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Comparison of two vegetation monitoring strategies implemented on four Washington State Department of Transportation wetland mitigation sites

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Abstract

The Washington State Department of Transportation (WSDOT) creates, restores, and enhances wetlands to mitigate for impacts that occur during highway construction projects. Monitoring data provides information on the development and success of these wetland mitigation sites. Valid monitoring data is critical to the adaptive management of site remediation and maintenance activities. In 2000, biologists surveyed wetland vegetation using two different sampling strategies on four mitigation sites in western Washington. Vegetative aerial cover data were collected using both the agency's historical, standardized monitoring approach, and an alternative method that combines changes in sampling design with new methods of data collection. Cover estimates were calculated for each data set and compared. Post-monitoring data analysis shows the alternate methods generate more reliable aerial cover estimates for target plant populations.

CHAPTER IV-I

.........................Wetlands, Streams, and Coastal Issues

COMPARISON OF TWO VEGETATION MONITORING STRATEGIES IMPLEMENTED ON FOUR WASHINGTON STATE DEPARTMENT OF TRANSPORTATION WETLAND MITIGATION SITES

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Abstract: The Washington State Department of Transportation (WSDOT) creates, restores, and enhances wetlands to mitigate for impacts that occur during highway construction projects. Monitoring data provides information on the development and success of these wetland mitigation sites. Valid monitoring data is critical to the adaptive management of site remediation and maintenance activities. In 2000, biologists surveyed wetland vegetation using two different sampling strategies on four mitigation sites in western Washington. Vegetative aerial cover data were collected using both the agency's historical, standardized monitoring approach, and an alternative method that combines changes in sampling design with new methods of data collection. Cover estimates were calculated for each data set and compared. Post-monitoring data analysis shows the alternate methods generate more reliable aerial cover estimates for target plant populations.

Introduction

A well-planned and effectively executed monitoring program can be used as the cornerstone of an adaptive management strategy designed to guide mitigation site remediation and maintenance activities. Valid monitoring data is central to the success of this strategy (Thom and Wellman 1996; Elzinga et al.1998) (Fig. 1a). A monitoring program that provides consistent and reliable information can be used to make management decisions that will improve the condition of a wetland mitigation site and ensure compliance with regulatory permits. Sound management decisions based on credible monitoring data can save resource management dollars when implemented in a timely fashion as part of an effective adaptive management strategy (Shabman 1995).

Frequently, however, monitoring results are inconclusive and fail to provide information necessary to evaluate the success of a wetland mitigation project (Peyre et al. 2001). When this occurs, the adaptive management cycle breaks down (Fig. 1b). Staff time and resources are wasted on an ineffective and inconclusive monitoring effort. Additionally, costs to the resource manager may climb as management decisions are based on inaccurate, ambiguous, or potentially misleading monitoring information (Shabman 1995; Elzinga et al. 1998).

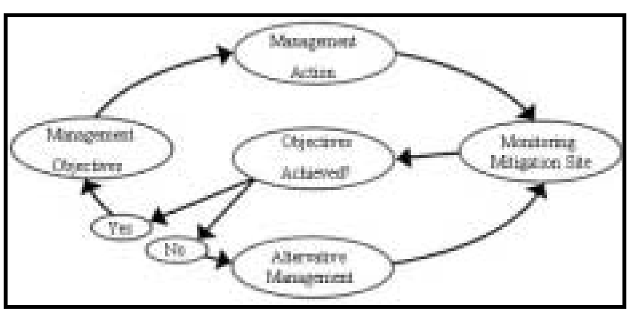

Fig. 1a. Successful Adaptive Management Cycle. Monitoring data was reliable and conclusive (Redrawn from Elzinga et al. 1998).

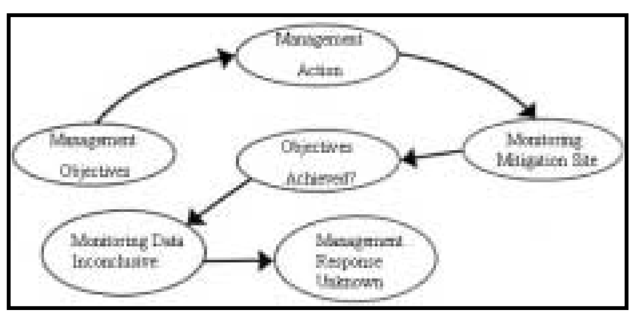

Fig. 1b. Unsuccessful Adaptive Management Cycle. Monitoring data was inconclusive (Redrawn from Elzinga et al. 1998).

In July and August 2000, WSDOT biologists surveyed vegetative communities using two different sampling strategies on 4 wetland mitigation sites in western Washington. On each site, aerial cover data were collected using both the agency's historical, standardized set of monitoring techniques, and an alternative approach that combines changes in sampling design and statistical analysis with new methods of data collection. The following provides a summary of these findings.

Methods

Using the historical, standardized monitoring techniques, two methods were used to collect and calculate vegetative cover on wetland study sites. For woody species, cover data was collected along sampling transects using the line intercept method (Canfield 1941; Bonham 1989). All woody vegetation intercepting a tape measure stretched the length of each sampling transect was identified and the length of each canopy intercept was recorded. The sum of the canopy intercept lengths was divided by the total length of all transects to calculate a mean aerial cover value. With this method, permanent sampling transects were placed along a baseline in a systematic, non-random manner. Sampling transects were angled through perceived vegetation planting zones prior to the first year of monitoring.

In the herbaceous plant community, ocular estimates of vegetative cover were made within one-meter diameter circular quadrats using the Daubenmire (1959) cover class method. Permanent quadrats were located along each sampling transect in a systematic, non-random manner. Plant species, bare soil, and structures (logs, etc.) were assigned cover class values based on the subjective, best professional judgment of the monitoring biologist. Using the Daubenmire method, the following cover class (CC) values were used for this study; CC1 (5% or less), CC2 (5-25%), CC3 (25-50%), CC4 (50-75%), CC5 (75-95%), and CC6 (95% or greater). Summary statistics were based on midpoint cover class values. Cumulative cover values were normalized to approximate herbaceous species aerial cover

Concurrent with the implementation of the historical methods, alternate sampling design and data collection techniques were employed on the 4 study sites. Stratified, systematic, and restricted random sampling designs were implemented using macroplots and microplots in multiple configurations, as appropriate. Using a random numbers table (Zar 1999), sample units (lines, point-lines, or quadrats) were randomly positioned along temporary transects. When necessary, sampling designs were stratified to address site-specific monitoring objectives for different vegetative zones. Both herbaceous and woody species cover data were collected along sampling transects.

Cover data for the woody species plant community was collected using the line intercept method, as in the historical methods. With the alternate techniques, however, temporary sample units (line segments) were randomly positioned along sampling transects. Woody species aerial cover values were calculated for each sample unit. Cover values were summed to calculate a sample mean and standard deviation.

For the herbaceous plant community, the point-line technique (Bonham 1989; Coulloudon et al. 1999) was used to collect aerial cover data. With this method, a vertical rod tipped with a pin was lowered from above the tallest vegetation. All plant species intercepted by the pin were recorded. If the pin intercepted no plant species, the ground surface was recorded as bare soil or structure. Temporary point-line sample units (series of points along a randomly located line segment) were positioned along sampling transects. Aerial cover values for each sample unit were summed to calculate a sample mean and standard deviation.

Use of sample size equations is predicated on the assumption that a sampling design is fully randomized and methods are objective (Elzinga et al. 1998). Due to the non-random, subjective nature of the historical methods, sample size analysis was deemed inappropriate.

With the alternate methods, however, sample size analysis was able to confirm that sufficient sampling had been completed based on sampling objectives and the desired level of statistical confidence. The following equation was used to perform this analysis (Elzinga et al. 1998). In this equation, the precision level equals half the maximum acceptable confidence interval width multiplied by the sample mean.

$$n = \frac{(z)^2 (s)^2}{(B)^2}$$

z = standard normal deviate
s = sample standard deviation
B = precision level
n = unadjusted sample size

Study Site 1: Wetland Pond

In July 2000, WSDOT biologists assessed scrub-shrub, invasive, and emergent plant species cover on a created wetland in southwest Washington.

Historical Sampling Design

Three permanent transects of various length were subjectively angled off an 80-meter baseline (Fig. 2a). Wetland scrub-shrub and emergent plant communities were identified along each sampling transect.

Two methods were used to collect and calculate cover values for plant communities in the emergent and scrub-shrub wetland zones. For woody species in the scrub-shrub zone, cover data was collected using the line intercept method. In the scrub-shrub and emergent zones, biologists used the Daubenmire method to estimate herbaceous species cover.

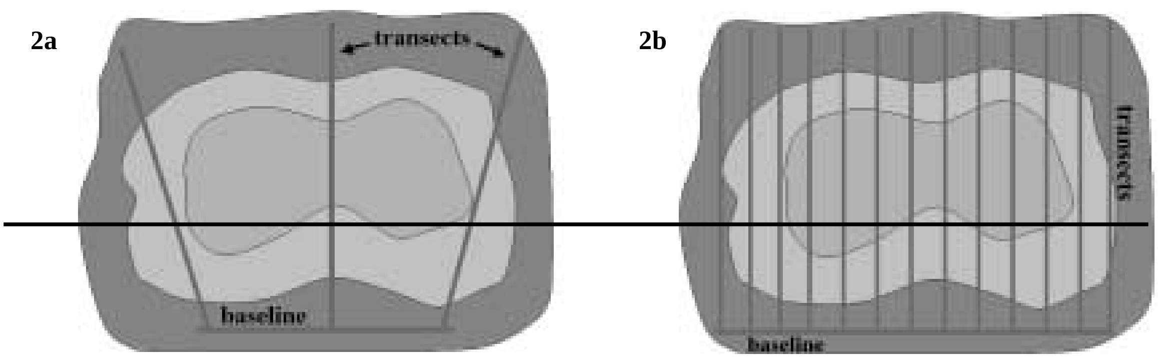

Fig. 2 . Sampling designs for study site 1, wetland pond (not to scale)

Thirty-four permanent, one-meter diameter circular quadrats were systematically positioned in a non-random manner along sampling transects. Summary statistics were based on midpoint cover class values. Cumulative cover values were normalized to estimate aerial cover.

Alternate Sampling Design

A temporary, 125-meter baseline was established along the length of the wetland mitigation site. Twenty-four transects were positioned perpendicular to the baseline using a systematic random sampling method (Elzinga et al. 1998) (Fig. 2b).

The line intercept method was used to collect woody species aerial cover data in the scrub-shrub zone. To achieve the desired statistical confidence interval specified in the site sampling objectives, data was collected from 24 22-meter sample units (line segments) randomly positioned along sampling transects in this zone.

The point-line technique was used to collect herbaceous species cover data. To achieve the desired statistical confidence interval, 26 10-meter sample units (point-lines) were randomly positioned in vegetation zones across the entire site.

Study Site 2: Estuarine Wetland

In July and August 2000, biologists collected scrub-shrub and saltmarsh plant species cover data at a restored, estuarine wetland mitigation site.

Historical Sampling Design
Five permanent transects of various length were subjectively angled off a 105-meter baseline (Fig. 3a). Using vegetative and topographic cues, wetland scrub-shrub and saltmarsh plant communities were identified along each sampling transect.

As in the previous study, two methods were used to collect and calculate plant species cover values. For woody species in the scrub-shrub zone, cover data was collected using the line intercept method. In the saltmarsh zone, biologists used the Daubenmire method to collect herbaceous species cover data from 30 permanent, one-meter diameter circular quadrats. Quadrats were systematically positioned in a non-random manner along sampling transects in this zone.

Alternate Sampling Design
A macroplot (100m × 75m) was strategically placed to include all vegetation zones in the estuary. The macroplot was divided along its length into 24 equal segments (Fig. 3b). One 75-meter sampling transect was randomly positioned in each segment of the

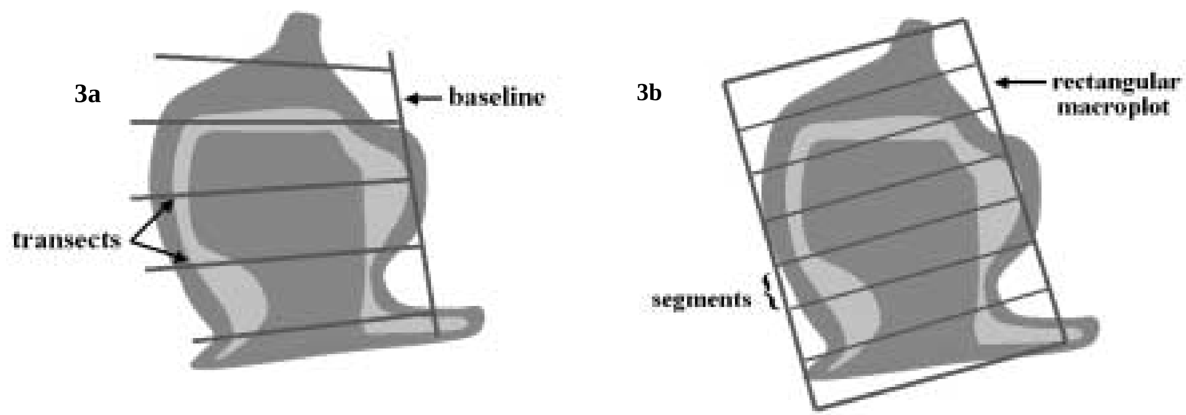

Fig. 3. Sampling designs study site 2, estuarine wetland (not to scale).

macroplot using a restricted random sampling method (Elzinga et al. 1998). Transects were broken into smaller sampling units to address zone-specific monitoring objectives.

For the herbaceous plant community, the point-line technique was used to collect aerial cover data in the saltmarsh. To achieve the statistical confidence interval specified in site sampling objectives, 51 10-meter sample units (point-lines) were randomly positioned along sampling transects.

The line intercept method was used to collect woody species cover data. To achieve the desired statistical confidence interval, data was collected from 36 13-meter sample units (line segments) randomly positioned along sampling transects in the scrub-shrub zone.

Study Site 3 and 4
Monitoring was conducted along a restored stream (site 3) and in a forested wetland (site 4). Using historical and alternate methods, similar sampling designs and monitoring methods were implemented on these study sites.

Results

Study Site 1: Wetland Pond

Using the historical, standardized methods, data analysis shows 8 native herbaceous wetland species provide 37% aerial cover in the emergent zone of the wetland pond. Analysis of data collected using the alternate methods shows 19 native wetland species provide 97% (CI 0.99 ± 0.05) aerial cover in this same zone (Fig. 4).

With historical methods, data analysis shows 6 native wetland woody species provide 26% aerial cover in the scrub-shrub zone that surrounds the pond. The alternate methods also show native wetland woody species in the scrub-shrub zone provide 26% (CI 0.80 ± 0.20) aerial cover (Fig. 4).

The historical methods show the emergent and scrub-shrub wetland zones support 6% aerial cover of reed canarygrass (*Phalaris arundinacea*). By contrast, the alternate techniques show aerial cover of reed canarygrass is 34% (CI 0.80 ± 0.20) in these same zones (Fig. 4).

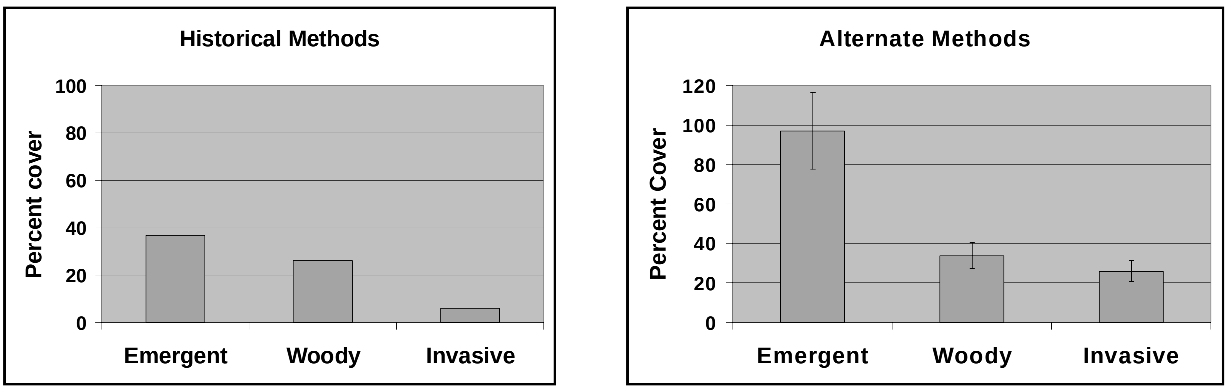

Fig. 4. Percent cover values for emergent, woody, and invasive species

Study Site 2: Estuarine Wetland

Using the historical, standardized methods, data analysis shows 15 native herbaceous saltmarsh species provide 48% aerial cover in the emergent wetland zone. Analysis of data collected using the alternative methods reveals that 20 species of native saltmarsh plants provide 56% (CI 0.95 ± 0.10) aerial cover in this zone.

With historical methods, data analysis shows 7 native wetland woody species provide 25% aerial cover in the scrub-shrub wetland zone. By comparison, the alternate methods indicate the scrub-shrub buffer area supports the same 7 species, but they provide 44% (CI 0.80 ± 0.20) aerial cover.

Study Sites 3 and 4

Table 1 summarizes data analyses for study sites 3 and 4. Forest species in site 4 are red alder (*Alnus rubra*), Oregon ash (*Fraxinus latifolia*), and red osier dogwood (*Cornus sericea*).

Table 1
Data summary for study sites 3 and 4

Study Site	Species	Aerial Cover (%) Old Method	Aerial Cover (%) New Method
3: Wetland Stream	Native emergent	0.50	0.65 (CI 0.80 ± 0.20)
	Native woody	0.10	0.17 (CI 0.80 ± 0.20)
4: Forest Wetland	*Alnus rubra*	0.53	0.37 (CI 0.90 ± 0.10)
	Fraxinus latifolia	0.11	0.08 (CI 0.90 ± 0.10)
	Cornus sericea	0.16	0.34 (CI 0.90 ± 0.10)

Discussion

Post monitoring data analysis shows the historical and alternate monitoring methods provide different aerial cover values for herbaceous and woody species. Using historical sampling strategies, sample size analysis cannot be used to confirm sufficient sampling has been completed. Therefore, cover values calculated using historical techniques are of unknown reliability and should not be reported with statistical confidence. In 10 of the 11 surveys, values calculated using these methods fall outside the confidence interval range for values calculated using the alternate techniques. By comparison, data collected using alternate methods can be reported with a statistical confidence interval and can be defended using accepted statistical tools.

Differences in historical and alternate sampling designs and resultant differences in cover values for two of the study sites would probably result in a different management or regulatory response. For the wetland pond (site 1), cover values for reed canarygrass (*Phalaris arundinacea*) are 6% and 34% using historical and alternate techniques, respectively. Considering the invasive nature of this species, from a resource management perspective, this difference is important. Where a value of 34% would likely trigger a management response, a value of 6% may fall below the threshold and indicate no management response is necessary. In this case, a decision to suspend or implement a weed control program will have serious implications for the future condition of the mitigation site.

Site goals and performance standards require a mixed tree and shrub community on the forest wetland mitigation site (study site 4). Though woody species cover estimates using the historical methods show a community dominated by a single species, alternate techniques indicate a mixed species distribution with similar cover values for red alder (*Alnus rubra*) and red osier dogwood (*Cornus sericea*). These results may generate a very different regulatory response in each case.

On all study sites, estimates of aerial cover calculated using the alternate methods were consistent with observations made in the field. Values calculated using both methods show alternate techniques are more statistically reliable and better demonstrate wetland site characteristics.

While federal, state, and local jurisdictions require mitigation at increasing levels, many agencies and municipalities are faced with static or decreasing resources. Environmental mitigation monitoring activities should be driven by statistically valid data to ensure good information is available for site management decisions. Reliable monitoring information is essential to efficiently utilize the resources available to manage wetland mitigation sites in a cost effective manner.

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