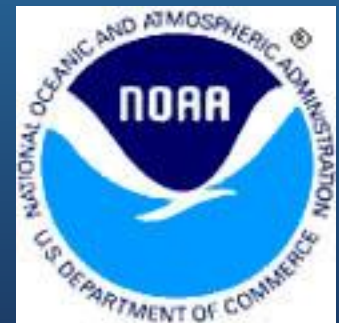
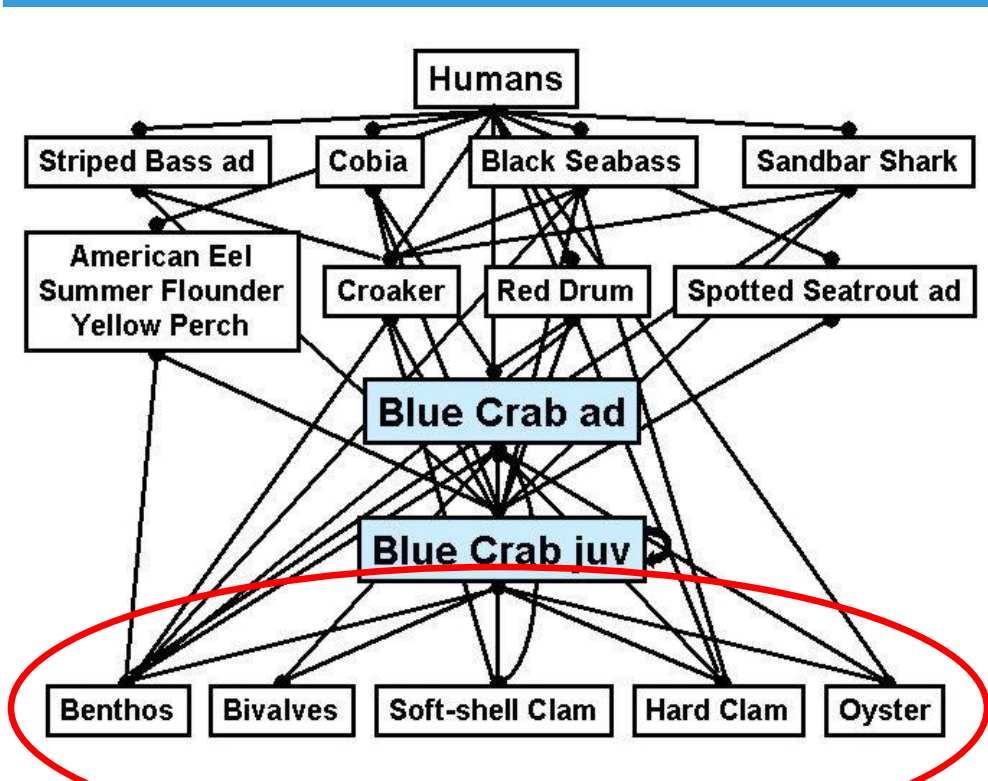


Benthic Species as Chesapeake Bay Forage: Stressors and Bottom-up Control

Rochelle Seitz, Katie Knick,
Denise Breitburg, Matt Kornis, & Diann Prosser
Virginia Institute of Marine Science



Importance of Benthic Communities

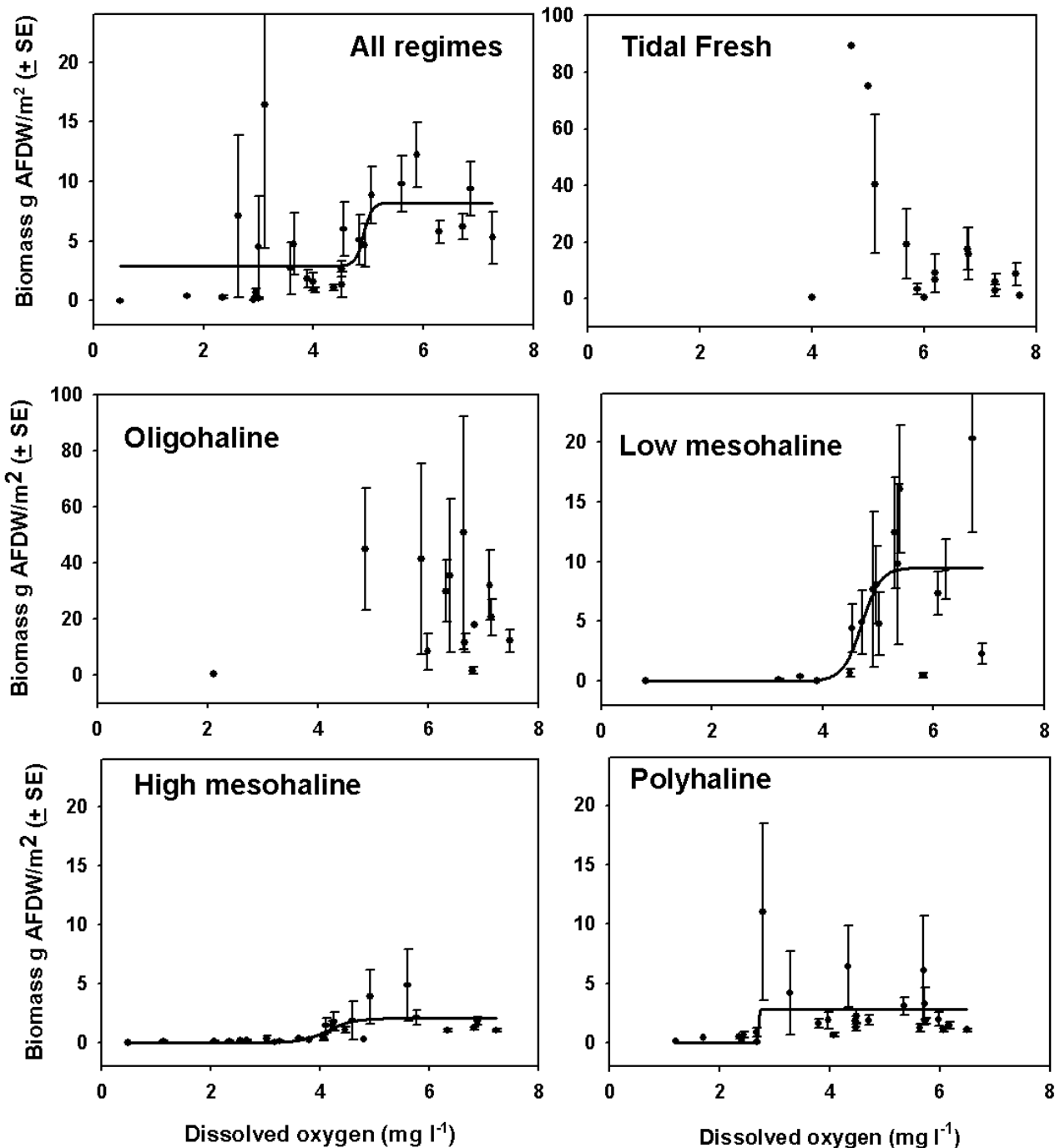


- The majority of... marine biodiversity is made up of invertebrates residing in... or on sediments... (Widdicombe & Spicer 2008)
- Important in food web
- Stressors: Hypoxia, shoreline and upland development

Bottom up control?

Hypoxia reduces benthic biomass

(CBP benthic survey data)



Macro-fauna group: 28 subestuaries 8 with complete site overlap

Objectives:

- Macro-faunal communities in shallow subtidal habitats



- Factors affecting communities

- Shoreline development
- Upland development
- Physical characteristics



- Objective: determine combined effects of shoreline and upland development on communities



- Compare benthic invertebrates, fish & crabs, birds

| <u>River</u> | <u>Benthic</u> | <u>Birds</u> | <u>Fish</u> |
|------------------|----------------|--------------|-------------|
| Stony Creek | 2011 | 2012 | 2010 |
| Magothy River | 2011 | 2012 | 2011 |
| East River | 2010 | 2011 | 2010 |
| Poquoson | 2010-2013 | 2011 | 2010 |
| Harris Creek | 2011 | 2013 | 2011 |
| Miles River | 2011 | 2012 | 2011 |
| Monroe Bay | 2011 | | 2011 |
| Corrotoman River | 2011 | 2013 | 2011 |
| Yeocomico | 2011 | | 2012 |
| Occohannock | 2010 | | 2010 |
| Mill Creek (Pax) | 2012 | 2013 | 2012 |
| Honga | | 2010 | 2010 |
| Langford Creek | | 2010 | 2010 |
| Rhode | | 2010 | 2010-2012 |
| St. Leonard | | 2010 | 2010 |
| Ware | | 2011 | |
| St. Mary | | 2010 | |
| Corsica | | 2010 | |
| Back | | 2011 | |
| South (MD) | | | 2010 |
| Wye River | | | 2012 |
| Main Creek | | | 2012 |
| Severn (VA) | 2012 | | |
| Catlett Islands | 2013 | | |
| Onancock | 2013 | | |
| Indian River | | | 2010-2011 |
| Pepper Creek | | | 2010-2011 |

Factors

Shoreline Types



Natural Marsh



Beach



Rip-Rap



Bulkhead

Upland Usage



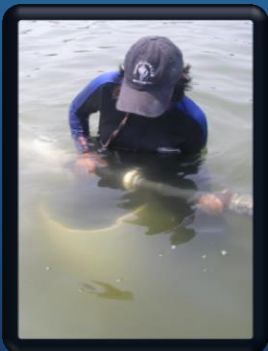
Forested



Developed



Agricultural

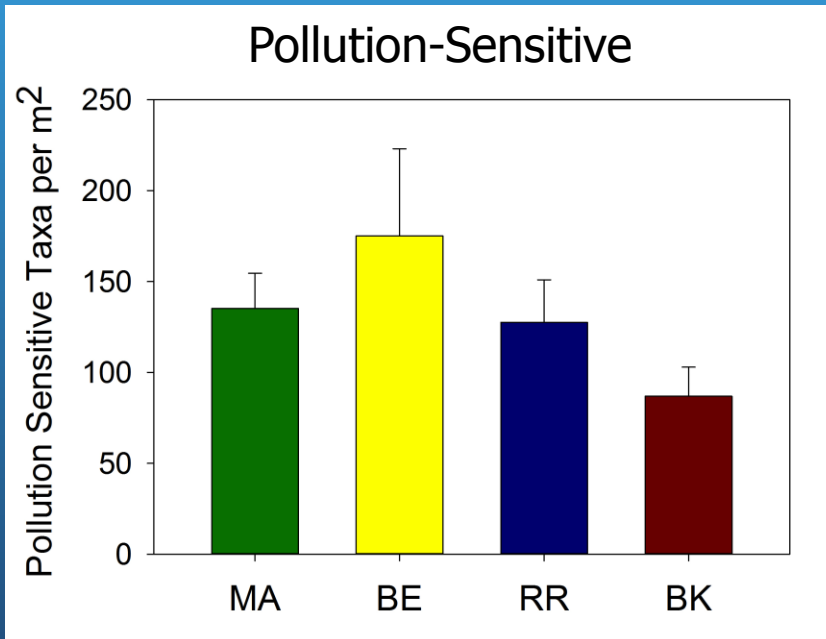


Suction Sampling

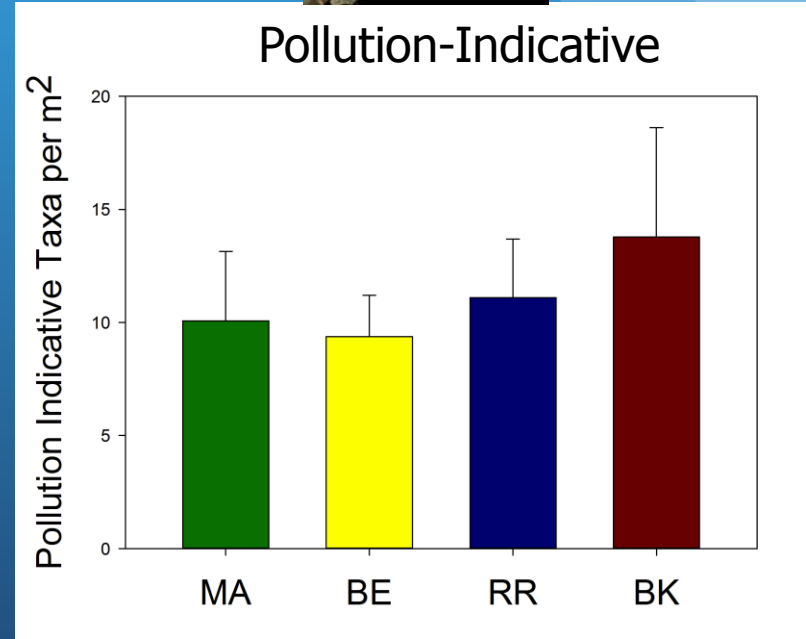
Experimental Design

- 4 shoreline types
- 3 upland usage types
- 6 replicates of each per subestuary

Density by shoreline: Pollution-sensitive vs. Pollution-indicative species

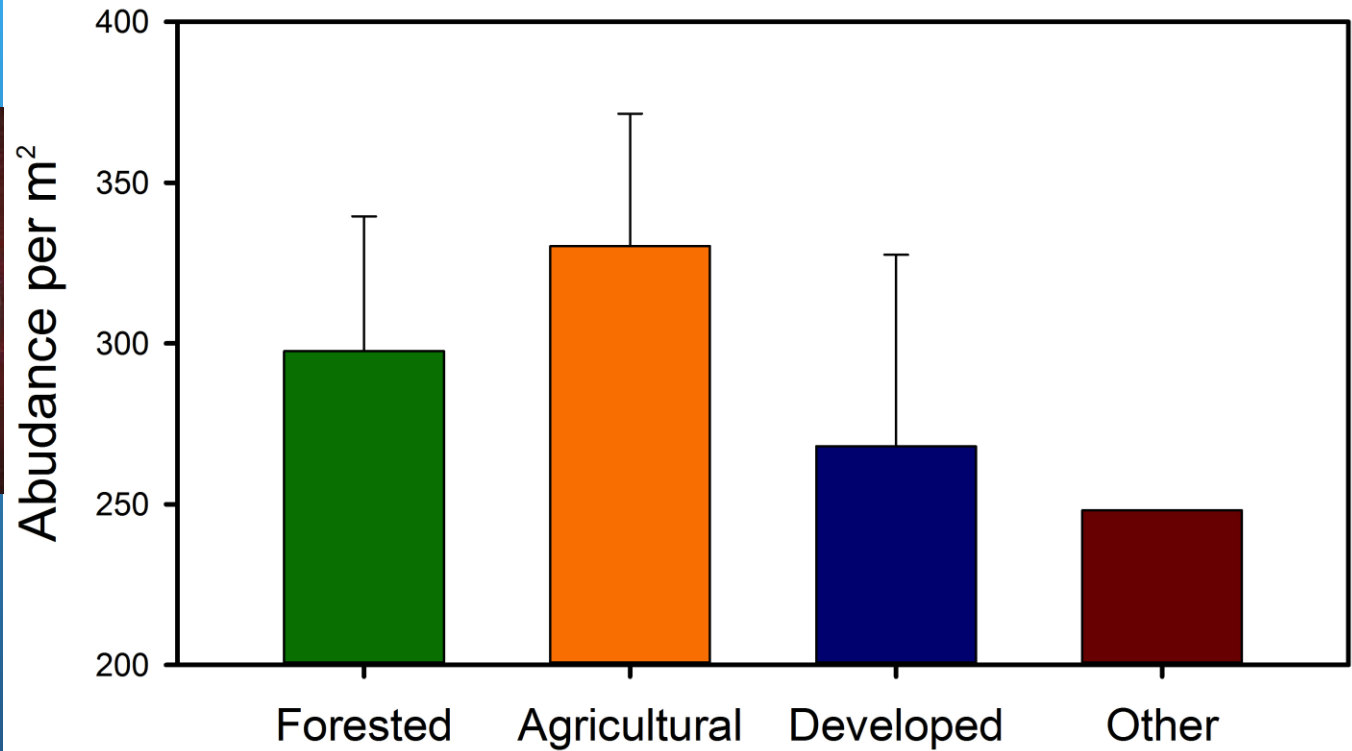


ANOVA:
 $P = 0.08$



ANOVA:
 $P = 0.21$

Density by Landuse



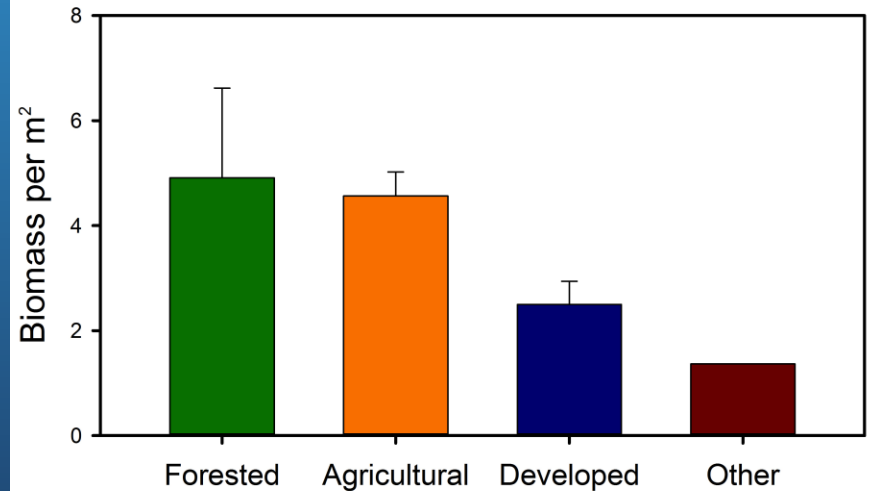
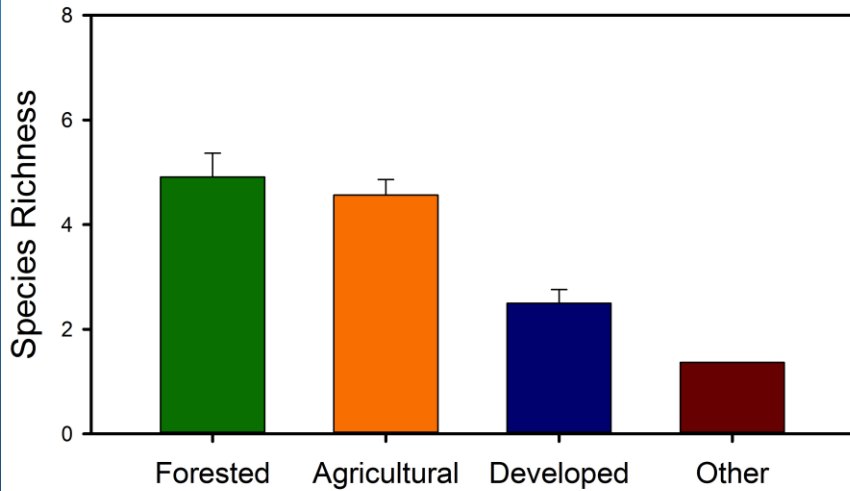
ANOVA:
 $P = 0.05$



Diversity and Biomass by Landuse

Diversity
ANOVA:
 $P < 0.0005$

Biomass
ANOVA:
 $P = 0.008$



AIC_c Model Selection

Macrofauna

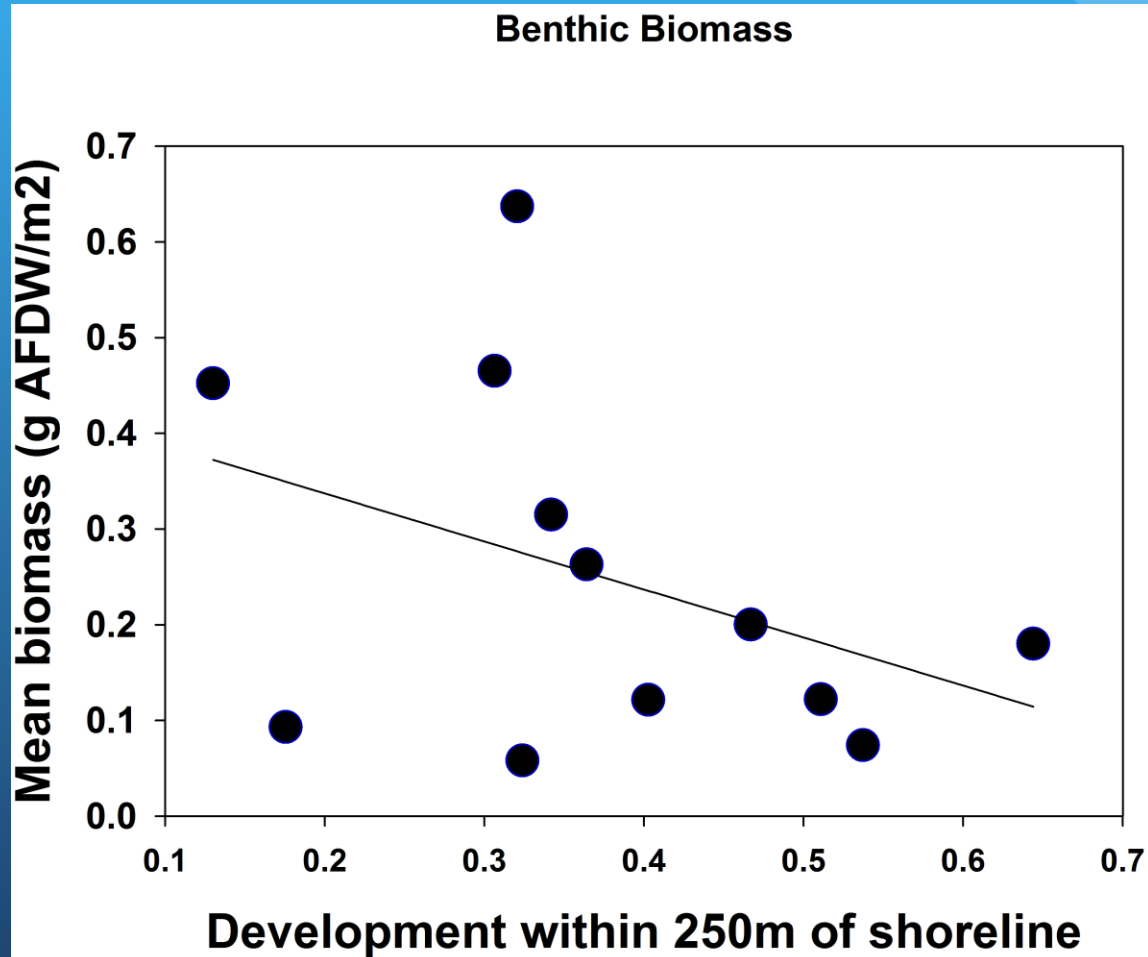
Diversity

Biomass

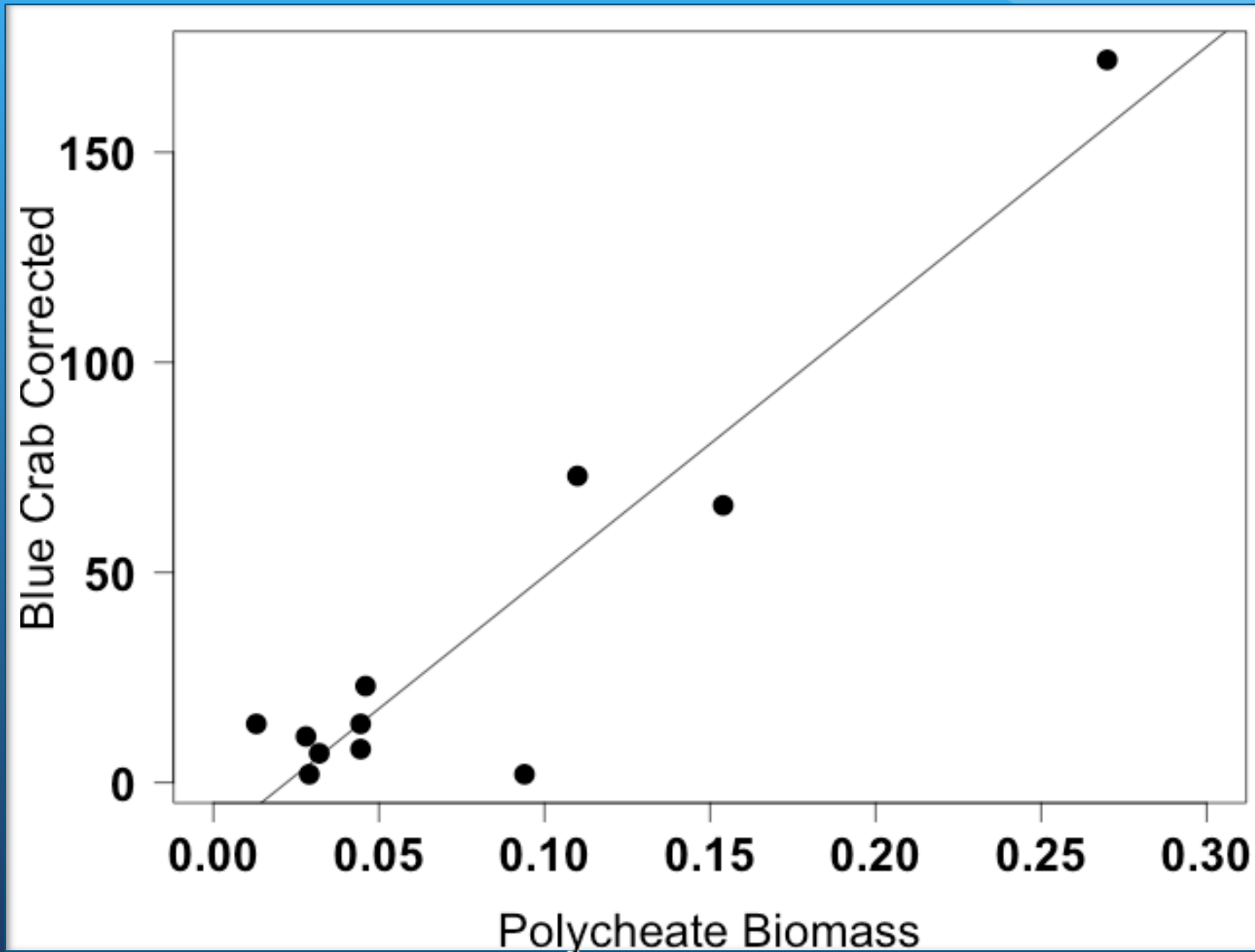
Density

| Model No. | Diversity Model Parameters | AIC _c | Δ_{AICc} | w_i |
|-----------|------------------------------------|------------------|-----------------|-------|
| 7 | Upland | 334.649 | 0 | 0.648 |
| 2 | Shoreline+Upland+Salinity | 336.763 | 2.114 | 0.225 |
| 1 | Shoreline+Upland+Salinity+Sediment | 338.366 | 3.717 | 0.101 |
| 5 | Shoreline+Upland | 341.898 | 7.249 | 0.017 |
| 3 | Shoreline+Upland+Sediment | 343.169 | 8.52 | 0.009 |
| 8 | (Null Model) | 359.797 | 25.148 | 0 |
| 6 | Shoreline | 367.177 | 32.528 | 0 |
| 4 | Shoreline+Sediment | 367.461 | 32.812 | 0 |
| Model No. | Biomass Model Parameters | AIC _c | Δ_{AICc} | w_i |
| 7 | Upland | 944.564 | 0 | 0.507 |
| 5 | Shoreline+Upland | 945.989 | 1.425 | 0.249 |
| 2 | Shoreline+Upland+Salinity | 947.551 | 2.987 | 0.114 |
| 3 | Shoreline+Upland+Sediment | 947.991 | 3.427 | 0.091 |
| 1 | Shoreline+Upland+Salinity+Sediment | 949.729 | 5.165 | 0.038 |
| 8 | (Null Model) | 973.813 | 29.249 | 0 |
| 6 | Shoreline | 974.454 | 29.89 | 0 |
| 4 | Shoreline+Sediment | 975.733 | 31.169 | 0 |
| Model No. | Density Model Parameters | AIC _c | Δ_{AICc} | w_i |
| 8 | (Null Model) | 953.695 | 0 | 0.273 |
| 6 | Shoreline | 953.812 | 0.117 | 0.258 |
| 4 | Shoreline+Sediment | 954.845 | 1.151 | 0.154 |
| 2 | Shoreline+Upland+Salinity | 956.169 | 2.472 | 0.079 |
| 5 | Shoreline+Upland | 956.452 | 2.758 | 0.069 |
| 3 | Shoreline+Upland+Sediment | 956.495 | 2.8 | 0.067 |
| 7 | Upland | 956.536 | 2.842 | 0.066 |
| 1 | Shoreline+Upland+Salinity+Sediment | 957.892 | 4.197 | 0.034 |

Benthic biomass vs. upland development



Bottom-up control of consumers



IWCI vs. Littoral Fish Biomass & Invert biomass (7 subestuaries)

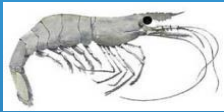
Littoral-Benthic



Mummichog



Striped Killifish



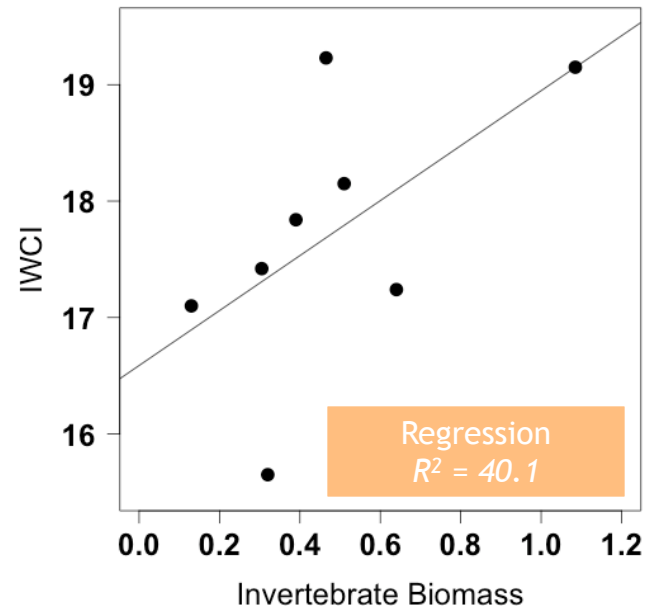
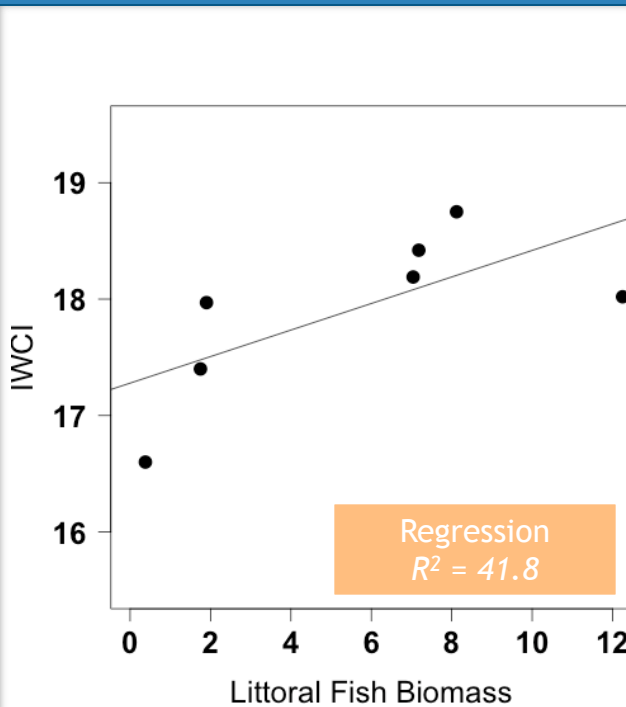
Grass Shrimp



Naked Goby



Bivalves & Polychaetes



Data from Diann Prosser

Benthos Conclusions -

Hypoxia reduces benthic biomass



- Shoreline trends show negative effects of hardening
- Significant negative effects of upland use and subestuary development on diversity and biomass
- Infaunal biomass decreases with % developed
 - Less food available to higher trophic levels
- Multiple stressors have negative effects on benthos!
- Ramifications up the food web
- Overall implications:
 - **Need to preserve natural habitats to maintain natural communities and forage base**