

CRAM Assessment the Strawberry Creek wetland with a floating vegetation mat dominated by *Phalaris arundinacea*

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Introduction

The California Rapid Assessment Method (CRAM) is a diagnostic tool used to quickly assess wetland health within a short amount of time. CRAM was developed based on three ideal criteria; the assessment be a snapshot in time not considering the past or future conditions, the assessment be carried out by two people in a day's time, and the assessment be unbiased by other studies (CWMW, 2012). This streamlined approach provides quick and useful information about the overall health of a wetland. Information gathered this way can then be used to better equip land managers with the tools to enhance or restore their wetlands (Maltby, 2009). The goal of CRAM is to "provide rapid, scientifically defensible, standardized, cost-effective assessments of the status and trends in the condition of wetlands and related policies, programs and projects throughout California" (CWMW, 2012). Information gathered using CRAM methods allows for recurring and consistent data to be used and evaluated over the long term (CWMW, 2012).

CRAM assesses several variables important to the proper function of a healthy wetland: buffer and landscape context, hydrology of immediate area, overall physical structure, and the biotic structure of the system. All of these variables have subset qualities that are looked at and then graded based on tables provided within the CRAM handbook. Scores collected this way are then interpreted on a grading scale ranging from 30-100, higher being "healthier" (CWMW, 2012).

The options of utilizing CRAM can vary from determining project areas, reference conditions, or long term monitoring. Periodic field courses are open to the public throughout the year in order to provide the basic level of understanding of wetlands and applying CRAM (CWMW, 2012).

Our project was a unique application on a wetland with characteristics not typical for the modules provided within CRAM. Strawberry Creek is located in Orick, CA. ~34 miles north of Arcata. Strawberry Creek has been impacted from having the channel relocated, ranching, sedimentation from historical logging, and dominated by invasive species. One particular feature that makes Strawberry Creek unique is its floating vegetation. Although there are some characteristics similar to a fen, there is no open channel and only seasonally standing water. The channel is covered and choked due to the invasive plant reed canary grass (*Phalaris arundinacea*). The plant is highly invasive and one of its characteristics is to create a mat by weaving together (Reinhardt 2004). Depths under the mat go beyond 5' deep. Although there is no real evidence as to how the system was formed, it is believed that sediment higher within the watershed was able to collect in the mat and closed over the channel (Reinhardt 2004). Modules within the CRAM assessment are fit to systems with defined characteristics; however Strawberry Creek poses an interesting test of the CRAM assessment because it does not conform to typical wetlands occurring in California. Our analysis utilized the Wet Meadow and Riverine Module within CRAM. By applying these two modules at the Strawberry Creek site, we are able to compare the results of each to determine which one better represents the system. Our conclusions will determine which module better fits Strawberry

Creek; while simultaneously determining the functionality of CRAM through its application on a unique system.

Purpose

Pre-Restoration Implementation

The purpose of this project attempted to determine CRAMs effectiveness in capturing large changes over time. The channel existing within the project area is covered by the floating vegetation mat. Strawberry Creek is set to undergo significant restoration that will remove the vegetation from the channel and re-contour the topography. Implementing CRAM prior to the restoration will capture the degraded conditions of the wetland. Utilizing two different modules will provide a comparative assessment of the wetlands capturing different characteristics. Information collected from this study will provide the basis necessary for testing CRAMs effectiveness as a monitoring tool.

Monitoring

CRAM produces information which summarizes the overall wetland health, and can be useful for project monitoring. In order for restoration to be effective, monitoring must be a part of the project plan. CRAM is a potential tool for project developers to conduct basic monitoring. Since our analysis applied CRAM prior to restoration, there is the potential for CRAM to be applied after the project in order to capture any changes. Using CRAM for monitoring will provide an analysis of how CRAM captures large physiological changes; as well as, determining the long term effectiveness of restoration efforts post project.

Methods

For a more detailed explanation of CRAMs methods, please visit <http://www.cramwetlands.org/>

CRAM evaluates the wetland health by interpreting and ranking structural indicators based on a gradient of one or more environmental stressors. Such indicators applied under the guidelines of CRAM can be useful for assessing wetland condition for management actions such as the case with Strawberry Creek. Using CRAM in the case of wetland restoration provides a set of baseline data for the current conditions as well as repeatable steps to make future monitoring simpler.

The first step using CRAM is to determine the type of wetland being assessed. This step establishes the category of indicators that can be found in differing systems. CRAM has compiled indicator characteristics for the most common California wetland types, this includes; estuarine, riverine, depressionnal, vernal pools and pool systems, and wet meadow with or without a channel. Following a Venn diagram we determined what wetland type best fits the site of assessment. This first step seems intuitive until faced with severely impacted systems of Strawberry Creek. To help understand how CRAM works in the field on Strawberry Creek, we decided the Riverine and Wet Meadow modules are most representative.

After determining the type of wetland, acquiring background information about land use and management, determining the appropriate timing for field work, the next step was to establish an “Assessment Area” (AA) in the office and verified in the field. The use of geographical information systems such as ArcGIS was used to aid in establishing an AA of appropriate size. Ultimately an AA represents the site based on the hydro-geomorphic integrity and size to encompass most of the sites variability. The boundaries should stop at obvious changes in hydrology, sediment supply, and

geomorphology while still containing the sites characteristics. The Riverine Module AAs focus on the channel therefore to assess the entire area we determined three smaller AAs would best represent the site. The Wet Meadow Module AA is larger therefore one AA would encompass the whole site.

Results

Attribute 1: Buffer and Landscape

The Riverine Module metric 1 scores the aquatic area abundance by looking for breaks in the riparian continuity. Reach A was the only reach to have a break in riparian continuity, due to RWNP old operation center buildings being adjacent to the creek. All other AAs had no interruption or were disconnected from adjacent wetlands or aquatic habitats (Appendix D). Breaks in riparian continuity were all at least 10m wide, meeting the criteria to be a segment. The old operations center only impacted reach A due to proximity. Reaches B and C do have roads next to them but do not meet the specifications to be considered a break in continuity.

Wet Meadow scored a 12 for attribute 1 because the 250m transects were mostly intersecting the wetland adjacent to Strawberry Creek. The Wet Meadow AA exists within the middle of the wetland, and would therefore increase contact with wetland. Wet Meadow also takes into account a much larger area adjacent to the AA when compared to the Riverine Module.

Buffer around both Riverine and Wet Meadow first considers immediate boundary characteristics. All reaches for riverine scored 12's; while the Wet Meadow scored a 9 (Appendix F). There were no significant non-buffer segments around any of the AA segments based on adjacent land use types. Wet Meadow scored lower due to a wildlife inhibiting fence on the north side of the AA, as well as development on the south side of the 250m buffer. Since the buffer for Wet Meadow extends further than the Riverine Module, it captures more land cover type differences. For this reason the Wet Meadow provides a better picture of the wetland since it differentiates buffer types.

Average buffer width (submetric B) measures the total lengths of each buffer segment. Riverine reaches A and C scored 12, while reach B scored a 9 (Table 1). Wet Meadow scored a 6 (Table 1). Reach B buffer segments ran into developed areas reducing its score. Wet Meadow segments also ran into developed areas as well as an inhibiting fence. Reach B was adjacent to the development and was affected as a result. However, reaches A and C also showed that the rest of the wetland was relatively unaffected.

The buffer condition (submetric C) is defined the same for both modules, making the scores relatable. All AA's for both modules scored a 6 (Table 1). A large portion of the AA's is dominated by non-native vegetation with some disturbance, resulting in a lower score. Since this part of the park is not visited by tourists very often, that was not a factor in determining a low score. The vegetation determines the low score for all AA's. As long as the dominant vegetation is invasive or there is human impact, both modules will score this metric the same.

Attribute 2: Hydrology

Wet Meadow and Riverine Modules follow the same basic rating indicators for determining the water source quality (metric 1). The scores for both modules in this metric scored a 12, because there are water sources via tributaries and groundwater and no artificial sources affecting the dry season conditions. Though the stream reaches are effectively fed by different sources, reach A the main stem of Strawberry Creek, reach B by groundwater flow, and reach C the culmination of A and B; they all are located within the floating mat system and end up in the storage of the wetland which is slowly drained through the channel outlet at the south west end of the site (Love, 2008).

Hydroperiod (metric 2) is specific to the Wet Meadow Module. This is a characteristic relating to the wetlands frequency and duration of inundation or saturation of the wetland during an average year. Changes that occur over small periods of time are the result of evapotranspiration of local vegetation and by the variability of rainfall. This metric is measured by considering deviations from the average rainfall year based on field indicators of reduced or increased extent and duration of ground water. At the Strawberry Creek site we found that the hydroperiod, extent and duration of shallow groundwater, fluctuates on seasonal rainfall cycles (Love, 2008). This site is not characterized by a hydroperiod presently influenced by anthropogenic drainage or drying as it was in the past by ranching on site, nor is there any water stored or added during dry seasons. For this metric we considered the current condition without alterations to the hydroperiod scoring it with the highest score of a 12. Although the hydroperiod is also important for the Riverine Module, data for many stream systems was not available. Like the Wet Meadow Module field indicators are essential for determining the hydroperiod but with the stream system the channel morphology provides the evidence for frequency, duration, and extent of the hydroperiod (Love, 2012).

Channel Stability (metric 2) is specific to the Riverine Module. This is based on channel form, cross section, plan view, and longitudinal profile. Though a channel exists, it is beneath the thick vegetation mat. The dense mat of vegetation acts as a catch for the sediment load transported downstream choking and spreading the flow across and under the mat (Love, 2008). There is no discernible bankfull transition to the floodplain. Under the Channel stability metric all reaches received a low score of a 6, due to the severe reduction in discharge velocity as the streams hit the dense vegetative mat (Love, 2008). This metric posed a problem in scoring the metric; we had to fall back on past research to determine the specific ratios for bankfull to floodplain. Channel to floodplain connection is always present below the mat; the only way we could have scored it lower was if the channel was artificially hardened such as a concrete channel.

Wet Meadow hydrologic connectivity (metric 3) describes the ability of water to flow in and out of the system or to accommodate flood waters without changing water levels enough to stress plants or animals occupying the wetland habitat. To score this metric for the Wet Meadow we had to decide whether this was a channeled meadow or non-channeled system. It seemed for our purposes since the channel flowed below the wetland that a non-channeled system more closely represented the area. Strawberry Creek is a channel that is in the process of aggradation; the channel is currently unable to move suspended load (fine particulates) and bed load (gravel and cobbles) due to interception of the floating mat. The hydrologic connectivity metric for the non-channeled Wet Meadow functions as a source area fed by natural springs, seeps, or flooding stream water for downstream surface flows and is not cut into braids or a series of channels that isolate the system discharges. Under the guidelines of CRAM the connectivity metric scores a 12.

The Riverine Module hydrologic connectivity (metric 3) places emphasis on the ability of the stream to overtop its bankfull height, by hydrological connectivity. These measurements at our site on Strawberry Creek were difficult to determine do to the mat. This metric posed a problem in scoring the wetland; we had to fall back on past research to determine the specific ratios for bankfull to floodplain. From the profile produced in a contractors report by Mike Love and Associates we were able to estimate bankfull width, max bankfull depth, flood prone depth, and flood prone width for the four cross sections for AA reach C. The CRAM module only requires estimations so we felt we could use this information with confidence. The entire mat and floodplain are identical therefore we estimated the width at approximately 1000 feet for the flood prone area. After averaging out the ratio for the four profiles we

found about 28 feet of floodplain width for every one foot of bankfull width which surpasses the rating for the non-confined riverine wetland entrenchment ratio of >2.2 to 1. The measurements for this metric came only from reach C as provided in the Mike Love report, and since the area is a homogenous floating mat floodplain each reach A,B,C get the same score of a 12 with an entrenchment ratio greater than 2.2 at ~28.5:1 (CWMW, 2012).

Attribute 3: Physical Structure

Structural patch richness (metric 1) looks for obvious diversity within the wetland that may provide habitat. All AA's within the Riverine Module scored a 6 (table 1). Wet Meadow scored a 9 (Table 1). The Wet Meadow has a higher score based on covering a larger area with the AA. Its grading threshold is also lower than the Riverine module, needing fewer structures to score higher. The similarities between both modules were varied, based on the size difference between both AA's. Features in one were sometimes found or not found in the other AA's. The only main difference between the two modules here is the extent of the AA's.

Topographic Complexity (metric 2) scores the wetland based on a variety of elevations, reliefs and hummocks. The riverine AAs were all relatively flat due to the arrangement of the AAs. This feature shared throughout all the riverine AAs resulted in a score of a 3 for each reach (Table 1). The Wet Meadow Module scored a 6 due to its longer range from upland to upland resulting in a more diverse topography (Table 1). Each AA in the riverine analysis did not yield defining characteristics typical for channeled wetlands, as there were no benches or banks.

Attribute 4: Biotic Structure

Vegetation is measured by the biological makeup of the AA. Invasive species common for each module AA were: *Agrostis stolonifera*, *Glyceria fluitans*, *Holcus lantus*, *Ranunculus repens*, *Phalaris arundinacea*. Native species encountered were *Scirpus microcarpus*, *Juncus bolanderi*, and other sedges/rushes common for this site. However, some of the more common native species were not in the same height class of the dominant invasive plants. The three height classes were broken into short (<0.5m), medium (0.5-1.5m), tall (>1.5m). Walking each AA resulted in the plant list of non-native invasive and native species. Dominance yielded each AA with similar result. Within the Riverine Module number of plant layers reach A and B scored a 9 while reach C scored a 12 (table 1); Wet meadow did not score this category due to different metrics. For co-dominant species reach A and C scored a 3 while reach B scored a 6 (table 1). Wet meadow scored a 9 for number of co-dominant species. Percent invasion scored a 3 for each module and AA. Another metric measured with the percent encroached; this was only measured with Wet Meadow. This metric was scored as a 12 (table 1). Horizontal interspersation scored a 3 for both modules and each AA. The vertical biotic structure scored a 6 for each Riverine Module AA and a 9 for Wet Meadow (table 1).

Overall Score:

CRAMs overall score varied between modules. Riverines reach A scored an overall score of 57% (table 1). Reach B scored a 61% and reach C scored a 59% (table 1). Wet meadows overall score was 73% (table 1).

Table 1: Summary table for CRAM scores of Wet Meadow (WM) and Riverine Modules (Grading: A=12, B=9, C=6, D=3)

		Riverine		Wet Meadow	
		Reach A	Reach B	Reach C	
Attribute 1: Buffer and Landscape Context	Riparian Continuity (WM: Aquatic Area Abundance)	9	12	12	12
	Submetric A: % with Buffer	12	12	12	9
	Submetric B: Avg Buff Width	12	9	12	6
	Submetric C: Buff Condition	6	6	6	6
Attribute 2: Hydrology	Water Source	12	12	12	12
	Channel Stability (WM: Hydro Period)	6	6	6	12
	Hydrologic Connectivity	12	12	12	12
Attribute 3: Physical Structure	Structural patch Richness	6	6	6	9
	Topographic Complexity	3	3	3	6
Attribute 4: Biotic Structure	Submetric A: # Plant Layers	9	9	12	n/a
	Submetric B: # Co-Dom Spp.	3	6	3	9
	Submetric C: % invasion	3	3	3	3
	Submetric D: # Encroachment Species	n/a	n/a	n/a	12
	Horizontal interspersation	3	3	3	3
	Vertical Biotic Structure	6	6	6	9
Overall AA Score (%)		57	61	59	73

Discussion

Creating a streamlined assessment method in a state with a broad range of unique wetland types has proved to be difficult. However, CRAM does provide a unique opportunity to utilize its methods in order to determine a general summary of a wetlands health. Information collected this way can then instigate further analysis or project development. Strawberry Creek's project results will influence further investigation into the process of CRAM and potential restoration efforts.

A streamlined process provides an excellent basis to conduct analysis if the system fits the criteria. Most wetlands share physical characteristics allowing them to be classified as marshes, swamps, fens, and bogs. However, not all wetlands can be easily fit into a specific type, making CRAM's application problematic. CRAMs approach starts with selecting wetland type and moving through a module appropriate for the wetland identified. Strawberry Creek is one of these examples due to its unique floating mat and lack of obvious channel. This physical ambiguity allowed analysis to consider two different modules within CRAM, Wet Meadow and Riverine. Since it shares some characteristics to fit both criteria, the results yielded interesting conclusions. Wet Meadow provided a higher overall score due to its ability to encompass more details of the wetland. While the Riverine Module required a channel and the scores suffered as a result, Wet Meadow lacked adequate buffer analysis. Both modules lacked in certain areas, but overall Wet Meadow provides a better analysis for Strawberry Creek. Due to its floating mat, there were more closely graded metrics that fit a Wet Meadow description yielding higher quality data. Despite Wet Meadows higher grade for the system, both modules indicate a degraded wetland.

Data collected this way could cautiously be used for restoration planning due to its rapid and general application. CRAM may lack specific detail necessary to inform the actual restoration process of

project development, but it has useful qualities. CRAM can act as a monitoring program that analyzes broad physical characteristics of a wetland for very little cost. This aspect of rapid assessment has very useful applications for restoration projects. Restoration projects are typically lacking effective monitoring plans due to budgetary constraints. CRAM can act as solution for this shortfall of current restoration projects. Although CRAM may be highly useful for low budget monitoring or capturing broad implications of restoration projects, its lack of detail may inhibit its usefulness for project planning.

CRAMs strength is speed and consistency with gathering broad information about a wetland. It is very straightforward and simple to use. Its final product offers a consolidated and easy to catalogue data sheet with information regarding each metric analyzed. These strengths make CRAM very useful on many levels within wetland management. Despite CRAMs strengths, its weaknesses vary. Some of the components lack variation to encompass unique wetland systems. This approach to rapid assessment forces systems to fit the criteria provided by CRAM, and may overlook a variable particular for that system. Certain parameters within CRAM may be influenced by the variables being overlooked resulting in a misrepresented score. This type of weakness comes with attempting a method that covers a very broad range of wetland types. As long as CRAM is used for rapid assessment and to act as a catalyst for further investigation it will always be useful. CRAM has the potential to become a new standard for restoration projects and wetland assessments within California.

Works Cited

- California Wetlands Monitoring Workgroup (CWMW). 2012. California Rapid Assessment Method (CRAM) for Wetlands and Riparian Areas, Version 6.0 pp. 95
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- Maltby E. and Barker T. (eds) (2009) *The Wetlands Handbook*. Wiley-Blackwell, Oxford. 1058 pp.
- Reinhardt, Carrie H., and Susan M. Galatowitsch. "Best Management Practices for the Invasive *Phalaris Arundinacea* L. (Reed Canary Grass) in Wetland Restorations." University of Minnesota Department of Horticultural Science, May 2004. Web. 7 Dec. 2012.

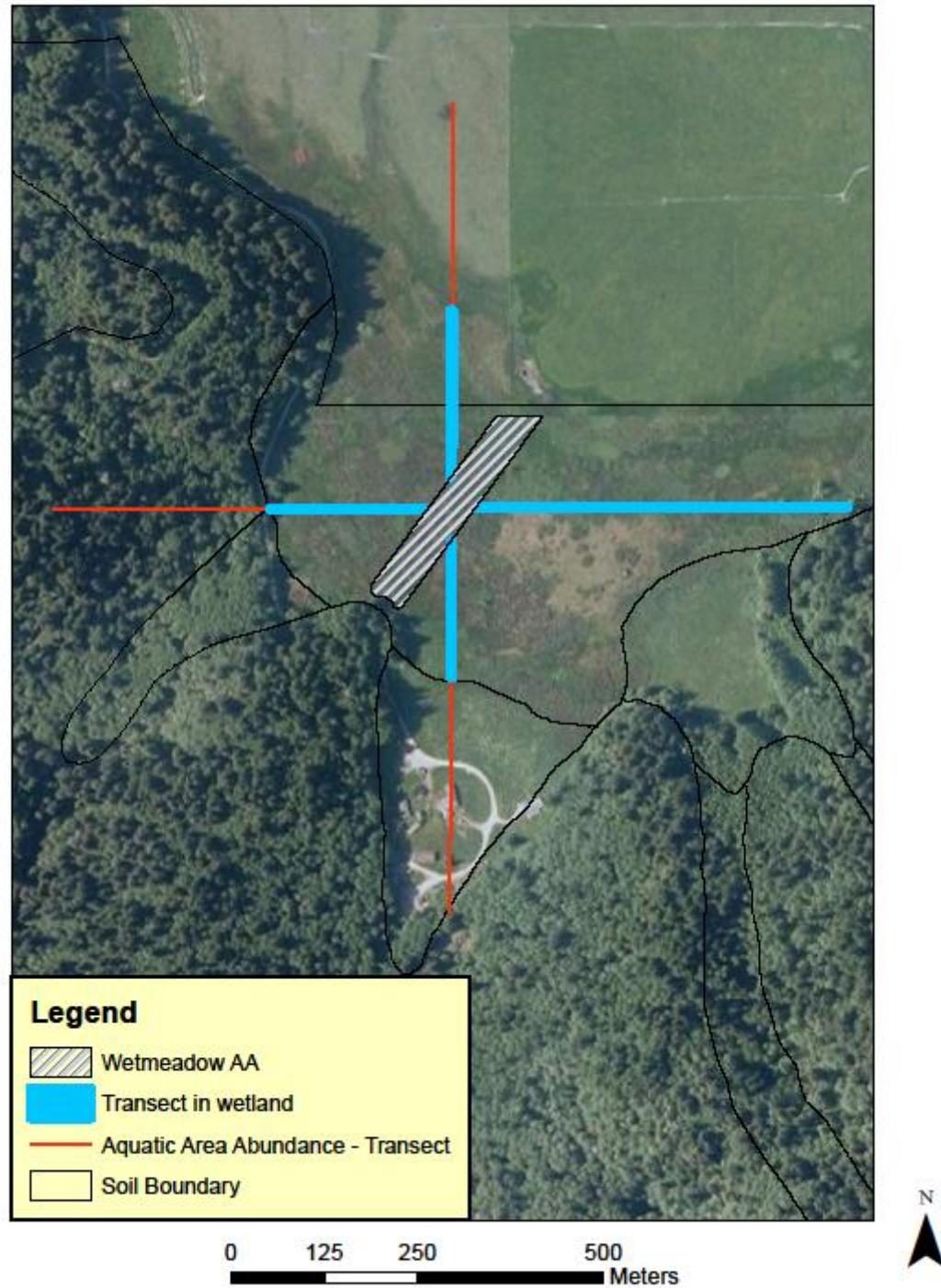
Appendix A: Riverine assessment areas



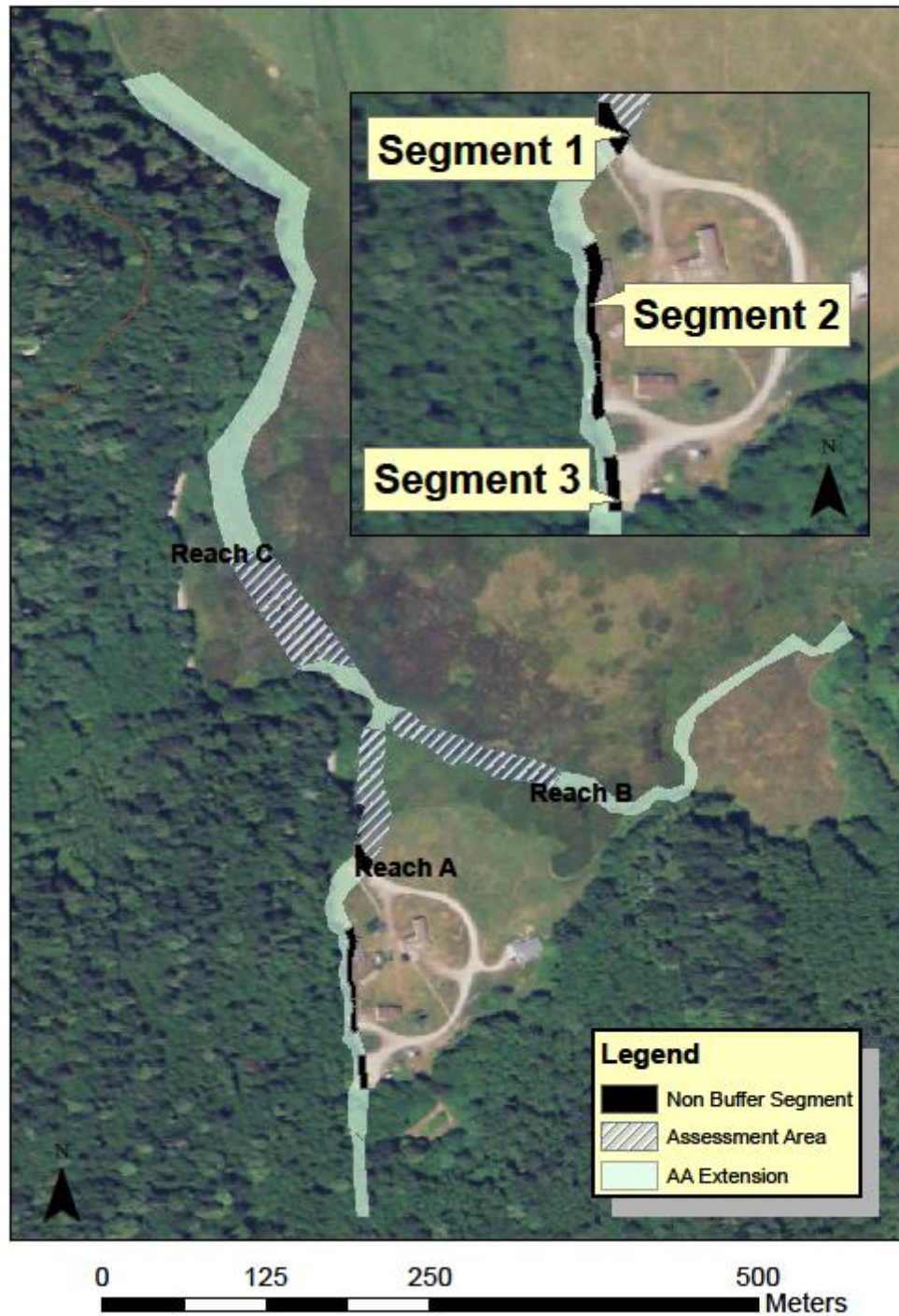
Appendix B: Wet Meadow assessment area



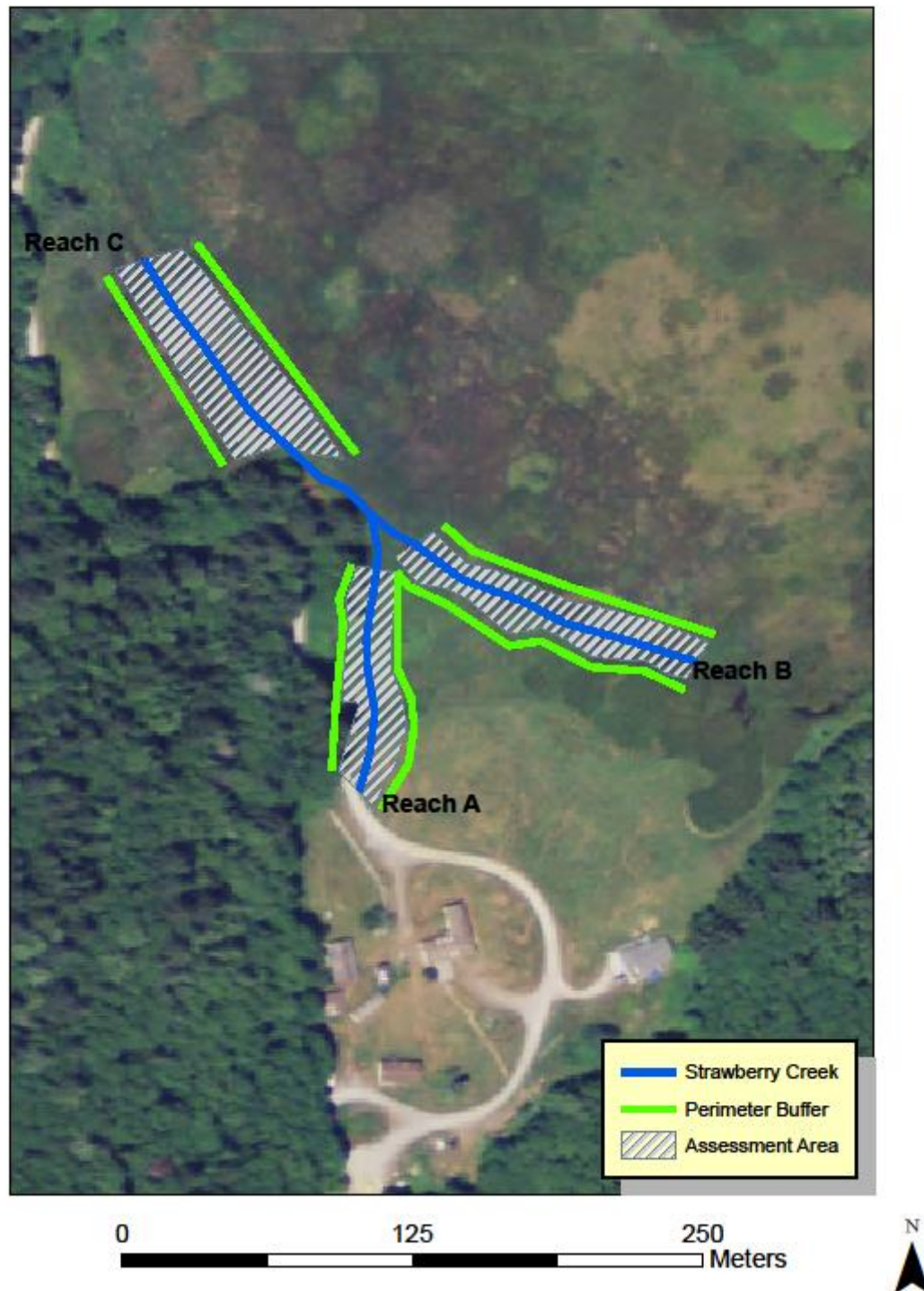
Appendix C: Wet meadow aquatic area abundance



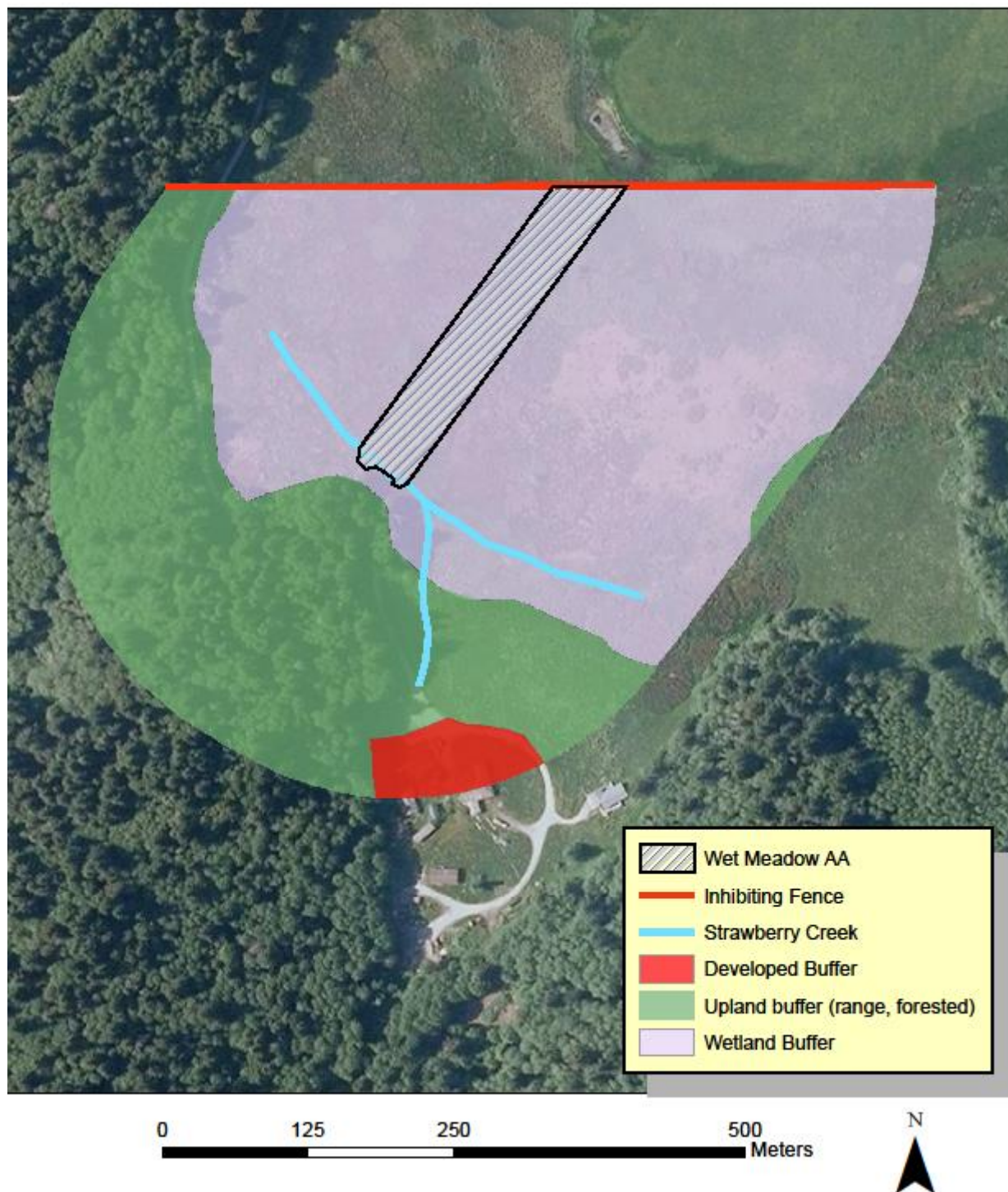
Appendix D: Riverine riparian continuity for all reaches



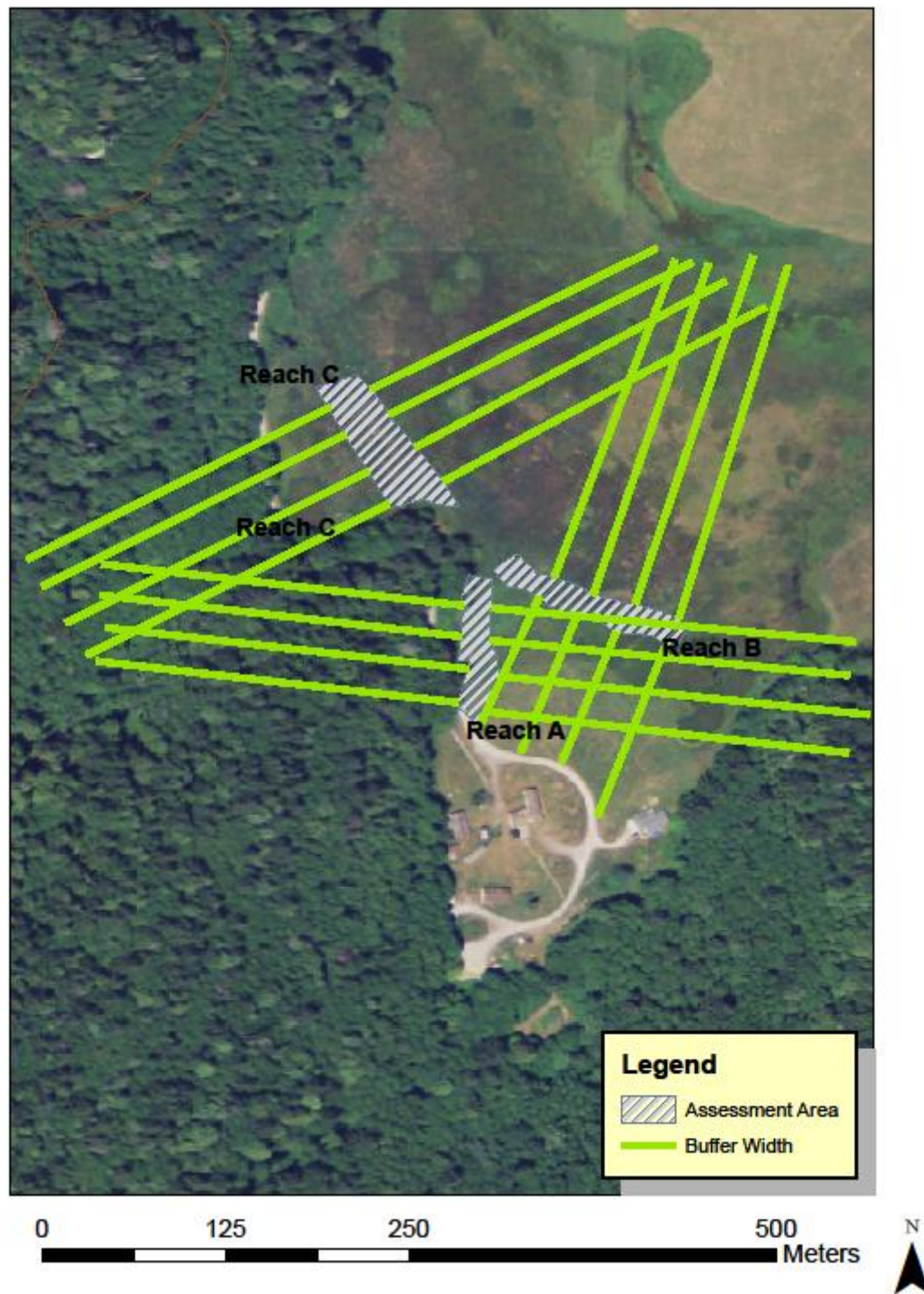
Appendix E: Riverine percent with buffer



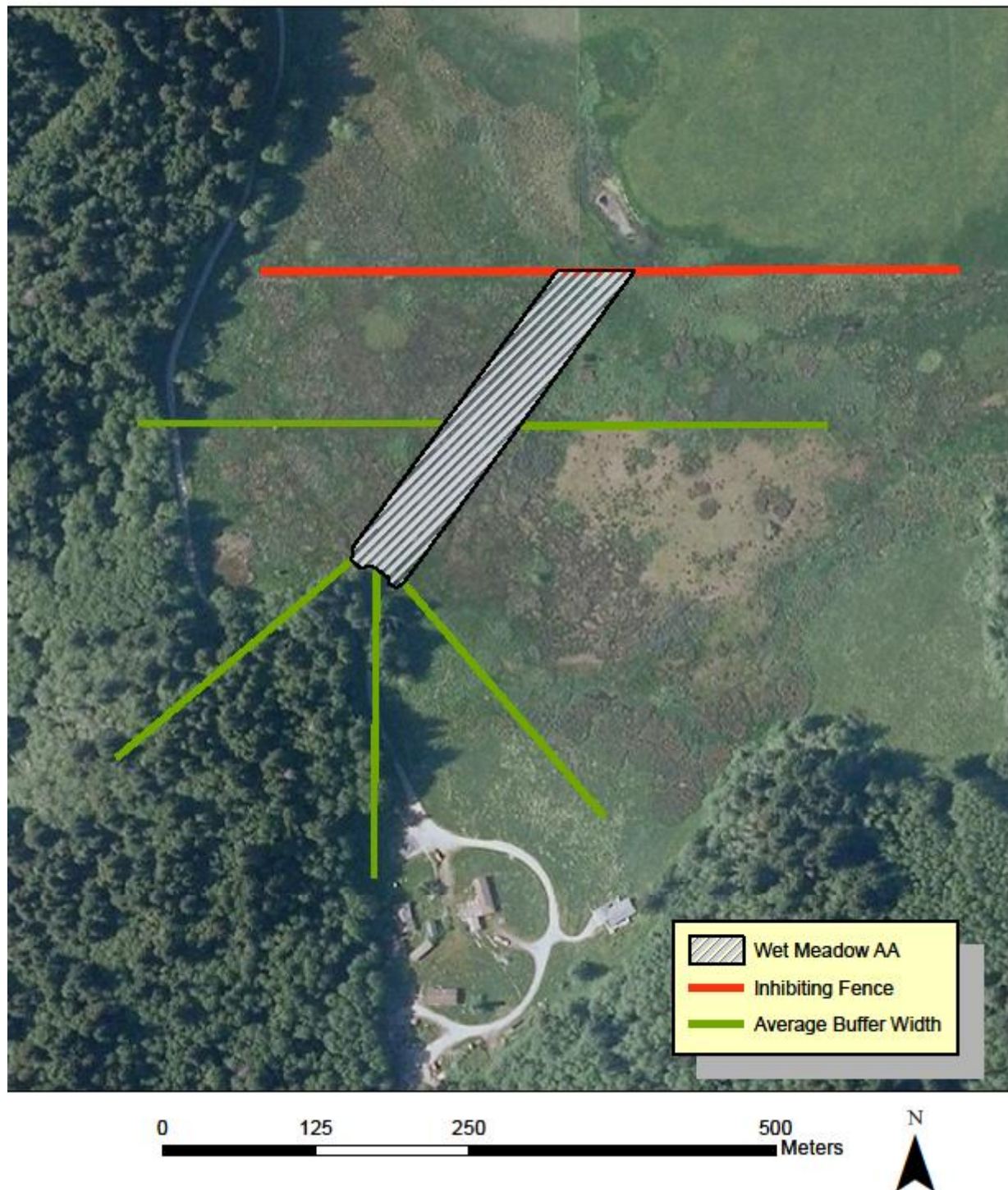
Appendix F: Wet Meadow buffer and land cover types



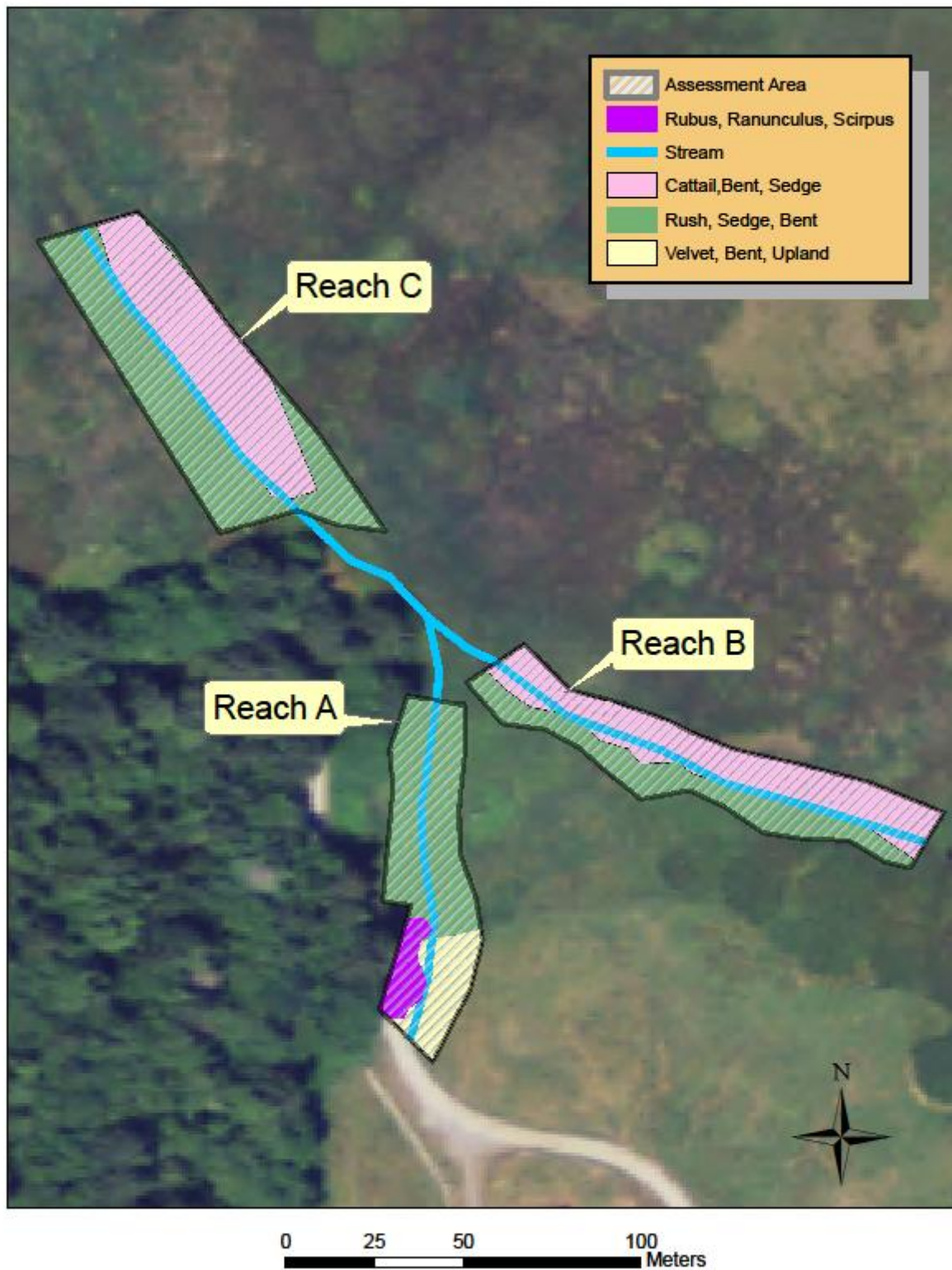
Appendix G: Riverine buffer width



Appendix H: Wet Meadow average buffer width



Appendix I: Riverine horizontal interspersions



Appendix J: Wet Meadow horizontal interspersions

