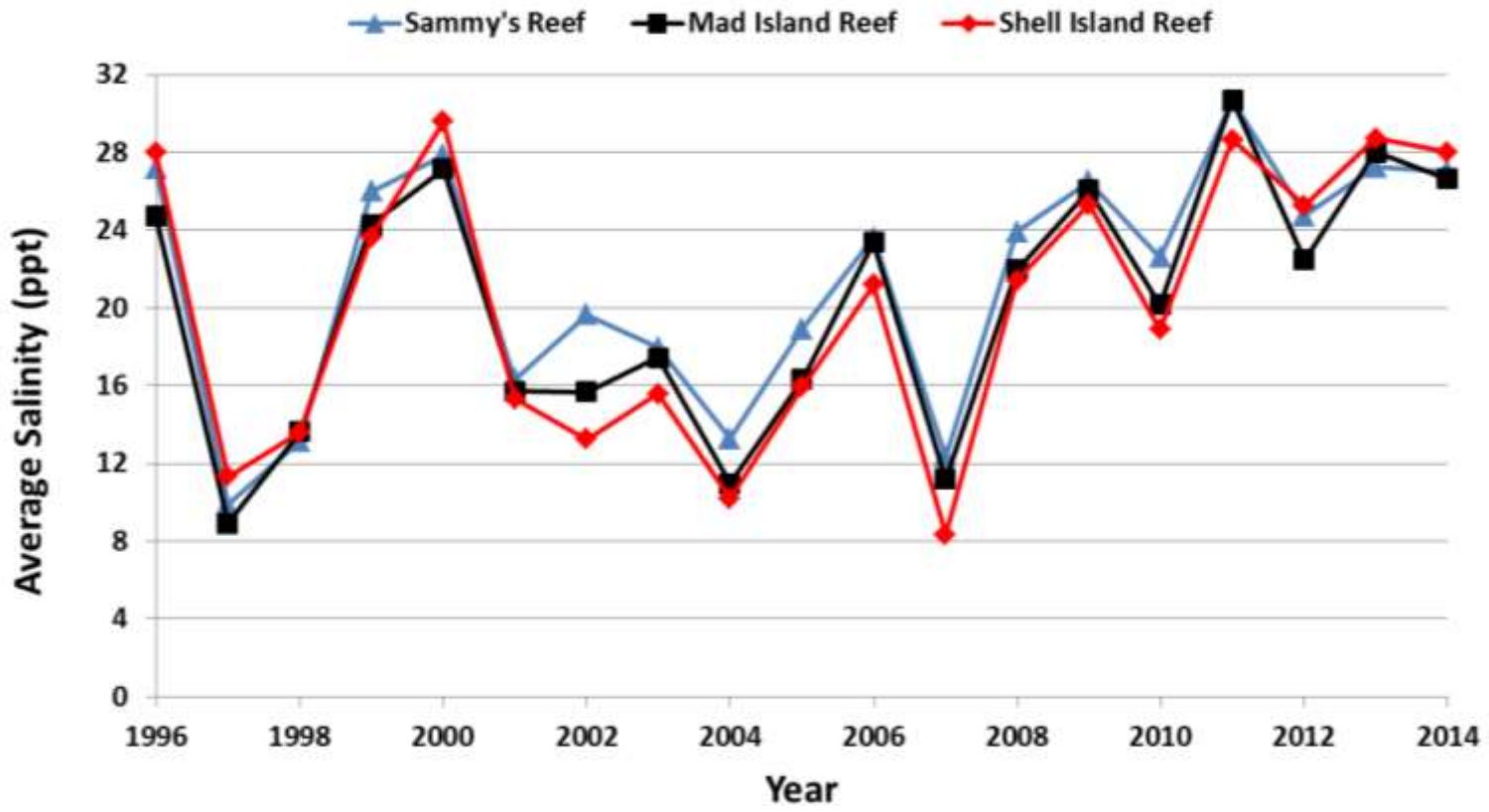
- 2007 statute to establish instream and freshwater inflow standards
  - Unique in the U.S.
  - Established for each basin
    - Science Team
    - Stakeholder Committee
  - More information
    - www.tceq.texas.gov/permitting/water_rights/wr_technical-resources/eflows
- Matagorda-Lavaca standards adopted in 2012
- Additional funds to validate or refine flow standards appropriated in 2013 and 2015

2012 Freshwater Inflow Standards for Matagorda and Lavaca Bays

- Based on previous studies from 2004–2008
  - Dermo (an oyster parasite) played a significant role, based on dependence on 2-year average salinity
    - Increasing salinity increases dermo
    - Two long term databases
      - Texas Parks and Wildlife Department (TPWD)
      - OysterSentinel
- Multiple flow levels and seasonal targets
  - However, short-term, high flow events (freshets) not explicitly included

Opportunity

- 2008–2014 data, collected during drought, provided opportunity to revisit analyses



Project Goal

- Corroborate existing inflow standards or suggest new relationships between inflows and ecology
  - Collect field data and extend existing datasets through 2014
  - Evaluate impacts of recent drought on previously developed relationships between inflows and ecology

Oyster Ecology

- Sessile (don't move as adults)
  - A good characteristic for an indicator species
- Euryhaline (wide range in salinity)
  - Tolerate averages from 5 to > 30 parts per thousand (ppt)
  - Optimal for adults: 10 to 15 ppt
  - Optimal for spawning (at > 25°C): ±20 ppt
- Important commercial fishery
- Provides numerous ecosystem services

Dermo Ecology

- *Perkinsus marinus*, a microscopic oyster parasite
  - Parasite growth rate increases at high temperature and salinity
- Estimated that 50% of market-sized oyster mortality in Gulf of Mexico is due to Dermo

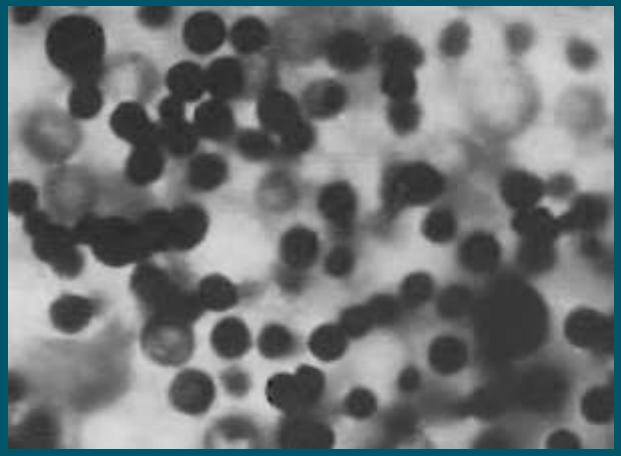


Image: Bushek et al. 1994

DERMO

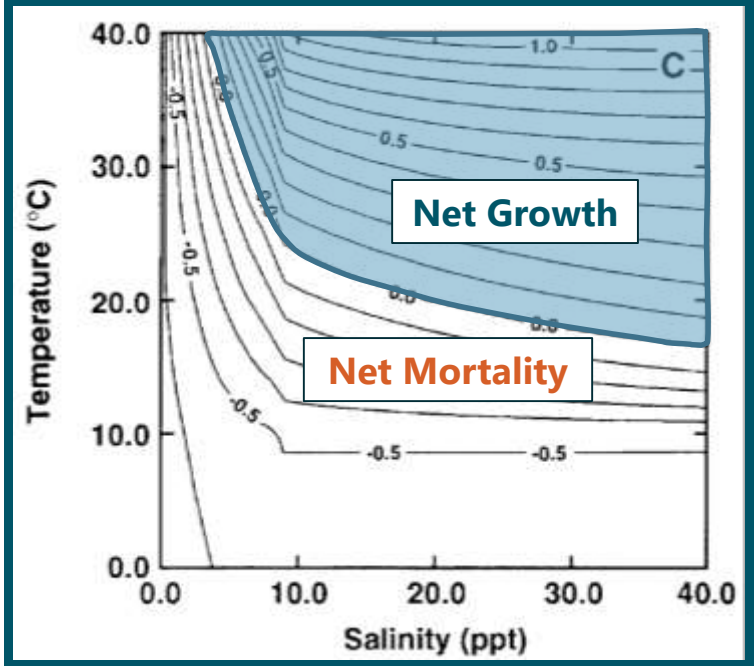
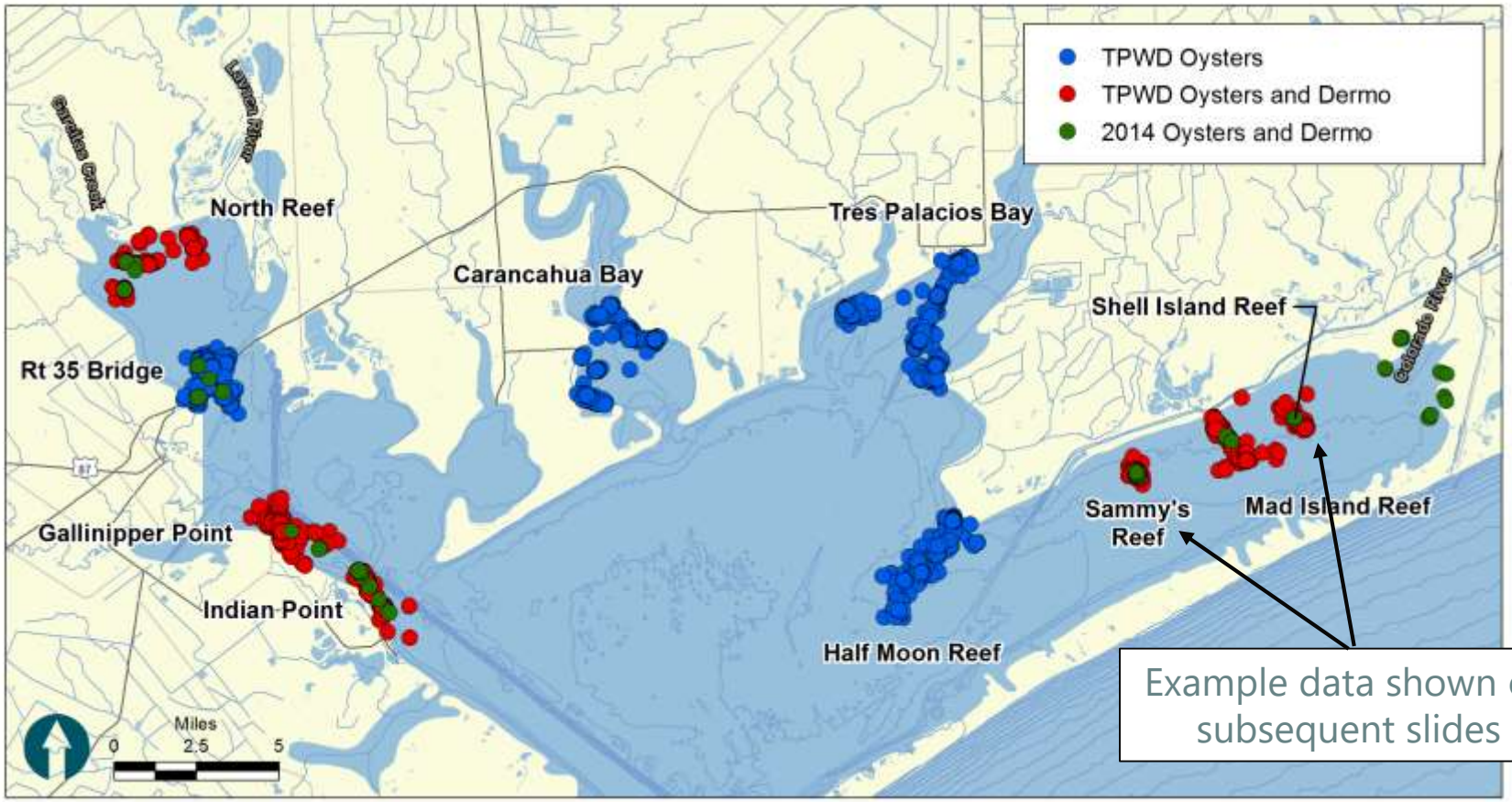


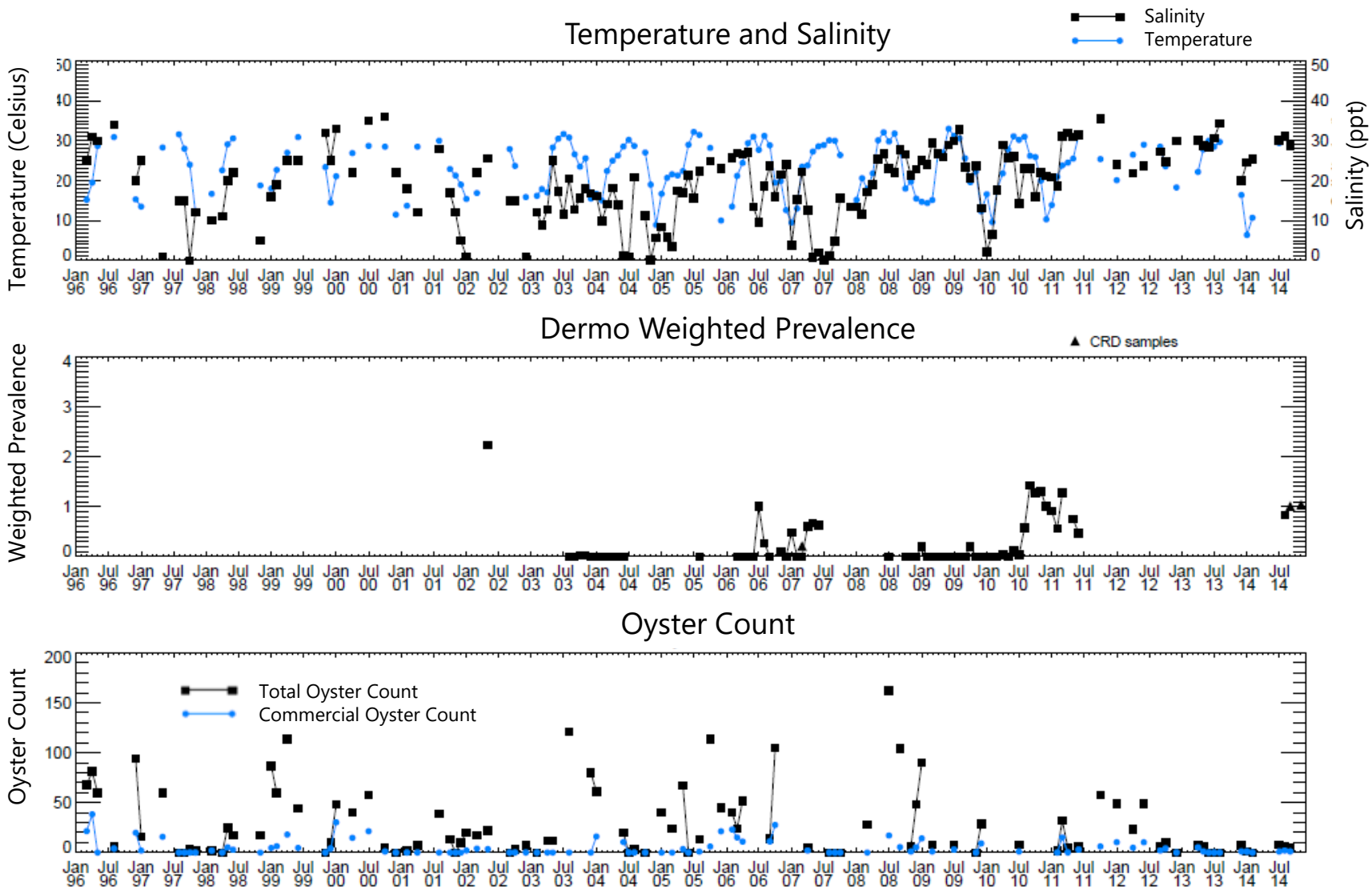
Figure adapted from Hofmann et al. 1995

Dermo Measurements

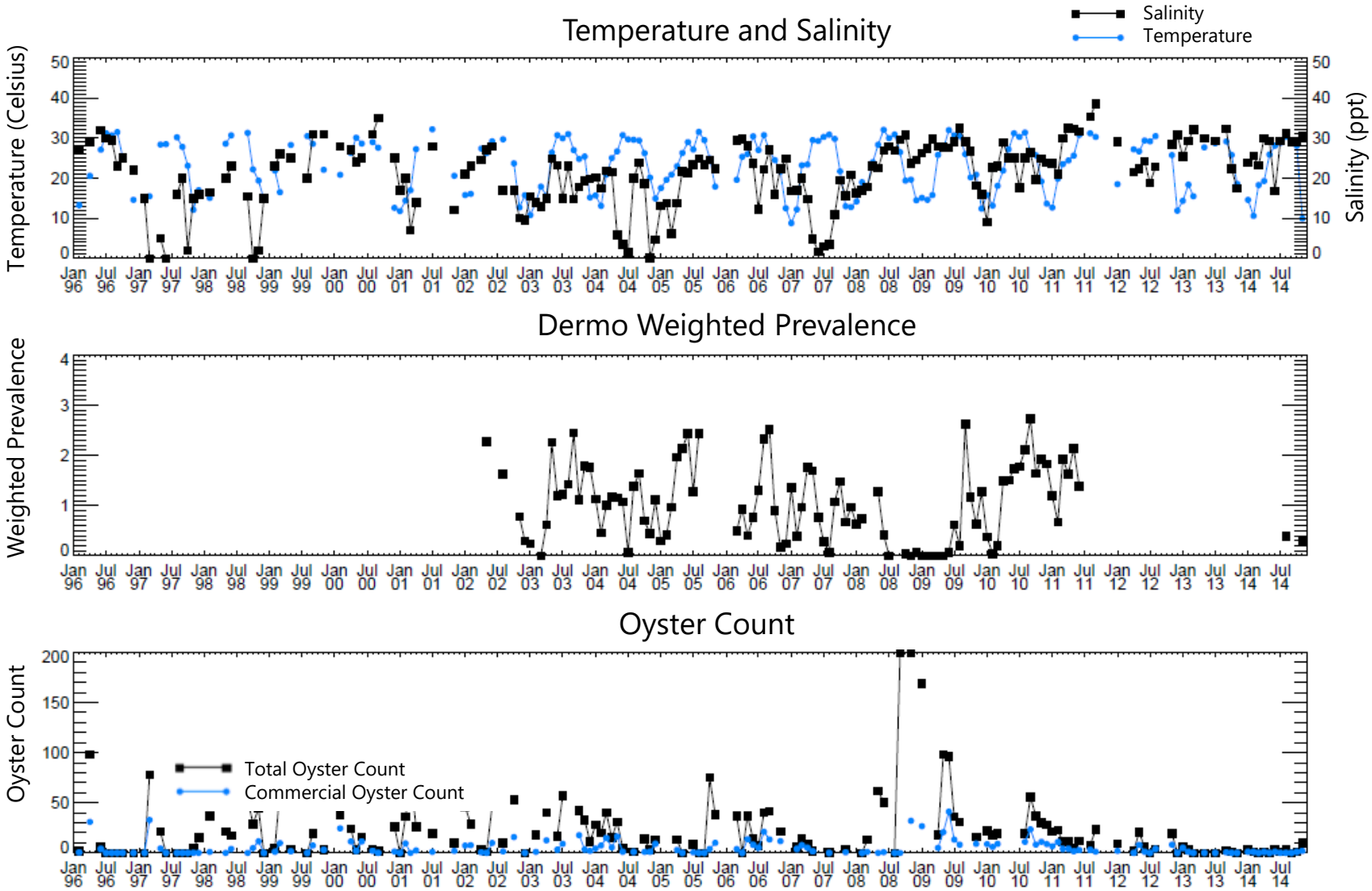
- Infection is rated using Mackin Scale
  - Scale: Uninfected (0) to Heavily Infected (5)
  - Weighted Prevalence (WP): average Mackin Scale for a group of oysters
- Point of reference
  - Mackin 1962: "[WP] of 2.00 contains an intense epidemic, and more than half of the population may be in advanced stages of disease, with all of the individuals infected."

Map of Data


TPWD Oysters
TPWD Oysters and Dermo
2014 Oysters and Dermo
Carancahua Creek
Lavaca River
North Reef
Tres Palacios Bay
Carancahua Bay
Shell Island Reef
Colorado River
Rt 35 Bridge
Gallinipper Point
Indian Point
Sammy's Reef
Mad Island Reef
Half Moon Reef
Miles
0
2.5
5
Example data shown on subsequent slides



Time Series Example: Shell Island Reef



Time Series Example: Sammy's Reef

Oyster Relationship to Salinity and Temperature

- Explored statistical dependency of commercial size oyster count on antecedent salinity and temperature
- Best Multiple Regression Model (R^2 = 0.33)
  - Average salinity in prior 2 years
    - Intermediate salinity (20 ppt) is best for oysters
  - Frequency of low salinity events in prior 10 years
    - Intermediate flood frequency is best
  - Average winter temperature in prior 2 years
    - Warm temperature during colder part of year is best

Dermo Relationship to Salinity and Temperature

- Explored statistical dependency of Dermo on antecedent salinity and temperature
- Best Predictive Regression Model (R^2 = 0.66)
  - Proportion of months with salinity ≤ 2 ppt in the prior 5 years
    - Increasing freshet frequency decreases Dermo
  - 3-month temperature, lag 1 month
    - Increasing temperature increases Dermo
  - 2-year average salinity, lag 1 year
    - Increasing salinity increases Dermo

Conclusions

- A freshet frequency variable and a long-term average salinity variable feature in both dermo and oyster models
  - Also in long-term average dermo and oyster count models across Galveston, Matagorda-Lavaca, and San Antonio bays
- Corroborates long-term salinity basis of existing freshwater inflow standards
- Highlights importance of protecting freshets
  - Existing standards have seasonal fluctuations but no events sufficient to drive salinity below 2 ppt at key reefs
  - Possible consideration in future re-evaluation of standards

Special Thanks

- TPWD for data
- BIO-WEST for collecting oysters
- Dr. Tom Soniat and staff at UNO for Dermo analyses
- Trungale Engineering and Science for hydrodynamic modeling

- Final Report
  - www.twdb.texas.gov/publications/reports/contracted_reports/doc/1400011715_Matagorda&Lavaca.pdf

Questions/Discussion