Comparison of light transmitted through different types of decking used in nearshore over-water structures

Aquatic Assessment and Monitoring Team
WDNR, Aquatic Resources Division

Objectives

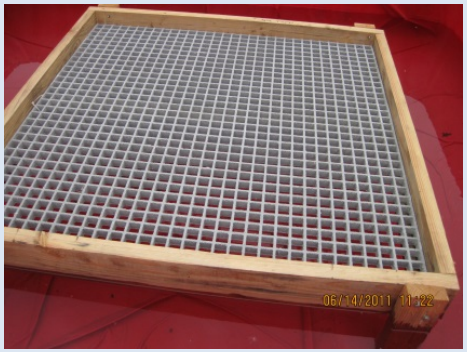
- Compare (Photosynthetically Active Radiation) PAR in shaded areas beneath and adjacent to overwater structures constructed of different decking materials to determine the relationship between decking type and PAR passing through the decking.

- Measure and compare PAR beneath and adjacent to these structures when the deck is at the water surface and elevated eighteen inches above water surface.

- Measure and compare light irradiance beneath these same over water structures oriented in north-south and in east-west orientations.

- Compare PAR measured in each treatment to empirically observed ecological thresholds to assess the effects of decking type, orientation and elevation on the frequency at which transmitted PAR fails to reach the threshold.

Decking Types



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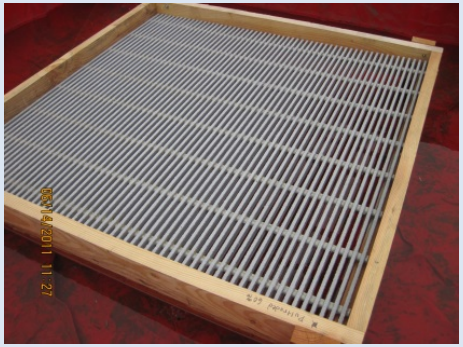

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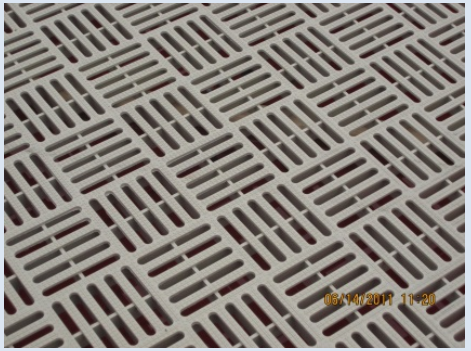

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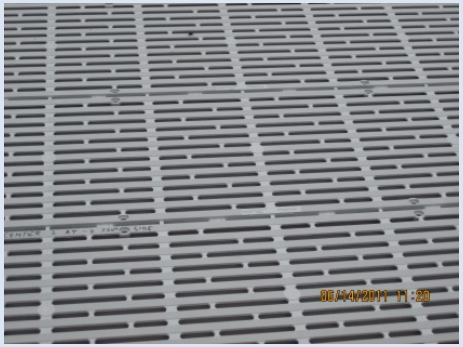

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1) Fibergrate® molded with 70% open space (FM), 2)Fibergrate® pultruded - 60% open space (FP), 3) TrueDeck ™ SunWalk ™ with 42% open space (SW), 4) ThruFlow ™ with 43% open space(TF), and, 5) Micro-Mesh® with 44 % open space (MM).

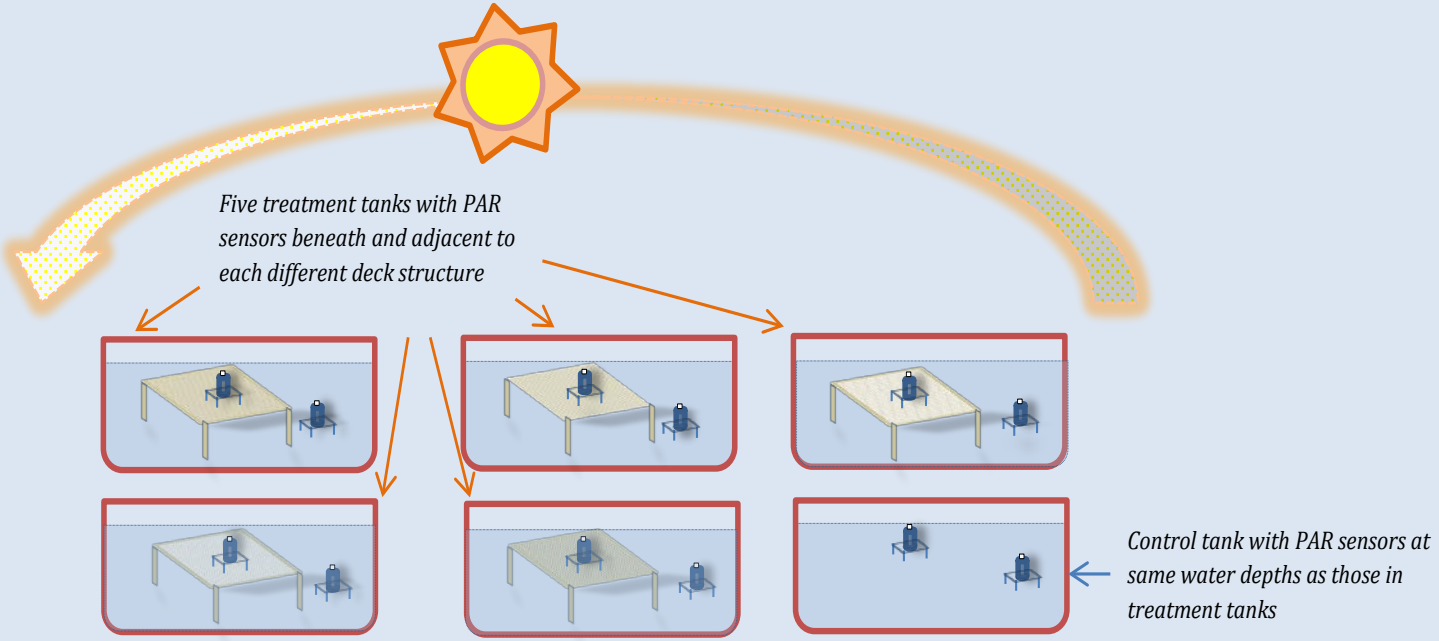
Equipment

Aqua Tank- 250 gallon capacity, 34 inch sides

Odyssey PAR sensor

Submerged, mounted PAR sensor at bottom of water tank

Controlled Experiment



The four treatments include:

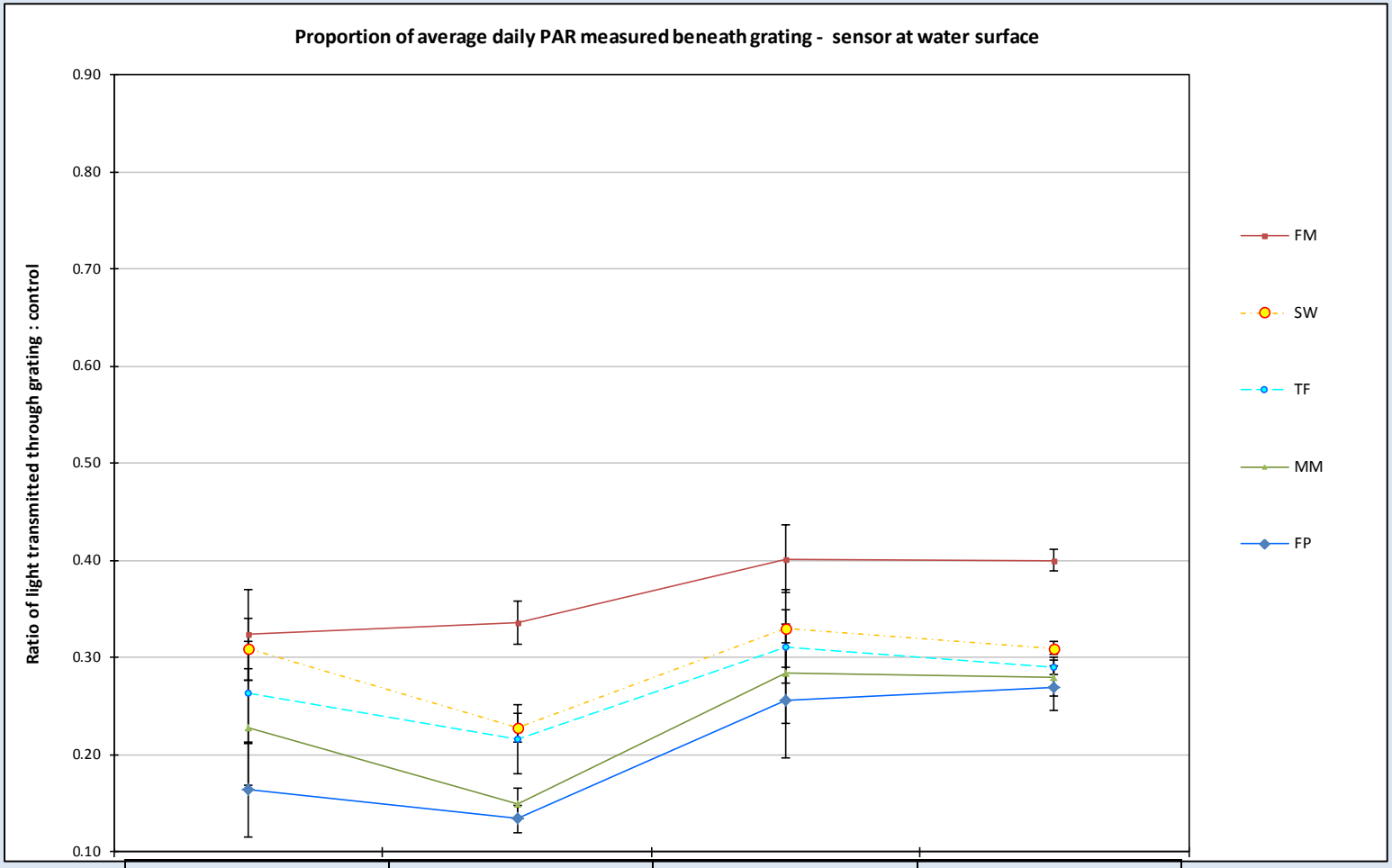
1) Deck at the water surface, long dimension of decking open spaces oriented in North-South direction;

2) Deck at the water surface, long dimension of decking open spaces oriented in the East-West direction;

3) Deck at eighteen inches above water surface, long dimension of decking open spaces oriented in the North-South direction; and

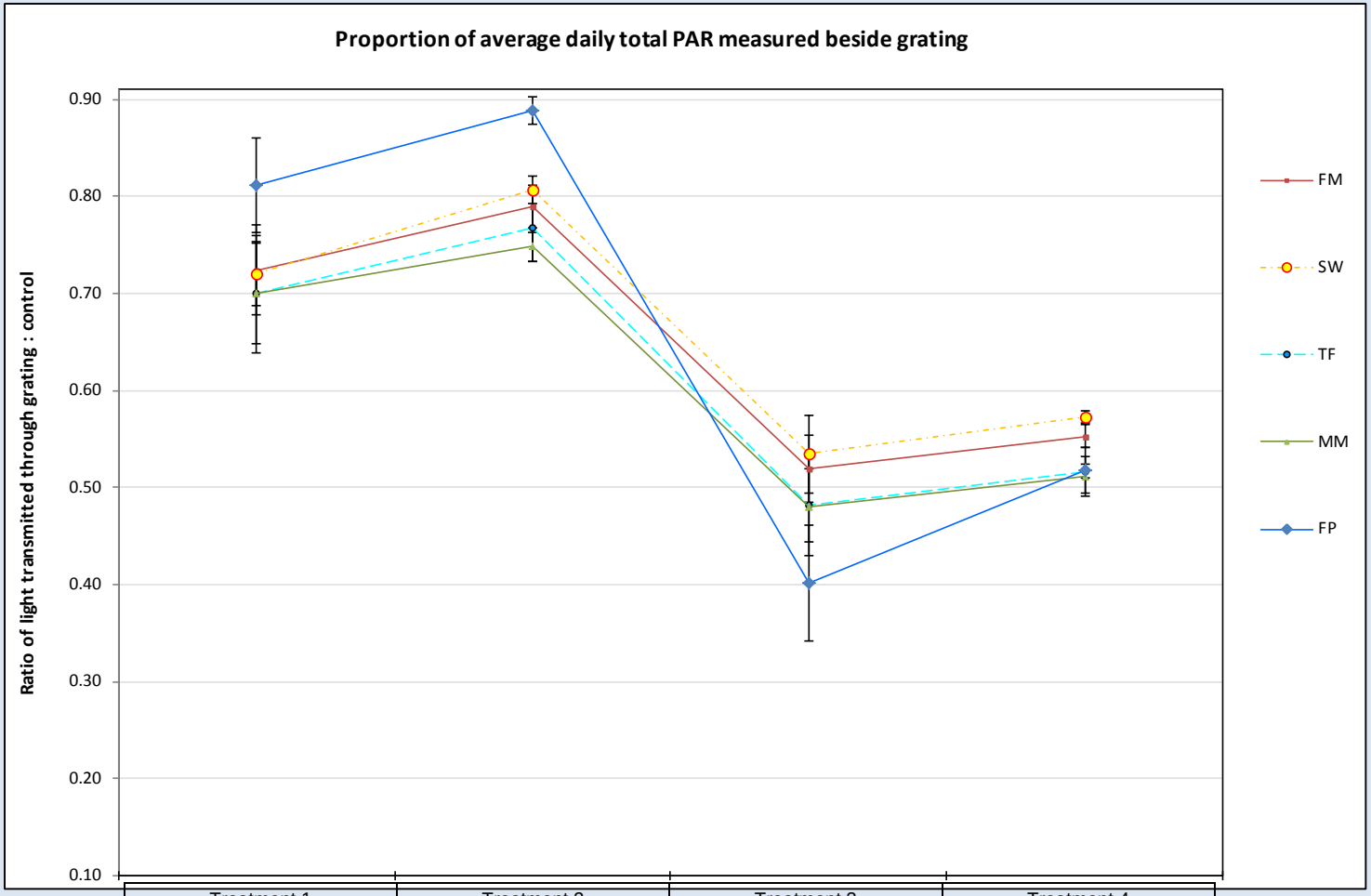
4) Deck at eighteen inches above water surface, long dimension of decking open spaces oriented in the East-West direction.

Results – beneath deck



	Treatment 1	Treatment 2	Treatment 3	Treatment 4
deck orientation	N-S orientation	E-W orientation	N-S orientation	E-W orientation
deck elevation	at water surface		18” above surface	

Results- beside deck



	Treatment 1	Treatment 2	Treatment 3	Treatment 4
deck orientation	N-S orientation	E-W orientation	N-S orientation	E-W orientation
deck elevation	at water surface		18" above surface	

ANOVA results comparing PAR measured when deck is at water surface and deck placed 18” above water surface.

Sensor position and deck open space orientation	**Deck @ H_2O surface**	**Deck 18” above H_2O surface**	ANOVA Significant difference
Beneath N-S	.26 ± .16	.32 ± . 06	Yes @ α = .10
Beneath E-W	.21 ± .10	.31 ± . 06	Yes @ α = .05
Beside N-S	.73 ± .18	.48 ± . 06	Yes @ α = .05
Beside E-W	.80 ± .10	.53 ± .06	Yes @ α = .05

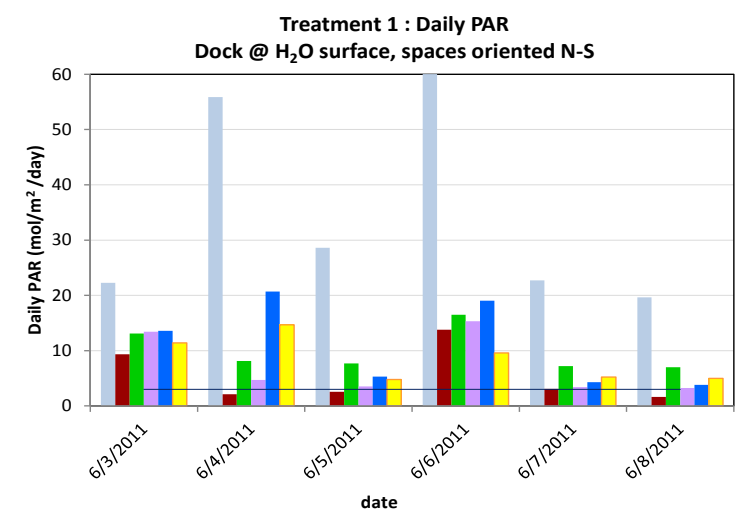
ANOVA results comparing PAR measured from sensor beside deck and sensor beneath deck

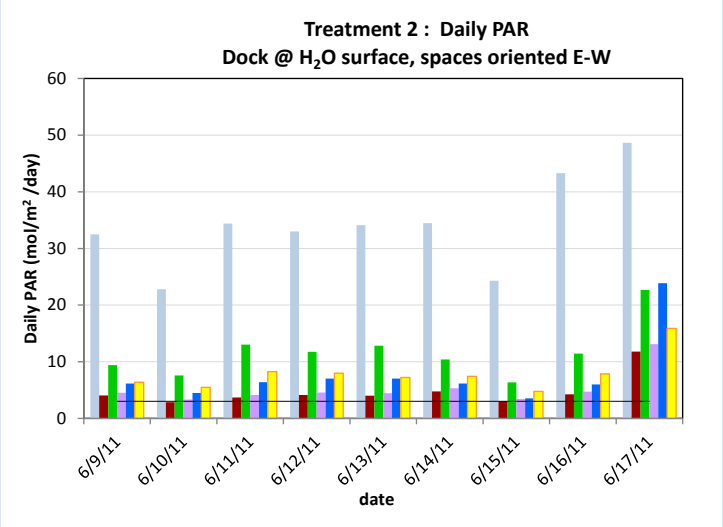
Deck elevation and open space orientation	**Sensor beside deck**	**Sensor beneath deck**	ANOVA Significant difference
@ H_2O surface N-S	.73 ±.18	.26 ±.16	Yes @ α =.05
@ H_2O surface E-W	.80 ±.10	.21 ±.06	Yes @ α =.05
18” above H_2O surface N-S	.48 ±.06	.32 ±.06	Yes @ α =.05
18” above H_2O surface E-W	.53 ±.06	.31 ±.06	Yes @ α =.05

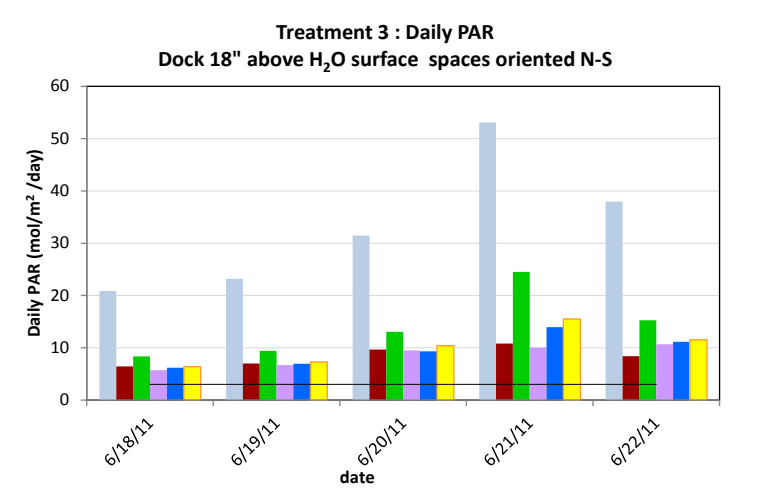
ANOVA results comparing PAR measured with open spaces oriented N-S and E-W

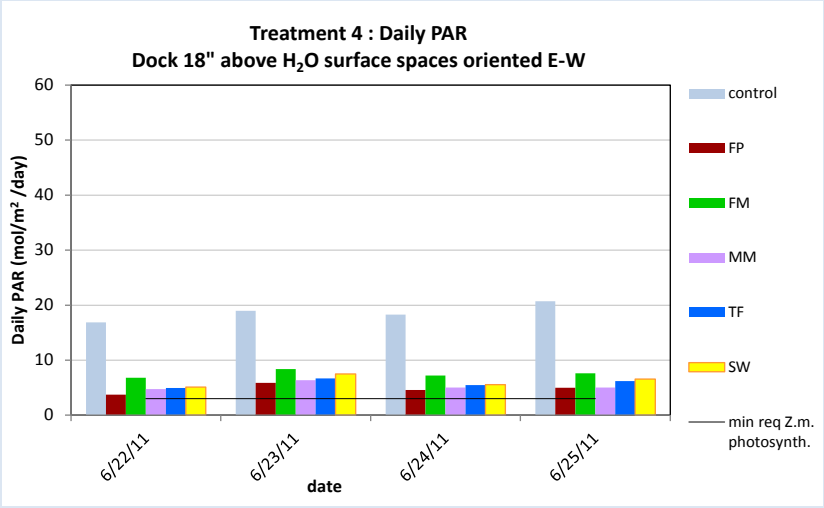
Sensor position and deck elevation	**N-S open space orientation**	**E-W open space orientation**	ANOVA Significant difference
Beneath @ H_2O surface	.26 ±.16	.21 ±.10	No @ α = .10
Beneath 18” above H_2O surface	.32 ±.06	.31 ±.06	No @ α = .10
Beside @H_2O surface	.73 ±.18	.80 ±.10	Yes @ α = .05
Beside 18” above H_2O surface	.48 ±.06	.53 ±.06	Yes @ α = .05

Compare mean total daily PAR measured <u>beneath</u> each deck type@ water surface for four different treatment scenarios to the minimum daily PAR required for *Z. marina* survival

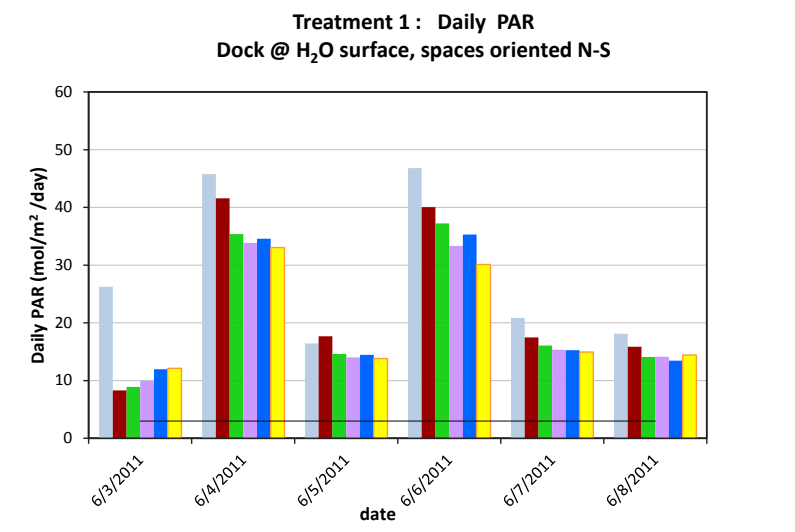


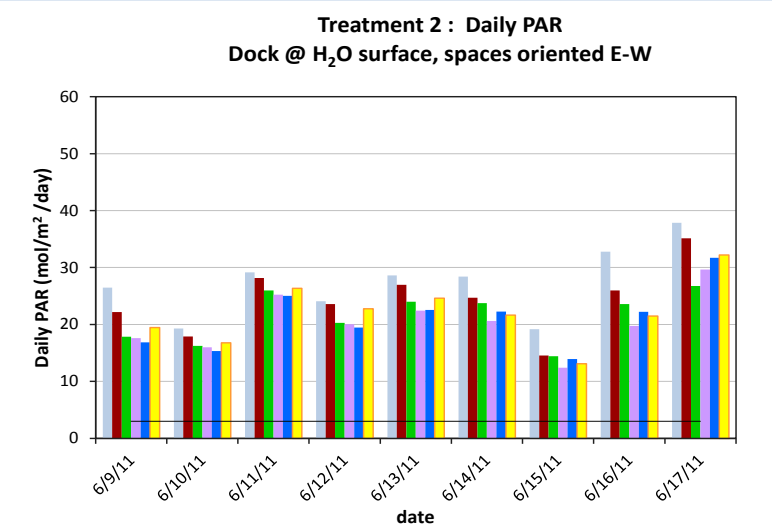


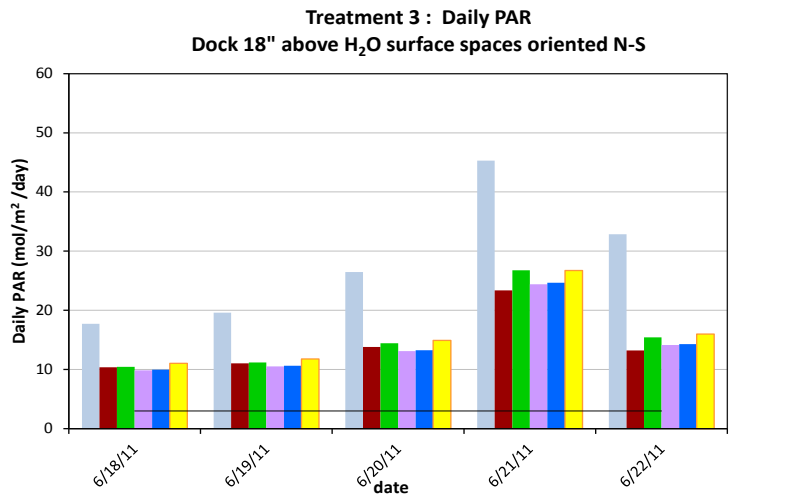


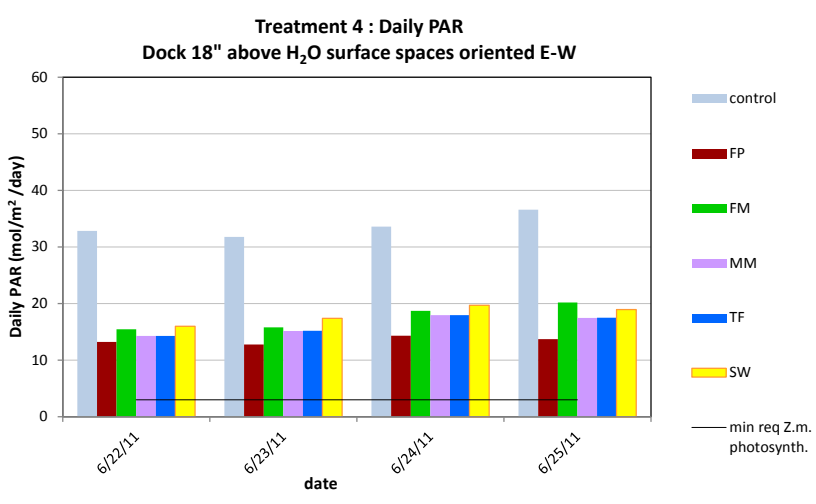


Compare mean total daily PAR measured <u>beside</u> each deck type@ water surface for four different treatment scenarios to the minimum daily PAR required for *Z. marina* survival



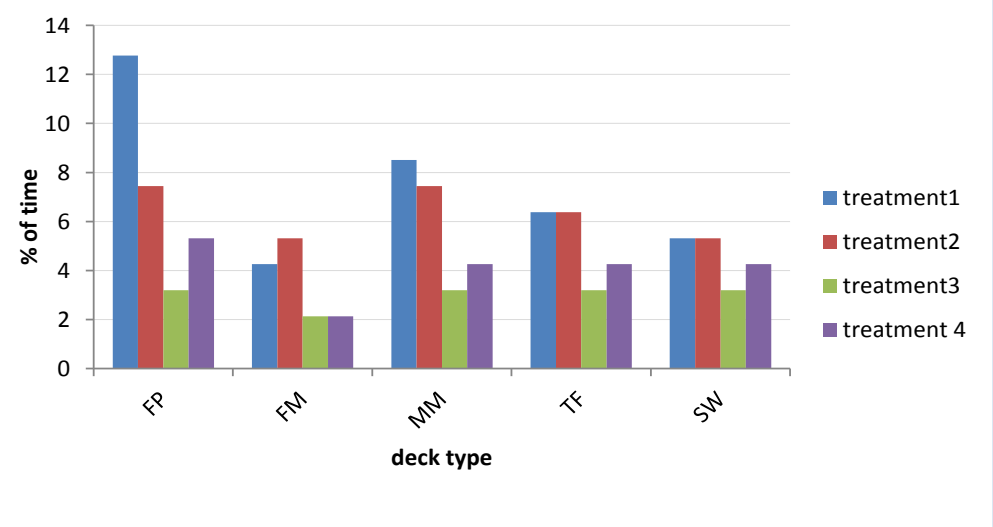




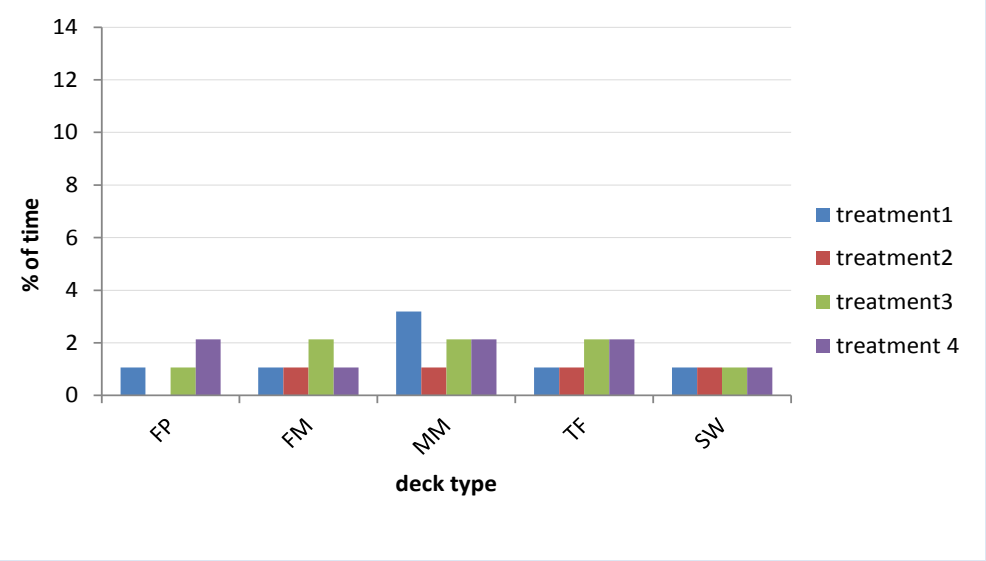


Compare percentage of time control sensor measured daily PAR values above fish behavior changing threshold of 2 µmol/m2/sec while sensor beneath or beside each deck type measured below this threshold.

Sensor beneath decking



Sensor beside decking



Discussion

The most important factor for maximizing light beneath decks is elevating the deck above the water surface..

However, raising the deck above water decreased the proportion of light reaching the sensors beside the deck.

There is not a positive linear relationship between amount of open space and the amount of shade cast beneath or beside a deck.

The orientation of the open space with respect to the arc of the sun traveled does influence the amount of light that is able to reach through the deck surface. Significantly greater PAR values were measured beside the deck when the open spaces were in the E-W direction.

Although none of the deck types reduced the amount of light reaching beneath the structure significantly below the eelgrass threshold PAR value, some of the values measured were just below or barely met the threshold value.

All deck types in all treatment scenarios blocked adequate light required for undisturbed fish behavior for some portion of the day. There was a greater percentage of time (ranging between 2-13 %~ 20 min to 2 hrs 16 hr daylight) where measured PAR values were below threshold values beneath the decks than beside the decks.

Management Recommendations

Require decks to be elevated above the water surface. Elevating the deck above the water surface increases the light available under the deck by allowing light to enter from the sides – often increasing the light intensity above the critical threshold values.

Stewardship measures that relies just on a minimum percentage open space criteria are not effective in minimizing reduction of light beneath and adjacent to docks. Requiring that a proportion of the incident radiant light to reach below water surface beneath dock would better account for the other parameters effecting light transmission including the shape, size and density of the open spaces

By orienting the longer dimension of the open spaces in the E-W direction when decks are elevated above the water reduces the shading beside structures of some decking types. To maximize light beneath entire structure, the long dimension of the structure itself should be oriented in the north-south direction,

Management Recommendations (continued)

Encourage use of the thinnest deck material and largest open spaces possible while still providing for safety, strength, and durability necessary for the structure's primary use.

It is possible to modify the design and placement of over water structures adequately to avoid reducing available light below the mean total daily PAR threshold required for eelgrass survival but not to avoid impacting light needed for fish. Modifications to avoid falling below the instantaneous PAR threshold where fish behavioral changes are observed are more complex..

Suggested Next Steps

Collect empirical data of the light extinction coefficients in WA waters. Use Beer-Lambert light extinction law to determine whether PAR needed for eelgrass survival is actually reaching eelgrass beneath these decking types.

Existing, operational docks constructed of the deck materials in this study should be instrumented with light meters and monitored in-situ over several peak solar irradiance days and compared with the study findings.

Comparing the 'before' and 'after' PAR values measured beneath and beside opaque and floating docks that are planned to be modified to include decking with open space and increased elevation above the water.