

Mitigating Impacts of Overwater Floats on Eelgrass *Zostera marina* L. in Puget Sound, Washington

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Abstract

The effects of using light-permeable deck grating on residential floats constructed over eelgrass (*Zostera marina*) was examined in the northern Puget Sound region of Washington to test the hypothesis that light permeable deck grating, inserted within the surface of a residential float would prevent loss of eelgrass underneath and adjacent to the float. Eelgrass shoot densities prior to construction of floats were compared to densities following construction at 9 sites which included 10 floats (one float had two parts that were tested separately). Each float was monitored for three years post-construction from 1991 to 1999. With up to 50 percent of the deck grating, a decline in eelgrass shoot densities was detected under four floats using ANOVA and under 6 floats using a linear regression approach. Adjacent to floats, a decline in eelgrass densities was only detected at one site. Our research suggests that grating up to 50 percent of the float deck was not by itself adequate to ensure “no net loss” of eelgrass.

We evaluated the effects of 20 attributes associated with the structure (e.g., size of vessel moored) and the surrounding landscape (e.g., density of the eelgrass and height of the float over the eelgrass) on changes in eelgrass density. There was no clear relationship between the overall number of positive or negative attributes and changes in eelgrass shoot density under floats. Rather, our results suggested that compass orientation of the float and seasonal removal of the float (i.e., removing the float during some months of the year) had an important influence on changes in eelgrass density under the float.

Presently, the only way to ensure that a float will not impact eelgrass is to not build the float or to avoid sites with eelgrass. Grating >50 percent of the deck surface in combination with floats oriented N/S and/or seasonally removed may successfully avoid impacting eelgrass density. Further research is needed to better define how to mitigate impacts of floats on eelgrass. We recommend that further studies focus on testing how the interaction between float grating (>50 percent), float orientation and float seasonality can be used to avoid impacts to eelgrass.

Introduction

In parts of Puget Sound, shoreline development has resulted in the loss of eelgrass (*Zostera marina* L.) (Thom and Hallum 1990). One source of eelgrass loss is overwater structures, which cover the surface of the water, potentially affecting the submarine light environment and reducing eelgrass cover. Reductions in the amount of light reaching eelgrass can affect plant density, vigor, and size (both length and width), and, in the worst case, eliminate seagrass from beneath a structure (Dennison 1987; Zimmerman and others 1991; Abal and others 1994; Zimmerman and others 1995).

While particular design features of overwater structures can potentially reduce or avoid impacting eelgrass (Burdick and Short 1999; Shafer 1999; Beal and Schmit 2000), there is little data available on the effectiveness of most potential approaches. The primary objective of this study was to test the hypothesis that constructing floats with deck grating to allow more light to reach under the structure would result in no net loss in the amount of eelgrass underneath and adjacent to the float. Our study focused on floats because this type of structure, rather than a fixed dock, is commonly placed over the eelgrass zone during the construction of overwater structures in Puget Sound. Floats are used because of the extreme tidal range (over 3m) that occurs in this area. As a result, management practices that can mitigate impacts of fixed height structures (e.g., increasing the height of the float over the eelgrass—Burdick and Short 1999), will not work on floats. A secondary objective of this study was to evaluate how other float and environmental attributes affected eelgrass density underneath and adjacent to the float.

Methods

All structures examined in this study were located in San Juan and Whatcom counties of northern Puget Sound. Ten sites were evaluated in this study; one site had two float components that were tested separately. The effects of deck grating were tested between 1991 and 2000 by comparing eelgrass densities before and after floats were built to densities in adjacent control areas. Baseline and three years of post-project monitoring at each float site was done with divers approved by the Washington Department of Fish and Wildlife (Fish and Wildlife). At each structure, divers swam transects that were randomly selected within discrete quadrates located: (1) under the float's centerline; (2) within about one structure width to each side of the float; and (3) in an undisturbed control area. Along each transect, eelgrass density was measured at randomly selected stations.

One-way analysis of variance (ANOVA; $\alpha=0.05$) was used to test if there was a significant change in average shoot density at stations under and adjacent to each float and at site-specific control stations over the four years each float was studied. For each float, a linear regression was also used to test if there was a change in shoot density over time.

Twenty different attributes that we believed would individually or in combination influence the light environment and hence eelgrass density and distribution were characterized at each float site. Attributes were scored as either having a positive (1), negative (-1), or neutral (0) influence. A numerical eelgrass bed quality metric (after Burdick and Short 1999) was computed for eelgrass underneath the floats by first computing the mean shoot density underneath the floats, three years after the floats were constructed. This value was then divided by the mean shoot density measured at the same stations, before the float was installed. The same pattern was followed to compute the metric for eelgrass adjacent to the float. Attributes were then correlated to the eelgrass bed quality metrics.

Results and Discussion

The results of the ANOVA (Table 1) indicated that a significant change in eelgrass shoot densities occurred under floats at six sites (1,2,5a,7, 8 and 10). An increase in eelgrass density occurred under float 8 while a decrease occurred at the other five sites. For stations adjacent to the floats, a significant loss was detected at sites 7 and 10 (Table 1) and a significant increase at floats 1 and 4. At control sites, a significant increase was detected at float 4 and a significant decline occurred near float 10. Based upon a comparison of changes under floats and at control stations, a float effect was indicated for floats 1,2,4,5a and 7. Adjacent to floats, an effect of the float is indicated at sites 1 and 7.

Using linear regression, a significant decline in shoot densities was detected under 7 floats (sites 1,2,5a,6,7, 9 and 10) (Table 2). A significant increase was not detected at any site.

Results of this study demonstrate that grating up to 50% of a float deck will not, in and of itself, consistently or predictably avoid impacts to eelgrass under the float. This amount of grating is thus not a sufficient way of achieving "no net loss" of eelgrass. If enough of a float deck is grated (>50%) and not obstructed (i.e., covered by skiffs or kayaks), shading impacts to eelgrass under the float should be

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avoidable. Features such as expected wind and currents, vessel size being moored and bottom topography will all influence the amount of a float that can be grated and still maintain structural integrity.

Although grating by itself was insufficient at avoiding shading impacts, eelgrass, albeit in reduced densities at some sites, was able to grow under all floats. Often, when ungrated floats have been used in the northern Puget Sound area, eelgrass has been eliminated from directly under the structure (Fish and Wildlife unpublished data). Of the 11 floats we examined, no impact was detected at 6 floats (ANOVA). In addition, at only one float was there nearly a total loss of eelgrass and that can probably be explained, at least in part, by the float directly grounding on the eelgrass. Light permeable grating thus improves the light environment underneath and adjacent to floats by mitigating effects of the “shadow” cast by the float.

Apparently, other site-specific attributes associated with the floats and the surrounding environment act singly or in combination to determine the overall impact of the structure on the eelgrass. The results of the correlations between attributes and the eelgrass density metric revealed that under float eelgrass bed quality was correlated with unobstructed grating ($r= 0.57$), float removal (whether the float was removed during fall and winter) ($r= 0.87$), and compass orientation of the float ($r= -0.72$). In addition, the quality of the bed near the float was correlated with unobstructed grating ($r= 0.50$), compass orientation of moored vessels ($r= -0.50$), float removal ($r= 0.50$) and compass orientation of the float ($r= 0.68$). Our study is the first to identify float removal as a potential mitigation measure in construction of overwater structures. The effect of orientation is similar to the results of studies in Massachusetts, Florida and Alabama, which found that as the structure’s orientation becomes more north-south, impacts to seagrasses were significantly reduced (Burdick and Short 1999; Shafer 1999; Beal and Schmit 2000).

We are encouraged by the success of grating. Grating, especially when used in combination with other design aspects (e.g., orientation), holds promise as a method that can be used avoid impacts to seagrasses. Further research is needed to more fully evaluate these and other possible mitigation approaches.

Table 1. Summary table of ANOVA P-value statistics for under float, near float, and control stations over the four years of the study. A single asterisk means shoot counts were significant at $p<0.05$. The near float and control values are the same for 5a and 5b.

Float	Under Float	Near Float	Control
1	0.01*	0.01*	0.40
2	0.01*	0.91	0.76
3	0.53	0.88	0.99
4	0.17	0.00*	0.00*
5a	0.00*	0.27	0.42
5b	0.23		
6	0.63	0.06	1.00
7	0.01*	0.00*	0.09
8	0.00*	0.11	0.05
9	0.11	0.08	0.23
10	0.01*	<0.01*	0.01*

A * indicates a significant difference at $\alpha < 0.05$.

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Table 2. Results of linear regressions testing for significant changes over time for under float stations ($\alpha \leq 0.05$).

Float	F	(α level)	r^2
1	19.60	0.0002	0.47
2	11.35	0.007	0.53
3	1.74	0.20	0.07
4	0.002	0.97	0.0002
5a	18.11	0.0002	0.38
5b	1.38	0.26	0.07
6	8.75	0.008	0.33
7	12.57	0.005	0.56
8	0.22	0.65	0.02
9	8.48	0.006	0.20
10	16.98	0.001	0.55

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