US Army Corps of Engineers ®
Seattle District

COMPONENTS OF A COMPLETE EELGRASS DELINEATION REPORT

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PREFACE

This document was developed by Dr. Deborah Shafer Nelson, U.S. Army Engineer Research and Development Center at the request of the Seattle District and Headquarters, U.S. Army Corps of Engineers, with funding provided through the Wetlands Regulatory Assistance Program.

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PURPOSE

This document provides technical guidelines and procedures for identifying and delineating eelgrass beds (*Zostera* spp.), which are a type of special aquatic site under Section 404 of the Clean Water Act (33 U.S.C. 1344). Eelgrass beds may also be affected by activities requiring permits under Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. 403). It has been developed to assist applicants and/or their consultants within the geographic area covered by the Seattle District U. S. Army Corps of Engineers when a delineation of an eelgrass bed is requested to evaluate proposed work within marine and estuarine waters. Note: This document was developed for eelgrass; however, we encourage the user to document other marine plant species, such as kelp, as that information may be required for the overall characterization of the project site. Also, although these guidelines are specifically for eelgrass, they may be applicable for other types of seagrasses that occur in Washington, such as surfgrasses (*Phyllospadix* spp.).

QUALIFICATIONS

Eelgrass bed delineations should be performed by someone who has demonstrated the ability to identify eelgrass species present within the project area, and conduct ecological surveys.

TIMING

Eelgrass delineations should be conducted during periods when above-ground leaves and shoots are present in sufficient quantities to be readily observable: June 1 through October 1.

Within eelgrass habitat, eelgrass is normally expected to fluctuate in density and patch extent; eelgrass can expand, contract, disappear, and re-colonize areas within suitable environments based on prevailing environmental factors (e.g., turbidity, freshwater flows, wave and current energy, bioturbation, temperature, etc.). Eelgrass bed boundaries on the Pacific coast can expand by an average of 5 meters (m) and contract by an average of 4 m annually (Washington Department of Natural Resources 2012).

Because of the potential for substantial interannual changes in the locations of the eelgrass bed boundaries, delineation results should be submitted with a permit application within one year of the delineation having been conducted. If it has been more than 1 year but less than 3 years since the delineation was performed, we recommend the mapped boundaries of the eelgrass beds be re-verified prior to submitting your permit application to ensure they have not changed. If more than 3 years have elapsed since the last eelgrass bed delineation, a new complete eelgrass delineation survey should be conducted prior to submitting the permit application.

OVERVIEW OF EELGRASS SURVEY TYPES

This document describes the procedures for the Preliminary Eelgrass Survey and Tier 1 Eelgrass Delineation Survey. In areas where there is a reasonable expectation for suitable eelgrass habitat (e.g. appropriate depth and substrate) to occur in the project vicinity, a Preliminary Survey may be used to support a statement regarding the absence of eelgrass at the project site. For those projects that intend to avoid work in eelgrass beds, a Tier 1 Delineation Survey may be used to identify the boundaries and spatial distribution of the eelgrass beds, in relationship to tidal elevation(s), and the proposed project footprint.

PRELIMINARY SURVEY

A non-quantitative Preliminary Survey may be used to support a statement regarding the absence of eelgrass at the site. This method should be used when there is reasonable expectation for eelgrass habitat to occur in the project vicinity. These areas could include waterbodies where eelgrass is present in the vicinity, the appropriate substrate is present, there was a historical presence, etc. The Preliminary Survey involves using an organized, systematic method to document the absence of eelgrass across the entire project area using a series of photographic images.

An acceptable methodology would be a series of photographs of the substrate taken while walking or wading at low tide. Transects or grid sampling patterns are commonly used to ensure complete coverage of the site, but other sample patterns (e.g., random) may be considered.

Sample points for the photographic documentation should be selected to be representative of the entire project area so as to clearly show the absence of eelgrass. Particular emphasis should be placed on any areas that appear to be occupied by submerged aquatic vegetation of any type, because it is often not possible to reliably distinguish between various species of seagrass and macroalgae from a photograph. Photos of the ground showing the substrate(s) present are the most helpful, since eelgrass typically grows only in certain substrates. Landscape type photos are generally not sufficient.

A Preliminary Survey report should include a figure or map of the project area showing the locations of each of the individual photographic sample points labeled with a GPS coordinate along with individual photos of the ground taken at each sample point.

There could be some situations where the absence of eelgrass could be documented without walking or wading the site. Low altitude, high resolution aerial imagery collected by unmanned aerial vehicle (UAV) is becoming more commonly available. This is an acceptable methodology for collecting photographs. If the aerial photographs reveal the presence of any areas that appear to be occupied by submerged aquatic vegetation of any type (i.e. green in color), on-ground photographs should be collected to verify the identification of the vegetation.

If eelgrass is known to be present within the project area, or if a Preliminary Survey reveals the presence of eelgrass beds, follow the procedures outlined below to conduct an eelgrass delineation.

DEFINING AND DELINEATING EELGRASS BED BOUNDARIES

The uppermost boundaries of seagrass growth are controlled by desiccation and temperature stress (Boese et al. 2005), but can also be locally influenced by activities such as shellfish harvest and reflective energy from shoreline armoring (Short and Wyllie-Echeverria 1996). The lower boundary, or maximum depth of seagrass growth, can be directly related to the submarine light environment (Duarte 1991). Within these limits, seagrass bed patterns range from continuous or semi-continuous over hundreds of meters to patchy distributions with patches ranging in size from a meter to tens of meters in the longest dimension (Fonseca and Bell 1998).

Potential native eelgrass (*Zostera marina*) habitat in the Pacific Northwest may be classified as either fringe or flats based on its geomorphic setting (Berry et al. 2003). Fringe *Z. marina* habitats are areas with relatively linear shorelines where potential *Z. marina* habitat is limited to a narrow band by water depth. Identification of eelgrass bed boundaries in fringe sites is relatively straightforward. Flats *Z. marina* sites are shallow embayments with extensive broad shallows that have little slope within the vegetated zones. Eelgrass beds in flats sites can be highly fragmented and very dynamic on both spatial and temporal scales. Bed patchiness increases with increasing wave exposure and tidal current speed. For more information on the influence of landscape setting and physical exposure on eelgrass bed configuration, see Appendix A.

If the eelgrass bed is composed of many individual patches, which each meet the definition of an eelgrass bed, and the distance between adjacent patches is 16 feet (5 meters) or less, then it is not necessary to delineate each individual patch. Considerable time savings can be achieved by mapping the outer limits or boundaries of patchy eelgrass habitat and describing them as a patchy bed rather than attempting to delineate and map each individual patch. In the context of this document, patchy eelgrass habitat area includes the cumulative area of the individual patches, including any areas between patches that are less than 16 feet (5 meters) apart. See examples in Appendix B.

In areas where there are too few eelgrass shoots to meet the bed thresholds described below, the survey map should indicate that there are a few isolated eelgrass shoots present, with no discernable beds.

Use one of the two following methods to identify eelgrass habitat and delineate native eelgrass (*Z. marina*) bed boundaries[1]. Although the two methods are slightly different, in practice the results of eelgrass bed delineations done with either method were found to be similar.

[1] Some in-water activities require an un-vegetated buffer around existing eelgrass beds (e.g. programmatic Endangered Species Act consultations, or a proposed mitigation plan). In these cases, the appropriate buffer should be included in maps/drawings. See Figure B1 in Appendix B for example. Once the bed edge is identified using either Method A or B, an un-vegetated buffer zone around the edge of each bed should be included on plan views or maps. Un-vegetated areas within this buffer zone may have eelgrass shoots a distance greater than 1 meter from another shoot and therefore not meet the definition of an eelgrass bed. The width of the un-vegetated buffer may vary by project type. Applicants should also be aware of local and state requirements for eelgrass surveys, as these may differ from the guidance presented here. Contact the District for more information.

Eelgrass Delineation Method A: An eelgrass bed is defined as a minimum of 3 shoots per 0.25 m^2 (1/4 square meter) within 1 meter of any adjacent shoots. To identify the bed boundary, proceed in a linear direction and find the last shoot that is within 1 meter of an adjacent shoot along that transect. The bed boundary (edge) is defined as the point 0.5 meter past that last shoot, in recognition of the average length of the roots and rhizomes extending from an individual shoot (Washington Dept. of Natural Resources (WADNR) 2012).

Eelgrass Delineation Method B: *The California Eelgrass Mitigation Policy and Implementing Guidelines* (NOAA Fisheries 2014) identify eelgrass bed edge as follows: any eelgrass within one square meter quadrat and within 1 meter of another shoot.

TIER 1 DELINEATION SURVEYS

The goal of a Tier 1 Delineation Survey is to identify the boundaries and spatial distribution of the eelgrass beds, in relationship to tidal elevation(s), and the proposed project footprint, in order to assist in avoidance of eelgrass beds.

Data Collection Methods

Sample intertidal sites by walking or wading during low tides. Divers may be needed to collect information at subtidal sites.

For very large sites, remote sensing methods such as aerial photography, underwater photography, or hydroacoustic surveys may be used instead of walking or wading the entire site to survey the boundaries of eelgrass beds. For more information on these methods, see the section on Eelgrass Survey and Mapping Methods. However, if remote sensing methods are used to prepare maps of eelgrass beds, select or limited ground-truth data should also be collected using walking, wading or diver surveys to verify the remotely sensed data. For ground-truth data collection, emphasis should be placed on data collection within those areas that appear to have submerged aquatic vegetation of any type, but the sampling effort should also include some areas that appear un-vegetated to verify whether eelgrass beds are absent.

Transect Layout

For linear projects (e. g. pipelines), establish a single transect aligned along the centerline of the proposed project footprint. Otherwise, establish a series of sample transects perpendicular to shore. In most cases, transects oriented perpendicular to shore are preferred over shore parallel transects because perpendicular transects are better suited to detecting and mapping the boundaries of submerged aquatic vegetation beds. However, if the boundary of the eelgrass bed is clearly visible, it may be more efficient to walk the boundary of the eelgrass bed in a shore parallel orientation, recording GPS coordinates of the bed boundary at intervals equivalent to the suggested transect spacing below (5-40 feet). For projects that are not adjacent to the shoreline (e.g., mooring buoys), orient transects relative to another physical reference, such as a channel boundary or depth gradient. Transects must also be referenced to a permanent feature at the site to ensure repeatability.

At sites where the eelgrass beds are smaller, with patchy or discontinuous distributions, sample transects should be closely spaced (5 to 15 feet). For sites containing relatively contiguous eelgrass beds, or for projects involving very large areas, transects spaced at intervals of 15 to 40 feet apart are appropriate. To start, at least one transect should be aligned along the proposed centerline of the project. Transects are then spaced at intervals starting from the centerline transect and continuing through the proposed project footprint. Locate additional transects 10 or 25 feet beyond the outer edges of the proposed project footprint. Transects should either extend to the deepest edge of the eelgrass bed, or at least 25 feet waterward beyond the project footprint, whichever is less.

There may be more than one eelgrass species present along each transect (e.g. an upper intertidal zone of continuous or patchy non-native dwarf eelgrass (*Zostera japonica*), a mid-intertidal bed of *Z. japonica* mixed with native eelgrass (*Z. marina*), a patchy or sparse *Z. marina* bed, and a dense or continuous *Z. marina* bed in the lower intertidal/subtidal zone) (see Appendix B for examples). Both eelgrass species may not be present at each site. Identification of the *Z. japonica* along each transect is necessary because of the potential for confusion and misidentification between the two *Zostera* species. For further information on how to distinguish *Z. marina* and *Z. japonica*, see Appendix C.

Along each transect, identify the locations of the upper and lower boundaries of the eelgrass beds or patches according to the instructions for either Method A or B. Because the bed edge is defined as the presence of eelgrass shoots within 1 meter of another eelgrass shoot, each transect should be roughly equivalent to a 2-meter wide belt transect (1 meter on each side of the centerline). Record the GPS coordinates, elevation (relative to mean lower low water (MLLW)), and distance along the transect for the upper and lower boundaries of each eelgrass bed as described above, if present.

Field Data Collection and Reporting
The following data should be recorded in the field and included in the survey report:

- Site name, sample date and time of day (start and finish); the name(s) of the person(s) conducting the survey; and whether Method A or Method B was used to delineate the eelgrass bed(s).

Preparation of Eelgrass Bed Maps
Prepare an eelgrass habitat distribution map using the GPS coordinates taken from the survey data. The map should include the following information:

- Boundaries of the project area and project footprint; and north arrow;
- Accurate depth contours (datum MLLW = 0.00 ft.) at intervals of 1 foot;
- Scale and measures of distance along the axis of the transects;
- Locations of all sample transects and sampling stations;
- Locations of the boundaries of *Z. marina* and *Z. japonica* (if present) eelgrass beds, including tidal elevations, and, if a buffer is proposed, the boundaries of the proposed buffer around bed edges.

If the individual patches of eelgrass are spaced less than 16 feet (5 meters) apart, it is not necessary to delineate each individual patch. Considerable time savings can be achieved by mapping the outer limits or boundaries of patchy eelgrass habitat and describing them as a patchy bed rather than attempting to delineate and map each individual patch. In the context of this document, patchy eelgrass habitat area includes the cumulative area of the individual patches, including any areas between patches that are less than 16 feet (5 meters) apart.

Reporting
In addition to the maps of eelgrass bed distribution within the project area described above, the report should also include the data sheets showing the information collected on each transect, and a summary of the tidal elevation ranges within which the eelgrass beds were observed to occur, based on the information collected on the survey transects.

For example:

+1-0' MLLW	Beds of mixed native (*Z. marina*) and non-native (*Z. japonica*) eelgrass species
+1-1' MLLW	Patchy beds of *Z. marina*
-1-5' MLLW	Continuous beds of *Z. marina*

EELGRASS DELINEATION AND MAPPING METHODS

Method 1: Walking or Wading
This method should be used if the site is intertidal. The shallow, or inshore, edge of the bed is usually clearly visible at low tide. At each site, establish a series of transect lines according to the guidelines provided in the previous sections. An observer with a handheld Geographic Positioning System (GPS) unit walks or wades along each transect and records the locations of boundaries of eelgrass beds, using either Method A or B for delineating the boundaries of the eelgrass beds. If the water is clear, the deep or offshore edge of the eelgrass bed may be visible with the naked eye from the boat or with the use of a bathyscope (underwater viewing box). GPS coordinates and water depth can be taken to track the deep edge of the bed.

Method 2: Snorkelers or Divers
If the water, even at low tide, does not allow observation of the bottom with the naked eye or a bathyscope from the boat, then use snorkelers or divers to identify the boundaries of eelgrass beds. Safety issues such as the potential for strong tidal currents in some areas should also be considered before using snorkelers or divers.

A series of buoys can be used to mark the deep edges of the eelgrass bed(s) to identify their locations. The scope, or length, of the line on the buoy needs to be minimized to the greatest extent possible to avoid inaccuracies due to buoys drifting away from their anchorage points. Having a large amount of scope on the line can lead to significant under/overestimate of actual eelgrass extent. Once the boundaries are marked with buoys, then a vessel can be maneuvered from buoy to buoy recording GPS coordinates.

Method 3: Underwater Photography
Underwater videography can be particularly useful for detecting and mapping the presence of eelgrass over large study areas that may be difficult to sample using more intensive methods

such as diver transects. At each site, establish a series of transect lines running perpendicular to the shoreline that begin just outside the boundaries of the proposed project area, making sure the transects cover the entire project area. Record underwater imagery along each transect and identify the locations of all visible eelgrass beds or patches. However, it may not always be possible to distinguish among Pacific Northwest seagrasses (e.g. *Z. marina*, *Z. japonica* and *Phyllospadix* spp.) (Berry et al. 2003). Where multiple seagrass species occur, perform the verification using Methods 1 or 2 above to verify species identification.

Method 4: Hydroacoustic Mapping
If the site is very large, hydroacoustic surveys may be considered as an alternative to the methods outlined above. Because detection and mapping of eelgrass using hydroacoustic equipment is not limited by water clarity, this method is particularly suitable for turbid water conditions; however, this method does have certain limitations[2]. Depending on the heterogeneity of the eelgrass beds, the size of the area, and the desired degree of survey resolution, transect spacing may vary from as little as 25 feet to more than 100 feet. However, ground-truthing using wading, divers, or underwater photography must be performed to verify the hydroacoustic mapping classifications. It should also be noted that this method is likely to underestimate the extent of the eelgrass beds, because the eelgrass bed boundaries as defined herein may be below the minimum detection thresholds of the hydroacoustic system.

Method 5: Aerial Photography
If the site is extremely large, aerial photography obtained from the state or other sources may be used to provide background information on the likely presence or absence of eelgrass at that site. Unmanned aerial vehicles (UAVs) are an emerging technology that has the capability of providing low altitude, high-resolution aerial imagery that could be useful to document the potential presence or absence of submerged aquatic vegetation for large sites. However, aerial imagery should not be used as the only source of information. When using aerial imagery, it is not possible to reliably distinguish between eelgrass and macroalgae, or between different species of eelgrass or other seagrasses. Aerial photography is also likely to underestimate eelgrass coverage because eelgrass occurring in deeper waters can appear dark and may not be detected. Ground-truthing using any of Methods 1 or 2 above should be performed to verify the mapping of eelgrass bed boundaries determined from aerial photography.

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[2] Limitations: Hydroacoustic surveys are not suitable for very shallow waters (less than 0.75 m) where access by small boats is limited. The hydroacoustic survey system is not currently capable of reliably distinguishing between underwater vascular plants (e.g. eelgrass) and macroalgae (e.g., kelp). In tidal waters, the information on canopy height is unreliable unless the surveys were conducted at slack tide.

APPENDIX A: THE INFLUENCE OF LANDSCAPE SETTING ON EELGRASS BED CONFIGURATION

Shallow eelgrass populations form characteristic landscapes with a configuration that is highly related to the level of physical exposure. Seagrass bed patterns range from continuous or semi-continuous over hundreds of meters to patchy distributions ranging from a meter to tens of meters in the longest dimension (Fonseca and Bell 1998). Bed fragmentation generally increases with increasing wave exposure and tidal current speed (Fonseca and Bell 1998). Therefore, the geomorphic setting and hydrodynamics of the nearshore zone have a strong influence on seagrass distribution and bed structure. Potential *Z. marina* habitat in the Pacific Northwest may be classified as either fringe (Figure A1) or flats (Figure A2) based on its geomorphic setting (Berry et al. 2003).

Fringe Eelgrass Habitats

Fringe *Z. marina* habitats are areas with relatively linear shorelines where potential *Z. marina* habitat is limited to a narrow band by water depth. Fringe eelgrass beds may be contiguous or nearly contiguous over long sections of linear shorelines (Figure A1). The fringe category is further classified into narrow fringe and wide fringe based on a 305 m (1000 ft) threshold width separating mean high water and the –20 ft depth contour at mean lower low water (Berry et al. 2003) (Figure A1).

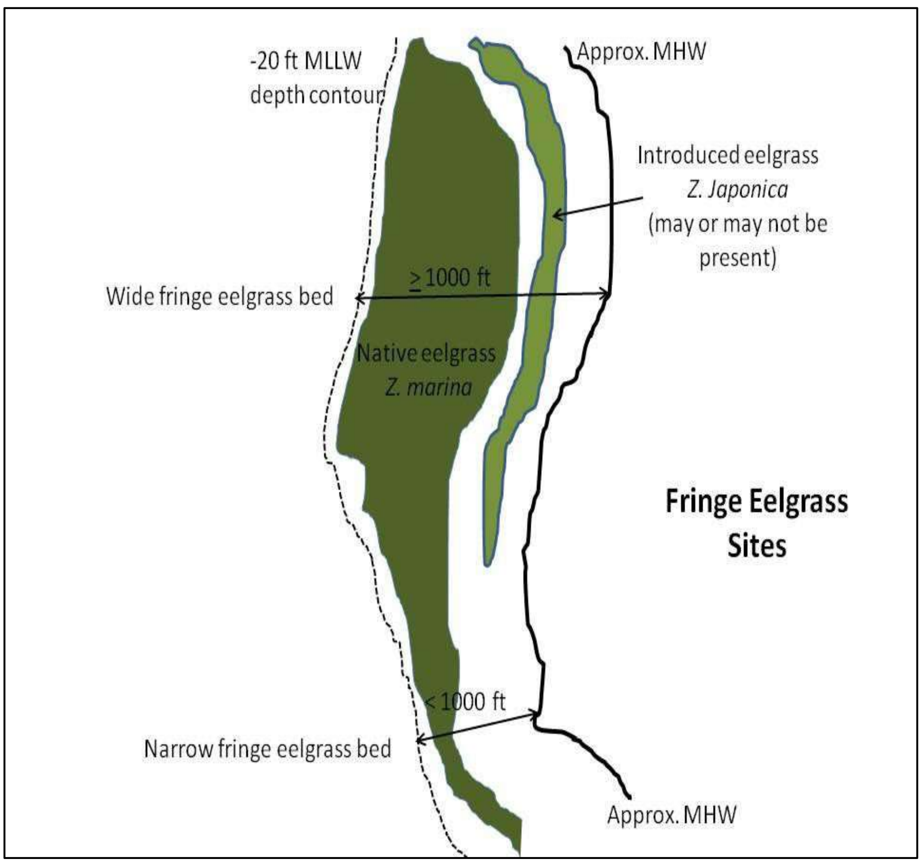


Figure A1. Illustration of fringe geomorphic classifications of eelgrass sites (modified from Berry et al. 2003).

Flats Eelgrass Habitats
Flats *Z. marina* sites are shallow embayments with extensive broad shallows that appear to have little slope within the vegetated zones. Slightly more than half of the total area of *Z. marina* habitat in Puget Sound is characterized as flats; one large embayment, Padilla Bay, contains approximately 20% of the *Z. marina* in Puget Sound (Berry et al. 2003). Flats sites may be further sub-classified into river-influenced flats such as river deltas, and tide-influenced flats (pocket beaches and other sites that lack a significant source of freshwater and associated sediment input) (Figure A2). Periodic pulses of sediment in river- influenced flats sites may generate shallow shoal complexes that can be highly dynamic over timeframes of months to years, leading to a continually changing mosaic of eelgrass patches interspersed with unvegetated shoals (Marbà et al. 1994).

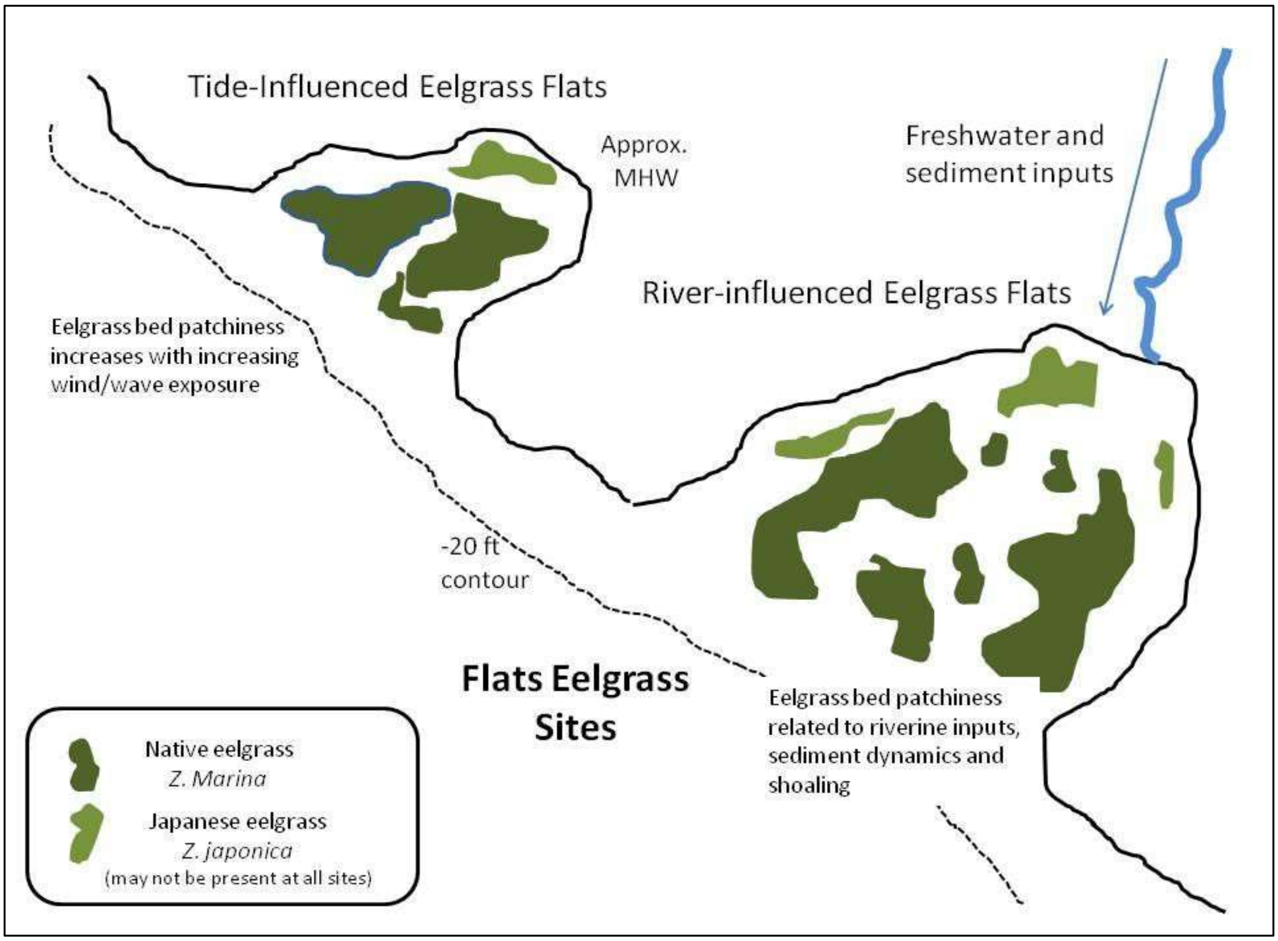


Figure A2. Illustration of flats geomorphic classifications of *Z. marina* habitats (modified from Berry et al. 2003).

Spatial and Temporal Variation in Eelgrass Bed Location
Within eelgrass habitat, eelgrass is expected to fluctuate in density and patch extent and can expand, contract, disappear, and re-colonize areas within suitable environments based on prevailing environmental factors (e.g., turbidity, freshwater flows, wave and current energy, bioturbation, temperature, etc.). Because the maximum depth of seagrass colonization is controlled by light availability, tracking the deep edge of growth can provide information on the

quality of the estuarine light environment over time relative to local and regional water quality standards. Upslope movements (deep → shallow) in the location of the deep bed edge have been used as an indicator of some type of chronic disturbance, either natural or anthropogenic, that results in increased turbidity and reduced light availability for seagrasses.

Eelgrass meadows in Puget Sound are characterized by substantial interannual variability that appear to be related to the occurrence of El Niño climate events, emphasizing the importance of multi-year surveys to adequately characterize seagrass abundance and distribution in a particular area (Nelson 1997). On average, vegetated eelgrass areas on the Pacific coast can expand by 5 meters (m) per year and contract by 4 m per year (Washington Dept of Natural Resources 2012). To account for these normal fluctuations, Fonseca et al. (1998) recommends that seagrass habitat include the vegetated areas as well as presently unvegetated spaces between seagrass patches.

Patterns in eelgrass bed 'patchiness' or fragmentation are related to the degree of exposure to disturbance from wind, waves and tidal currents. Wind-generated wave dynamics and tidal currents create sediment movement, which may either bury plants, expose roots and rhizomes or during heavy storms even uproot entire plants (Kirkman and Kuo 1990). Plant burial was found to be an important mechanism of gap formation in a seagrass system in Tampa Bay, USA (Bell et al. 1999); the patch dynamics of *Zostera marina* vegetation in Rhode Island, USA was likewise thought to be controlled by sediment movement (Harlin and Thorne-Miller 1982).

Eelgrass patches may be constantly moving even during periods when a relatively constant total eelgrass area suggests stable conditions in the population. For example, although the total area of eelgrass was quite stable in the 1980s in Amager, Denmark, where a complex system of alternating eelgrass belts and sandbars is found, about 55 % of the eelgrass changed between two consecutive mappings (Frederiksen et al. 2004). The mechanism is probably that extrinsic disturbance factors constantly change growth conditions in the exposed areas and keep the eelgrass populations in a state of continuous re-colonization. The maps showed that the eelgrass belts migrated in a northeasterly direction and the sandbars migrated in the same direction. Outer sandbars feed the inner sandbars with sediment and substantial transportation of sand thus occurs along the sandbars (Frederiksen et al. 2004). This sediment movement most likely led to either burial or erosion on the western edges of the eelgrass patches and new growth mainly occurred in the eastern parts. Similar patterns have been observed in the eelgrass beds associated with a flood tide delta in Rhode Island, USA (Harlin and Thorne-Miller 1982), and in Tillamook Bay, OR. Comparison of historic eelgrass maps and aerial imagery in Tillamook Bay suggests that eelgrass associated with shallow sandy shoals may have become buried or eroded over time, then became re-established in different locations as the shoals shifted in response to current or sediment pulses (Figure A3). Other areas in the Pacific Northwest that exhibit this pattern include eelgrass beds near the mouth of the Dungeness River in northern Washington.

Figure A3. Historic maps of eelgrass distribution on river-influenced flats in Tillamook Bay, OR (shown as light green polygons) superimposed on more recent aerial photography, showing apparent changes in the location of the eelgrass beds over time in an area with dynamic sediment movement and shoaling.

APPENDIX B: EXAMPLE EELGRASS HABITAT MAPS FOR TIER 1 DELINEATION SURVEYS

This section includes several examples of eelgrass habitat maps prepared using the results of the delineation process described in this document. In these examples, an un-vegetated buffer around existing eelgrass beds is shown. The buffer may be required for some, but not all, in-water activities. Situations where an eelgrass buffer may be required include programmatic Endangered Species Act consultations, or a proposed mitigation plan. In these cases, the appropriate buffer should be included in maps/drawings, as shown in these examples. Consult your local Corps representative for more information.

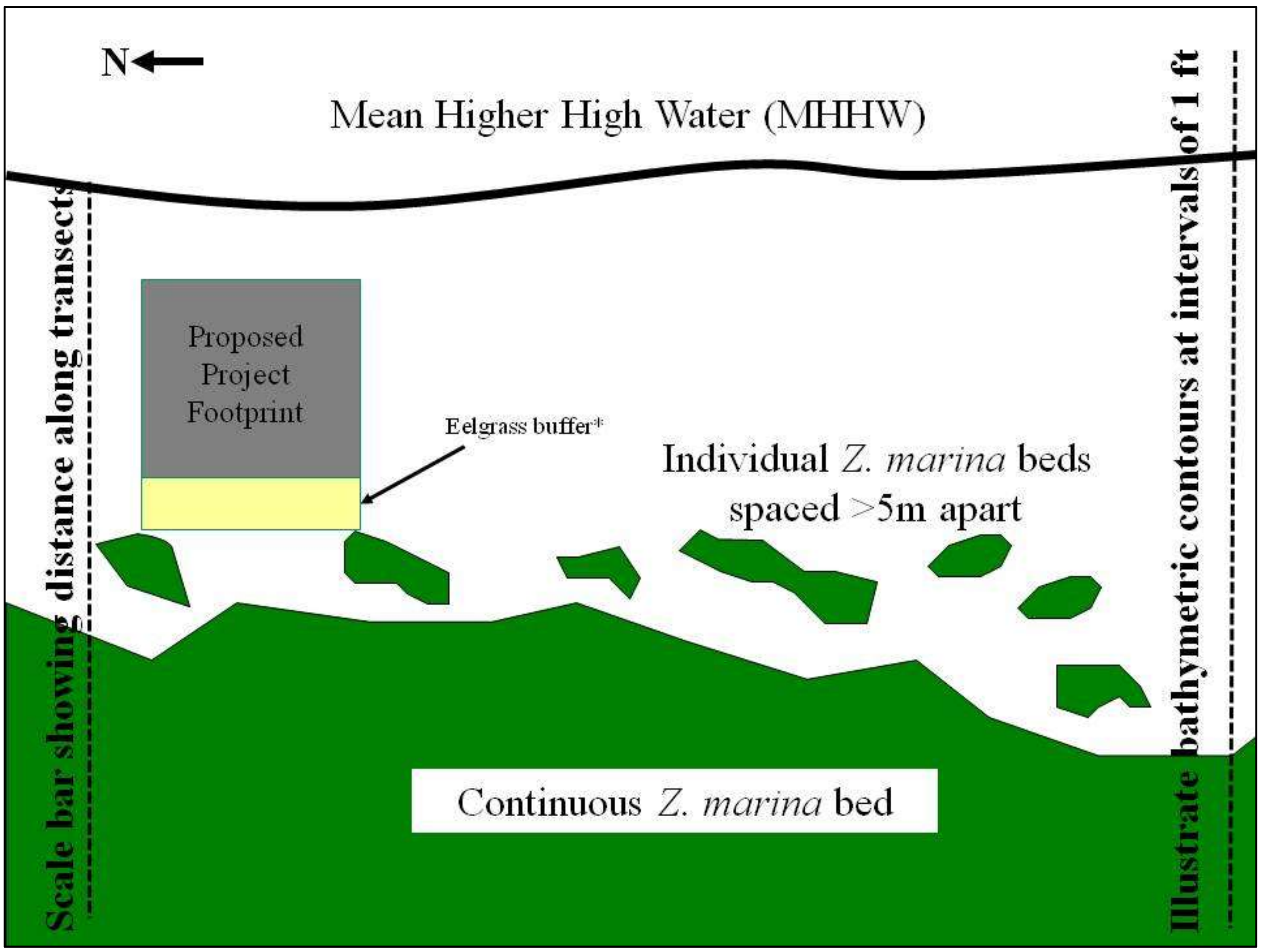


Figure B1. This example illustrates numerous individual beds of native eelgrass (Z. marina) in the mid-intertidal zone and a continuous bed of native eelgrass in the lower intertidal zone. In this illustration, the individual beds of eelgrass each meet the definition of a bed and are more than 5 meters apart. In this case it is appropriate to delineate and map each individual bed of native eelgrass as shown here.

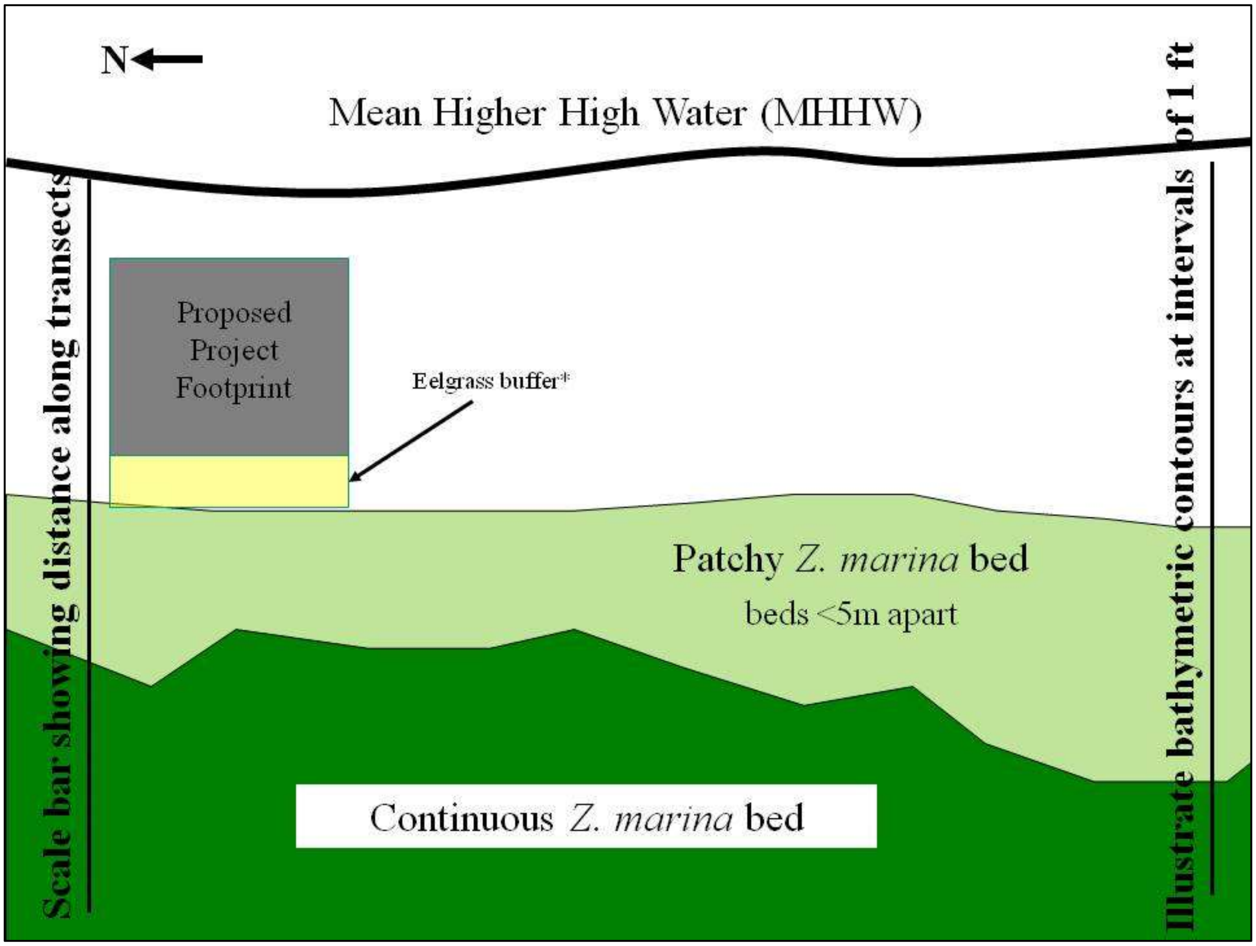


Figure B2. This example illustrates a bed of patchy native eelgrass in the mid-intertidal zone and a continuous bed of native eelgrass in the lower intertidal zone. In this illustration, there are multiple individual beds of eelgrass in the patchy bed, each meeting the definition of a bed. However, in this example, the individual beds are less than 5 meters apart. In this case, we recommend that only the upper and lower boundaries of the patchy eelgrass be mapped, without the need to delineate each individual patch.

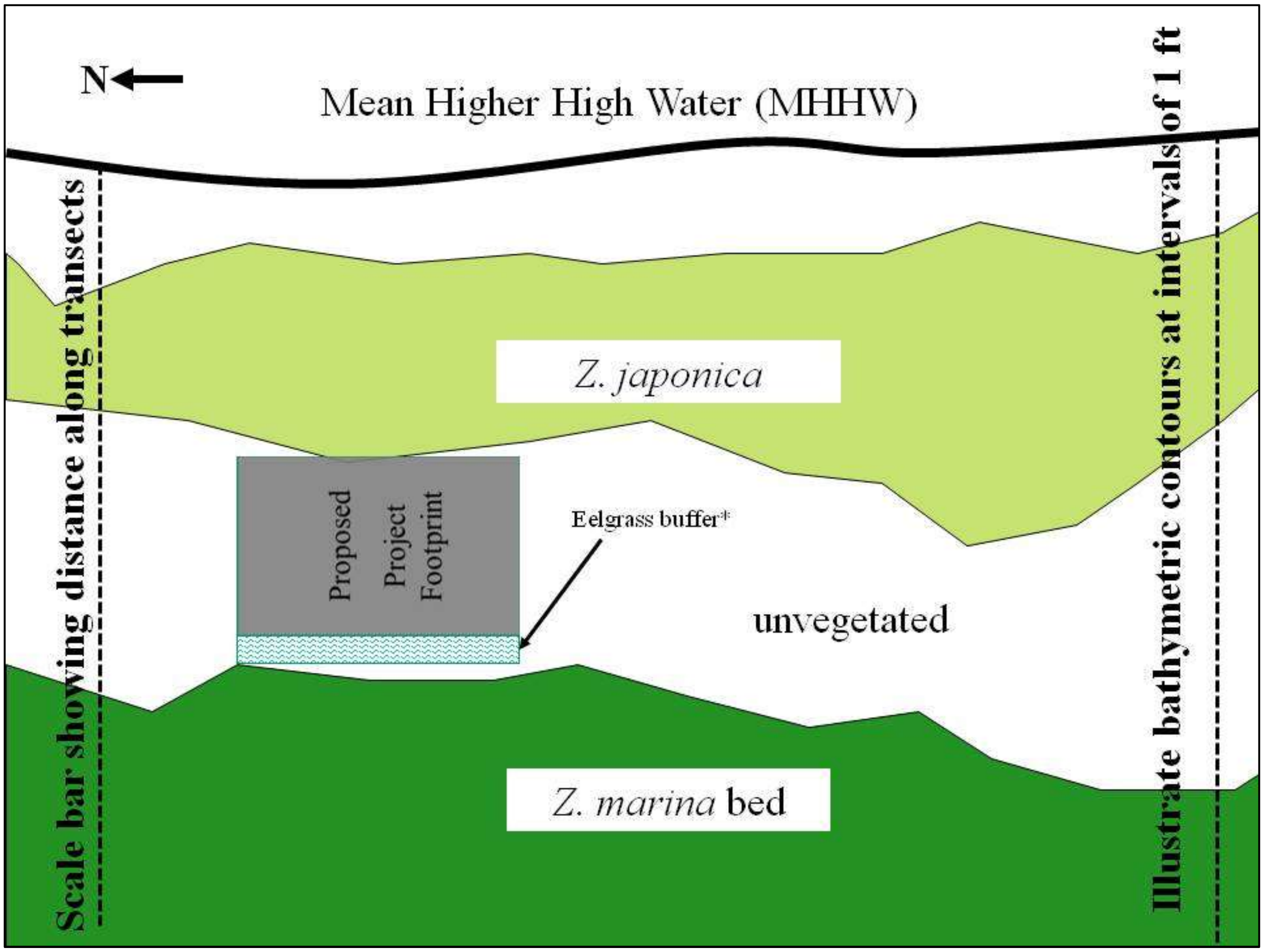


Figure B3. Example of eelgrass delineation where both eelgrass species (Z. marina and Z. japonica) are present. The non-native Z. japonica typically occupies a slightly higher position in the intertidal zone, with the native eelgrass (Z. marina) occurring in deeper waters. In some cases, there may be a variable width of un-vegetated substrate separating the two eelgrass species, as shown in this example. The presence of non-native eelgrass should be shown because of the potential for confusion and mis-identification between the two species. However, the criteria for bed thresholds apply only to the native eelgrass Z. marina.

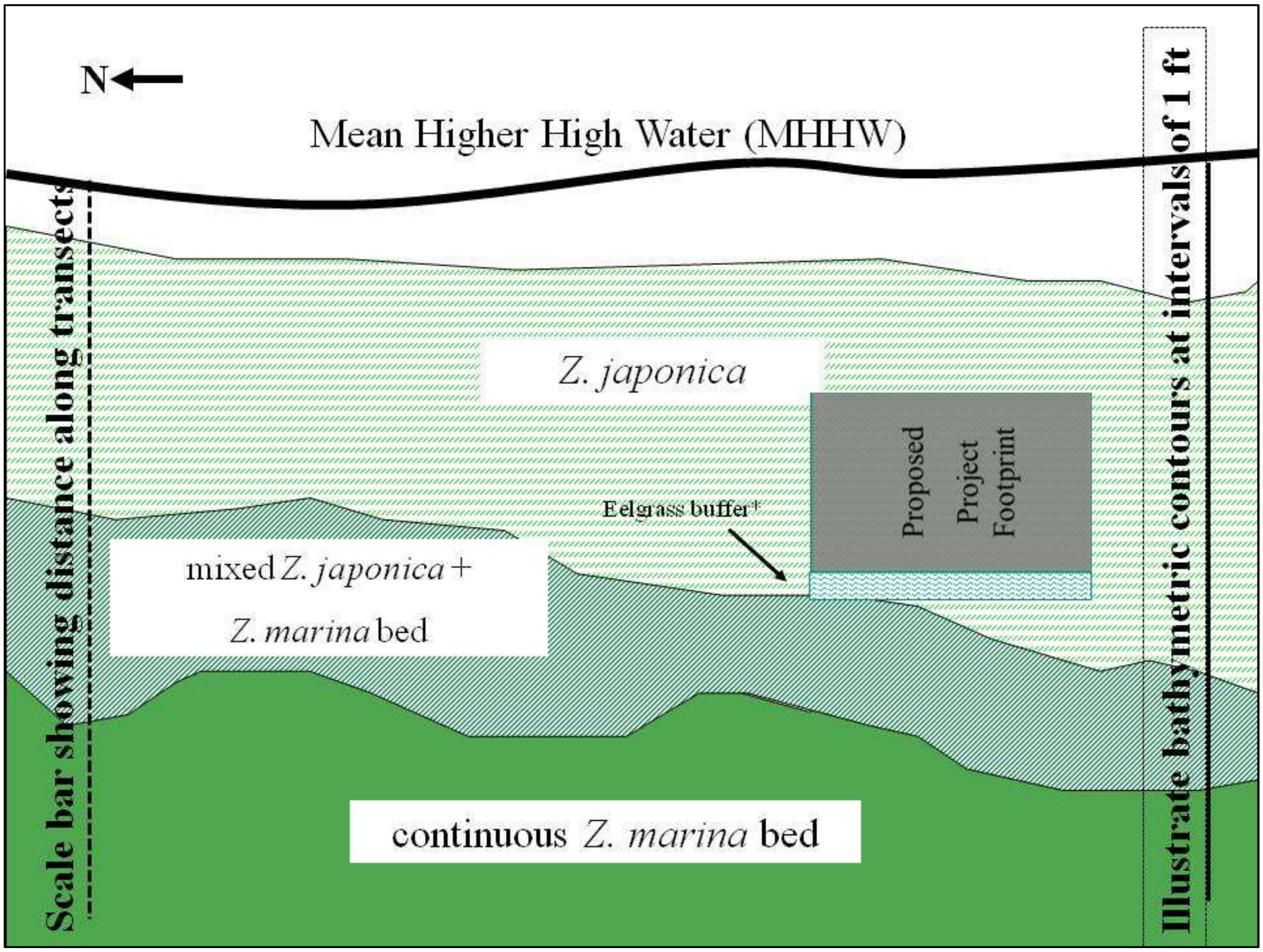


Figure B4. Another example of eelgrass delineation where both eelgrass species (Z. marina and Z. japonica) are present. The non-native Z. japonica typically occupies a slightly higher position in the intertidal zone, with the native eelgrass (Z. marina) occurring in deeper waters. In this example, there is a mixed zone where both species grow intermingled. In these situations, the mixed beds should be carefully examined to determine where there is sufficient native eelgrass present to meet the bed definitions. However, the criteria for bed thresholds apply only to the native eelgrass Z. marina.

APPENDIX C: IDENTIFICATION OF *ZOSTERA MARINA* AND *ZOSTERA JAPONICA*

Zostera marina (eelgrass) Status: Native

Zostera marina is the most widely distributed seagrass in the world. Its range spans the area from Alaska to Baja California on the West Coast of North America; it is also found on the North American East Coast, Europe, Asia, and the Middle East. Common in low intertidal and subtidal zones to a depth of 20-30 feet along sheltered areas with sandy or muddy beaches. Leaf blades are usually about ½ inch (8-10 mm) wide but may be narrower. The blades reach a length of 10 ft (3 m) and are flat. This species blooms from June through August. The inflorescence (flower clusters) grow on the tips of long shoots separate from the leaf blades.

Habitat: marine to brackish waters, lower intertidal and shallow subtidal; sandy to muddy sediments.

Ecology: Eelgrass habitats play an important role as foraging habitat for juvenile salmonids, particularly chum and Chinook. Pacific eelgrass stands also provide habitat for other important fishes and shellfish, including Dungeness crab and starry flounder. Spawning Pacific herring utilize eelgrass as a substrate to deposit eggs. Pacific eelgrass beds also harbor a diversity of infaunal and epifaunal species, including polychaetes, gastropods, bivalves, amphipods, echinoderms, and other crustaceans that are known prey of many commercially valuable fish and invertebrates. Eelgrass meadows are also important foraging habitats for many species of migratory geese, ducks, and swans. Pacific Black Brant feed almost exclusively on eelgrass (both native and non-native), and their populations can be affected by declines in eelgrass abundance. Eelgrass leaves, roots, and rhizomes attenuate wave energy and provide shoreline stabilization. Eelgrass beds also sequester carbon and may play a role in minimizing the effects of ocean acidification, thus helping to mitigate the effects of global climate change.

Zostera japonica (dwarf eelgrass) Status: Introduced

Z. japonica forms dense stands in shallow, sheltered bays and estuaries. In its native range, it occurs from Korea and Japan northward to the Kamchatka Peninsula in Russia. In North America, this species ranges from southern British Columbia to Humboldt Bay, California, and is expected to continue expanding its range. In the northern part of its range in North America (British Columbia), Z. japonica lives as an annual, overwintering as buried seeds. Towards the southern part of its established range in North America, it occurs as a short-lived perennial. It is listed as a Class C noxious weed in California and Washington, but is not listed on the federal invasive species list. It reproduces vegetatively through rhizomatous cloning and sexually through seed production. The habitat structure provided by this species may perform similar functions as native eelgrass; in particular, additional research is needed to verify its role in fisheries species utilization. This species is known to be an important food source for many species of migratory waterfowl, especially Pacific Black Brant. The dispersal of the seeds, both within and between estuaries, may be aided by waterfowl species.

Habitat: marine to brackish waters, lower intertidal and shallow subtidal; sandy to muddy sediments. It typically occupies the upper to mid-intertidal zone at a higher elevation than the native eelgrass, Z. marina.

Distinguishing Native and Introduced Eelgrass

Zostera marina

Native Eelgrass

(typical)

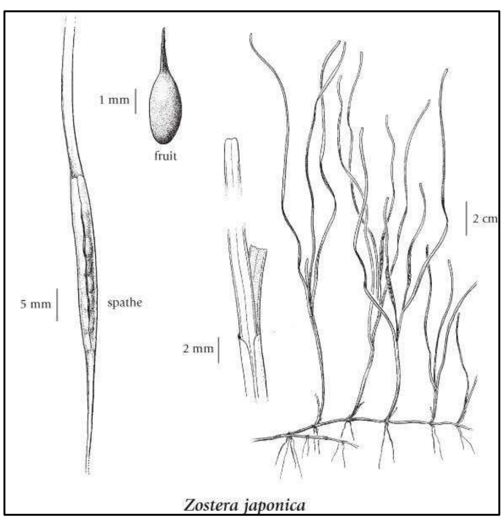
Zostera japonica

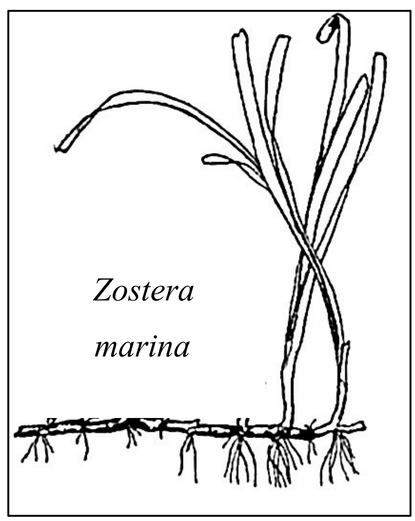
Japanese eelgrass

Introduced

IMPORTANT:

Leaf size is NOT a reliable indicator. *Z. marina* can sometimes look very similar to *Z. japonica*





DISTINGUISHING CHARACTERISTIC

***Z. japonica* has roots in pairs at each rhizome node.**

***Z. marina* has roots in bundles (>2) at each rhizome node.**

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