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
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
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)

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

Belowground biomass (mol C/m²)

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

Local data

Photosynthesis

Respiration

Translocation and exudation of carbon

Density dependence

Mortality

May 1, 2014
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
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
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**
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)

Date

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
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Thank you!

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