Routine Monitoring Guidance for Vegetation

A Companion Document to the Compensatory Mitigation for Non-Tidal Wetlands and Tidal Waters and Compensatory Non-Wetland Mitigation
(OAR 141-085-0680 to 141-085-0765)

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*This is a beta version available for review and comment.

This draft guidance is still under development and is subject to change. Please check Web site for the most updated version:
www.oregonstatelands.us

Note: This document is equipped with hyperlinks and
an interactive table of contents to facilitate navigation
through the document and to external resources.

Department of State Lands Routine Monitoring Guidance for Vegetation

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Applicability

Monitoring allows the Department and the permittee to detect whether compensatory wetland mitigation sites are on a trajectory to providing replacement by class, functions and values. The purpose of this Routine Monitoring Guidance (RMG) is to improve the quality and the readability of data received in compensatory wetland mitigation (CWM) monitoring reports so that the Department can determine whether regulatory requirements are being met.

Vegetation is a strong focus of CWM compliance monitoring because it is an indicator of many of the functions that wetlands provide, and vegetation monitoring can be completed with reasonable expense and effort. The RMG outlines monitoring and data analysis techniques for CWM sites that are using the Routine Performance Standards for Vegetation (Appendix A), and is a companion to the Removal-Fill Guidance Document, which is incorporated here by reference. **Before using this guidance, review individual permit conditions as they take precedence over this guidance and may differ from the routine performance standards.**

Use of the RMG exactly as written is not required, however it represents the level of monitoring that is expected at all CWM sites to achieve the following standards:

   (a) *Separate habitat types for sampling procedures and performance assessment:* To ensure correct sampling procedures and performance assessment, areas of different vegetation habitat classes (actual or targeted) that are 0.25 acres or larger should be stratified into separate monitoring units.
   (b) *Be representative of the site*
      Any monitoring protocol used should be able to estimate the population mean with a confidence level of 80%. The maximum acceptable confidence interval (precision) is ±10. A sufficient number of samples should be taken using a random approach.
   (c) *Be verifiable*
      All sample plots should be clearly marked or otherwise locatable in the field (e.g. distance along a permanently monumented transect) so that data reported can be checked during Department visits, if necessary.

   When proposing to use the RMG as written, please reference the RMG and version in Section 8 (Monitoring Plan) of the CWM Plan and provide a map showing the sampling design (see Office Component and Figure 5). If not, the permit applicant should describe and justify the alternative methods. Once the project is constructed and monitoring begins, any changes from the approved monitoring method should be described in the annual monitoring reports.

The RMG is adapted from Marshall et al. (2007)[1] and Elzinga et al. (1998)[2] and is divided into three components: office preparation, field data collection, and data analysis/reporting. The RMG seeks to balance the rigor of the sampling protocol with the questions being asked of the data. The variety of CWM site conditions that can be encountered, the range of equipment commonly available, and the costs associated with vegetation monitoring are all factors that were considered in development of this guidance.

Vegetation Monitoring Methods

Routine monitoring standards require annual estimates of cover, species diversity, and density of woody vegetation (shrub-dominated and forested wetlands only) (Appendix A). The RMG focuses on the use of permanent plots and visual estimates to sample CWM sites for these parameters.

Visual estimates of percent cover are generally sufficient for mitigation monitoring, although there is an unknown level of observer bias involved. However, because this method is commonly used for both vegetation monitoring and wetland delineations, this is the method focused on in the RMG. Techniques such as using small plot sizes, frames with smaller grid squares of known area (Figure 1a), or training with visuals representing known cover values (Figure 1b), can help to reduce measurement errors.

> Cover values can change over the course of a growing season, so measurements should be done at approximately the same stage of the growing season each year when plant species are more readily identifiable.

Other sampling methods, such as point-line, point-frame, line-intercept, unequal-area belt transect, or some combination of methods may be better suited to the CWM site being sampled or preferred by the applicant, but should be proposed as part of the CWM Plan and include calculations showing how the sample size requirements in this RMG will be met using the alternate method. Chapter 8 of Elzinga et al. (1997), pg. 159-205 provides information on various field techniques.

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[1] This draft protocol is available as part of the VEMA download (see Appendix C) from Northwest Habitat Institute at http://www.nwhi.org/index/publications.

[2] A 2001 version of this resource is available, but the RMG uses the 1998 version because it is available for download online.
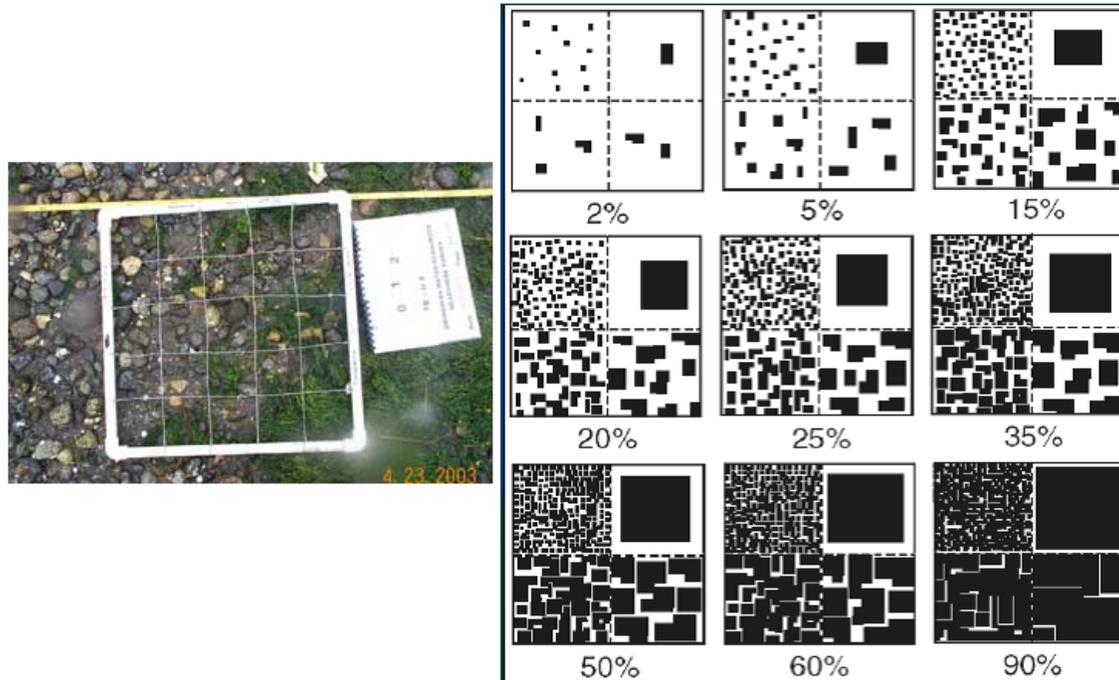
Figure 1. Dividing the sample plot into smaller sections of known area (a), or using visual comparison tools (b) can help improve the accuracy of aerial cover estimates.

Instructions for Office Component

Step 1: Map Vegetation Habitat Classes

DSL has routine performance standards for 4 habitat classes: herbaceous, shrub-dominated, forested, and upland buffers. Therefore, stratifying (drawing boundaries around) these habitat classes is necessary to evaluate site performance. Stratification is also used to decrease the variability in the data so that the number of samples required to represent site conditions is more manageable.

Shrub and forested habitat classes are distinguished for stratification based on potential height, not actual height. Note that these habitats are given the same routine performance standards with the assumption that while a potential forest habitat unit may be on a trajectory toward success, it will not be classified as forest until the woody plants in the unit reach 6-meters (based on Cowardin 1979) (Marshall et al. 2007).

For the CWM Plan, estimate the boundaries of each habitat class using the proposed hydrology and grading plan elevations. The boundaries of each habitat class should be drawn on top of the most recent, aerial photograph available and be included as a figure in the CWM Plan. An appropriate scale for mapping is 1 inch = 100 feet. For large study areas, a scale of 1 inch = 200 feet may be sufficient. Note that habitat class boundaries may not the same as boundaries noting areas of existing wetland enhancement versus proposed wetland restoration or creation areas.

The habitat stratification map should be updated after major mitigation activities are completed to provide a record of the site's as-built condition and may also need to be updated annually based on conditions encountered during monitoring. Marshall et al. (2007) recommends that if a given monitoring sample plot indicates that it may represent uplands, contain invasive species in greater abundance than allowed by the performance standard, or be of a different habitat class than the rest of the samples in the habitat class, the surrounding area should be evaluated. For sites less than 100-acres, if the difference in condition occurs over an area 0.25 acre or larger, it should be stratified separately and the sampling and data analysis should be adjusted accordingly. For sites greater than 100 acres, the area to base stratification on is discretionary (Marshall et al. 2007).

There are many potential sources for imagery of the mitigation site. Note that some of these sources may have licensing requirements for commercial use:
- Google Maps web site: http://maps.google.com/. Click on Satellite and zoom to maximum desired.
- Google Earth: http://earth.google.com/. You can download the free version.
- Bing web site: http://www.bing.com/maps/.
- Terra Server USA: http://terraserver-usa.com/. These are generally older images than can be found at other sites, although there may be exceptions for some areas of Oregon.
- State or local sources (e.g. WAC Inc. in Eugene, Corps of Engineers Photogrammetry Section in Portland, and local municipalities and Councils of Government).
- Oregon Explorer Imagery web site: http://www.oregonexplorer.info/imagery/. The finest-resolution imagery (0.5 m) available to the public will be found here, but must be downloaded into a GIS, and the transfer is not rapid.
- Digital orthophotos for every county in the United States are available as free downloads from the United States Department of Agriculture website http://datagateway.nrcs.usda.gov/ but must be viewed with a GIS or other image processing software.

A hierarchical code may be used for labeling habitat classes on the base map (see Table 1), or otherwise designated (e.g. color blocks with a legend as in Figure 2). Stratified areas of the same habitat class, but that are disconnected, are referred to as sample units. Therefore, one area of emergent wetland would be labeled E1 and a second E2. If field sampling reveals that there is a heterogeneous area that should be stratified as a different habitat class, use small letters to distinguish the subdivided unit (e.g. E1a).

Table 1: Sampling Grid Code

Grid Feature	Code	Sample Code
Habitat classes	Code letter*	H, S, F, or B
Sample Unit	Number	1

*Use standard Cowardin class abbreviations, or habitat class codes = H (Herbaceous), S (Shrub), F (Forested), B (Buffer)
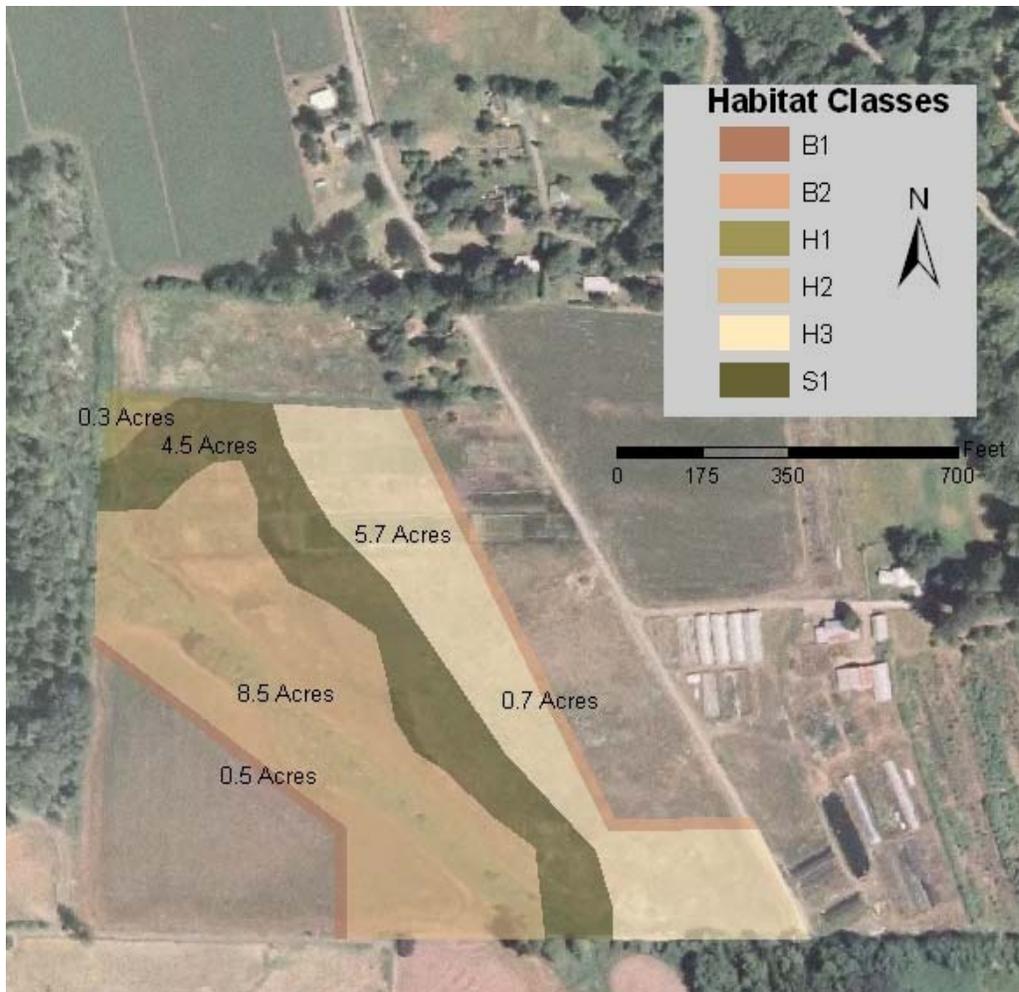
Figure 2. An example of a habitat stratification map made using ArcMap. Note that there are two sampling units for buffer habitats and three for herbaceous habitats because they are not continuous.

Step 2: Sample Size

An adequate number of samples must be taken within each habitat class to determine whether the area is meeting its performance standards. The Department highly recommends that field workers complete pilot sampling at the CWM site to assess the efficiency of the proposed sampling design and to assist in determining the number of samples needed, whenever possible (Elzinga et al. 1998). However, the RMG seeks to balance the need to gather a representative sample with practical considerations of time and manpower. Therefore, one of the following methods for determining sample size may be used:

Option 1: Minimum number of samples

The Department recognizes that it is not possible to prescribe a minimum number of samples that will accurately describe conditions at every CWM site. However, some minimum guidelines are necessary to bring the quality of monitoring up to a common level. The minimum number of samples outlined in Table 2 could result in oversampling

and extra costs incurred. Under this option, the minimum number of samples outlined should be collected each year of monitoring. The Department reserves the right to require more samples to achieve the minimum data standards (see the Data Analysis section).

Table 2. Minimum Sample Sizes **per** habitat class area

Habitat/Vegetation Types	Plot size (m^2)*	Number of Plots: Habitat class area Up to 2 acres	Number of Plots: Habitat class area >2 to 5 acres	Number of Plots: Habitat class area >5 acres
Herbaceous	1-2 m^2	10	20	30
Shrub-dominated and Forested	65 to 265 m^2	5 (Plus10 herbaceous plots)	10 (Plus 20 herbaceous plots)	15 (Plus 30 herbaceous plots)
Upland Buffer	Use appropriate plot sizes depending on vegetation type	5	10	15

*Plot sizes are suggestions and may differ based on the shape of the plot used for sampling (e.g. circular plots versus square plots) and conditions at the site.

The minimum sample sizes outlined apply to each habitat class. If the habitat class is divided into more than one sample unit, distribute the plots based on area and place at least 2 plots in each sample unit. Minimum sample sizes for the 15.7-acre site example in Figure 1 are shown in Table 3.

Table 3. Minimum sample sizes for the 15.7-acre site shown in Figure 1. Note that samples have been divided between sample units for the herbaceous and buffer habitats.

Habitat Class	Acres	Number of Samples
Herbaceous	14.5	30
H1	0.3 (2%)	2
H2	8.5 (59%)	17
H3	5.7 (39%)	11
Shrub-dominated	4.5	10 + 20 herbaceous plots
Buffer	1.2	5
B1	0.5 (42%)	2
B2	0.7 (58%)	3

The area of the plots may vary depending on the conditions at the site. Generally, plots should be larger than the average size of the dominant plants and larger than the average space between plants. Refer to Elzinga et al. (1998) page 102 for methods to determine the best plot size and shape if pilot sampling is conducted. In most circumstances, the Department recommends 1 to 2m^2 plots for herbaceous plant communities. Shrub-

dominated and forested habitats should use 65 to 265 m^2 plots to collect shrub/sapling and tree layer information, with 1 to 2m^2 plots to collect data for the herb stratum.

Option 2: Sample size calculations

Some CWM sites may be adequately monitored using a fewer number of samples, particularly when conditions are fairly uniform. Knowing this number will prevent oversampling and may reduce monitoring costs for the permittee. Other sites may require more samples to be taken. If pilot data has been collected in advance of monitoring, start with the year 2 instructions below. Otherwise, data collected in Year 1 of monitoring will be used to calculate the sample size.

Year 1
In the first monitoring year, use the minimum sample sizes outlined in Table 2.

Years 2-4
Data collected during the first monitoring session should be analyzed to determine the number of samples necessary to evaluate the performance standards with a confidence level of 80% and an absolute confidence interval width of 10 (note this is not a percent of the mean). The correct sample size should be calculated for each habitat class.

A summary statistic and sample size workbook (Microsoft Excel) is available on the DSL website, courtesy of the Oregon Chapter of the Nature Conservancy. See the text box for directions on using this workbook with the RMG. Cover by native species (grouping by layer), invasive species (grouping by layer), bare substrate, plus plant counts in shrub-dominated or forested habitats, should be evaluated to determine sample size. The category by layer resulting in the highest required sample size will determine the number of samples to be taken for monitoring years 2 through 4. Diversity and prevalence index calculations do not need to be considered to calculate the required sample size.

Year 5
Data collected during the fourth monitoring session should be re-analyzed as described for Years 2-4 above.

Guidance for using the Summary Statistic and Sample Size Workbook (The Oregon Chapter of the Nature Conservancy)

1. Use Equation #1 to determine the necessary sample size for a single population mean or population total.
2. In the Targeted Precision Level section, enter a confidence interval of 80%, an absolute confidence interval width of 10, and a tolerance probability of 0.8.
3. Enter the sample size and summary statistics for your data. Evaluate cover by the groupings of native species, invasive species, bare substrate, and plant counts.
4. The data from step 4 that yields the highest sample size should be used for successive monitoring years.

As an example, a 4-acre forested wetland was monitored in the first year using ten 15-ft radius plots, and twenty 1-m^2 herbaceous plots. The results are shown in Table 4. The mean and standard deviation for each category by layer were entered into the sample size workbook (Figure 3). Figure 3 shows that the highest sample size requirement is 16 samples for native herbaceous cover. Only 2 samples are required to sample the overstory. Therefore, in monitoring years 2-4 the monitor may choose to only sample a total of 2 shrub plots and 16 herbaceous plots. These plots should be randomly located, but can be taken from the plots established in Year 1. The Department reserves the right to require more samples if the minimum standards are not met.

Table 4. Year 1 Vegetation Monitoring Results from a 5-acre mitigation site.

Herbaceous Sample #	Bare Substrate	Native Herbaceous	Forested Sample #	Native Tree and Shrub Cover	Native Tree and Shrub Count
1	20	80	1	7	4
2	15	85	2	6	5
3	6	94	3	9	9
4	6	94	4	9	9
5	5	95	5	9	9
6	5	95	6	9	9
7	5	95	7	10	10
8	8	92	8	7	7
9	40	60	9	7	7
10	5	95	10	4	7
11	60	40			
12	16	0			
13	0	100			
14	25	75			
15	0	100			
16	0	100			
17	10	90			
18	0	100			
19	0	100			
20	0	100			
Mean	11.30	84.50		7.70	1.40
Standard deviation	15.37	25.11		1.83	1.08

Return to Main Menu	Determining the necessary sample size for estimating a single population mean or a single population total with a confidence interval around the mean or total.	

The user needs to enter targeted level of precision from a sampling objective and summary statistics from pilot sampling

Targeted precision level

Desired confidence level (e.g., 90%, 95%)	80%	80%	80%	80%
Desired confidence interval width -- choose **one** of the following:				
A. Confidence interval width as a percent of mean (e.g., within ± 20% of mean)				
B. Absolute confidence interval width	10	10	10	10
Tolerance probability	0.8	0.8	0.8	0.8

Additional information if sampling from a Finite Population

Specify total population area -->				
Specify area of 1 quadrat -->				
Formula yields big N =	1E+10	10000000000	10000000000	10000000000

Summary statistics from pilot sampling (need ability to type in summary stats or derive from data pasted into this file starting on line 45)

A. Summary statistics derived from data pasted below starting on line 45 — n				
Sample mean				
Sample standard deviation				
B. Summary statistics typed in by user — n	20.000	20.000	10.000	10.000
Sample mean	11.300	84.500	7.700	1.400
Sample standard deviation	15.370	25.110	1.829	1.075
Summary statistics copied from one of the above sources that is used in sample size, MDC, and Power calculations — n	20	20	10	10
Sample mean	11.300	84.500	7.700	1.400
Sample standard deviation	15.370	25.110	1.829	1.075
Confidence intervals around sample mean — 95% C.I.	7.193	11.752	1.308	0.769
FPC 95% C.I.	7.193	11.752	1.308	0.769
C.I. width as % of mean	63.7%	13.9%	17.0%	54.9%

Sample size to achieve the sampling objective based on pilot sampling results

Calculated absolute confidence interval width	10.000	10.000	10.000	10.000
Sample size (with Kupper and Hafner correction)**	8.0	16.0	2.0	2.0
FPC Sample size (with Kupper and Hafner correction)**	8.0	16.0	2.0	2.0

Figure 3. A screen capture of the sample size workbook (TNC). The user typed in summary statistics from Table 2 (Option B-rows 21 to 23).

Step 3: Determine the Sampling Design

Use the air photo from Step 1 to draw a representative layout of the sampling strategy. Plots must be randomly located and well disbursed across the habitat class, and each plot must be located entirely within the defined wetland project area. Two suggested methods of locating samples are systematic sampling and use of GPS. For guidance on generating random numbers refer to Appendix 4 of Elzinga et al. (1998).

Systematic Sampling

Systematic sampling along transects is a convenient way to locate and relocate plots, as shown in Figure 4. From a random start, transects are established at equal intervals perpendicular to an established 'baseline'. Similarly, the first plot on each transect is randomly located and subsequent plots are spaced at equal intervals along the transect (Marshall et al. 2001, Elzinga et al.1998). The baseline should run parallel to any slope so that transects pass through homogeneous conditions.

Adjacent transects and plots should be a sufficient distance apart to reduce the chance that they are correlated due to vegetation growth patterns, and to ensure the last point will be near the opposite end of the baseline or transect (Marshall et al. 2001). At a minimum, the distance between plots should be larger than the average size of individual plants, clonal species, gaps, or bare areas (Elzinga et al. 1998).

A baseline and transect design may be set up to sample multiple habitat classes and/or sample units. As long as the plots are assigned to the appropriate habitat class for data analysis, and there are enough plots to meet the sample size requirements for each habitat class, this can save time in initially setting up the sampling design in the field. Alternatively, there may be some habitat classes and/or sample units that have their own baseline and transects.

Using GPS
An alternative to laying out baselines and transects when GPS is available is to use a grid method to generate sample points. For this method, overlay stratified areas with a grid, the corners of which correspond to a latitude and longitude that can be located in the field. For example, Google Earth allows a lat/long grid to be displayed over the image, with increasing detail of the degree lines (and smaller grids) as you zoom in (Figure 4). The number of plots needed dictates how many grid corners are randomly selected and sampled. Keep in mind that the sample size must be reached for each habitat class.

Figure 4. Using Google Earth© with the grid feature to generate potential sampling locations. Each grid within a habitat class could be numbered, and each corner of a grid could be a potential sampling location. Both the grid number and the corner could then be randomly selected.

Using our example CWM site, Figure 5 shows the sampling design required to achieve the minimum sample sizes calculated in Table 3. A systematic sampling design was used with a baseline run diagonally and roughly parallel to the stream channel. The ten plots

in the shrub habitat (S1) will have two $1m^2$ herbaceous plots each to reach the required sample size (see Step 5).
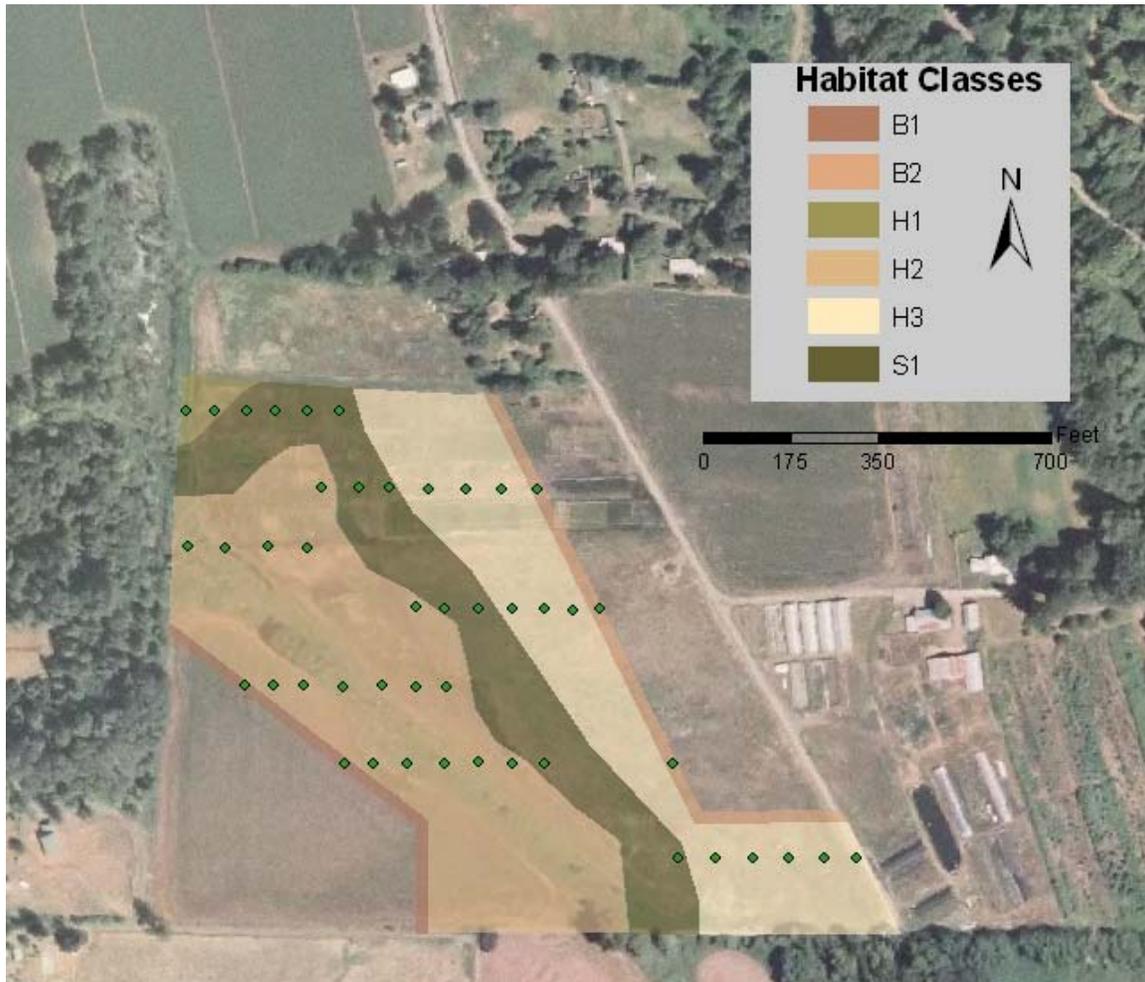

Figure 5. Map showing the sampling design for a 15.7-acre wetland mitigation site.

Step 4: Download Monitoring Forms
Print monitoring forms for use in the field. Sample monitoring forms are available in Appendix B, however other reporting forms may be used.

Instructions for Field Component

Step 5: Locate Plots in the Field

If using systematic sampling, use a compass, tape and the base map prepared in the office to lay out the baseline and transects. Permanently monument the start and end points of the baseline and transects, and record their coordinates if GPS is available. If using randomly selected coordinates, locate these in the field using GPS, record the actual location in the field, and clearly monument each point. DSL recommends monumenting locations using a rebar stake or T-post with a color safety cap or bright paint.

Consistently placing the sample plot relative to the random point helps ensure an unbiased sample. Place the lower left of a square or rectangular plot, or the center of a circular plot at the randomly selected point. If the management unit is shrub-dominated or forested, 1-2m^2 herbaceous plots can be located within the larger sample plot. The first herbaceous plot may be placed so that the randomly selected point aligns with the lower left corner of a square or rectangular plot, or the center of a circular plot. If additional herbaceous plots are sampled, they should be located at the opposite corner, or at some otherwise consistent location not adjacent to each other. Figure 6 shows suggested layouts.
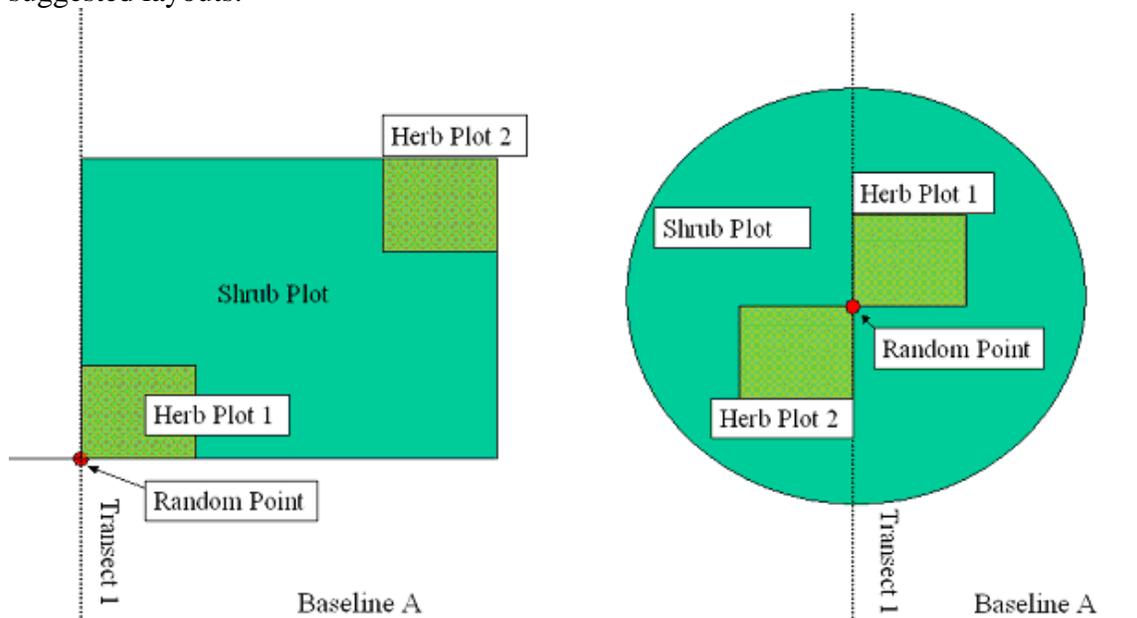

Figure 6. Suggested plot layouts for shrub-dominated or forested habitat classes.

Step 6: Record Plot Data

Figure 8 shows a sample data sheet for one plot within a shrub-dominated habitat class.

Cover: See the text box for steps to visually estimate aerial cover. Area not covered by vegetation should be recorded as bare substrate. Include and make note if the bare substrate is open water, litter, duff, wood, bare soil or rock. This distinction can help the Department consider site-specific conditions when evaluating the bare substrate standard. Total cover in a plot should be recorded as absolute values and therefore may exceed

100% due to layering. For shrub and tree cover, the crowns are projected vertically. Distinct holes in the canopy should be subtracted from the estimate. Plants overhanging into the sample plot, but that are rooted in an area that does not represent plot conditions, should be subtracted from cover estimates (e.g. rooted outside the wetland boundary). Areas covered by water that have limited access may require alternative sampling methods or timing for monitoring (in areas of seasonal inundation). If sampling in an area with water, record cover of aquatic vegetation present by species, even if it is submersed. Areas not covered by vegetation should be recorded as open water and considered a special category of bare substrate.

Steps for Visually Estimating and Recording Aerial Cover for Routine Performance Standards

The following procedure may be used to record cover data for projects using the routine performance standards:

Use a plot frame or a handful of flags to mark the perimeter of your plot, and divide the plot into 4 quarters (or smaller) to improve accuracy of estimates.

1. First, estimate the percent of the whole plot area that is **bare substrate**, which includes all areas of the plot in which, when viewed from above, the ground surface is not obscured by (or contain in the case of open water) live plant material. Include and make note if the bare substrate is open water, litter, duff, wood, bare soil or rock. This is the number to compare to the percent bare substrate performance standard.
2. Next, list **each** plant species observed in the plot by strata. Include plants that are rooted outside the plot but extend into the plot. (Exception – do not include cover of plants that are rooted on a different topographic surface, that do not reflect conditions in the plot itself. Cover by moss should not be recorded.) Look above the frame for tree or shrub canopies.
3. Record the **absolute cover** of each listed plant in the plot – the percent of the whole plot area occupied by that species. Include foliage that is layered over by some other species.
4. Add up all the vegetative cover percents. In dense vegetation, this total can exceed 100%, even if there is also some bare ground.

Density: In shrub-dominated and forested systems count the number of live plants for shrubs, and the number of live stems for trees. Volunteer vegetation as well as planted stock may be counted, but dead plants do not count. A plant should be counted if any part of the stem lies within the plot.

Diversity: Diversity standards for most habitat classes are tied to cover and this information will be collected as species names and associated covers are entered onto the data sheets.

Figure 8. Routine Monitoring Guidance Field Sampling Form Example

Date: <u>April 30, 2009</u>   Site Name: <u>CWM 1</u>   DSL Permit #<u>55555-RF</u>   Surveyor: <u>JDL</u>

County: <u>Washington</u>   HUC:<u>170900100</u>   T R S <u> 1N 42W 42W</u>

Management Unit
Habitat class: <u>S</u> Sample Unit: <u>1</u>   Primary Plot Dimensions (m)<u> 9 </u>   Secondary Plot Dimensions (m)<u> 1 x 1 </u>
(Habitat classes are: E= Emergent/Herbaceous; WP = Wet Prairie; S = Shrub-dominated; F = Forested; B = Buffer)

Systematic Sampling Information
Baseline
Bearing_____ Start Lat/Long._____
End Lat/Long._____ Length _____
First Transect
Intersect on Baseline_____ Distance Between Transects (m)_____

Systematic Sampling Information		Plot GPS Location	Plant Species (Latin name)/Bare Ground	Indicator Status	N NN I	Strata T S H	Percent Cover	Live Plant (Shrub)/Stem (Tree) Count
Transect Number	Plot Number and Distance on Transect							
	1	45.548468/-123.187928	Bare—Wood				10	
			Bare—Soil				5	
			Alnus rhombifolia	2	N	T	15	1
			Symphoricarpus albus	4	N	S	10	1
	1a (nested)	45.548468/-123.187928	Carex obnupta	1	N	H	50	
			Festuca arundinacea	3	NN	H	15	
			Juncus effusus	2	N	H	5	
	Continue . . .							

Instructions for Data Analysis

Calculations

DSL recommends entering all data into the Vegetation Manager (VEMA) relational database to make the necessary calculations and reports, but any spreadsheet or program is acceptable for analysis and reporting. VEMA is a free, downloadable database developed under contract by the Northwest Habitat Institute with EPA funding to help record, calculate and report vegetation performance of mitigation sites. Information about plant species (wetland status, native/non-native/invasive status, and woody designations) is built into VEMA and can be appended. For system requirements and to download a version of VEMA, visit the Northwest Habitat Institute website at http://www.nwhi.org/index/publications. If using VEMA, see Appendix C for guidance on how to enter data and generate reports.

If not using VEMA, guidance on manual calculations of the performance standards is provided below. Covers may be reported as absolute or relative amounts, but must be evaluated based on the total cover in the plots. See the text box for more information.

Absolute and Relative Cover

Absolute Cover refers to the percentage of the ground surface that is covered by the aerial portions (leaves and stems) of a plant species when viewed from above. Any portion not covered by vegetation is recorded as bare ground. Absolute cover values are used to calculate the Prevalence Index.

Relative Cover is calculated as the absolute cover divided by the sum of all cover (vegetation plus substrate) in the plot. Relative cover values may be used to report on mean cover, but not used to calculate the prevalence index.

Either method of recording cover may be used, but should be consistently applied.

Cover Calculations:
1. For each plot within the same sample unit (Table 1), develop a table or spreadsheet that displays and performs the following calculations:
    a) For each plot, enter the cover for each species encountered, plus bare substrate.
    b) Classify each plant species as native, non-native, or invasive;
    c) Note which strata each species occurs in [herbaceous, shrub, or tree (>6m tall)];

2. Review each non-native plant species to determine if it has greater than 15% cover in 10% or more of the plots. Reclassify species meeting this criterion, and that have increased in cover or frequency since the last monitoring period, as invasive.

3. Average cover values for each species or category of vegetation as required by the performance standards:

   a. For herbaceous/emergent sample units calculate the average cover for native species, invasive species, and bare substrate, respectively;

   b. For shrub-dominated and forested sample units, calculate the average cover for native species in the herbaceous stratum, invasive species in the herbaceous stratum, invasive species in the shrub and tree stratum, and bare substrate. If the cover of invasive species in the herbaceous layer is between 10% to 30%, also calculate the cover of native species in the overstory (shrub and tree strata);

   c. For upland buffers, calculate the average cover for native and invasive species. If the cover of invasive species is 10% to 30%, also calculate the cover of native species in the overstory (shrub and tree strata).

Invasive Species

A plant species should automatically be labeled as invasive if it appears on the current Oregon Department of Agriculture Noxious Weed list, plus known problem species including *Phalaris arundinacea, Mentha pulegium, Holcus lanatus, Anthoxanthum odoratum,* and the last crop plant if it is non-native. Non-native plants should be labeled as such if they are listed as non-native on the USDA Plants Database. Beginning in year 2 of monitoring, DSL will consider a non-native plant species invasive if it comprises more than 15% cover in 10% or more of the sample plots in any habitat class, and increases in cover or frequency from the previous monitoring period. Plants that meet this definition should be considered invasive for all successive years of monitoring.

The Prevalence Index

The prevalence index of each plot and sample unit average may be calculated using methods outlined in the 1987 U.S. Army Corps of Engineers Wetlands Delineation Manual Supplements. Analysis of the wetland status of vegetation should use the *National List of Plant Species That Occur in Wetlands, 1988 National Summary* and *1993 Supplement to the List of Plant Species That Occur in Wetlands: Northwest (Region 9)*. When averaged across the sample unit, the prevalence index can provide a picture of the moisture tolerance of the area (Marshall et al. 2004).

1. Using the species and cover data entered above for each plot within a sample unit:
   a. Assign each plant species in a sample plot a number corresponding to its wetland indicator status (e.g. 1 = obligate, 2 = FACW, 3 = FAC, 4 = FACU, and 5 = UPL). If a species does not have an assigned indicator status, or the status is NI or NOL, assign the species an upland (5) status.
   b. Sum the absolute percent cover for all species in the plot;

      c. Multiply the absolute percent cover of each species by its respective prevalence index from step 1(a) to derive a weighted prevalence index for each species;

      d. Sum the weighted prevalence index for all species in the plot;

      e. Divide the sum in step d by the sum in step b to derive the average prevalence index for the plot.

2. Average the plot prevalence indexes for each habitat class to derive its' prevalence index.

Plant Diversity

If not already completed, review the data for each non-native species and compare it to previous years' data (if applicable). Non-native species that comprise more than 15% cover in 10% or more of the plots in any habitat class, and that show an increasing trend over time should be reclassified as invasive.

To count toward the diversity standard a species should be native, represent at least 5% cover, and have a 10% frequency within the habitat class. Review the plot data and mark native species that occur in 10% of the plots. For example, if 20 plots were sampled, mark species occurring in at least 2 plots. Next, review which of the species marked also have at least 5% average cover. Report the number of species that meet both criteria.

Woody Plant Density

1. For each plot in the same habitat class, sum the number of live native trees and native shrubs (number of plants) found. Non-native or invasive trees and shrubs should not be counted.
2. Calculate the average number of live native trees and native shrubs for the habitat class;
3. Divide the mean number of live woody plants in the habitat class by the size of the plot used to derive the mean woody plant density;
4. Multiply step 3 by the number of square meters in an acre (4046.86) to derive mean number of woody plants per acre. If using square feet, multiply by 43,560.
5.   Repeat steps 1-4 for each habitat class at the CWM site.

Data Reporting and Comparison to Performance Standards

Reports should follow the monitoring report format in the Removal Fill Guidance (http://www.oregonstatelands.us/DSL/PERMITS/docs/CWM_RFG_draft.doc), Section 141-085-0710.

The sample mean and confidence interval should be reported for each performance standard and compared to the threshold to determine if action is necessary or if the objective has been reached. DSL's objective is to be 80% confident that the estimate reported is within ±10 units of the true population. Values for vegetation performance standards (excluding diversity and prevalence index standards) should be reported as Mean ($CI_x = Y_1 - Y_2$), where:

- CI = confidence interval
- x = 80% confidence level
- Y_1 = low estimate
- Y_2 = high estimate

, where Y_1 and Y_2 are calculated as Mean $\pm$ (standard error * t-factor $_{80\%}$). Standard error is calculated as the standard deviation divided by the square root of the number of samples taken in the habitat unit (stdev/sqrt(n)). The t-factor for an 80% confidence level is 1.282.

The Department will assume that cover values reported represent absolute cover. If relative cover is presented instead, please note and label every instance where this occurs. Substrate should have been included in the sum of all cover, or if necessary, subtracted so that the values reported are relevant to the performance standards. Covers should not be made relative to a particular fraction of the plot. For example, "The cover of native species in the herbaceous stratum" should be evaluated based on the total cover in the plot, and not relative to cover in the herbaceous stratum only.

The mean value calculated for each performance standard should be compared to the threshold value outlined in the permit. The confidence interval will be evaluated to determine whether adequate samples have been collected. If the confidence interval is greater than ± 10 of the mean, DSL may require additional samples be taken the following monitoring year. There are three possibilities and associated DSL actions.

1. The mean falls below a maximum threshold, or above a minimum threshold and the confidence interval is within ± 10 units of the mean. In this case, the performance standard is met and the CWM site is in compliance for that standard. For example, the mean native cover is reported as 70% ($CI_{80\%}$ = 61% to 79%). This falls above the minimum threshold value of 60% and the confidence interval is ± 9.
2. The mean falls above a maximum threshold, or below a minimum threshold. In this case, the performance standard is not met and the site will be considered out of compliance, with an exception if the standard does not have to be met until a later monitoring year (e.g. diversity and woody vegetation standards). For example, the mean native cover is reported as 40% ($CI_{80\%}$ = 32% to 48%). This falls below the minimum threshold value of 60% and the site is out of compliance. Since the confidence interval is ± 8 units, taking more samples is not likely to improve the mean. Remedial actions should be described in Section 5 (Conclusions and Recommendations) of the monitoring report to improve the condition of native vegetation at the site.
3. The confidence interval reported exceeds ± 10 units of the mean. In this case, if the site is in years 1-4 of monitoring, additional samples should be taken. Section 5 (Conclusions and Recommendations) of the monitoring report should show a revised monitoring strategy for the following year. If the site is in its final year of

monitoring, DSL may use discretion on what action to take, including but not limited to requiring additional monitoring.

Fill out the "Mitigation Monitoring Report Cover Sheet" by comparing the performance standard (using the exact language found in the permit) to the values obtained from the data analysis and indicate whether the standard is being met. If the standard is not being met for the site as a whole, provide a brief explanation based on the data.

Data at the habitat class scale should be provided in the Summary Data section of the report, with data from each plot provided as an appendix. Provide the map created from the office component in the Map section.

If a performance standard is not being met at the site, as reported on the monitoring report cover sheet, use the data to discuss reasons for this and to outline remedial actions in the Conclusions and Recommendations section of the report.

References

Cowardin, L.M., V. Carter, F. Golet, and E. LaRoe. 1979. *Classification of wetlands and deepwater habitats of the United States*. Biological Services Program, U.S. Fish and Wildlife Service, Washington, D.C., 103 pp.

Elzinga, C.L., D. Salzer, J.W. Willoughby. 1998. *Measuring and monitoring plant populations.* Bureau of Land Management (BLM) Technical Reference 1730-1, BLM National Business Center, Denver, Colorado. 477 pp.

Marshall, J.L. 2007. *Draft guidance for vegetation planning and monitoring in Western Oregon wetlands and riparian areas: Using reference sites to help plan and evaluate vegetation performance of mitigation sites.* U.S. Fish and Wildlife Service and Oregon Department of State Lands, 52 pp.

Appendix A: Routine Performance Standards for Vegetation

Herbaceous Wetlands
1. The cover of native species is at least 60%;
2. The cover of invasive species is no more than 10%;
3. Bare substrate represents no more than 20% cover;
4. By Year 3 and thereafter, there are at least 6 different native species. To qualify, a species must have at least 5% average cover in the habitat class, **and** occur in at least 10% of the plots sampled; and
5. Prevalence Index is <3.0.

Shrub-dominated and Forested Wetlands
1. The cover of native herbaceous species is at least 60%;
2. The cover of invasive herbaceous species is no more than 10%. After the site has matured to the stage when desirable canopy species reach 50% cover, the cover of invasive understory species may increase but may not exceed 30%;
3. The cover of invasive shrub or tree species is no more than 10%;
4. Bare substrate represents no more than 20% cover;
5. By Year 3 and thereafter, there are at least 6 different native species. To qualify, a species must have at least 5% average cover in the habitat class, **and** occur in at least 10% of the plots sampled[α];
6. Prevalence Index total for all strata is <3.0[α]; and
7. The density of woody vegetation is at least 1,600 native plants (shrubs) and/or stems (trees) per acre (native species volunteering on the site may be included, dead plants/stems do not count)[α].
[α]Woody vegetation standards should be met for two successive years without irrigation.

Upland buffers
1. The cover of native species is at least 60%;
2. The cover of invasive species is no more than 10%. After the site has matured to the stage when desirable canopy species reach 50% cover, the cover of invasive species may increase but may not exceed 30%.

Appendix B: Routine Monitoring Guidance Field Sampling Form

Routine Monitoring Guidance Field Sampling Form

Date: _____ Site Name: _____ DSL Permit #_____ Surveyor:_____

County:_____ HUC:_____ T R S_____

Sample Unit
Habitat class:_____ Sample Unit: _____ Area:_____ Primary Plot Dimensions (m)_____ Secondary Plot Dimensions (m)_____
(Habitat classes are: E= Emergent/Herbaceous; WP = Wet Prairie; S = Shrub-dominated; F = Forested; B = Buffer)

Systematic Sampling Information
Baseline
Bearing_____ Start Lat/Long._____
End Lat/Long._____ Length _____
First Transect
Intersect on Baseline_____ Distance Between Transects (m)_____

Systematic Sampling Information		Plot GPS Location	Plant Species (Latin name)/Bare Ground Type	Indicator Status	N NN I	Strata T S H	Percent Cover	Live Plant (Shrub)/Stem (Tree) Count
Transect Number	Plot Number and Distance on Transect							

Appendix C. Using VEMA with the Routine Monitoring Guidance
(Optional)

Overview
VEMA is currently available as a free Microsoft Access relational database that may be used to calculate and report on vegetation performance standards collected as percent cover and/or woody stem counts, regardless of what method of data collection is used (e.g. aerial estimates in plots, point intercept, etc.). For system requirements and to download a version of VEMA, visit the Northwest Habitat Institute website at http://www.nwhi.org/index/publications. VEMA is not a stand-alone software product. You must have your own copy of Microsoft Access software to run VEMA, and the 2003 version or later is recommended.

A mobile version of VEMA (VEMA Mobile Desktop Management Tool) that will allow data to be entered in the field is near completion and may be available for a charge. Please contact Northwest Habitat Institute for more information.

A Help feature is available as part of the VEMA download and will provide detailed information on its use. Some specific guidelines for using VEMA with the Routine Monitoring Guidance are provided here.

VEMA should be downloaded to the hard drive (C:\) as a zip file. To use VEMA, open the VEMA.mbd file and go to the main navigation toolbar menu titled VEMA (top left corner of the Access window), and follow these steps to create a site and sampling layout:

1. To enter a CWM site, click on "Sites" under the VEMA menu to open the Site Tools form. Enter as much information about your site as you like, but only the site name field is required.
2. Go back to the VEMA menu and click on "Site Visit". Select the site name you created in Step 1 from the drop down menu. To create a site visit, click on the button with a green plus sign. Click on the properties button (hand holding a paper) to enter the dates of monitoring and to assign the sizes of the plots used. Plot dimensions are used by VEMA to calculate stems per acre and correspond to the strata for which data can be entered. Note that scrub-shrub habitat plots must be entered as squares and forested habitat plots must be entered as circles for VEMA to correctly calculate stems per acre.
3. Under the site layout tab on the site visit tools screen, add the number of units that have been stratified on the CWM site using the button with a green plus sign. For each unit number, define the habitat class and enter the number of plots for the unit by clicking on the button with a green plus sign located under "Sample Plot

The plot layout should be entered as number of plots only. While a baseline and transect layout may have been used to monitor, DSL wants to see the information for each sample plot, and to have these sample plots summarized directly to the unit number level. If transects are used, VEMA calculates the relative percent of each plant species as compared to the entire transect.

Count." The habitat choices in VEMA are unconsolidated bottom, aquatic bed, emergent, scrub-shrub, or forested. Forested habitats are those dominated by trees greater than 6m tall. Upland buffers should be assigned the appropriate habitat class, but to distinguish these as non-wetland units, include "upland buffer" in the description box, and do not fill in the Cowardin information.

Entering Data

To enter data, click on the Field Sampling Form tab and select a habitat unit. The plot numbers appear with an arrow next to the plot that is active for data input. Data should be entered according to the strata or "layer" it was found. Layers in VEMA are surface substrate, floating emergent, herbaceous/emergent, scrub-shrub (woody, <6m tall) and tree (woody, >6m tall). Woody plant density collected as number of live shrubs or trees should be entered in VEMA as a "stem count" for density calculations.

Figure C-1. The VEMA Field Sampling form where plot data is entered.

VEMA contains predefined lists of vegetation with the native/non-native/invasive status, wetland indicator status, and woody designation for each species as available. These lists were constructed for the Willamette Valley, but they may be added to or modified as required through the "Managers" form from the main VEMA menu toolbar. If a larger number of species needs to be entered, it is quicker to open the file VEMAData.mdb and enter the information into the plants database sheet directly. It is up to the user to keep these vegetation lists up to date as species' Latin names, native status and/or wetland indicator status' change. If a plant species does not have a defined wetland indicator status in

Plants listed as "Non-Native Invasive" in VEMA should be reviewed to determine if they meet the definition of "invasive" as used in the RMG.

National List of Plant Species That Occur in Wetlands, 1988 National Summary and *1993 Supplement to the List of Plant Species That Occur in Wetlands: Northwest (Region 9),* it should be given an upland designation (5).

A plant's status may need to be changed to invasive if any non-native species qualifies as invasive at the CWM site. If this is the case, simply change the type to NNI (non-native invasive) when entering the plot data. Do not modify it in the plants database directly or it will appear as NNI for all sites entered into VEMA.

Generate VEMA Reports

Field Sampling Summary Report for Percent Cover
Within the Field Sampling Form tab select the first habitat unit type and click on the "Plant and Soil % Cover by Layer" report button. With the report open, use the Ctrl+F11 keyboard combination in VEMA to open the standard access menu. Under the View menu, select Design View and scroll to an empty column on the bottom half of the screen. Under the Field row select Plant: Type from the drop down menu and make sure the box is checked in the Show row (Figure C-2). Go back into the View menu and select Pivot Table View, then click on the "Export to Microsoft Office Excel" button. [An alternative spreadsheet program may be selected by clicking on the File menu, selecting the Export option, and choosing the output format and location for the data].
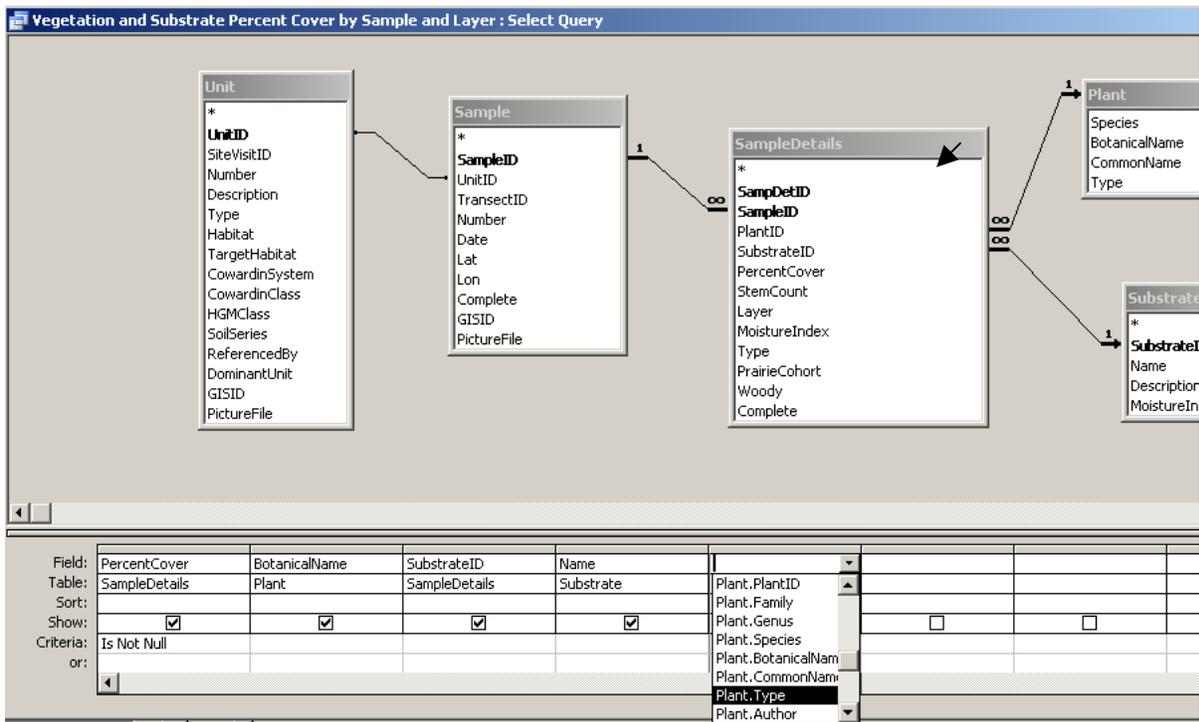
Figure C-2. The "Plant and Soil % Cover by Layer" pivot table design view is used to display the Plant.Type designation (native/non-native/invasive status) to species.

Sheet 1 of the resulting Microsoft Excel file shows a pivot table of relative cover amounts for each plot in the habitat unit. Click anywhere on the table and select the Pivot Table Wizard by right clicking or using the Data menu, then click on the layout button. From the right hand side of the layout screen, click and drag the "Type" field to the row to appear below the "Layer" field (Figure C-1) and click OK. Print sheet 1 (Table C-3) for inclusion in the monitoring report.
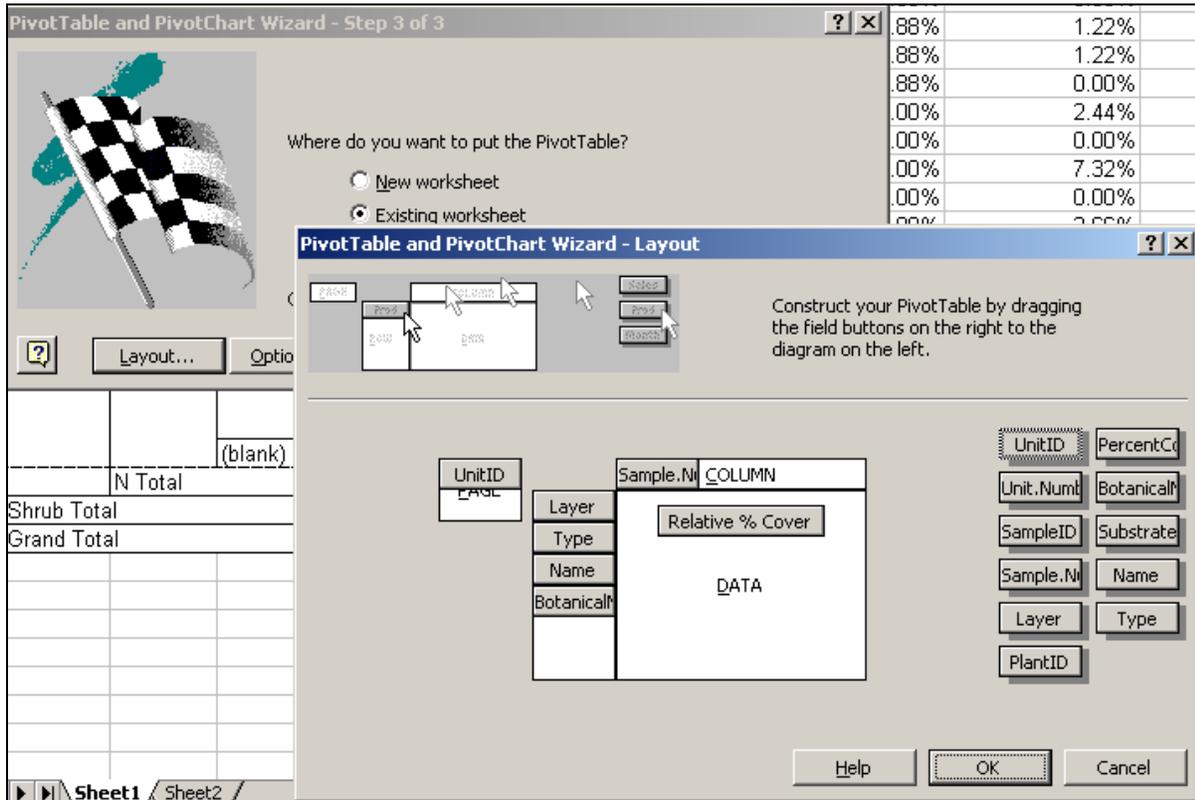

Figure C-3. Adding the "Type" field to the pivot table report in Microsoft Excel.

Sheet 2 of the Excel spreadsheet should be used to compare to the performance standard thresholds. To do this arrange or sort the data so that the average and standard deviation can be calculated for the following groups by layer: native plant cover, invasive plant cover, ground cover. A pivot table works well for this and the subsequent calculations, as shown in Figure C-4. Note that unless cover data entered into VEMA totaled 100% for each plot, category totals from Sheet 1 will not exactly match the averages calculated using the absolute values from Sheet 2.

Generate the field sampling report for percent cover for each habitat unit at the CWM site.

Table C-1. Example of the "Plant and Soil % Cover by Layer" generated in VEMA for a shrub-dominated habitat. Note that covers are given as relative percentages of all sample plots and not absolute covers.

UnitID	(All)

Relative % Cover				Sample.Number				
Layer	Type	Name	BotanicalName	28	29	30	31	Grand Total
Ground	(blank)	Clay	(blank)	9.76%	1.22%	0.00%	0.00%	10.98%
		Clay Total		9.76%	1.22%	0.00%	0.00%	10.98%
	(blank) Total			9.76%	1.22%	0.00%	0.00%	10.98%
Ground Total				9.76%	1.22%	0.00%	0.00%	10.98%
Herbaceou	N	(blank)	Agrostis exarata	0.00%	7.32%	0.00%	3.66%	10.98%
			Alisma plantago-aquatica	0.00%	0.00%	0.73%	0.00%	0.73%
			Alopecurus aequalis	4.88%	1.22%	4.88%	0.00%	10.98%
			Alopecurus geniculatus	4.88%	1.22%	4.88%	4.88%	15.85%
			Beckmannia syzigachne	4.88%	0.00%	2.44%	7.32%	14.63%
			Deschampsia cespitosa	0.00%	2.44%	2.44%	8.54%	13.41%
			Eleocharis ovata	0.00%	0.00%	0.73%	0.00%	0.73%
			Elymus trachycaulus	0.00%	7.32%	0.00%	0.00%	7.32%
			Glyceria occidentalis	0.00%	0.00%	2.44%	0.00%	2.44%
			Hordeum brachyantherum	0.00%	3.66%	0.00%	0.73%	4.39%
		(blank) Total		14.63%	23.17%	18.54%	25.12%	81.46%
	N Total			14.63%	23.17%	18.54%	25.12%	81.46%
Herbaceous Total				14.63%	23.17%	18.54%	25.12%	81.46%
Shrub	N	(blank)	Alnus rubra	0.00%	0.00%	0.00%	0.49%	0.49%
			Cornus sericea	1.46%	0.73%	0.00%	3.41%	5.61%
			Malus fusca	0.00%	0.00%	0.00%	0.49%	0.49%
			Sambucus racemosa	0.49%	0.00%	0.00%	0.49%	0.98%
		(blank) Total		1.95%	0.73%	0.00%	4.88%	7.56%
	N Total			1.95%	0.73%	0.00%	4.88%	7.56%
Shrub Total				1.95%	0.73%	0.00%	4.88%	7.56%
Grand Total				26.34%	25.12%	18.54%	30.00%	100.00%
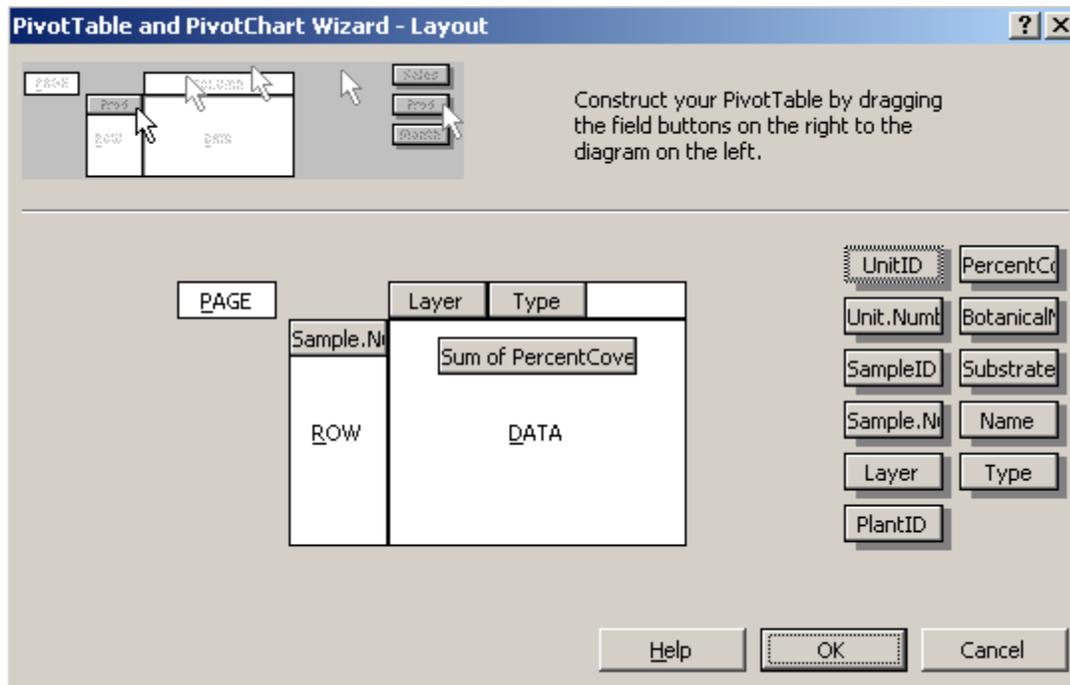
Sum of PercentCover	Layer	Type					
	Ground	Ground Total	Herbaceous	Herbaceous Total	Shrub	Shrub Total	Grand Total
Sample.Number	(blank)		N		N		
28	40	40	60	60	8	8	108
29	5	5	95	95	3	3	103
30	0	0	76	76	0	0	76
31	0	0	103	103	20	20	123
Grand Total	45	45	334	334	31	31	410
Average		11.25	83.5		7.75		
Standard deviation		19.31	19.33		8.81		
Standard error		9.66	9.67		4.40		
Low estimate--Y1:		-1.12838329	71.1091754		2.104		
High estimate--Y2:		23.62838329	95.8908246		13.4		

Figure C-4. An example of a pivot table created using data generated from Sheet 2 of the "Plant and Soil % Cover by Layer" report. The top image shows the layout of the pivot table. The resulting pivot table appears below. The average and standard deviation for each category have been calculated outside of the pivot table using the AVERAGE and STDEV functions in Microsoft Excel. The 80% confidence interval around the mean was also calculated. Note that a pivot table option has been used to assign empty cells a "0" value so that calculations are made correctly.

Performance Solution Sets
VEMA includes a predefined set of vegetation performance criteria that will need to be modified based on individual permit conditions. This can be done within the "Performance Criteria" tab in the Site Visit form. Different performance criteria can be outlined for each unit designated in the site layout. Since the routine performance standards involving percent cover will be evaluated based on the Field Sampling Cover Report generated above, only the prevalence index standard and the density of woody vegetation standard must be evaluated using a performance solution set.

Set Performance Criteria

Within the site visit form, the "Performance Criteria" tab may be used to create vegetation performance reports for each sample unit Figure C-5). Enter the following information by habitat class if using the Routine Performance Standards (Appendix A):

Emergent Habitat
1. Moisture index value is less than 3.[*]

Shrub-dominated and Forest Habitats
1. Moisture index value is less than 3.[*]
2. Stem count per acre native. The average stem count will be returned. Do not enter a comparison term or values.

*Moisture index is calculated the same as the prevalence index and should be used to report on that performance standard.

Figure C-5. Performance criteria can be set for each unit. Note that VEMA will give the density of vegetation entered when performance is evaluated, but a threshold cannot be set as part of the criteria. Be sure that the correct plot sizes have been outlined in the Site Visit Properties.

Generate Performance Solution Sets

To generate performance solution sets, click on the "Performance" tab. To create a new performance solution set, check all units and layers; give the solution set a title (e.g. site name, monitoring year and unit name), and click on the "Go" button. It may take a moment

to generate the report. If an error box appears and the report is not displayed in the solution set list, click on another tab and then return to the Performance tab to look for the report.

Figure C-6. Creating a performance solution set in VEMA.

Figure C-7. A performance set solution generated using VEMA for a shrub-dominated wetland habitat unit. Note that the stem count per acre is shown and should be compared to the routine performance standard threshold when reporting to DSL.

<u>Reporting to DSL</u>

Include the following information with your monitoring report:

1. Print the field sampling summary for percent cover ("Plant and Soil % Cov by Layer"—Sheet 1 pivot table) for each habitat unit and include as an appendix in the Monitoring Report.

2. Print the Unit Solution pages of the Performance Solution Sets generated for each habitat unit (these appear at the end of the report after plot solutions) and include as an appendix in the Monitoring Report (Figure C-2). **Please do not include the plot solution pages.**

3. Complete the "Mitigation Monitoring Report Cover Sheet" using the information from Sheet 2 of the field sampling summary for percent cover ("Plant and Soil % Cov by Layer") and the Unit Performance Solutions. Cover thresholds should be reported as the sample mean with an 80% confidence interval. Diversity, prevalence index, and density of woody vegetation may be reported as the sample mean only.