APPENDIX A: SUMMARY OF KNOWLEDEGE GAPS

<table>
<tr><th colspan="2">Knowledge Gaps</th></tr>
<tr><td rowspan="7">Local and Regional Impacts</td><td>Relationship between peatland type (e.g., bog vs. fen), feature type (e.g., pad vs. road) and direction of water flow relative to the feature on the occurrence of off-site impacts</td></tr>
<tr><td>Impacts of pads and roads left in place on groundwater, wildlife habitat, wildlife movement and use of the landscape</td></tr>
<tr><td>Methods that can be used to measure the occurrence and extent of current pad impacts to hydrology, as well as the potential for future impacts</td></tr>
<tr><td>Cumulative impacts of multiple pads and roads on local and regional peatland hydrology, chemistry, vegetation and greenhouse gas fluxes and the threshold at which cumulative impacts degrade overall ecological function of the region</td></tr>
<tr><td>Magnitude of carbon emissions released during pad removal (including site access) and associated net environmental “benefit” associated with pad removal vs. leaving the pad in place</td></tr>
<tr><td>Success rate of pad removal in achieving peatland ecosystem function, ecological land classification and the factors and reclamation practices that contribute to success or failure. Specifically:
• Extent of peat compression under the pad, and impact of overall thickness and weight of the pad
• Extent of peat rebound after pad removal and impact from duration of pad being in place and thickness/weight of the pad
• Potential for and risk of minimal peat rebound and the creation of an open water body instead of a site on a trajectory to a functional peatland
• Impacts to underlying peat chemistry resulting from the pad material, and how those changes may impact a developing plant community after pad removal</td></tr>
<tr><td>Cumulative effect threshold based on scientific and geographical approaches to allow a proportion of wetland in a given area to be “lost” without significant degradation of function of the region</td></tr>
<tr><td rowspan="5">Site Specific Considerations</td><td>Factors that result in padded sites impacting the surrounding peatland ecosystems in the long term and affect the extent and severity of these impacts</td></tr>
<tr><td>Effectiveness of partial reclamation activities for alleviating impacts resulting from pads (wellsite and/or access roads) in peatlands</td></tr>
<tr><td>Likelihood of success for peatland recovery if the pad is removed</td></tr>
<tr><td>Success rate of pads left in place that achieve and maintain upland ecosystem function and ELC in the long term. Specifically:
• Relative importance of factors that influence successful reforestation of pads (e.g., soil quality, topsoil depth, compaction, dispersal vectors, historical revegetation efforts, time, surrounding peatland type, water quality and levels, etc.)
• Potential for water table to rise into the root zone over time
• Resiliency of upland ecosystems developed on pads left in place</td></tr>
<tr><td>Factors that result in sustainable forest ecosystem development on padded sites</td></tr>
</table>

APPENDIX B: RESEARCH OBJECTIVES, QUESTIONS AND EXPERIMENTAL APPROACHES

Objective 1) Investigate the factors that result in sustainable forest ecosystem development on padded sites in peatlands

Rationale

One factor in the decision to leave a pad in place in a peatland is the sustainability of the ecosystem that has developed on the pad; this must be demonstrated to justify/approve reclamation certification. Additional understanding of the factors that encourage the development of sustainable forest ecosystems on padded sites is required to optimize reclamation practices to achieve this goal.

Research Questions

Objective 1 will specifically focus on the following research questions:

- Does the vegetation community on pads meet expected thresholds for composition and tree growth performance of forest ecosystems?
- Which pad characteristics result in a vegetation composition and tree growth performance that meet expected thresholds for a forest ecosystem?

Experimental Approach

To determine if sustainable forest ecosystems develop on pads and what factors result in development of sustainable forest ecosystems, reclaimed pads with different vegetation compositions will be selected. Sites will be stratified into groups or treatment levels based on their vegetation composition:

- Closed or nearly closed tree and shrub canopy
- Open canopy of trees and shrubs
- No/minimal tree and shrub canopy.

Differences between the pad characteristics and local surroundings of pads of the treatment levels will be used to determine which factors affect development of a sustainable forest ecosystem on pads. To determine if pads support sustainable forest ecosystem, a fourth treatment level will be upland (forested) wellsites that have met the natural recovery or planted requirements of the Forested Reclamation Criteria and have received a reclamation certificate. These upland wellsites will be compared to pads with closed or nearly close tree and shrub canopy.

Effect of time will be controlled by selection sites that have been reclaimed between 15 and 20 years previous (this age range may change depending on availability of sites).

Factors that will be measured to compare pads in the different treatment groups and determine what contributes to sustainable forest ecosystem development on pads will include:

- Reclamation practices: none, deep ripping, mounding, application of amendments (or salvaged topsoil), fertilization (depending on the availability of sites)
- Pad thickness and size
- Presence, type and depth of liner (e.g., corduroy, geotextile)

- Physical and chemical properties of the pad material
- Water level within the pad material (i.e., pad water table; depth to water below the surface of the pad)
- Surrounding peatland size and proximity of the pad to off-site seed sources for upland or mineral wetland ecosystems
- Surrounding peatland type: bog, poor fen, moderate-rich fen, extreme-rich fen

Measurements that will be used to compare forest ecosystems on pads to upland wellsites will include:

- Vegetation cover, composition and structure
- Tree density, height, diameter at breast height, age, mean annual increment
- Litter accumulation and decomposition
- Density and diversity of propagules in the soil seedbank

Application

Results from this objective will be used to refine the site-specific decision support tool in the Decision Framework and Support Tool. It will provide measurable characteristics that can be used to determine if a sustainable forest ecosystem is likely to develop on the pad and the pad could be left in place or if the pad should be removed.

Objective 2) Develop a mechanism for detecting and evaluating the effects of pads off-site

Rationale

To make decisions about leaving a pad in place in a peatland, or to justify/approve reclamation certification for a pad left in place in a peatland, appropriate metrics, and an accurate methodology to assess the metrics, are needed to verify that there are acceptable to the surrounding peatlands. There are many options for metrics and methodologies that could be used to indicate that pads left in place are not having impacts on the surrounding peatland. The value of these different methods needs to be evaluated to ensure that we are using the appropriate measurements to have certainty about the occurrence of impacts within the peatland ecosystem overall, while also avoiding measuring unnecessary parameters that do not provide additional benefits in terms of decision making.

Research Questions

Objective 2 will focus specifically on the following research questions:

- What is the effectiveness of remote sensing as a method to detect impacts of pads left in place in peatlands and can remote sensing accurately detect different kinds of impacts?
- Are measurements of water chemistry, water levels or sedimentation required to detect impacts or are impacts to water chemistry or water levels reflected in the vegetation?
- When should impacts be detected or evaluated (I.e. how many years after pad construction or reclamation does it take for impacts reach their maximum or steady-state, if they reach a steady-state)?

Identifying ecological thresholds that define an impact was identified as an important question for this objective; however, determining thresholds needs to consider various factors include land uses, ecological role/function and risk tolerance of regulatory bodies and land users and would be beyond the scope of this research proposal. For this research objective, impact[1] will be defined as a statistical difference, at an alpha value of 0.05, between the peatland surrounding the site and an appropriate reference area(s).

Experimental Approach

To answer the research questions, sites will be stratified into groups based on visual indicators of off-site impacts:

- No visual impact
- Visual impact – difference in vegetation or ponded water as observed on an aerial image

Sites will also be stratified by time since construction of the pad:

- 5 to 10 years since construction
- 10 to 20 years since construction
- >20 years since construction

Field measurements of water levels, water chemistry, sedimentation and vegetation composition, cover and density of the peatland adjacent to the pad will be taken and compared to an appropriate reference area. Similarly, remote sensing will be utilized to characterize the peatland adjacent to the pad and the remote sensing data will be compared to an appropriate reference area.

Data will be analyzed as follows:

1. To determine if remote sensing can be used to identify impacts, outcomes of field-based measurements (impact or no-impact based on differences between peatland adjacent to the pad and a reference area) will be compared to remote-sensing based outcomes to determine if there is a correlation. The effectiveness of remote sensing to identify vegetation impacts compared to water and sedimentation impacts as well as the ability to detect less severe impacts will be evaluated.
2. To determine if water chemistry, water levels or sedimentation measurements are needed to identify impacts or just vegetation measurements, measurements will be compared to reference areas, if there is a difference in water chemistry, water levels or sedimentation but not vegetation, it could suggest that vegetation measurements are not sufficient. However, if vegetation, water chemistry, water levels and sedimentation are all different, vegetation measurements may suffice. These outcomes may be related to time since construction of pad as vegetation may take longer to respond than the other parameters. Hence, including different ages of pads in the comparison may determine when (years since pad construction/reclamation) vegetation measurements alone can

[1] *The definition for impact is subject to change based on site selection.*

be used to identify impacts and when water chemistry, water levels or sedimentation measurements also required to identify impacts.

3. To determine when impacts should be detected or evaluated and when they reach their maximum or steady state will utilize remote sensing. Historical remote sensing data will be utilized and learnings from analysis 1 and 2 will be incorporated. Changes in impacts will be tracked over time to determine when a maximum or steady-state has been achieved. The field measurements and outcomes from analysis 2 will also be used to verify the results.

Application

Results from this objective will be used to develop standardized methods for measuring site impacts which can be used to guide decisions in the local and regional impacts decision support tool.

Objective 3) Investigate the factors that result in padded sites having off-site impacts to their surrounding peatland ecosystems in the long-term and affect the extent and severity of these impacts

Rationale

The occurrence, or the potential for the occurrence, of impacts to the surrounding peatland as a result of a pad left in place is a major factor in justifying/approving reclamation certification for pads left in place in peatlands. Current and short-term off-site impacts can be directly measured (through work to address Objective 1), but prediction of future impacts is also a critical component of the decision. In the absence of long-term monitoring, there is a need to understand the factors that result in off-site impacts, to use these as predictors of long-term impacts.

Research Questions

Objective 3 will focus specifically on pads, including both padded wellsites and access roads, that have been reclaimed for 20 years or greater and the following research questions:

- What characteristics of pads result in impacts to the long-term health and function of the surrounding peatland ecosystem?
- What characteristics of peatland ecosystems and the location and orientation of the wellpad/access road within a peatland result in the pad having a long-term impact on the ecosystem?

Experimental Approach

To answer the research questions, sites will be stratified into groups based on visual indicators of off-site impacts:

- No visual impact
- Visual impact – difference in vegetation or ponded water as observed on an aerial image

Post data analysis, sites may be reclassified as impacted and not impacted based on the definition of impacts; however, this will ensure that sites with and without impacts are included.

Sites will also be stratified by peatland type:

- Bog
- Fen
- Marsh

Effect of time will be controlled by selection sites that have been reclaimed >20 years previous (this age range may change depending on availability of sites and assuming that impacts have reached a steady state). As explanatory factors for pad impacts, measurements of the following characteristics will be made in the field and using remote sensing data/aerial imagery. Data collected from Objective 1 and 2 will be utilized:

- Facility type: padded wellsite without a padded access road, padded wellsite with a padded access road, padded access road only
- Pad size
- Pad thickness
- Physical and chemical properties of the pad material.
- Location of the pad within the peatland
- Erosion and run-off potential of the pad; inferred from vegetation cover, slope and evidence of past erosion
- Peat thickness
- Texture of the substrate below the peat.
- Size of the peatland
- Heterogeneity of the peatland

To determine the characteristics of pads and peatlands that result in impacts to the long-term health and function of the surrounding peatland ecosystem, pads with impacts in the surrounding peatland will be compared to pads without impacts to determine if there are certain characteristics associated with pads with or without impacts. If there are associated characteristics, these characteristics can be used as predictions for impacts.

Application

Results from this objective will be used to refine the local and regional impacts decision support tool in the Decision Framework and Support Tool. It will provide measurable characteristics that can be used to determine if a pad could be left in place or if the pad should be removed.

Objective 4) Evaluate the effectiveness of partial reclamation activities for alleviating off-site impacts resulting from pads left in place in peatlands

Rationale

Instead of complete pad removal, alleviating adverse effects to surrounding peatlands caused by pads left in place may be achieved through partial reclamation. Whether or not partial reclamation activities are successful at alleviating these off-site impacts is one of several factors that is considered in justifying/approving reclamation certification for pads left in place in peatlands.

For the purposes of this project, the partial reclamation options that will be studied are those that mitigate off-site impacts and may include:

- Partial removal of pad material to create drainage channels (e.g., swales), allowing water flow across/through the padded feature
- Partial removal of pad material from a vertical perspective to reduce the thickness of the pad and lower the elevation of the pad surface to match the surrounding peatland (on all or portions of the site)

Installation of culverts was not included as a potential partial reclamation option that will be studied because culverts cannot be left in place for reclamation certification. Partial reclamation options targeted at alleviating or improving soil conditions on the pad itself (e.g., deep ripping) are also not included in the project.

Research Questions

This project will specifically focus on the following research questions:

- Are partial reclamation methods effective in reducing off-site impacts caused by pads left in place in peatlands?
- What characteristics of the pads affect the success of partial reclamation?
- What characteristics of peatland ecosystems and the location and orientation of the pads within a peatland affect the success of partial reclamation?

Experimental Approach

Objective 4 will not include application of partial reclamation treatments to unreclaimed sites, instead sites where partial pad removal has already been conducted will be located and these pads will be utilized to answer the research questions. Sites will be stratified into groups or treatment levels based on reclamation treatment:

- Partial pad removal: swales
- Partial pad removal: vertical
- No pad removal
- Full pad removal

Sites will also be stratified by facility type:

- Access Road
- Wellsite

And sites will be stratified by peatland type:

- Bog
- Fen
- Marsh

Remote sensing will be utilized (incorporating the learnings from the use of remote sensing in Objective 2), to evaluate historical impacts in the peatlands surrounding the pads prior to application of the reclamation treatment. This will be compared to conditions of the peatland after application of the reclamation treatment and over several years (if possible) to determine how the peatland changes due to the partial reclamation. Field measurements of water levels, quality and vegetation composition and cover of the surrounding peatland will also be taken and compared to an appropriate reference area to verify the presence or absence of impacts.

In addition to the treatments, the following field measurements will also be taken on pads with partial reclamation to determine where partial reclamation is successful:

- Pad size and shape
- Pad thickness and size
- Physical and chemical properties of the pad road material
- Length of time the pad road has been present
- Location of the pad road within the peatland and distance to edge of the peatland
- Peat depth
- Permeability of the substrate below the peat
- Peatland size
- Peatland heterogeneity
- Peatland water level and hydrology

Application

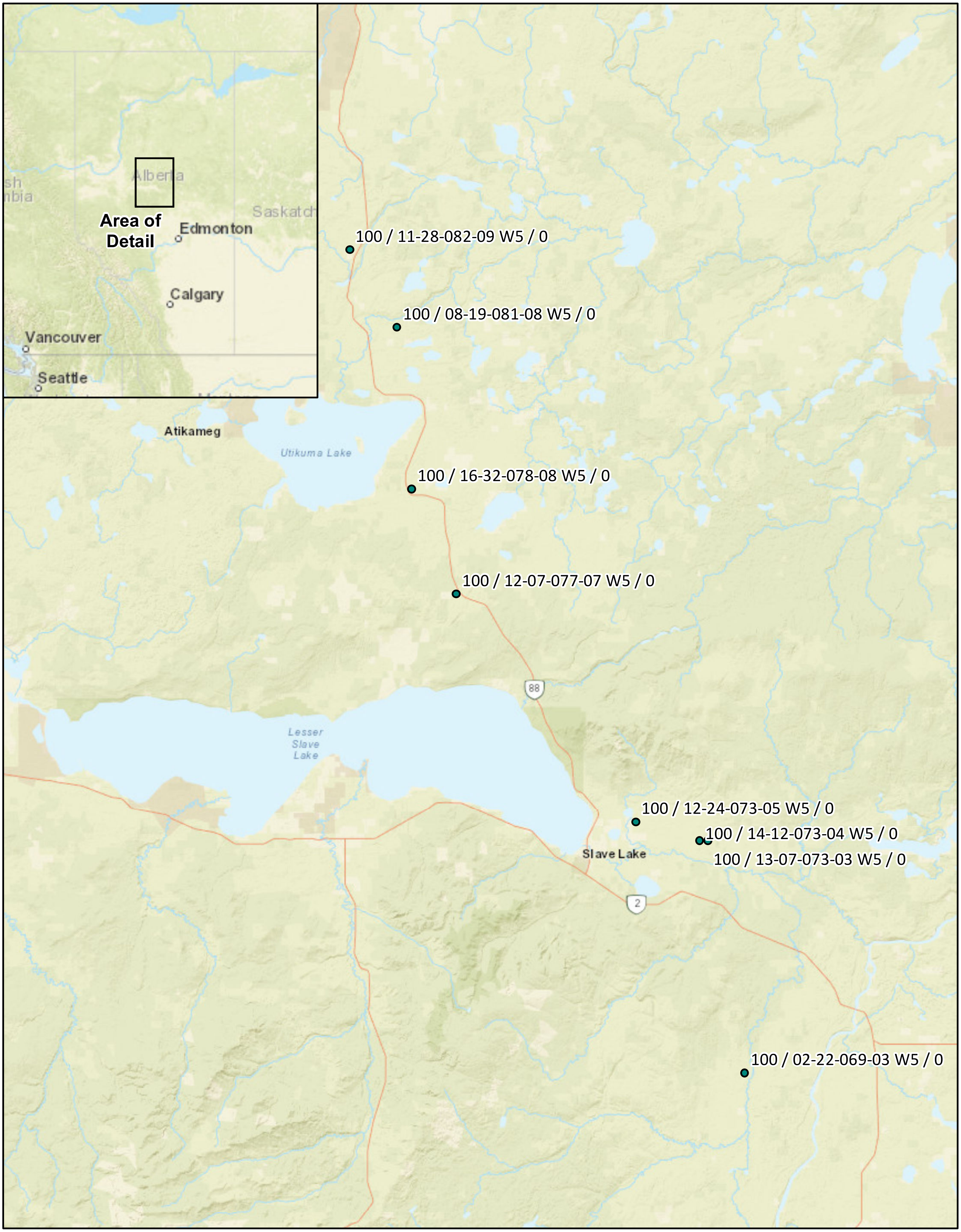
Results from this objective will be used to help determine when partial reclamation can be applied to alleviate off-site impacts.

APPENDIX C: DATA PREPERATION

To prepare the field data for data analysis:

- The mean of the three sample areas per stratification zone was calculated for use in statistical analysis and is shown on figures
- Select variables were excluded from analysis due to insufficient replication or lack of data (e.g., if a tree species was not present on a site, annual tree height growth could not be determined for that site)
- No sites were excluded from analysis despite outlying characteristics due to limited replication (e.g., 100 / 02-22-069-03 W5 / 0 was not excluded even though it may have been located in a transitional area and not a peatland); however, sites may be excluded in a large-scale study
- Tree height and age data were used to determine mean annual tree height growth (height divided by age). This calculation was used in the pilot study for simplicity, but in a large-scale study a standardized method such as site index should be used
- Data from the two understory vegetation plots at each sample area were averaged and the species cover data were used to calculate the Shannon Diversity Index. Shannon Diversity Index was calculated using all species as well as using only species native to the boreal forest ecosystem
- The total number of native species present on the site (wellsite and access road) was determined by counting number of entries in the list of species generated during the 10-minute walkaround
- Uniformity of the pad texture was rated as uniform (entire depth profile had a similar texture) or variable (two or more layers with different textures)
- Organic matter presence in the profile (excluding the litter layer) was rated as present or absent
- Changes in pad material colour (gleying or mottling) were used to determine a depth to anoxic conditions
- Percent sand, silt and clay were analyzed rather than soil texture categories (e.g., loam, clay loam)
- A numerical rating system was applied to categorical data (e.g., texture, consistence, structure)
- For sample areas where soil samples were collected from 0-15 and 15-30 cm depth intervals, an average of these two depths was calculated to allow comparison to other sample areas where only a 0-30 cm depth interval sample was collected.

APPENDIX D: MAPS



Site Locations

MAP: **1**

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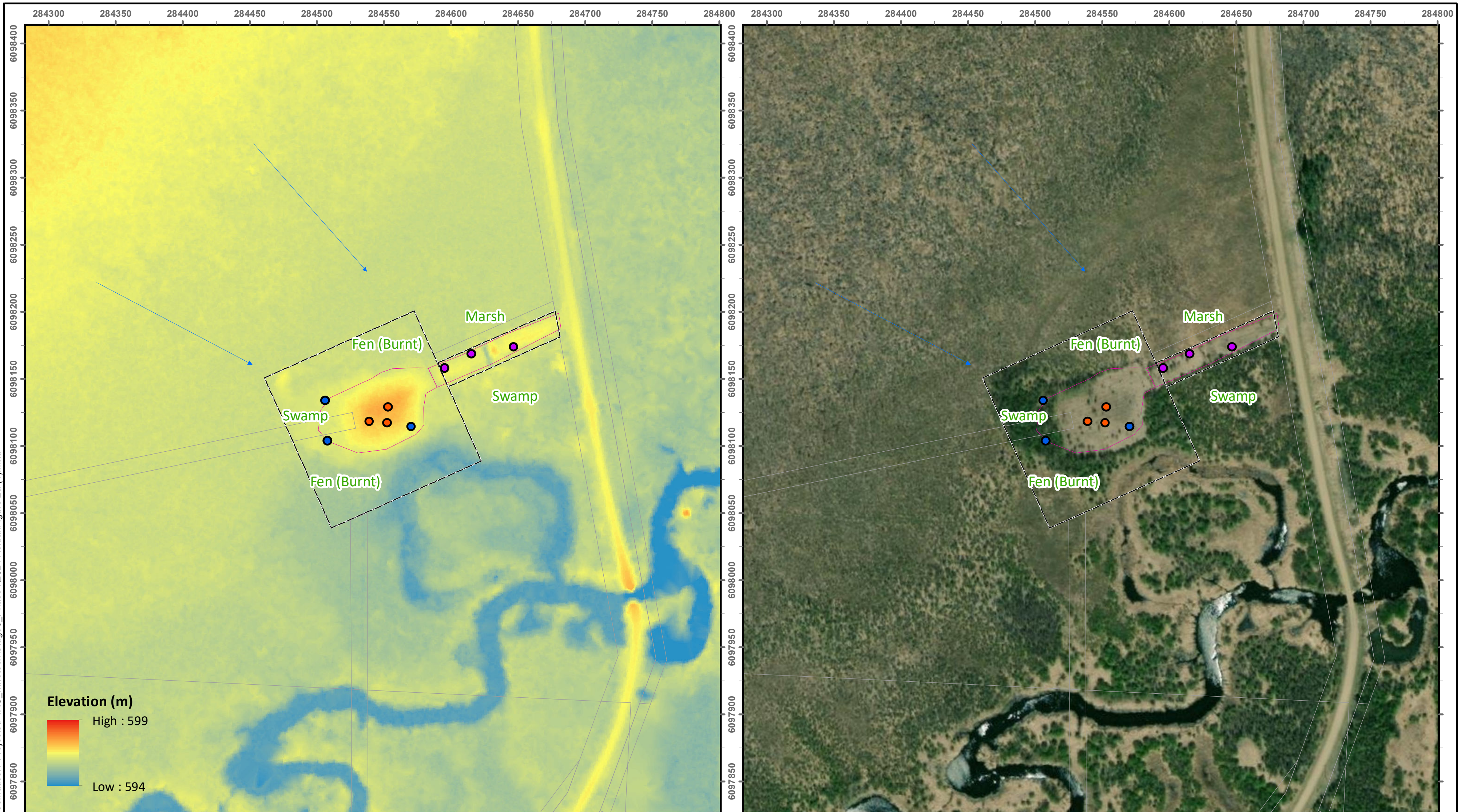


- Access Road Sample Area
- Pad Centre Sample Area
- Pad Periphery Sample Area
- Water Flow
- Surveyed Site Boundary
- Pad
- Disposition

0 12.5 25 50 75 100 125 m

NAD 1983 UTM Zone 12N

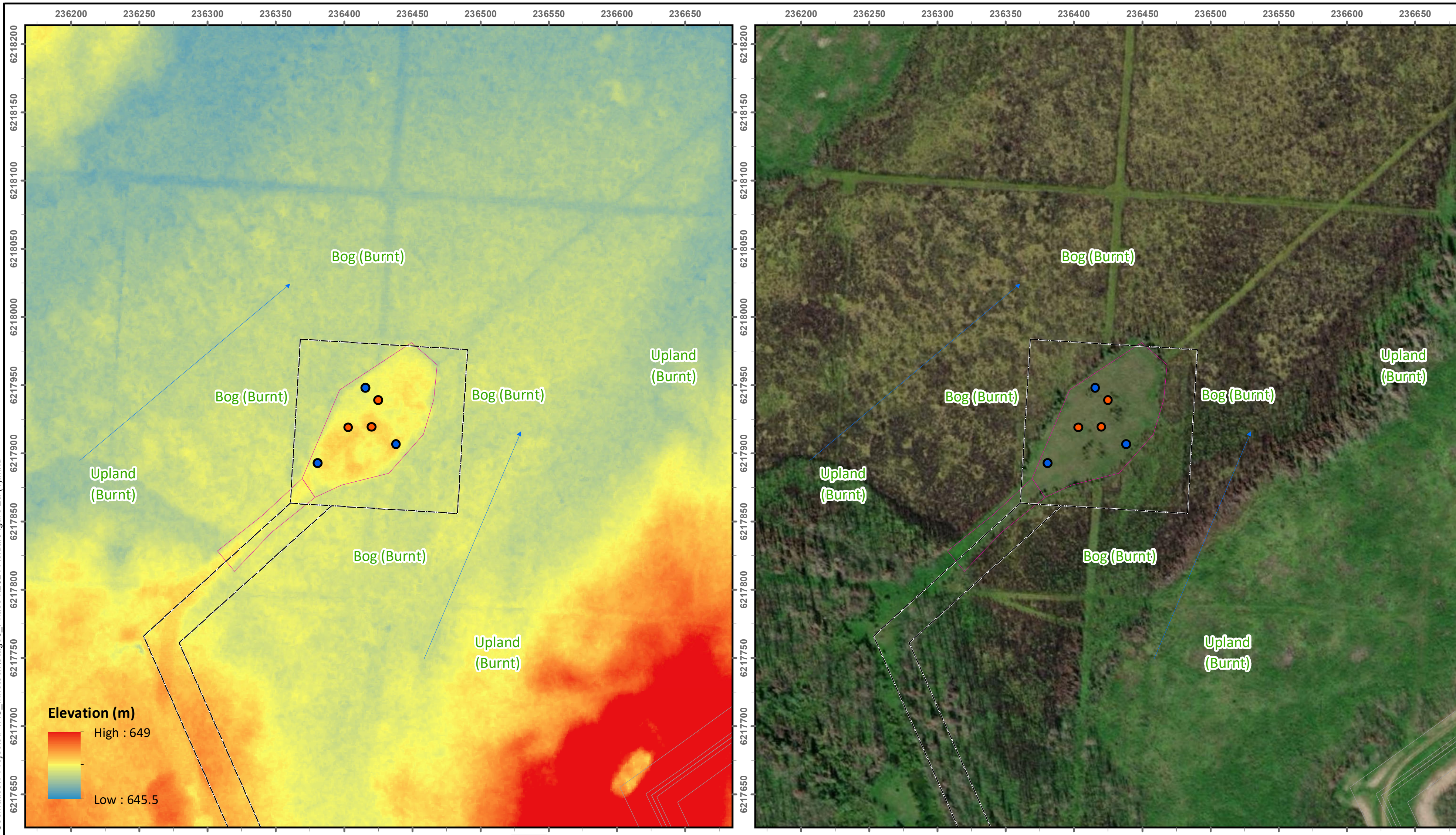
Date: Mar 17/22

N

100 / 02-22-069-03 W5 / 0
Digital Elevation Model and Aerial Imagery

MAP: **2a**

Note:



- Access Road Sample Area
- Pad Centre Sample Area
- Pad Periphery Sample Area
- Water Flow
- Surveyed Site Boundary
- Pad
- Disposition

0 12.5 25 50 75 100 125 m

NAD 1983 UTM Zone 12N

Date: Mar 17/22

N

100 / 08-19-081-08 W5 / 0
Digital Elevation Model and Aerial Imagery

MAP: **2b**

Note:

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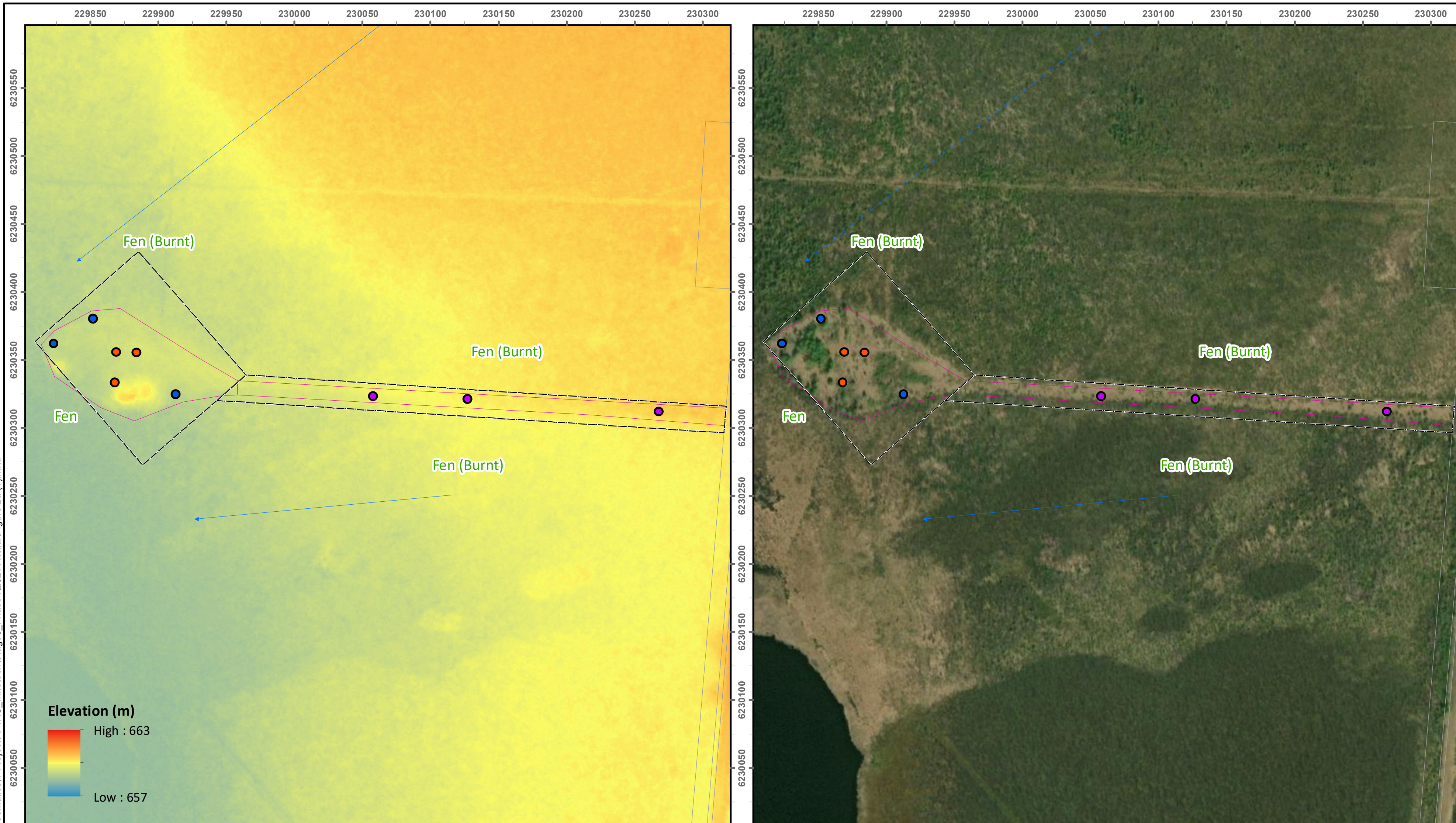

- Access Road Sample Area
- Pad Centre Sample Area
- Pad Periphery Sample Area
- Water Flow
- Surveyed Site Boundary
- Pad
- Disposition

0 12.525 50 75 100 125 m

NAD 1983 UTM Zone 12N

Date: Mar 17/22

N

100 / 11-28-082-09 W5 / 0
Digital Elevation Model and Aerial Imagery

MAP:

2c

Note:

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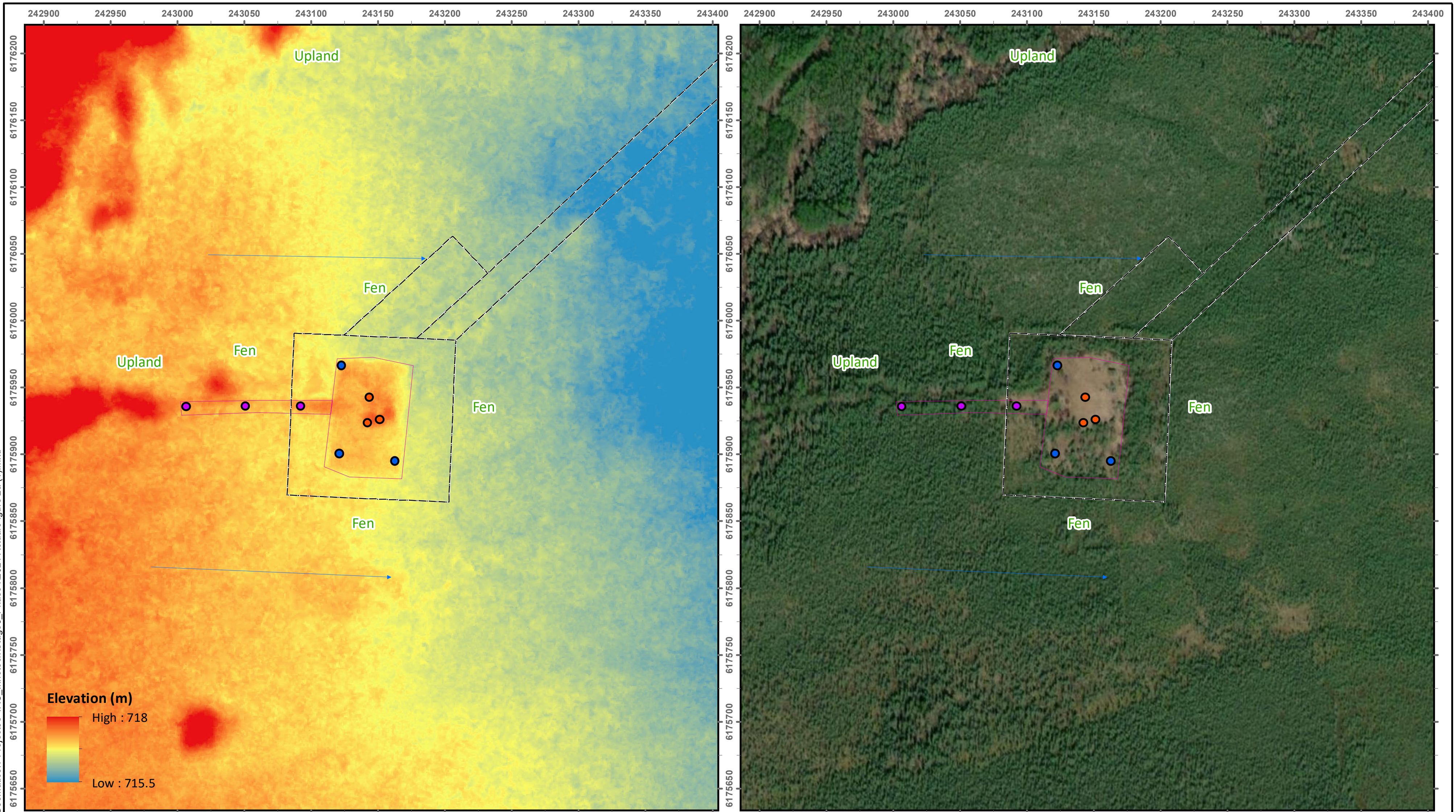

Access Road Sample Area

Pad Centre Sample Area

Pad Periphery Sample Area

Water Flow

Surveyed Site Boundary

Pad

Disposition

0 12.525 50 75 100 125 m

NAD 1983 UTM Zone 12N

Date: Mar 17/22

N

100 / 12-07-077-07 W5 / 0
Digital Elevation Model and Aerial Imagery

MAP: **2d**

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Note:

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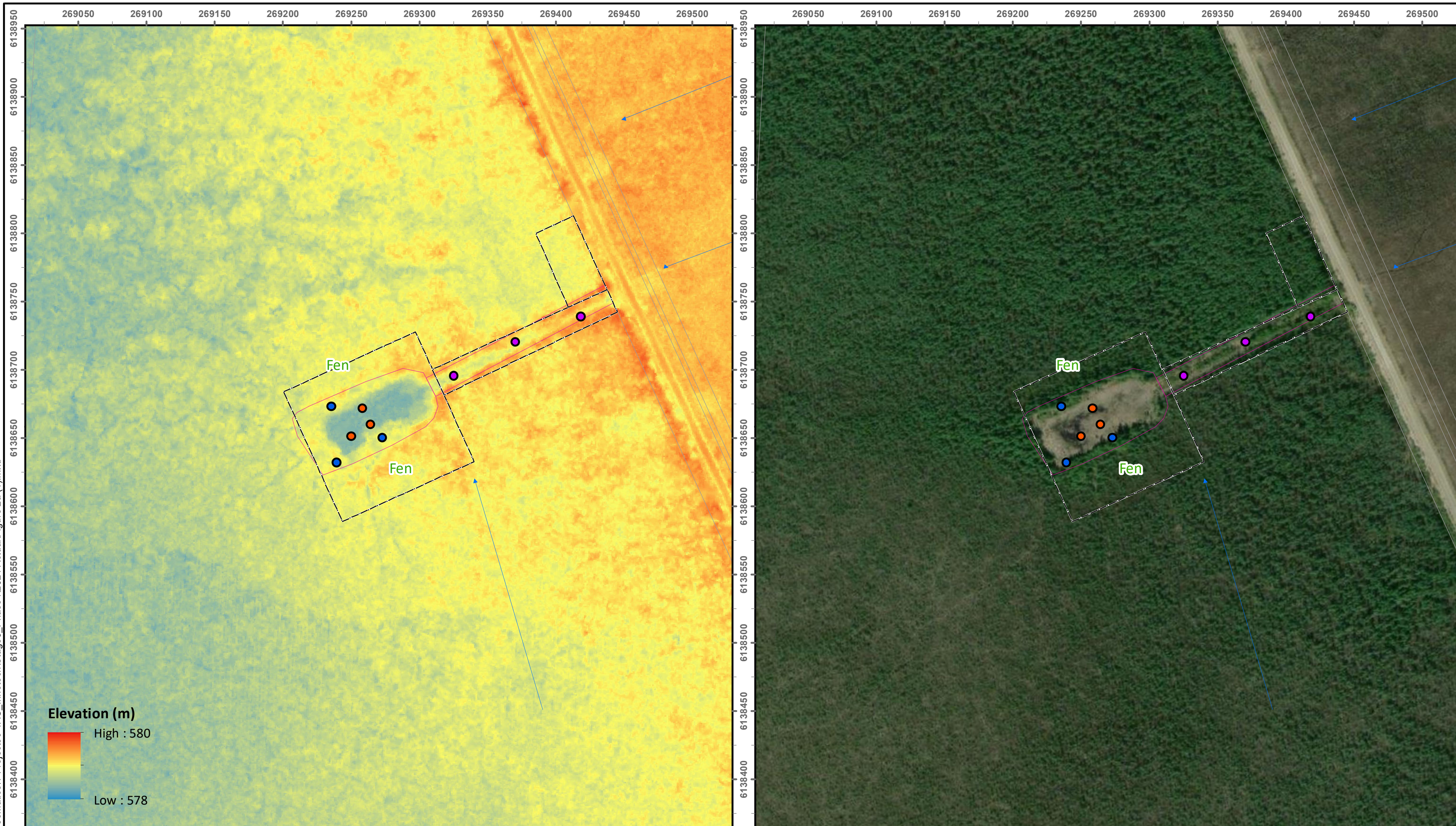

- Access Road Sample Area
- Pad Centre Sample Area
- Pad Periphery Sample Area
- Water Flow
- Surveyed Site Boundary
- Pad
- Disposition

0 12.525 50 75 100 125 m

NAD 1983 UTM Zone 12N

Date: Mar 17/22

N

100 / 12-24-073-05 W5 / 0
Digital Elevation Model and Aerial Imagery

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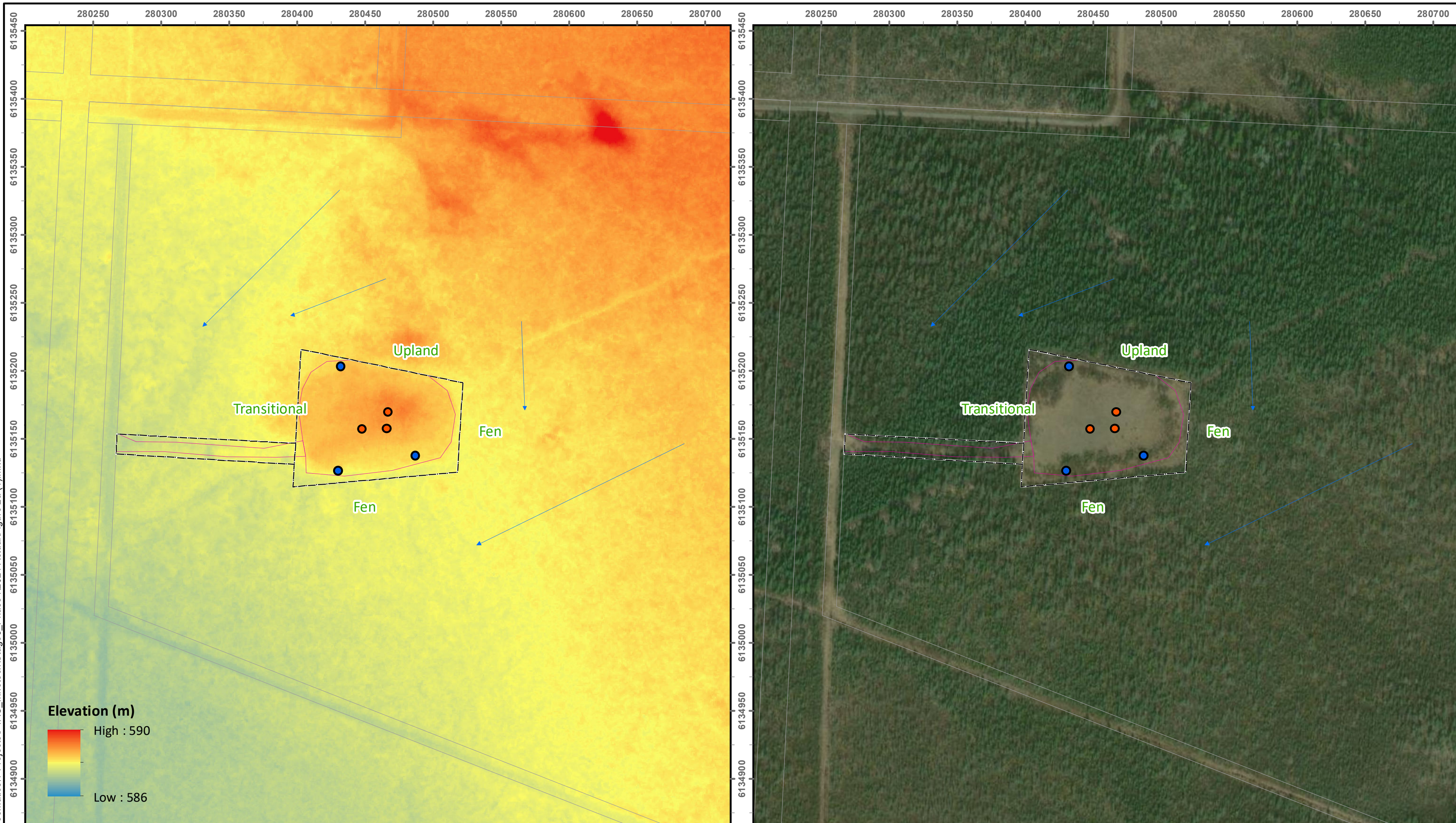
Note:



Access Road Sample Area

Pad Centre Sample Area

Pad Periphery Sample Area

Water Flow

Surveyed Site Boundary

Pad

Disposition

0 12.525 50 75 100 125 m

NAD 1983 UTM Zone 12N

Date: Mar 17/22

N

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Digital Elevation Model and Aerial Imagery

MAP:

2f

Note:

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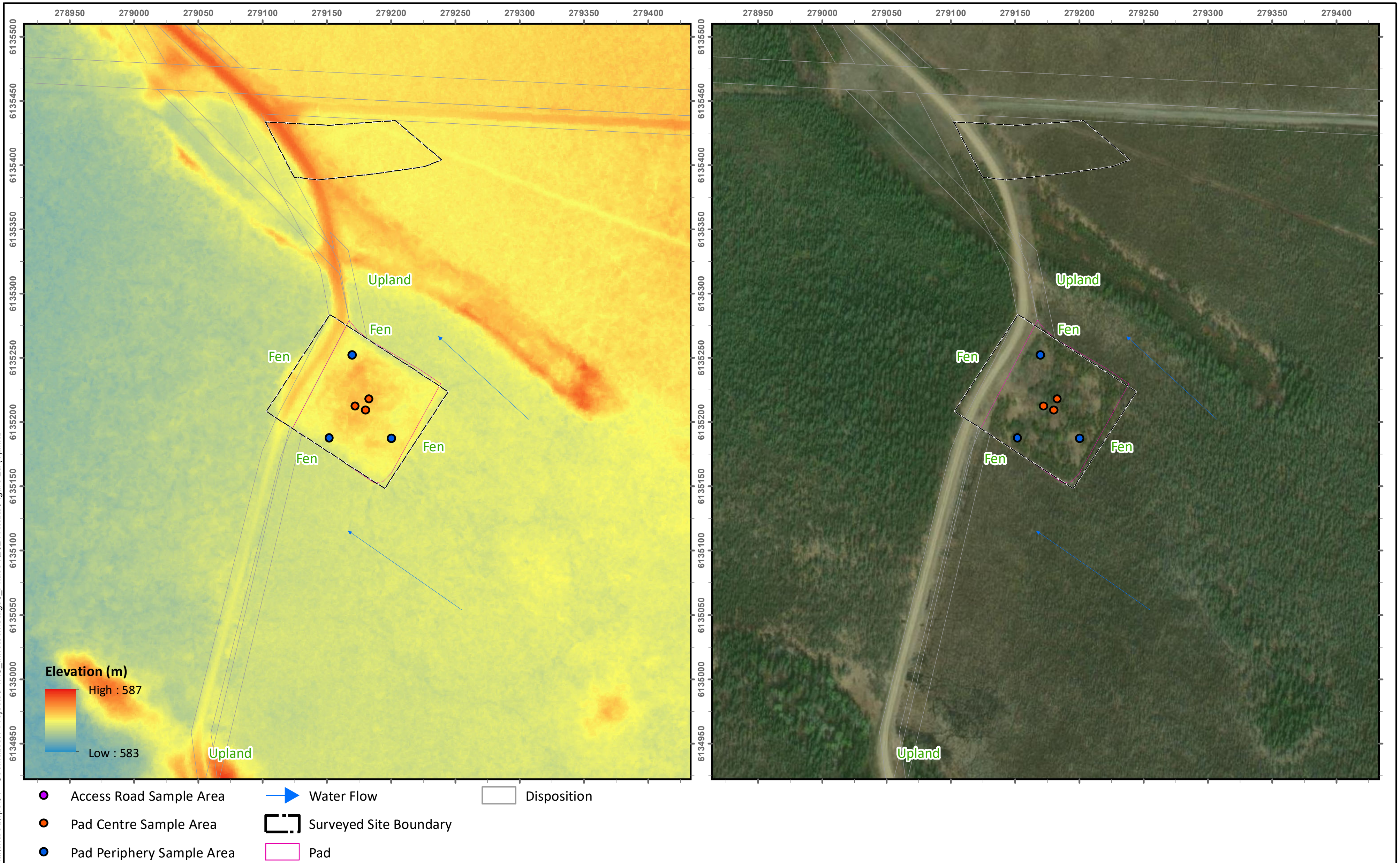

0 12.525 50 75 100 125 m

NAD 1983 UTM Zone 12N
Date: Mar 17/22

N

100 / 14-12-073-04 W5 / 0
Digital Elevation Model and Aerial Imagery

MAP: **2g**

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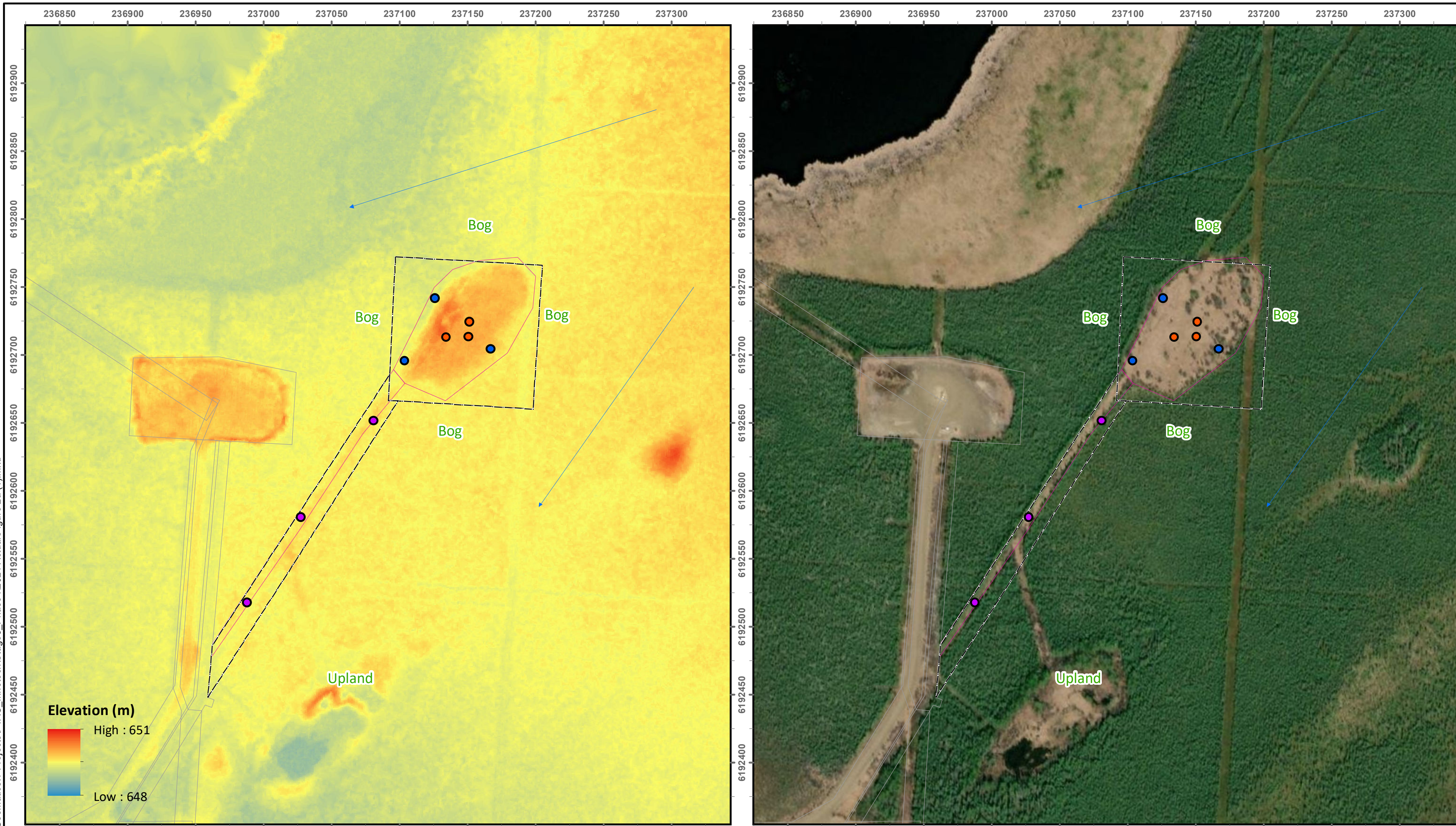

- Access Road Sample Area
- Pad Centre Sample Area
- Pad Periphery Sample Area
- Water Flow
- Surveyed Site Boundary
- Pad
- Disposition

0 12.525 50 75 100 125 m

NAD 1983 UTM Zone 12N

Date: Mar 17/22

N

100 / 16-32-078-08 W5 / 0
Digital Elevation Model and Aerial Imagery

MAP:

2h

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Note:

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APPENDIX E: FIGURES

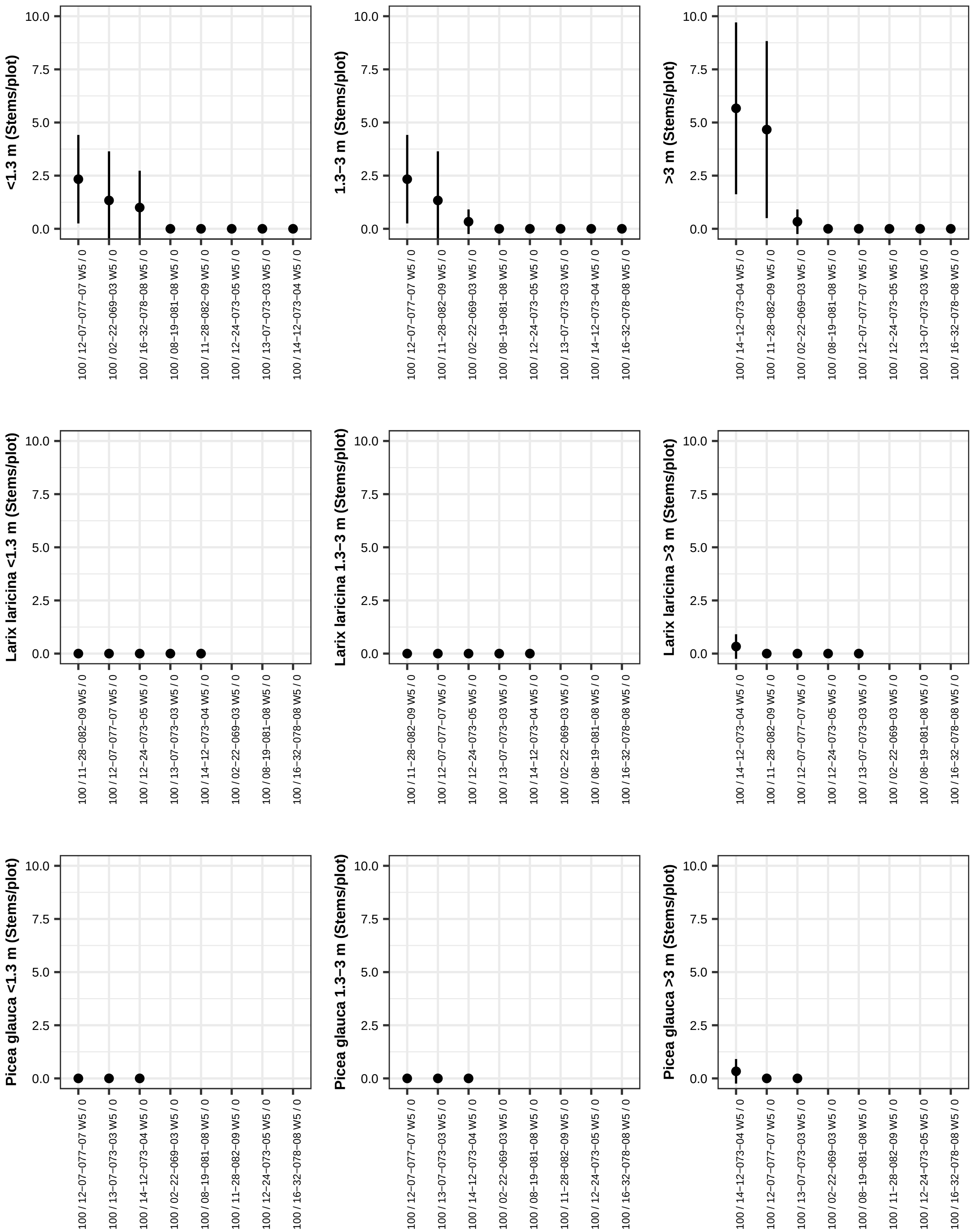


Figure 1a: Tree Stem Density in a 10 m^2 Plot by Species (including all species combined), Height Class, and Site. Error Bars Represent Standard Deviation of the Pad Centre Plots.

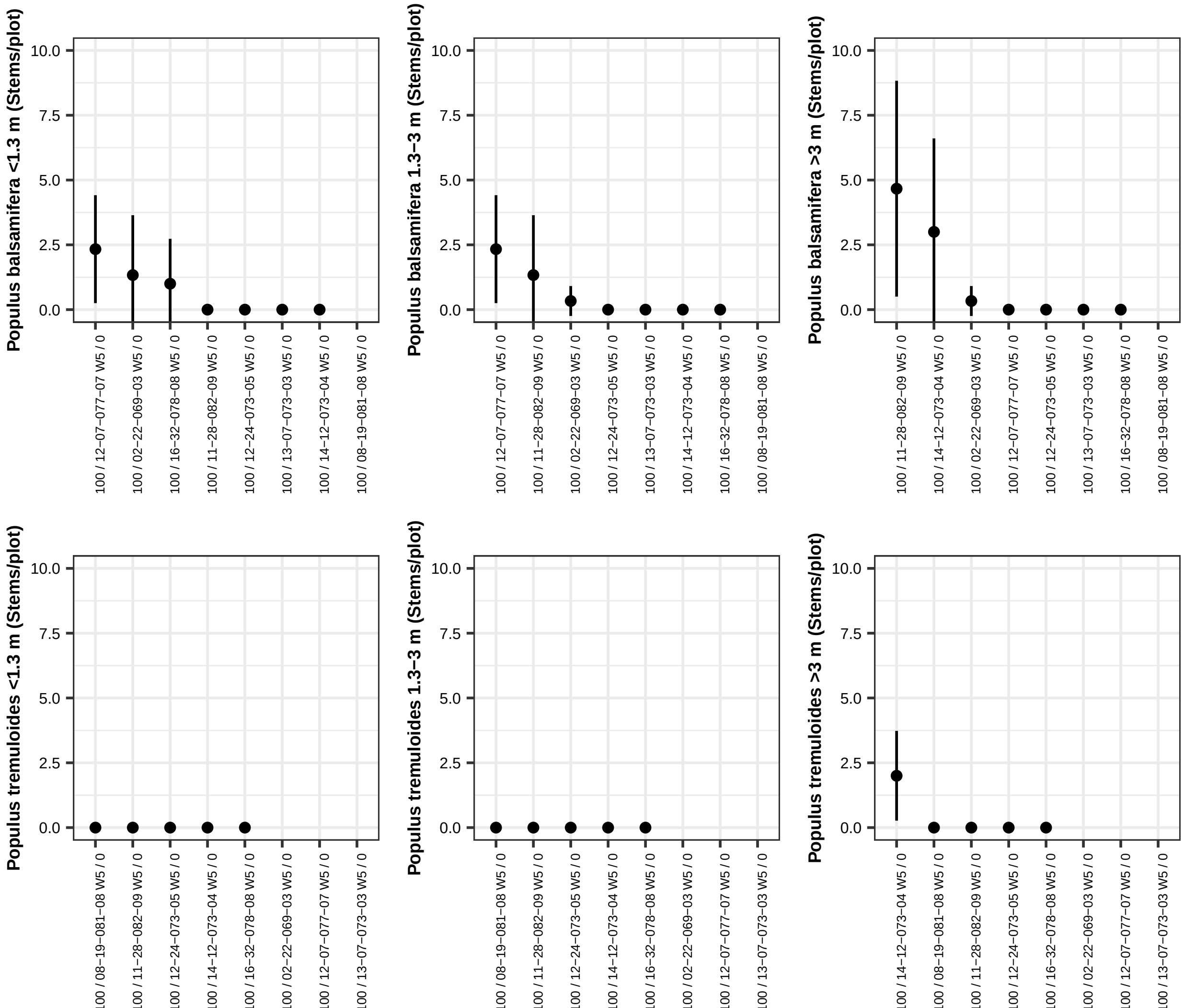


Figure 1a: Tree Stem Density in a 10 m^2 Plot by Species (including all species combined), Height Class, and Site. Error Bars Represent Standard Deviation of the Pad Centre Plots.

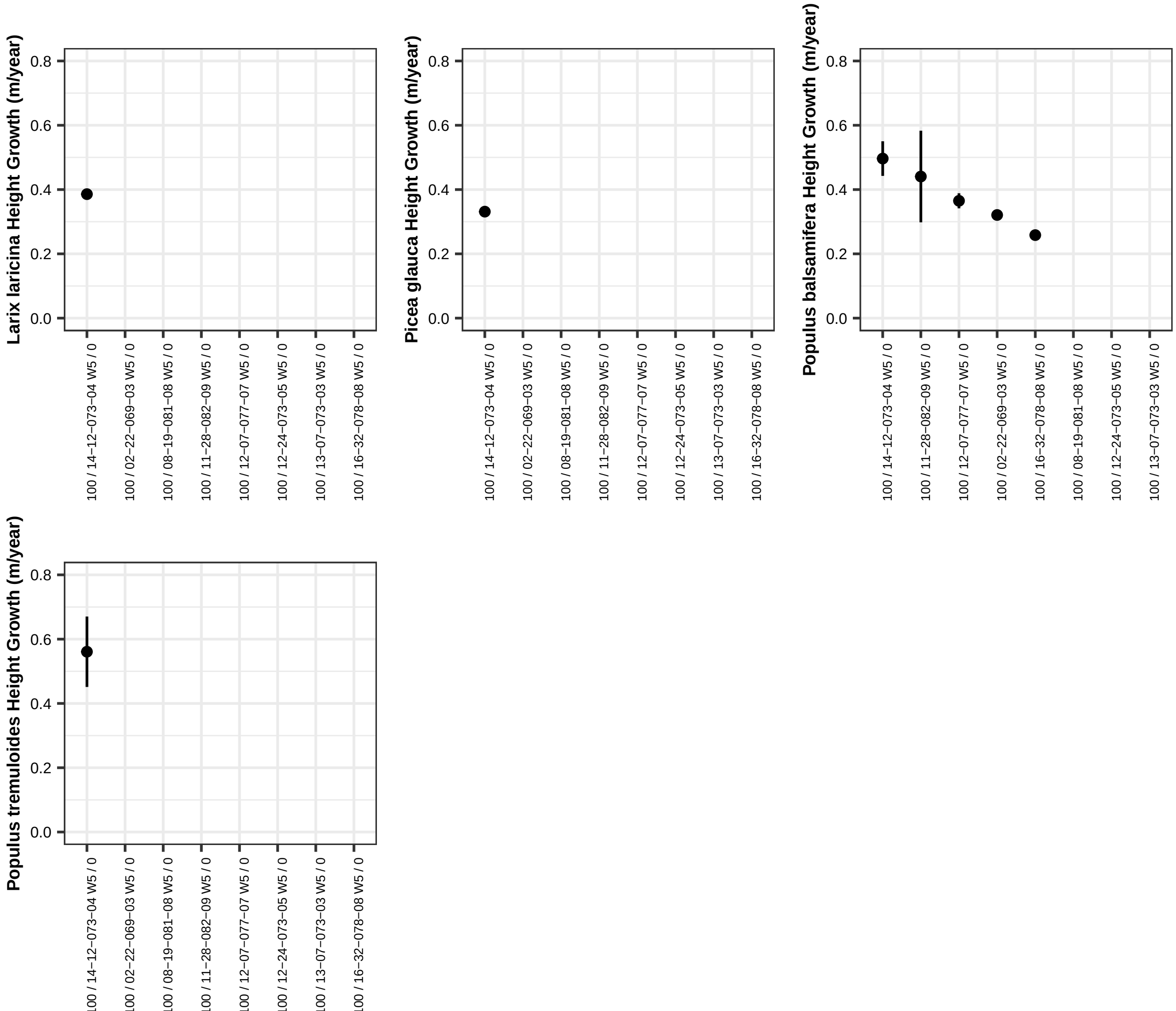


Figure 1b: Annual Tree Height Growth by Species and Site. Error Bars Represent Standard Deviation of the Pad Centre Plots.

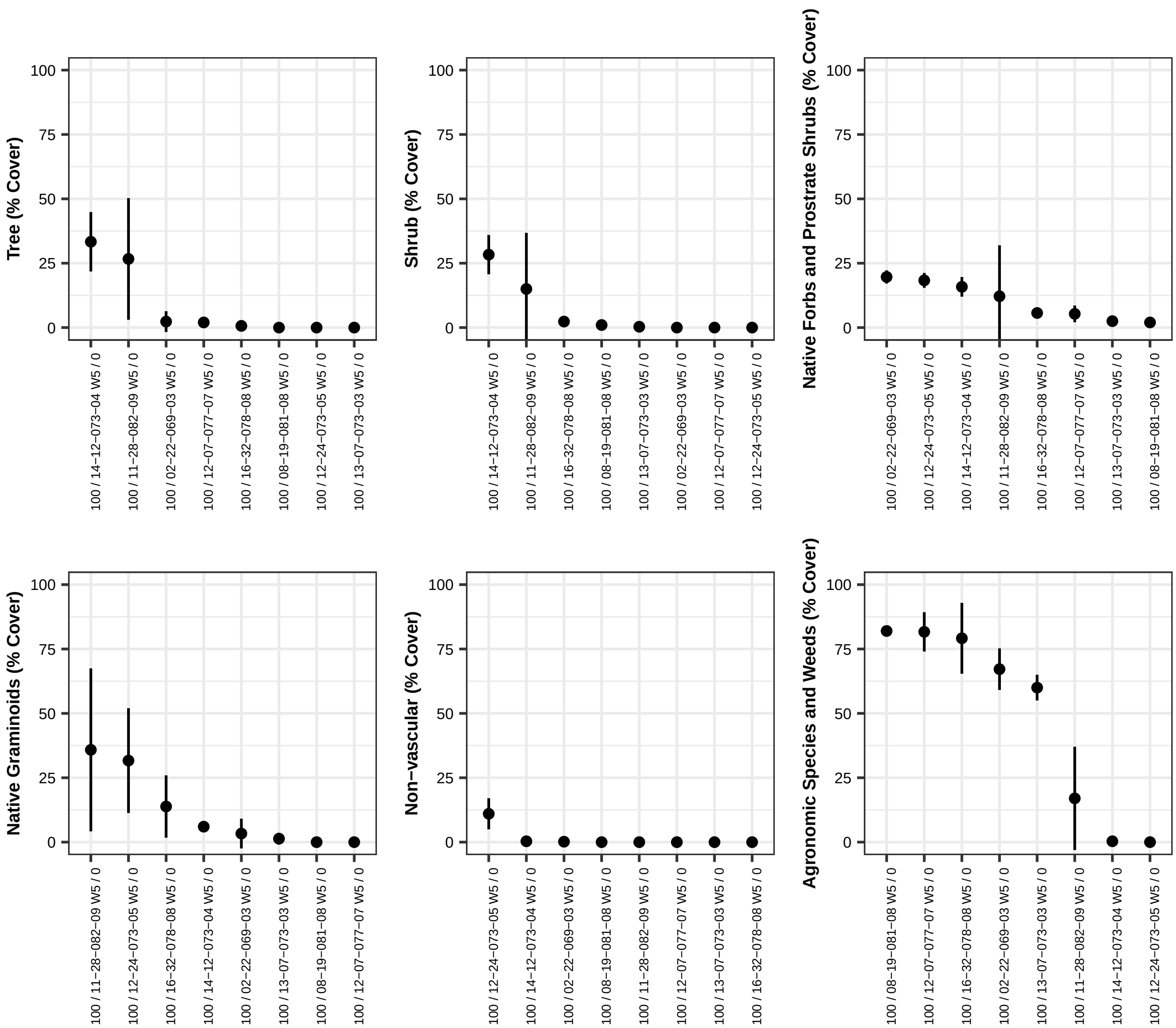


Figure 1c: Percent Canopy Cover by Vegetation Strata and Site. Error Bars Represent Standard Deviation of the Pad Centre Plots.

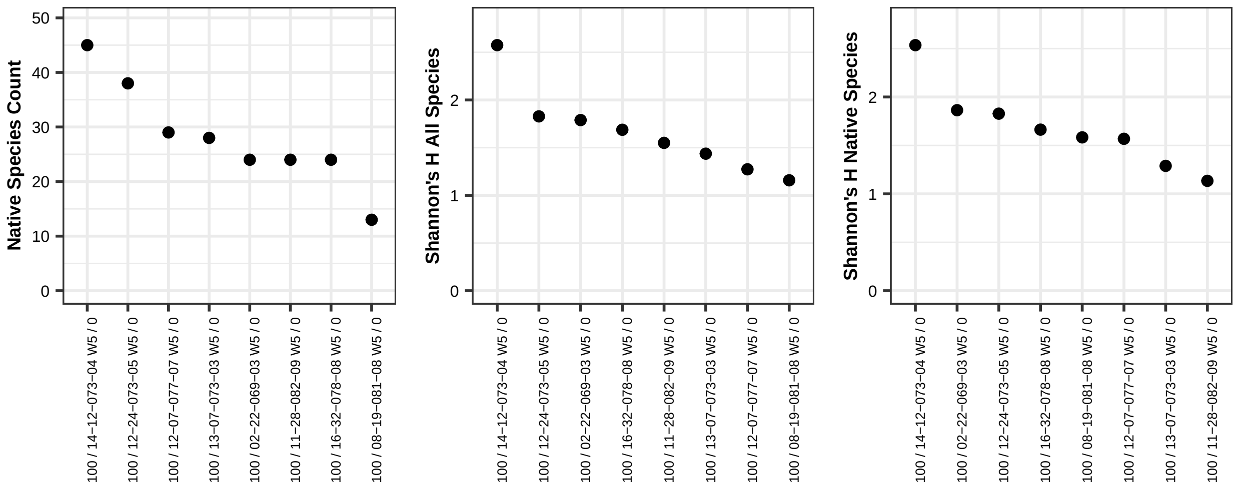


Figure 1d: Species Counts and Shannon Diversity Index by Site.

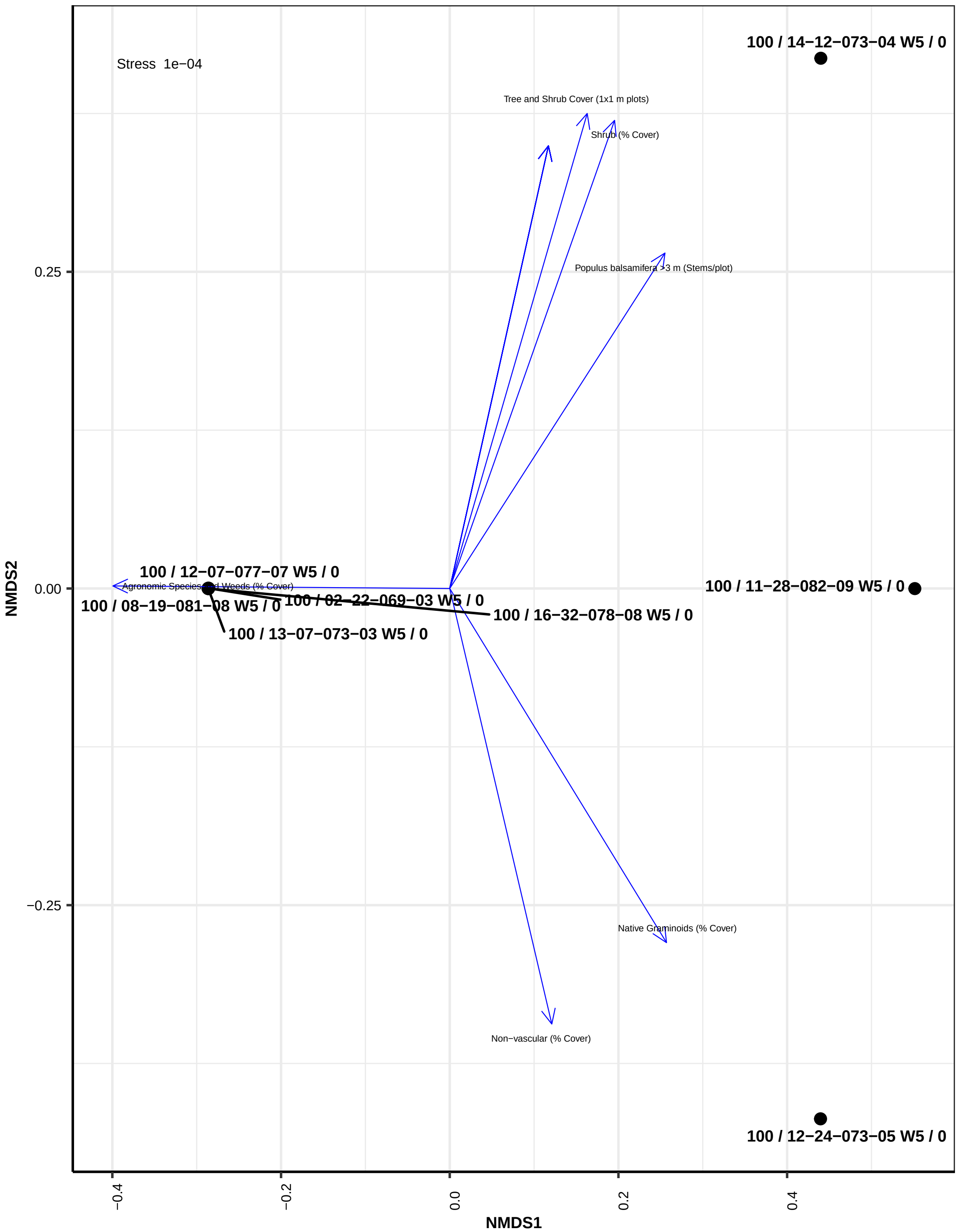


Figure 2: Non-metric Multidimensional Scaling of Vegetation Characteristics by Site. Measurements with a Coefficient of Determination Value (R^2) Greater than 0.6 are Shown as Vectors - the Measurement Increases in the Direction of the Vector.

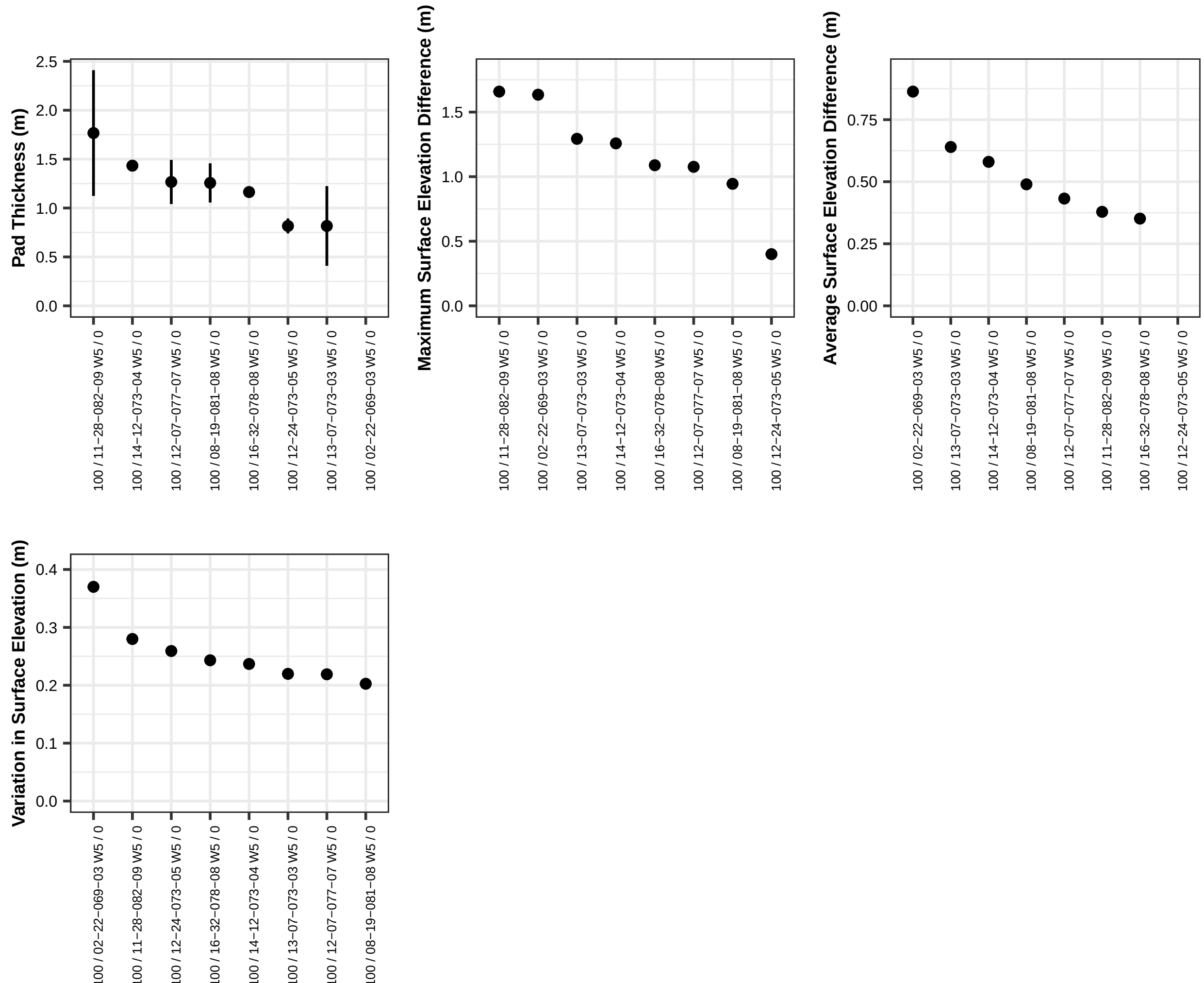


Figure 3a: Pad Centre Thickness and Elevation Characteristics. Error Bars Represent Standard Deviation of the Pad Centre Plots. Pad Thickness was not Characterized at 100/02−22−069−03 W5 / 0. Surface Elevation Difference is Between the Pad and Surrounding Peatland.

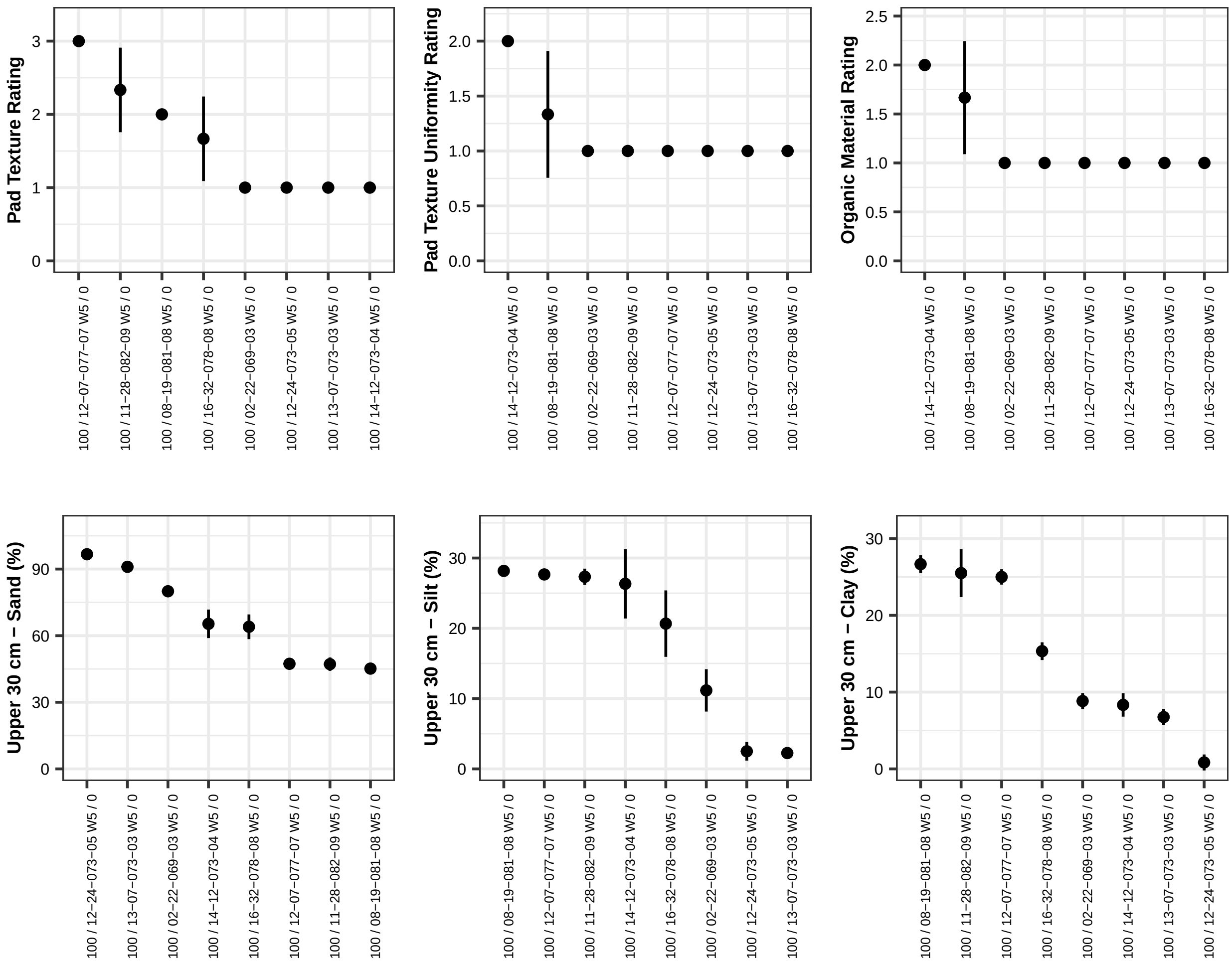


Figure 3b: Texture Characteristics, as Ratings, at Pad Centre for the Entire Pad Thickness and Upper 30 cm. Error Bars Represent Standard Deviation of the Pad Centre Plots. Soil Texture Rating (1=Coarse, 3 = Fine); Soil Texture Uniformity Rating (1=Uniform, 2=Variable); Organic Material Rating (1=Absent, 2=Present).

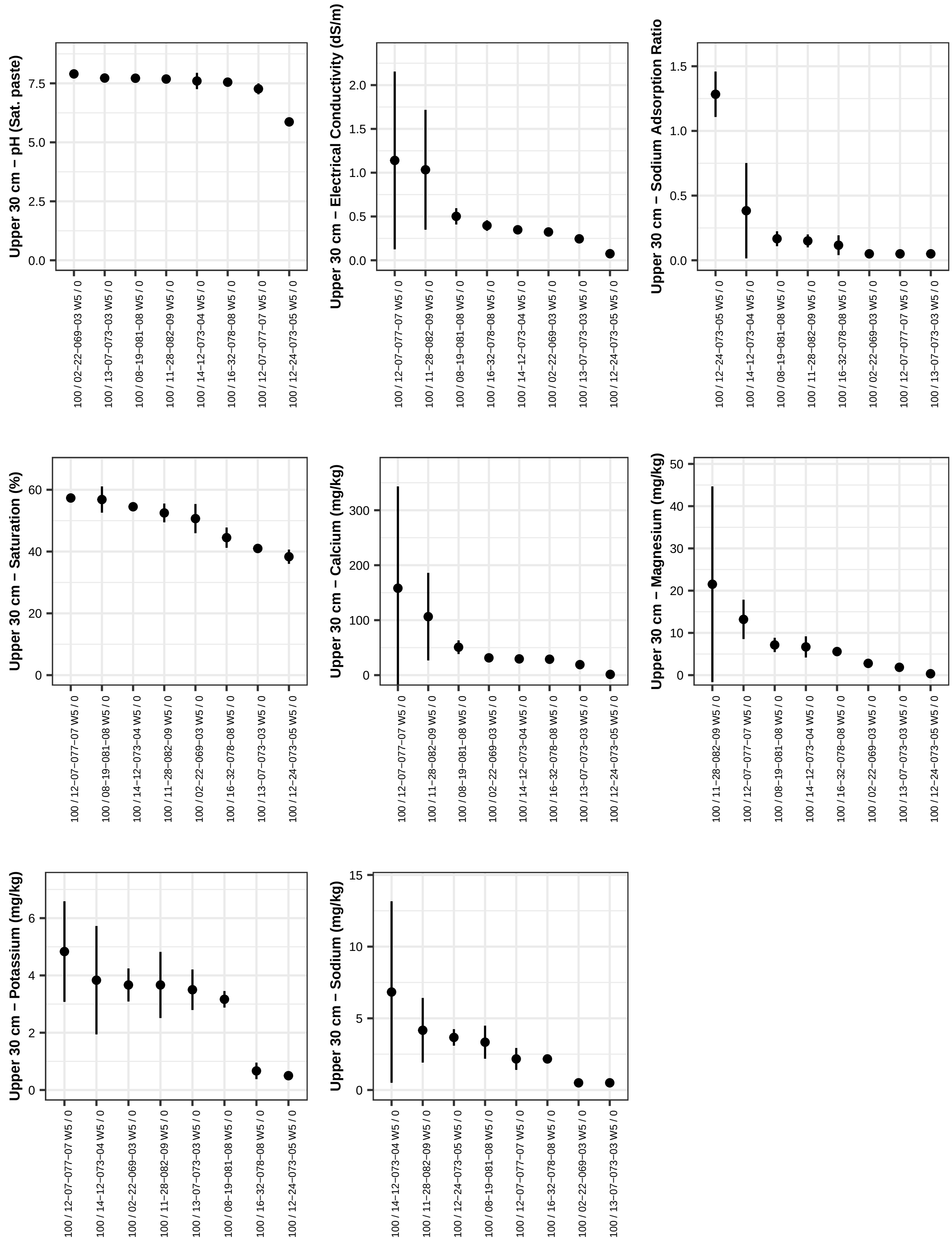


Figure 3c: Chemical Properties of the Upper 30 cm of Pad Material at Pad Centre. Error Bars Represent Standard Deviation of the Pad Centre Plots.

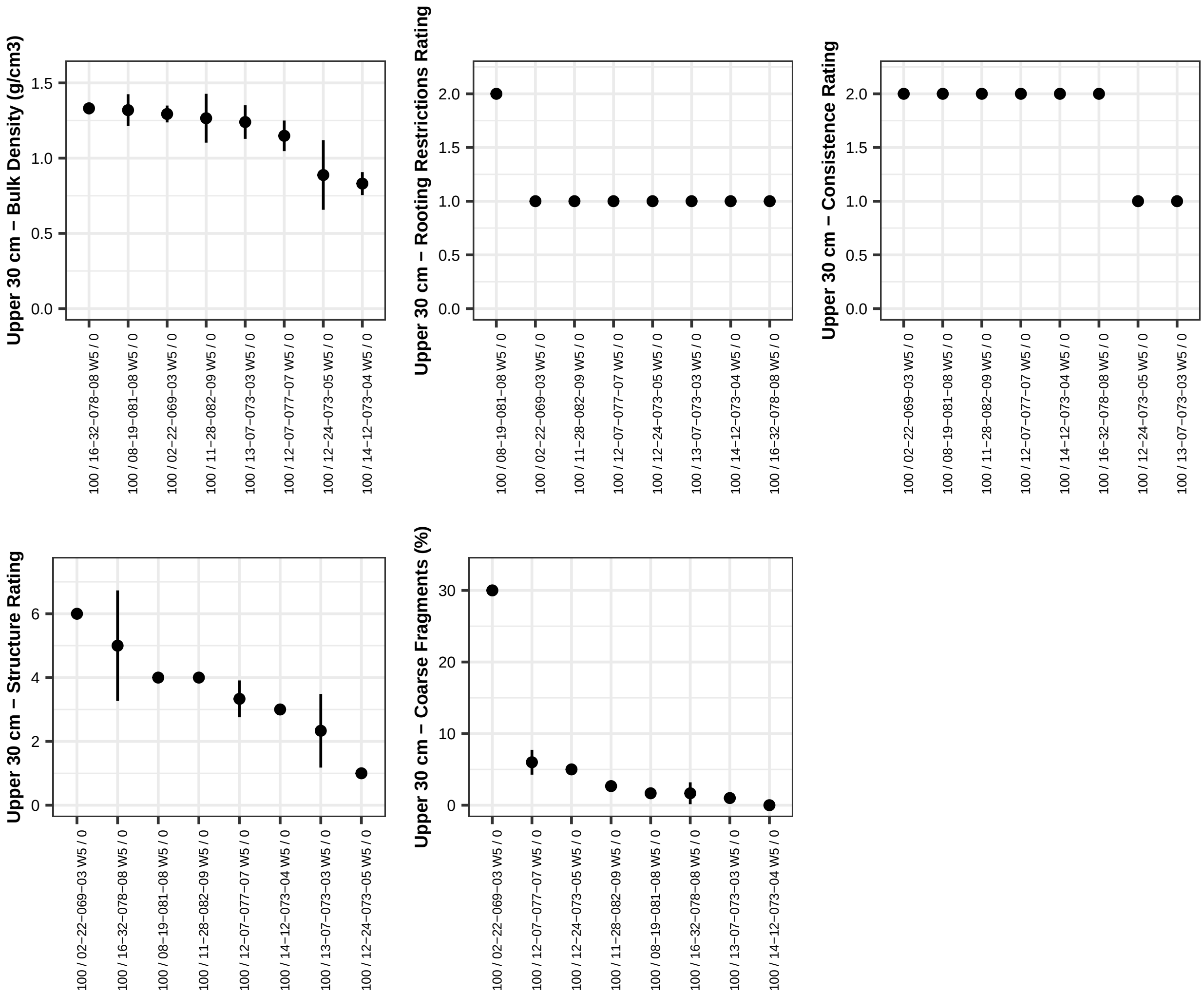


Figure 3d: Physical Properties of the Upper 30 cm of Pad Material at Pad Centre. Error Bars Represent Standard Deviation of the Pad Centre Plots. Rooting Restrictions Rating (1=None, 2=Slight); Consistence Rating (1=Loose, 2=Friable, 3=Firm); Structure Rating (1=Single Grain, 2=Medium Subangular Blocky, 3=Coarse Subangular Blocky, 4=Coarse Angular Blocky, 5=Platy, 6=Massive).

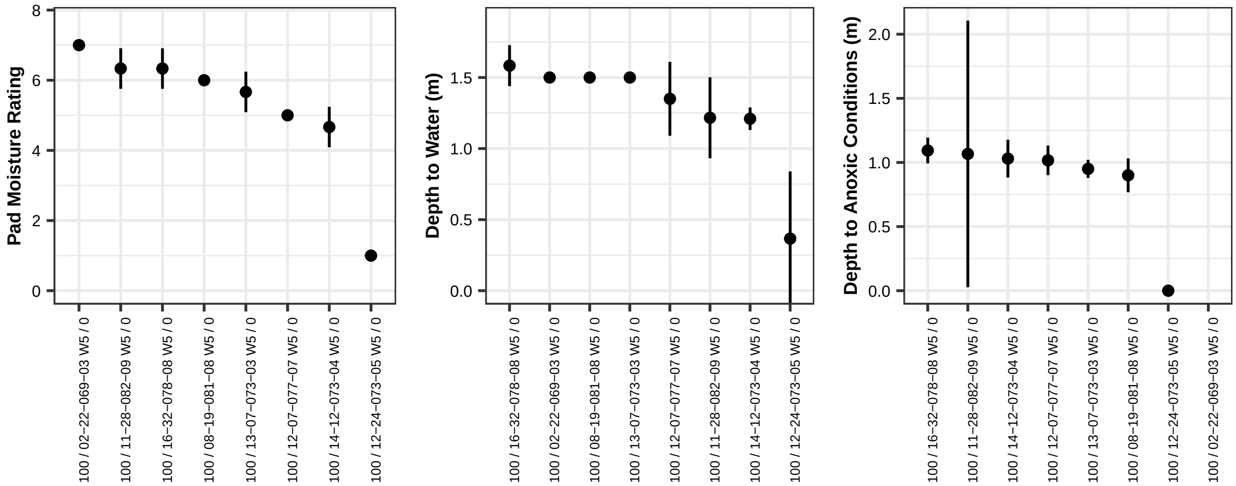


Figure 3e: Moisture Properties at Pad Centre. Error Bars Represent Standard Deviation of the Pad Centre Plots. Pad Moisture Rating (1=Saturated, 7=Dry).

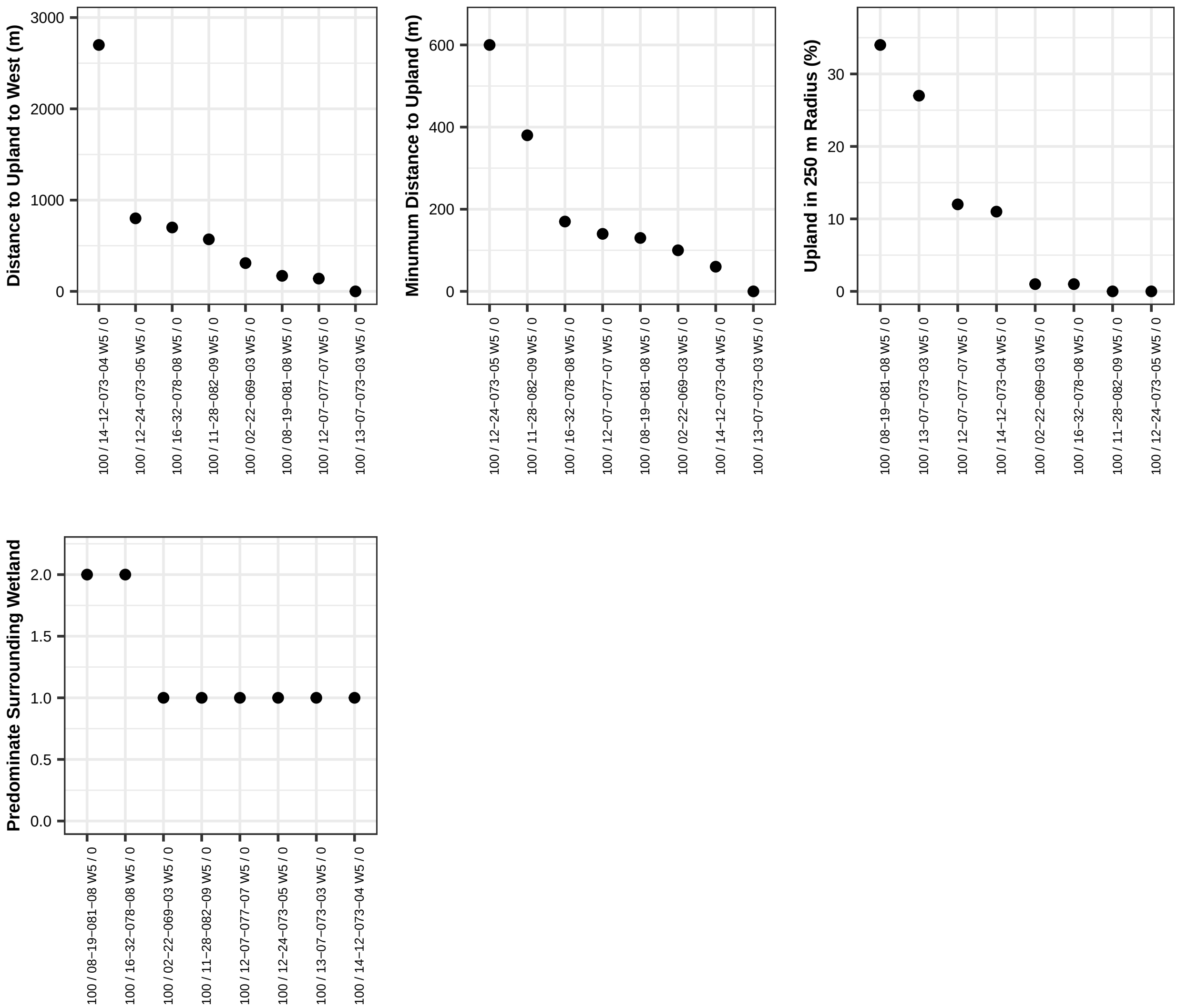


Figure 3f: Characteristics of the Surrounding Area. Wetland Type (1=Fen, 2=Bog).

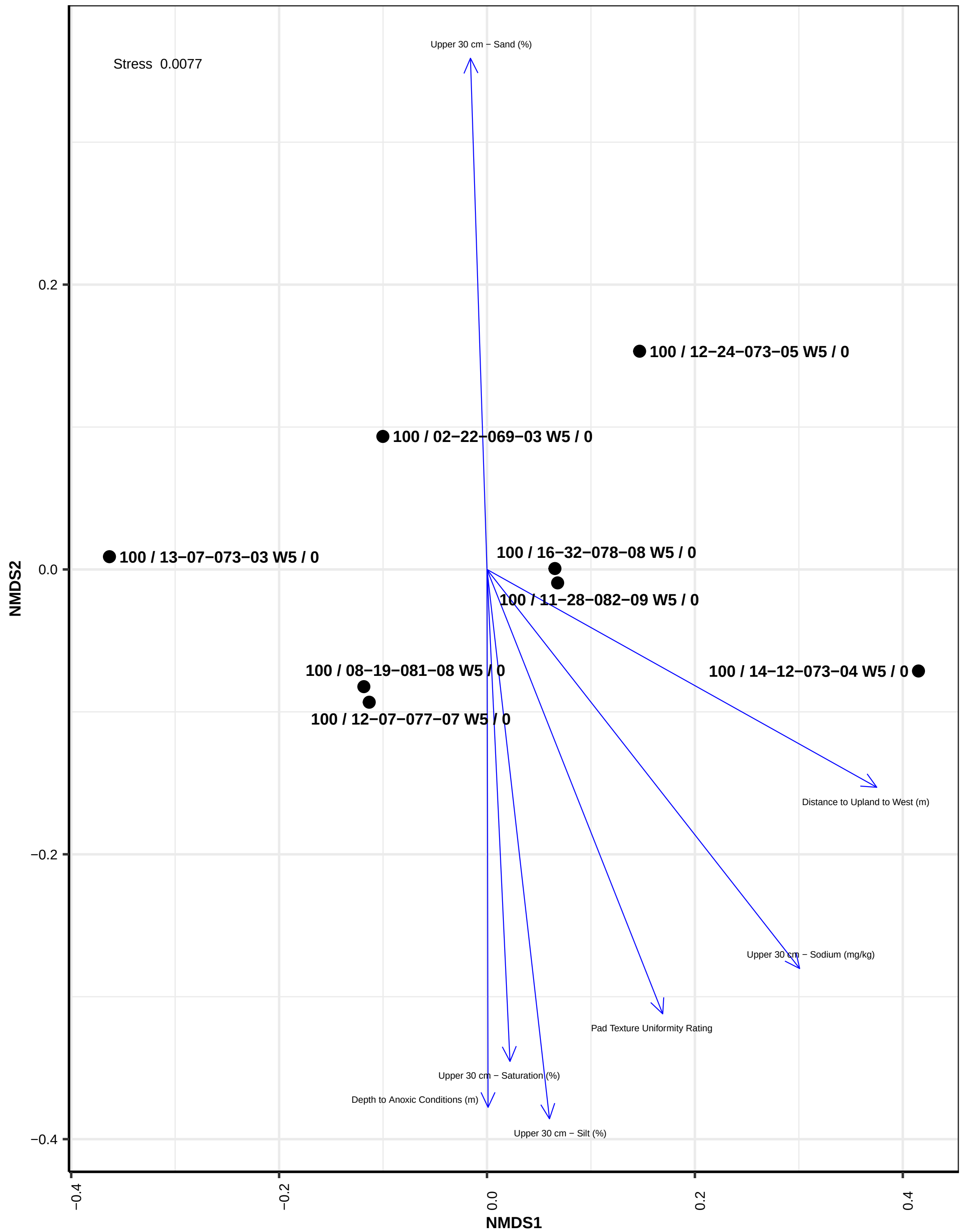


Figure 4: Non−metric Multidimensional Scaling of Pad Characteristics by Site. Measurements with a Coefficient of Determination Value (R2) Greater than 0.6 are Shown as Vectors − the Measurement Increases in the Direction of the Vector.

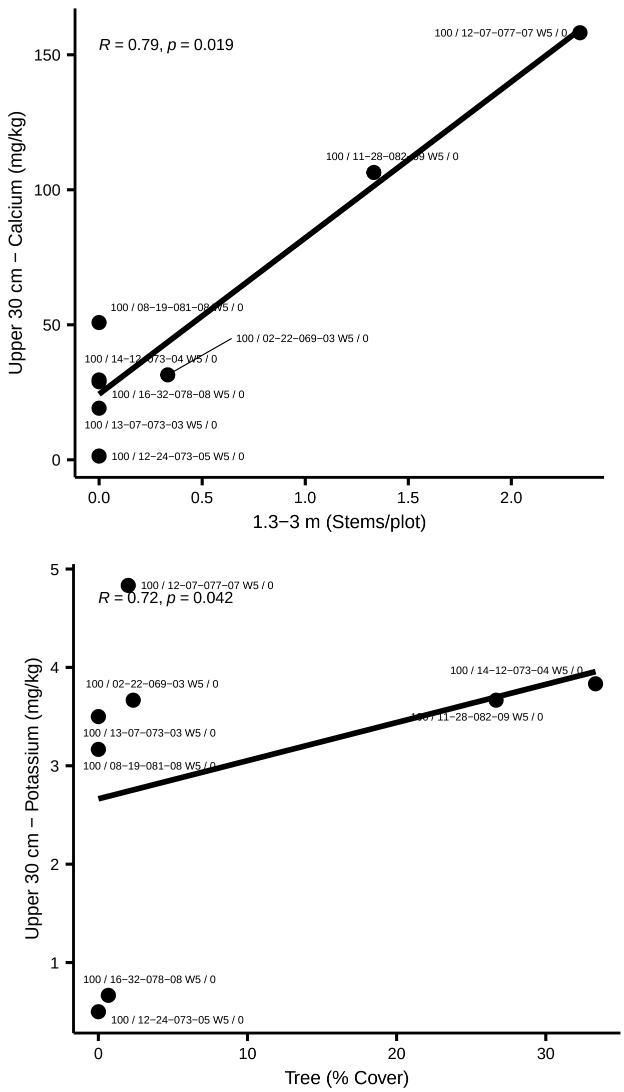


Figure 5a: Spearman Rank Correlation between Pad Chemical Characteristics of the Upper 30 cm of Pad Material and Vegetation.

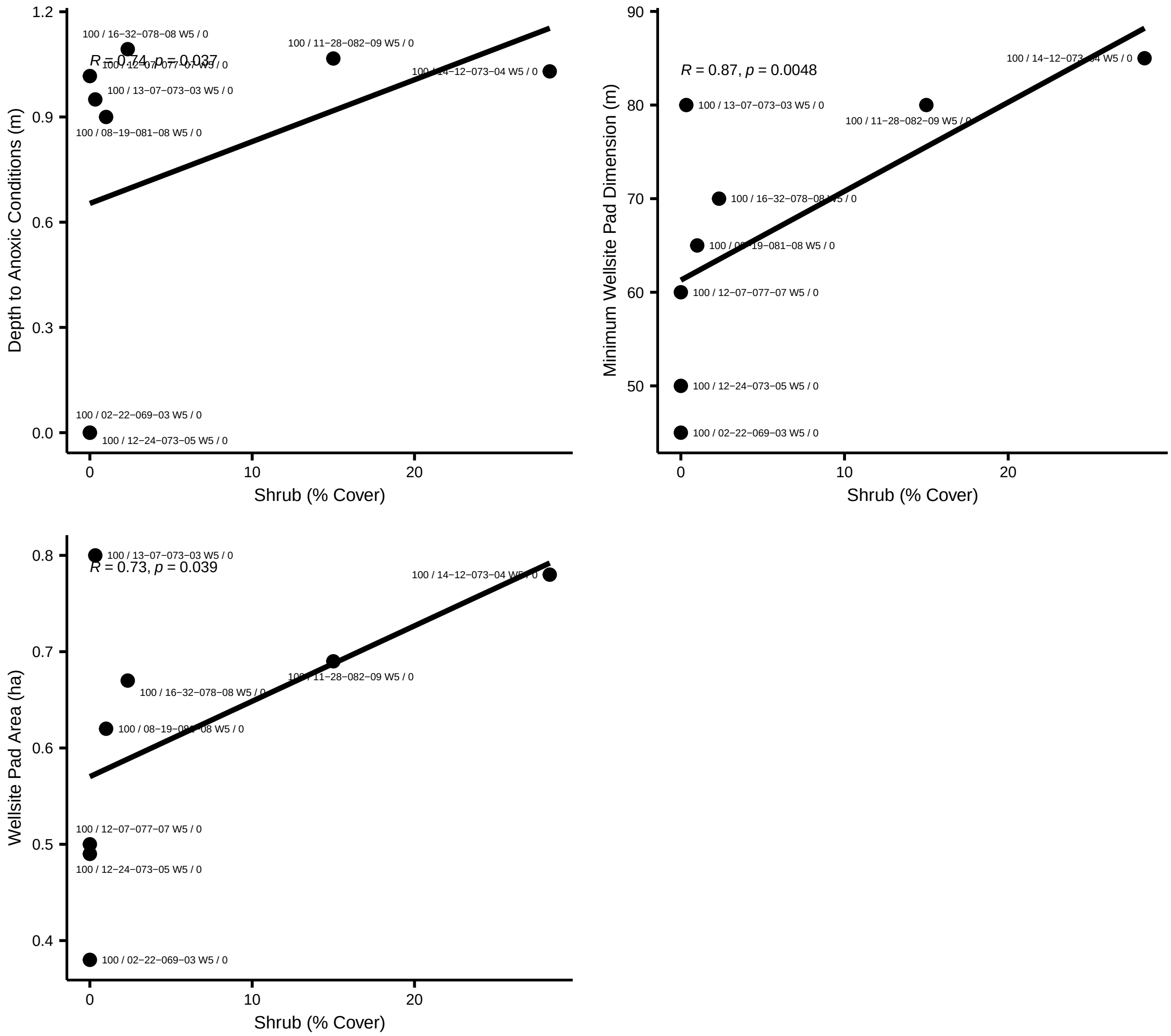


Figure 5b: Spearman Rank Correlation between Pad Moisture and Size Characteristics and Vegetation.

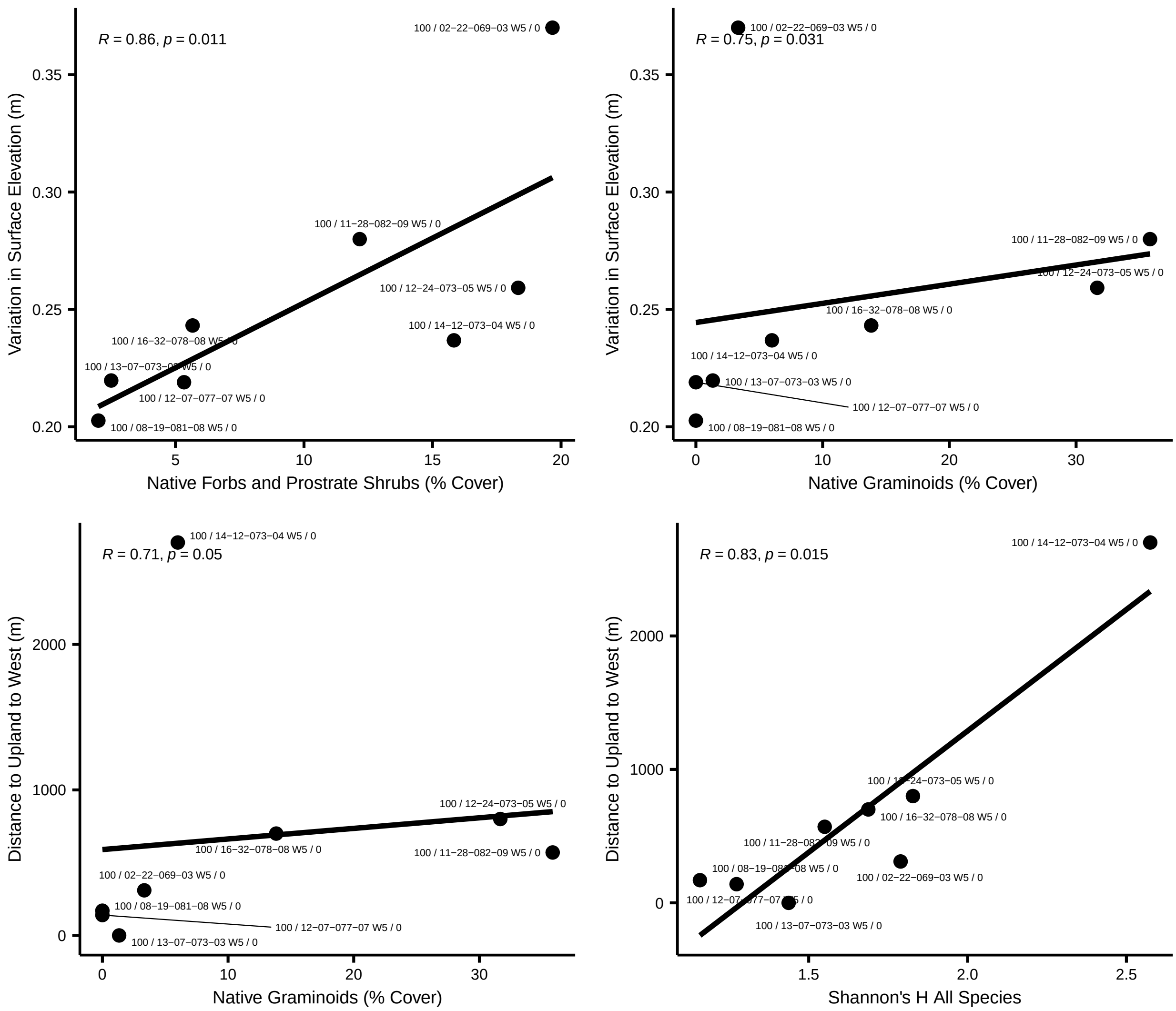


Figure 5c: Spearman Rank Correlation between Pad Elevation Characteristics and Proximity to Upland and Vegetation.

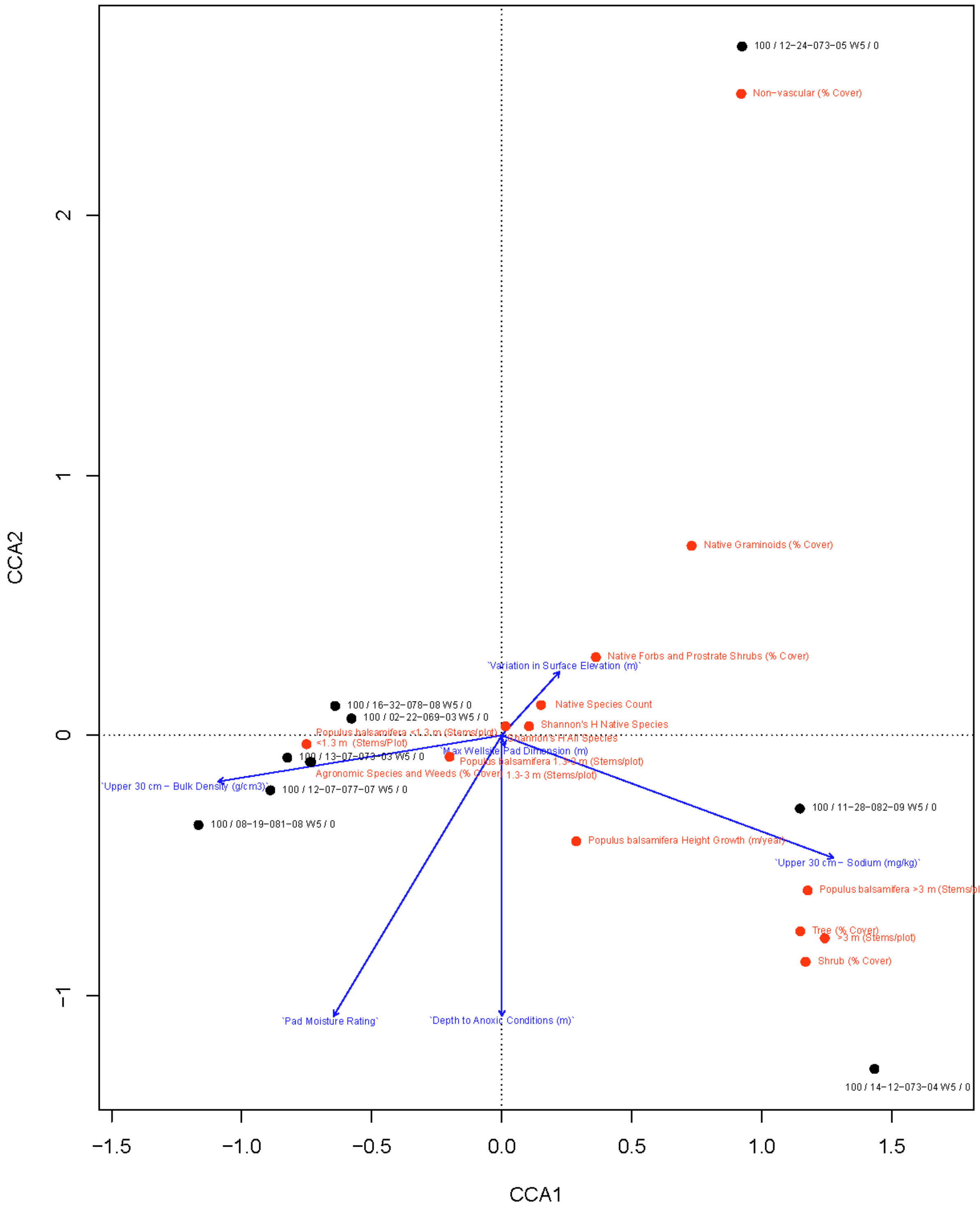


Figure 6: Canonical Correlation Analysis of Pad and Vegetation Characteristics. Positive Correlations between Variables are Indicated by Proximity to One Another or in the Direction of the Vector.

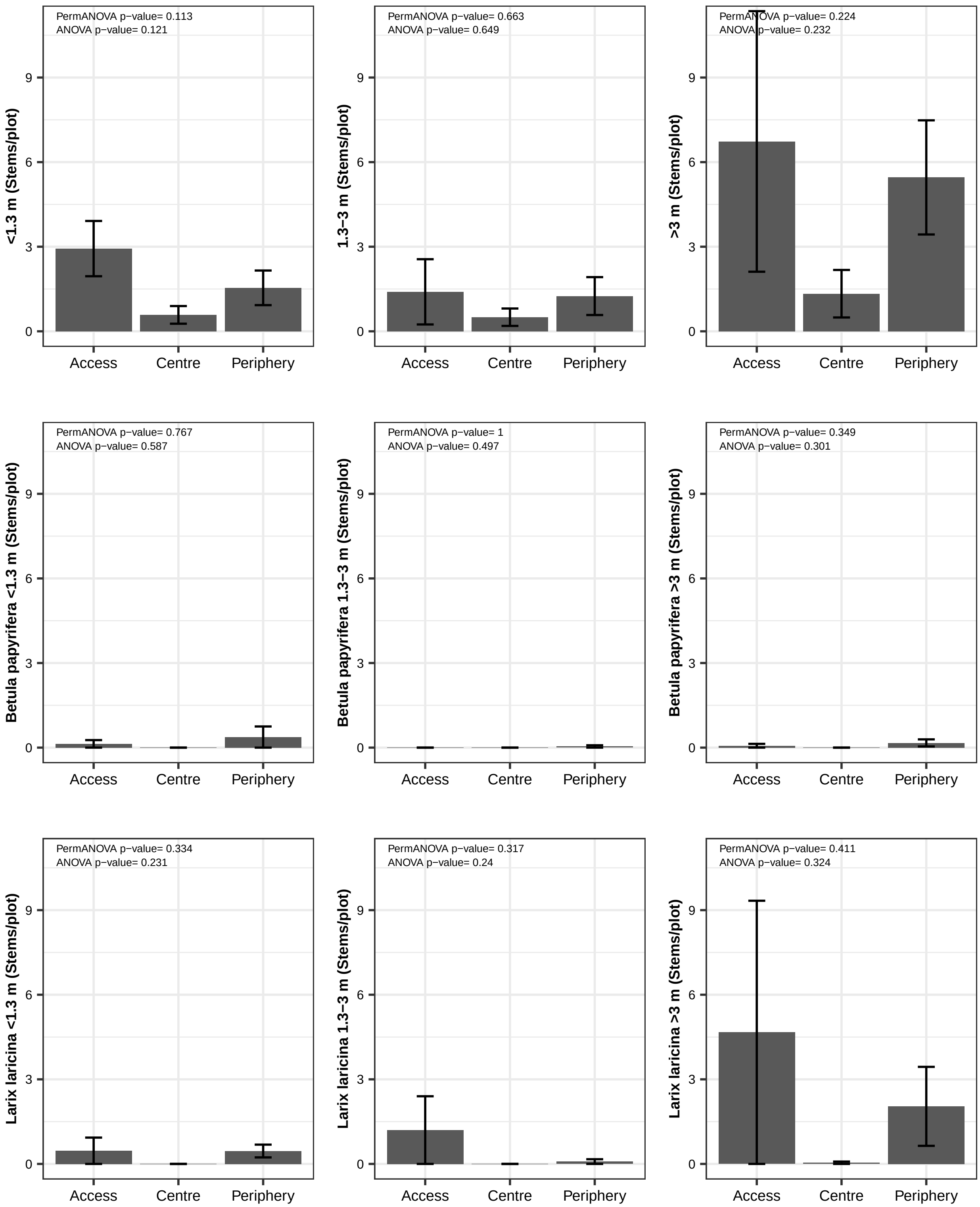
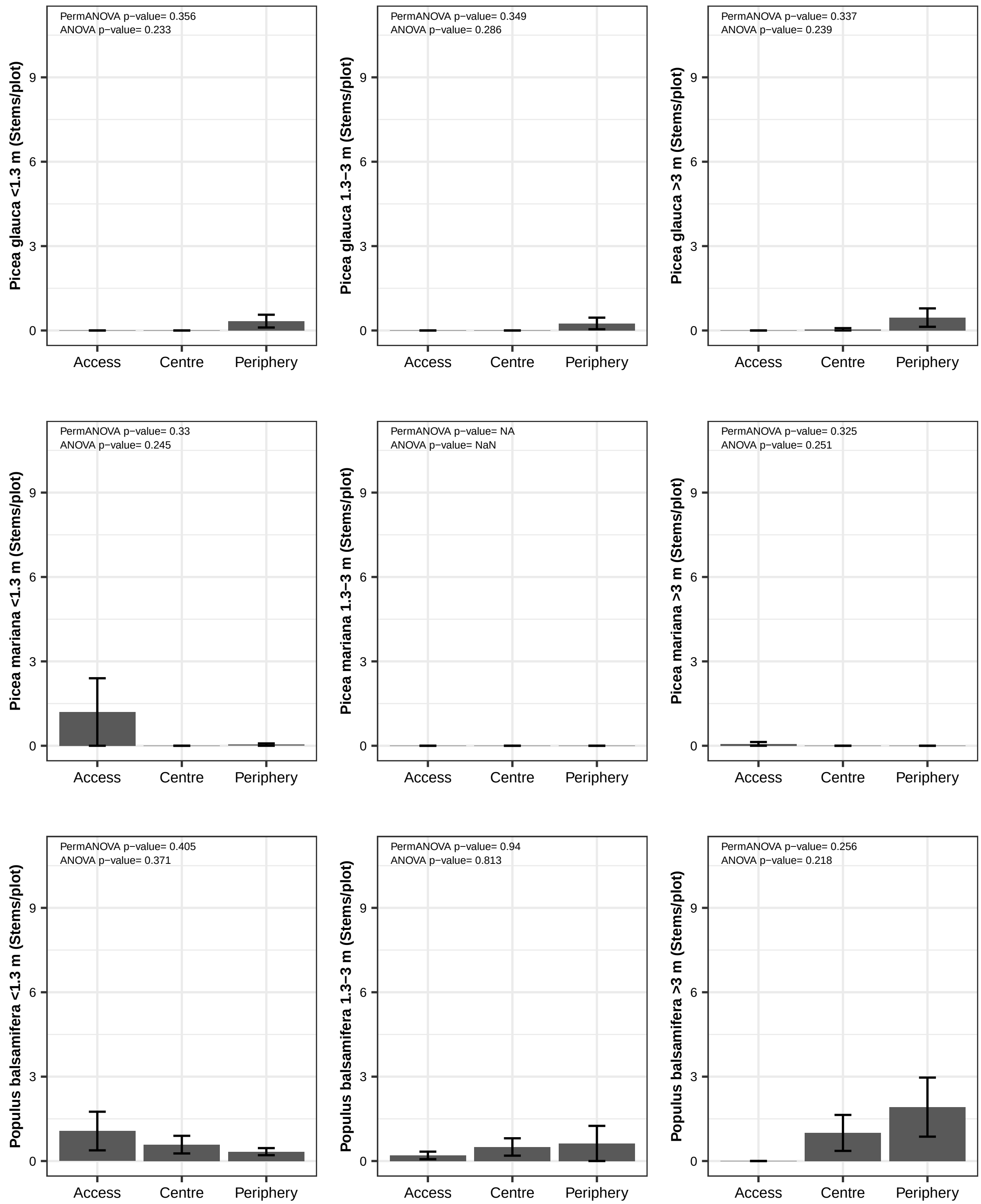


Figure 7a: Comparison of Tree Stem Density by Height Class in a 10 m^2 Plot Between Padded Access Road, Wellsite Pad Centre and Wellsite Pad Periphery. Error Bars Represent Standard Error.



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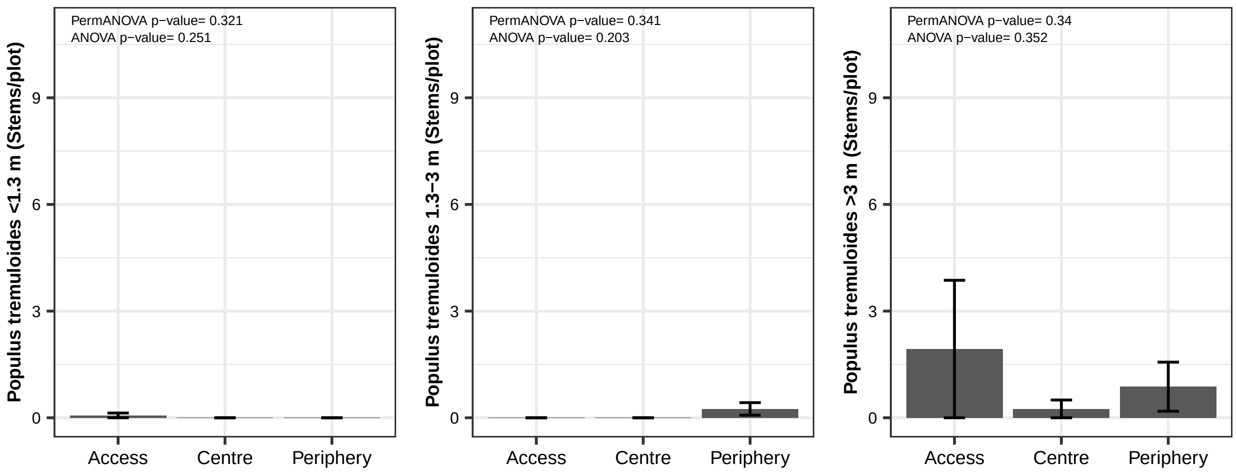

Figure 7a: Comparison of Tree Stem Density by Height Class in a 10 m^2 Plot Between Padded Access Road, Wellsite Pad Centre and Wellsite Pad Periphery. Error Bars Represent Standard Error.

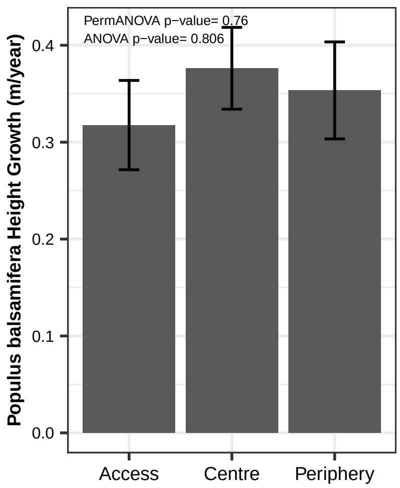

Figure 7b: Comparison of Annual Tree Height Growth Between Padded Access Road, Wellsite Pad Centre and Wellsite Pad Periphery. Error Bars Represent Standard Error.

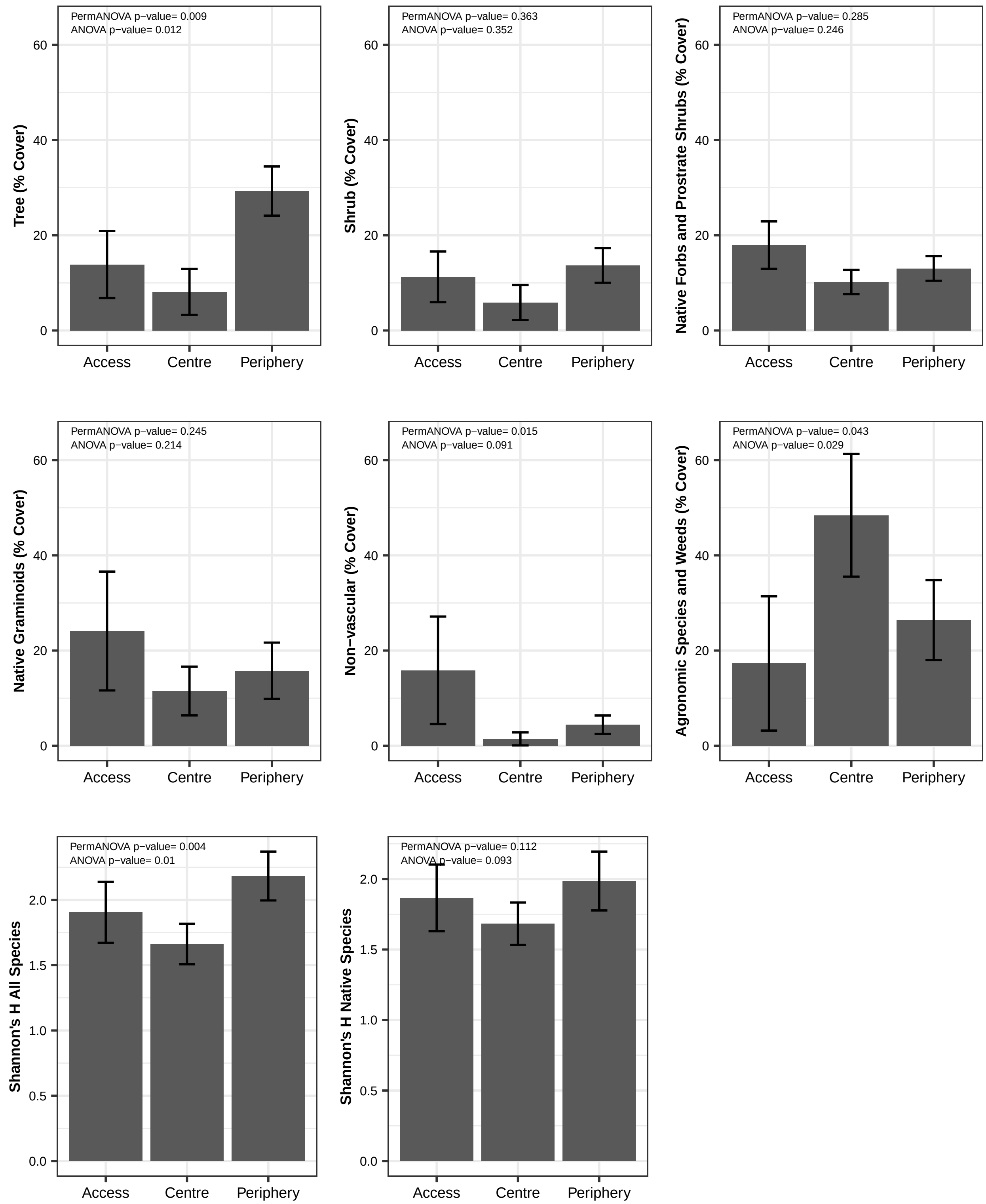

Figure 7c: Comparison of Percent Canopy Cover by Vegetation Strata and Species Diversity Between Padded Access Road, Wellsite Pad Centre and Wellsite Pad Periphery. Error Bars Represent Standard Error.

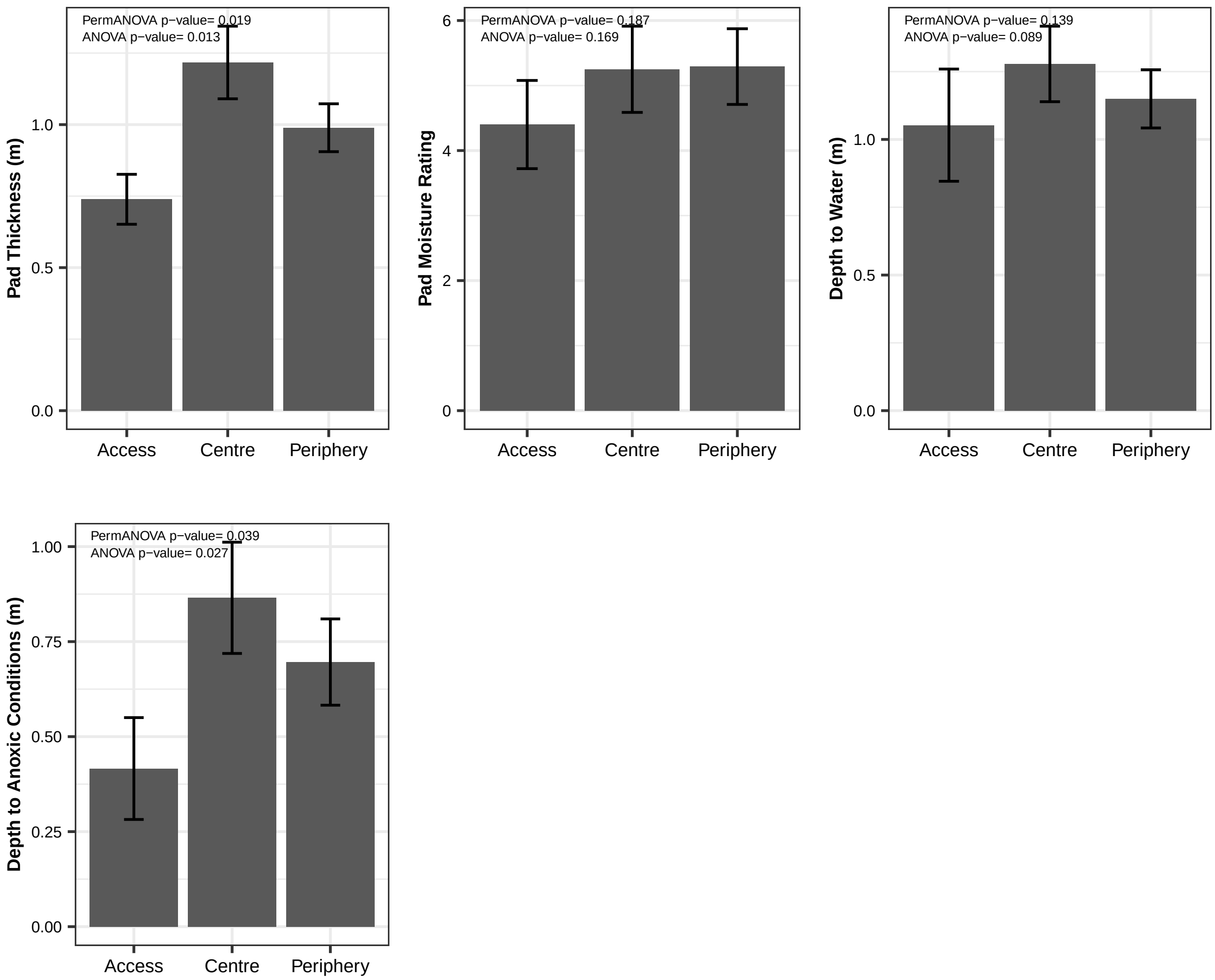

Figure 8a: Comparison of Pad Thickness and Moisture Characteristics Between Padded Access Road, Wellsite Pad Centre and Wellsite Pad Periphery. Error Bars Represent Standard Error. Pad Moisture Rating (1=Saturated, 7=Dry).

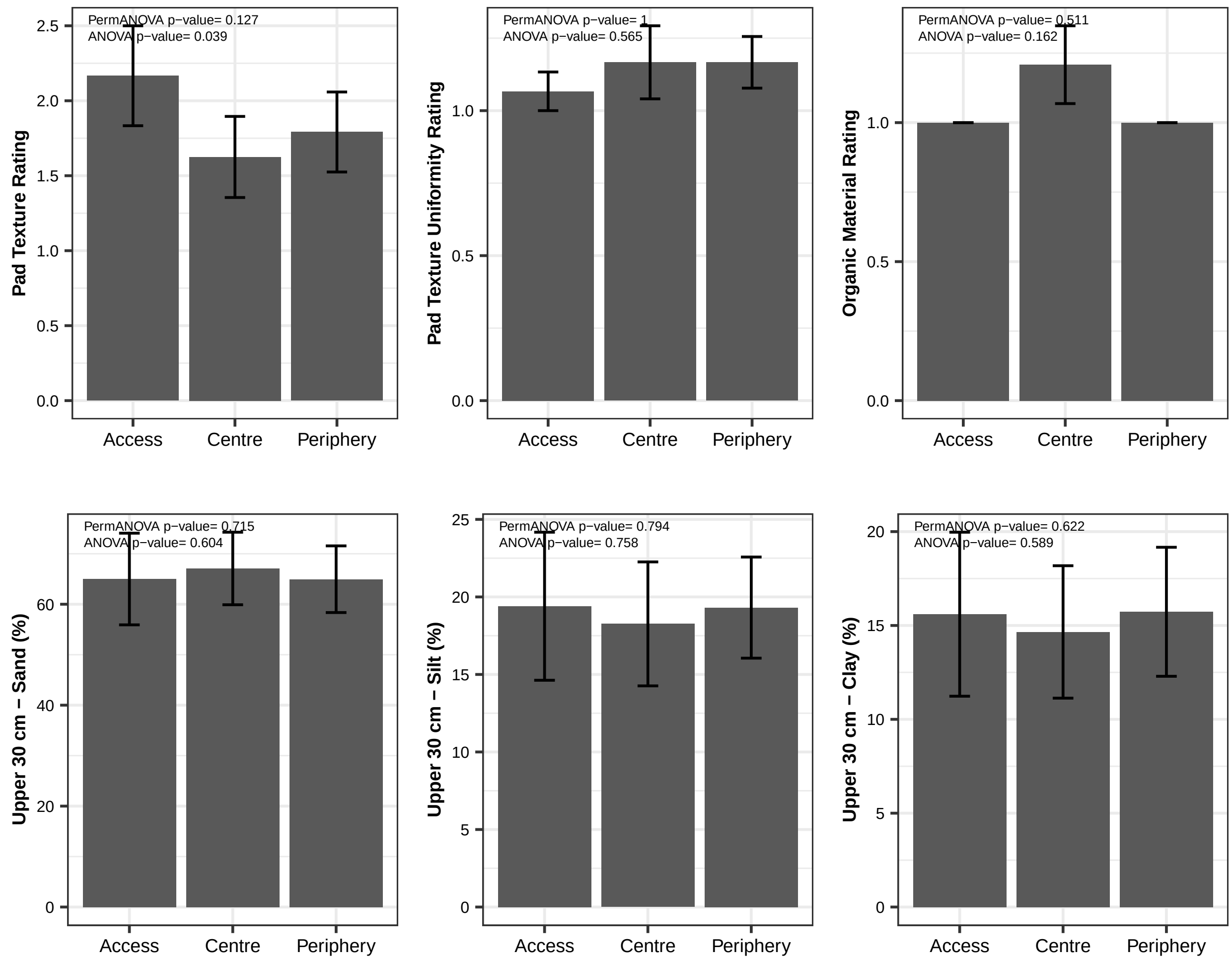

Figure 8b: Comparison of Texture Characteristics Between Padded Access Road, Wellsite Pad Centre and Wellsite Pad Periphery. Error Bars Represent Standard Error. Soil Texture Rating (1=Coarse, 3 =Fine); Soil Texture Uniformity Rating (1=Uniform, 2=Variable); Organic Material Rating (1=Absent, 2=Present).

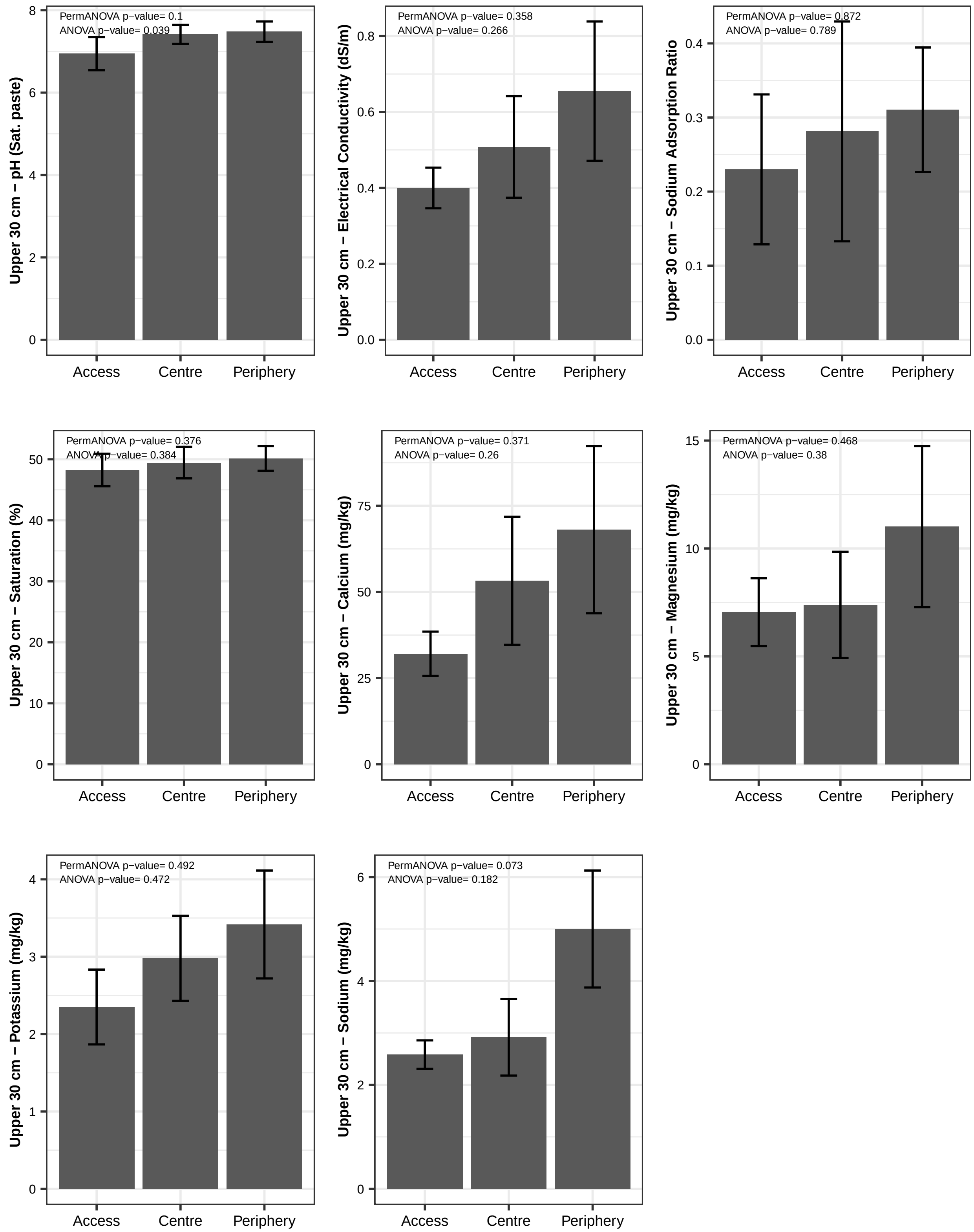

Figure 8c: Comparison of Chemical Properties of the Upper 30 cm of Pad Material Between Padded Access Road, Wellsite Pad Centre and Wellsite Pad Periphery. Error Bars Represent Standard Error.

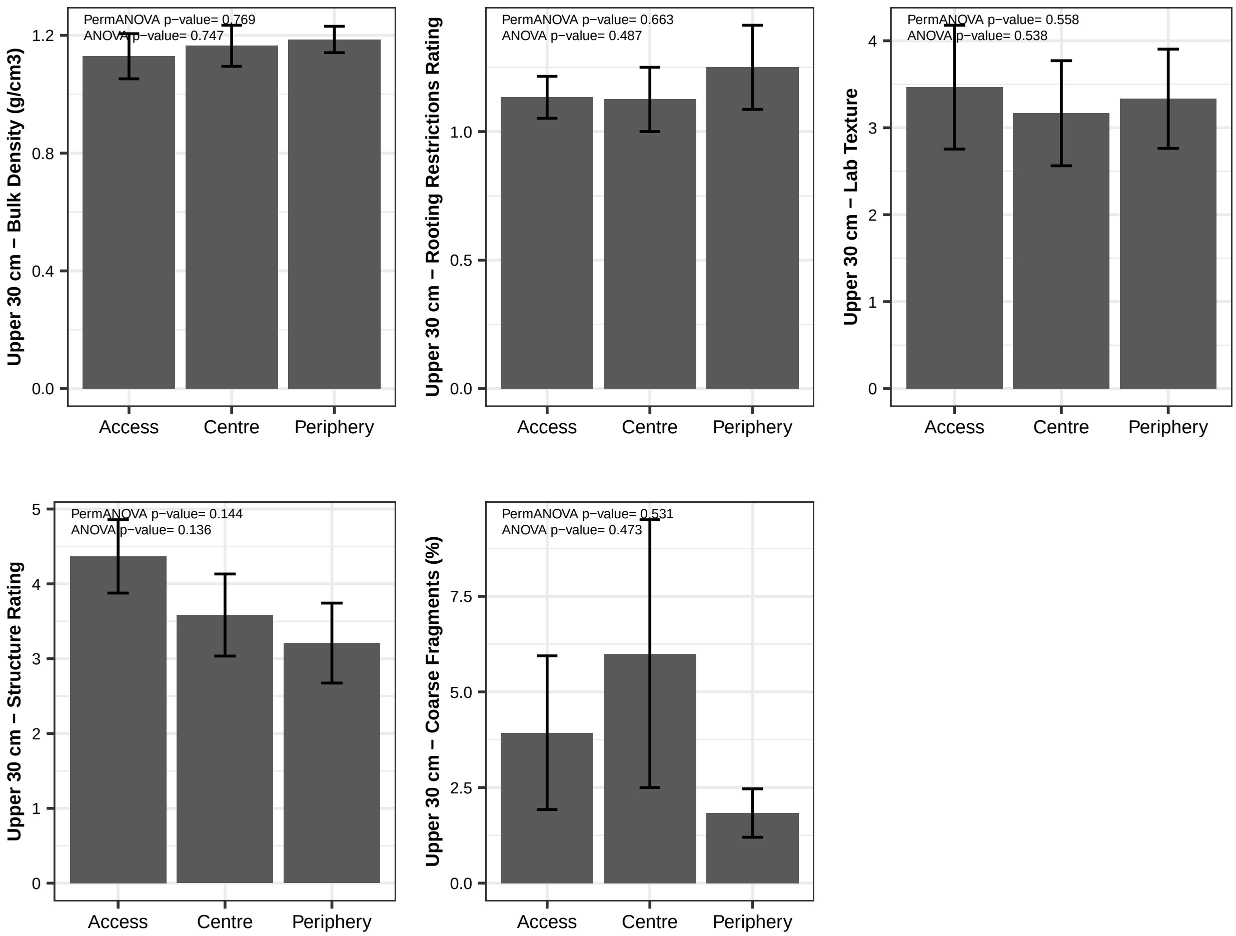

Figure 8d: Comparison of Physical Properties of the Upper 30 cm of Pad Material Between Padded Access Road, Wellsite Pad Centre and Wellsite Pad Periphery. Error Bars Represent Standard Error. Rooting Restrictions Rating (1=None, 2=Slight); Consistence Rating (1=Loose, 2=Friable, 3=Firm); Structure Rating (1=Single Grain, 2=Medium Subangular Blocky, 3=Coarse Subangular Blocky, 4=Coarse Angular Blocky, 5=Platy, 6=Massive).

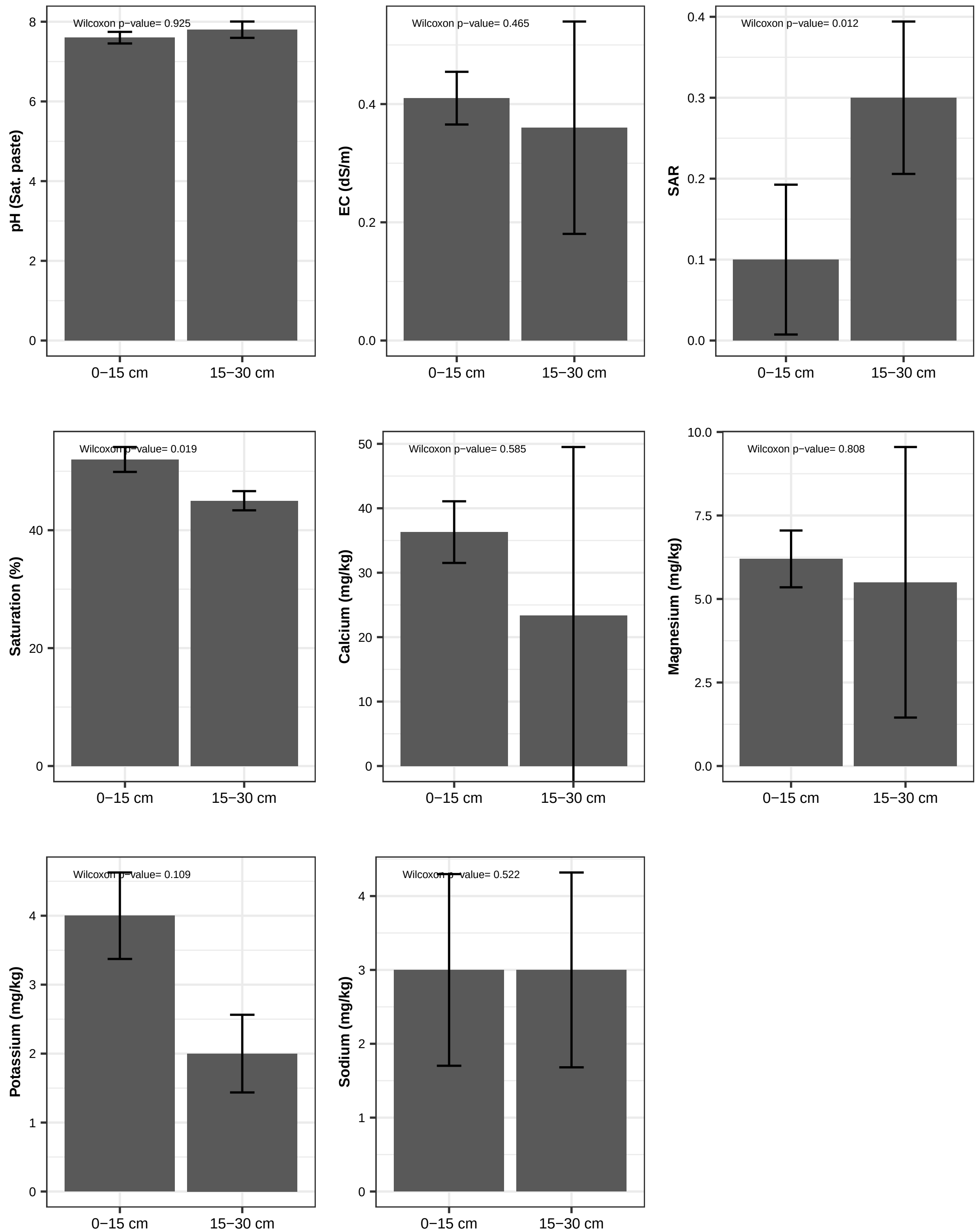

Figure 9a: Comparison of Chemical Properties of Pad Material Between Sample Depths. Medians are Presented and Error Bars Represent Standard Error.

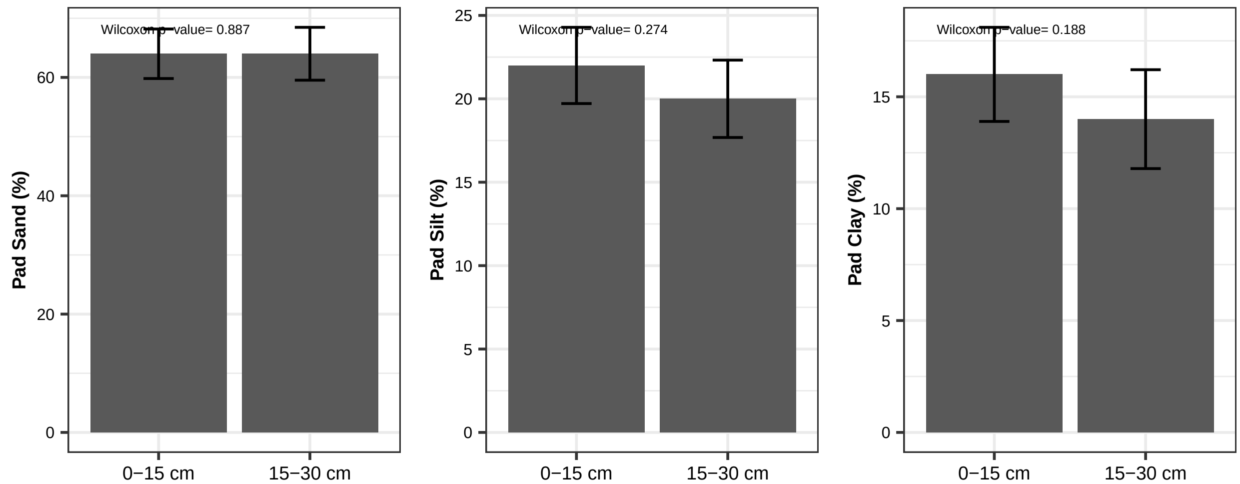

Figure 9b: Comparison of Physical Properties of Pad Material Between Sample Depths. Medians are Presented and Error Bars Represent Standard Error.