Molecular Markers and Stable Isotopes as Indicators of the Paleo-Occurrence of Eelgrass (*Z* . marina) in Westcott Bay, San Juan Islands, WA

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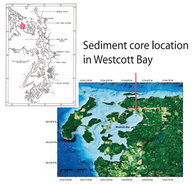
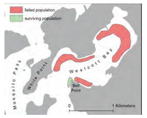
1 INTRODUCTION and STUDY AREA

Z. marina (eelgrass) is valuable nearshore resource that provides critical habitat for a number of marine and estuarine animals, including juvenile salmon, Pacific herring, and Dungeness crab in the Puget Sound/ Georgia Basin. A recent (2003) widespread loss and fragmentation of eelgrass meadows occurred in Westcott Bay (located on the northwest corner of San Juan Island; Figure 1). Is this die-off part of a natural cycle or exacerbated by anthropogenic activity?

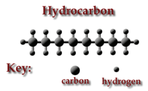




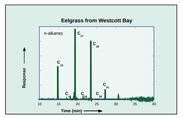
2 APPROACH and STRATEGY

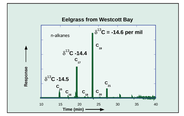
The goal was to develop a diagnostic chemical signature for Z. marina to measure the spatial and temporal occurrence of eelgrass in sediment cores. We developed and applied a multi-index technique using molecular biomarkers and stable isotopes. We found that specific hydrocarbons, in particular the low molecular weight (LMW) nC_{17} and nC_{19} n-alkanes, the higher-plant sterols: stigmasterol, ß-sitosterol, and campesterol, in combination with the lignin phenols are good indicators of eelgrass.

3 n-ALKANES in EELGRASS

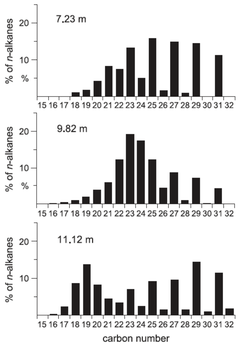


n-alkanes in pure eelgrass with an odd-over-even (OE) carbon number preference and a peak at nC_{17} or nC_{19}





4 TYPICAL n-ALKANE DISTRIBUTIONS



Strong terrestrial component, marked by strong odd over even predominance in the range C_{25} - C_{32}

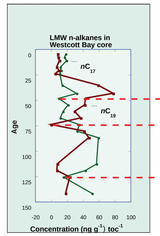
Strong macrophyte input, marked by no odd over even predominance in the range C_{22} - C_{25}

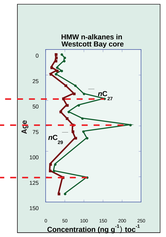
Strong algal input, marked by bell shaped pattern centered within the range C_{17} - C_{21} and a strong terrestrial input as well

5 n-ALKANES in WESTCOTT BAY SEDIMENT

LMW n-alkanes as proxies for eelgrass, potential algal interference

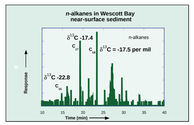
HMW n-alkanes as proxies for terrestrial input





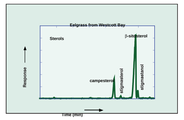
more eelgrass → more terrestrial →

Negative oscillations in down core profile of LMW n-alkanes at 48, 75, and 125 years ago, that correlate with positive oscillations in HWW alkanes

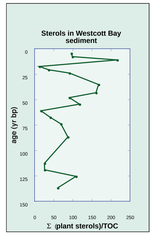


6 PLANT STEROLS

the higher-plant sterols: stigmasterol, ß-sitosterol, and campesterol, are abundant in eelgrass.

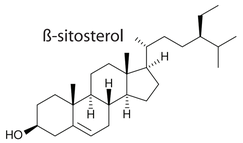


7 STEROLS in WESTCOTT BAY SEDIMENT



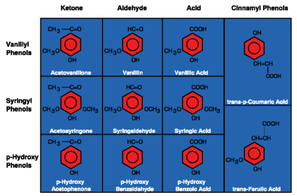
more plants →

Sterols are a necessary but not diagnostic component of eelgrass except in the absence of terrestrial material



8 LIGNIN PHENOLS in EELGRASS

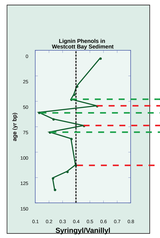
Lignin phenol ratios (S/V, C/V, P/V) provide information on sources of lignin to the sediments. Lignin from seagrass contains very low levels of syringyl phenols (S/V < 0.02). The p-hydroxy/Vanillyl (P/V) ratio provides information on algal versus vascular plant contributions to the sedimentary organic matter

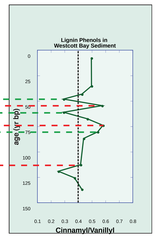


Lignin is relatively resistant to biodegradation in sediments

9 LIGNIN PHENOLS in WESTCOTT BAY SEDIMENT

Lignin phenol ratios (S/V, C/V) as proxies for eelgrass abundance





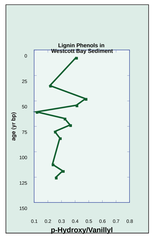
← more eelgrass ← more eelgrass

time of more eelgrass

time of less eelgrass

Positive oscillations in the downcore profile of the S/V and C/V ratios at ~5, 54, 75, and 120 years before the present indicate times of less eelgrass abundance. With some exceptions, these data correlate reasonably well with similar oscillations in the downcore profile of the n-alkanes, in particular with the nC_{19} profile.

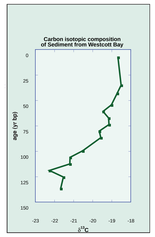
Lignin phenol P/V ratio as proxy for algae vs. vascular plants

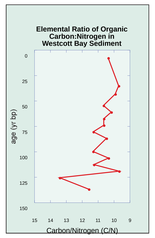


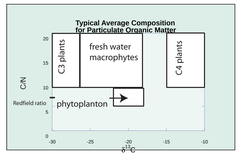
The downcore profile of P/V is similar to the downcore profile of S/V and indicates an inverse relationship between the relative amounts of eelgrass and algae

more algae →

10 ELEMENTAL & ISOTOPIC CONTENT of WESTCOTT BAY SEDIMENT





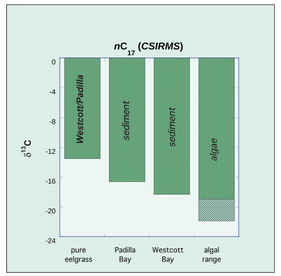


← more C3 terrestrial ← more terrestrial

Bulk $\delta^{13}C$ and the C/N ratio indicate a shift gradual shift from terrestrial input to marine input over the last 150 years.

11 COMPOUND SPECIFIC ISOTOPE RATIO MASS SPECTROMETRY

CSIRMS can be utilized to de-convolute confounding concentrations of LMW n-alkanes possibly derived from an algal source because Z. marina is a C3 type plant with some C4 characteristics such as 13C-enriched n-alkanes



CSIRMS measurements of nC_{17} extracted from sediment from Padilla and Westcott Bays are intermediate between CSIRMS measurements of nC_{17} extracted from pure eelgrass and typical for alage, indicating that the nC_{17} is derived from a mixture of eelgrass and algae. Using the lower end of the algal range, the nC_{17} from Padilla Bay is ~50% derived from eelgrass whereas the nC_{17} from Wescott Bay is ~90% derived from algae.

12 CONCLUSIONS

Downcore oscillations in the concentrations of the LMW n-alkanes and specific ratios of lignin phenols in a sediment core from Westcott Bay in the San Juan Islands, WA, coupled with molecular markers for terrigenous organic matter indicate a natural variation in the temporal abundance of both eelgrass and terrigenous organic matter throughout the past 150 years. The data appear also to indicate a trend in the algal contribution to the sedimentary organic matter that has been increasing toward recent time.