# Newport Commercial Marina Section 107 Navigation Project

## Integrated Feasibility Report and Environmental Assessment

## Appendix D – Eelgrass Modeling and Mitigation Plan

US Army Corps
of Engineers®
Portland District

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**Contents**



## Tables

## Figures

# 1 Avoidance and Minimization Measures

To reduce potential adverse effects of project alternatives to eelgrass, the following or equivalent avoidance and minimization measures have been incorporated into the planning process or would be included as part of project implementation. For unavoidable losses to existing eelgrass beds, the Corps and Port sponsor are proposing mitigation measures consistent with Corps policy for planning studies (i.e., see Engineer Regulation ER 1105-2-100 and ER 1105-2-103) and as authorized by Congress under Section 906 of the Water Resources Development Act (WRDA) of 1986.

- An eelgrass survey was conducted to determine the extent of eelgrass in the Action Area. This survey identified the boundaries and spatial distribution of existing eelgrass beds relative to the tidal elevation and the proposed dredging footprint. The Tier I survey used a combination of side-scan sonar and SCUBA to map eelgrass in the project vicinity that could be affected by proposed activities (MTS 2023).
- For planning purposes, estimates for the area of direct and indirect effects to eelgrass will be based on surveys in the port dock area that were completed in August 2023 (MTS 2023)
- Alternatives will avoid existing eelgrass beds to the maximum extent practicable, while still achieving project purposes.
- The project will seek offset measures (e.g., eelgrass transplanting, planting, etc.) for any unavoidable loss of eelgrass due to project activities.
- A Corps-approved model has been developed to compare the suitability between site(s) proposed for potential eelgrass habitat creation or enhancement with that of site(s) where eelgrass is likely to be directly affected by proposed dredging activities. The model will help estimate the area needed to offset adverse effects to existing beds.
- During the feasibility stage, the Corps and Port sponsor will estimate direct and indirect effects to eelgrass based on the project footprint, identify potential areas for eelgrass offset measures, and use the aforementioned model to provide tentative estimates for the acreage targets for offsetting eelgrass impacts.
- After construction, a post-action survey of the eelgrass habitat in the Action Area and at an appropriate reference site(s) would be completed. Surveys would take place within 30 days of completion of construction, or within the first 30 days of the next active growth period that follows completion of construction and occurs outside of the active growth period.
- Any future eelgrass surveys will be conducted between May 1 and September 31 to ensure overlap with the growing season, or period when shoots would be most abundant and readily observable.
- Monitoring to achieve a successful mitigation project will include eelgrass surveys to confirm the spatial extent, plant survival, and eelgrass density within newly established beds at least annually, along with concurrent monitoring of those same metrics within a reference eelgrass bed to be identified at the start of implementation.

# 2 Model to Assess Eelgrass Habitat Suitability

There is no singular Corps-approved model for eelgrass. However, there are Corps studies (e.g., East San Pedro Bay Ecosystem Restoration) that have developed their own models to evaluate the effects to eelgrass or other submerged aquatic vegetation. The Corps decided to adapt the eelgrass component of the Bay Model for the Newport Commercial Marina Section 107 Navigation Project Feasibility Study because it focused on the same genus of seagrass seen in Yaquina Bay (i.e., Zostera) and was tailored to conditions found in a Pacific coast estuary, but at a lower latitude.

The Southern California Coastal Bay Ecosystem Model (i.e., Bay Model) was developed for the East San Pedro Bay Ecosystem Restoration Feasibility Study in Long Beach, California (USACE 2018). The Bay Model is a quantitative ecological model that was used to estimate the benefits associated with proposed restoration activities. The full model included a series of habitat-specific linear equations to calculate habitat suitability for multiple habitat types found in East San Pedro Bay (USACE 2018). For our purposes, the Corps focused solely on the eelgrass sub-model which identified four critical parameters for determining eelgrass habitat suitability: 1) circulation (i.e., water velocity), 2) water depth, 3) substrate, and 4) water temperature. Salinity was also deemed important, but similar to the assumption the Corps would make for the Newport CAP Study, it was conceptually a go/no go point within the conceptual model. Practically, all alternatives under consideration in the Newport CAP study are located in lower Yaquina Bay where typical salinities fall well within the acceptable range for eelgrass (Nelson 2009). Prior studies indicate the salinity in the lower reach of the Yaquina estuary (i.e., approximately from the Yaquina Bay Bridge to the upstream edge of Sally's Bend) likely falls between 27 and 34 practical salinity units (PSUs) (Kentula and DeWitt 2003, Lewis et al. 2019). The remaining parameters included within the Bay Model, with corresponding response curves updated according to the range of suitable values specific to Yaquina Bay, are presented below.

## 2.1 Literature Review

The Corps conducted an extensive literature review and sought the expertise of local experts in adapting the model for our purposes. Table 2-1 summarizes key studies and their findings related to the four parameters included in the Bay Model and specific considerations for *Z. marina* in Yaquina Bay.

***Table 2-1. Literature references for Zostera marina Yaquina Bay habitat in terms of circulation, water depth, substrate, and temperature.***

| **Reference** | **Focal Species** | **Study Location** | **Findings Related to Water *Circulation (i.e., velocity)*** |
|---|---|---|---|
| Brown 2009 (review) | *Z. marina*<br><br>*T. testudinum*<br><br>*Z. noltii* | Multiple | Optimal water velocity between 10 and 35 cm/sec; Diffusional limitation at < 5 cm/sec; Sediment deposition on leaves at < 8 cm/sec; Sediment erosion causing exposure of roots and rhizomes at 50-150 cm/sec; Physical damage to plants at ≥ 70 cm/sec; Threshold for damage at 33-85 cm/sec |
| Koch et al. 2001 (review) | *Z. marina* | Multiple | Minimum current velocity of 3 cm/sec required for Z. marina growth and occurrence; Current velocity < 180 cm/sec needed for Z. marina growth and occurrence |
| **Reference** | **Focal** | **Study** | **Findings Related to *Depth*** |

| | Species | Location | |
|---|---|---|---|
| Lee & Brown 2009 | *Z. marina* | Yaquina Bay | Aerial photography detects *Z. marina* to a depth of approximately 6 feet (1.8 meters) below Mean Lower Low Water (MLLW). Approximately 90% of the intertidal and shallow subtidal *Z. marina* classified from the orthophotography images occurred within the depth range -3.0 ft to +3.0 ft (-0.9 m to +0.9 m) MLLW. |
| **Reference** | **Focal Species** | **Study Location** | **Findings Related to *Temperature*** |
| Kaldy et al. 2015 | *Z. marina* | Yaquina Bay | Temperature monitoring near *Z. marina* plants near Idaho Point were typically (30-100% of the time) exposed to temperatures below 12$^{o}$C and no temperatures were recorded above 30$^{o}$C. The temperature range was between 5.1 and 22.8$^{o}$C at *Z. marina* sites. |
| Magel et al. 2022 | *Z. marina* | Willapa Bay, Washington and Netarts Bay, Yaquina Bay, and Coos Bay, Oregon | Average water temperatures in Yaquina Bay during the summer (July/August) growing season ranged between 9 and 13$^{o}$C from 2006 to 2019. Summer eelgrass biomass showed a positive relationship with water temperature across all years. |
| Kaldy 2014 | *Z. marina* | Yaquina Bay | Manipulative temperature experiments conducted on Z. marina transplants from Yaquina Bay found leaf growth metrics had linear, positive relationship with increasing water temperature (range of 4-25$^{o}$C); However, plants exposed to 18$^{o}$C and 25$^{o}$C experienced more wasting disease that those at 10$^{o}$C |
| Lee et al. 2007 (review) | Multiple seagrass species, including *Zostera* | Multiple | Temperate seagrass species exhibit optimal growth between 11.5$^{o}$C and 26$^{o}$C |
| **Reference** | **Focal Species** | **Study Location** | **Findings Related to *Substrate*** |
| Lee & Brown 2009 | *Z. marina* | Yaquina Bay | Sediment characteristics of Yaquina Bay is 37.9 % fines (median) (Table 7-2). Approximately 50-100% of intertidal zone in Yaquina Bay is composed of 40-90 % fines (Fig 7-10). |
| Kaldy & Lee 2007 | *Z. marina* | Yaquina Bay | Sediments in Yaquina Bay consist of 80–90% sand, 5–10% clay and 5–10% silt. |

## 2.2 Key Findings and Adjusted Model Curves

### 2.2.1 Modified Circulation Curve - Yaquina Bay Eelgrass HSI Model

The Corps initially adjusted the circulation curve included in the Bay Model to ensure HSI values remained below the maximum suitability of HSI = 1. The Corps then revised the overall curve to reflect threshold values reported in reviews of studies conducted throughout the Pacific northwest. The Corps translated the summary figure from Brown (2009, Figure 2-1) and complimentary findings from Koch 2001 into a table with water velocity ranges and corresponding suitability scores based on the projected eelgrass response (Table 2-2). Figure 2-2 shows the differences between the water circulation response curve in the original Bay Model, with slightly revised equations (Figure 2-2), and the new curve for the Newport CAP study based on ranges presented in the table.

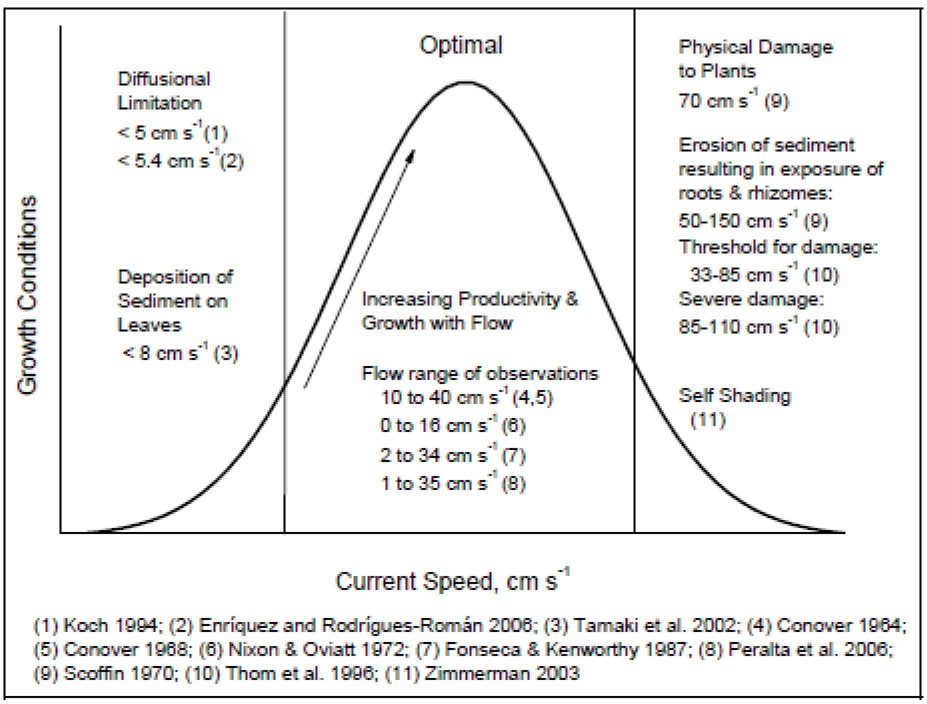


***Figure 2-1. Growth conditions of seagrass as function of current speed, adapted from Brown 2009.***

***Table 2-2. Water velocity ranges and eelgrass habitat suitability for Yaquina Bay.***

| Water Velocity (cm) | Water Velocity (m) | ***Inferred*** HSI |
|---|---|---|
| <3 cm/sec | 0.02 | 0 |
| 3-5 cm/sec | 0.03 | 0.1 |
| 5-8 cm/sec | 0.05 | 0.25 |
| 8-10 cm/sec | 0.08 | 0.5 |

| | | |
|---|---|---|
| 10-35 cm/sec | 0.10 | 1 |
| 35-70 cm/sec | 0.40 | 0.5 |
| 70-85 cm/sec | 0.70 | 0.25 |
| 85-110 cm/sec | 0.85 | 0.15 |
| 110-150 cm/sec | 1.10 | 0.1 |
| 150-180 cm/sec | 1.50 | 0.05 |
| >=180 cm/sec | 1.80 | 0 |

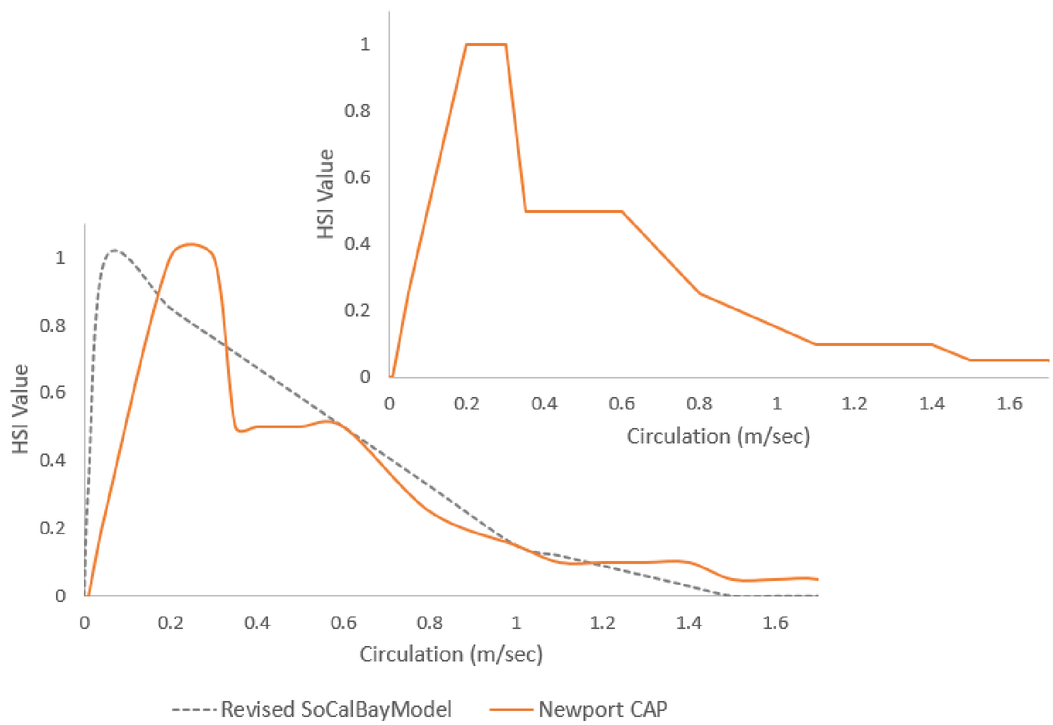


***Figure 2-2. Eelgrass circulation HSI curve for the original Bay Model and Newport CAP study, with inset showing the Newport CAP study curve without a smoothing function applied to the result.***

### 2.2.2 Modified Depth Curve - Yaquina Bay Eelgrass HSI Model

Unlike East San Pedro Bay, most *Z. marina* habitat in Yaquina Bay is found in shallow intertidal areas of the lower bay. A study based on aerial imagery estimated that approximately 91% of *Z. marina* with the Yaquina Estuary occurs from -0.9 m to 0.9 m MLLW, and roughly 98% occurs in the range from -1.8 to 1.8 meters (-6 to 6 feet) MLLW (Young et al. 2009). The Corps referenced the frequency of occurrence presented by Young et al. (2009) and inferred suitability based on the relative distribution of eelgrass detected in the given depth range. The Corps assumed maximum habitat suitability from -0.6 to 0 meters MLLW, with suitability tapering off on either side of that range. The Corps assigned suitability scores in a similar fashion as the frequency distribution curve, with a higher frequency of occurrence indicative of greater suitability (Figure 2-3).

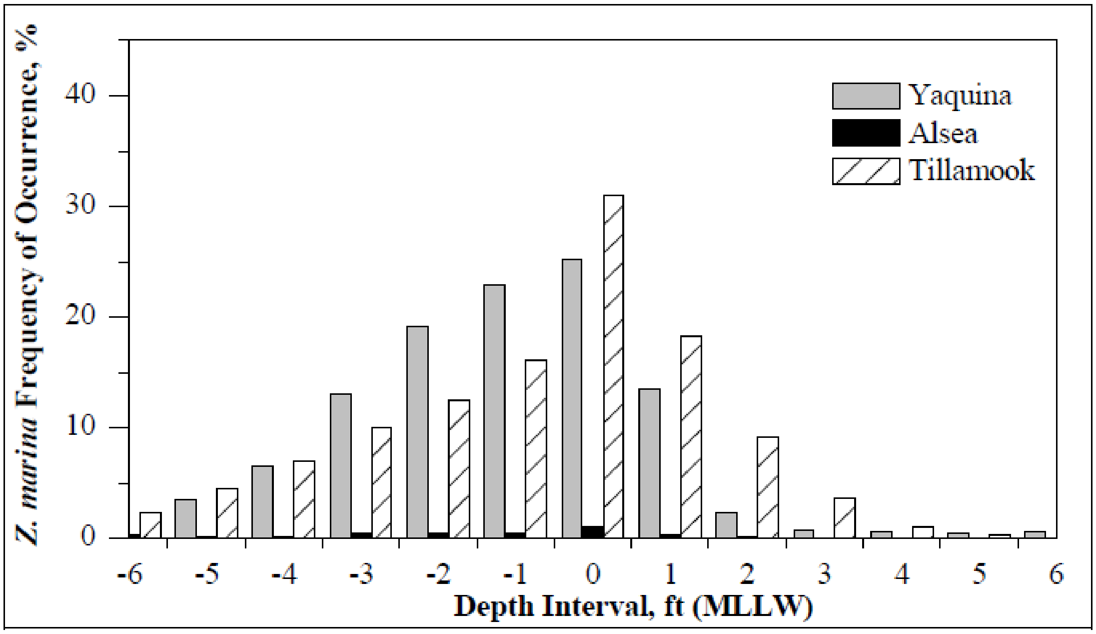


***Figure 2-3. Frequency of occurrence of eelgrass over the given depth range in three Oregon coast estuaries, adapted from Young et al. 2009.***

***Table 2-3. Estimated Z. marina frequency of occurrence and inferred habitat suitability relative to water depth (MLLW).***

| Water Depth (ft) | Water Depth (m) | ***Approximate*** Frequency of Occurrence | ***Inferred*** HSI |
|---|---|---|---|
| -7 | -2.1 | 0% | 0 |
| -6 | -1.8 | 0% | 0 |
| -5 | -1.5 | 4% | 0.1 |
| -4 | -1.2 | 7% | 0.25 |
| -3 | -0.9 | 13% | 0.5 |
| -2 | -0.6 | 19% | 1 |
| -1 | -0.3 | 22% | 1 |
| 0 | 0.0 | 25% | 1 |
| 1 | 0.3 | 13% | 0.5 |
| 2 | 0.6 | 3% | 0.1 |
| 3 | 0.9 | 1% | 0.05 |
| 4 | 1.2 | 1% | 0.05 |
| 5 | 1.5 | 1% | 0.05 |
| 6 | 1.8 | 1% | 0.05 |

| Water Depth (ft) | Water Depth (m) | ***Approximate*** Frequency of Occurrence | ***Inferred*** HSI |
|---|---|---|---|
| 7 | 2.1 | 0% | 0 |

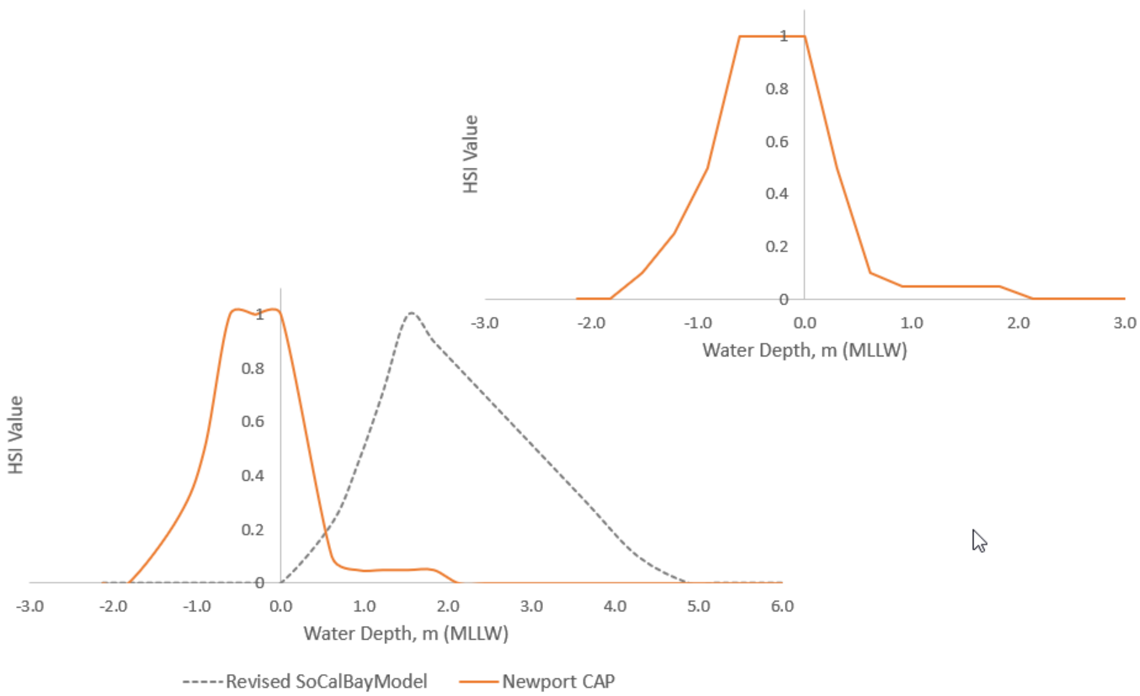


***Figure 2-4. Depth HSI curve for the original Bay Model and Newport CAP study, with inset showing the modified relationship curve for the Newport CAP study without a smoothing function applied to the result.***

### 2.2.3 Modified Substrate Curve – Yaquina Bay Eelgrass HSI Model

*Z. marina* has been detected in varying substrate conditions in Yaquina Bay. An intermediate percentage of fines may promote higher nutrient concentrations in the sediment that aid plant growth, however, there have been mesocosm experiments conducted on *Z. marina* stock from the Yaquina and plants were successfully cultivated in 100% sand (J. Kaldy pers comm.; Nelson 2009). In Yaquina Bay as a whole, the median percentage of fines is approximately 38% (Lee & Brown 2009, Table 7-2) and 50-100% of the intertidal areas have 40-90% sand (Lee & Brown 2009, Figure 7-10). A benthic ecologist that has been monitoring eelgrass and other habitats in Yaquina Bay and other estuaries throughout the state further concluded that higher percentages of fines in the substrate can actually be a hindrance to the growth and establishment of eelgrass. In the case of transplants and seeding new areas, finer material can be easily mobilized by wind and wave action, such that new transplants and shoots are washed away (pers comm. Tony D'Andrea, ODFW, 2 April 2024). The substrate curve from the Bay Model was revised to reflect a wider range of acceptability with regard to the percentage of fines and the apparently higher tolerance and affinity of *Z. marina* in the Yaquina Bay for more sandy substrates (Figure 2-5). The original Bay Model substrate curve is shown for comparison, with slight modifications to ensure the underlying equations matched the earlier graph (Figure 2-5).

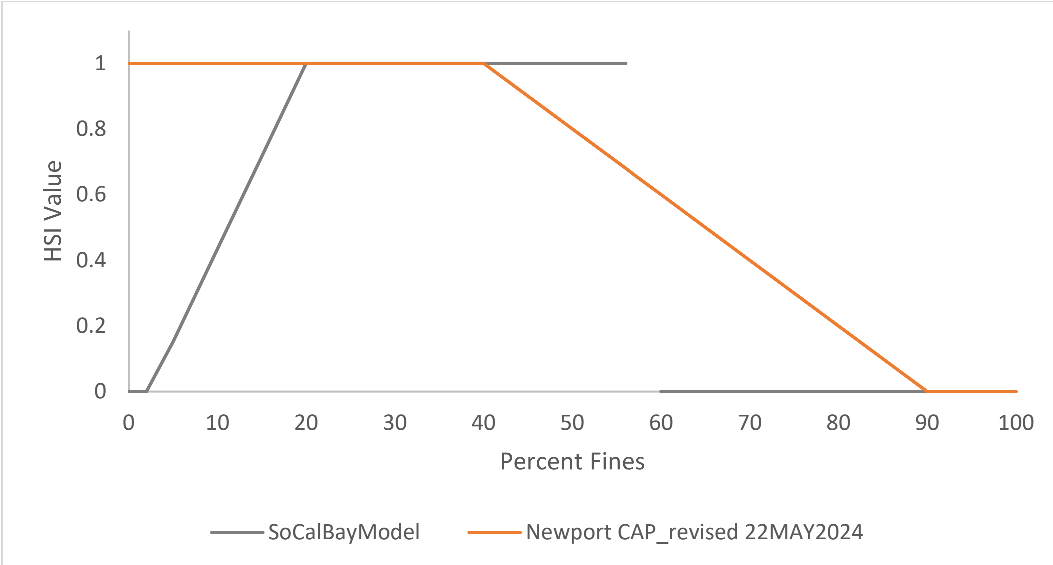


***Figure 2-5. Substrate HSI curve for the Bay Model and the modified response curve for the Newport CAP study.***

### 2.2.4 Modified Temperature Curve – Yaquina Bay Eelgrass HSI Model

There were a range of studies with largely complementary findings for the effects of temperature on eelgrass growth and survival in Yaquina Bay. Generally, summer upwelling along the Oregon coast results in cooler water temperatures near the mouth of estuaries in summer. There was general agreement that temperatures above 20°C would have negative effects on eelgrass growth (J. Kaldy pers. comm.) and evidence from literature also supported this general conclusion (Table 2-1). However, the Corps made slight adjustments to the temperature curve in the Bay Model because eelgrass in Yaquina Bay may experience temperatures near 5°C with no adverse effects on growth. In addition, the curve was adjusted to indicate less suitability for temperatures above 15°C.

Table 2-4 summarizes our general conclusions related to the eelgrass temperature response in Yaquina Bay and inferred habitat suitability. The corresponding figure shows how the Bay Model and revised model curves differ (Figure 2-6). For all variable response curves, the Corps assumes a linear relationship between values representative of boundary conditions and the next or preceding value.

***Table 2-4. Justification linking temperature to eelgrass habitat suitability in Yaquina Bay.***

| **Temperature (°C)** | **Final Justification** | ***Inferred* HSI** |
|---|---|---|
| <5 | No evidence for consistent exposure of eelgrass to temperatures below 5°C in the lower Yaquina Bay. | NA |
| 5-15 | Most eelgrass in lower Yaquina Bay likely experiences temperatures <12°C (Kaldy et al. 2015), but no evidence for adverse effects below 15°C. | 1 |

| **Temperature (ºC)** | **Final Justification** | ***Inferred* HSI** |
|---|---|---|
| 15-25 | Eelgrass shows signs of physiological stress above 15ºC (Magel et al. 2022). | 0.5 |
| >25-35 | Temperatures above 25ºC stress the carbon balance (Kaldy 2014). | 0.25 |
| >=35 | Prolonged exposure to temperatures above 35ºC would have adverse effects to eelgrass in Yaquina Bay (Kaldy and Shafer 2012), though Z. japonica may be slightly more tolerant to warmer temperatures (Kaldy et al. 2015) | 0 |

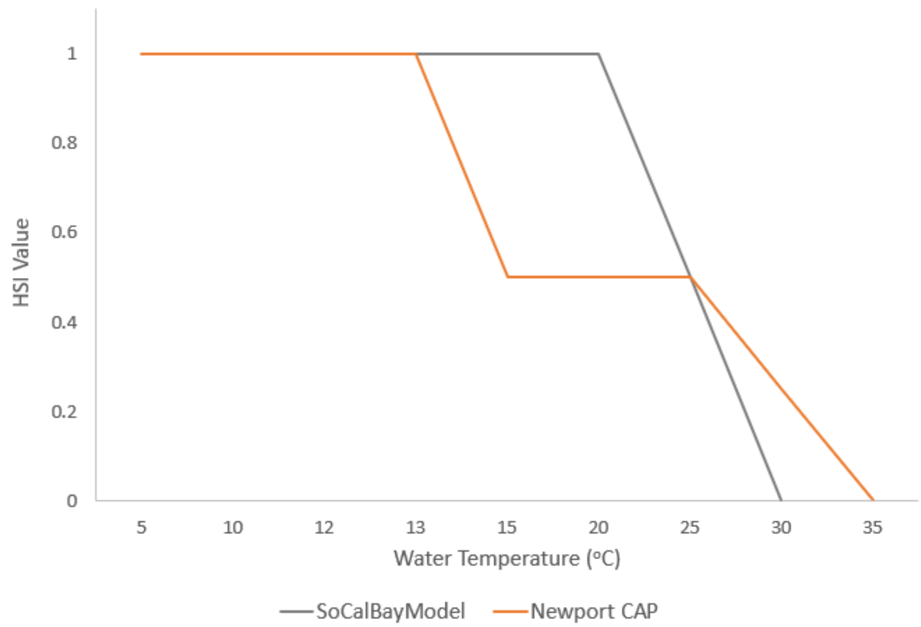


***Figure 2-6. Temperature curve for eelgrass in the Bay Model and modified curve for the Newport CAP study.***

# 3 Model Application to Newport CAP

The Corps adapted the eelgrass subcomponent of the Bay Model to suite the unique needs of the Newport Commercial Marina Section 107 Navigation Project Feasibility Study and more accurately reflect habitat constraints for eelgrass in the Yaquina Bay. This modified Yaquina Bay Eelgrass HSI Model is only intended for use in this study to inform planning and ways to offset potential adverse effects to eelgrass caused by proposed activities.

## 3.1 Locations Evaluated

In order to compare the level of suitability of any potential site proposed for offsetting adverse effects, the Corps first had to evaluate the suitability of existing eelgrass beds that may be adversely affected by project activities. All action alternatives would include dredging of the Port Dock 5 and Port Dock 7 channels, whereas only alternatives that included dredging the east entrance channel would likely result in additional effect to eelgrass (Figure 3-1). For purposes of evaluating the baseline suitability of the existing eelgrass beds using the model, the Corps assumed Port Dock channel conditions on the interior of the breakwater were sufficiently representative of all eelgrass impact areas associated with the project. In determining potential sites for eelgrass restoration or establishment to offset effects to eelgrass within marina dredging area (M), Port-owned subtidal and intertidal areas in the project vicinity were evaluated. Three potential locations were identified by the Port for further consideration; one located on the south side of the breakwater (BW), and two additional sites in Sally's Bend (SB1 and SB2), the large embayment just upriver of the Port (Figure 3-2).

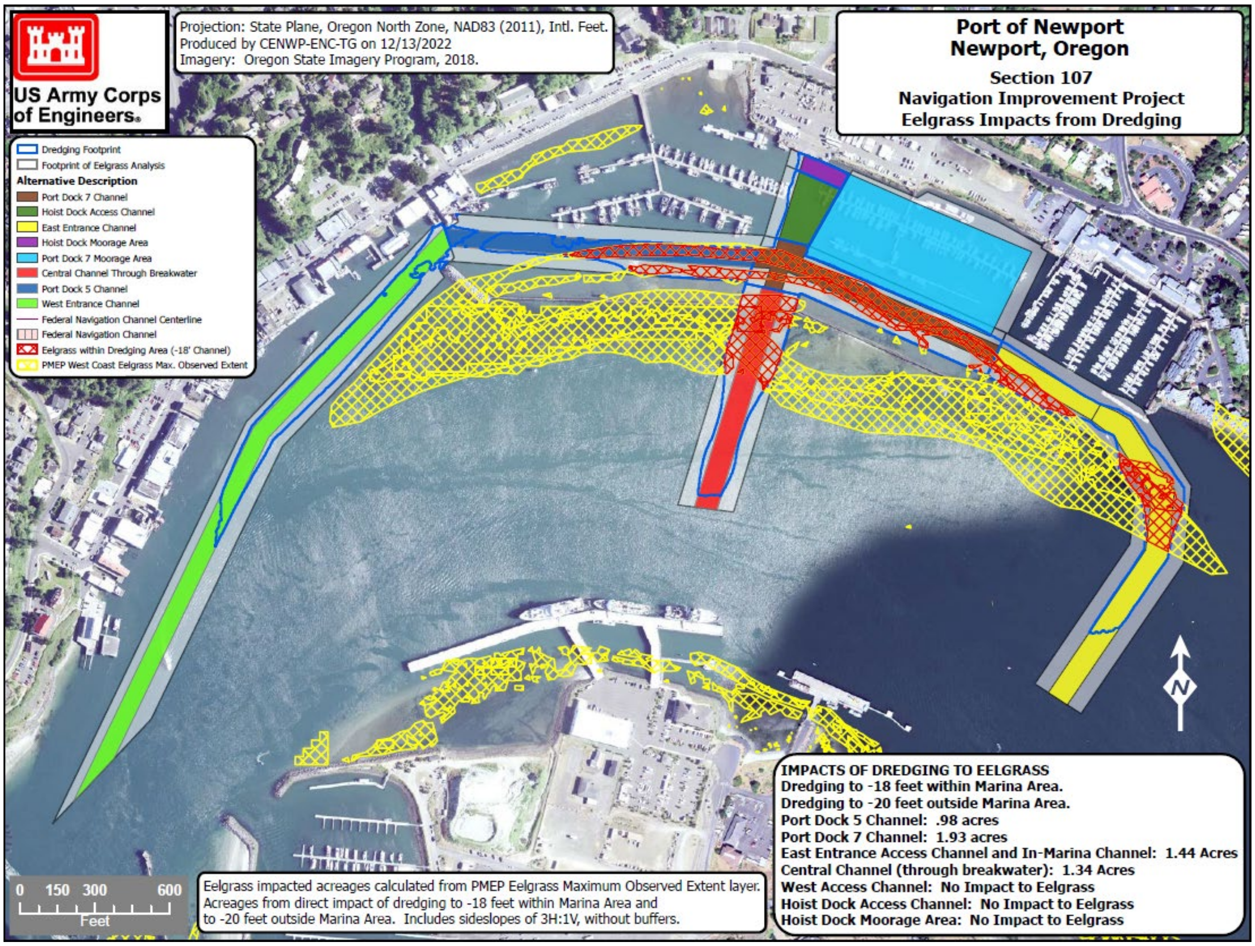


***Figure 3-1. Eelgrass effects based on maximum observed extent from Sherman and DeBruyckere, 2018.***

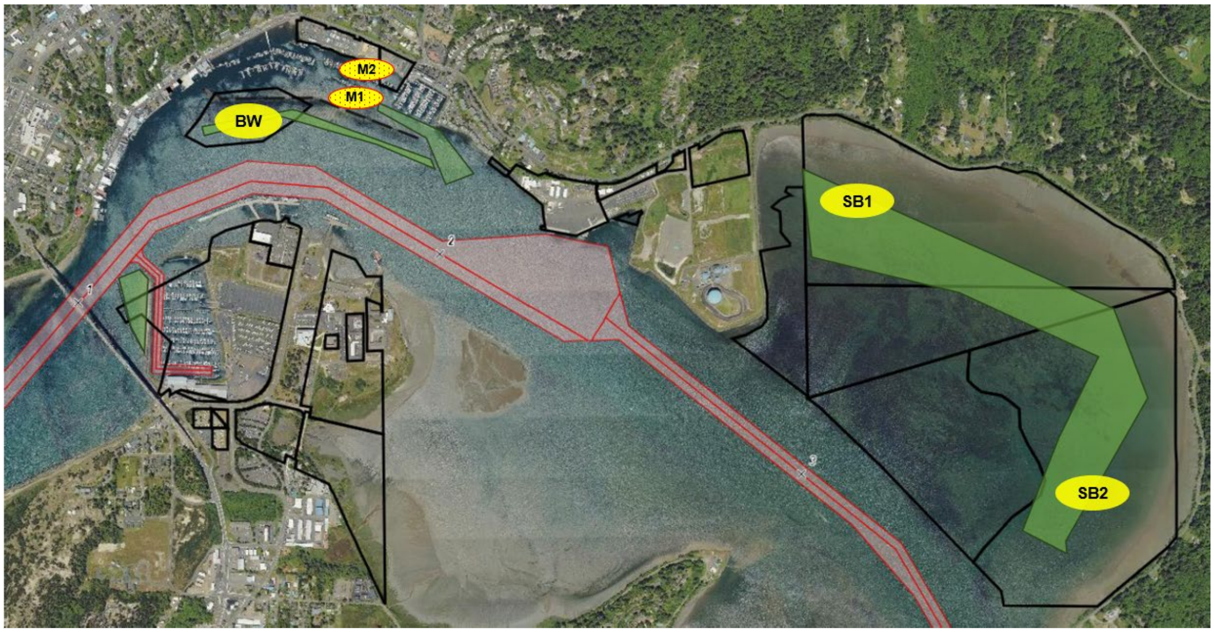


***Figure 3-2. Marina dredging area (M) and potential eelgrass habitat enhancement areas on the exterior of the breakwater (BW) or in Sally's Bend (SB1 and SB2).***

## 3.2 Eelgrass Model Habitat HSI Score and Assumptions

The HSI score at each site was calculated based on the suitability score ($SI$) associated with each parameter, as described in Equation 1 below.

$$(1) \qquad HSI = \sqrt[4]{(SI_{Circ} \times SI_{Depth} \times SI_{Temp} \times SI_{Fines})}$$

In the eelgrass model, the final HSI score for each location was the 4th root of the product of the suitability of water circulation, water depth, water temperature, and the percentage of fines in the sediment. The habitat units (HUs) were then calculated based on the approximate acreage of a given site multiplied by the HSI score. Lastly, because the Corps' planning studies estimate habitat outcomes over the 50-year planning horizon, Equation 2 was used to estimate the cumulative HUs over each time period, where $A$ and $H$ are the area and suitability of habitat, respectively, compared between two time periods ($T$), analyzed separately for each site ($j$). $T_0$ would be the base condition immediately after dredging, $T_1$ would be assumed conditions one year after construction, $T_5$ would be assumed conditions five years post-construction, and $T_{50}$ would be assumed conditions at the end of the 50-year planning horizon. The Corps added a parameter ($S$) representing likely eelgrass survivability (or cover) over each period of analysis as a multiplier to the area and suitability score. For the impact sites, a conservative assumption for the base condition was 100% eelgrass cover over the entire site footprint. However, for potential offset areas, no eelgrass presence was assumed in the base year, up to 50%-cover after one year (i.e., post-restoration), and a maximum cover (or survivorship) of 60% in years 5 through 50. The last assumption is based on a recent study indicating that between ~32% and 60% of restoration plots did not meet success criteria by the end of the monitoring period (Ward & Beheshti 2023). The Corps believes a 60% success rate is feasible for the offset areas selected for mitigation in this project because they have historically supported extensive eelgrass beds, and all sites are large enough to accommodate some degree of professional judgement by the eelgrass restoration practitioner to select plots within the larger polygon that have the highest chances for planting success and survivorship. The 3 and 6 in the denominator of Equation 2 are constants derived from integrating the area and suitability over the interval between two target years.

$$(2) \qquad HU_{ij} = (T_i - T_{i-1}) \left[ \frac{A_{j(i-1)}H_{j(i-1)}S_{j(i-1)} + A_{ji}H_{ji}S_{ji}}{3} + \frac{A_{ji}H_{j(i-1)}S_{j(i-1)} + A_{j(i-1)}H_{ji}S_{ji}}{6} \right]$$

Because Equation 2 only accounts for conditions between the first two years (i.e., $T_0$ and $T_1$), HUs were calculated separately for the remaining two periods (i.e., between years $T_1$ and $T_5$, and between years $T_5$ and $T_{50}$) in the planning horizon. The Corps then summed the cumulative HUs across all periods and divided by the full 50-year planning horizon to get average annualized habitat units (AAHUs) in Equation 3.

$$(3) \qquad AAHU_j = \frac{\sum_{i=0}^{T} HU_{ij}}{50}$$

A separate AAHU estimate was calculated for each of the five sites considered in the suitability model.

## 3.3 Model Inputs

The Corps used existing data and historic studies to estimate representative values for each of the model parameters at each the five (i.e., marina dredge areas, BW, SB1, and SB2) sites. The Corps conferred with local ecologists, reviewed prior studies, and perused available data to get the appropriate inputs for model parameters (i.e., water circulation or velocity, water depth, water temperature, and percent fines). Again, salinity was presumed fairly consistent between the four lower bay sites thus was not included in the habitat suitability scores. The Corps used an existing circulation model for the Yaquina Bay to populate the HSI model parameters, including temperature, water depth, water velocity, and salinity. The work to derive the estimates for each of the target areas was done by M. Conley, J. Lerczak, and R. Hetland at Oregon State University using the Finite Volume Community Ocean Model (FVCOM). The model simulated conditions based on data collected between July 2021 and March 2022, and the spatial grid for the bathymetry and example output for one of the impact sites is shown in Figures 3-3 and 3-4, respectively.

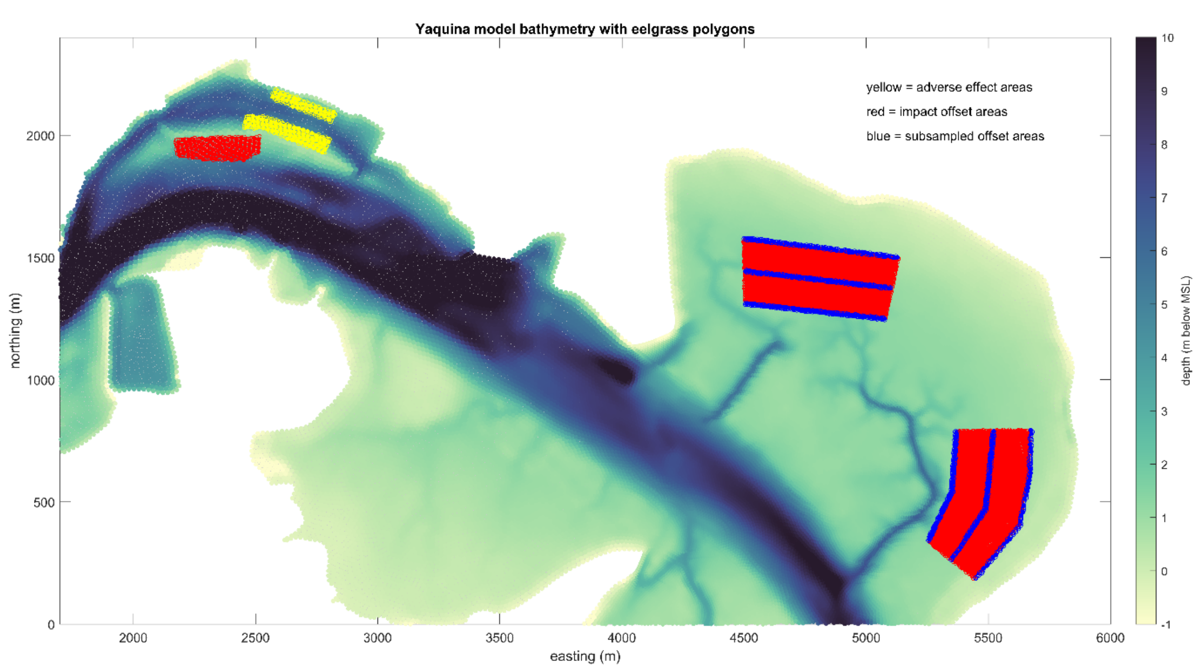


***Figure 3-3. Yaquina Bay circulation model bathymetry, with polygons for areas targeted for evaluating potential eelgrass habitat suitability.***

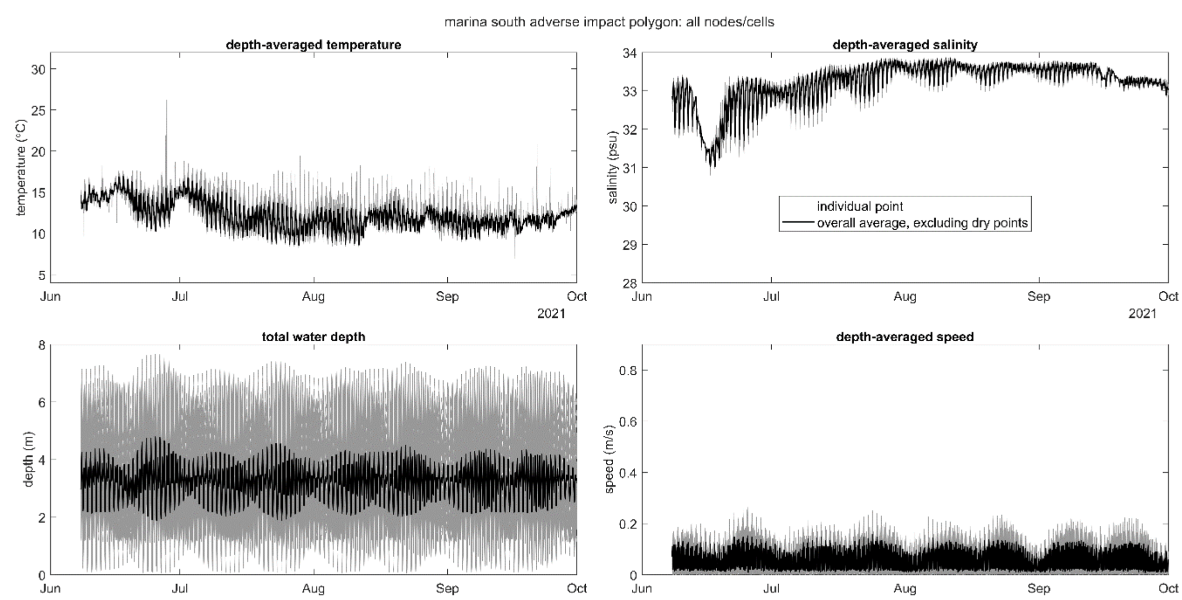


***Figure 3-4. Yaquina Bay circulation model output for the potential eelgrass impact area in the marina access channel (i.e., M1 polygon in Figure 3.2).***

## 3.4 HSI Model Results

The Corps used parameter inputs from the Yaquina Bay circulation model and Equations 1 through 3 to estimate AAHUs for the two impact sites and the three potential offset areas depicted in Figure 3.2. The two impact sites were approximately 1 acre each, and the model estimated the AAHUs attributed to the impact sites based on that area assumption. For the offset areas identified for potential eelgrass restoration and enhancement, the suitability scores varied between sites, so the acres needed to offset presumed losses also differed. More specifically, the estimated HSI score for the offset area near the breakwater was higher than either of the HSI values estimated for the two offset areas in Sally's Bend (Table 3-1).

***Table 3-1. Calculated HSI scores and annualized average habitat units (AAHUs) for impact areas (i.e., M1 and M2) and potential offset areas (i.e., BW, SB1, and SB2). The acres for impact sites are based on the estimated extent of existing eelgrass beds, whereas acres at offset areas is based on the eelgrass acreage needed at each site to fully offset the combined impacts.***

| | $HSI_{SITE\text{-}SCORE}$ | Eelgrass Acres | AAHUs (50-year planning horizon)* |
|---|---|---|---|
| **M1**, *South marina* | 0.575 | 1 | 0.58 |
| **M2**, *North marina* | 0.468 | 1 | 0.47 |
| **Total Impact** | | **2** | 1.04 |
| **BW**, *Breakwater* | 0.7625 | **2.5** | 1.12 |
| **SB1**, *NW Salley's Bend 1* | 0.5489 | 3.5 | 1.12 |
| **SB2**, *SE Salley's Bend 2* | 0.5338 | 3.5 | 1.09 |

**AAHU estimates in impact areas are for the future without project condition and assume undisturbed beds over the 50-year planning period. AAHUs in the three potential offset areas are based on assumptions outlined in Section 3.2.*

# 4 Offsetting Adverse Effects to Eelgrass

The Corps adapted the eelgrass subcomponent of the Bay Model to suite the unique needs of the Newport Commercial Marina Section 107 Navigation Project Feasibility Study and more accurately reflect habitat constraints for eelgrass in the Yaquina Bay. This modified Yaquina Bay Eelgrass HSI Model is only intended for use in this study to inform planning and identify options for offsetting potential adverse effects to eelgrass caused by proposed activities. A fully implementable eelgrass mitigation plan, for purposes of compensating for any unavoidable adverse effects to eelgrass, is beyond the scope of this feasibility study. That level of detail will depend on the ultimate footprint of adverse effects and rely on the expertise of contractors familiar with eelgrass restoration and enhancement. In this plan, the Corps outlines a set of minimum elements (e.g., techniques and considerations) that would be included in the more detailed plan based on published literature and recommendations from leading practitioners (Beheshti and Ward 2021; Altman et al. 2023; Ward and Beheshti 2023). The eelgrass implementation plan would be finalized during the project implementation phase when the tentative plan has been finalized and unavoidable effects to eelgrass are confirmed. The HSI model output and AAHU estimates were used as a planning tool to inform the effects analysis and alternatives selection for purposes of NEPA and provide resource agencies with a general basis for their consultations. The remainder of this document assumes selection of the marina breakwater site (i.e., BW) due to its higher suitability relative to sites in Sally's Bend (see Table

3-1), potential greater likelihood of eelgrass survival and growth, proximity to the impact sites, and the lower acreage needed to offset eelgrass impacts which would presumably result in lower costs. The following sections outline the steps and general methods to be employed as part of eelgrass mitigation. A slightly more robust implementation plan will be developed, consistent with these elements, but with specific details tailored to observed site conditions. The contractor tasked with completing the mitigation actions would have some discretion with regard to their means and methods but will be required to follow the steps listed below to ensure the plan meets minimum requirements to achieve mitigation success. Any deviations will require justification for the variance and Corps approval.

For purposes of mitigation planning, we assume the loss to eelgrass in channel excavation areas would be permanent, with channel maintenance activities precluding any long-term plant reestablishment. The breakwater site has the highest estimated suitability, among the three potential mitigation planting sites, and has been tentatively selected for mitigation implementation, with a goal to establish 2.5 acres of new eelgrass beds to compensate for the loss of 2 acres of eelgrass within the proposed dredging footprint. The mitigation plan includes surveys, identification of reference beds, selection of donor beds (or a nursery source) from which to source eelgrass, selection of the most appropriate methods (e.g., using shoots and anchors, or perhaps turions) for transplanting based on site conditions. If possible, eelgrass would be sourced from the impact area slated for dredging. A qualified contractor would be selected to implement the mitigation plan. Active transplanting would occur between April and September, and site monitoring would occur for five years thereafter. Monitoring would be completed to determine the extent to which transplanted beds are meeting performance criteria such as a minimum shoot density, plant survival, and areal coverage. Once the mitigation site meets the success criteria detailed in Chapter 5 of this document, responsibility for long-term management of the mitigation area would be transferred to the Port. Neither the Corps nor Project Sponsor will mitigate further for any eelgrass that may revegetate within the impact areas for which mitigation has already been completed.

## 4.1 Survey and Environmental Assessment

Prior to implementing a full-scale eelgrass restoration project, it would be imperative for a potential contractor to assess the in-situ environmental conditions within the impact and offset areas. There is widespread consensus that environmental covariates are large determinants for the success or failure of an eelgrass mitigation project (Beheshti and Ward 2021; Altman et al. 2023). Thus, one of the first steps would be to collect representative data for key environmental parameters to understand potential differences between the conditions at impact and offset areas and confirm whether or not transplanting shoots from the impact sites could be a viable mitigation strategy and to confirm the suitability assumptions asserted in the model. Specific parameters for measurement could include light availability, Chlorophyl A or nutrient concentration, bathymetry, sediment composition, temperature, salinity, water velocity, and elevation relative to the tidal datum. Depending on the level of variability across the site and expert opinion, it could be necessary to collect multiple data points to capture the full range of conditions present across the site.

In addition to assessing relevant environmental covariates, a contractor will need to complete a more robust eelgrass survey within the impact sites and target offset area to characterize the species present and map the density across the site. Surveys would need to be conducted during the growing season (i.e., May through September) and would likely entail a combination of remote sensing and direct methods (e.g., snorkeling, wading, diving) to confirm the spatial extent of any existing beds and identify areas for potential eelgrass bed enhancement or establishment within the offset site boundaries. The specific survey methods employed would be selected by a qualified contractor experienced in eelgrass assessment and mitigation techniques and a determination of the most appropriate method based on the site conditions. However, final survey information collected would include the following:

- Mapped site boundary;
- Depth contours relative to MLLW or other datum;
- Scale and measure of distance along the axis of transects;
- Georeferenced locations for all sample locations and transect endpoints;
- The extent of existing beds, by species; and
- The approximate density of eelgrass within delineated eelgrass beds.

For purposes of mapping, eelgrass patches less than 5 meters apart could be considered a single bed. An example map depicting the results of this level of effort is presented in Figure 4-1.

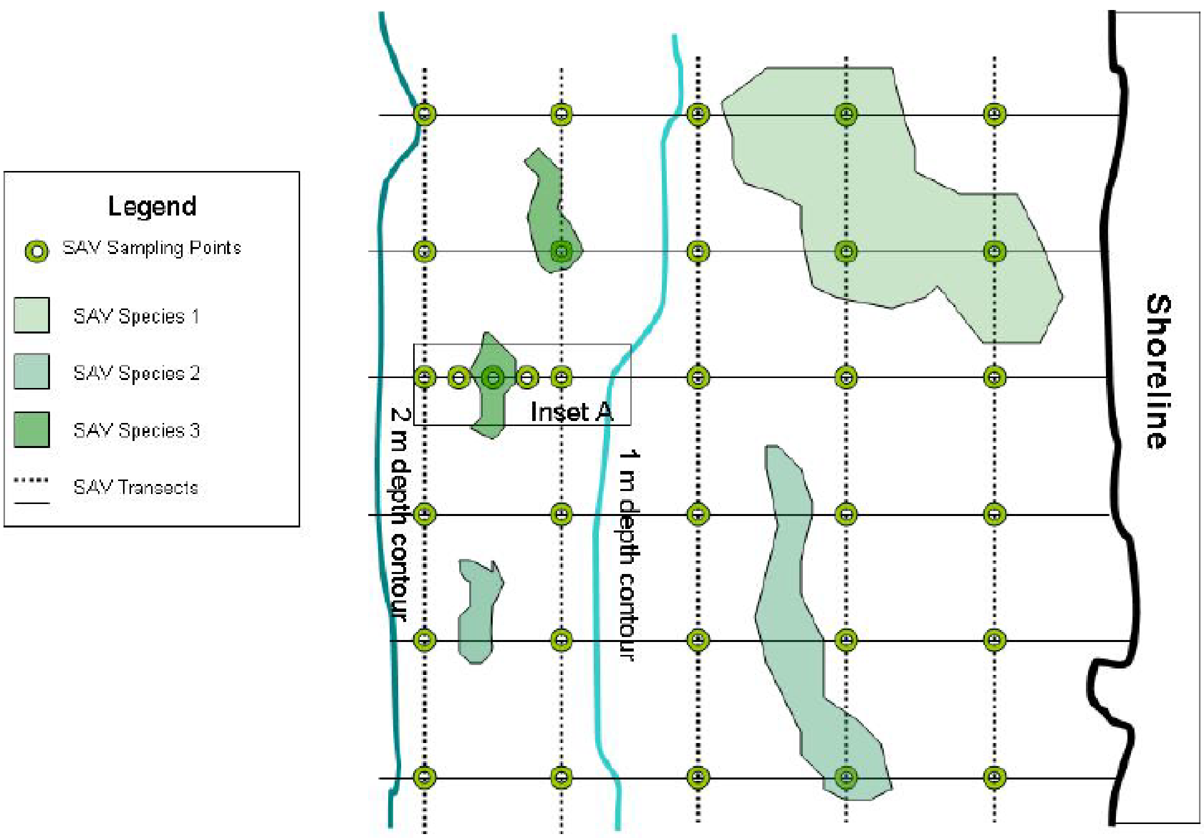


***Figure 4-1. Example transect layout and results from eelgrass survey, adapted from Shafer and Bourne 2012.***

## 4.2 Selection of Target Restoration and Reference Sites

Based on the survey results obtained, the next step would be for the qualified contractor to select the specific areas within the larger offset site to target for eelgrass restoration, enhancement, or creation. The areas selected should fall fully within with the polygon of submerged lands owned by the Port sponsor (Figure 3-2) but could be discontinuous based on the suitability of site conditions and location of existing beds. The restoration practitioner (i.e., contractor) would take steps to maintain a minimum 5-meter buffer around existing beds to reduce the potential for inadvertent adverse effects during planting and monitoring activities. Locations selected for eelgrass offset measures would be clearly mapped and georeferenced points would be established within each area to serve as the basis for monitoring over the 5-year adaptive management (AM) period. In addition to establishing points for documenting eelgrass performance within the restoration areas, the contractor would also select a reference bed that would be used for relative comparison with the restoration plots over the duration of performance monitoring. The reference site would ideally be established in an area of minimal disturbance with site conditions (e.g., water depth, velocity, substrate, etc.) fairly similar to that of the eelgrass mitigation plots. Possible eelgrass reference sites within the project vicinity could include existing beds in Sally's Bend, Idaho Flats, or beds along the breakwater that would not be affected by proposed activities. The ultimate size and location of the reference bed and plots therein would be selected at the discretion of the field expert. In addition, best management practices would be established to minimize potential adverse effects to reference sites over the course of monitoring.

## 4.3 Identify Appropriate Eelgrass Restoration Methods

There are several possible means of eelgrass habitat restoration, enhancement, and creation that could be pursued for a given site. For example, eelgrass shoots could be established from seed, transplanted from existing beds, or obtained from an eelgrass nursery. In the case of the Newport CAP project, the preferred option would be to transplant all necessary shoots from the impact sites (i.e., areas M1 and M2) prior to proposed dredging. However, the most appropriate source material and method will largely depend on site conditions. Transplanting from existing sites outside the footprint of proposed dredging would be minimized to avoid adverse effects to existing habitat within established natural and conservation zones to the maximum extent practicable. Should donor beds be established outside the area of dredging, no more than 5% of eelgrass would be harvested from those beds to allow for donor beds to recover quickly. This 5% target is less than the 10% harvest limit that has been used in other mitigation plans (Merkel 2012; Merkel & Associates 2021). Given the likely constraints on transplanting from area donor beds, it is likely that some level of nursery-derived planting or seeding will be necessary to meet the goal of establishing or enhancing approximately 2.5 acres of successful eelgrass within the larger BW offset area. Multiple restoration techniques have been identified by practitioners engaged in eelgrass restoration and mitigation projects on the Pacific coast, and each has certain advantages and disadvantages (Figure 4-2). The final restoration methodology will be selected by the restoration practitioner, subject to final approval by the Corps and Port sponsor. Depending on the project implementation schedule, planting test plots may be established up to a year prior to full-scale restoration to determine the most appropriate planting methodology, density, and plot size. If feasible, test plots can help reduce uncertainty and maximize success for the full-scale eelgrass mitigation (Shafer 2015; Beheshti and Ward 2021; Ward and Beheshti 2023).

While not certain, it is assumed that active restoration using shoots and anchors, or turions, will be required. Based on mitigation completed at other Corps projects, we assume a planting spacing that would range between one and two meters on grid center (Merkel 2012; Shafer 2015; Merkel & Associates 2021). For purposes of estimating cost associated with implementing the plan, it is assumed that 75% of the area will require nursery plantings and 25% of the enhancement area will utilize transplants from existing beds. Any existing beds selected as donor sites for eelgrass transplanting will be clearly mapped and georeferenced points will be established to track the level of revegetation within those sites over the AM period. The number and spacing of turions (or shoots) needed to establish or enhance eelgrass beds to achieve a target density mimicking the reference site conditions would be based on best professional judgement of the eelgrass restoration practitioner, subject to approval by the Corps and Port sponsor.

## 4.4 Establish Timeline for Eelgrass Transplanting

In general, all efforts to transplant and establish new eelgrass beds will occur early in the growing season between April and June. All planting will occur in submerged lands owned by the Port sponsor. The specific dates would depend on the timeframe for project implementation, but all efforts will be made to ensure that work to establish new beds commences before any proposed dredging. It is assumed that active transplanting efforts for the full-scale site restoration would be completed within 30 days. If test plots are feasible, they would be established a year prior to the full-scale restoration.

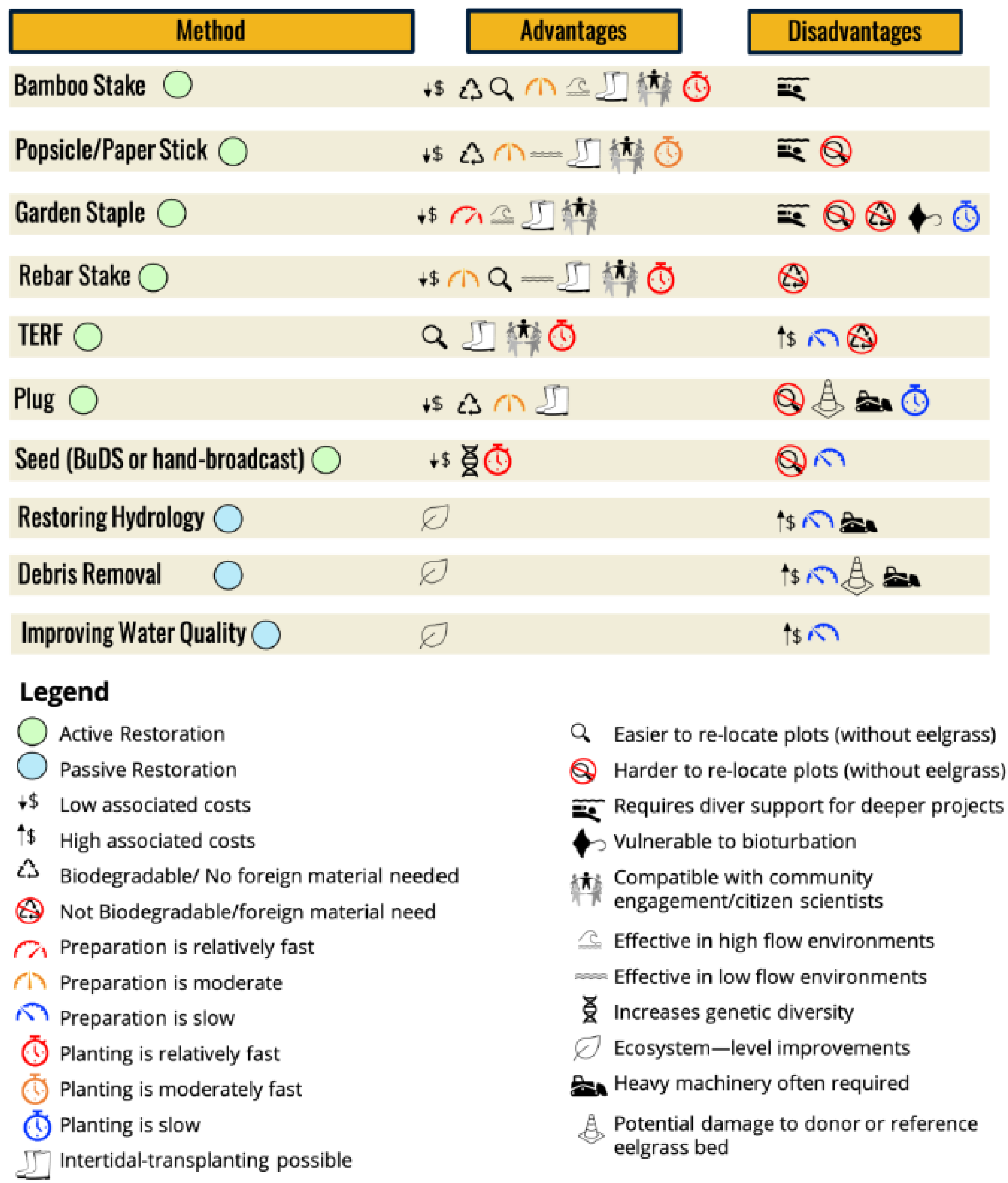


***Figure 4-2. Figure from Beheshti and Ward 2021 depicting common methods for active and passive eelgrass restoration on the West coast.***

# 5 Performance Criteria and Success Metrics

In order to evaluate the efficacy of eelgrass mitigation measures, the Corps must identify appropriate response metrics for monitoring. Metrics including **shoot density, plant survival, and areal coverage** are common criteria used in eelgrass restoration and mitigation projects (Ward and Beheshti 2023) and they would also be the focus of performance monitoring for the Newport CAP project's eelgrass mitigation plan. Other environmental and plant data may also be collected to the extent that it could help explain stressors or other covariates influencing the performance criteria and overall quality of eelgrass transplants. Those could include metrics such as leaf length, the percentage of plants flowering, evidence for eelgrass wasting disease, epiphyte cover, and others. Monitoring metrics at the mitigation site will be compared with those of a reference bed to help account for potential variability attributed to external factors.

While Oregon does not have an explicit eelgrass mitigation policy, the National Marine Fisheries Service (NMFS) has developed policy and guidance for eelgrass mitigation in California that includes performance monitoring metrics and milestones focused on areal coverage and shoot density (NMFS 2014). Those milestones are summarized in Table 5-1 and would also be tracked for this project. **However, consistent with assumptions in the eelgrass model, it is assumed that a maximum 60% eelgrass coverage will be achieved across the 2.5-acre BW mitigation site**. Thus, the target areal coverage in any given year would not exceed 60% and corrective measures would only be pursued if the areal coverage 24 months after planting was less than 60%.

***Table 5-1. Example performance milestones from the California Eelgrass Mitigation Policy (NMFS 2014), with project-specific changes for the Newport CAP noted in the second column.***

| Time since planting (months) | Minimum plant survival | Minimum areal coverage | Minimum shoot density |
|---|---|---|---|
| 0 | N/A | Confirm full coverage distribution of target planting units | N/A |
| 6 | 50% survival of initial planting units | Well-distributed coverage over entire site | N/A |
| 12 | N/A | 40% coverage | 20% density of reference site(s) |
| 24 | N/A | ~~85% coverage~~<br><br>60% coverage for Newport CAP | 70% density of reference site(s) |
| 36, 48, 60 | N/A | ~~100% coverage~~<br><br>60% coverage for Newport CAP | 85% density of reference site(s) |

# 6 Monitoring

Monitoring within areas of eelgrass enhancement and establishment, as well as any reference plots, would commence within a month of initial planting and during the peak growing season (i.e., June 1 – October 1) for a period of five years. It is anticipated that, at minimum, temperature, salinity, depth, and light would be measured at both the mitigation and reference sites. If test plots are ultimately included in the plan, they would be monitored quarterly to better understand and track changes within those sites. Then, the final mitigation planting plan would ultimately be conducted at the test plots exhibiting the highest rates of plant survival after a year. Once the final mitigation plots are selected, performance metrics within mitigation and reference beds will be measured at least annually during the growing season for a period of 5-years.

Should eelgrass mitigation fail to meet the 60% areal coverage needed across the 2.5-acre mitigation site to compensate for eelgrass losses, revegetation using transplants from donor beds, or a nursery source will be done to offset eelgrass coverage shortfalls. Depending on the key drivers attributed to transplant failure, areas may be replanted in Year 1 and Year 2, and subsequently monitored, to achieve minimum coverage targets. Should replanted areas fail to meet success criteria for two sequential years, new transplant areas may be identified within the larger BW site or alternate Sally's Bend sites and targeted for new planting in Year 3. Should reference areas fail or decline alongside the transplant mitigation areas for reasons outside the control of the Corps, the Corps will not be held responsible for similar declines in the mitigation areas.

A more detailed eelgrass monitoring plan will be developed by the eelgrass restoration practitioner as part of their proposed means and methods. This detailed plan will include a summary of statistical methods to be employed to appropriately evaluate the performance and success criteria outlined in the plan, with particular attention to determining the extent to which conditions in the eelgrass mitigation beds differ from observations within reference beds. The final plan is subject to review and approval by the Corps and Port sponsor to ensure it meets the minimum standards outlined in this section.

# 7 Adaptive Management

Adaptive management can help maximize the potential for proposed eelgrass mitigation to meet success criteria within five years of project implementation. Beheshti and Ward (2021) presented a somewhat circular and iterative framework for evaluating success or failure that could aid in building a robust AM plan. Restoration success will also be measured and reported based on the relative functional performance of mitigation plots relative to those in reference eelgrass beds. The restoration practitioner will ultimately be required to outline specific triggers under, at minimum, the three performance metrics articulated above (i.e., eelgrass survival, density, and spatial extent), with additional detail about corrective actions or measures to be implemented when targets are not met within the mitigation site. The final plan is subject to review and approval by the Corps and Port sponsor to ensure it meets minimum standards outlined in this section.

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