PAR and light extinction above eelgrass, at bed surface, and beneath decks in Puget Sound, WA

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Introduction

The Photosynthetically Available Radiation (PAR) required for eelgrass survival and juvenile fish passage is influenced by the presence, size and type of suspended particles gradients in water, temperature, salinity and density gradients, concentrations of plankton, and shading by over-water structures. This project quantifies light passage through deck gratings on floating and raised structures, and assesses light penetration through the water column at different marine sites dominated by eelgrass in the Puget Sound.

Methods

① A controlled scale-model study was conducted to quantify and compare light attenuated by overwater structures constructed of different decking types that are currently available from various vendors. Odyssey™ logging light sensors were submerged in water below each decking, and compared with light reaching unobstructed sensors in a control tank. The experiments were designed to quantify the amount of light getting through each decking type to the water surface and evaluate the effect of each decking type, height above the water surface, and deck orientation on light attenuation.

ThruFlow ™ with 43% open space(TF)

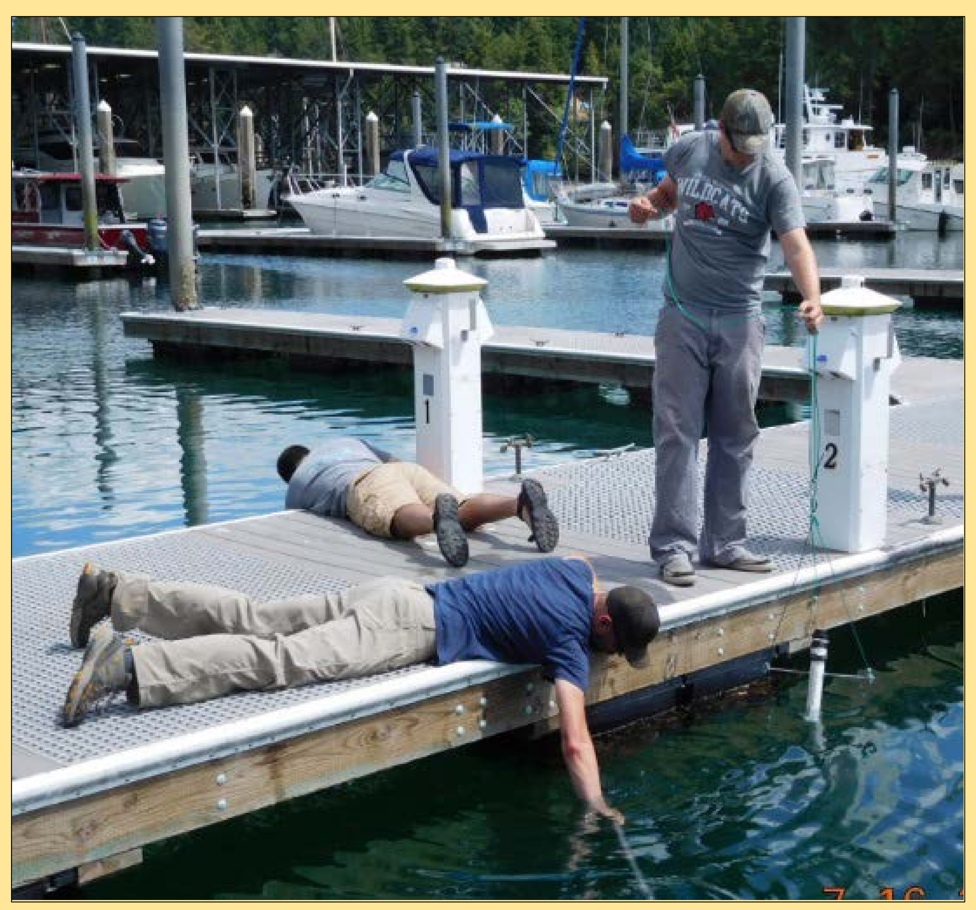
Fibergrate® pultruded with 60% open space (FP)

Fibergrate® molded with 70% open space (FM)

TrueDeck ™ SunWalk ™ with 42% open space (SW)

Micro-Mesh® with 44 % open space (MM)

② In a field investigation, light penetration through the water column was measured at nine eelgrass dominated sites in Puget Sound. A Li-Cor underwater quantum sensor (LI 192) was lowered through the water column from the water surface to the sediment bed. PAR measurements were logged at 0.5 m depth increments at each location during high tides one day in summer and one in fall.



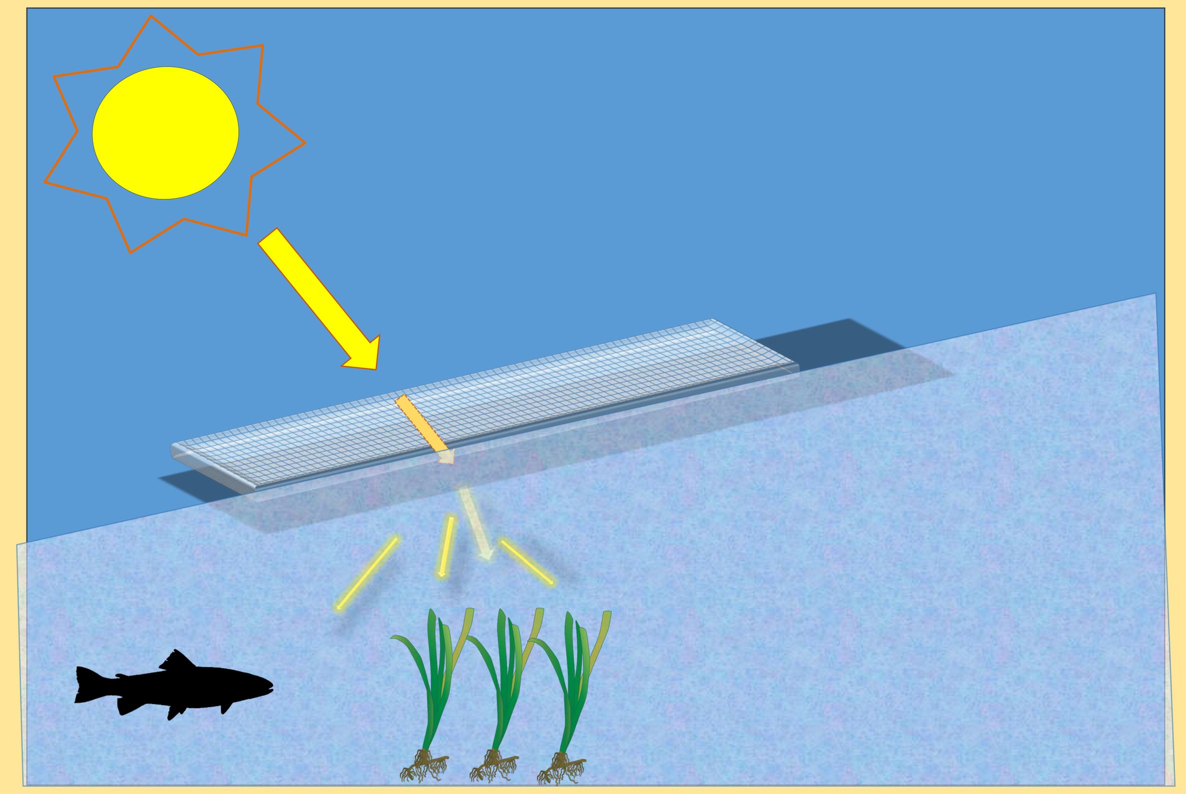
③ Light extinction coefficients were calculated and statistically compared for each sample site, tidal cycle components (i.e. ebb, flow, slack) and sun angles, demonstrating how variable light penetration is throughout the marine waters of Puget Sound.

④ Once the amount of light getting through each decking type to the water surface, I_O, is measured, shoot height data is gathered and the extinction coefficients, k, calculated, Beer's Law is applied to compute the amount of light that reaches the depth of the top if the eelgrass canopy:

$$I_D = I_O e^{-kD}$$

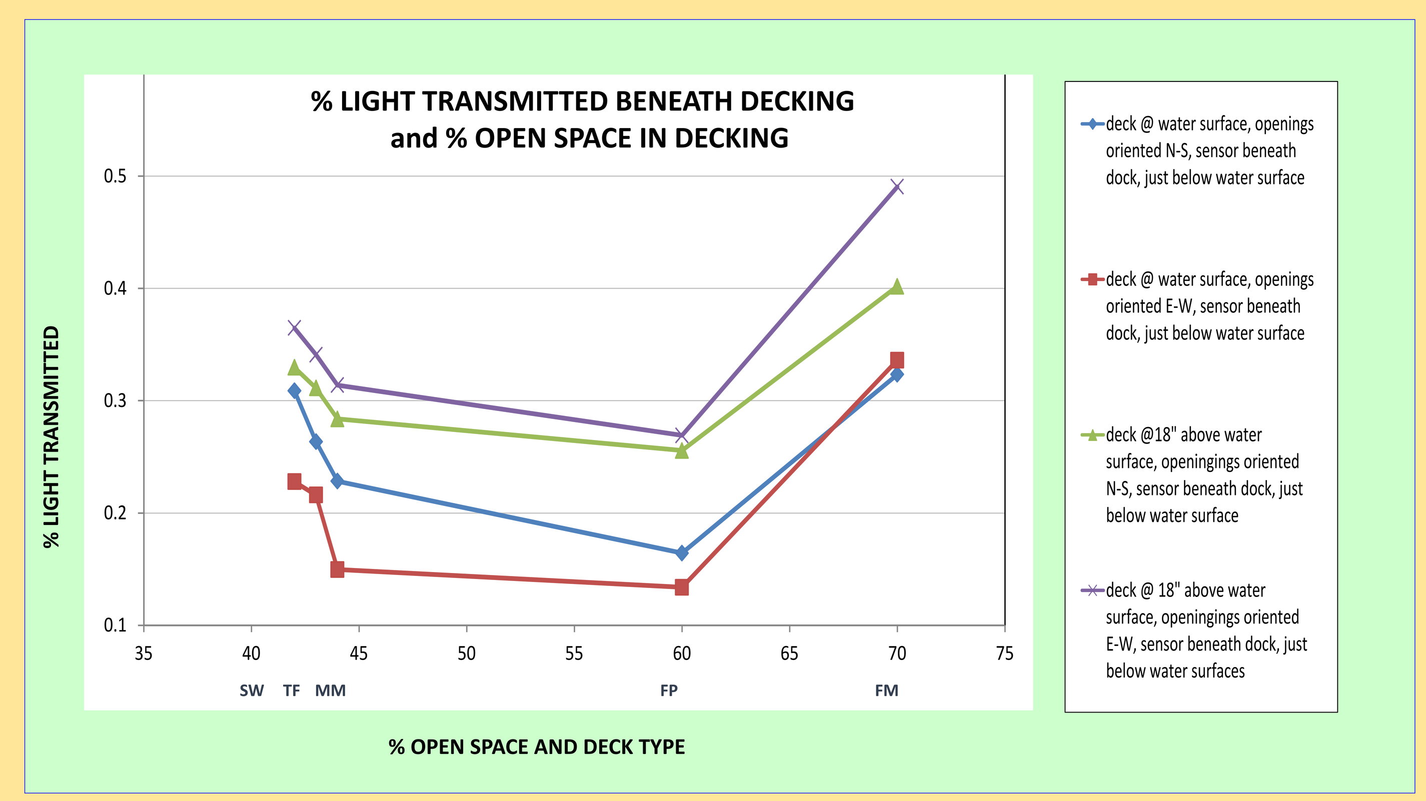
These values are then compared to the average daily minimum amount of light required for eelgrass survival

The amount of light reaching the sediment bed is also calculated and compared to light thresholds below which behavior changes have been observed in juvenile salmon.

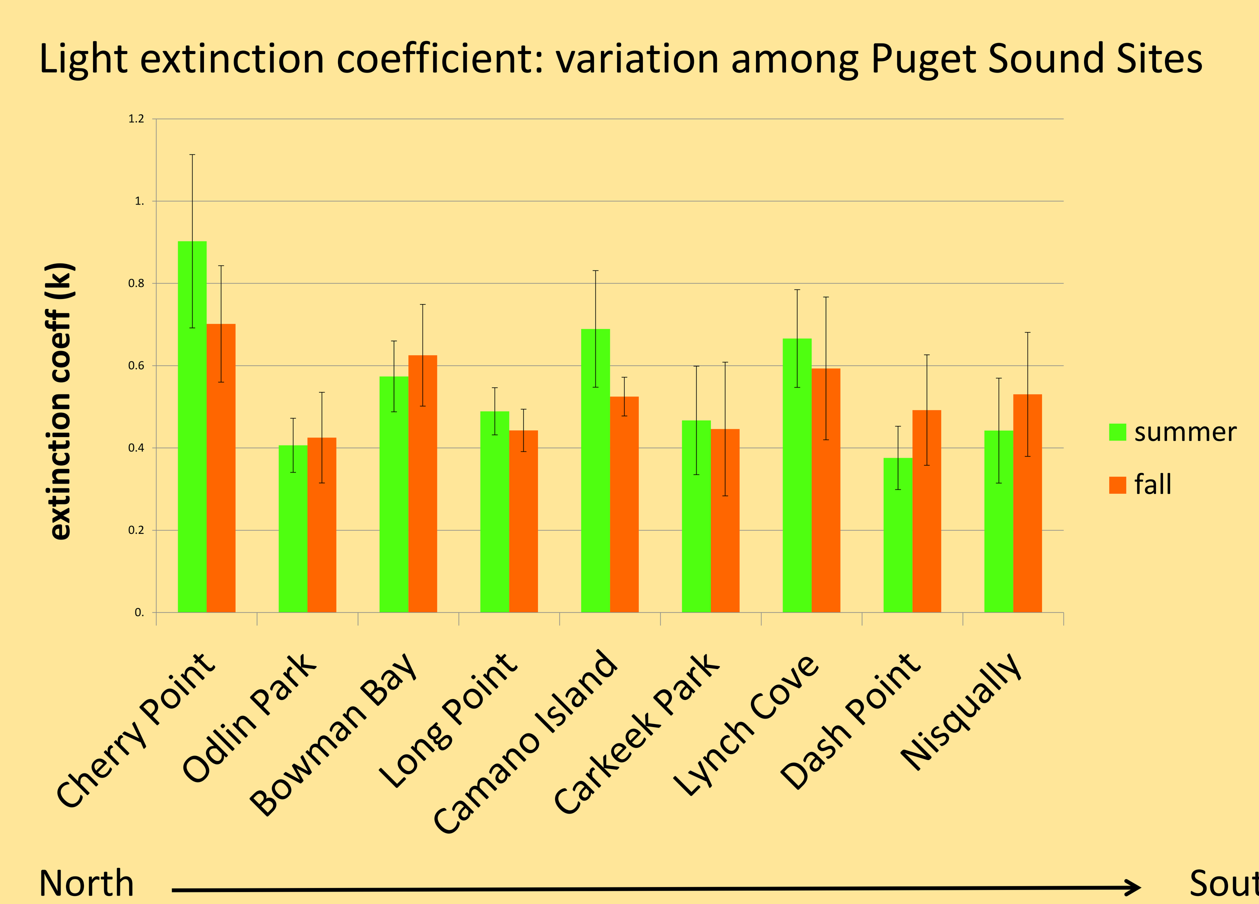


Results and Conclusions

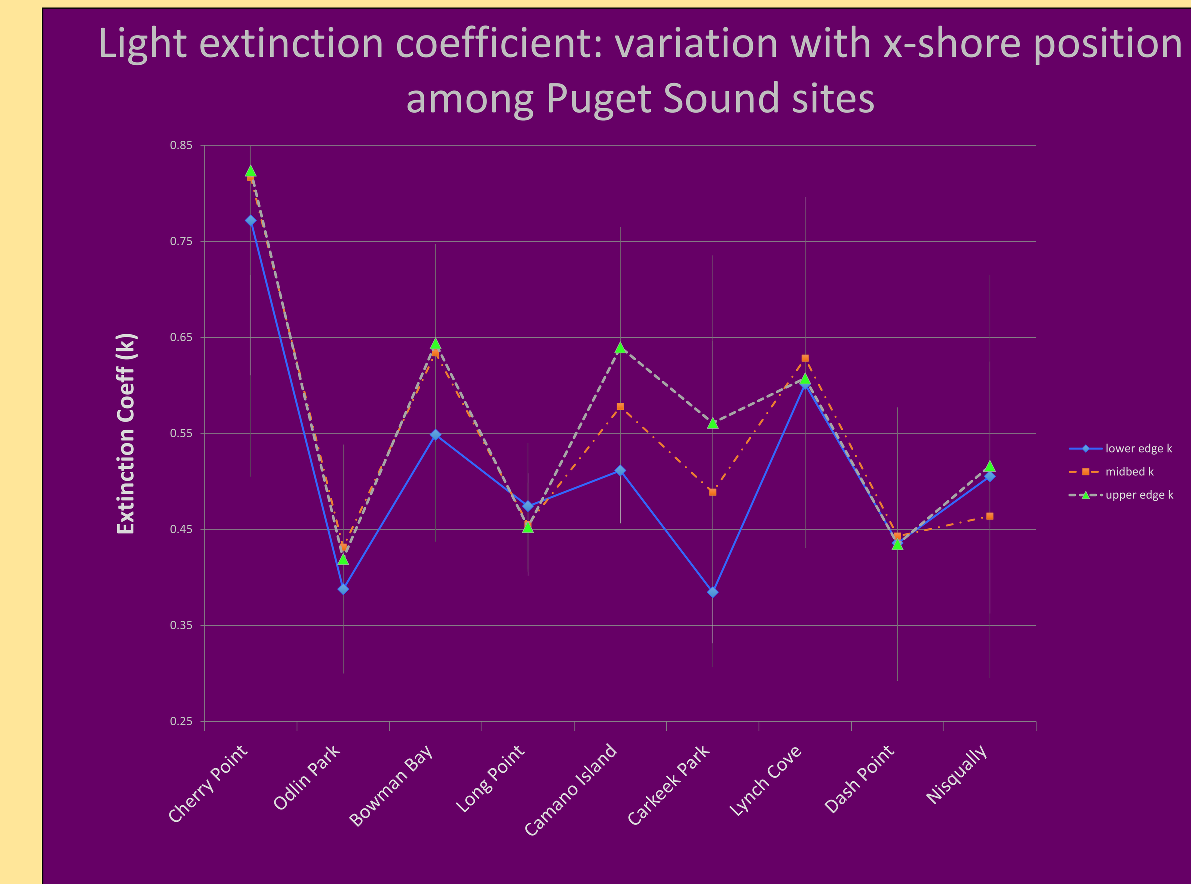
Elevation of the decks eighteen inches above the water resulted in significantly higher values of light reaching directly beneath the deck compared to decks at the water surface. There is not a positive linear relationship between amount of open space and the amount of shade cast beneath and beside a deck. The shape of the open space, the size of the open space and thickness of the decking material all affect the amount of light that passes through a deck top.

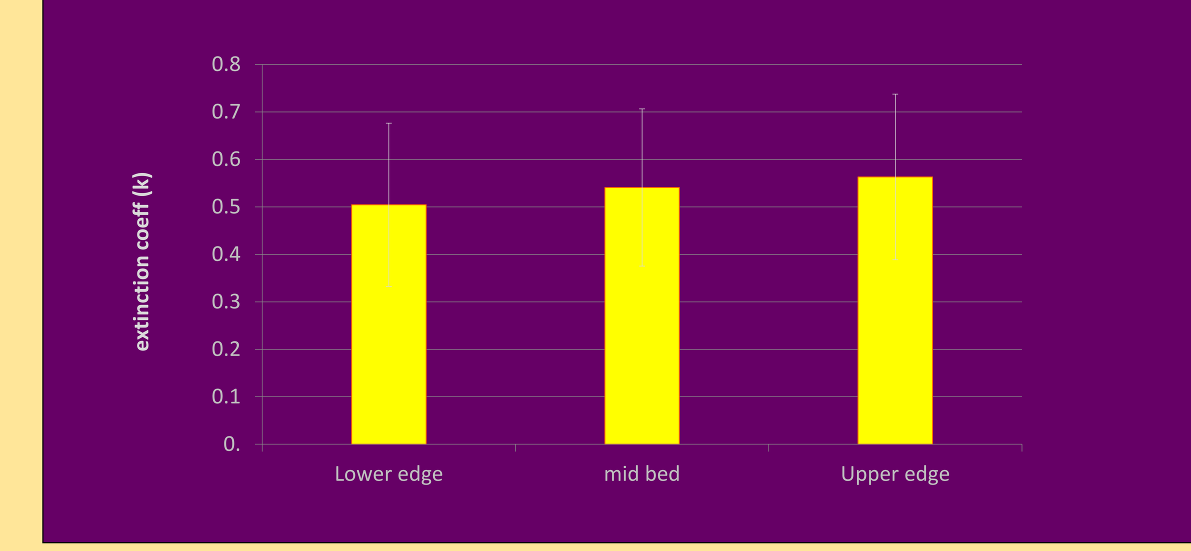


A multi-factorial Analysis of Variance with light extinction as the response variable and Puget Sound location, water-depth, cross-shore position, and season as the fixed parameters indicates that light extinction varies significantly with site, cross-shore position and water depth. The difference between light extinction measured in summer versus fall is not significant and no apparent geographic trend was observed.



Light extinction differs significantly at the three cross-shore positions at all sample sites. The extinction coefficient at the upper edge of the eelgrass bed- the more shoreward position- is consistently greater than the mid-bed and lower edge extinction coefficient values. Waves breaking along the shore and currents picking up sediment and debris in this shallower part of the beach would explain this effect.





Regardless of the percentage open space, none of the deck types investigated allow enough light to reach eelgrass canopy at all Puget Sound for *Z. marina* survival.