Methods for Mapping and Monitoring Japanese Eelgrass (Zostera japonica) Habitat in British Columbia

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PRECISION IDENTIFICATION
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Preface

Field Methods for Mapping and Monitoring Eelgrass Habitat in British Columbia was written in 2002 to provide readers with a basic understanding of native eelgrass (*Zostera marina* L.) ecology and to provide a standardized set of methods to map, classify, and monitor native eelgrass habitat on a local level.

Stewardship Groups have since expressed interest in documenting and monitoring habitat changes relating to the introduced Japanese eelgrass (*Z. japonica* Aschers. & Graebn.) in their local communities. The following document was designed to provide the guidance necessary for studying the introduced eelgrass species.

A document entitled 'Mapping Eelgrass using the Garmin 12XL GPS: A manual for the West Coast of British Columbia' is available on line, and provides detailed guidance on the use of a GPS (http://www.shim.bc.ca/eelgrass/GPSManual.pdf).

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Precision Identification would like to thank and acknowledge the following individuals for their review of the manuscript.

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1.0 Introduction

Japanese eelgrass, *Zostera japonica* Aschers. & Graebn., is not native to British Columbia. It is believed to have arrived accidentally along with “seed” oysters imported from Japan to Washington State (Harrison & Bigley, 1982).

The first recorded specimen of *Zostera japonica* on the Pacific coast of North America was collected in Washington State in 1957 (Hitchcock et al., 1969). There was some confusion over the identity of this plant for several decades; it has been referred to as *Z. nana, Z. americana*, and *Z. noltii,* however it’s identity has now been confirmed as *Z. japonica*.

Z. japonica was first discovered in Boundary Bay, B.C. in 1974, by 1978 it had spread northward 25 km along the foreshore, and in 1979 it was collected in Nanaimo on the east coast of Vancouver Island (Harrison & Bigley, 1982). Recently, it has been collected in Port Renfrew, Port Alberni, Ucluelet, and Cortes Island (Durance, pers. com.). The current distribution of *Z. japonica* along the B.C. coast is the focus of a study by Precision Identification and the Seagrass Conservation Working Group. The success of the study depends on volunteers submitting samples from new locations for verification. Information about submitting samples may be obtained from precid@shaw.ca

2.0 Identification

Z. japonica cannot be distinguished from small *Zostera marina* solely on the basis of leaf length and width. However, the leaf sheath of *Zostera japonica* consists of two overlapping flaps, whereas the leaf sheath of *Zostera marina* is a complete tube that encases the leaves. The two species may be distinguished in the field by gently pulling the two outer leaves away from each other; the sheath of *Z. marina* will tear while that of *Z. japonica* will open without tearing (Figures 1, 2, & 3).

3.0 Life History

Z. japonica is an annual or short lived perennial. The plant typically overwinters as seeds buried in the sediment. In British Columbia the seeds germinate in the spring, between March and May. In sheltered habitats one may find short vegetative shoots that overwinter, but these usually die the following spring (Harrison & Bigley, 1982). The seedlings branch to form additional shoots vegetatively (Figure 4). A single plant may consist of many shoots that are connected via underground rhizomes. Flowers are produced during the summer and seeds released in the fall. The majority of the shoots senesce by November. More details about the life history of *Z. japonica* may be found in Miki (1933), Arasaki (1950a, b), Harrison (1979, 1982a,b) and Bigley (1981).

Figure 1. *Zostera japonica* sheath.

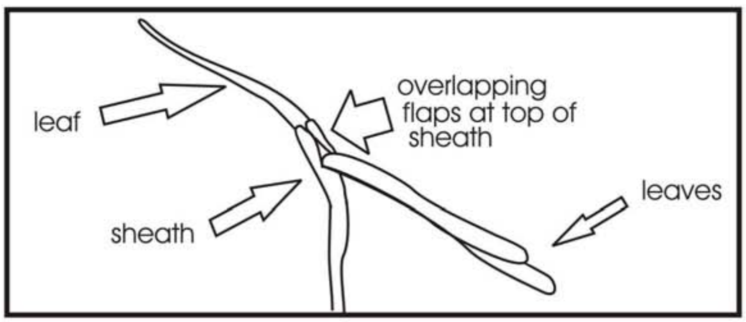

Figure 2. Schematic drawing of Figure 1.

Figure 3. *Zostera marina* sheath.

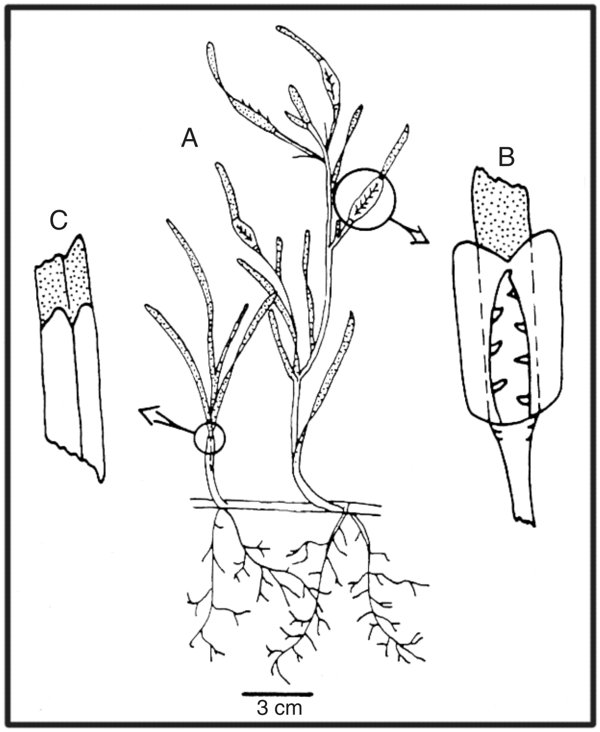

Figure 4. *Zostera japonica*. A. Whole plant, showing vegetative shoot (left), branched flowering shoot (right), horizontal rhizome, and roots. B. Detail of inflorescence with flowers removed and spathe open to show, in this specimen seven retinacula. C. Detail of leaf sheath (unshaded), showing two overlapping flaps. From: Harrison & Bigley, 1982.

4.0 Habitat

Z. japonica grows in soft-sediment (sand and/or mud) of intertidal areas. Generally, it is found higher in the intertidal than *Z. marina*, although in some areas the species grow intermixed. Research has shown that the growth rate of *Z. marina* may be twice that of *Z. japonica* under summer light conditions when both species are continually submerged, thus the *Z. japonica* can't successfully compete for light in the subtidal (Harrison, 1982c). The lower resistance of *Z. marina* to desiccation (drying out during low tide) limits its colonization of the intertidal. Therefore, the invasion of *Z. japonica* is not likely to threaten *Z. marina* populations.

Zostera japonica provides valuable fisheries habitat in areas where it is native. In Hong Kong for example, there are major efforts underway to restore *Z. japonica* beds (http://www.afcd.gov.hk/conservation/eng/sea_grass.htm). The habitat value provided by *Z. japonica* in North America is a controversial topic. It is generally considered beneficial, from a fisheries perspective, since it provides many of the functions that the native species of eelgrass does. Several species of seabirds forage in and on *Z. japonica*, however other species, such as sandpipers, have lost foraging areas due to *Z. japonica* colonization. The presence of the plants alters the sediments and hence the organisms that can live there; substantially changing the ecological role of these habitats.

California has eradication programs designed to eliminate *Z. japonica*, while in Washington State it is protected as valuable fish habitat.

5.0 Mapping & Monitoring

Mapping and monitoring projects should be conducted between May 1 and September 1. The density of shoots usually increases over the summer, so if the area is to be monitored on an annual basis then the subsequent studies should be completed within two weeks of the original calendar date.

Every bed should be assigned a reference number or unique identifier code for tracking purposes. Each group that collects data may establish their own system for doing this.

A hand held GPS, such as the Garmin 12XL, should be used to map the perimeter of the eelgrass bed. A document entitled 'Mapping Eelgrass using the Garmin 12XL GPS: A manual for the West Coast of British Columbia' provides detailed guidance on the use of a GPS for this purpose (http://www.shim.bc.ca/eelgrass/GPSManual.pdf).

Small beds of *Z. japonica* need to be mapped differently than larger ones due to the limitations of hand held GPSs. Beds that are greater than 10 metres in any direction should be assessed using Data Sheet A (Appendix 1); beds less than 10 metres in all directions should be assessed using Data Sheet B (Appendix 2).

The first section of the datasheet is used to record the metadata; information about who, how, when, and where the data was collected. This section needs to be completed once for each bed.

The second section is designed for recording field data about the *Z. japonica* bed, and includes percent cover, distribution, and density estimates.

5.1 Percent Cover

Percent cover in this study, refers to the percentage of the substrate that is covered by *Z. japonica* at low tide. The percent cover is estimated as, 1% to 10%, 11% to 25%, 26% to 50%, 51% to 75%, or >75%. You need to classify the primary percent cover; estimates for the secondary and tertiary percent cover are optional. These are discussed later in this section.

One way to estimate percent cover is to imagine moving the plants together. Figures 5 and 6 are provided to illustrate this idea, in very general terms. The photographs show only a portion of a bed, in the field you would be estimating the cover of the entire bed not just the small area shown in the pictures. The pictures are simply provided to help illustrate the concept.

The top photograph in Figure 5 shows an area with sparse *Z. japonica*, the area that is occupied by this species has been outlined in black. In the centre photograph, the areas occupied by *Z. japonica* have been shaded white and moved to one corner. The area shown in the picture has been divided in four equal squares, with each square representing 25% of the entire area shown.

The shaded areas that extend out of the upper right square in the centre picture have been moved into that square in the bottom picture. The total shaded area fits within the square, thus the percent cover is less than 25%. Since more than half of the square is shaded white the percent cover would fall into the 11 to 25% range.

You may find it easier to estimate the ‘bare’ area when the percent cover is greater than 50%. For example, if most of the area is covered by plants, it may be easier to estimate that 15% of the substrate is not vegetated; hence the percent plant cover would be 85%. Figure 6 is provided to illustrate this concept. The bare areas have been outlined in the top photograph, and moved together in the centre photograph. The bottom photograph shows that the bare areas total less than 25% of the area, thus the percent cover by *Z. japonica* would be classified as >75%.

In cases where the bed is larger than you can see from a single vantage point, you can walk along it estimating percent cover as you go and then averaging. In some areas you may find that the percent cover varies dramatically from one part of the bed to the next. For example, a bed could consist of; a wide band near shore where the percent cover is 7%, a much larger area where the percent cover is 35%, and a relatively small ‘pocket’ within the bed with 95% cover. The primary percent cover would be classified as 26-50% since most of the bed falls into this range. The secondary and tertiary percent cover are optional fields, but if you wanted to complete these the secondary would be 1 to 10%, and the tertiary >75%. The secondary and tertiary fields would assist in identifying trends during multiyear monitoring.

The section of the datasheet that relates to percent cover is shown below.

1.) Percent Cover of *Zostera japonica*

Primary	1 to 10%	....	Secondary	1 to 10%	....	Tertiary	1 to 10%	....
	11 to 25	....	(optional)	11 to 25%	....	(optional)	11 to 25%	....
	26 to 50%	....		26 to 50%	....		26 to 50%	....
	51 to 75%	....		51 to 75%	....		51 to 75%	....
	> 75%	....		> 75%	....		> 75%	....

Figure 5. *Z. japonica* 11% to 25% cover.

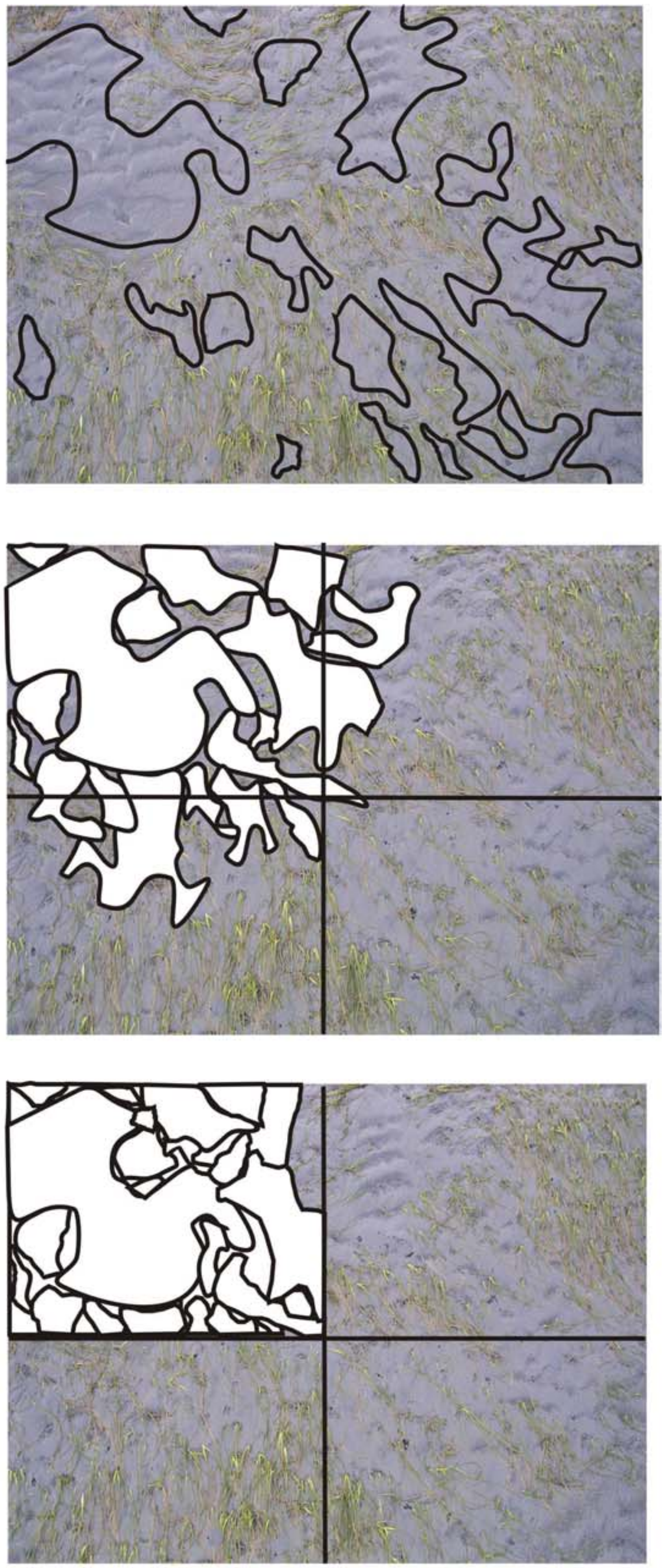

Figure 6. *Z. japonica* >75% cover.

5.2 Distribution

The distribution of *Z. japonica* within the bed is classified as either patchy or continuous. It is patchy if there are dense 'islands' of plants surrounded by unvegetated substrate (Figure 7). The bed is continuous if there are plants spread out though most of the area (Figure 7). There may be areas of unvegetated substrate within a continuous bed.

If the eelgrass distribution is patchy and the distance between patches is greater than 10 m, then the each patch should be mapped as an individual bed if time allows. The distribution within each patch may be either patchy or continuous. If time is limited then the area may be mapped as one large patchy bed.

5.3 Density

The density of *Z. japonica* is estimated by quadrat sampling. A quadrat is a frame that defines a set area, this study uses a quadrat that measures 25 cm by 25 cm, and thus the area within the quadrat is 1/16 m^2(0.0625 m^2).

The quadrat is tossed into the *Z. japonica* bed, and where ever it lands is a sampling site. You then count the number of shoots that are rooted within the area framed by the quadrat. There may be leaves trapped under the quadrat that are attached to shoots rooted outside of the quadrat, these are not to be included in the tally.

Figure 7. Photograph of *Z. japonica*; patchy distribution.

Figure 8. Photograph of *Z. japonica*; continuous distribution.

5.4 Field Survey

Z. japonica field surveys can usually start two (2) hours before a good low tide and extend about two (2) hours after the low tide.

A list of the equipment that is necessary to complete a field survey is provided in Section 6.6.

The order in which a survey is completed may be decided by the field survey leader, a suggested protocol is provided below for large (>10m) and small beds (<10m).

5.4.1 Beds > 10m in at least one direction

Step 1 – Record

Fill in the Background section of Datasheet A and assign the bed a unique identifier code or reference number.

Step 2 – Delineate

Walk the perimeter of the *Z. japonica* bed, using a GPS set to track log. Refer to the GPS manual for detailed instructions.

Step 3 – Record

Complete the Overview section of Data Sheet A.

Step 4 – Photograph

Select a reference point from which to take a photograph. Record a GPS point for the reference point and the compass direction in which the photograph will be taken. Take the photograph and record the frame number on the datasheet. It may be necessary to take several photographs in order to capture the entire bed.

Step 5 - Sample

Toss the quadrat within the *Zostera japonica* bed; avoid tossing the quadrat within 3m of any edge to avoid fringe effects. Count the shoots that are rooted within the area enclosed by the quadrat. Record the number on Data Sheet A. If the quadrat lands in a bare area within the bed record ‘0’ on the data sheet. Repeat for a total of fifteen (15) samples. Try to distribute the counts throughout the bed; avoid clustering samples near each other.

5.4.2 Beds < 10m in all directions

Step 1 – Record

Fill in the Background section of Datasheet A and assign the bed a unique identifier code or reference number.

Step 2 – Delineate

Estimate the centre of the bed and record a GPS point. Measure, using a metre tape, the length of the bed parallel and perpendicular to the shore. Record the measurement to the nearest cm.

Step 2 – Record

Complete the Overview section of Data Sheet B.

Step 3 – Photograph

Select a reference point from which to take a photograph. Record a GPS point for the reference point and the compass direction in which the photograph will be taken. Take the photograph and record the frame number on the datasheet.

Step 4 - Sample

Toss the quadrat within the *Zostera japonica* bed, and count the shoots that are rooted within the area enclosed by the quadrat. Record the number on Data Sheet B. If the quadrat lands in a bare area within the bed record ‘0’ on the data sheet. Repeat for a total of fifteen (15) samples.

5.5 Post Processing

Calculate the mean number of shoots/16m^2 by adding the 15 values collected in the field for each bed and dividing the total by 15. Multiply the mean by 16 to obtain the density per m^2. The section of the datasheet that is used to calculate the density/m^2 is shown below as an example.

sample	**# per 0.16 m^2**
1.	85
2.	72
3.	68
4.	102
5.	97
6.	84
7.	6
8.	12
9.	58
10.	66
11.	49
12.	92
13.	59
14.	66
15.	72
Total	988
Mean (Total ÷ 15)	65.88
#/m^2 (mean x 16)	1053.87

The mean density for this set of data is 1053.87 shoots/m^2.

The data from the GPS should be downloaded onto a computer. Directions for this are provided in the GPS manual.

5.6 Equipment

Zostera japonica field data sheets (waterproof paper recommended)
1/16m^2 quadrat (25 cm x 25 cm)
clipboard & pencils
GPS
Tide tables
Metre tape
Compass
Sunscreen
Drinking water

Camera

6.0 Glossary

Citations are provided in brackets for the definitions that were extracted from published references.

Abiotic: The non-living components of the planet, not currently part of living organisms, such as soil, rocks, water, air, light, and nutrients (1).

Annual: An organism that complete its life cycle from birth or germination through to death within one year (1).

Asexual reproduction: Reproduction without fertilization, no union of gametes occurs, and no exchange of genetic material takes place (1).

Bract: a specialized, reduced, or modified leaf associated with an inflorescence (3).

Desiccate: To dry up (1).

Dehisce: To burst or split open such as seed capsule from a plant (2).

Delineate: To trace the form or outline of (2).

Density: The number of shoots in relation to some unit of area (1).

Forage: Search for food, browsing or grazing.

Germination: The start of growth in a mature, generally dormant, seed, spore, or pollen grain (1).

Inflorescence: The flowering part of a plant (1).

Intertidal: A coastal environment occurring between the mean high and the mean low tides (1).

Organism: Any living entity from single-cell bacteria, viruses, fungi, to all plants and animals (1).

Overwintering stage: The stage in which an organism endures the adverse conditions of winter (1).

Quadrat: A small, clearly defined plot or sampling area of a known size, used as part of a sampling or study scheme to ascertain characteristics of a larger ecosystem or vegetation pattern (1).

Perennial: A plant that continues growth from year to year (1).

Retinacula: Viscid glands connected with the stigma and holding fast the pollen masses (2).

Rhizome: A root-like stem, growing horizontally below the ground surface. The rhizome is used for storage of food materials (1).

Root: Plants depend on roots for anchorage, uptake of water and nutrients, storage of food reserves, and the synthesis of organic compounds (1).

Sheath: A tubular covering, such as the basal part of a grass leaf surrounding the stem (1).

Senescence: 1. Generally, the process of aging in mature individuals, typically towards the end of an organisms life. Organisms at this stage are said to be senescent. 2. In deciduous plants the process of shedding leaves (2).

Spadix: A spike with small, crowded flowers on a thickened, fleshy axis (3).

Spathe: A large, generally solitary bract subtending and often enclosing a spadix or other inflorescence (3).

Substrate: The abiotic material forming the bed of a stream, lake, or ocean (1).

Subtidal: A marine or estuarine environment occurring below mean low tide.

Vegetative reproduction: Asexual reproduction in plants (1).

Vegetative shoots: shoots that are not reproductive (not supporting flowers or seeds).

Viscid: thick, syrupy, and sticky (2).

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Appendix A Field Data Sheets

Zostera japonica Field Data Sheet A
Beds > 10m

Background

Location:……...

Date: .... *(dd/mm/yr)* Unique Identifier Code (Reference #)……………

Primary Field Surveyor: ....

Crew: ....

....

Make and Model of GPS…………………………………………………………………………………………

GPS track #………………………………………….. Photograph #………………………………………………

GPS point for photograph……………………………………………Compass Direction…………………………

Overview

1.) Percent Cover of *Zostera japonica*

Primary	1 to 10%	....	Secondary	1 to 10%	....	Tertiary	1 to 10%	....
	11 to 25	....	(optional)	11 to 25%	....	(optional)	11 to 25%	....
	26 to 50%	....		26 to 50%	....		26 to 50%	....
	51 to 75%	....		51 to 75%	....		51 to 75%	....
	> 75%	....		> 75%	....		> 75%	....

2.) Distribution (check one) Continuous _____ Patchy _____

Density Data

sample	# per 0.16 m^2
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	
10.	
11.	
12.	
13.	
14.	
15.	
Total	
Mean (Total ÷ 15)	
#/m^2 (mean x 16)	

Zostera japonica Field Data Sheet B
Beds < 10m

Background

Location: ....

Date: .... *(dd/mm/yr)* Unique Identifier Code (Reference #)…………….

Primary Field Surveyor: ....

Crew: ....

....

Make and Model of GPS ……………………………………………………………………………………………

GPS Point #………………………………………….. Photograph #………………………………………………

GPS point for photograph…………………………………………Compass Direction…………………………

Overview

1.) Percent Cover of *Zostera japonica*

Primary	1 to 10%	....	Secondary	1 to 10%	....	Tertiary	1 to 10%	....
	11 to 25	....	(optional)	11 to 25%	....	(optional)	11 to 25%	....
	26 to 50%	....		26 to 50%	....		26 to 50%	....
	51 to 75%	....		51 to 75%	....		51 to 75%	....
	> 75%	....		> 75%	....		> 75%	....

2.) Distribution (check one) Continuous _____ Patchy _____

3.) Width of bed (paraelle to shoreline)………………. Length of bed (perpendicular to width)…………

Density Data

sample	# per 0.16 m^2
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	
10.	
11.	
12.	
13.	
14.	
15.	
Total	
Mean (Total □ 15)	
#/m^2 (mean x 16)	