May 1st, 3:30 PM - 5:00 PM

Eelgrass (Zostera marina) biomass models for predicting restoration potential in Puget Sound

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An eelgrass (Zostera marina) biomass model for predicting restoration potential in Puget Sound

Kate E. Buenau, Lyle F. Hibler, And Ronald M. Thom
Salish Sea Ecosystem Conference
Seattle, WA
May 1, 2014
Eelgrass Restoration Site Selection for Puget Sound

- Puget Sound Hydrodynamic Model
- Eelgrass Biomass Model
- Eelgrass Monitoring/Historical Extent
- Suitability Maps/Site Selection
- Shoreline Planning
- Expert Knowledge
- Test Planting/Monitoring
Objectives

- Develop a dynamic eelgrass model to help predict restoration potential
- Adapt existing model to *Z. marina* with local data
- Use output from Puget Sound hydrodynamic model
- Focus on factors that vary spatially

Why use a dynamic model?

- Integrate environmental conditions over time
- Interactions between controlling factors
- Climate and management scenarios
Biomass model

Aboveground biomass (mol C/m²)

\[ C_{a,t+1} = C_{a,t} + \Delta t \left[ (1 - \tau) P(I_z, T, S) C_{a,t} \left( 1 - \frac{C_{a,t}}{\kappa} \right) - R_a(T) C_{a,t} - M_a C_{a,t} \right] \]

\[ C_{b,t+1} = C_{b,t} + \Delta t \left[ (\tau - \delta) P(I_z, T, S) C_{a,t} \left( 1 - \frac{C_{a,t}}{\kappa} \right) - R_b(T) C_{b,t} - M_b C_{b,t} \right] \]

Belowground biomass (mol C/m²)

Adapted from Burd and Dunton 2001, Eldridge et al. 2004, Kaldy and Eldridge 2006
Biomass model – current focus

Aboveground biomass (mol C/m²)

\[ C_{a,t+1} = C_{a,t} + \Delta t \left[ (1 - \tau) P(I_z, T, S) C_{a,t} \left( 1 - \frac{C_{a,t}}{\kappa} \right) - R_a(T) C_{a,t} - M_a C_{a,t} \right] \]

Belowground biomass (mol C/m²)

\[ C_{b,t+1} = C_{b,t} + \Delta t \left[ (\tau - \delta) P(I_z, T, S) C_{a,t} \left( 1 - \frac{C_{a,t}}{\kappa} \right) - R_b(T) C_{b,t} - M_b C_{b,t} \right] \]
Not currently included

- Seasonal differences in mortality
- Use of carbon stored belowground
- Nutrients
- Desiccation
- Substrate
- Wave energy

Future development

Post-processing with spatial datasets
Physiological data from Sequim Bay eelgrass population

![Graph showing temperature and respiration](temperature_respiration_graph.png)

![Graph showing salinity and proportional change](salinity_production_graph.png)
Temperature-Photosynthesis relationship—what function?

From Burd and Dunton 2001 (for *Halodule wrightii*)
Temperature-Photosynthesis relationship—what function?

\[ \Delta AIC = 6.7 \]
Photosynthesis relationship with light and temperature

Gross primary productivity (mol C/(mol C hr))

- Light (mol/(m² day))
- Temperature (°C)

GPP (mol C/(mol C hr))

- Temperature (°C)

- Light (mol/(m² day))

May 1, 2014
Model input for Sequim Bay

- Monthly averages derived from Marine Water Quality Monitoring Program (WA Ecology) Secchi depth data
- Weather Research and Forecasting Model (UW) light inputs, attenuated through water depth
Model output for Sequim Bay

- **Attenuation Coefficient**
- **Water Temperature**
- **PAR at Canopy**
- **Salinity**
- **Photosynthetic Production**
- **Respiration**
- **Growth Rate**
- **Aboveground Biomass**

Data shaded colors are observations at Catherine Island.
Comparison of Sequim Bay (thin lines) and Hood Canal (thick lines)
Spatial inputs

Means of yearlong time series

Temperature (C)  Salinity (psu)  Attenuation ($K_{PAR}$, 1/m)
Sound-wide results (index)

-1m NAVD88

-5m NAVD88
Comparison with eelgrass growth data

Cumulative Change in Biomass (mol C/m²) vs Date

- Modeled
- Observed

Dates:
- 6/20
- 7/10
- 7/30
- 8/19
Conclusions

- Use of data collected in Puget Sound improved spatial patterns of biomass predictions
- Predictions are best used as a relative measure, with consideration of characteristics of particular sites
- Significant data needs remain
Data needs

- Nearshore light attenuation
- Physiological data over broader range of conditions and local populations
- More biomass data with light and temperature for validation
- Belowground physiology
- Seasonal changes in physiology and mortality
Thank you!

Contributors
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