MODELING AND MAPPING

SHALLOW WATER PROPERTIES

by

H. Kyle Chisholm

BSc. Forestry, University of New Brunswick, 2012

A Thesis Submitted in Partial Fulfillment
Of the Requirements for the Degree of

Masters of Science in Forestry

In the Graduate Academic Unit of
Forest and Environmental Management

Supervisor: Paul Arp, PhD, FOREM

Examining Board: Paul Arp, PhD, FOREM
Charles Borque, PhD, FOREM
Rick Cunjak. PhD, Biology

This thesis is accepted by the
Dean of Graduate Studies

THE UNIVERSITY OF NEW BRUNSWICK

September 2014

© Hugh Kyle Chisholm, 2014

ABSTRACT

Shallow water property values referring to dissolved oxygen (DO), pH, electrical conductivity (EC), temperature and colour were measured along transect plots within and across wetlands in northwestern Alberta at the Ecosystem Management Emulating Natural Disturbance (EMEND) site, the University of New Brunswick (UNB) Forest and a stream-channel permeated Jack Pine (*Pinus banksiana*) plantation in Fredericton, New Brunswick, and a wetland in Saint John, New Brunswick. These measurements were then analyzed in relation to wetland class (bog, fen, marsh, swamp) and the resulting soil hydraulic conductivity (HC) values; contrasting climate, and topographically determined terrain conditions. Local climate conditions refer to precipitation (ppt), evapo-transpiration (AET) and terrain conditions refer to the DEM-derived cartographic depth-to-water index (DTW), flow accumulation (FA), slope, potential relative radiation (PRR), and tree height, using LiDAR (Light Detection and Ranging) point-cloud data. Seasonal water property changes were also addressed. It was found that pH, EC, and temperature were generally lowest for bogs (generally low input from mineral groundwater, slow organic matter decomposition rates, and thick organic layers) and highest for marshes (increased seepage input from upland mineral sources, and water table generally close to surface); DO had highest values for bogs, and lowest values for marshes.

The water properties were best quantified by way of the following regression variables: DO: $\log_{10}$DTW, $\log_{10}$PRR, $\log_{10}$HC and season (temperature) ($R^2 = 0.35$); EC: AET/ppt ratio multiplied by PRR, and EMEND wetland class ($R^2 = 0.60$); pH (away from bogs):

$\log_{10}$DTW, $\log_{10}$FA and $\log_{10}$EC Raster (R^2 = 0.48); pH (within bogs): tree height and $\log_{10}$HC (R^2 = 0.14); Temperature: $\log_{10}$DTW, season, and wetland class (R^2 = 0.23); water colour: pH, $\log_{10}$HC, and $\log_{10}$Slope (R^2 = 0.15).

These regression results were then used to map the water properties within and around the wetlands within the 4 study locations using (i) area-wide LiDAR-DEM determinations for DTW, slope, FA, PRR, and tree height, (ii) image-derived wetland classification, and (iii) regional specifications for AET/ppt. These maps were than overlaid with the corresponding transect derived data, for visual comparison purposes. In detail, these maps showed how water properties vary as a continuum within and across DTW-influenced neighborhoods around each mapped and categorized wetland, from summer to fall. The conformance between actual and predicted water property values suggest that the procedures used can be generalized over wider areas where conditions similar to the study areas exist. Practical applications would refer to land and water use planning within and around wetlands, including wetland and flow channel conservation and reclamation, quantifying water DO, EC, pH, temperature and colour contributions for use in Environmental Site Assessment monitoring, and for determining possible upstream disturbance.

TABLE OF CONTENTS

ABSTRACT ii
ACKNOWLEDGEMENTS vi
LIST OF TABLES vii
LIST OF FIGURES x
CHAPTER 1 INTRODUCTION 1
Project Objectives 3
Acronym Glossary 6
CHAPTER 2 LITERATURE REVIEW 7
Watershed Processes 7
Water Properties 9
Mapping Water Properties 16
CHAPTER 3 RESEARCH SITES 18
Introduction 18
Ecosystem Management Emulating Natural Disturbance (EMEND) Site 18
New Brunswick Sites 20
CHAPTER 4 METHODS 23
Sampling Design 23
Data Collection 28
Wetland Classification 30
Wet-Areas Mapping. 31
Derivation of Geospatial Datalayers 33
Data Compilation 34
Data analysis 36
Map Water Properties Using ArcGIS 38
CHAPTER 5 DISSOLVED OXYGEN 40
Introduction 40
Results 40
Discussion 55

CHAPTER 6 ELECTRICAL CONDUCTIVITY 60
Introduction 60
Results 60
Discussion 75
CHAPTER 7 pH 79
Introduction 79
Results 79
Discussion 95
CHAPTER 8 WATER TEMPERATURE 100
Introduction 100
Results 100
Discussion 113
CHAPTER 9 COLOUR 119
Introduction 119
Results 119
Discussion 132
CHAPTER 10 SYNTHESIS AND APPLICATIONS 137
Synthesis 137
Applications 146
CHAPTER 11 CONCLUSIONS 149
Closing Remarks 149
Suggestions for further work 150
REFERENCES 152
APPENDIX I 161
APPENDIX II 188
APPENDIX III 194
APPENDIX IV 200
APPENDIX V 211
CURRICULUM VITAE 217

ACKNOWLEDGEMENTS

Thanks to the Environment and Sustainable Resource Development branch of the Alberta Government for the financial support which made this thesis possible. The guidance of Dr. Paul Arp was especially helpful throughout all stages of this project, from project implementation and design, to data analysis and report formulation, while supervisors Dr. Barry White and Dr. Fan-Rui Meng contributed invaluable feedback towards the improvement of this thesis. Jae Ogilvie was instrumental in this project for the development and assistance of many tools and data layers that were used in ArcGIS and Mark Castonguay provided technical assistance regarding field equipment use and maintenance. Finally, I need to thank the field assistants who helped to collect and organize the data for this project, including Monique Goguen, Shane Furze, Mike Hutchinson, Jan Keine, Robin Wurg, and Kathrine Heigel.

LIST OF TABLES

Table 1. Number of plots surveyed by site location and wetland class. 28

Table 2. Number of plots surveyed by depth to water class (4 ha flow initiation). 28

Table 3. Categorical and continuous variables tested for use in predicting water properties. 33

Table 4. Example of coding used to identify wetland classes. 35

Table 5. Example of coding used to identify study locations. 35

Table 6. Hydraulic conductivity values for wetland classes and uplands. 36

Table 7. Correlation coefficients of all measured values. 37

Table 8. Plot distribution based on location/season and class, of the 100 test plots. 38

Table 9. Summary of DO values by wetland and depth-to-water classes 43

Table 10. Best fit predictive variables used to model DO (R^2 = 0.35) using multiple regression analysis. 45

Table 11. Correlation coefficients between DO and all measured variables. 47

Table 12. Correlation coefficients for actual, predicted and mapped DO values. 47

Table 13. DO values taken from a literature review compared with DO values measured for this thesis. Average and range of measured DO values are shown, excluding outliers 54

Table 14. Summary of EC values by wetland and DTW classes. 63

Table 15. Best fit predictive variables used to model $\log_{10}$EC (R^2 = 0.60) using multiple regression analysis. 65

Table 16. Correlation coefficients between EC and all measured variables. 67

Table 17. Correlation coefficients for actual, predicted and mapped log_{10}EC values. .. 67

Table 18. EC values taken from a literature review compared with EC values measured for this thesis. Average and range of measured EC values are shown, excluding outliers 74

Table 19. Summary of pH values by wetland and DTW classes. 82

Table 20. Best fit predictive variables used to model non-bog pH (R^2 = 0.48) using multiple regression analysis. 84

Table 21. Best fit predictive variables used to model bog pH (R^2 = 0.14) using multiple regression analysis. 85

Table 22. Correlation coefficients between pH and all measured variables. 87

Table 23. Correlation coefficients for actual, predicted, and mapped pH values. 87

Table 24. PH values taken from a literature review compared with pH values measured for this thesis. Average and range of measured values are shown, excluding outliers .. 94

Table 25. Summary of temperature values by wetland and DTW classes..... 103

Table 26. Best fit predictive variables used to model temperature (R^2 = 0.23) using multiple regression analysis. 105

Table 27. Correlation coefficients between temperature and all measured variables.. 107

Table 28. Correlation coefficients for actual, predicted and mapped temperature values. 107

Table 29. Summary of colour values by wetland and DTW classes..... 121

Table 30. Best fit predictive variables used to model colour (R^2 = 0.15) based on multiple regression analysis. 123

Table 31. Correlation coefficients between colour and all measured variables..... 124

Table 32. Correlation coefficients for actual, predicted and mapped colour. 125

Table 33. Colour values taken from a literature review compared with colour values measured for this thesis. Average and range of measured colour values are shown, excluding outliers. 131

Table 34. Variables used for modelling and mapping water properties. 138

Table 35. Correlation coefficients for variables; with significant correlations highlighted..... 139

Table 36. Principle component analysis using modeling and mapping variables..... 140

Table 37. Mapped water property variables and their corresponding predictor variables. 142

Table 38. Examples of agencies involved in the watershed/wet-areas/wetland water property monitoring and mapping. 148

Table 39. Correlation coefficients for predicted versus mapped water property values. 216

LIST OF FIGURES

Figure 1. Location of EMEND site in northwestern Alberta (56°44'N, 118°19'W)..... 20

Figure 2. Location of UNB Forest (45°56'N, 66°41'W), Saint John (45° 17'N, 66°13'W), and Jack Pine plantation (45°53'N, 66°35'W) sites. 22

Figure 3. Location of field plots for EMEND (left) and UNB Forest (right) sites, overlaying image derived wetland classification raster. 24

Figure 4. Location of field plots for Saint John (left) and Jack Pine plantation (right) sites, overlaying image derived wetland classification raster. 25

Figure 5. Location of field plots for EMEND (left) and UNB Forest (right) sites, overlaying depth-to-water as derived using a 4 ha flow initiation catchment area..... 26

Figure 6. Location of field plots for Saint John (left) and Jack Pine plantation (right) sites, overlaying depth-to-water as derived using a 4 ha flow initiation catchment area. 27

Figure 7. Example of a plot, showing site details. 29

Figure 8. EMEND (left) and UNB Forest (right) sites showing plot locations with measured DO..... 41

Figure 9. Saint John Wetland (left) and Jack Pine (right) sites showing plot locations with measured DO..... 42

Figure 10. Boxplots showing transformed DO distributions by site and wetland class to highlight outliers. 44

Figure 11. Average measured DO values by site and season. 44

Figure 12. Scatterplot of actual versus predicted transformed DO values, with best fit regression line, and visually determined outliers highlighted in red. 46

Figure 13. Frequency distribution of the residual values from DO model. 46

Figure 14. Field DO values overlaying DO rasters for the EMEND (left) and UNB Forest (right) sites. 48

Figure 15. Field DO values overlaying DO rasters for the Saint John (left) and Jack Pine (right) sites. 49

Figure 16.Showing actual versus predicted DO values for 100 test plots, with best fit regression line and outliers highlighted in red. 50

Figure 17. Average DO values by wetland class and location. 50

Figure 18. Correlation coefficients of actual versus predicted DO values by wetland class. 51

Figure 19. Frequency distributions for actual and predicted DO values for each wetland class. 52

Figure 20. EMEND (left) and UNB Forest (right) sites showing plot locations with measured EC. 61

Figure 21. Saint John Wetland (left) and Jack Pine (right) sites showing plot locations with measured EC. 62

Figure 22. Boxplots showing $\log_{10}$EC distributions by site and wetland class to highlight outliers. 64

Figure 23. Average measured $\log_{10}$EC values by site and season. 64

Figure 24. Scatterplot of actual versus predicted $\log_{10}$EC values, with best fit regression line and visually determined outliers highlighted in red. 66

Figure 25. Frequency distribution of the residual values from the $\log_{10}$ EC model. 66

Figure 26. Field EC values overlaying EC rasters for the EMEND (left) and UNB Forest (right) sites. 68

Figure 27. Field EC values overlaying EC rasters for the Saint John (left) and Jack Pine (right) sites. 69

Figure 28. Showing actual versus predicted $\log_{10}$EC values for 100 test plots, with best fit regression line. 70

Figure 29. Average $\log_{10}$ EC values by wetland class and location. 70

Figure 30. Correlation coefficients of actual versus predicted $\log_{10}$EC values by wetland class. 71

Figure 31. Frequency distributions for actual and predicted $\log_{10}$EC values by wetland class. 72

Figure 32. EMEND (left) and UNB Forest (right) sites showing plot locations with measured pH. 80

Figure 33. Saint John Wetland (left) and Jack Pine (right) sites showing plot locations with measured pH. 81

Figure 34. Boxplots showing pH distributions by site and wetland class to highlight outliers. 83

Figure 35. Average measured pH values by site and season. 83

Figure 36. Scatterplot of actual versus predicted pH values, with best fit regression line, and visually determined outliers highlighted in red. 85

Figure 37. Scatterplot of actual versus predicted bog pH values, with best fit regression line, and visually determined outliers highlighted in red. 86

Figure 38. Frequency distributions for residual values of the non-bog pH (left) and bog pH (right) models. 86

Figure 39. Field pH values overlaying pH rasters for the EMEND (left) and UNB Forest (right) sites. 88

Figure 40. Field pH values overlaying the regression-derived pH rasters for the Saint John wetland (left) and Jack Pine (right) sites. 89

Figure 41. Showing actual versus predicted pH values for the 100 test plots, with best fit regression line. 90

Figure 42. Average pH values by wetland class and location. 90

Figure 43. Correlation coefficients of actual versus predicted pH values by wetland class. 91

Figure 44. Frequency distributions for actual and predicted pH values by wetland class. 92

Figure 45. EMEND (left) and UNB Forest (right) sites showing plot locations with measured temperatures. 101

Figure 46. Saint John Wetland (left) and Jack Pine (right) sites showing plot locations with measured temperatures. 102

Figure 47. Boxplots showing temperature distributions by site and wetland class. 104

Figure 48. Average temperature values by site and season. 104

Figure 49. Scatterplot of actual versus predicted temperature values, with best fit regression line and visually determined outliers highlighted in red. 106

Figure 50. Frequency distribution for residual values of the temperature models..... 106

Figure 51. Temperature raster and field temperature values for the EMEND (left) and UNB Forest (right) sites 108

Figure 52. Temp. raster and field values for the St.John (left) and Jack Pine (right) sites 109

Figure 53. Actual versus predicted temperature values for 100 test plots. 110

Figure 54. Average temperature values by wetland class and location. 110

Figure 55. Correlation coefficients of actual versus predicted temperature values. 111

Figure 56.Frequency distributions for actual and predicted temperature values 112

Figure 57. Temperature for each wetland class for the UNB Forest in spring, summer and fall. 114

Figure 58. EMEND (left) and UNB Forest (right) sites showing plot locations with measured colour values. 120

Figure 59.Boxplots showing transformed colour distributions by site and wetland class. 122

Figure 60. Scatterplot of actual versus predicted colour values, with best fit regression line and visually determined outliers highlighted in red. 123

Figure 61. Frequency distributions for residual values of the water colour models. ... 124

Figure 62. Water colour raster and field measured water colour values for the EMEND (left) and UNB Forest (right) sites. 126

Figure 63. Actual versus predicted colour values for 100 extracted test plots. 127

Figure 64. Average colour values by wetland class and location. 127

Figure 65. Correlation coefficients of actual versus predicted colour values by wetland class. 129

Figure 66. Frequency distributions for actual and predicted colour values by class. .. 130

Figure 67. DO and EC predictive rasters expanded for the EMEND site..... 143

Figure 68. PH and Temperature predictive rasters expanded for the EMEND site..... 144

Figure 69. Colour predictive raster expanded for the EMEND site..... 145

Figure 70. EMEND (left) and UNB (right) sites showing $\log_{10}$DTW and plot locations. 200

Figure 71. Saint John (left) and Jack Pine (right) sites showing $\log_{10}$DTW and plots. 201

Figure 72. EMEND (left) and UNB (right) sites showing $\log_{10}$FA and plot locations.202

Figure 73. Saint John (left) and Jack Pine plantation (right) showing $\log_{10}$FA (150m Focal Mean) and plot locations. 203

Figure 74. EMEND (left) and UNB (right) sites showing $\log_{10}$PRR and plot locations. 204

Figure 75. Saint John (left) and Jack Pine (right) showing $\log_{10}$PRR and plot locations. 205

Figure 76. EMEND (left) and UNB (right) sites showing $\log_{10}$Slope and plot locations. 206

Figure 77. Saint John (left) and Jack Pine (right) showing $\log_{10}$Slope and plot locations. 207

Figure 78. EMEND (left) and UNB (right) sites showing Tree Height and plot locations. 208

Figure 79. Saint John (left) and Jack Pine (right) showing Tree Height and plot locations. 209

Figure 80. Frequency distributions for all continuous variables used to predict water properties. 210

Figure 81. Field verified wetland classes and wetland class raster for EMEND (left) and UNB Forest (right). 213

Figure 82. Field verified wetland classes and wetland class raster for Saint John Wetland (left) and Jack Pine Plantation (right). 214

Figure 83. Distance between GPS plot location and image derived wetland class raster values for bogs, fens, swamps, marshes and uplands. 215

Figure 84.Distance between GPS plot location and image derived wetland class raster values for open water and domed bogs. 215

CHAPTER 1

INTRODUCTION

Modeling and mapping of landscape attributes including soil and water properties is important for a variety of land-use management aspects such as planning and conducting field operations in forestry, agriculture, industrial and residential developments, reclamation, as well as land and wildlife conservation (Mcbratney and Pringle, 1999; Murphy et al., 2011). Modeling and mapping soil moisture regimes across the landscape and within watersheds is particularly important because variations in soil water availability and drainage affect water quality and what grows where, and this needs to be considered in land-use and water-resource planning (Petrone et al., 2008; Maxa and Bolstad, 2009; Murphy et al., 2011).

Since soil moisture regimes are topographically related to where water flows and is retained, it is now possible to quantify and model variations in soil moisture regimes by elevational change away from local flow channels and open water pools, lakes and shorelines, using remotely sensed data. One method to do so is the wet areas mapping process (WAM; Murphy et al., 2007). This process (i) uses the D8 algorithm for determining flow direction, flow accumulation and flow channels along depression-filled digital elevation surfaces, and (ii) determines the cartographically defined depth to water (DTW) below the bare-earth surface away from the open water bodies. The digital elevation model (DEM) derived flow-channel network can be expanded towards and shrunk away from the uplands depending on flow accumulation threshold set for

stream flow initiation, which would be set to lower/higher values depending on (i) wetter/drier weather conditions, (ii) and/or permeable to impermeable soil conditions. Once mapped, the resulting stream network is then used to determine where the DTW would be zero. In turn, the elevational change away from the DTW = 0 locations defines the cartographically expected depth to water below the soil surface anywhere across the landscape (Murphy et al., 2011).

The accuracy of this mapping increases with increased DEM resolution and has been found sufficient for delineating soil drainage, soil type, and vegetation type next to all open water bodies, and for projecting variations in soil moisture regimes, soil-moisture referenced vegetation cover, wetlands, and soil texture and organic matter content across landscapes (Murphy et al., 2007; 2009; 2011; Hiltz et al., 2012; White et al., 2012). This mapping process, however, does not permit distinction of soil and vegetation variations and related water conditions including wetland type within the wet DTW zones as these would all be affected by variations in water flow rates, retention and soil permeability. In order to map such variations, it is therefore necessary to supplement the WAM process with data layers that inform about the extent of specific soil and vegetation conditions and wetlands within the wet-area zones.

This thesis focuses on how water chemistry variables such as dissolved oxygen (DO), pH, electrical conductivity (EC), temperature and water colour vary away from flow channels through wetlands and towards the adjacent uplands, and how these variations can be mapped by geospatially relating these variables to surface images and LiDAR-derived landscape attributes including stream network, DTW, wetland class and

potential relative radiation (Lee, 1980; Pierce et al. 2005; Mitsch and Gosselink, 2007). Additional landscape attributes refer to surrounding upland soils, extent of upland water contributing areas (flow accumulation), flow paths and soil permeability. For example, upland seepage water would be clear and have elevated pH, DO and EC levels. Bog water would be coloured with low pH and EC values. In comparison, fen water DO would be lower than bog water DO because of higher levels of root respiration. Permeable soil conditions would maintain elevated DO levels but enhance soil leaching and acidification, while impermeable soil conditions would deplete DO at neutral to near-neutral pH levels. Water that flows or remains through organic soils would accumulate dissolved organic matter (DOM) as part of the organic humification process and would turn brown, especially at elevated temperatures, while water that would seep through soils would be clear on account of DOM adsorption.

Project Objectives

The purpose of this project is to determine if it is possible to map shallow water DO, pH, EC, temperature, and colour in wet areas using LiDAR- and image-derived landscape attributes dealing with bare-ground elevation, flow accumulation, vegetation type and soil permeability. This determination is done by:

1. Measuring shallow water properties and site attributes across four wetland classes towards adjacent uplands.
2. Doing this by choosing contrasting ecozone examples as represented by the Boreal Plain in Alberta and the Atlantic Maritime Ecozone in New Brunswick (Chapter 3).

3. Using ArcGIS image analysis and the Canadian Wetland Classification guidelines to determine the wetland classes at each measurement location (Appendix V).
4. Using regression analysis to relate the measured soil water properties to wetland classes and LiDAR-generated wet-area attributes.
5. Using the resulting regression equations to project the wetland- and DEM-inferred water properties across the wetland to upland transitions across the contrasting ecozone examples.

The contrasting ecozone examples refer to the Ecosystem Management Emulating Natural Disturbance (EMEND) site north of Peace River, Alberta, and three bog complexes in New Brunswick. This thesis is organized as flows:

Chapter 2 contains a literature review of hydrological processes that affect water properties, along with dissolved oxygen, pH, electrical conductivity, temperature and colour background and information, and review of current research involving mapping water properties.

Chapter 3 introduces the research sites that were utilized for this thesis.

Chapter 4 details the methodology that was applied throughout this thesis; including project design, data collection, data compilation, data analysis and spatial data projections.

Chapters 5 to 9 investigate the relationship between DO, EC, pH, temperature and colour with LiDAR derived WAM and topographic attributes, respectively; which

includes spatial representation of predicted water properties across wetlands for each study site.

Chapter 10 provides a thesis summary along with potential applications for the water property predictive rasters

Chapter 11 provides concluding remarks on this thesis; detailing the project outcomes, claims of originality, and suggestions for further work.

Acronym Glossary

AB: Alberta

AET: Actual Evapotranspiration

CWCS: Canadian Wetland Classification System

DEM: Digital Elevation Model

DO: Dissolved Oxygen

DOC: Dissolved Organic Carbon

DOM: Dissolved Organic Matter

DTW: Depth to Water

EC: Electrical Conductivity

EMEND: Ecosystem Management Emulating Natural Disturbance

ESRD: Environment and Sustainable Resource Development

FA: Flow Accumulation

GIS: Geographic Information Systems

GPS: Geographic Positioning System

Ha: Hectare

HC: Hydraulic Conductivity

JP: Jack Pine

L: Litre

LiDAR: Light Detection and Ranging

Mg: Milligram

MrSID: Multiresolution Seamless Image Database

NB: New Brunswick

NWWG: National Wetlands Working Group

PRR: Potential Relative Radiation

PCU: Platinum Cobalt Units

pH: Power of Hydrogen

Ppt: Precipitation

S: Siemen

SAR: Synthetic Aperture Radar

Std dev: Standard deviation

SJ: Saint John

SNB: Service New Brunswick

UNB: University of New Brunswick

UP-WL: Upland to Wetland

WAM: Wet Areas Mapping

CHAPTER 2

LITERATURE REVIEW

Watershed Processes

Understanding watershed and water-affecting processes begins with the condensation and precipitation of water in the form of rain, fog, sleet or snow (Lee, 1980; Barker and Maltby, 2009a; Bourbonniere, 2009). The fate of precipitation, and the occurrence of saturated soil within wet areas and wetlands within watersheds depends on the amount and accumulation of water, topography, vegetation, and soil hydraulic conductivity (Tiner, 2005). Wet-areas and wetlands occur where saturated conditions persist completely or partially. Under these conditions, oxygen within the water in the form of dissolved oxygen becomes limited, causing temporary to continuous anaerobic processes to be initiated (Mitsch and Gosselink, 2007). Wet areas and wetlands are also affected by acid buffering and acid forming processes (Tiner, 2005).

Precipitation first passes through the forest canopy, where it is intercepted, or passes to the forest floor via throughfall or stemflow; after which it may infiltrate the soil (Lee, 1980). Surface-retained water would move along the surface, across the forest floor and would then converge into flow channels (Brady and Weil, 2002). In this, topography defines watershed boundaries, flow direction, and the rate of surface water flow as it may vary from fast on steep slopes to stagnant in flat terrain. Water may also remain in depressions, thus forming vernal pools or permanent pools where the soil is partially permeable or impermeable, respectively (Lee, 1980; Mitsch and Gosselink, 2007).

Topography also affects surface temperatures, and thus vegetation growth and evapotranspiration rates. In this way, north facing slopes are cooler and wetter than south facing slopes due to a decrease in direct sunlight, thereby encouraging the growth of shade-tolerant species (Lee, 1980).

The rate at which water moves through soil is controlled by the hydraulic conductivity of the parent material (Lee, 1980). Coarse parent materials, such as sandstone, have higher hydraulic conductivity rates than those composed of fine material, such as siltstone or shale. Also, the position on the landscape will determine the accumulation of fine materials and humified organic matter, both of which are dominant in depressions, fens and swamps (Gafni and Brooks, 1990; Brady and Weil, 2002). Fibrous organic matter in the form of the forest litter accumulations of the forest floor and undecomposed sphagnum peat allows water to infiltrate and drain quickly. The type of wetland and the conditions within that wetland therefore have a strong influence wet-area water properties (Mitsch and Gosselink, 2007).

In general, water properties such as DO, pH, EC, temperature and water colour within watershed, wet areas and wetlands are affected by allogenic features, such as climate (precipitation, air temperature, season), bedrock and topography, and are further modified by autogenic processes due to vegetative and micro-organism metabolisms involving water uptake, growth, respiration (oxygen uptake and carbon dioxide release), chemical adaptation to partial to complete anoxic conditions, and organic matter decomposition (Lloyd and Heathcote, 1985).

Water Properties

Dissolved Oxygen (DO), commonly measured in mg/L (ppm), is a time-variable attribute that is directly affected by the extent of atmosphere-soil exchange and soil biological activities. Oxygen enters water in three ways, i) diffusion, ii) water aeration, and iii) plant exudes. The concentration of oxygen is higher in air than in water, so oxygen will move from the high pressure to low pressure in an attempt to reach equilibrium (Shotyk, 1988). The rate of diffusion will increase with increased surface area, which provides more area for oxygen to diffuse across. In the wetland environment, this equates to higher aeration of water in fibric organic soils than in mesic or hemic soils, because fibric soils provide space for air, as opposed to finer textured soils, which do not. Water aeration occurs in moving water, as oxygen is pushed into water due to increased air pressure, and increased surface area; both of which result from water turbulence (Shotyk, 1988). Plants produce oxygen through photosynthesis, and as oxygen is transported to roots some oxygen exits the plant and enters the surrounding soil ecosystem (Sand-Jensen et al., 1982).

Processes that decrease oxygen concentration in water are water stagnation, microbial activity and plant use (Husson, 2013). Water that is not moving will be unable to acquire oxygen through diffusion or aeration as discussed above and aerobic microorganisms will use oxygen as electron acceptors for metabolic activity when consuming organic matter (Shotyk, 1988). Microorganism activity will increase with increasing soil temperature, and switch from aerobic to anaerobic processes as the dissolved oxygen content decreases, thereby decreasing the redox potential of soil and

water from oxygenating to reducing. This has been shown to occur in wetlands as well as streams, rivers, and lakes (Pierce, 1953; Mitsch and Gosselink, 2007).

As dissolved oxygen decreases, potential for anoxic conditions and low redox potential develops (Mitsch and Gosselink, 2007). Dissolved oxygen levels between 4 to 16 mg/L are considered oxic, < 4 mg/L are low, < 2mg/L are hypoxic, and when 0 mg/L of oxygen remain water is anoxic (Pearsall and Mortimer, 1939). Redox potential, which is a measure of electron pressure, decreases with a decrease in available oxygen and increasing pH. The relationship between dissolved oxygen and redox potential is logarithmic, with redox potential increasing sharply as oxygen levels increase from anoxic to hypoxic, then levelling off as oxygen levels increase from hypoxic to oxic (Armstrong, 1967).

As redox potential decreases and oxygen becomes limited, at approximately 250 mV redox potential (<1 mg/L dissolved oxygen), microorganisms begin to use elements other than oxygen as electron acceptors, beginning with nitrogen, then, as redox potential decreases further, manganese, iron, sulfur and carbon are reduced in sequential order (Armstrong, 1967; Mitsch and Gosselink, 2007).

Nitrogen is one of the most limiting elements in wetland soils, primarily due to its position on the redox potential scale, which causes it to become an electron acceptor more readily than other elements. The nitrogen cycle in wetlands shows nitrogen in a variety of oxidation states, resulting in plant uptake, volatilization, or leaching as a result of denitrification (Tiner, 2005; White and Reddy, 2009). Manganese and iron reduction follows nitrate on the redox potential scale; existing in reduced forms, and

sometimes reaching toxic concentrations. This can be problematic as plant roots exude oxygen, causing the reduced forms of iron to become oxidized and form a coating on roots, preventing proper nutrient exchange (Verhoeven, 2009). The reduction of sulfur, which follows on the redox potential scale, can cause a buildup of hydrogen sulfide, which can be toxic to plant roots, limit availability of sulfur to plants, or immobilize zinc and copper; however this is more common in saltwater wetlands, due to increased levels of sulfates (Mitsch and Gosselink, 2007). The reduction of carbon requires very low redox potentials, below -200 mV, and can lead to methane emissions and fermentation.

Electrical conductivity (EC), expressed in µS/cm (microsiemens per centimetre) or ms/cm (millisiemens per centimetre), is a measure of water's ability to conduct an electric current (Chang et al., 1983). The rate of the electric current depends on the concentration and charge of dissolved ions in solution, and temperature of the solution. Electrical conductivity values increase as ion concentration and ion charges increase. With regard to temperature, electrical current and temperatures increase concurrently (Lloyd and Heathcote, 1985).

While the activity of ions can be measured with EC, the specific ions in solution cannot be read with an EC tester (one ion cannot be distinguished from another). Total dissolved solids (TDS), however, can be inferred from EC values; an increase in EC equals an increase in TDS (Atekwan et al., 2004; Lloyd and Heathcote, 1985). Electrical conductivity values increase as water moves through mineral soil and bedrock as electrolytes from the mineral component of the soil are dissolved into the

water, raising the ion concentration. Soil and bedrock composition, therefore, will affect EC values. Further, evaporation of mineral rich water will increase the concentration of dissolved solids (Lloyd and Heathcote, 1985).

With regard to wetlands, electrical conductivity can be an indicator of a mineral versus an organic water source, with lower EC values being found in organic derived water, such as from bogs or surface flow, due to a lack of interaction with dissolved ions, and increased organic acids (Shotyk, 1988). High EC values in wetlands, indicating mineral water, can provide information about mineral content of wetlands if there is some knowledge of parent material mineral composition, and will impact vegetation composition on the site (Schwintzer and Tomberlin, 1982). Also, wetlands located upstream of fish bearing streams may contribute to the TDS content of streams and rivers, which can be detrimental to fish populations.

Water pH, referring to acidity or alkalinity of soil water, is a measure of hydrogen ion concentration. Low soil pH generally indicates low base cation availabilities for plant use while increasing the solubility of toxins such as aluminum and manganese ions (Brady and Weil, 2002).

Controlling factors of pH include bedrock type, climate, organic matter, and vegetation type (Brady and Weil, 2002).

Bedrock weathers to form the mineral component of soil, which contains base cations, such as calcium (Ca), magnesium (Mg), and potassium (K); and as such, the composition of the minerals in soil and soil water depend on the mineral composition of

bedrock (Brady and Weil, 2002; Shotyk, 1988). As groundwater passes through mineral soil, hydrogen ions are attracted to soil particles, thereby increasing pH; the effect of which is increased with a decrease in soil particle size (Brady and Weil, 2002).

Climatic effects, precipitation and evapotranspiration, will result in predominately acidic soils when the former surpasses the latter (Berner and Berner, 1987). Further, increased precipitation causes increased nutrient leaching, as well as the addition of both weak and strong acids (Berner and Berner, 1987; Leonardi and Fluckiger, 1987). Weak acids, predominantly carbonic acid, form as carbon dioxide mixes with water in the atmosphere, or at the soil surface, and can lower pH. The effect of carbonic acid is more pronounced when pH is between 5 and 7. Strong acids form as a result of the oxidation of elements such as nitrogen and sulfur, which may occur in clouds, then fall to the earth as precipitation or dry deposition. Historically lightning, forest fires, and volcanoes have resulted in the addition of sulfur and nitrogen to the atmosphere, however this has increased due to anthropogenic sources, such as fossil fuel burning (Brady and Weil, 2002).

Vegetation can affect soil pH by i) helping to control soil temperature and moisture, ii) influencing soil organic matter, and its accumulation, and iii) supplying base cations. The effect of vegetation on temperature and soil moisture depends on vegetation type and position on the landscape (Whigham, 2009). Thick forest canopies, especially those on north facing slopes, can encourage cool and moist soil temperatures, which are prevalent to acid forming processes, due to a reduction of bacterial decomposition, and an increase in fungal decomposition (Rousk et al., 2009). The type of vegetation,

specifically deciduous versus coniferous, will determine whether organic matter consists primarily of ligneous or cellulose material (Shotyk, 1988). Ligneous material, consisting of coniferous needles, decomposes more slowly than cellulose material, and therefore will accumulate on the forest floor. This accumulation of organic matter increases acid functional groups, and decreases base cation recycling, which results in soil pH decrease. Deciduous leaf litter, however, contains more cellulose, and can be broken down more easily than coniferous litter, therefore organic matter does not accumulate on the forest floor, and base cations from the organic matter are released back into the soil (Shotyk, 1988).

Organic matter accumulation will cause pH to decrease for two reasons; i) organic matter contains many acid functional groups, which release hydrogen ions into solution, increasing pH, ii) organic matter forms organic complexes with base cations, making them soluble, and subject to leaching (Brady and Weil, 2002). Cool, wet conditions, especially those found in wetlands and saturated soils, are subject to organic matter accumulation, due to lower temperatures in wet versus moist soil.

Water Temperature, a measure of heat intensity, often expressed in degrees Celsius, provides an indication of kinetic energy, and the energy available for biological processes, including both primary productivity and decomposition (Kätterer et al., 1998). As temperature increases, available energy and microbiological activity increases. As a result, temperature can be used to indicate soil respiration rates, or the peak rate of biological activity (Fang and Moncrieff, 2001). Further, storage of nutrients

such as carbon and nitrogen has been found to decrease with an increase in temperatures (Kirschbaum, 1995).

Factors influencing soil temperature include solar insolation, land form, soil moisture, and vegetation (Beaudette and O'Geen, 2009; Pierce et al., 2005). The effect of solar insolation, which includes diffuse, direct beam and reflected radiation from the sun, is controlled in part by latitude, slope and aspect (Pierce et al., 2005). The angle at which the sun's light hits the earth will determine the intensity of the direct beam radiation (Pierce et al., 2005). As a result, soils occurring at low latitudes, on south facing slopes and/or on flat topography have greater exposure to solar radiation than those at high latitudes, on north facing slopes and uneven terrain.

Land form has been shown to affect solar radiation, but it also controls moisture regimes and water accumulation patterns (Beaudette and O'Geen, 2009; Swanson et al., 1988). As water accumulates on the landscape, oxygen becomes limited, a greater degree of energy is required to heat soil, and organism activity slows (Fraser, 1957). Land form also contributes to vegetation patterns, which affect soil temperatures in a variety of ways including shading, organic matter accumulation, and moisture retention. Canopy cover intercepts solar radiation, and promotes a cool, moist and humid environment, while vegetation species presence determines organic matter accumulation based on cellulose versus lignin content of leaves and branches, as well as by absorbing and holding water at or near the soil surface (Swanson et al., 1988).

Water colour, which can be measured in platinum cobalt units (PCU), refers to the yellow to brown tint in filtered water, with clear and highly coloured samples having

low and high tints (PCU values), respectively. True colour (suspended particles removed), as opposed to apparent colour (suspended particles included), is an indicator of dissolved organic matter, including lignin, humic and fulvic acids; with bog water being shown to contain higher true colour values than fen or swamp water (Clausen and Brooks, 1983; Wallage and Holden, 2010). Clear colour in fens and swamps compared to bogs is attributed to increased movement of fen and swamp water (Schwintzer and Tomberlin, 1982). Water colour, specifically dissolved humic substances, can affect water chemistry by influencing metal complexation, light absorption and pH values (McKnight, Thurman, and Wershaw, 1985; T. R. Moore and Jackson, 1989).

Mapping Water Properties

Current research involving spatial mapping of water properties has thus far mainly focused on open water areas. Giusti and Marsili-Libelli (2009) and Khan (2012) utilized remote sensing for mapping and predicting DO in open water. Khan (2012) investigated the effect of water flow and temperature on DO. Giusti and Marsili-Libelli (2009) incorporated abiotic factors such as climate and photoperiod, and biotic factors such as sediment nutrient release and organic matter decay, in order to predict daily DO fluctuation. Costa (2006) used SAR to investigate pH and total dissolved solids of lakes in order to better understand lake evolution and distribution. Aquatic and emergent vegetation was used as a proxy for water geochemistry, which allowed remotely sensed spectral signatures to be used as water quality indicators, with three distinct lake types, ranging from low pH and TDS to high, being identified. Pongpetch (2012) studied the water quality of open swamp water, which included DO, pH, and TDS, and applied the

results to an ArcGIS mapping platform (Pongpetch and Suwanwaree, 2012). This study was applicable for open water that had been largely affected by anthropogenic processes. Rogers et al. (2012) and Wallage (2010) used remote sensing techniques to investigate dissolved organic matter (DOM) and dissolved organic carbon (DOC) in open water, with the spectral signature of the water used for water property predictions (Rogers et al., 2012; Wallage and Holden, 2010). Andersson (2008) investigated spatial properties, extracted from topographic maps and applied in ArcGIS, and their effect on DOC in stream water (Andersson and Nyberg, 2008).

The WAM process, which displays depth to water, is an ideal candidate for testing below surface water property mapping abilities based on its proven accuracy, ability to locate wet areas and wetlands based from bare-earth DEMs. The inclusion of the cartographically defined depth to water may be useful as an indicator of not only soil but water property attributes as well (Murphy et al., 2007; White et al., 2012). For example, the WAM process proved useful in the geospatial mapping of soil nitrate leaching from uplands and subsequent wet-area denitrification zones (Murphy et al., 2011). The DEM-derived stream network should also prove useful for high resolution mapping of near-surface seepage locations as these would punctuate the hyporheic zones next and along the bottom of streams and lakes. At these locations, there would be a greater flow of DOC- and mineral-carrying water which would, in turn, create “hot spots” for microbially induced processes such as the sulfate-induced conversion of mineral Hg to methyl mercury.

CHAPTER 3

RESEARCH SITES

Introduction

This chapter introduces the study areas used for data collection and mapping purposes. These areas were chosen based on availability of high-resolution images and LiDAR derived digital elevation models (DEM exemplifying a strong geographic and ecozone contrast (boreal versus temperate maritime), accessibility, and prior familiarization. The specific areas refer to the Ecosystem Management Emulating Natural Disturbance (EMEND) site 90 km northwest of Peace River, Alberta (56°44'N, 118°19'W), a wet-area complex within the University of New Brunswick Forest, in Fredericton, New Brunswick (45°56'N, 66°41'W), a stream-permeated Jack Pine (*Pinus banksiana*) plantation also in Fredericton, New Brunswick (45°53'N, 66°35'W), and a wet-area complex near Saint John, New Brunswick (45° 17'N, 66°13'W).

Ecosystem Management Emulating Natural Disturbance (EMEND) Site

The EMEND site (56°44'N, 118°19'W) belongs to the Boreal Plains Ecozone (ESWG 1995) (Figure 1). Average yearly air temperature at EMEND is 1.2°C; -17.7°C and 15.9°C for January and July, respectively. Average yearly precipitation is 431mm, with 38% falling as snow (Kishchuk, 2004).

This site is predominantly northeast sloping, with topography being defined by ground moraine and lacustrine deposits, resulting in level to slightly undulating surface; with

surface materials consisting of fine textured glaciolacustrine and glacial till deposits (Kishchuk, 2004). Elevation ranges between 677 and 880m above sea level, and drainage becomes poor as the topography levels off (Kishchuk, 2004). Mineral soil for this site consisted of primarily fine textured materials, containing few coarse fragments. Eluviation and illuviation of clay fragments was the dominant pedologic process, with luvisols being the predominant soil type, followed by brunisols and gleysols (Kishchuk, 2004).

The forest overstory consists primarily of spruce (*Picea*), pine (*Pinus*), and aspen (*Populus*), while low-bush cranberry (*Viburnum edule*), prickly rose (*Rosa acicularis*), alders (*Alnus*), and buffaloberry (*Shepherdia canadensis*) dominate the understory (Hiltz, 2014). The site consists of natural forest as well as compartments that have had silvicultural treatment, including variable retention treatments (10%, 20%, 50%, and 75% retention), and controlled fire disturbance (Kishchuk, 2004); however all areas surveyed are natural and un-harvested wetlands.

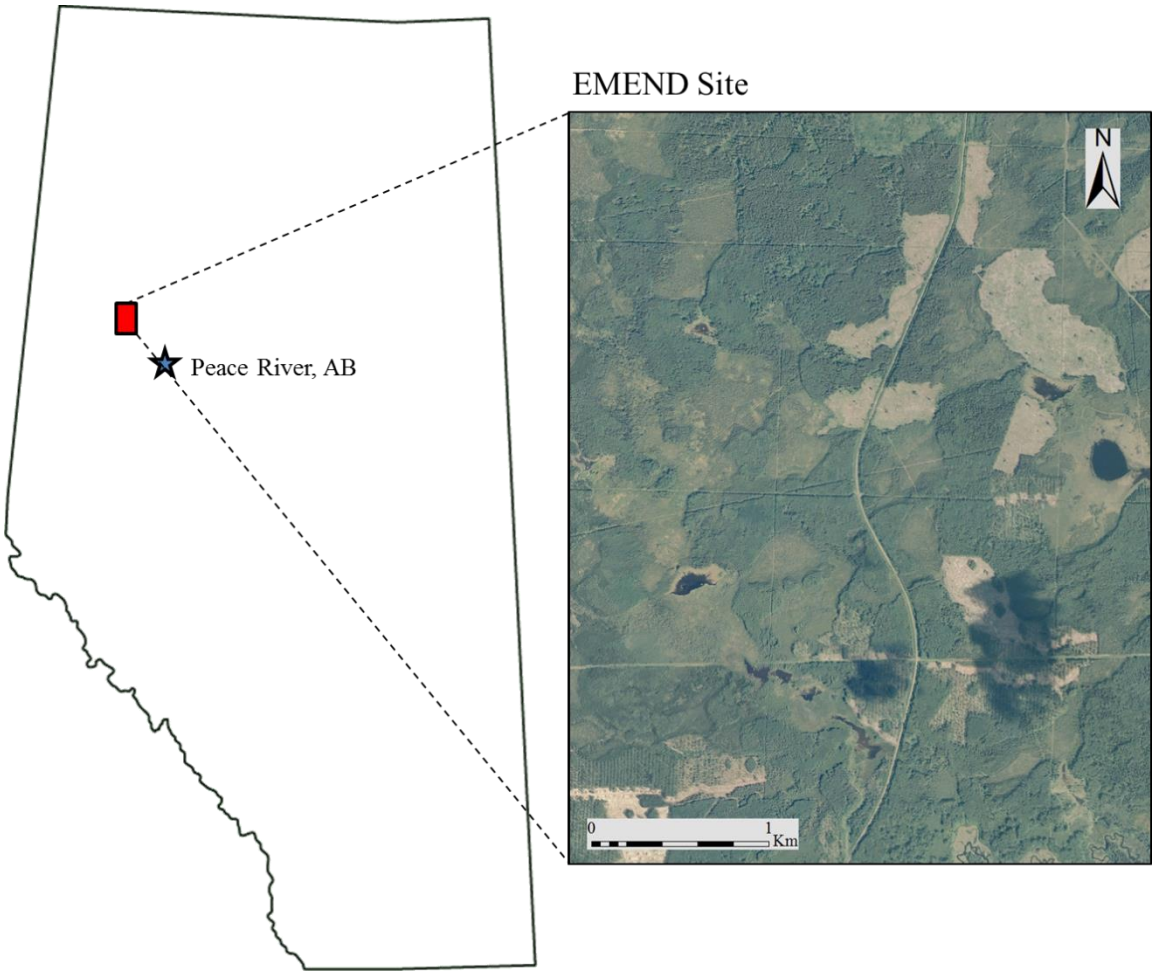


Figure 1. Location of EMEND site in northwestern Alberta (56°44'N, 118°19'W).

New Brunswick Sites

The University of New Brunswick (UNB) Forest (45°56'N, 66°41'W), Jack Pine plantation (45°53'N, 66°35'W), and the Saint John Bog (45° 17'N, 66°13'W) all belong to the Atlantic Maritime Ecozone (ESWG, 1995); with the Fredericton sites occurring in the Saint John River Valley, and the Saint John site occurring in the Southern New Brunswick Uplands (Figure 2). Average yearly air temperature for the

Fredericton sites and the Saint John site is 4.5°C and 5°C, respectively; with average air temperatures for both areas being -5°C in winter and 15°C in summer. Average yearly precipitation is 1140mm, with 23% falling as snow (ESGW, 1995).

The Fredericton and Saint John sites contain blanket and veneer glacial till, with the Fredericton sites occurring on undulating to gently rolling terrain, and the Saint John site having a more moderate rolling topography with hills and ridges, which consist of igneous bedrock with a till covering (Stobbe, 1940; Wicklund and Langmaid, 1949). Elevation ranges between 105 and 120m above sea level for the Fredericton sites, and approximately 70 to 80 m elevation for the Saint John site. Drainage varies considerably for both sites; however it is generally rapid, with poorly drained areas occurring in gently undulating topography (Stobbe, 1940; Wicklund and Langmaid, 1949).

Mineral soil for both sites is predominantly podzolic, having developed from glacial till, most notably grey sandstone; gleysols and brunisols occur less frequently (Stobbe, 1940; Wicklund and Langmaid, 1949). The Saint John site has some component of resistant rocks such as granite and shale, which have eroded from bedrock material.

Both the Fredericton and Saint John sites consist of mixedwood Acadian forests, with sugar maple (*Acer saccharum*), red maple (*Acer rubrum*), white birch (*Betula papyrifera*) and yellow birch (*Betula alleghaniensis*) dominating the deciduous component of the forest, and balsam fir (*Abies balsamea*), black spruce (*Picea mariana*), red spruce (*Picea rubens*), and Eastern hemlock (*Tsuga canadensis*) being

the dominant conifers (ESGW, 1995). These sites are managed as part of ongoing forest harvest operations, however all sites surveyed were natural and un-harvested wetlands.

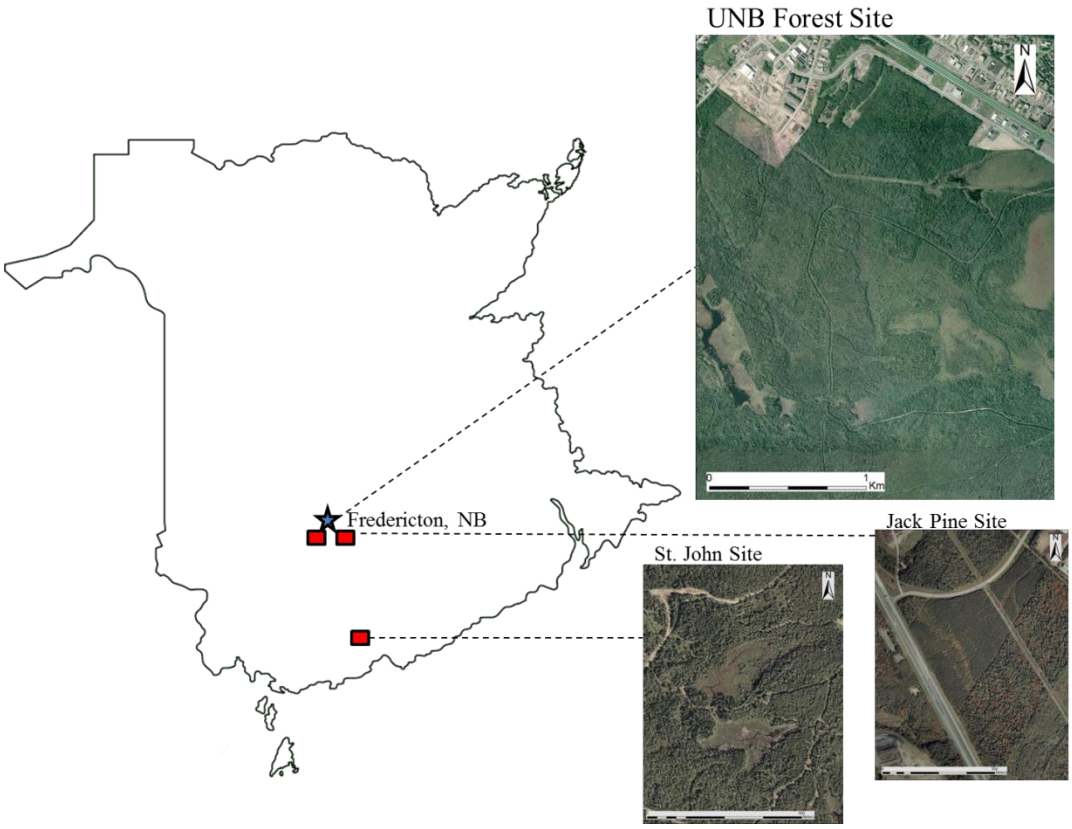


Figure 2. Location of UNB Forest (45°56'N, 66°41'W), Saint John (45° 17'N, 66°13'W), and Jack Pine plantation (45°53'N, 66°35'W) sites.

CHAPTER 4

METHODS

Sampling Design

The natural variability of landscape soils and their related chemistry requires that they be divided into similar classes for stratified random sampling (Crepin and Johnson, 1993). Therefore, prior to field excursions, data collection zones were grouped by wetland class, i.e., bogs, fens, marshes and swamps. These wetland zonations for the study areas are shown in Figure 3 and 4 the resulting plot numbers per wetland class are shown in Table 1. The sample size for each water property across the study areas contained at least 50 plots per wetland class to ensure that the plot means per class were represented at 95% confidence (Crepin and Johnson, 1993). The catchment areas above the plot locations were all within 365 ha, to underscore the intent to determine wet-area water properties as affected by the immediate areas within and above the wet-area sampling locations.

Transects were laid out across wetland classes from the highest to the lowest DTW to capture the natural variation of the five water properties from the partial to complete soil saturation, including wet-area zones, 0-10 cm, 10-25 cm, 25-50 cm, 50-100 cm, and 100-275 cm DTW, referring, respectively, to very poor, poor, imperfect, moderately well, and well-drained soil drainage conditions. (Figure 5 and 6; Table 2) (Schwintzer, 1982). Additional plots were taken along the outer boundary of wetlands, to obtain a sufficient sample size for the higher DTW classes.

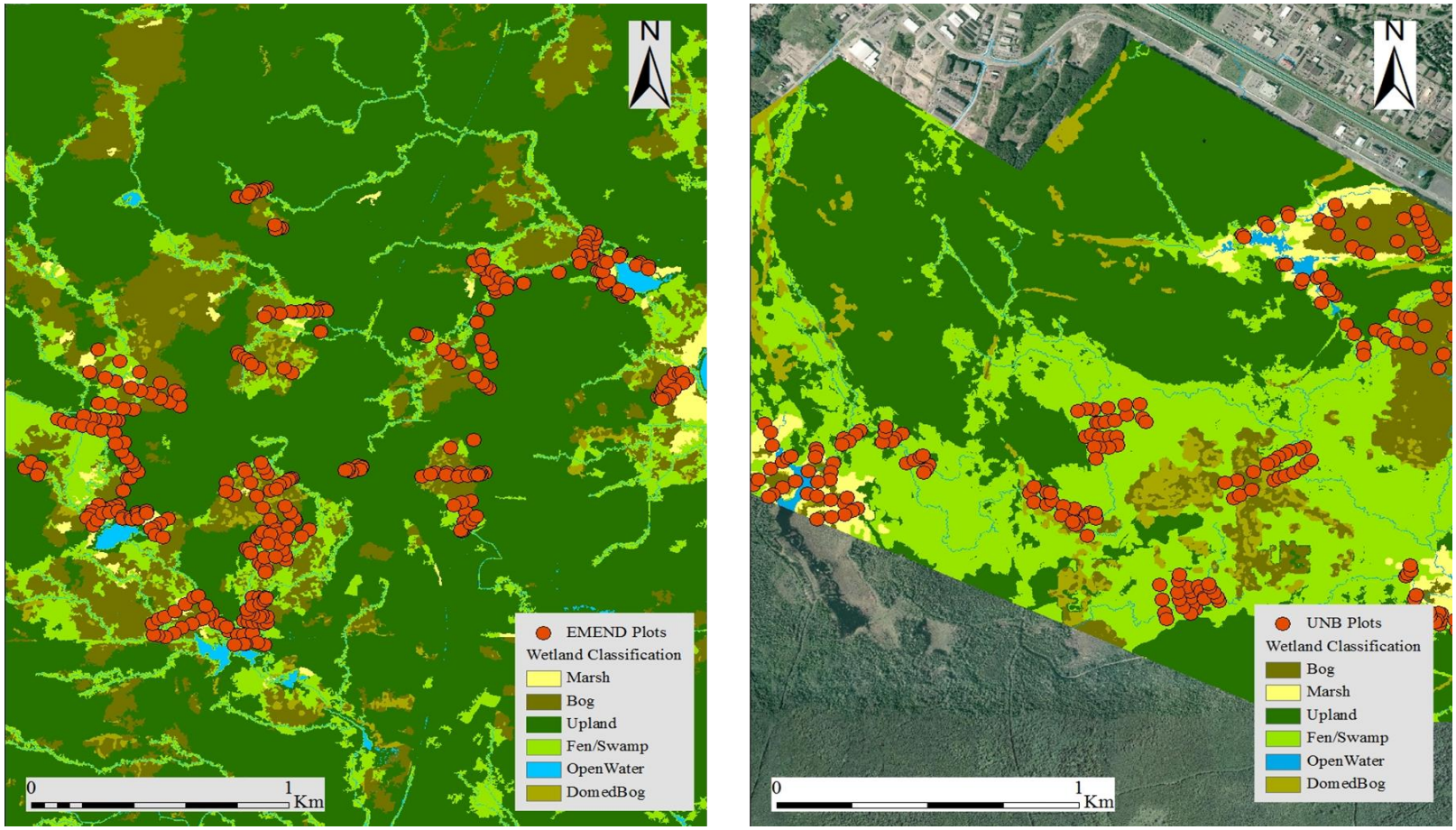


Figure 3. Location of field plots for EMEND (left) and UNB Forest (right) sites, overlaying the image derived wetland classification raster.

Figure 4. Location of field plots for Saint John (left) and Jack Pine plantation (right) sites, overlaying the image derived wetland classification raster.

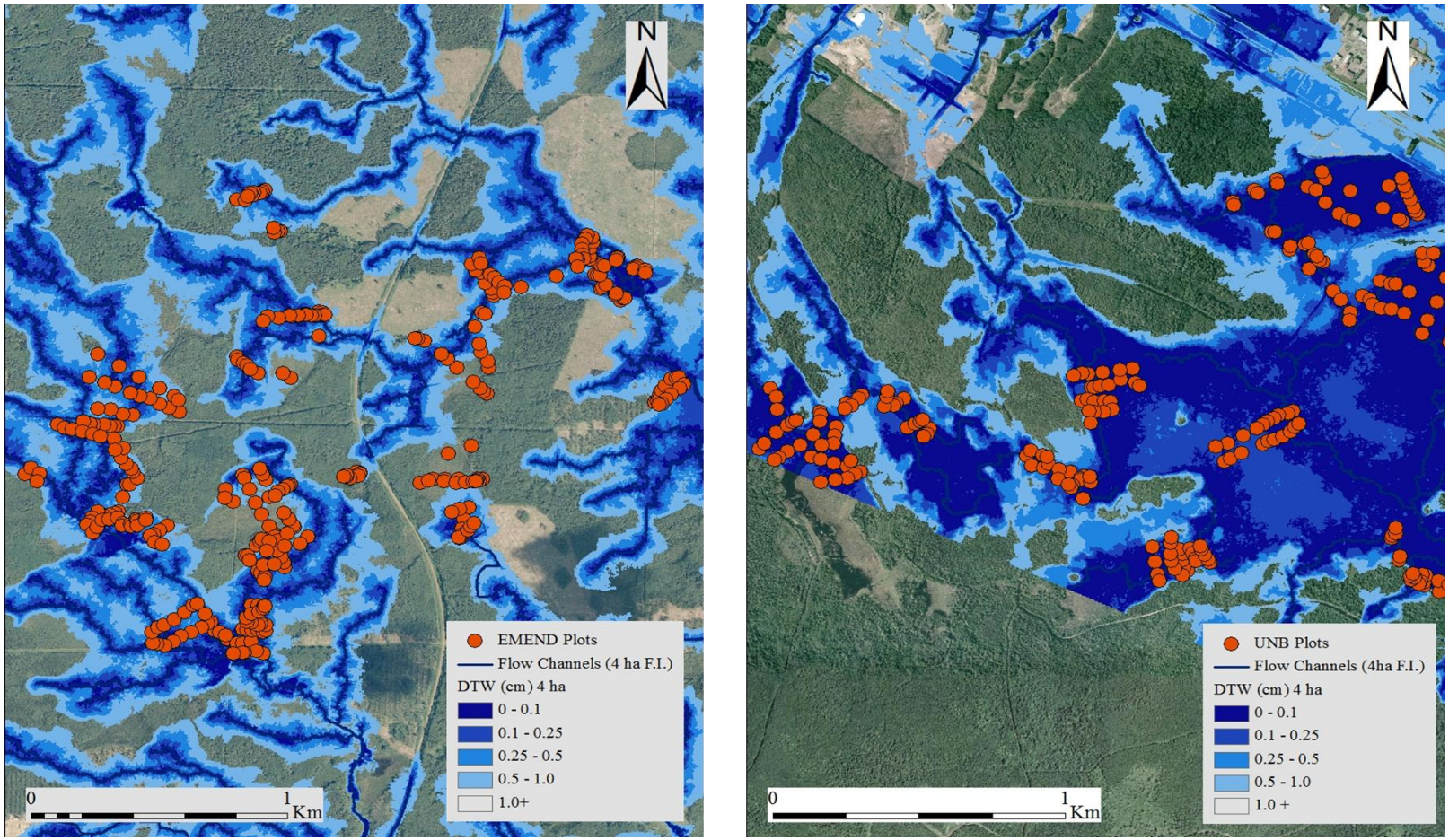


Figure 5. Location of field plots for EMEND (left) and UNB Forest (right) sites, overlaying the depth-to-water raster that is associated with the channel network with 4 ha flow initiation.

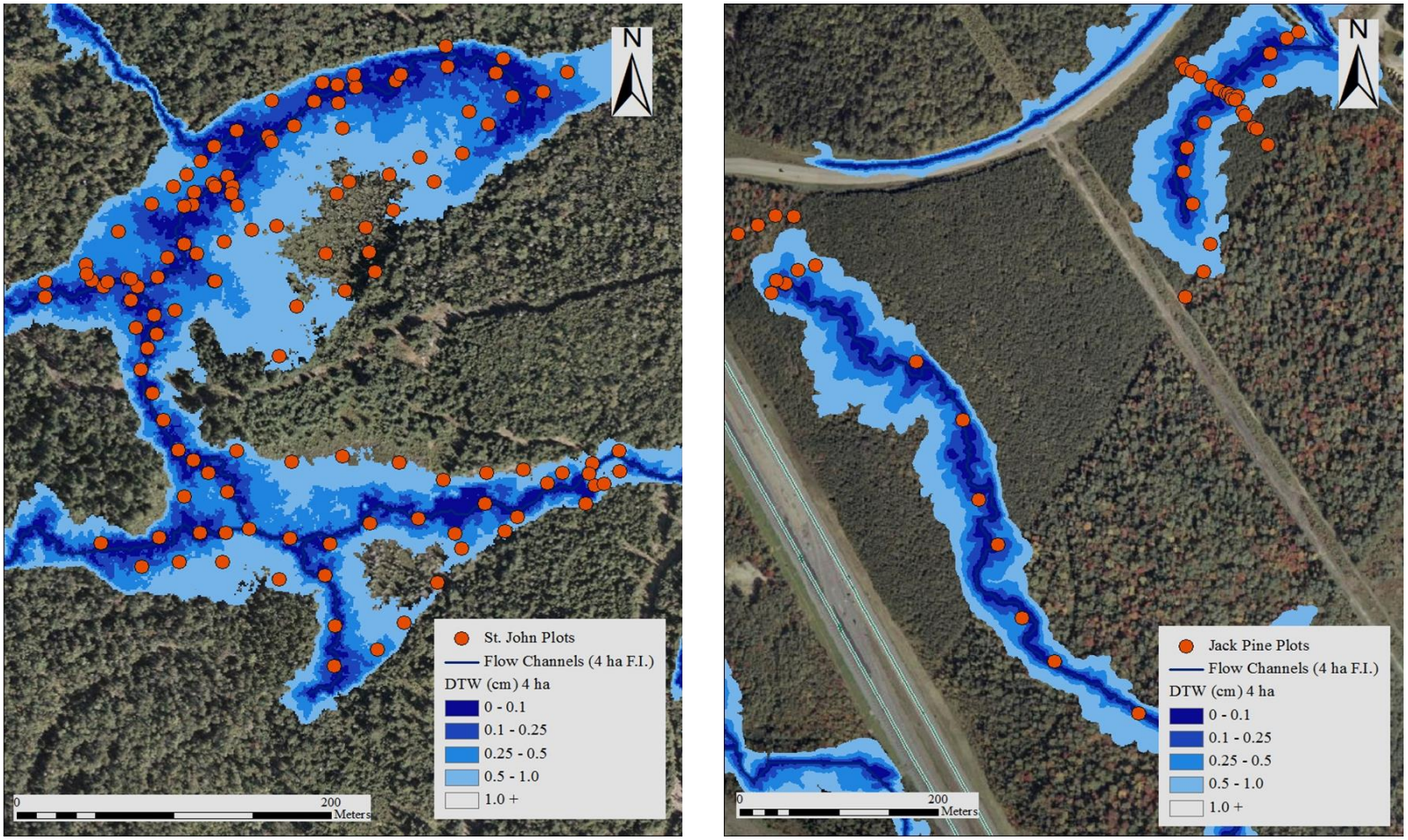


Figure 6. Location of field plots for Saint John (left) and Jack Pine Plantation (right) sites, overlaying the depth-to-water raster that is associated with the channel network with 4 ha flow initiation.

Table 1. Number of plots surveyed by site location and wetland class.

	Wetland Class					
Site	**Bog**	**Fen**	**Marsh**	**Swamp**	**Upland**	**Sum**
EMEND	78	94	42	46	79	339
UNB	118	162	145	236	20	681
St. John	21	83	0	21	7	132
Jack Pine	0	0	0	32	14	46
Sum	217	339	187	335	120	1198

Table 2. Number of plots surveyed by depth to water class (4 ha flow initiation).

	DTW Class (cm) - 4ha Flow Initiation					
Site	**0 - 10**	**10 - 25**	**25 - 50**	**50 - 100**	**100 - 260**	**Sum**
EMEND	16	82	104	70	67	339
UNB	471	169	36	3	2	681
St. John	2	24	44	33	29	132
Jack Pine	1	7	16	9	13	46
Sum	490	282	200	115	111	1198

Data Collection

In order to quantify spring-to-fall seasonal effects, plots measurements were taken for the New Brunswick study areas at three time periods, May, late June and September / October. Field measurements were taken in June and August of 2013 and in July of 2014 for the EMEND site.

Plots were accessed through ground travel and transect walking and GPS referenced with a Magellan Mobile Mapper with (+/-) 4m accuracy. At each plot, a pit was dug to approximately 50 - 75 cm or until some obstruction was reached (Figure 7). Shallow water from at or near the rooting zone (if available) was then collected into a receptacle for the DO, pH, EC, temperature, and colour measurements.

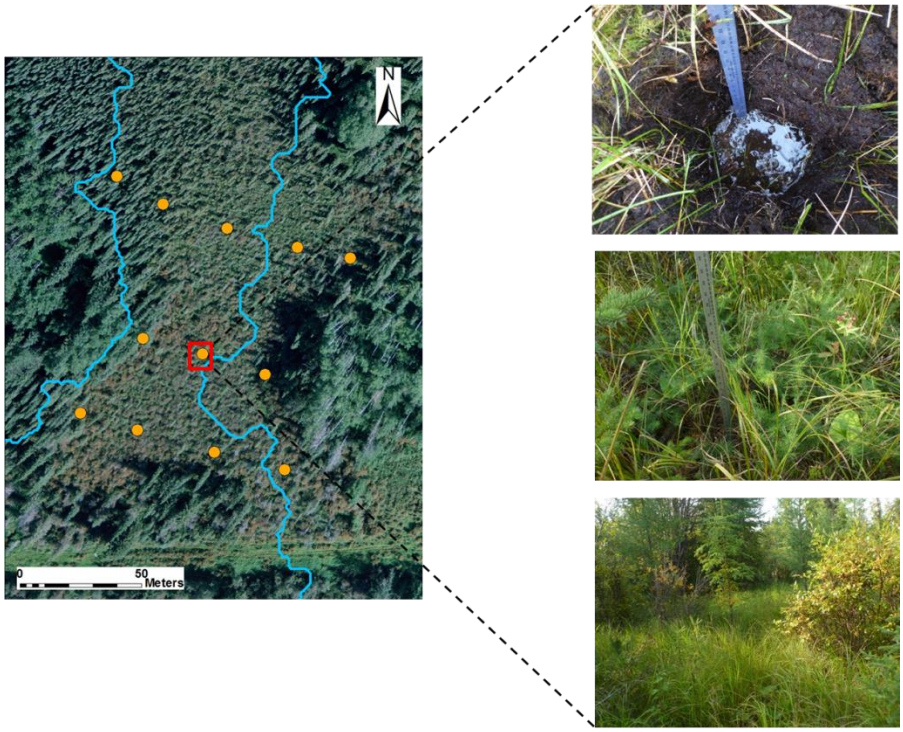


Figure 7. Example of an EMEND plot showing site details.

Dissolved oxygen was measured in situ with an optical DO metre (mg/L), YSI Professional Series PRO ODO instrument. Measurements required that the DO sensor was submerged in water for up to 35 seconds, or until the digital DO reading stabilized. The readings had an accuracy of ± 0.2 mg/L. **EC** was measured in situ with a Waterproof EC Tester (µS/cm), Eutech Instruments; Oakton. The instrument sensor was placed in water until the digital reading stabilized. All readings were accurate to ± 1% of the readings, and were normalized to 25°C. **Water pH** was measured in situ with a Waterproof pH tester 30, Eutech Instruments, Oakton, with ± 0.01 pH accuracy. The pH measurements were taken once the prone readings stabilized. All pH readings were automatically normalized to 25°C. **Water temperature** was measured with a Taylor

digital Thermometre (°C). The thermometre was placed in the water directly in the pit until the digital reading settled. Measurements were accurate to ± 0.1 °C. **Water colour** was determined using a 250mL sample, which was filtered with a 40µm filter paper to remove suspended materials, and measured with a Hanna Colour of Water Portable Photometre (PCU), accurate to ± 10 PCU.

Additional plot data were generated by determining plot-specific tree height, vegetation presence by species, and forest floor and/or peat depth (Zoltai 1995). All trees / shrubs within 5 metres from the plot centre were recorded and dominant types; hardwood, softwood, shrub and mixed were determined based on relative dominance (> 50% cover) within the plot area. A tree representing the average canopy height per plot was chosen and measured with a Suunto Hypsometre. Ground vegetation surveys consisted of recording all species within a $1m^2$ plot near the centre plot (Hiltz, 2014). Six photos were taken at each plot for visual reference pointing downward, skyward and along the basic cardinal directions (north, east, south, and west).

Wetland Classification

A combination of techniques involving aerial imagery, LiDAR-derived topographic data, and wet-area mapping attributes were used for wetland classification based on the Canadian Classification System wetland definitions. These definitions referred to domed bog, basin bog, fen/ swamp, marsh and non-wetlands, or uplands (Appendix V). The image-based wetland classification was done using the ArcGIS supervised image classification tool. The images as acquired from the Government of Alberta (ESRD)

and the Government of New Brunswick (SNB) had a 1m lateral resolution. The supervised classification process involved selecting training areas each specific to a particular wetland class, to be used as guiding input for the automated Maximum Likelihood Classification process. This classification was successful for the delineation of fens, swamps and marshes. The domed or raised bogs area delineated from the high-resolution bare-earth LiDAR DEMs using the Standard Deviation of the Focal Statistics tool in ArcGIS: standard deviation greater than 0.1m within 10 m circles within any centre cell would locate raised bogs within their wet-area zones. Also, the 0 and 0-10 cm DTW zones were classified as open water zones, and fen/swamps, respectively.

The Near tool in ArcGIS was used to determine the distance each classified plot was to the nearest matching wetland class for quantitative assessment of the wetland allocation, and field measured wetland class results were compared graphically with ArcGIS derived wetland allocations for visual determination of conformance.

Wet-Areas Mapping.

Wet area maps were created using the LiDAR derived DEMs (< 1m lateral accuracy) as per Murphy et al. (2011) by applying the FILL tool in ArcGIS to remove depressions in the point cloud LiDAR data and then deriving flow direction, slope gradient and flow accumulation using the D8 and D-infinity algorithms. Four hectare and 1 ha flow accumulation thresholds, emulating end of summer flow conditions, and periods of excessive precipitation, respectively, according to White et al. (2012), were used to display predicted streams across the study sites. Slope and distance from DTW = 0

locations will then be used to determine the depth to water below the soil surface (Murphy et al. 2011). Depth to water is calculated with the following equation:

$$\text{DTW(m)} = \left[\sum \frac{dz_i}{dx_i} a\right] x_c \qquad \text{Equation 1}$$

where dz/dx represents the slope for each cell, i represents each cell along the flow path, a represents the value determined by flow across a cell, and x represents the cell size in metres. Two wet-areas mapping procedures were used: (i) the "standard Alberta" method, i.e., all LiDAR-located wetlands were automatically assumed to be flat and were assigned a DTW value of 0, and (ii) the original method, i.e., only streams and open water bodies were assigned a DTW value of zero. The former method is important for outlining the extent of wet area features, whether it is a bog, fen, swamp or marsh, and when knowing the changes in DTW within these features is not important, such as, for specific operations planning, such as delineating harvest block layout and road access. The original method was used for the purpose of this thesis, because this method automatically assigns DEM-defined DTW and flow accumulation values across the landscape and inside wetlands. This is important because the five water properties being researched could - in principle - be differently affected by each local combination of flow accumulation the depth-of-water below the surface of the ground. Two datalayers, i.e., **DTW(4ha)** and **DTW(1ha)** were derived based on the 4ha and 1ha flow initiation thresholds.

Derivation of Geospatial Datalayers

Various geospatial datalayers were derived from LiDAR generated point cloud data using ArcGIS raster manipulation software; listed in Table 3 and described in this section.

Table 3. Categorical and continuous variables used for predicting water properties.

Continuous Variables	Categorical Variables
Depth to Water	Site
Flow Accumulation	Season
Slope	Wetland Class
Curvature	Wetland Class by Site
Tree Height	Evapotranspiration/Precipitation (Ratio)
Potential Relative Radiation (PRR)	Hydraulic Conductivity
Ratio*PRR	
Mapped Water Properties	

The DEM-derived Flow accumulation (FA) values were converted to **$\log_{10}$FA** the values were converted into mean values for each circular 50 and 150m neighborhood around each raster cell, to generate the **mean $\log_{10}$FA (50m)** and **mean $\log_{10}$FA (150m)** datalayers, using ArcGIS focal statistics.

Slope rasters referred to as **Slope(5m)**, **Slope(10m)**, **Slope(20)**, **Slope(50m)**, **Slope(150m)** and **Slope(500m)** were generated from the 5, 10, 20, 50, 150 and 500m circular neighborhoods of each raster cell, average with ArcGIS focal statistics. **Height of vegetation** was determined by subtracting the last (full feature) from the first (bare earth) point cloud LiDAR returns using the Raster Calculator tool in ArcGIS. **Curvature rasters** were created by applying the ArcGIS Curvature tool to the LiDAR

generated bare earth DEM (1 m resolution). Average values within 5m, 50m, and 100m were determined for each site using the Focal Statistics tool. Curvature values consisted of three types of curvature; i) profile curvature, ii) planform curvature, and iii) combination of profile and planform curvature. Profile curvature is parallel to the direction of slope, while planform curvature is perpendicular to the direction of slope (Buckley 2010).

The bare-earth DEM was also used to determine the extent of **Potential relative radiation (PRR)**, following Pierce (2005). This was done by using the ArcGIS hourly hillshade tool for all growing-season daylight hours, i.e., any month having an average temperature above 5°C. The resulting hourly values were summed to get daily, monthly and growing-season totals.

In order to represent the climatic effect for the four study areas, a **ratio of evapotranspiration over precipitation** was calculated. This ratio was multiplied to PRR using the Raster Calculator in ArcGIS, to obtain an index that accounts for local climate differences among the study areas.

Data Compilation

All field determinations and plot-extracted data layer values were assembled into a spreadsheet and organised primarily by location and sampling date. This compilation involved the previously mentioned numerical and categorical variables (Table 3), as well as sampling date, photo reference numbers, plots specifics (vegetation species, and forest floor / peat depth).

The wetland class specification was based on the Canadian Wetland Classification Guidelines (NWWG, 1997). The classes were specified by name (bog, fen, marsh, swamp, upland) and the names were then coded as 1 when applicable and 0 when not, as follows. Similarly, the study area locations were identified by name and by 0 and 1 coding as follows in Table 4 and 5.

Table 4. Coding used for the wetland classes.

Plot	Bog	Fen	Marsh	Swamp	Upland
1	1	0	0	0	0
2	0	1	0	0	0
3	0	0	1	0	0
4	0	0	0	1	0
5	0	0	0	0	1

Table 5. Coding used for the study locations.

Plot	EMEND	UNB	Jack Pine	Saint John
1	1	0	0	0
2	0	1	0	0
3	0	0	1	0
4	0	0	0	1

The wetland classes were further distinguished by way of their expected hydraulic conductivity values (Clapp and Hornberger, 1978; Letts 2000) and were assigned to bogs, fens/swamps, marshes, uplands, and open water (uplands varied for each site) (Table 6).

Table 6. Hydraulic conductivity values for wetland classes and uplands.

Substrate HC (cm/second)	
Bog Domed: 0.028	Upland EMEND: 0.0002451
Bog Basin / Marsh: 0.0002	Upland UNB: 0.0034563
Fen / Swamp: 0.00001	Upland SJ / JP: 0.0009644
Open Water: 0.5	

The continuous and categorical variables were viewed in histograms and box plots for visual examinations of the data distribution by categorical variables: (i) data that were skewed were log or square-root transformed to obtain normally distributed variables to be used as possible independent regression variables; outliers among the data were identified, and retained if judged to be free of error.

Data analysis

Data analysis involved correlation and multiple regression analyses. The regression analysis adopted DO, pH, EC, Temperature, Colour as the dependent regression variables, and used the previously listed continuous and categorical variables as independent variables. The correlation coefficient of all measured variables, except for forest floor depth, was also determined, and those with high correlation coefficients were tested for use in the predictive model, whether or not they could be used to map water properties (Table 7). Forest floor / peat depth could not be used as a quantitative variable because it was often not possible to measure the entire depth of the organic soil layers.

Table 7. Plot-determined variables: Pearson correlation coefficients.

	DO	pH	EC	log10EC	Temperature	Color	Dom. Tree	Ground Veg.
DO	1.000							
pH	0.144	1.000						
EC	0.222	0.435	1.000					
$\log_{10}$EC	0.177	0.549	0.725	1.000				
Temperature	-0.149	-0.038	-0.176	-0.296	1.000			
Color	-0.111	-0.435	-0.272	-0.218	-0.085	1.000		
Dom. Tree	-0.145	0.128	-0.167	-0.292	0.392	-0.134	1.000	
Ground Veg.	-0.191	-0.445	-0.214	-0.290	0.119	0.158	-0.080	1.000

Variables that had the strongest influence on the dependent variables were retained through step-wise deletion. Best-fitted results were retained if (i) the R^2 value of the best-fitted regression model would increase significantly, (ii) the best-fitted scatter plot of actual versus modelled would be linear and more or less evenly distributed about the 1:1 line, (iii) the coefficients of the retained regression variables would have a low error of estimate, a high t-value, and p-values < 0.001.

Regression analysis began by plotting the predicted results from the regression equation in order to visually assess normality of the residuals. The test data set, consisting of values that were set aside and not used for model formulation, was then used to compare actual versus predicted results. The set of 100 randomly selected test plots contained samples of each wetland class and location (Table 8).

Table 8. Number of verification plots by location/season and wetland class. Total number: 100.

Site	#Plots	Class	#Plots
Emend	23	Bog	20
UNB-spring	15	Fen	30
UNB-summer	15	Marsh	15
UNB-fall	27	Swamp	29
SJ	16	Upland	6
JP	4		

Scatter plots and correlation coefficients were developed to quantify the ability of the model to predict test data. Further data analysis involved averaging of all wetland class data, for both EMEND and NB, and quantifying their relationships. Actual versus predicted average values were plotted, and correlation coefficients were determined in order to show general data trends and predictive results based on wetland class. In order to display and quantify the model's ability to predict water properties across wetland classes, actual and predicted values for each wetland class: bog, fen, marsh, swamp, and upland, were grouped and correlation coefficients were determined. Data outliers, for all data analyses, were investigated for reasons of possible non-conformance.

Map Water Properties Using ArcGIS

The ArcGIS Raster Calculator was used to project the dependent regression variables based on the best-fitted regression equations. The resulting rasters where then overlaid by the corresponding plot derived values for the dependent variables such that the projected and plot-based values would be coded to have the same colour, to enhance visual data to map comparisons. The values so mapped would then be compared with

plot-based values used for the regression analysis, for verification purposes. This was a done by quantifying the trend of the plot-based values against the map-projected values.

CHAPTER 5

DISSOLVED OXYGEN

Introduction

This chapter deals with DO as reviewed in Chapter 2 of this thesis. The site details and methodology for this chapter can be found in Chapters 3 and 4 of this thesis, respectively. The primary goal of this research is to determine if shallow water DO can be mapped using remotely sensed data, primarily LiDAR derived WAM and topographic attributes, while accounting for wetland class and seasonal variation. The resulting map would identify areas that typically have higher/lower oxygen demand, and therefore demonstrate the accompanying ecological characteristics, such as specific vegetation presence/absence.

Results

A total of 1198 DO plots were measured at the EMEND and NB locations, which included all wetland classes and seasonal variation at the UNB Forest (Figure 8 and Figure 9). DO values were transformed for use in regression analysis using the formula:

$$Calculated\ DO = log10\ (DO/(DOmax - DO)) \qquad \text{Equation 2}$$

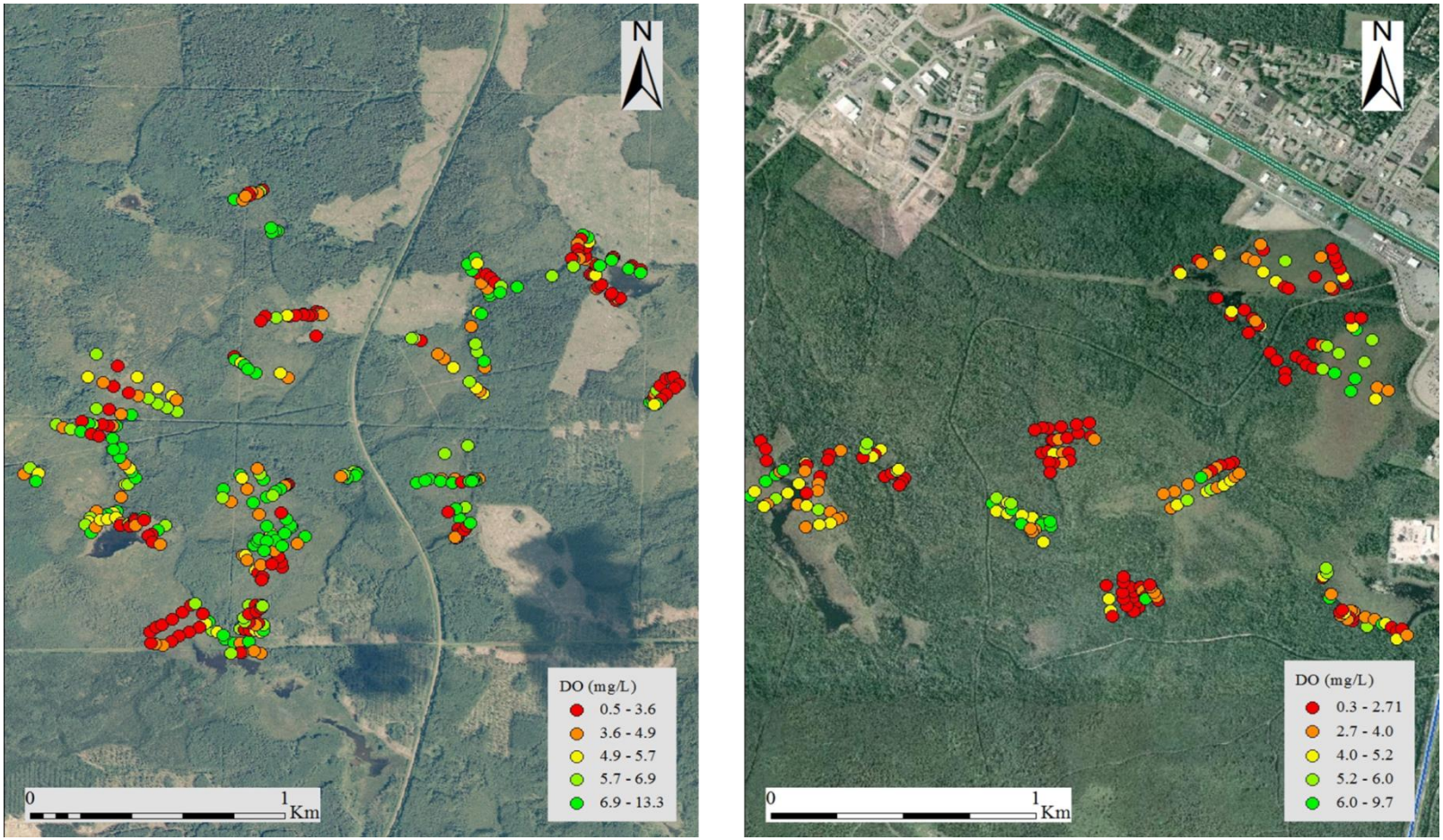


Figure 8. EMEND (left) and UNB Forest (right) plot locations with measured DO.

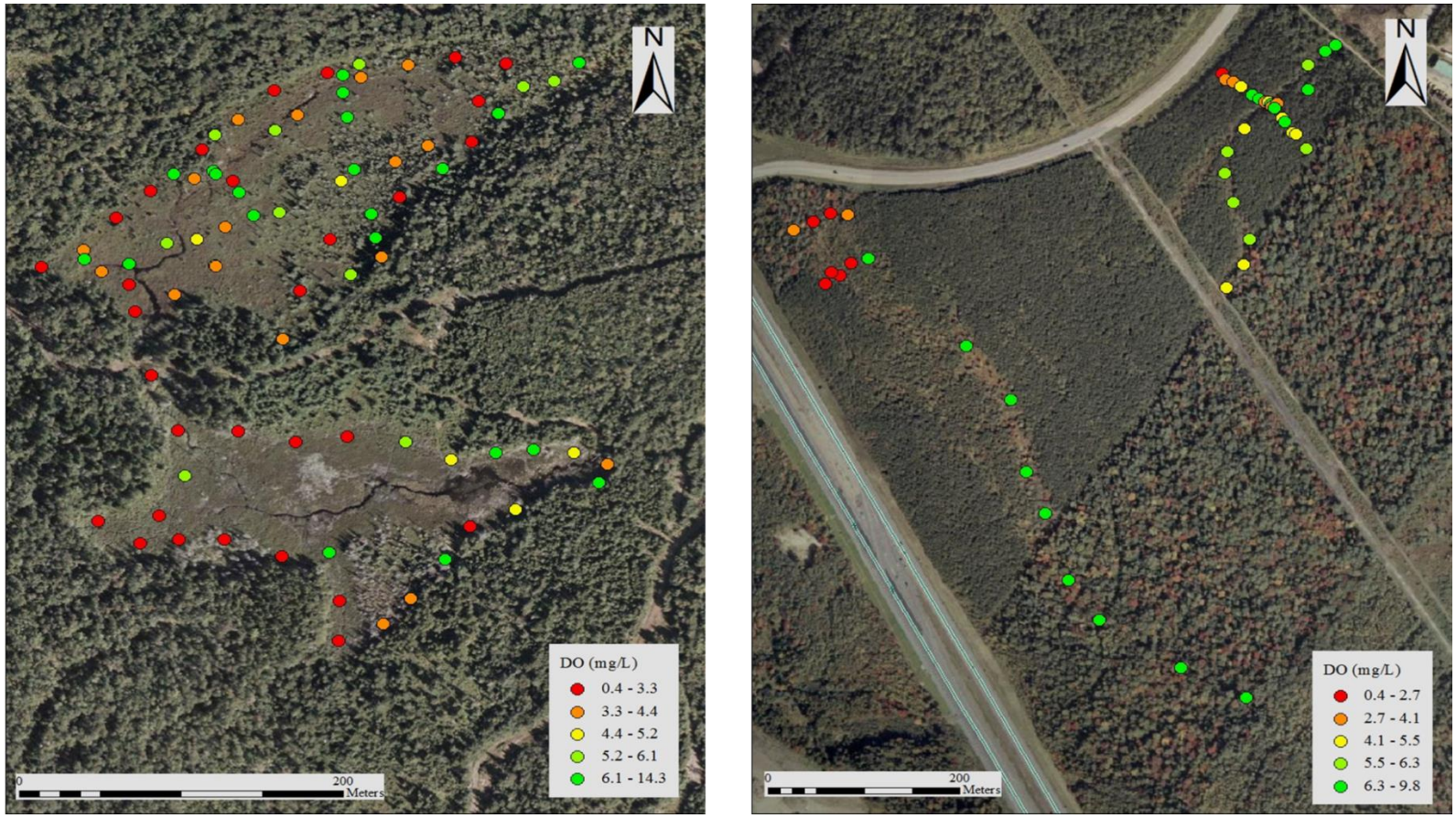


Figure 9. Saint John Wetland (left) and Jack Pine (right) plot locations with measured DO.

A summary of all measured DO values based on wetland and depth-to-water classes showed that DO values were highest in uplands and bogs and lowest in marshes and fens; while DO and DTW increased concurrently (Table 9).

Table 9. Summary of DO values by wetland and depth-to-water classes

Dissolved Oxygen (mg/L)									
Class	**Min**	**Max**	**Mean**	**Std dev**	**DTW (cm) 4 ha**	**Min**	**Max**	**Mean**	**Std dev**
Bog	1.1	12.6	4.9	2.3	**0 - 10**	0.3	12.2	3.3	2.0
Fen	0.3	14.3	3.6	2.7	**10 - 25**	0.4	13.3	3.9	2.5
Marsh	0.4	13.3	3.6	2.5	**25 - 50**	0.5	12.7	5.0	2.7
Swamp	0.4	10.0	3.9	2.4	**50 - 100**	0.4	14.3	5.6	3.0
Upland	1.4	10.6	6.4	2.0	**100 - 275**	0.5	11.3	6.2	2.4

Boxplots showing the distribution of transformed DO values for both site and wetland class revealed three common outliers, which were removed from the data set due to possible influence of open water on the measurements (Figure 10). While a graphical demonstration of average DO based on site and season showed DO values were lowest at UNB, most notably in the summer (Figure 11).

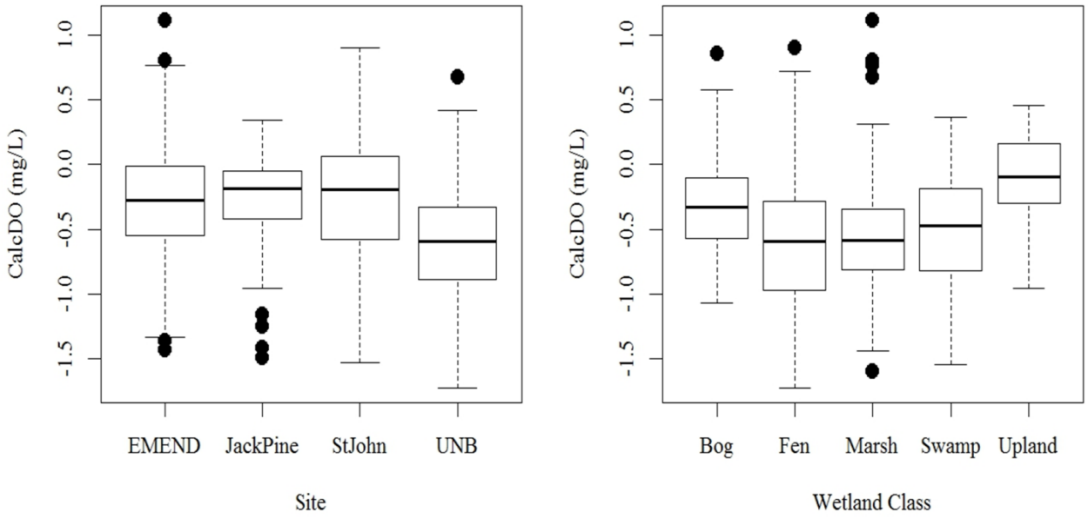


Figure 10. Boxplots showing the 10th, 25th, 50th, 75th and 90th percentiles of transformed DO distributions by site and wetland class, with outliers.

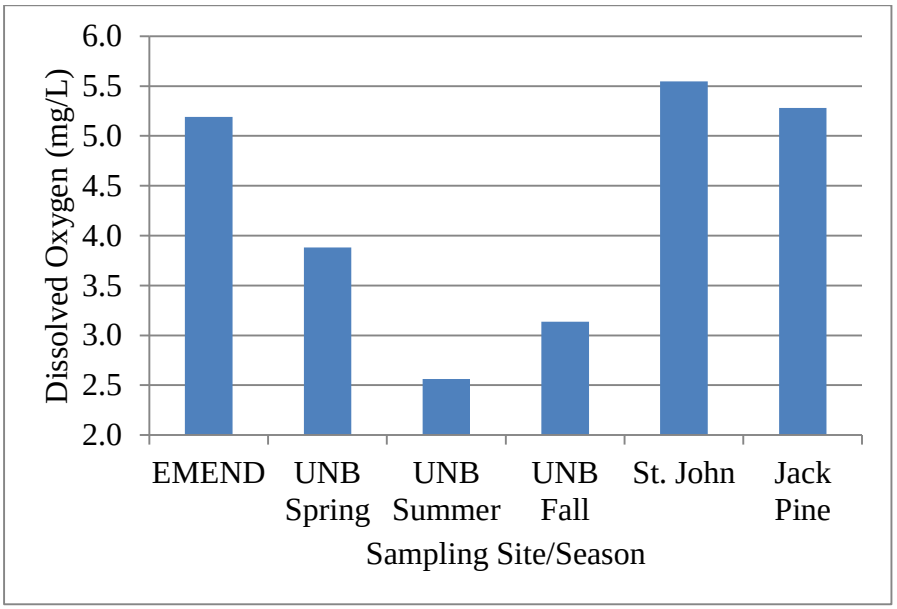


Figure 11. Average field-determined DO values by site and season.

Multiple regression analysis revealed that among the continuous and categorical variables (Table 3) available for predicting DO; UNB summer, $\log_{10}$DTW (4ha flow initiation), $\log_{10}$PRR, and $\log_{10}$HC were the most important variables for explaining observed DO trends ($R^2 = 0.35$) (Table 10; Figure 12). Residual values were shown to have a normal distribution (Figure 13). Outliers, values which were found to be inconsistent with the majority of plots that had similar landscape attributes, were determined by visual analysis of the residuals, and when removed gave an $R^2 = 0.38$. Correlations between DO and field measured variables demonstrated weak relationships, among which the strongest was between DO and EC, which had a correlation coefficient of 0.22; and as such, measured variables were not used for predicting DO (Table 11).

Table 10. Best fit predictive variables used to model DO ($R^2 = 0.35$) using multiple regression analysis.

	Coefficient	**Std. Error**	**Std. Coefficient**	**t-Value**	**P-Value**
Intercept	6.04	1.019	6.04	5.9	<0.0001
UNB Summer	-0.22	0.034	-0.163	-6.4	<0.0001
$\log_{10}$DTW (4ha)	0.198	0.022	0.242	8.8	<0.0001
$\log_{10}$PRR	-1.47	0.256	-0.154	-5.7	<0.0001
$\log_{10}$HC	0.118	0.007	0.435	17.8	<0.0001

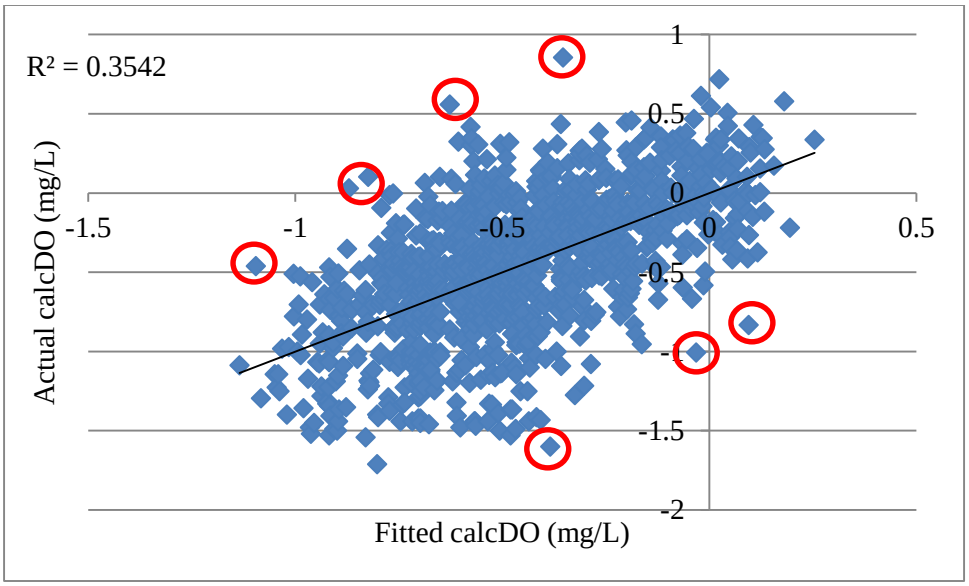


Figure 12. Scatterplot of actual versus predicted transformed DO values, with best fit regression line; outliers in red.

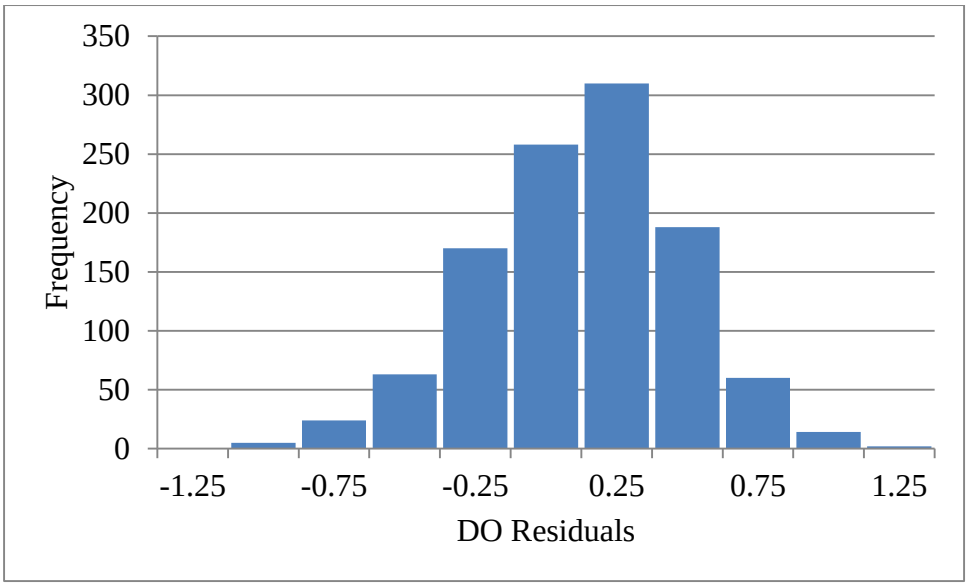


Figure 13. DO model: frequency distribution of the residuals.

Table 11. Correlation coefficients between DO and all measured variables.

	Correlation Coefficient
	DO
DO	1.00
EC	0.22
$\log_{10}$EC	0.18
pH	0.14
Color	-0.11
Dom. Tree	-0.14
Temperature	-0.15
Ground Veg.	-0.19

Wetland classification for each study site showed generally good conformance between field measured and image determined wetlands, with field measured wetland classes occurring within 10m of image class determined wetlands >80% of the time (Appendix V). Specific wetland forms; domed bogs, and open water, were within 60m of ArcGIS determined wetland forms >80% of the time (Appendix V). Correlations between actual, predicted and mapped DO (Table 12) revealed a better relationship between actual versus predicted, then actual versus mapped DO values.

Table 12. Correlation coefficients for actual, predicted and mapped DO values.

	Correlaton Coefficient
	DO Actual
DO Actual	1.00
DO Predicted	0.60
DO Mapped	0.41

The DO rasters created using the best fit multiple regression equation provided a data layers that reveal general visual conformance across all sites and wetland classes (Figure 14 and Figure 15).

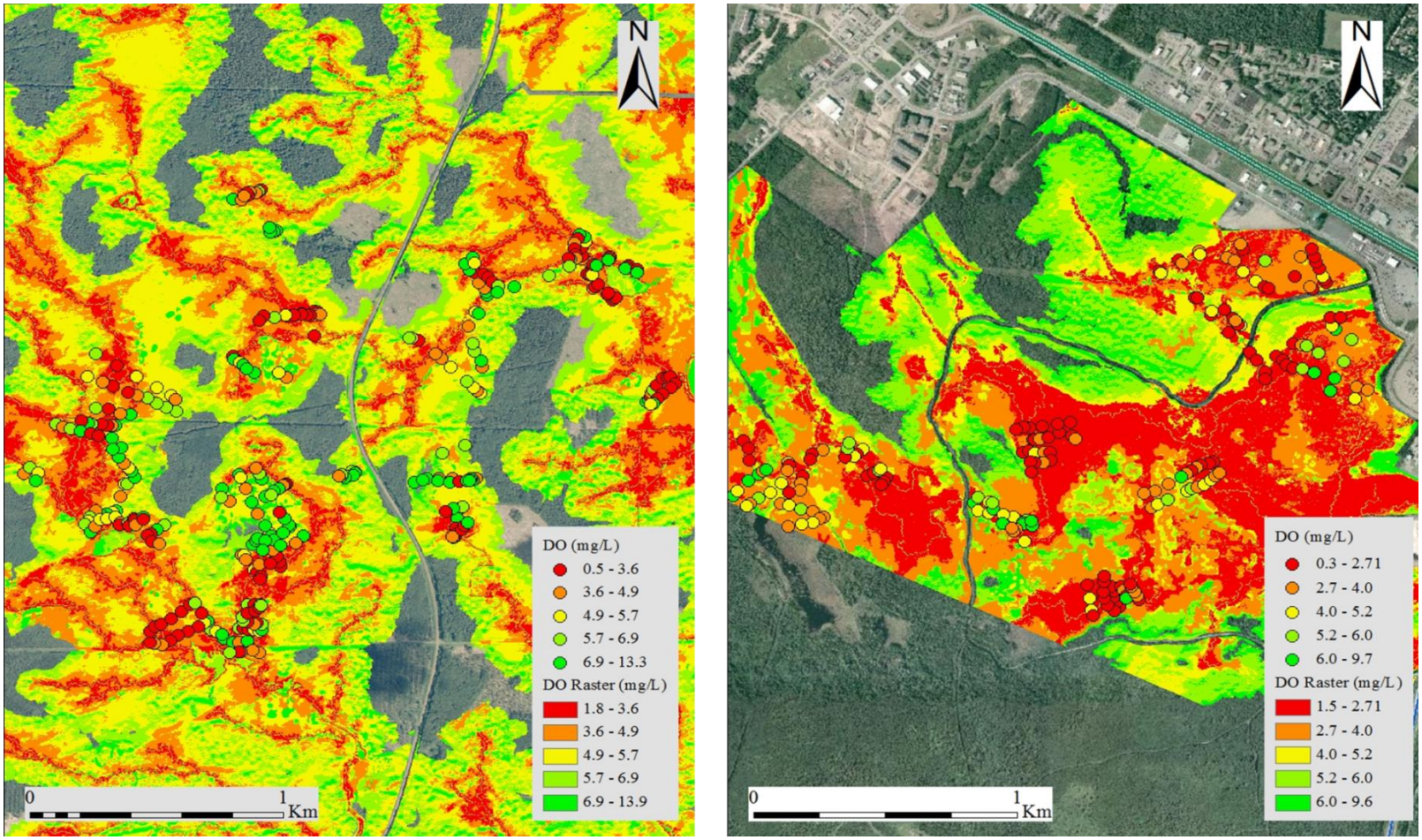


Figure 14. Field-determined DO values overlaying DO rasters for the EMEND (left) and UNB Forest (right) sites.

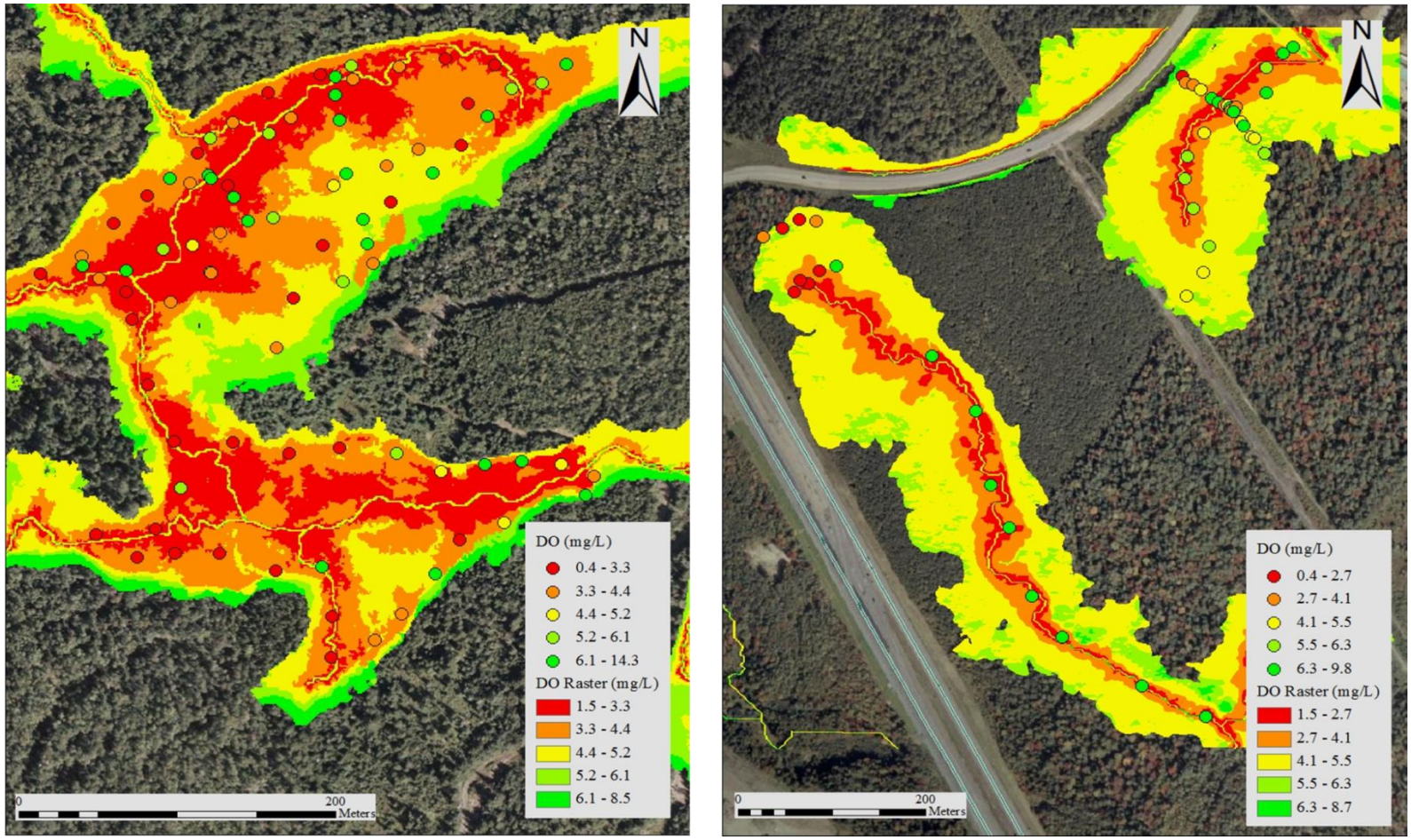


Figure 15. Field DO values overlaying DO rasters for the Saint John (left) and Jack Pine (right) sites.

Regression analysis comparing the DO of the test plots (100 extracted values) and the modelled values showed an R^2 of 0.41 (Figure 16). Average DO values for each wetland class by location revealed a correlation coefficient of 0.78 (Figure 17).

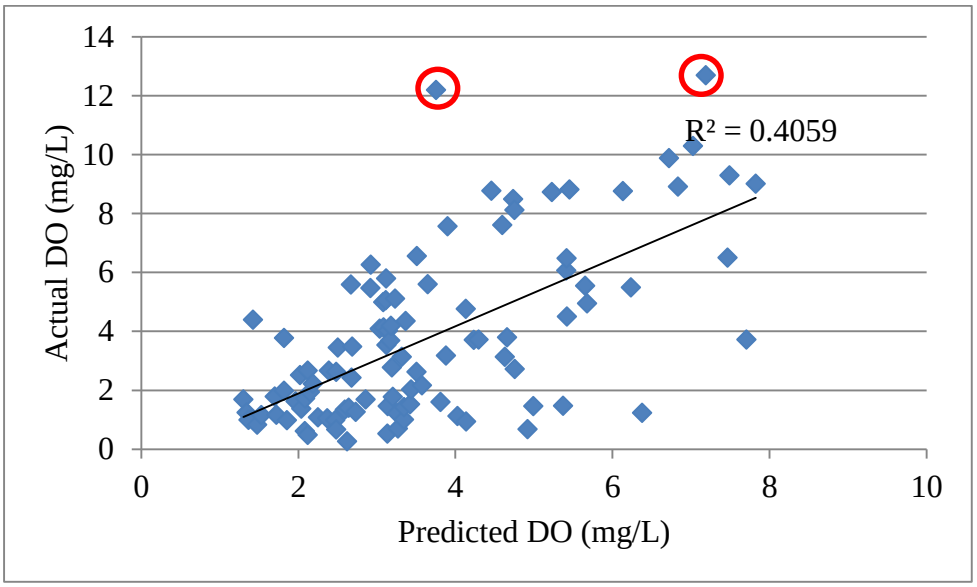


Figure 16. Actual versus predicted DO values for the 100 verification plots, with best fit regression line and outliers highlighted in red.

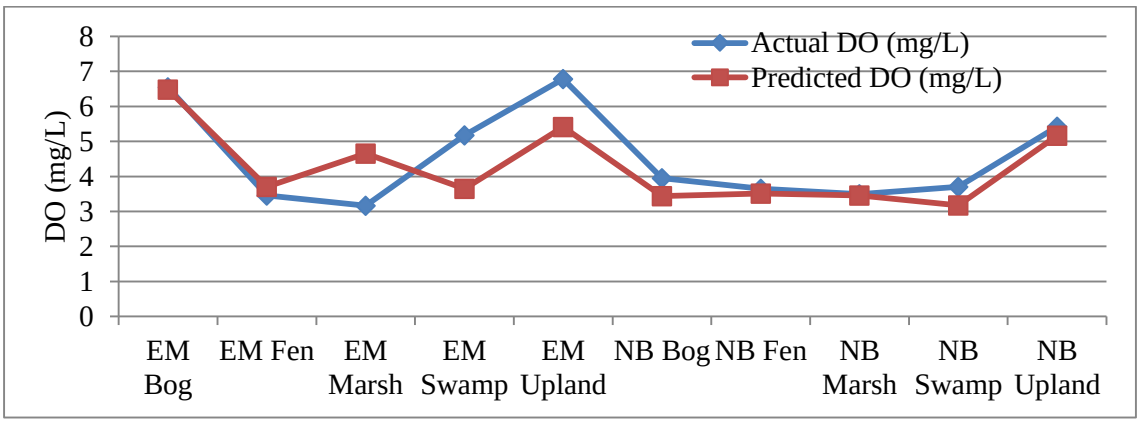


Figure 17. Average field-determined DO values by wetland class and location.

Comparison of actual versus predicted DO values within each wetland class showed the best results were found in bogs and fens, with correlation coefficients of 0.68 and 0.59, respectively; while upland DO demonstrated the poorest relationship, with a correlation coefficient of 0.24 (Figure 18).

Both bogs and fens showed similar frequency distributions of low to high DO values. Actual DO in swamps showed a broad distribution from 1 mg/L to 8 mg/L, while predicted values were more narrowly distributed, showing a DO value commonly around 3 mg/L (Figure 19). Actual marsh DO values tended to be approximately 1 mg/L lower than predicted values; while frequency distributions for upland DO showed that modelled results did not account well for high DO values.

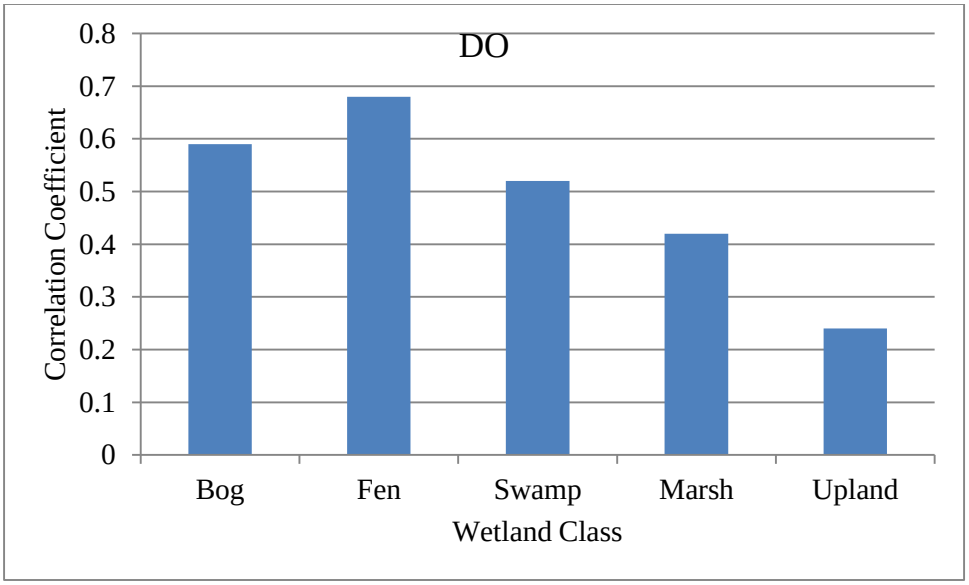


Figure 18. Correlation coefficients of actual versus predicted DO values by wetland class.

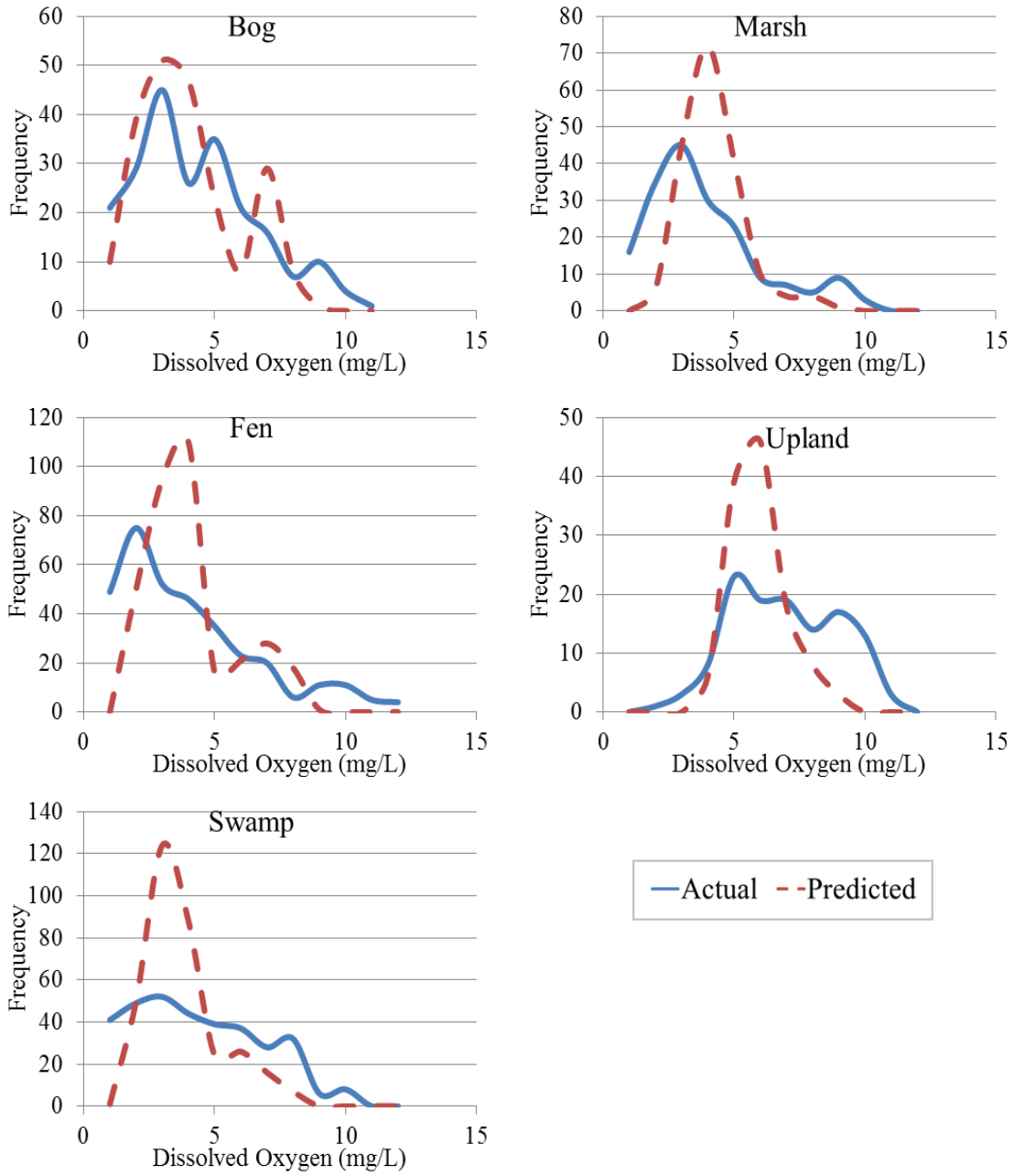


Figure 19. Frequency distributions for actual and predicted DO values by wetland class.

Dissolved oxygen values taken from a literature review show fens and swamps having generally low DO values, while plots influence by open water, and uplands have higher

DO values (Table 13). Although general landscape information was available for each of the DO measurements, including transition zones and dominant tree cover, the spatial distribution of DO values was not available.

Table 13. Literature versus field-determined DO values: averages and ranges, field-determined outliers excluded.

Wetland / Forest Type	DO (mg/L)	Location	Source	Wetland Class	DO (mg/L)	Location
Bog	6.4	Minnesota, USA	Clausen and Brooks (1983)	Bog	6.5, 1.8 - 11.3	EMEND
Black Spruce Bog	0.1 - 0.7	Wisconsin, USA	Pierce (1953)	Bog	3.9, 1.1 - 12.6	New Brunswick
Bog / Fen Transition	5.4	Wisconsin, USA	Clausen and Brooks (1983)			
Alder Fen	0.2 - 1.6	Wisconsin, USA	Pierce (1953)	Fen	3.4, 0.5 - 8.7	EMEND
Willow Fen	9.2	Wisconsin, USA	Pierce (1953)	Fen	3.6, 0.3 - 12.7	New Brunswick
Black spruce / Alder Fen	2.5	Wisconsin, USA	Pierce (1953)			
Fen	2.8 - 8.0	Algonquin Park, ON	Sparling (1966)			
Cedar Swamp	0.1 - 2.5	Wisconsin, USA	Pierce (1953)	Swamp	5.2, 1.0 - 9.7	EMEND
Black Spruce Swamp	0 - 2.6	Wisconsin, USA	Pierce (1953)	Swamp	3.7, 0.4 - 10.0	New Brunswick
Open Water Marsh	7.3	Wisconsin, USA	Pierce (1953)	Marsh	3.2, 0.7 - 8.7	EMEND
Sedge Marsh	0.9	Wisconsin, USA	Pierce (1953)	Marsh	3.5, 0.4 - 9.6	New Brunswick
Cattail Marsh	2.5	Wisconsin, USA	Pierce (1953)			
Upland Adjacent Zone	2.1 - 3.7	Wisconsin, USA	Pierce (1953)	Upland	6.8, 3.2 - 10.6	EMEND
Upland	6.9 - 8.0	North Carolina, USA	Daniels et. al. (1973)	Upland	5.4, 1.4 - 10.4	New Brunswick
Stream	11.2	Wisconsin, USA	Pierce (1953)	Stream	5.3, 1.3 - 8.4	New Brunswick

Discussion

Dissolved oxygen is utilized by organisms for metabolic function, which increases as soil and water temperatures rise (Fang and Moncrieff, 2001). The lowest average values for all DO plots sampled occurred in the summer at the UNB Forest, and the 'UNB Summer' variable demonstrated a significant influence on DO modelling. Depth to water ($\log_{10}$DTW) was also found to be influential for predicting DO. The transition from shallow to deep water resulted with DO values increasing, due to cooler soil conditions, and diminished biological activity deeper in the soil profile, as shown in Chapter 8 of this thesis. For example, water close to the surface is warmer (in summer) and contains more organic matter than water deep in the soil profile; resulting in increased biological activity and oxygen reduction (Fang and Moncrieff, 2001; Mitsch and Gosselink, 2007; Thomas et al., 2009). Flat or south facing sites would tend to have lower DO values than north facing sites, with the exception of domed bogs, which were insulated from radiation by a thick organic layer. When potential relative radiation values increased, meaning the microsite was generally receiving more heat, the DO values would decrease; thus $\log_{10}$PRR provided another means for valuing the degree of biological activity across the landscape.

Hydraulic conductivity increases showed an increase in DO values as the easily decomposed material that occurs in fens and swamps produced a component of fine material that caused the hydraulic conductivity to slow, resulting in a decrease in pore space, and a reduction of oxygen diffusion into water (Gafni and Brooks, 1990; Thomas et al., 2009). Additional continuous and categorical variables available for possible DO

predictions were found to either correlate with predictive variables, or to have no effect on DO predictions. Among field measured variables, DO related best with EC (Table 11), however the relationship was weak due to wide ranging DO values along the EC gradient, which resulted from factors such as temperature and water stagnation's influence on DO being more prevalent than EC.

The results of the multiple regression analysis for predicting DO revealed an R^2 value of 0.35, which was due to the variability of the natural landscape. While the regression trend for predicting DO was significant, factors that affect water properties in the natural environment, such as tree species heterogeneity, canopy cover, mound and pit topography, and sub-surface groundwater interactions, could not all be accounted for (Ulanowski and Bran, 2013). The occurrence of landscape heterogeneity was most notable for outlier plots, where low/high DO values occurred where there was no indication of change in predictive variables. For example, hummocky terrain may result in fine scale DTW, temperature, and DO variations, however 1m resolution LiDAR derived data may reveal generally no change in landscape attributes.

The DO raster created with the best fit regression equation allowed for the DO values to be mapped across the wetland area for all study sites. The maps provide visual confirmation of the validity of the modelled results, while allowing the extrapolation of information for the remaining wetland areas. Discrepancy between predicted and mapped DO results occurred where actual wetland classes differed from mapped wetland classes. While the majority of wetland plots were within 10m of mapped wetlands, DO values extracted from ArcGIS represented the DO within 5m of plot

centre, thereby resulting in loss of conformance between predicted and mapped results. Spatially defined wetland classes were used to display HC values across the landscape, therefore when HC values, were improperly mapped, spatial DO values differed from predicted DO values. The average difference between all predicted and mapped DO values, across all plots, remained only 0.5 mg/L. The majority of data analysis involved actual versus predicted results, instead of actual versus mapped results in order to ensure clear viewing of the strengths and weaknesses of the model.

Further investigation into the results of the model predictions, beginning with the test plots, revealed that, among a random selection of wetlands and locations, a good relationship was found to exist between actual and predicted results. Residual outliers occurred due to having higher than average DO values, measured in open water. A comparison of average actual versus predicted wetland class data showed a generally good correlation; with EMEND marsh, EMEND swamp and EMEND uplands having the furthest diversion from actual mean values. While the EMEND marsh DO values were the lowest of all surveyed locations, they did not possess any other attributes that made them distinguishable for mapping purposes, and the use of 'EMEND Marsh' was not used as a categorical predictive variable, because it did not show significant results. As a result, the differences in mean values are not better accounted for with this model; however the difference in mean DO values is only 1.5 mg/L.

Average actual DO values in EMEND swamps and uplands are higher than model predicted values because, while low HC values typically occur in swamps, coniferous dominated swamps and uplands found at the EMEND site occasionally had higher field

observed HC values, resulting in their having higher DO values than the model predicted.

DO values taken from a literature review showed similarities to the results of this thesis, including low DO values in fens, swamps and marshes, and generally higher DO values in uplands; however, the data were not supported by specific site information, therefore outliers, such as very low DO in a black spruce bog, are not able to be validated. While generalized site details including dominant vegetation were available, plot specific data, such as influence of open water on measurements and depth to water, were not. Pierce (1953) measured water properties in transects across wetlands, and showed similar trends as those in this thesis. DO values were high in uplands and streams, and decreased in wetlands. Low bog DO values measured by Pierce could be attributed to the comparatively warm climate in which data was measured, or the unknown bog form; as basin bogs having typically lower DO values than domed bogs.

In summary, the results of this study show that DO within and across wetlands can be modelled and mapped using LiDAR derived WAM and topographic attributes, allowing for a spatial representation of DO, which can be used to gain insight into the ecological conditions occurring on the landscape. Areas having low DO values commonly occur with deciduous vegetation, warm position on the landscape, and increased biological activity; while cool, deep water, such as that in domed bogs and uplands, with low biological activity, tended to have high DO values. Improvements in mapping resolution, specifically, the utilization of LiDAR data with sub-metre lateral accuracy for WAM and topographic attribute determination, may improve DO mapping; most

notably by allowing users to identify and map small scale variations, such as mound and pit topography and forest stand heterogeneity; which have been found to affect DO values across the landscape.

CHAPTER 6

ELECTRICAL CONDUCTIVITY

Introduction

This chapter deals with EC as reviewed in Chapter 2 of this thesis. The site details and methodology for this chapter can be found in Chapters 3 and 4 of this thesis, respectively. The primary goal of this research is to determine if shallow water EC can be modelled and mapped for select wetlands in Alberta and New Brunswick using LiDAR derived WAM and topographic attributes, thus demonstrating the ability to display EC values across a wide variety of wetland terrain, while accounting for wetland class and seasonal variation.

Results

A total of 1181 EC plots were measured at the EMEND and NB locations, which included all wetland classes and seasonal variation at the UNB Forest (Figure 20 and Figure 21).

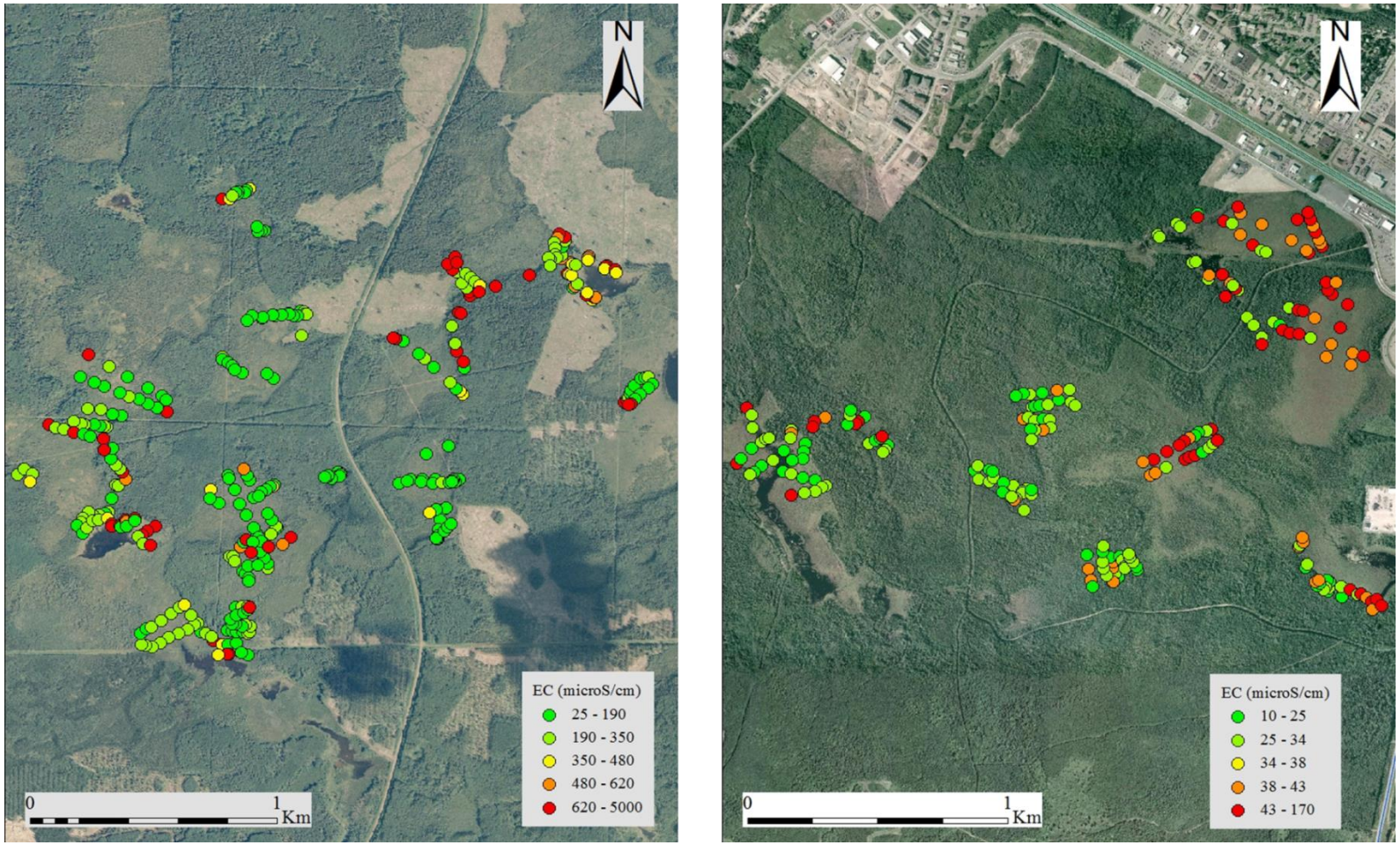


Figure 20. EMEND (left) and UNB Forest (right) sites showing plot locations with measured EC.

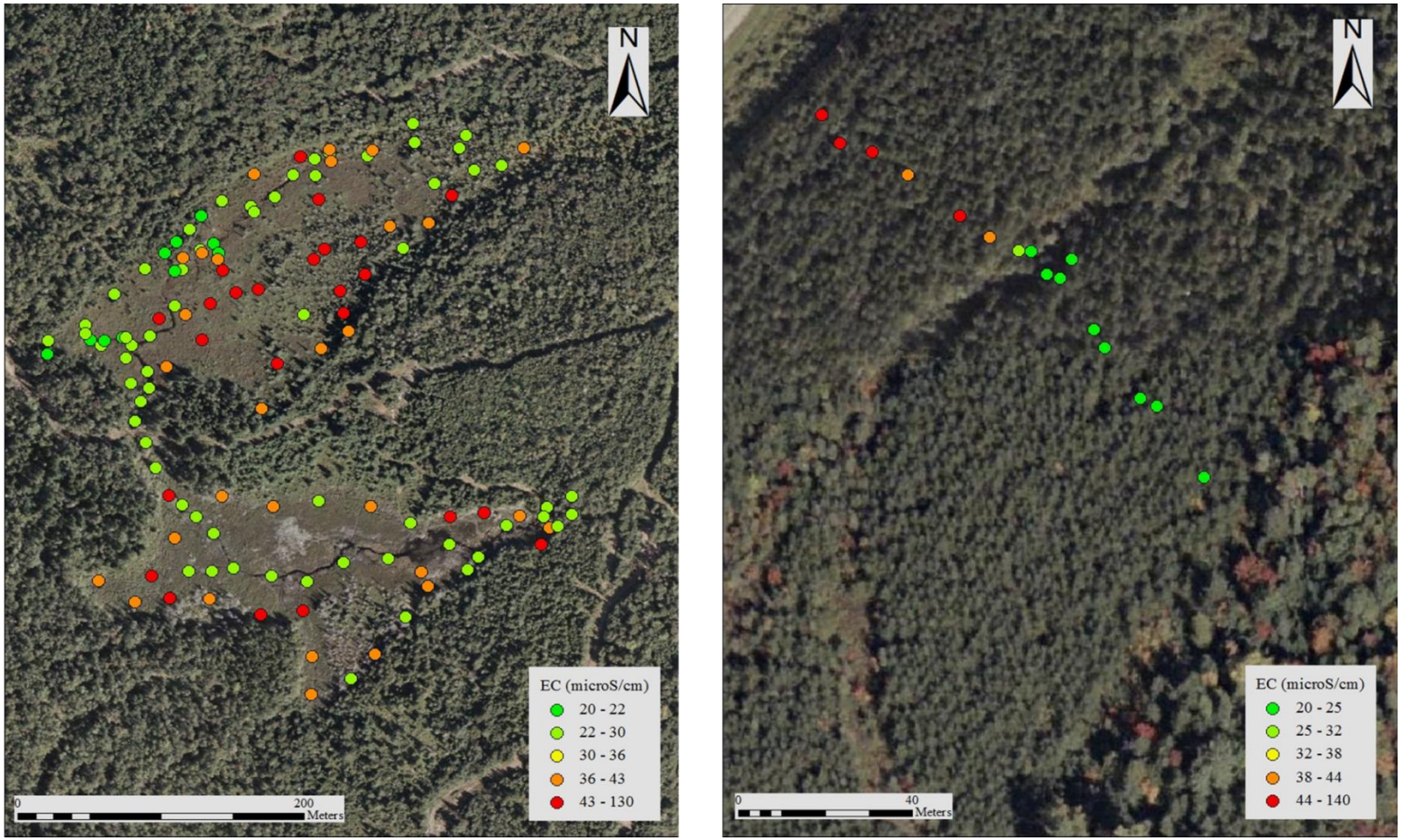


Figure 21. Saint John Wetland (left) and Jack Pine (right) sites showing plot locations with measured EC.

A summary of all measured EC values based on wetland and depth-to-water classes showed that measured EC values were highest in uplands, while remaining similar for bogs, fens, swamps, and marshes; with swamps having the lowest average EC values; and the 50 – 100 cm depth-to-water range had the highest EC values among all DTW classes (Table 14).

Table 14. Summary of EC values by wetland and DTW classes.

Electrical Conductivity (micro S / cm)									
Class	**Min**	**Max**	**Mean**	**Std dev**	**DTW (cm) 4 ha**	**Min**	**Max**	**Mean**	**Std dev**
Bog	20.0	940.0	74.8	85.9	**0 - 10**	10.0	380.0	45.9	42.8
Fen	10.0	600.0	77.8	84.0	**10 - 25**	20.0	1390.0	114.0	184.6
Marsh	10.0	3100.0	183.6	446.2	**25 - 50**	20.0	5000.0	295.9	637.9
Swamp	20.0	2600.0	91.6	220.4	**50 - 100**	20.0	3800.0	373.6	696.9
Upland	10.0	5000.0	560.4	905.3	**100 - 275**	20.0	3000.0	178.8	419.9

EC values were transformed using a $\log_{10}$ conversion, due to being strongly skewed to the left. Boxplots showing the distribution of $\log_{10}$EC values for both site and wetland class revealed four common outliers, which were removed from the data set due to possible measurement error (Figure 22). Average $\log_{10}$EC values, plotted for each site, and season for the UNB Forest, showed the New Brunswick sites all having low $\log_{10}$EC values around 1.5, while the EMEND $\log_{10}$EC values were significantly higher, by approximately 1 order of magnitude (Figure 23).

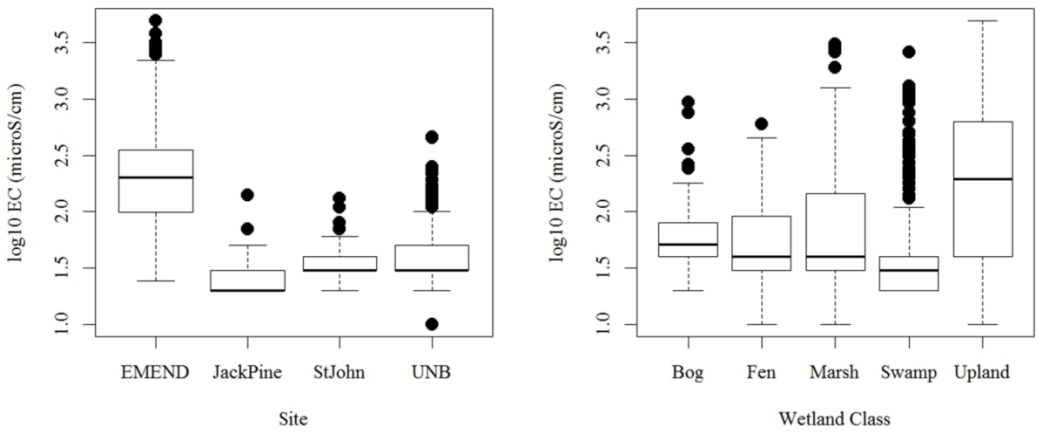


Figure 22. Boxplots showing $\log_{10}$EC distributions by site and wetland class to highlight outliers.

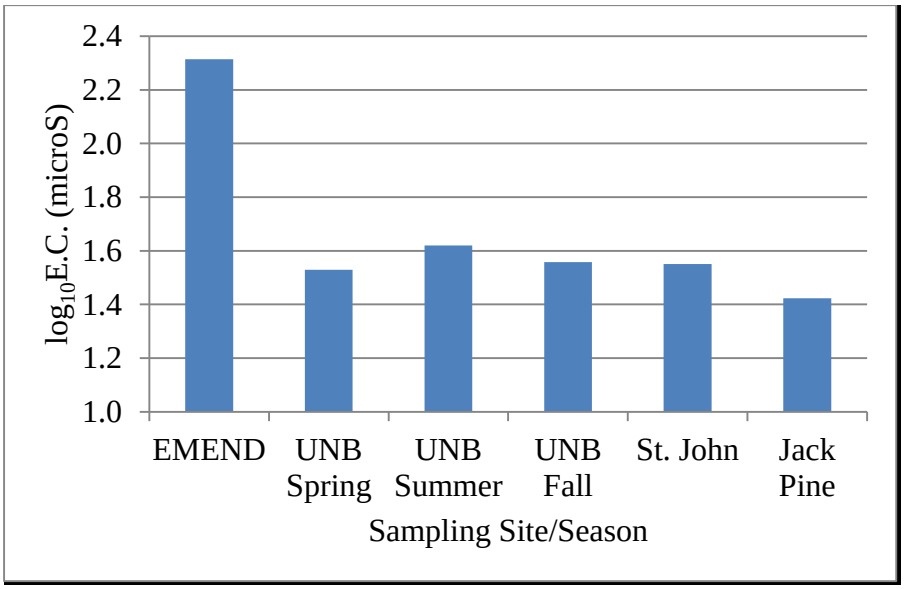


Figure 23. Average measured $\log_{10}$EC values by site and season.

Multiple regression analysis revealed that among the continuous and categorical variables (Table 3) available for predicting $\log_{10}$EC; evaporation/precipitation ratio

multiplied by potential relative radiation, EMEND marsh, EMEND swamp, and EMEND upland were the most important variables for explaining observed $\log_{10}$EC trends ($R^2 = 0.60$) (Table 15, Figure 24). Residual values were shown to have a normal distribution (Figure 25). Outliers, values which were found to be inconsistent with the majority of plots that had similar landscape attributes, were determined by visual analysis of the residuals, and when removed gave an $R^2 = 0.63$. Correlations between EC and measured variables showed that pH was well correlated with EC and $\log_{10}$EC (Table 16).

Table 15. Best fit predictive variables used to model $\log_{10}$EC ($R^2 = 0.60$) using multiple regression analysis.

	Coefficient	**Std. Error**	**Std. Coefficient**	**t-Value**	**P-Value**
Intercept	0.252	0.079	0.252	3.187	0.0015
Ratio*PRR	0.00024	0.000013	0.404	17.685	<0.0001
EM Marsh	0.556	0.053	0.216	10.464	<0.0001
EM Swamp	0.500	0.049	0.215	10.299	<0.0001
EM Upland	0.742	0.036	0.417	20.444	<0.0001

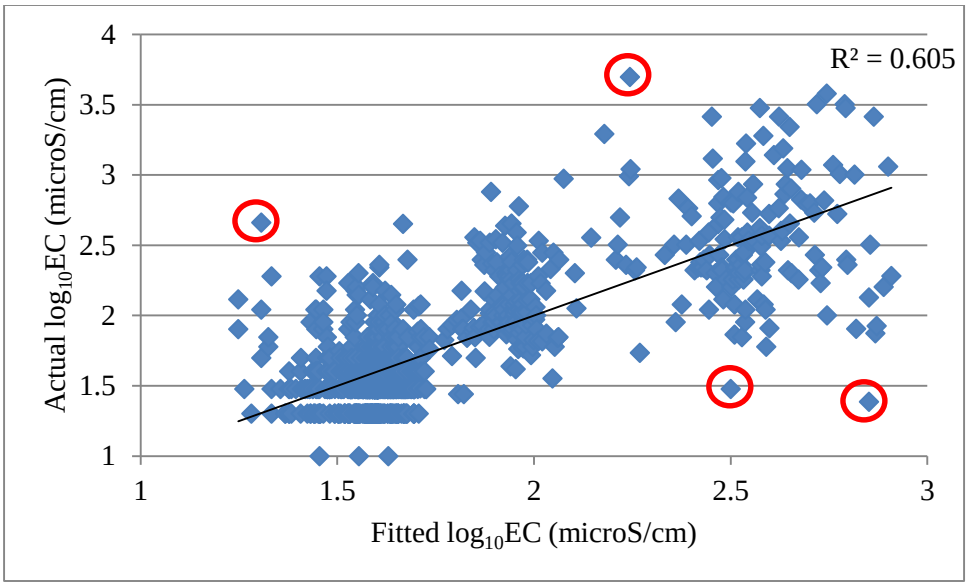


Figure 24. Scatterplot of actual versus predicted $\log_{10}$EC values, with best fit regression line and visually determined outliers highlighted in red.

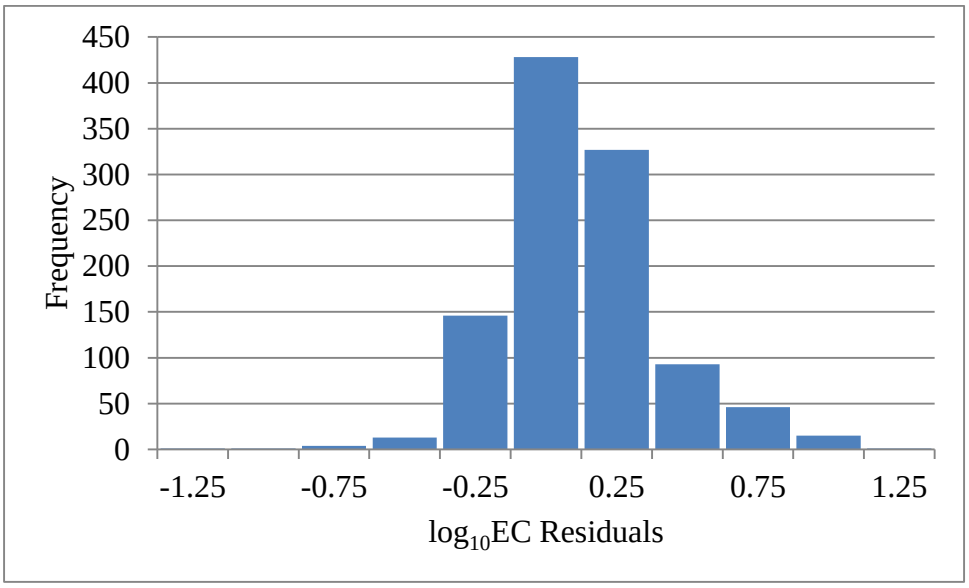


Figure 25. Frequency distribution of the residual values from the $\log_{10}$ EC model.

Table 16. Correlation coefficients between EC and all measured variables.

	Correlation Coefficient
	EC
EC	1.00
$\log_{10}$EC	0.72
pH	0.44
DO	0.22
Dom. Tree	-0.17
Temperature	-0.18
Ground Veg.	-0.21
Color	-0.27

Wetland classification for each study site showed generally good conformance between field measured and image determined wetlands, as discussed in Chapter 5 and Appendix V of this thesis. Correlations between actual, predicted and mapped $\log_{10}$EC revealed a similar relationship between actual versus predicted, and actual versus mapped $\log_{10}$EC values (Table 17).

Table 17. Correlation coefficients for actual, predicted and mapped $\log_{10}$EC values.

	Correlaton Coefficient
	$\log_{10}$EC Actual
$\log_{10}$EC Actual	1.00
$\log_{10}$EC Predicted	0.78
$\log_{10}$EC Mapped	0.75

The EC rasters created using the best fit multiple regression equation provided a data layer that revealed general visual conformance across all sites and wetland classes (Figure 26 and Figure 27).

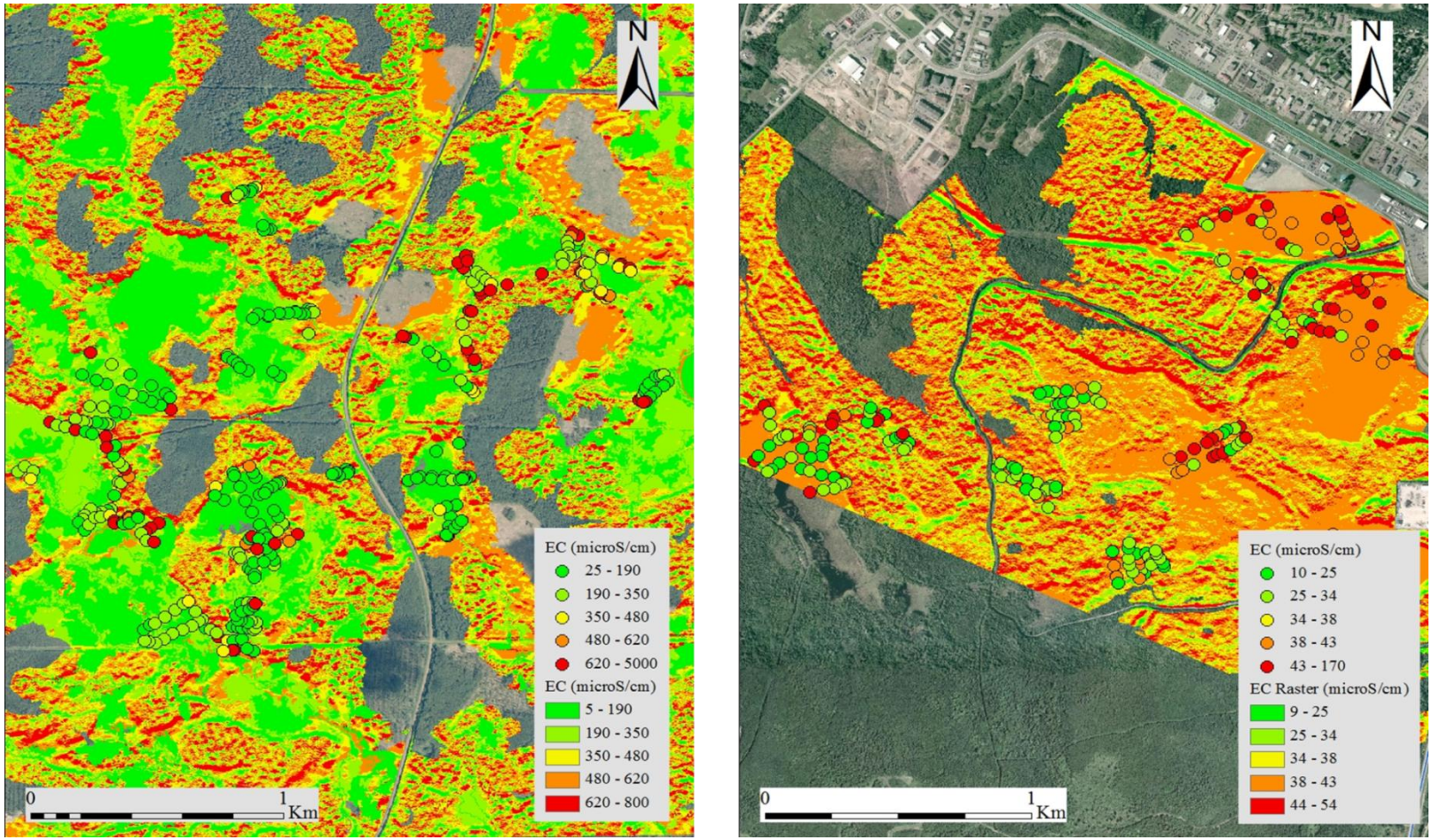


Figure 26. Field EC values overlaying EC rasters for the EMEND (left) and UNB Forest (right) sites.

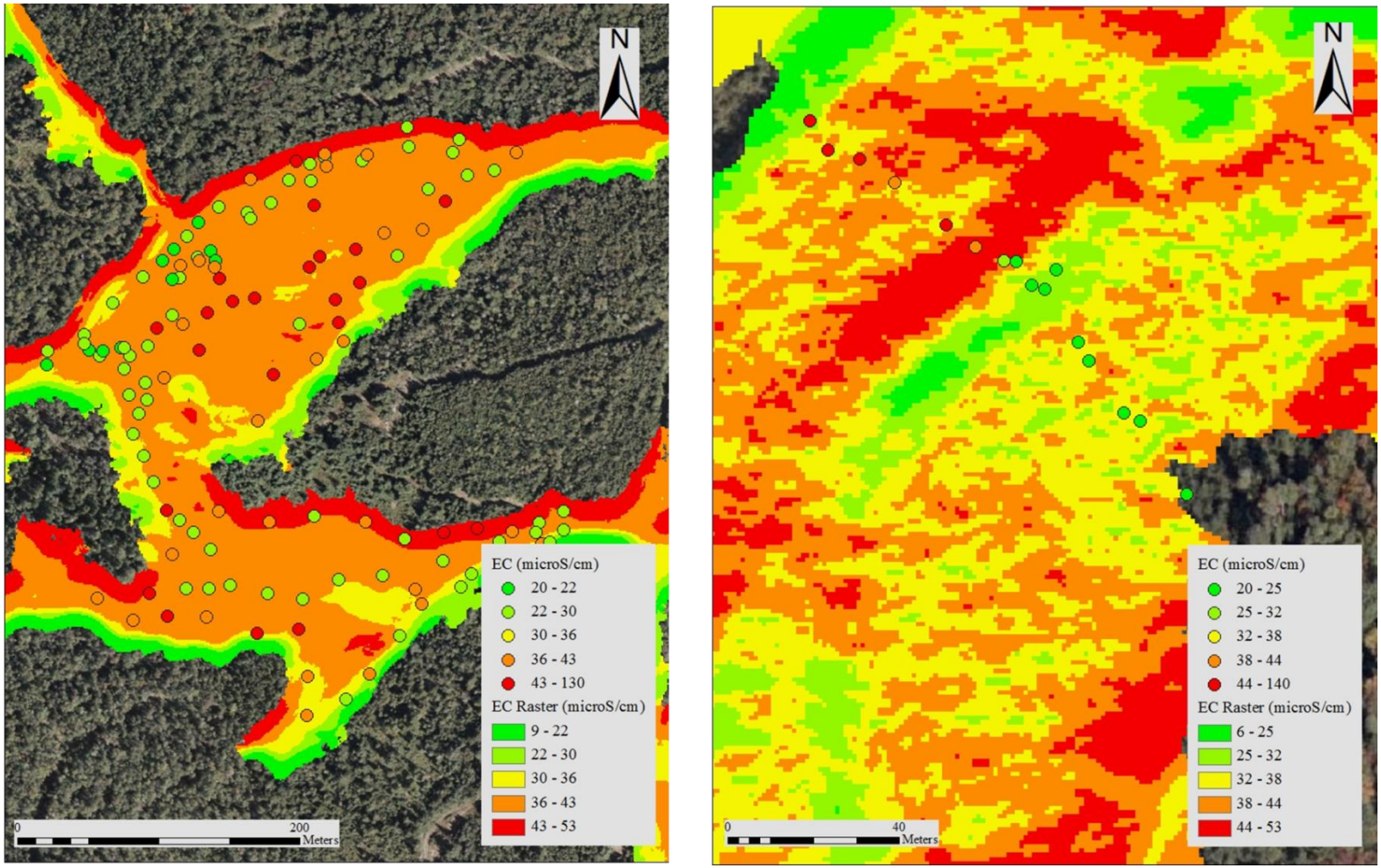


Figure 27. Field EC values overlaying EC rasters for the Saint John (left) and Jack Pine (right) sites.

Regression analysis comparing the $\log_{10}$EC of the test plots (100 extracted values) and the modelled values showed an R^2 of 0.61 (Figure 28). Average $\log_{10}$EC values for each wetland class by location revealed a correlation coefficient of 0.97 (Figure 29).

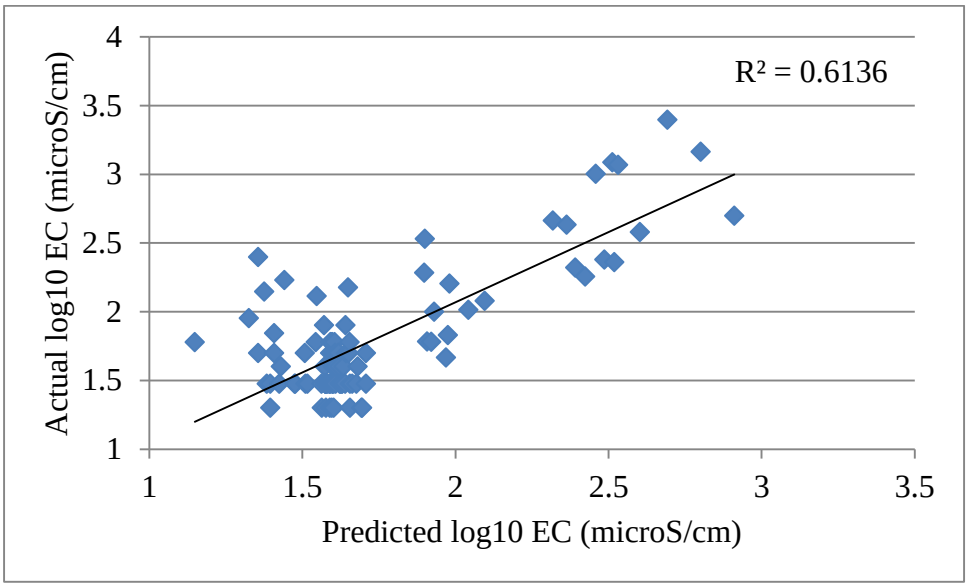


Figure 28. Showing actual versus predicted $\log_{10}$EC values for 100 test plots, with best fit regression line.

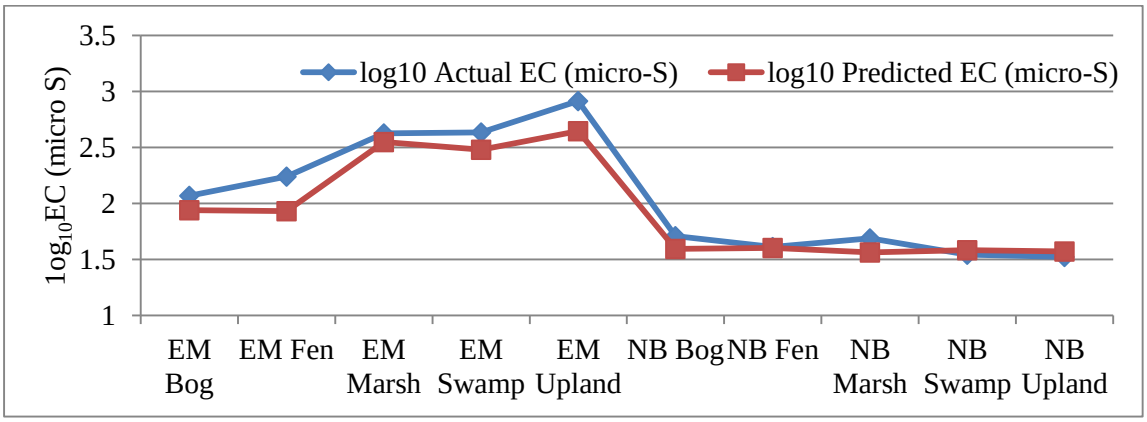


Figure 29. Average $\log_{10}$ EC values by wetland class and location.

Comparison of actual versus predicted $log_{10}EC$ values within each wetland class showed that marshes, fens and uplands demonstrated the strongest actual versus predicted relationships, with all correlation coefficients above 0.70 (Figure 30).

Investigation of the frequency distributions for each wetland class showed that marsh, swamp, and upland $log_{10}EC$ values were slightly bi-modal, and the predicted results captured this distribution well. The actual high and low $log_{10}EC$ values in fens were not well predicted with modelled results, most notably for high $log_{10}EC$ values; while both the actual and predicted bog $log_{10}EC$ values were shown to occur with a normal unimodal distribution (Figure 31).

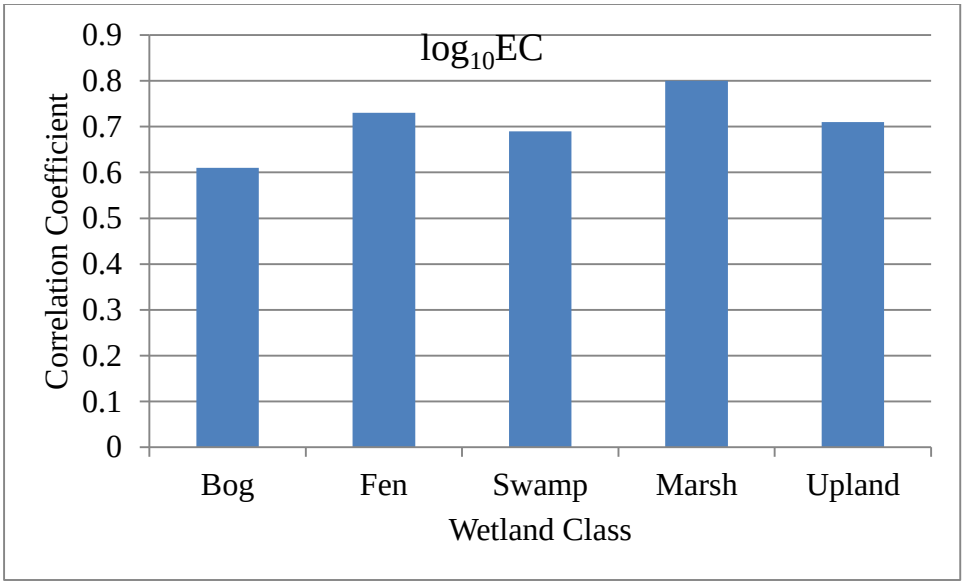


Figure 30. Correlation coefficients of actual versus predicted $log_{10}EC$ values by wetland class.

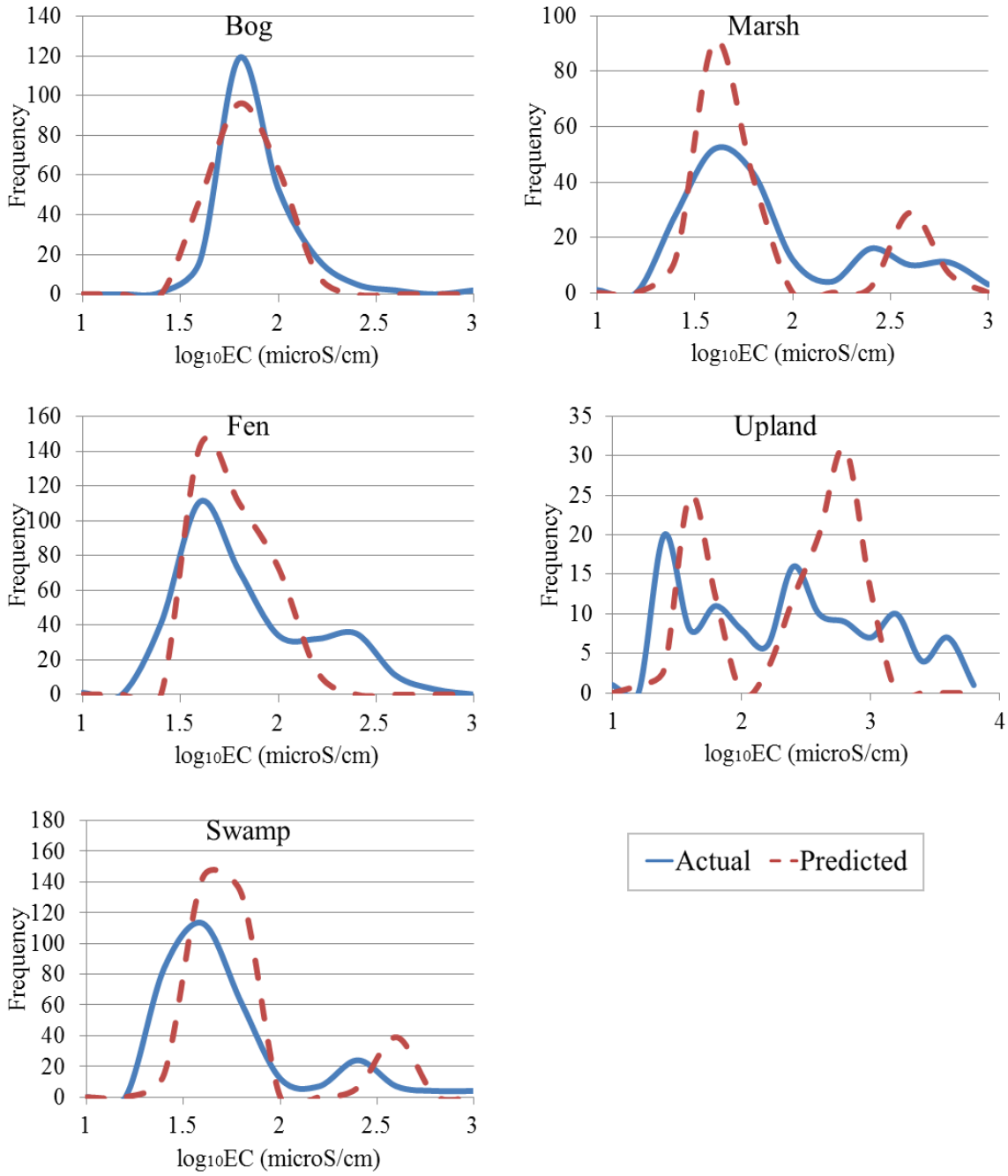


Figure 31. Frequency distributions for actual and predicted $\log_{10}$EC values by wetland class.

A literature review of EC values found across wetlands showed an increasing trend from bog to non-bog wetlands (Table 18). While some spatial information about the area in which EC measurements were taken was available, there was no spatially explicit map displaying EC transition across wetlands.

Table 18. EC values taken from a literature review compared with EC values measured for this thesis. Average and range of measured EC values are shown, excluding outliers

Wetland / Forest Type	EC (microS/cm)	Location	Source	Wetland Class	EC (microS/cm)	Location
Bog	0 - 75	Alberta, Manitoba, Saskatchewan	Kuhry et. al. (1993)	Bog	116, 28 - 940	EMEND
Bog	< 55	Minnesota, USA	Bourbonniere (2011)	Bog	51, 20 - 150	New Brunswick
Bog	45	Minnesota, USA	Clausen and Brooks (1983)			
Perched Bog	51	Minnesota, USA	Verry (1975)			
Perched Bog	16 - 46	Minnesota, USA	Bay (1967)			
Middle of Bog	20	Scandinavia	Shotyk (1988)			
Edge of Bog	50	Scandinavia	Shotyk (1988)			
Bog / Fen Transition	30 - 80	Minnesota, USA	Bourbonniere (2011)			
Bog / Fen Transition	72	Minnesota, USA	Clausen and Brooks (1983)			
Fen	262	Lower Michigan, USA	Schwintzer and Tomberlin (1982)	Fen	173, 28 - 600	EMEND
Fen	171	Minnesota, USA	Clausen and Brooks (1983)	Fen	41, 10 - 190	New Brunswick
Ground Water Fed Fen	125	Minnesota, USA	Verry (1975)			
Ground Water Fed Fen	45 - 133	Minnesota, USA	Bay (1967)			
Marshy Wetland	57 - 120	Colorado, USA	Nelson et. al. (2011)	Marsh	422, 70 - 600	EMEND
				Marsh	48, 10 - 460	New Brunswick
Conifer Swamp	325	Lower Michigan, USA	Schwintzer and Tomberlin (1982)	Swamp	429, 90 - 2600	EMEND
Hardwood Swamp	515	Lower Michigan, USA	Schwintzer and Tomberlin (1982)	Swamp	35, 20 - 230	New Brunswick
Thicket Swamp	374	Lower Michigan, USA	Schwintzer and Tomberlin (1982)			
Stream Adjacent to Wetland	54 - 105	Colorado, USA	Nelson et. al. (2011)	Stream	32	New Brunswick

Discussion

Electrical conductivity of shallow water is strongly affected by evapotranspiration and precipitation; with evapotranspiration causing dissolved solids to concentrate in solution, raising EC, while precipitation dilutes the soil solution and lowers EC (Lloyd and Heathcote, 1985). As the climate in the Peace River region of Alberta (high evapotranspiration, low precipitation) reflects conditions that support high EC values, it was expected that the EMEND site would contain significantly higher EC values than the NB sites; where more precipitation, dilution of the dissolved solids, and nutrient leaching is common. As a result, the evapotranspiration/precipitation (ratio) variable was found to be useful in predicting EC values, but was improved when multiplied by potential relative radiation (PRR), which displayed the localized trends of EC value increase in areas that receive more sunlight versus areas that remain comparatively cool and wet

The effect of the ratio*PRR predictive variable on EC was found to be complimented with the addition of EMEND marsh, swamp and upland categorical variables; which accounted for the increasing EC values that resulted from the enrichment of dissolved solids, occurring due to periodic flooding in those areas.

The regression trend for predicting $\log_{10}$EC relied on the distribution of data collected across all sites. While the EC values measured in NB were very consistent, with 95% of all values measuring between 10 and 100 microS/cm, values in EMEND had a much wider range, with 95% of EMEND values measuring between 25 and 1800 microS/cm. The distribution of the predicted data set showed a strong linear trend; however

variation occurred due to natural variability of EC values, which may have been affected by interaction with groundwater and/or small scale topographic variation (Schwintzer and Tomberlin, 1982). Such variation could not be accounted for based on the resolution of the LiDAR derived topographic data, and the absence of groundwater specific maps. Further, residual outliers of the regression analysis occurred as a result of EC values being low in upland forests, which could be a result of groundwater saturation, and the subsequent dilution of EC. Outliers with high EC values occurred when an uncommonly high value of 5000 microS/cm was measured in an EMEND upland site, and a value of 460 microS/cm was measured in a NB marsh; both situations were difficult to predict due to the rarity of their values. Correlation coefficients, shown in Table 16, showed a strong relationship between pH and EC, and while pH could have been used to predict EC, it was found that $\log_{10}$EC was better used as a predictor of pH, which is demonstrated in Chapter 7 of this thesis.

The EC raster created with the best fit regression equation allowed for the EC values to be mapped across the wetland area for all study sites. Predicted and mapped $\log_{10}$EC results were highly correlated because EMEND upland, marshes and swamps were accurate to within 15m for 90% of all plots, and ratio*PRR was a strong predictive variable, unaffected by wetland classification.

The strength of the regression trend was demonstrated using the results of the test plots, which contained a random selection that included all wetland classes and sites. Actual versus predicted $\log_{10}$EC values revealed a good linear trend, with an R^2 of 0.61, which was equal to the R^2 of the predictive equation. Further investigation into the

relationships between average actual versus average predicted values for each site and class, showed a very good correlation coefficient of 0.97.

Investigation of the robustness of the model for each wetland class specifically showed that although all classes were well correlated, marshes had the highest correlation coefficient, which resulted from both the low and high values being predicted with accuracy, which can be seen in the results of Figure 31. Uplands were also well predicted; however the highest EC values were not accounted for with the model, which resulted in actual average values being higher for uplands than average predicted values. A subset of the EMEND upland data had inordinately high EC values, which resulted in some loss of predictive strength of the model. Swamps and fen actual versus predicted data also correlated well, with the bimodal distribution of the actual measured data being well accounted for.

Bog correlation between actual and predicted values was low due to the model's bi-modal portioning of the data, while actual data had a normal distribution. The use of PRR for predicting EC across bogs resulted in some loss of accuracy because while actual bog EC decreased from bog edge to bog centre, an increase in PRR values caused the model to predict an EC increase. This occurrence was for bogs only, with all other wetlands showing the inverse relationship.

Electrical conductivity values taken from a literature review compared with those measured for this thesis, with low values (0 – 80 microS/cm) being found in bogs and higher values (45 – 515 microS/cm) in areas with mineral water enrichment. Generalized site data were used to describe each of the wetland classes, and therefore

little could be inferred about landscape position, degree of groundwater influence, or forest heterogeneity. Shotyk (1988) reported an increase in EC values from the centre of a bog to the edge, which represents the limited groundwater influence in domed bogs, and the interaction between ombrotrophic bog water and mineral enriched water near bog edges. Results also showed that fens in Lower Michigan had higher EC values than those in Minnesota. Both sites occurred on glacial deposits and received almost equal mean annual precipitation, therefore it appears the difference in EC can be attributed to the higher mean annual temperature (6.5°C in Lower Michigan, 3 – 5 °C in Minnesota) in Lower Michigan.

In summary, the results of this study have shown that EC can be modelled and mapped within and across wetlands primarily using LiDAR derived potential relative radiation values multiplied by an evapotranspiration/precipitation ratio. This reflected the findings that lower EC values were found in cool wet areas (e.g. NB) and higher EC values were found in warm, dry areas (e.g. EMEND). Further, increased precipitation and decreased evapotranspiration caused leaching of base cations, and lower EC values. The addition of swamp, marsh, and upland categorical variables for EMEND were used to account for the high EC values found due to periodic flooding, and further base cation enrichment.

CHAPTER 7

pH

Introduction

This chapter deals with pH as reviewed in Chapter 2 of this thesis. The site details and methodology for this chapter can be found in Chapters 3 and 4 of this thesis, respectively. The primary goal of this research is to determine if pH can be mapped using remotely sensed data, primarily LiDAR derived WAM and topographic attributes, while accounting for wetland class and seasonal variation. The resulting map would identify the pH transition across wetlands and between wetland classes and a link to ecosystem health and function as it relates to pH could be derived.

Results

A total of 1189 pH plots were measured at the EMEND and NB locations, which included all wetland classes and seasonal variation at the UNB Forest (Figure 32 and Figure 33).

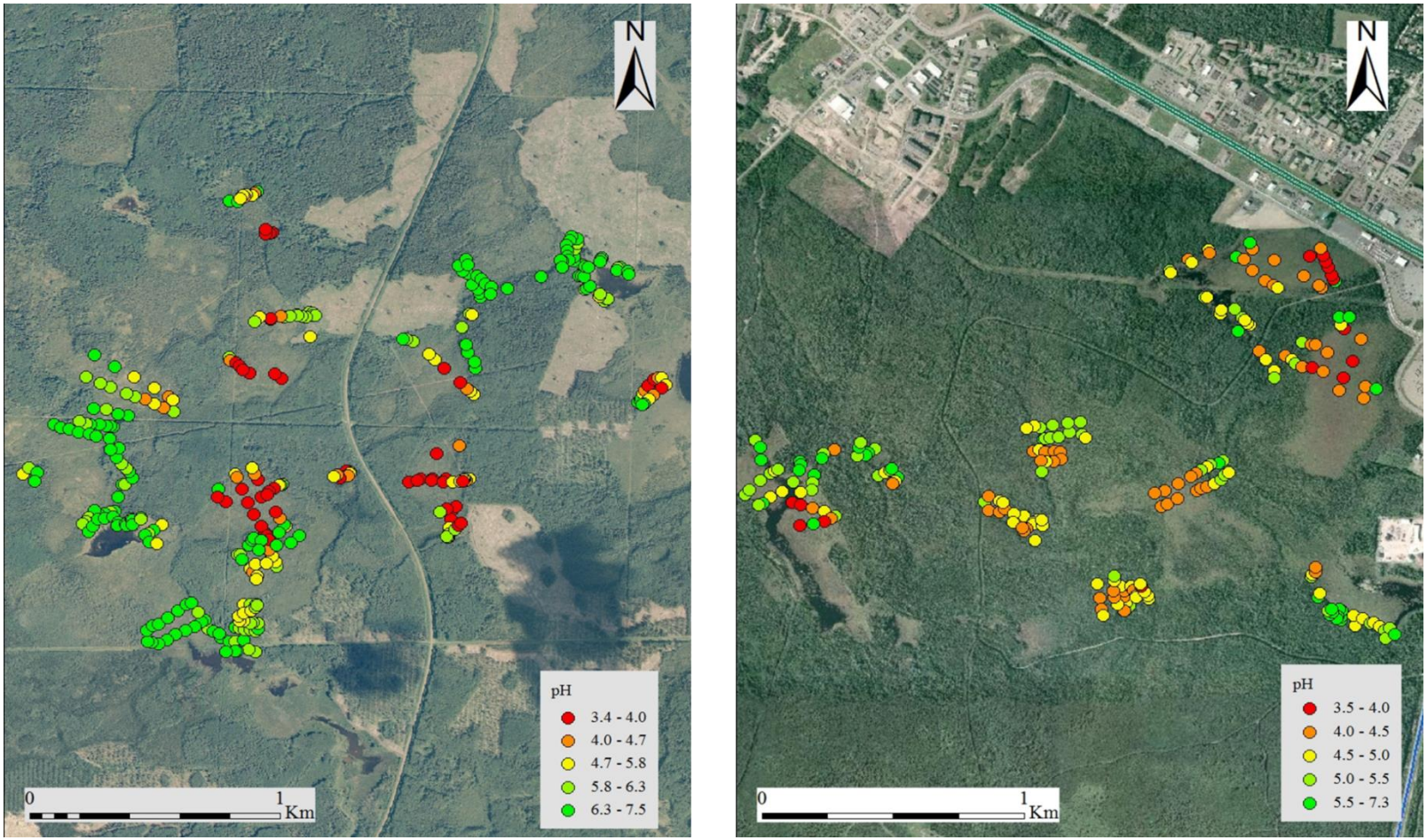


Figure 32. EMEND (left) and UNB Forest (right) sites showing plot locations with measured pH.

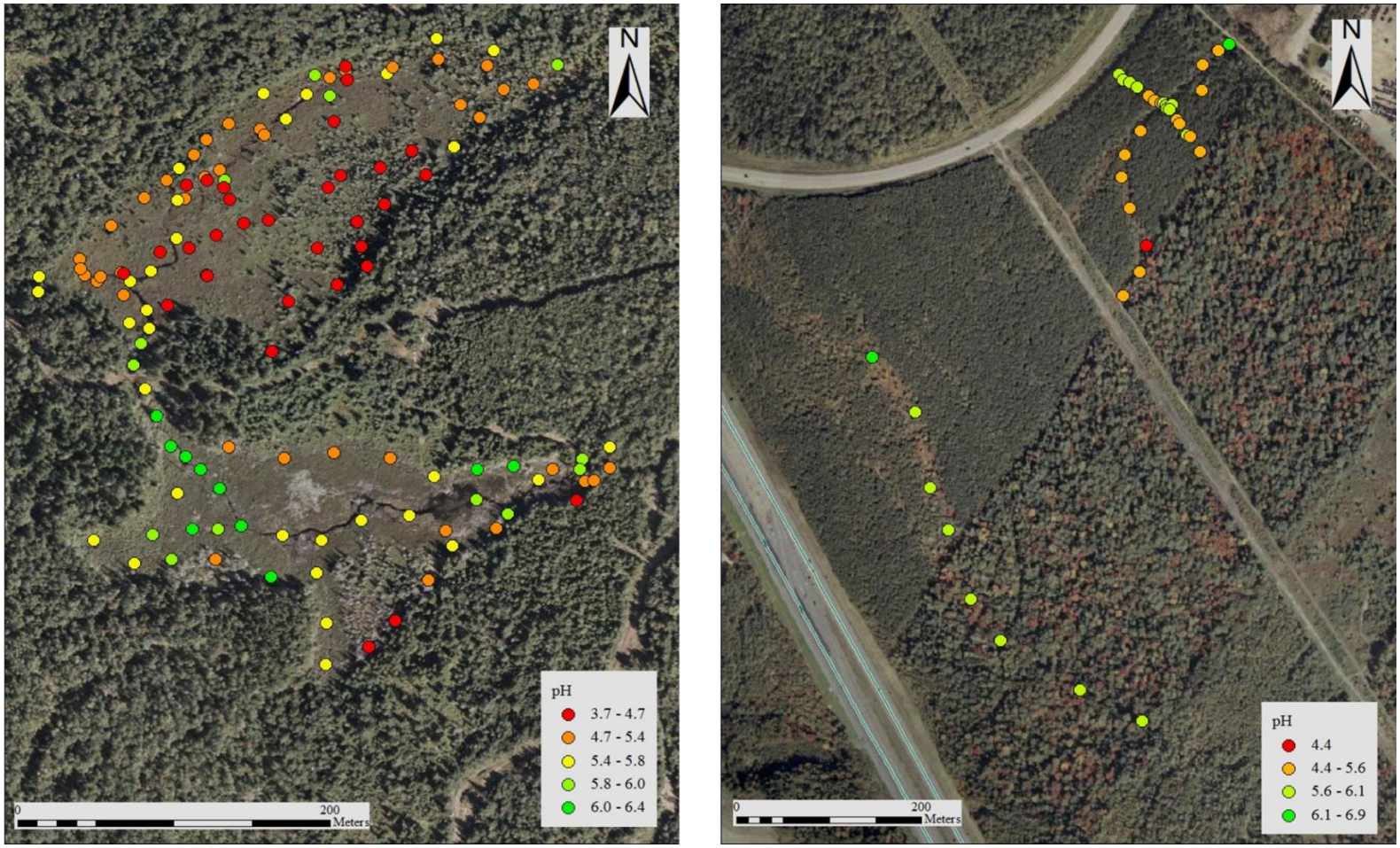


Figure 33. Saint John Wetland (left) and Jack Pine (right) sites showing plot locations with measured pH.

A summary of all measured pH values based on wetland and depth-to-water classes showed that average pH values were highest in upland sites, and where water was between 50 and 100 cm depth-to-water (Table 19). Lowest average pH was measured in bogs.

Table 19. Summary of pH values by wetland and DTW classes.

pH									
Class	**Min**	**Max**	**Mean**	**Std dev**	**DTW (cm) 4 ha**	**Min**	**Max**	**Mean**	**Std dev**
Bog	3.4	6.4	4.1	0.5	**0 - 10**	3.5	7.3	4.8	0.6
Fen	3.5	7.0	5.4	0.7	**10 - 25**	3.5	7.8	5.2	0.9
Marsh	3.9	7.8	5.5	0.8	**25 - 50**	3.4	7.5	5.6	0.9
Swamp	3.9	7.0	5.1	0.8	**50 - 100**	3.4	7.5	5.8	1.0
Upland	3.7	7.5	6.0	0.9	**100 - 275**	3.4	7.5	4.9	1.1

Boxplots showing the distribution of pH values for both site and wetland class revealed no common outliers, therefore all data were used for analyses (Figure 34). Average pH values, plotted for each site, and season for the UNB Forest, showed the lowest pH values were found in UNB summer, and highest pH values were found in the EMEND site and the Jack Pine plantation, respectively (Figure 35).

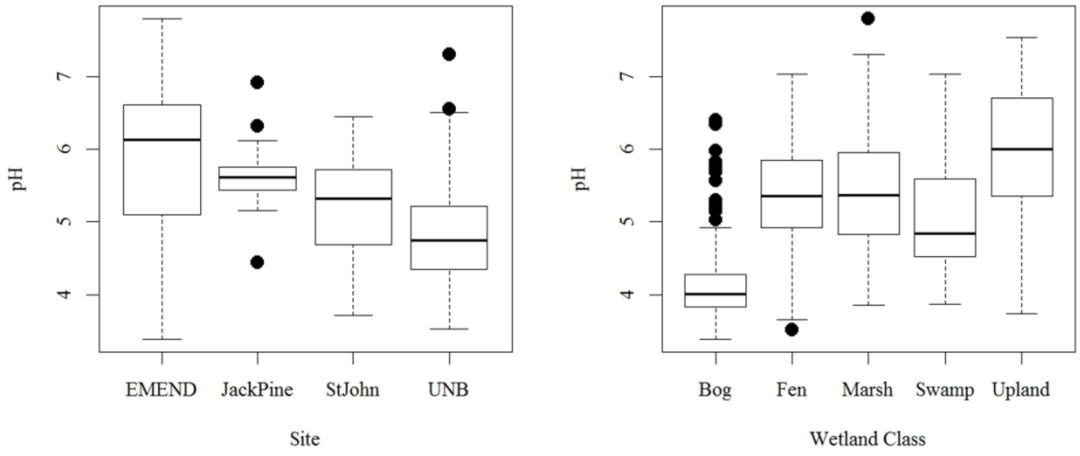


Figure 34. Boxplots showing pH distributions by site and wetland class to highlight outliers.

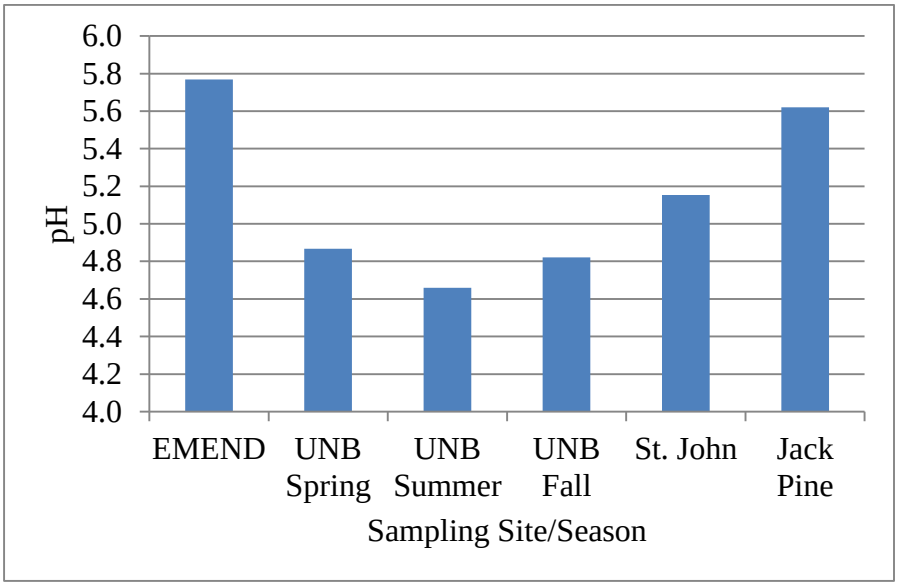


Figure 35. Average measured pH values by site and season.

Due to the strongly bi-modal distribution of the pH values occurring at bog versus all other wetland classes, multiple regression analyses were applied for all data, i) excluding bog plots, and ii) for bog plots only. Analysis revealed that among the continuous and categorical variables (Table 3) available for predicting non-bog pH; $\log_{10}$DTW (4ha flow initiation), $\log_{10}$FA, and $\log_{10}$EC (raster) were the most important variables for explaining observed pH trends (R^2 = 0.48) (Table 20; Figure 36). Analysis to determine the most important variables for predicting pH in bogs revealed that tree height and $\log_{10}$HC could be used to weakly predict pH of bogs, with an R^2 value of 0.14 (Table 21; Figure 37).

Residual values for non-bog pH and bog pH predictions were shown to have normal distributions (Figure 38). Outliers, values which were found to be inconsistent with the majority of plots that had similar landscape attributes, were determined by visual analysis of the residuals, and when removed gave R^2 values of 0.52 and 0.18 for non-bog and bog predictions, respectively. Correlations between pH and field measured variables showed that pH was positively related with EC (log10EC), and negatively related with colour and ground vegetation (Table 22).

Table 20. Best fit predictive variables used to model non-bog pH (R^2 = 0.48) using multiple regression analysis.

	Coefficient	Std. Error	Std. Coefficient	t-Value	P-Value
Intercept	2.704	0.174	2.704	15.574	<0.0001
$\log_{10}$DTW (4ha)	0.499	0.046	0.312	10.815	<0.0001
$\log_{10}$FA	0.427	0.046	0.239	9.291	<0.0001
$\log_{10}$EC Raster	0.869	0.055	0.447	15.767	<0.0001

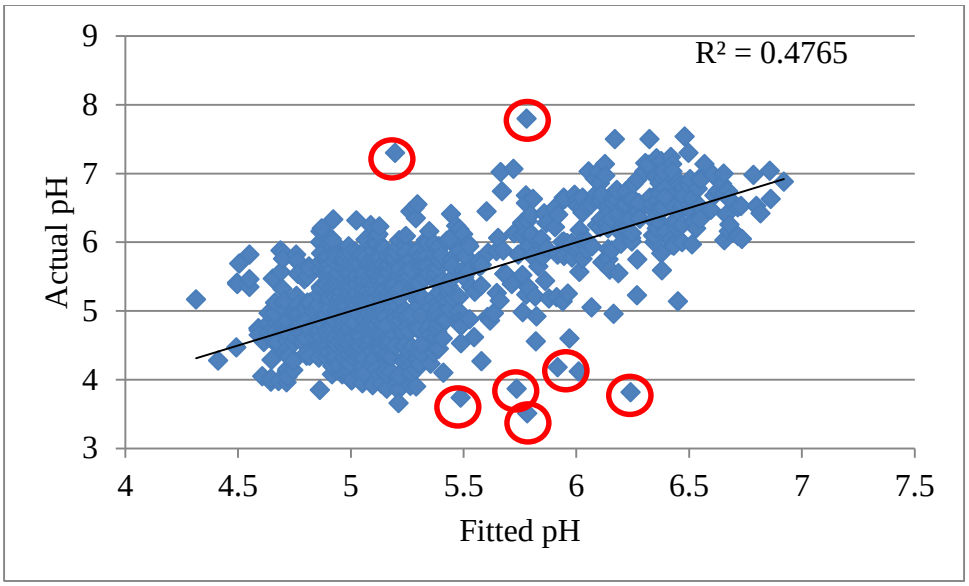


Figure 36. Scatterplot of actual versus predicted pH values, with best fit regression line, and visually determined outliers highlighted in red.

Table 21. Best fit predictive variables used to model bog pH (R^2 = 0.14) using multiple regression analysis.

	Coefficient	Std. Error	Std. Coefficient	t-Value	P-Value
Intercept	3.584	0.114	3.584	31.408	<0.0001
Tree Ht	0.044	0.011	0.262	3.92	0.0001
$\log_{10}$HC	-0.13	0.034	-0.255	-3.824	0.0002

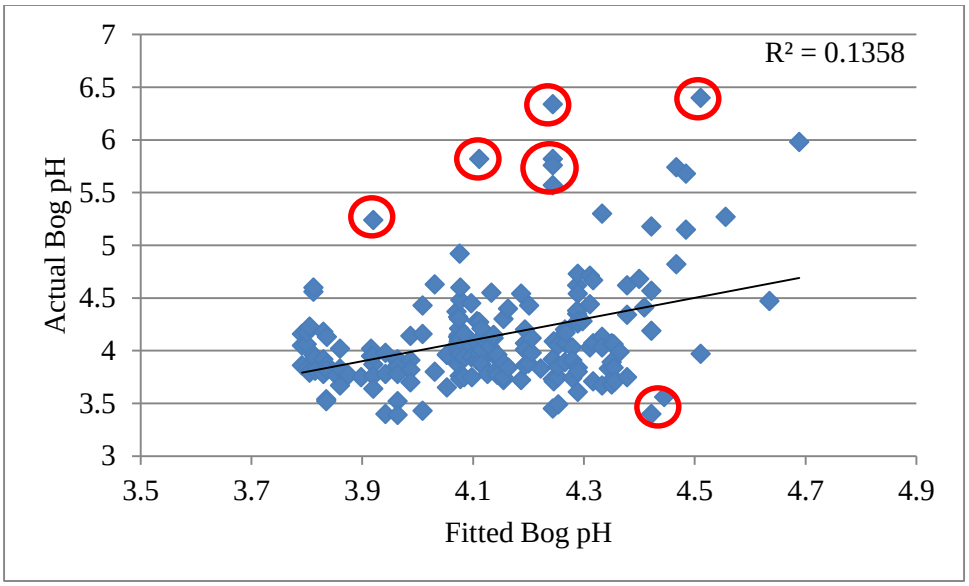


Figure 37. Scatterplot of actual versus predicted bog pH values, with best fit regression line, and visually determined outliers highlighted in red.

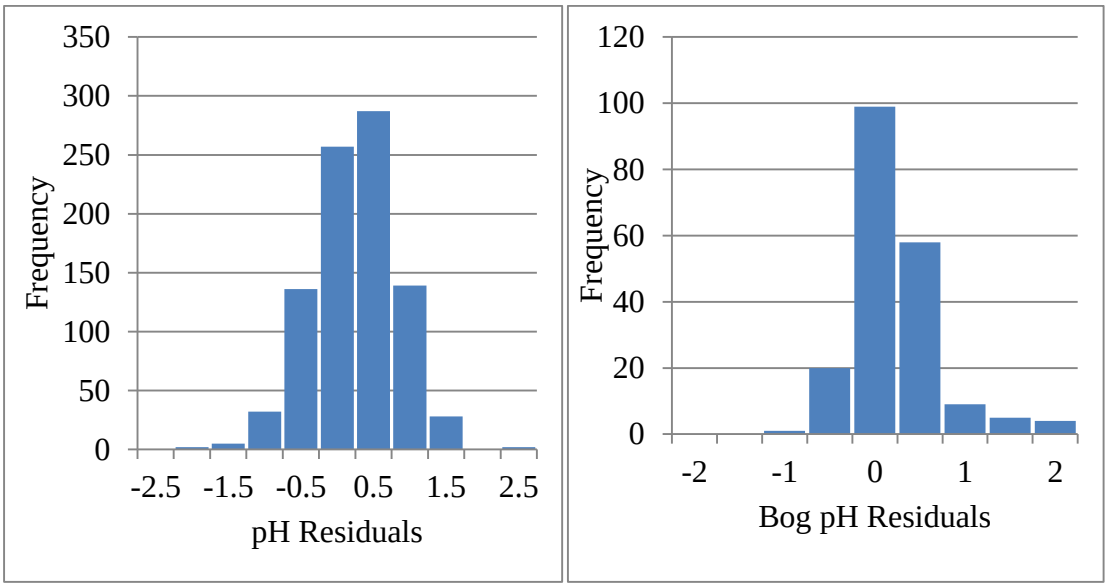


Figure 38. Frequency distributions for residual values of the non-bog pH (left) and bog pH (right) models.

Table 22. Correlation coefficients between pH and all measured variables.

	Correlation Coefficient
	pH
pH	1.00
$\log_{10}$EC	0.55
EC	0.44
DO	0.14
Dom. Tree	0.13
Temperature	-0.04
Color	-0.43
Ground Veg.	-0.45

Wetland classification for each study site showed generally good conformance between field measured and image determined wetlands, as discussed in Chapter 5 and Appendix V of this thesis. Correlations between actual, predicted and mapped pH (Table 23) revealed a better relationship between actual versus predicted, then actual versus mapped pH values.

Table 23. Correlation coefficients for actual, predicted, and mapped pH values.

	Correlaton Coefficient
	pH Actual
pH Actual	1.00
pH Predicted	0.76
pH Mapped	0.58

The pH rasters created using the best fit multiple regression equation provided a data layer that revealed general visual conformance across all sites and wetland classes (Figure 39 and Figure 40).

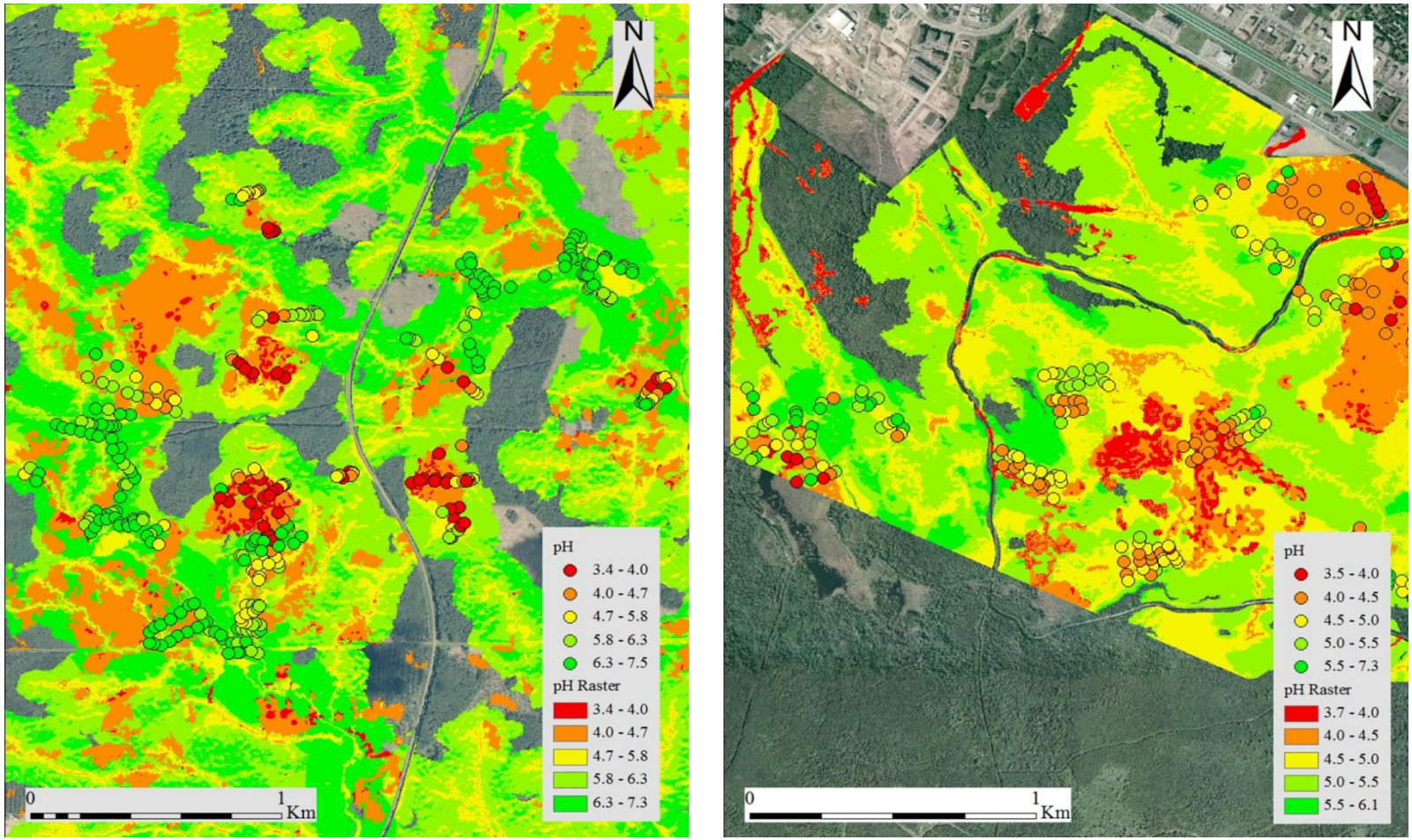


Figure 39. Field pH values overlaying pH rasters for the EMEND (left) and UNB Forest (right) sites.

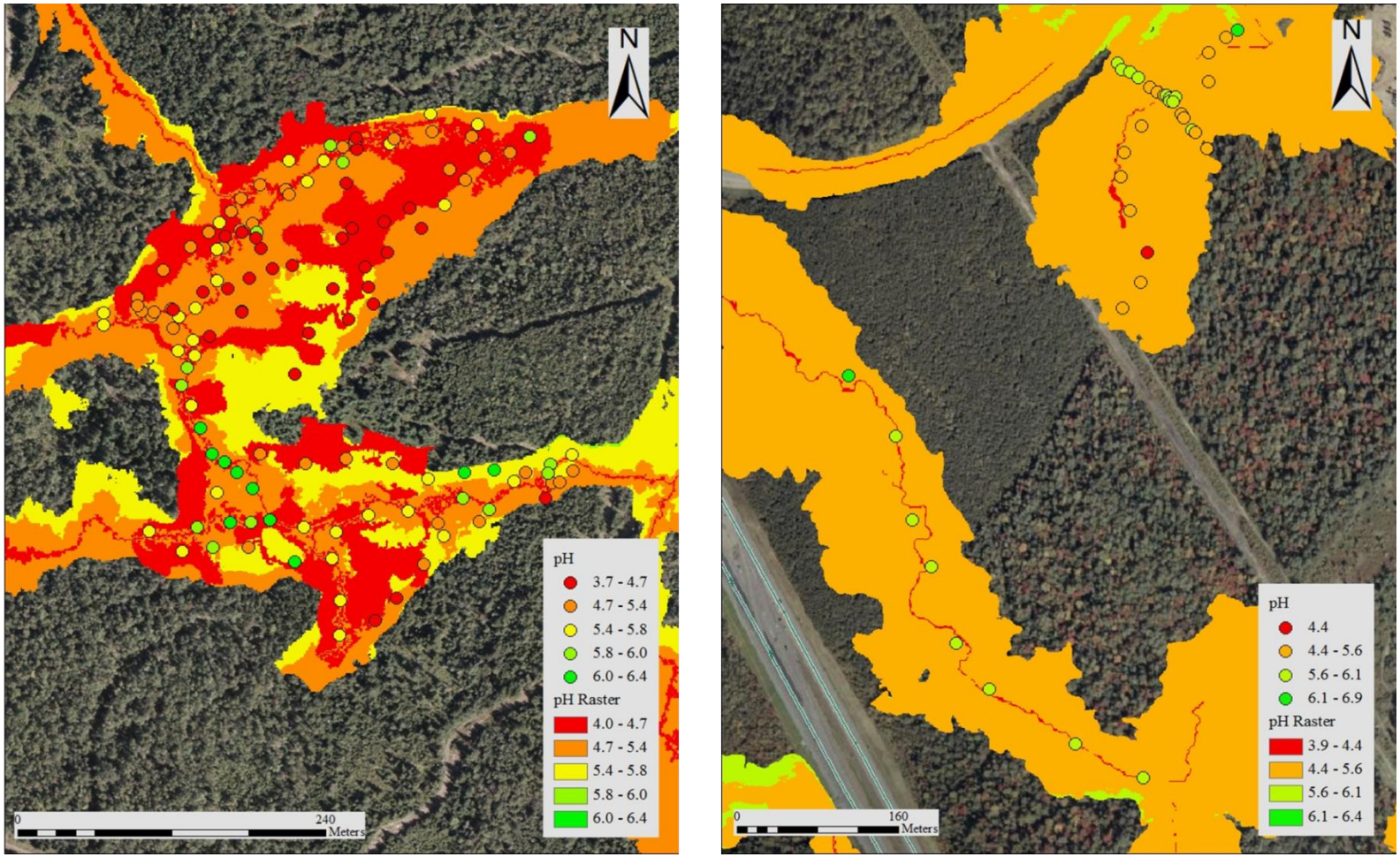


Figure 40. Field pH values overlaying the regression-derived pH rasters for the Saint John wetland (left) and Jack Pine (right) sites.

Regression analysis comparing the pH of the test plots (100 extracted values) and the modelled values showed an R^2 of 0.68 (Figure 41). Average pH values for each wetland class by location revealed a correlation coefficient of 0.99 (Figure 42).

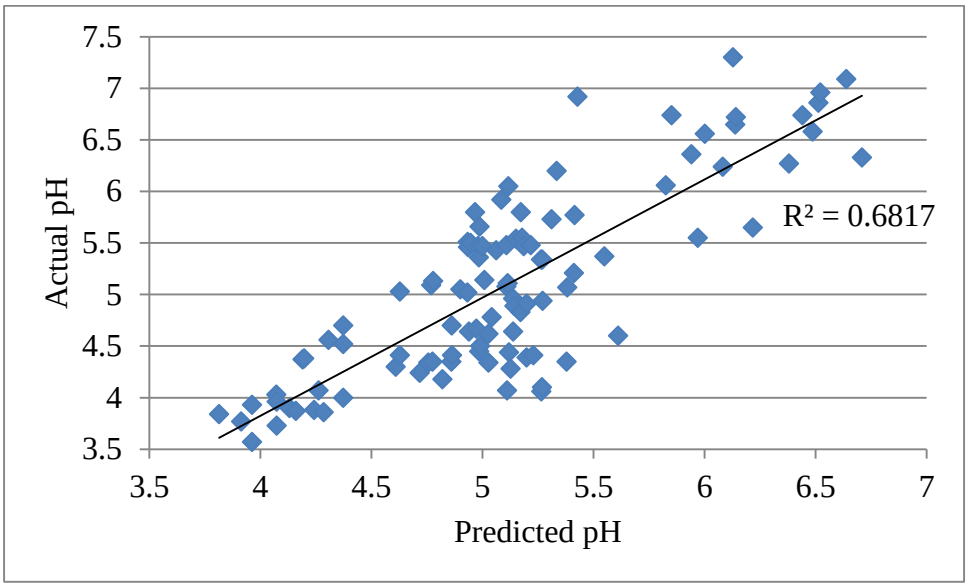


Figure 41. Showing actual versus predicted pH values for the 100 test plots, with best fit regression line.

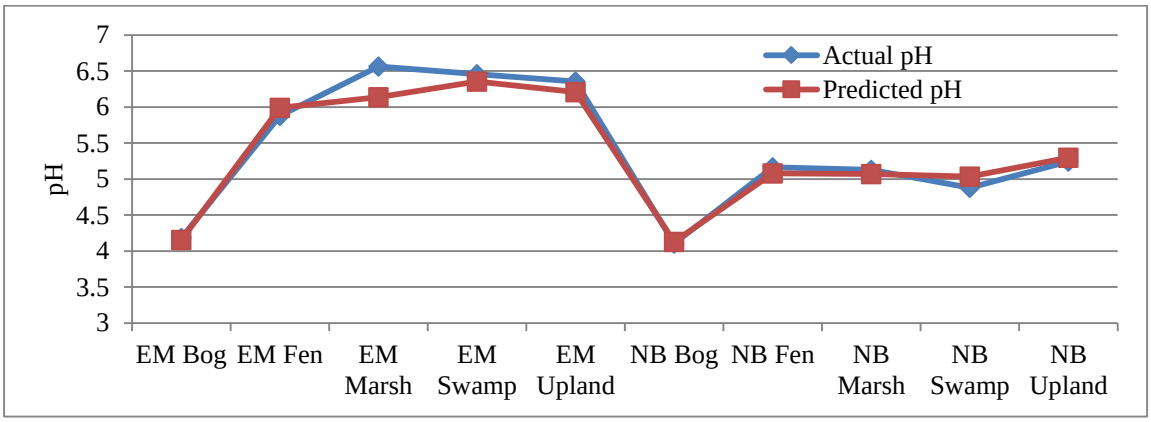


Figure 42. Average pH values by wetland class and location.

Comparison of actual versus predicted pH values within each wetland class showed that the best results were found in swamps and uplands, with correlation coefficients of 0.73 and 0.64, respectively; in bogs pH demonstrated the poorest relationship, with a correlation coefficient of 0.39 (Figure 43).

Frequency distributions revealed that predicted marsh pH values, while similar to actual values, were commonly predicted at a pH of 5, while high and low values (pH < 4 and pH > 7) were less well represented (Figure 44). Predicted bog and swamp pH values tended to be lower than actual pH values; while upland pH values were somewhat bi-modal, with lower values (pH ~ 5.5) being well represented, however higher values (pH ~ 7) were not predicted well with the model.

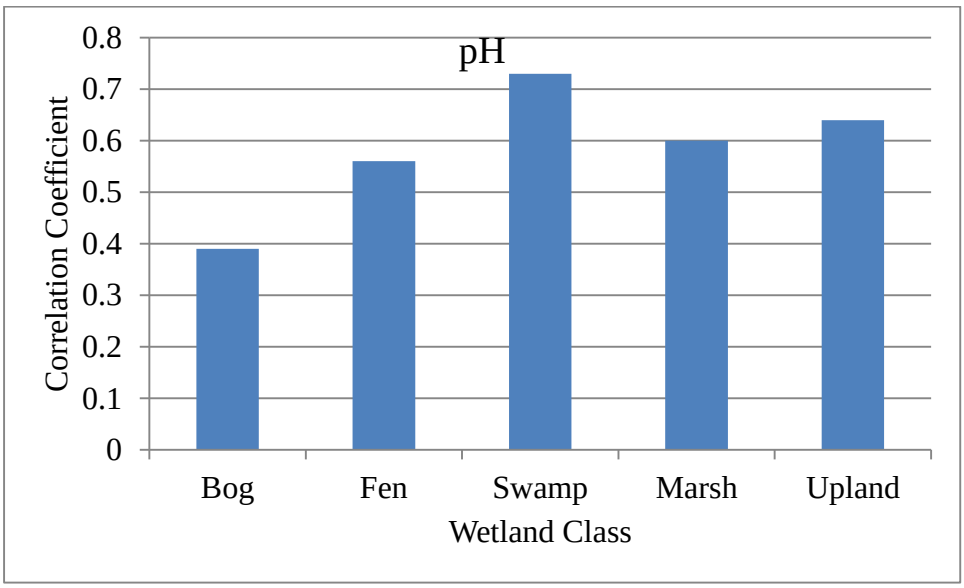


Figure 43. Correlation coefficients of actual versus predicted pH values by wetland class.

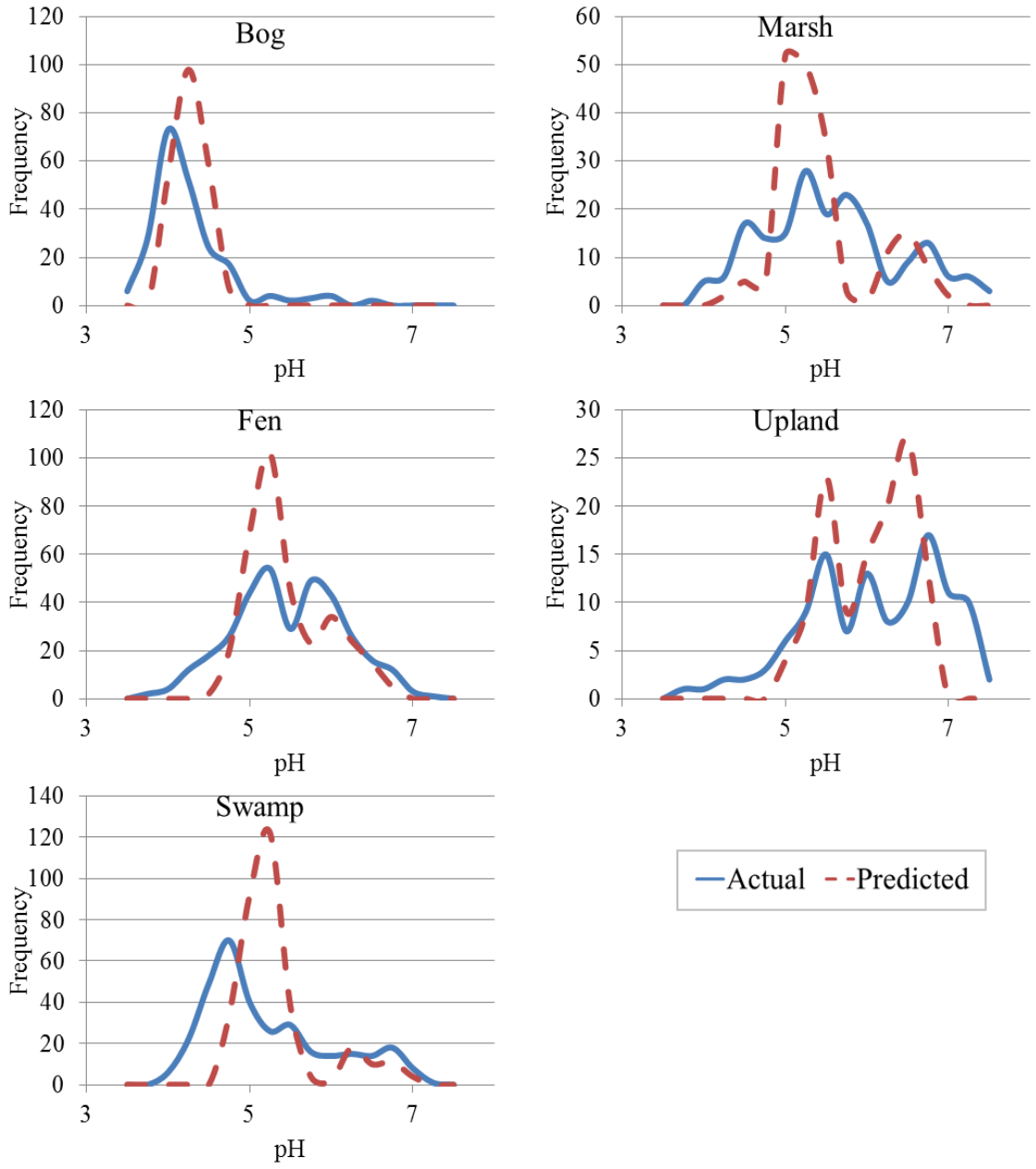


Figure 44. Frequency distributions for actual and predicted pH values by wetland class.

Results of the literature review show generally consistent pH values between 3.5 and 4.5 pH for bogs; while fens, swamps, and marshes show more variability depending on the groundwater influence, and forest conditions (Table 24). Information about the landscape position of the measured pH values was occasionally included, such as indication of transition zones and dominant tree species cover; however a spatially explicit map of pH transitions across wetlands was not available.

Table 24. PH values taken from a literature review compared with pH values measured for this thesis. Average and range of measured values are shown, excluding outliers

Wetland / Forest Type	pH	Location	Source	Wetland Class	pH	Location
Bog	4.0	Minnesota, Sweden, Nova Scotia	Gorham et. al. (1984)	Bog	4.2, 3.4 - 6.4	EMEND
Bog	3.8 - 4.5	Saskatchewan / Manitoba	Kuhry et. al. (1993)	Bog	4.1. 3.5 - 5.8	New Brunswick
Bog	3.7 - 4.2	N / A	Shotyk (1988)			
Bog	4.3	Hudson Bay Lowlands	Ulanowski and Bran (2013)			
Peat Bog	3.2 - 3.9	Minnesota, USA	Heinselman (1963)			
Perched Bog	3.6 - 4.7	Minnesota, USA	Bay (1967)			
Black Spruce Bog	4.0 - 4.1	Wisconsin, USA	Pierce (1953)			
Raised Bog	4.2 - 5.0	Poland	Malawska et. al. (2006)			
Extreme Poor Fen	3.8 - 5.0	N / A	Shotyk (1988)	Fen	5.9, 3.5 - 7.0	EMEND
Poor Fen	4.3 - 5.5	N / A	Bourbonniere (2011)	Fen	5.2, 3.7 - 6.5	New Brunswick
Intermediate Poor Fen	5.2 - 6.4	N / A	Shotyk (1988)			
Fen	5.7 - 7.9	Hudson Bay Lowlands	Ulanowski and Bran (2013)			
Alder Fen	6.1	Wisconsin, USA	Pierce (1953)			
Transition Rich Fen	5.8 - 7.0	N / A	Shotyk (1988)			
Extreme Rich Fen	7.0 - 8.4	N / A	Shotyk (1988)			
Hardwood Swamp	6.8	Lower Michigan, USA	Schwintzer and Tomberlin (1982)	Swamp	6.4, 5.7 - 7.0	EMEND
Black Spruce / Alder Swamp	5.4	Wisconsin, USA	Pierce (1953)	Swamp	4.9, 3.9 - 6.9	New Brunswick
Cedar Swamp	6.0	Wisconsin, USA	Pierce (1953)			
Conifer Swamp	7.1	Lower Michigan, USA	Schwintzer and Tomberlin (1982)			
Cattail Marsh	7.3	Wisconsin, USA	Pierce (1953)	Marsh	6.6, 5.1 - 7.0	EMEND
Sedge Marsh	7.4	Wisconsin, USA	Pierce (1953)	Marsh	5.1, 3.9 - 7.3	New Brunswick
Open Water Marsh	8.8	Wisconsin, USA	Pierce (1953)			
Upland Adjacent Zone	5.3 - 6.3	Wisconsin, USA	Pierce (1953)	Upland	6.3, 3.7 - 7.5	EMEND
Upland	5.9 - 6.7	Minnesota, USA	Bay (1967)	Upland	5.2, 4.1 - 6.1	New Brunswick

Discussion

Visual analysis of wetland class pH distribution revealed an abundance of outliers in the bog class, resulting from the influence of groundwater on bog plots which occurred in depressions and close to fringe zones. Further, the majority of high bog pH values were found in EMEND due to the generally higher pH of groundwater in northern Alberta compared with New Brunswick.

Average pH values displayed across site and season show little seasonal variation, however significant variation occurred between EMEND and UNB Forest plots. Saint John and Jack Pine Plantation plots had high pH values, which could be attributed to limited bog plots, which consistently had low pH values.

Outside bogs, depth to water and pH increased concurrently, due to the acidification processes occurring near the soil surface, which includes organic matter accumulation and decomposition, introduction of functional groups with free hydrogen to the soil solution, and the effects of acid precipitation; while deeper in the soil profile base cation enrichment from groundwater and limited input of surface acids cause pH to increase (Bay, 1967; Berner et al., 1987; Brady and Weil 2002). An increase in flow accumulation also reflected a pH increase due to the addition of base cations from accumulating surface and groundwater (Gorham, Bayley, and Schindler, 1984; Shotyk, 1988).

Electrical conductivity and pH were found to increase concurrently partially because pH and EC values were higher in EMEND than in NB sites, due to the increase in

evapotranspiration over precipitation in EMEND compared with NB. Evaporation allows base cations to become more concentrated, while excess precipitation leads to leaching of base cations, and decreased pH values. Further, areas with high pH, such as rich fens and upland to wetland transition zones, contain high amounts of base cations due to mineral water enrichment, and decomposition of deciduous trees, causing an increase in EC values (Bay, 1967). As such, the $\log_{10}$EC raster, discussed in Chapter 6 of this thesis, was found to be the most useful variable for predicting pH.

In bogs, tree height was used to determine pH variations, with tree height and pH increasing simultaneously. Areas of bogs with the poorest conditions, often near the centre, would demonstrate stunted trees, while the fringe areas would show increased tree growth, due to warmer temperatures and possible influx if nutrients from deciduous leaves in the transitional zones (Bay, 1967). Hydraulic conductivity variation represents the difference between domed bogs, and basin bogs, with the former having higher HC values than the latter. As a result, increasing $\log_{10}$HC values showed a decrease in pH. The domed bog areas were colder and raised above any groundwater influence, which resulted in decreased rates of decomposition, organic matter accumulation, high lignin content of the organic soil, and ultimately, lower pH values than the basin bog areas (Shotyk, 1988). Additional continuous and categorical variables available for possible pH predictions were found to either correlate with predictive variables, or to have no effect on pH predictions. The relationship between pH and field measured variables shown in Table 22 further highlight the strong relationship between pH and EC, as has been discussed, and shows that pH related well with water colour, and with ground

vegetation. Water colour was predicted using pH, discussed in Chapter 9 of this thesis; while ground vegetation improved the predictions only slightly, and was borrowing predictive strength from $\log_{10}$DTW, as the two variables were correlated.

While the regression trend for predicting pH for non-bogs was significant, the variation and R^2 value ($R^2 = 0.48$) of the predictions can be attributed to the scale at which pH varies across the landscape; which can change as a result of micro-topographic variation, forest heterogeneity, and unseen groundwater influence (Ulanowski and Bran, 2013).

Regarding bog pH predictions, the regression trend was less significant, and outliers were more common than for non-bog predictions because landscape features were relatively homogenous, while pH varied at a micro-scale. There were no large scale trends acting on bog pH, such as increasing flow accumulation that could be relied on for predictive strength.

The pH raster created with the best fit regression equation allowed for the pH values to be mapped across the wetland area for all study sites. Discrepancy between predicted and mapped pH results occurred where actual wetland classes differed from mapped wetland classes. While the majority of wetland plots were within 10m of mapped wetlands, pH values extracted from ArcGIS represented the pH within 5m of plot centre, thereby resulting in loss of conformance between predicted and mapped results, most notably as a result of variability in spatial hydraulic conductivity data, directly related to wetland classification mapping.

Investigation of the test plots, which consisted of a random selection of wetland classes and locations, revealed a very good relationship between actual and predicted pH values, further demonstrating the robustness of the predictive model. A comparison of average actual pH versus average predicted pH values also showed a very strong correlation, with the largest average discrepancy between actual and predicted results (0.4 pH) occurring at EMEND marsh plots. Average actual EMEND marsh, swamp and upland pH values were all slightly higher than predicted values, which resulted from the effect of evapotranspiration and mineral deposition due to periodic flooding. NB swamps, marshes and uplands affected by the same flooding processes did not see the same pH increase due to the excess precipitation and predominantly coarse grained soils that lead to nutrient leaching (Brady and Weil, 2002).

The results of a literature review on wetland pH occurrence shows conformance with the bi-modal distribution of data collected for this thesis; average bog pH ~3.8 and remaining wetlands average pH of ~6.3. Among the extensive information available on pH values for wetland classes, variability within classes may result from data collection methods, regional variation, or localized wetland conditions; such as topography or forest composition. Regional variation in surficial geography and soil composition can affect pH through base cation availability, and evaporation/precipitation ratios, both of which affect groundwater influenced wetlands (Brady and Weil, 2002). Data for the transition from poor to rich fens provided a spatial representation of pH variation across the landscape, however there was no clear reference to pH transitions within wetlands. Ulanowski (2013) considered the spatial distribution of groundwater pH, by focusing

on small scale (7m x 7m grid) spatial distribution, for bogs and fens only; however the focus was on identifying variability across small areas, and not mapping pH.

In summary, the ability to predict and map pH within and across wetlands has been demonstrated using LiDAR derived WAM and topographic attributes. The multiple regression analysis of bog and non-bog wetland was done separately due to the bi-modal distribution of pH values, which are generally lower in bogs than for fens, swamps, marshes and uplands. Depth-to-water was the most significant variable for predicting non-bog pH, as DTW increase was shown to cause an increase in pH, due to increased base cation enrichment and lack of organic acid deposition for water deep in the soil profile.

CHAPTER 8

WATER TEMPERATURE

Introduction

This chapter deals with shallow water temperature as reviewed in Chapter 2 of this thesis. The site details and methodology for this chapter can be found in Chapters 3 and 4 of this thesis, respectively. The primary goal of this research is to determine if temperature can be mapped using remotely sensed data, primarily LiDAR derived WAM and topographic attributes, while accounting for wetland class and seasonal variation. As the resulting map would identify temperature transitions across wetlands, the biological characteristics that accompany generally warm versus generally cool portions of the wetland landscape would also be identified.

Results

A total of 1198 temperature plots were measured at the EMEND and NB locations, which included all wetland classes and seasonal variation at the UNB Forest (Figure 45 and Figure 46).

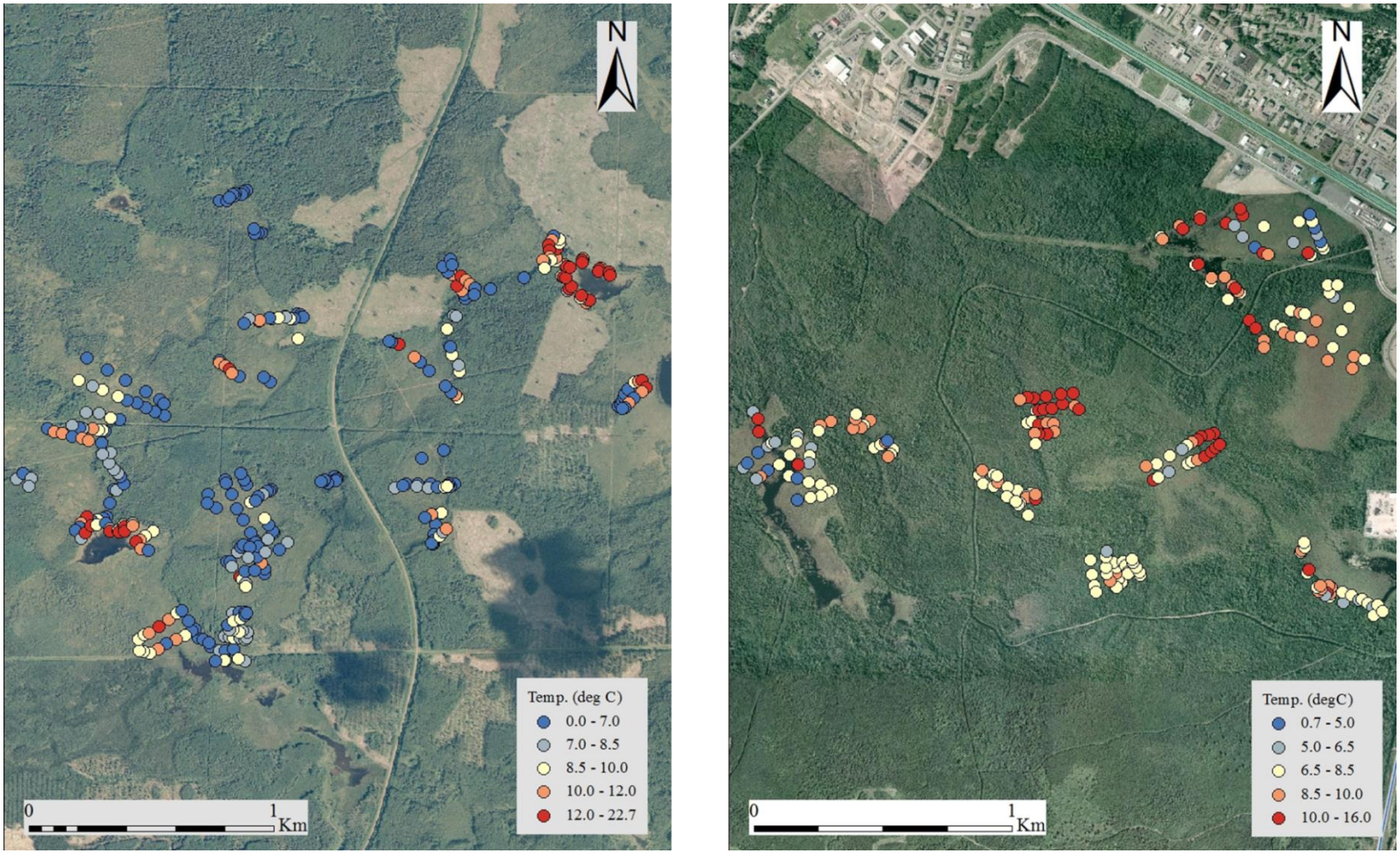


Figure 45. EMEND (left) and UNB Forest (right) sites showing plot locations with measured temperatures.

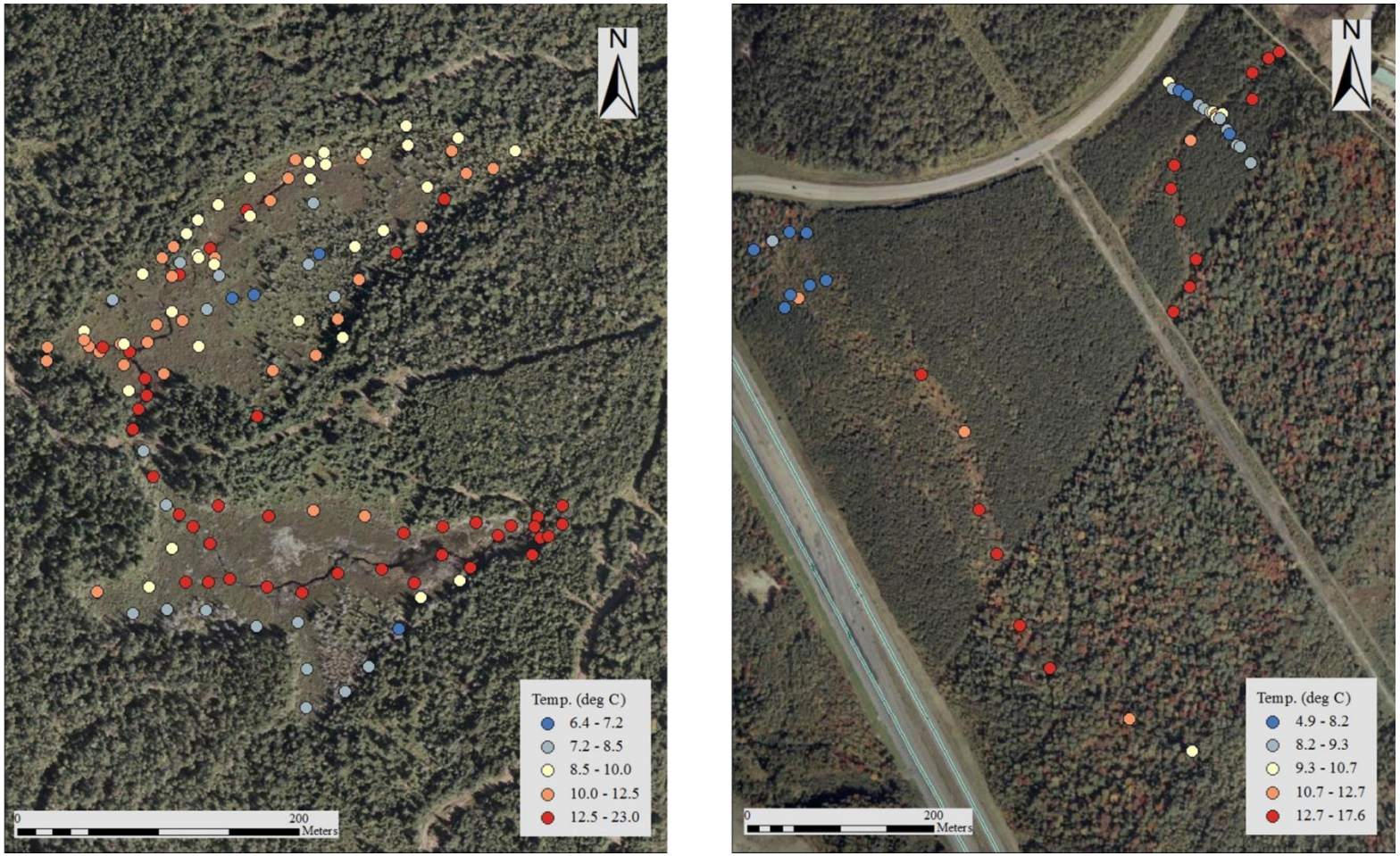


Figure 46. Saint John Wetland (left) and Jack Pine (right) sites showing plot locations with measured temperatures.

A summary of all measured temperature values based on wetland and depth-to-water classes showed that measured temperatures were highest in marshes, with fens and swamps being only slightly lower, while bogs and uplands had statistically lower temperatures; and temperature decreased with an increase in DTW values (Table 25).

Table 25. Summary of temperature values by wetland and DTW classes.

Temperature (deg C)									
Class	**Min**	**Max**	**Mean**	**Std dev**	**DTW (cm) 4 ha**	**Min**	**Max**	**Mean**	**Std dev**
Bog	0.0	16.0	8.3	4.0	**0 - 10**	1.7	26.1	11.6	3.1
Fen	1.2	26.1	11.1	4.3	**10 - 25**	0.6	22.7	9.9	3.5
Marsh	1.5	22.7	11.5	3.3	**25 - 50**	0.5	23.0	9.9	3.9
Swamp	2.1	18.8	10.7	2.8	**50 - 100**	0.2	22.2	8.5	4.5
Upland	0.6	20.3	7.6	3.3	**100 - 275**	-0.3	19.7	7.0	4.5

Boxplots showing the distribution of temperature values for both site and wetland class revealed eleven common outliers, which were removed from the data set due to possible influence of open water on the measurements and thermometre error due to failing batteries (Figure 47). Average temperature values, plotted for each site, and season for the UNB Forest, showed the lowest values were found at EMEND, while UNB Spring temperatures were approximately 2°C higher. The highest average temperatures were found in the UNB Summer plots, while the remaining NB plot temperatures varied only by approximately 1°C (Figure 48).

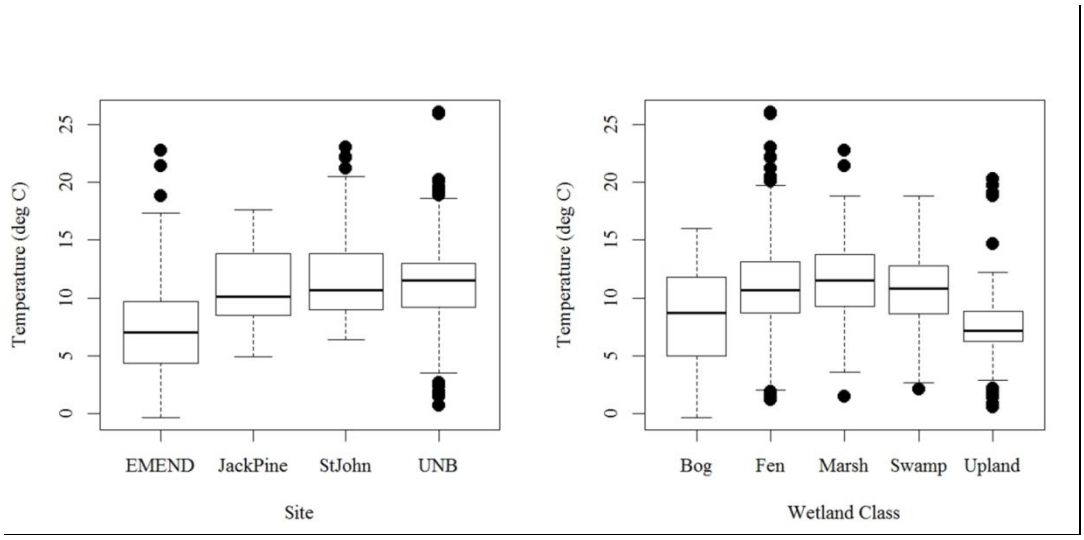


Figure 47. Boxplots showing temperature distributions by site and wetland class.

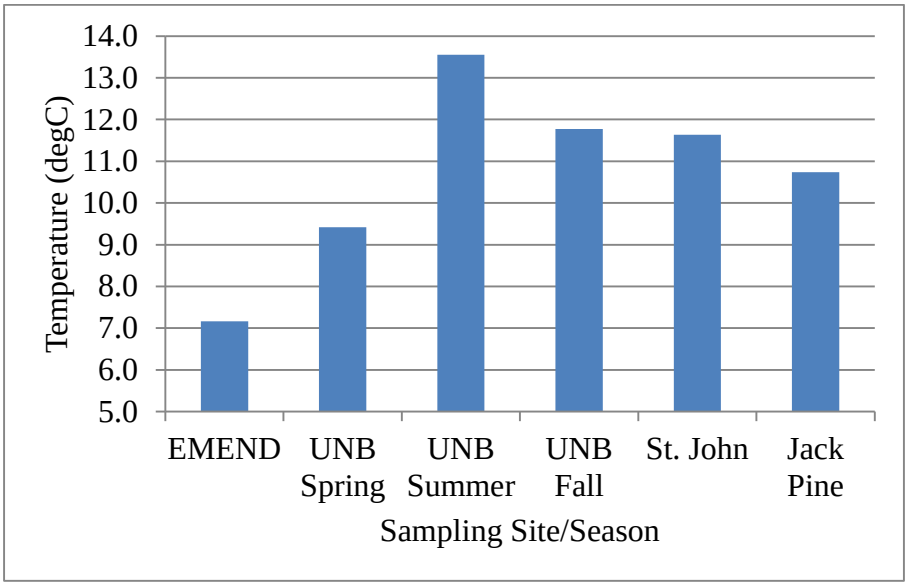


Figure 48. Average temperature values by site and season.

Multiple regression analysis revealed that among the continuous and categorical variables (Table 3) available for predicting temperature; $\log_{10}$DTW (4ha flow

initiation), UNB spring, and Bog were the most important variables for explaining observed temperature trends (R^2 = 0.23) (Table 26; Figure 49). Residual values were shown to have a normal distribution (Figure 50). Outliers, values which were found to be inconsistent with the majority of plots that had similar landscape attributes, were determined by visual analysis of the residuals, and when removed gave an R^2 = 0.32. Correlations between temperature and measured variables demonstrated that dominant tree species and $\log_{10}$EC were correlated with temperature, while other measure variables were weakly correlated (Table 27).

Table 26. Best fit predictive variables used to model temperature (R^2 = 0.23) using multiple regression analysis.

	Coefficient	**Std. Error**	**Std. Coefficient**	**t-Value**	**P-Value**
Intercept	8.381	0.191	8.381	43.944	<0.0001
$\log_{10}$DTW (4ha)	-3.058	0.196	-0.443	-15.611	<0.0001
UNB Spring	-2.144	0.246	-0.246	-8.715	<0.0001
Bog	-1.785	0.26	-0.184	-6.867	<0.0001

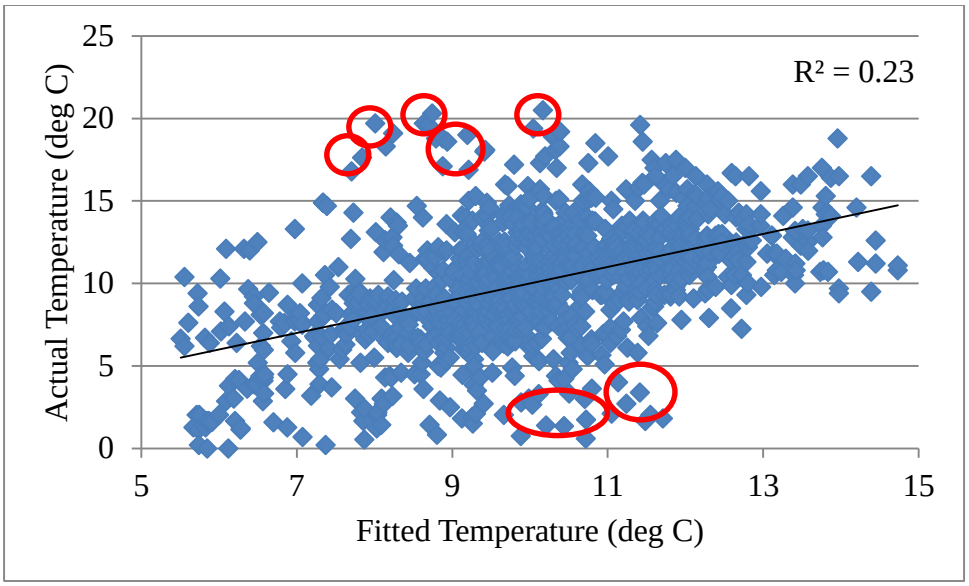


Figure 49. Scatterplot of actual versus predicted temperature values, with best fit regression line and visually determined outliers highlighted in red.

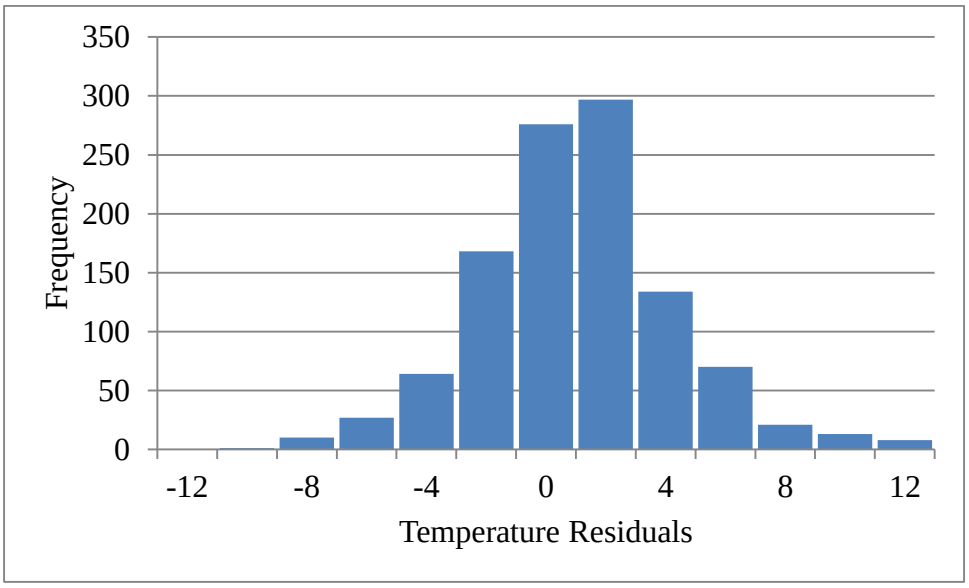


Figure 50. Frequency distribution for residual values of the temperature models.

Table 27. Correlation coefficients between temperature and all measured variables.

	Correlation Coefficient
	Temperature
Temperature	1.00
Dom. Tree	0.39
Ground Veg.	0.12
pH	-0.04
Color	-0.08
DO	-0.15
EC	-0.18
$\log_{10}$EC	-0.30

Wetland classification for each study site showed generally good conformance between field measured and image determined wetlands, as discussed in Chapter 5 and Appendix V of this thesis. A comparison between actual, predicted and mapped temperature values revealed almost equal correlation coefficients between actual versus predicted and actual versus mapped temperature values (Table 28).

Table 28. Correlation coefficients for actual, predicted and mapped temperature values.

	Correlaton Coefficient
	Temperature Actual
Temperature Actual	1.00
Temperature Predicted	0.47
Temperature Mapped	0.49

The temperature rasters created using the best fit multiple regression equation provided data layers that reveal general visual conformance across all sites and wetland classes (Figure 51 and Figure 52).

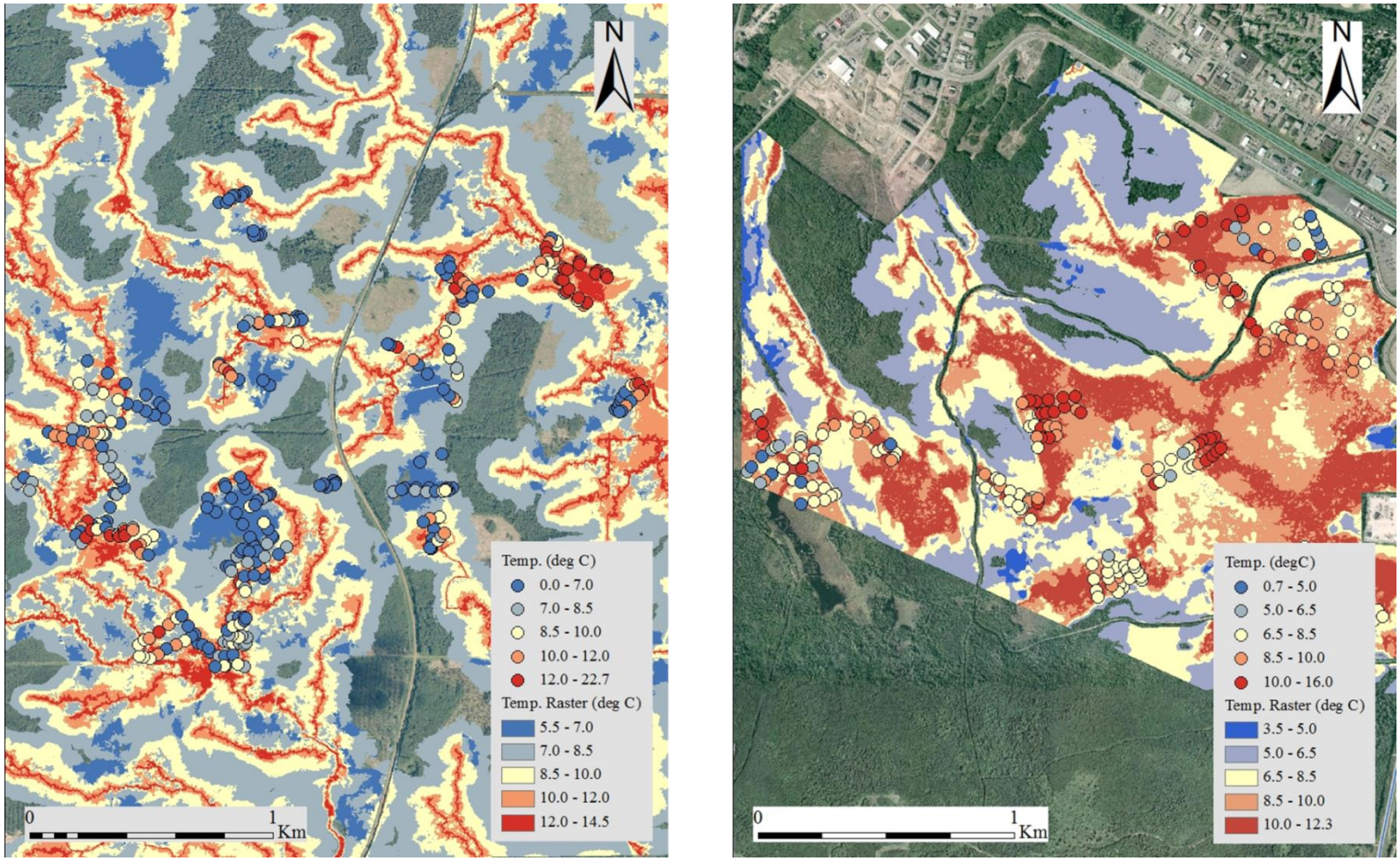


Figure 51. Temperature raster and field temperature values for the EMEND (left) and UNB Forest (right) sites

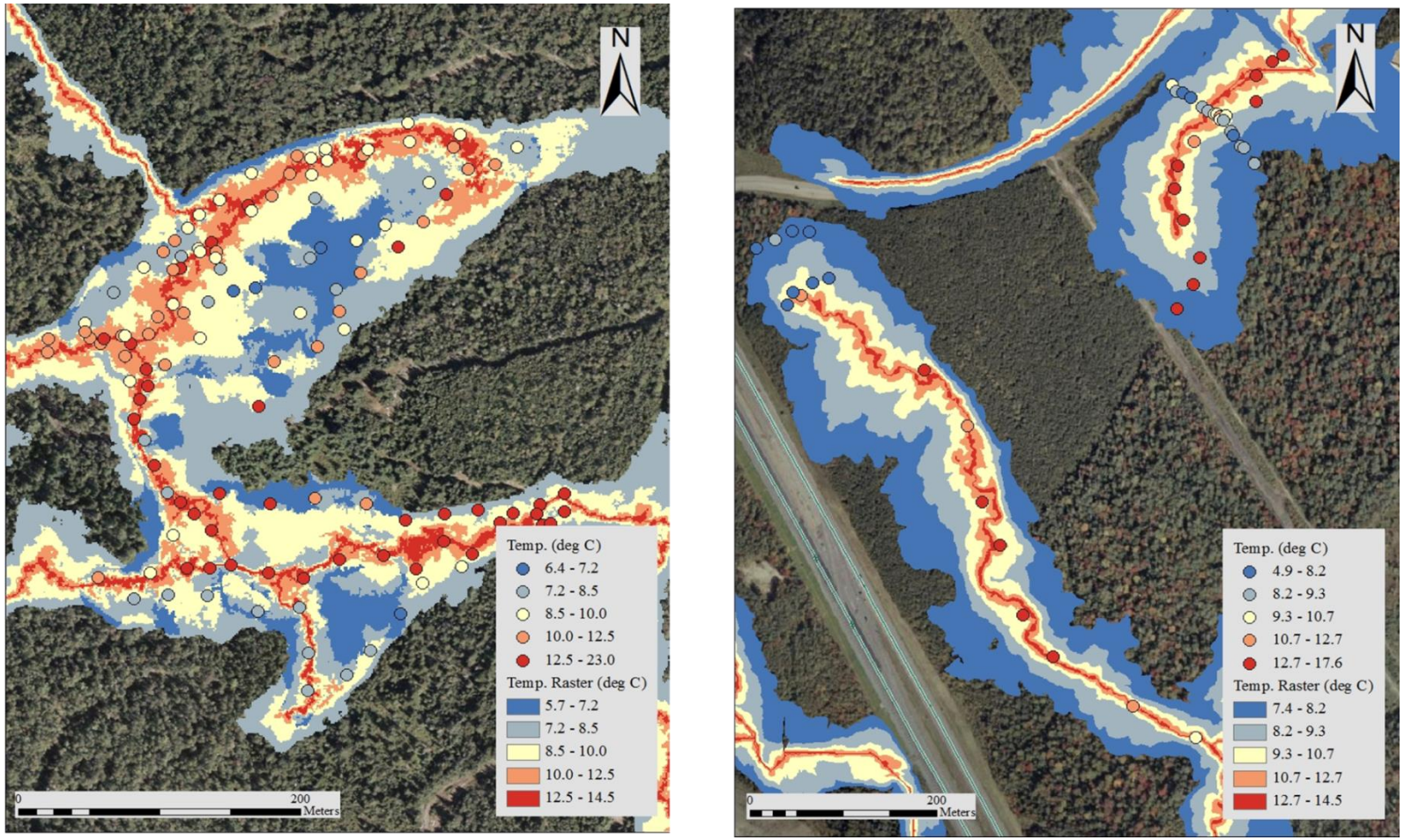


Figure 52. Temp. raster and field values for the St.John (left) and Jack Pine (right) sites

Regression analysis comparing the temperature of the test plots (100 extracted values) and the modelled values showed an R^2 of 0.13 (Figure 53). Average temperature values for each wetland class by location revealed a relationship with a correlation coefficient of 0.77 (Figure 54).

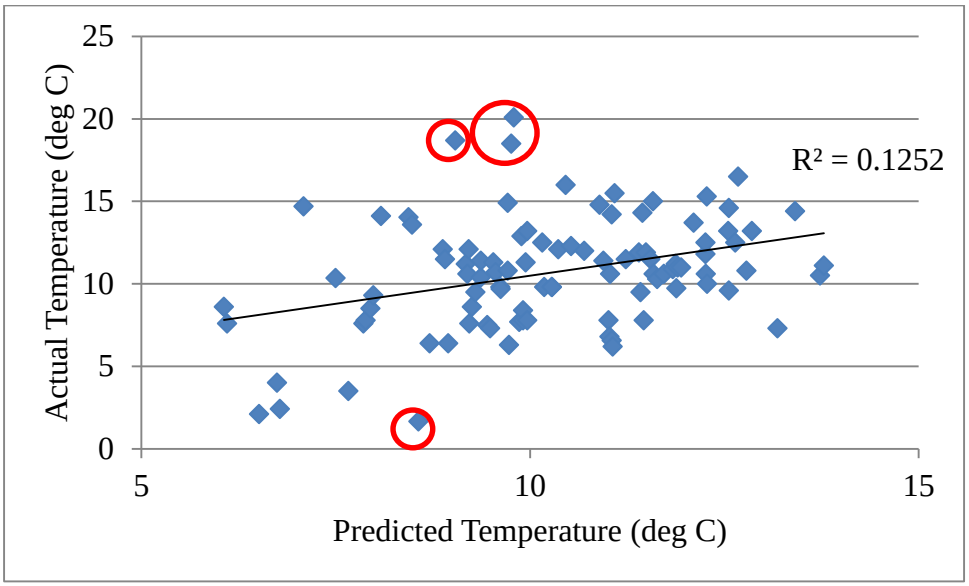


Figure 53. Actual versus predicted temperature values for 100 test plots.

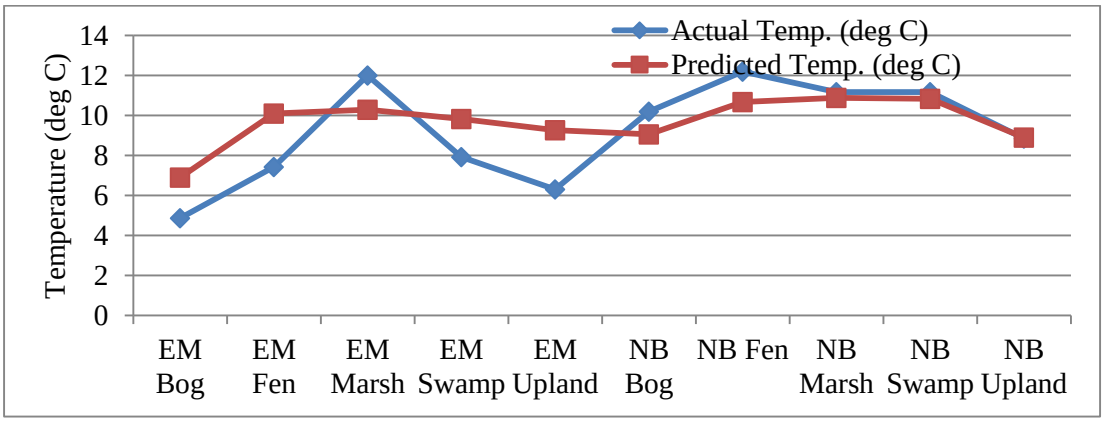


Figure 54. Average temperature values by wetland class and location.

Comparison of actual versus predicted temperature values within each wetland class showed that the best results were found in bogs, with a correlation coefficient of 0.69; while upland and fen temperatures demonstrated the poorest relationships, with correlation coefficients of 0.04 and 0.14, respectively (Figure 55).

Frequency distributions showed that while median temperature values were well represented with predicted values for bogs, fens, swamps and uplands, low and high temperature values were poorly represented (Figure 56). Predicted upland temperatures were approximately 2°C higher than actual temperature values for the majority of the results, and actual temperature values below 5°C were not represented with the model.

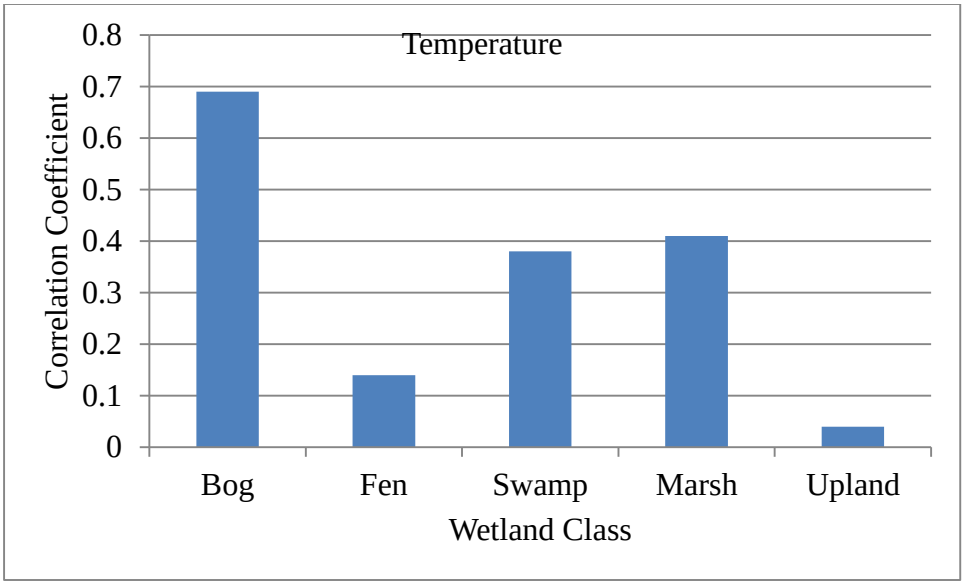


Figure 55. Correlation coefficients of actual versus predicted temperature values.

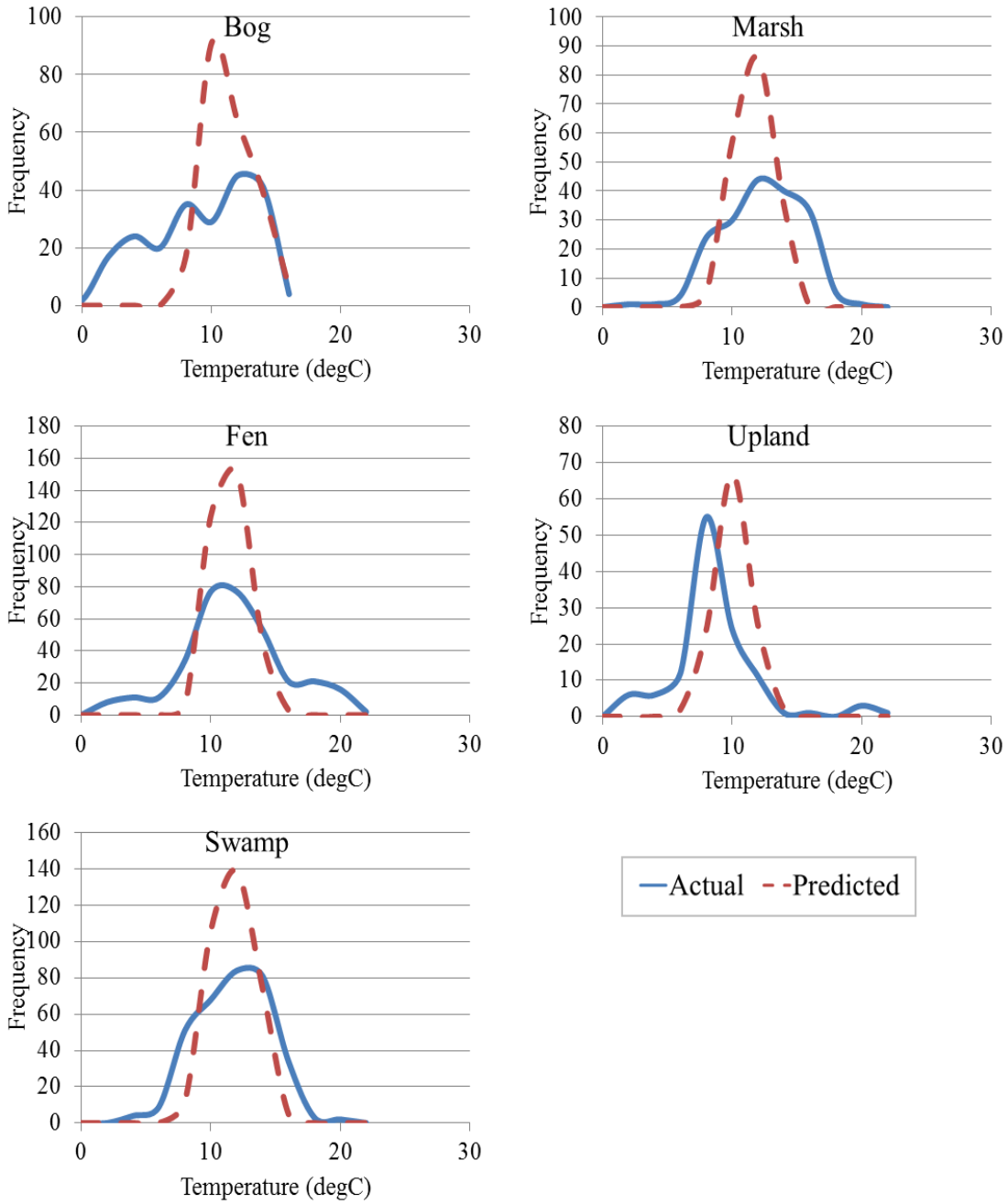


Figure 56.Frequency distributions for actual and predicted temperature values

Discussion

Shallow water temperature is sensitive to seasonal air temperature variations, and water temperature changes lag behind air temperatures, due to insulating factors such as depth to water and organic matter accumulation (Whigham, 2009; Wolken et al., 2011) As a result, water temperatures at the UNB Forest were significantly cooler in spring when compared with summer and fall values, making UNB spring an important variable for explaining observed temperature trends.

Depth to water was the most influential variable for predicting water temperature because water that was increasingly deep below the soil surface remained cooler due to soil insulation for the majority of the growing season (Tim R. Moore et al., 2011). Soil water temperature will heat up slowly at the beginning of the growing season, and retain heat for longer thereafter; a process that was demonstrated in the UNB Forest seasonal temperature measurements. A graph of average seasonal temperatures for each wetland class (Figure 57) shows that bogs retained heat longer than other wetlands in fall, however among the majority of plots measured, bog temperatures were significantly lower than other wetland classes.

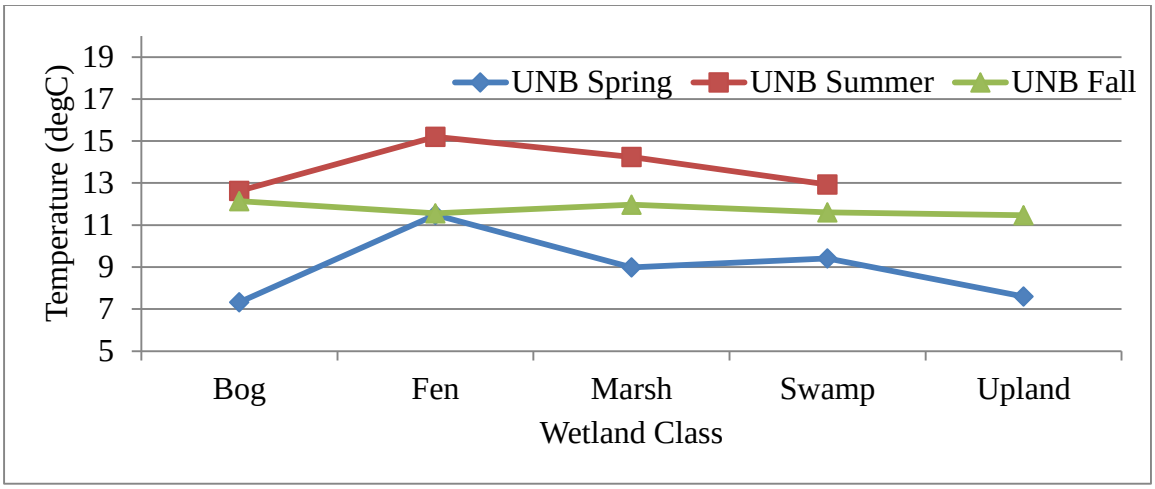


Figure 57. Temperature for each wetland class for the UNB Forest in spring, summer and fall.

The results of the multiple regression analysis show an R^2 of 0.23, with 32 visible outliers, however the trend for predicting shallow water temperature is significant. Factors that affect shallow water across wetlands, such as micro-topography, variability in organic matter accumulation, vegetation presence/absence, and groundwater influence will cause small scale temperature variations, resulting in variability between actual and predicted temperatures because not all of this variation could be detected with WAM and topographic attributes. The use of field measured variables did not improve model predictions because, as was shown in Table 27, $\log_{10}$EC and dominant tree were the only variables that related well with temperature. Temperature was well related with $\log_{10}$EC variable because average temperatures in NB were higher than those in AB, therefore the relationship was driven by location, rather than environmental factors, making $\log_{10}$EC an unreliable variable to use in temperature predictions. Dominant tree, although it was related to temperature, was not used to

improve predictions because it was related to wetland classes; for example, the dominant tree type in bogs was softwood 75% of the time.

Water temperature readings measured in open water resulted in residual outliers with high temperatures shown in the multiple regression scatterplot. Residual outliers displaying low temperature values, between 0 and 5°C, occurred at fen and upland EMEND plots, where DTW was between 10 and 20cm. Although no visible conditions were noted in in the field, all of these plots were along edges between uplands and wetlands, which suggested that influence of cold groundwater could have affected these measurements.

The temperature raster created with the best fit regression equation allowed for the shallow water temperature values to be mapped across the wetland area for all study sites. The maps provide visual confirmation of the validity of the modelled results, while allowing the extrapolation of information for the remaining wetland areas. There was little discrepancy between predicted and mapped temperature results because DTW was the most influential variable for determining the correlation between actual and predicted temperature values. The accuracy of predicted versus mapped temperature results could only have been affected by the categorical ‘bog’ predictor variable, which was spatially defined during wetland class allocation, however predicted and mapped temperature values had an average difference of only 0.6°C across all 1187 plots. The majority of data analysis involved actual versus predicted results, instead of actual versus mapped results in order to ensure clear viewing of the strengths and weaknesses of the model.

Investigation of the test plots for conformance with modelled predictions showed that although the relationship was significant, the trend between actual and predicted results was weak. Residual outliers occurred due to open water as well as possible groundwater influence on temperature measurements.

Comparison of the average actual versus average predicted temperatures for each wetland class demonstrated a correlation coefficient = 0.77. While both EMEND and NB showed good relationships, the correlation coefficient for NB was stronger (correlation coefficient = 0.86), than for EMEND (correlation coefficient = 0.74), primarily due to the model's inability to predict low EMEND temperatures. Temperatures in EMEND were generally cooler than those in NB, due of an abundance of domed bogs, and deeper upland soil pits. These cooler EMEND temperatures, deep in the soil profile, were reflected in the predictive model with the DTW variable.

Actual versus predicted bog temperatures had the strongest relationship (correlation coefficient = 0.69), which can be partially attributed to the increased bog temperatures that coincided with DTW increases from EMEND to NB. Warmer bog temperatures were found in NB, along with more shallow DTW values. Within the EMEND site, temperature continued to follow a decreasing trend from shallow to deep DTW. Extreme low and high bog temperatures were not accounted for due the variability in bog temperatures measured.

Swamp and marsh actual versus predicted results showed similar correlation coefficients (~0.4) and frequency distributions, however once again low and high temperatures were not well predicted. Lack of correlation is attributed to ranging

temperatures measured at similar DTW's for each wetland class. For example, swamps with DTW between 0cm and 10cm showed temperatures ranging from 3.5°C to 17.5°C. This variation becomes even more significant, and correlation between actual and predicted results becomes weaker with fens, which showed average temperatures ranging from 1.5°C to 19.5°C for DTW 0-10cm. Actual versus predicted upland temperatures showed very poor correlations due upland temperatures showing almost no direct relation to DTW. While temperatures for uplands were higher at 0-25cm DTW compared to those >25cm DTW, they do not appear to follow any trend moving further into the soil.

Temperature is specific to location, time of year, and wetland / forest conditions; and as such, a literature review of common temperature values revealed limited results that could be applied for comparative purposes to the results of this thesis, however bogs were shown to have generally lower temperature values than fens (Clausen and Brooks, 1983; Bridgham et al., 1999; Jassey et al., 2011).

In summary, the mapping component of the temperature predictions presented in this thesis demonstrate the ability to predict shallow water properties spatially across wetlands primarily based on LiDAR derived WAM attributes; from areas of low temperatures, such as those with thick organic layers or deep DTWs, to areas of high temperature, such as those with water at the surface. While wetland specific correlations between actual and predicted temperature values were generally weak, average wetland class temperatures were shown to correlate well those predicted by the model, demonstrating the applicability of the temperature predictions.

The spatial representation of temperatures for wetlands allows for the identification of areas with increased temperature, which represents higher biological activity, increased species abundance, and potentially sensitive areas; compared with generally cool areas, which have low rates of biological activity, and lower species abundance (Šímová et al., 2011).

CHAPTER 9

COLOUR

Introduction

This chapter deals with water colour as reviewed in Chapter 2 of this thesis. The site details and methodology for this chapter can be found in Chapters 3 and 4 of this thesis, respectively. The primary goal of this research is to determine if shallow water colour can be mapped using LiDAR derived WAM and topographic attributes, in order to provide a continuous representation of water colour across wetlands and into adjacent uplands.

Results

A total of 451 water colour plots were measured at the EMEND and NB locations, which included all wetland classes (Figure 58).

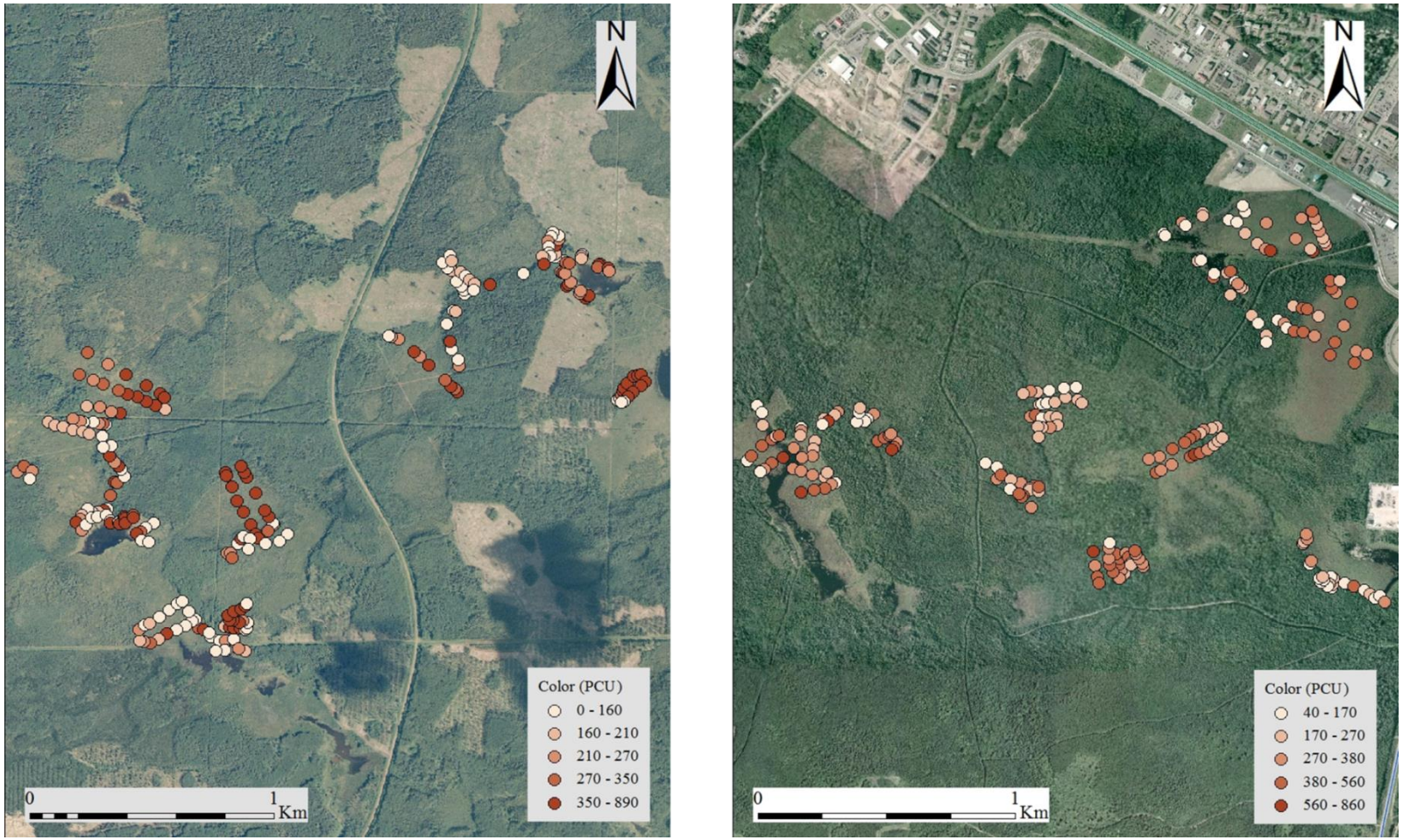


Figure 58. EMEND (left) and UNB Forest (right) sites showing plot locations with measured colour values.

A summary of all measured water colour values based on wetland and depth-to-water classes showed that colour values were highest for bogs, and significantly lower for all other wetland classes; with uplands having the lowest average colour values, approximately 200 PCU, while water colour values remained consistent across all DTW classes (Table 29).

Table 29. Summary of colour values by wetland and DTW classes

Water Colour (PCU)									
Class	**Min**	**Max**	**Mean**	**Std dev**	**DTW (cm) 4 ha**	**Min**	**Max**	**Mean**	**Std dev**
Bog	150.0	891.8	489.2	200.7	**0 - 10**	40.0	805.2	288.0	129.8
Fen	40.0	851.2	270.7	153.4	**10 - 25**	50.0	764.4	309.6	175.1
Marsh	30.0	782.6	281.7	154.2	**25 - 50**	0.0	873.6	310.9	225.2
Swamp	0.0	873.6	278.9	167.3	**50 - 100**	30.0	891.8	264.7	226.6
Upland	30.0	837.2	204.8	169.3	**100 - 275**	30.0	837.2	396.1	277.8

Boxplots showing the distribution of colour values for both site and wetland class revealed no common outliers, therefore all data was used for further analysis (Figure 59). As the random selection of 100 plots was generated from the entire data set (1198 plots) only 40 occurred for water colour plots, however the test plots contained samples of each wetland class and location).

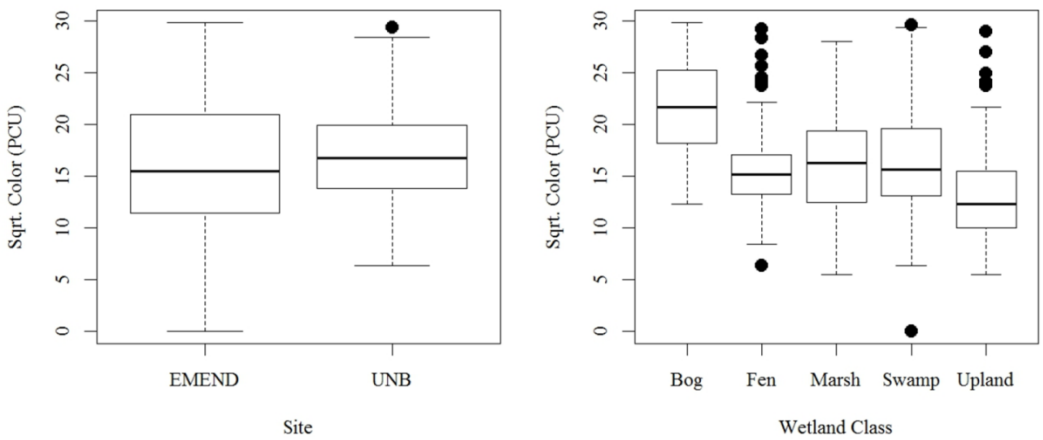


Figure 59.Boxplots showing transformed colour distributions by site and wetland class.

Multiple regression analysis revealed that among the continuous and categorical variables available for predicting water colour (Table 3); pH Raster, $\log_{10}$HC, and $\log_{10}$Slope were the most important variables for explaining observed temperature trends ($R^2 = 0.15$) (Table 30; Figure 60). Residual values were shown to have a normal distribution (Figure 61). Outliers, values which were found to be inconsistent with the majority of plots that had similar landscape attributes, were determined by visual analysis of the residuals, and when removed gave an $R^2 = 0.19$. Correlations between colour and measured variables showed that colour was weakly related to all variables except pH and EC which were inversely related to colour (Table 31).

Table 30. Best fit predictive variables used to model colour (R^2 = 0.15) based on multiple regression analysis.

	Coefficient	Std. Error	Std. Coefficient	t-Value	P-Value
Intercept	18.137	3.29	18.137	5.513	<0.0001
pH Raster	-1.785	0.347	-0.246	-5.144	<0.0001
$\log_{10}$HC	1.296	0.26	0.231	4.987	<0.0001
$\log_{10}$Slope	-8.553	2.018	-0.200	-4.238	<0.0001

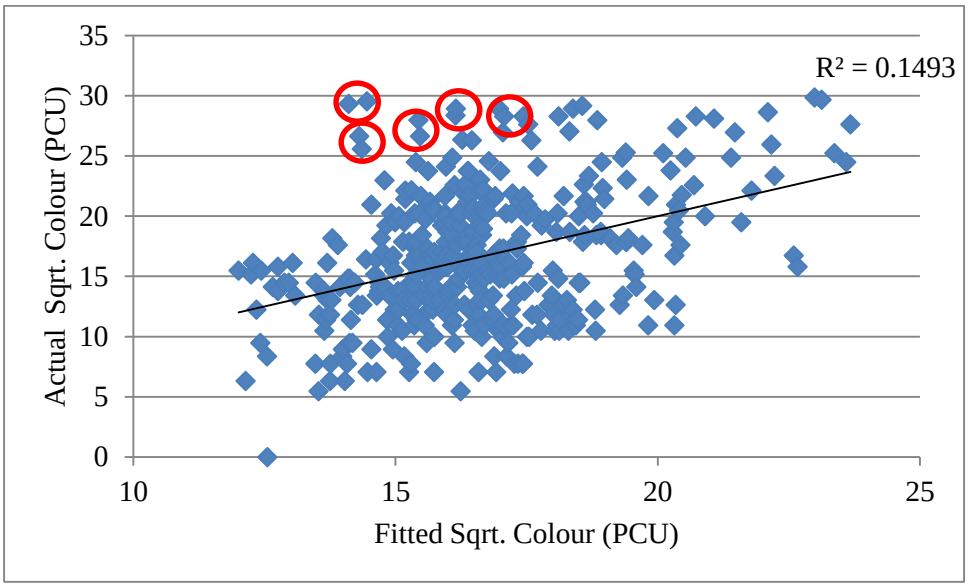


Figure 60. Scatterplot of actual versus predicted colour values, with best fit regression line and visually determined outliers highlighted in red.

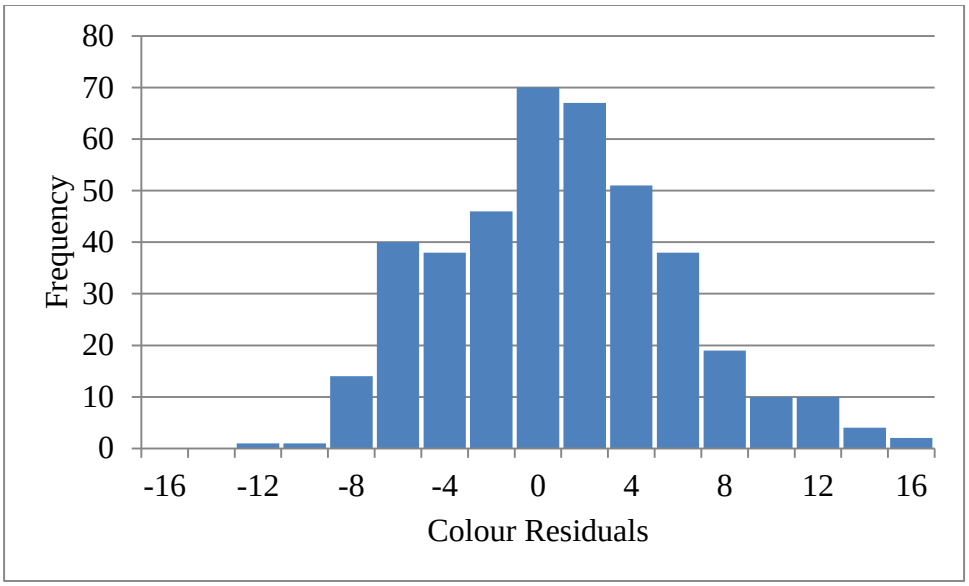


Figure 61. Frequency distributions for residual values of the water colour models.

Table 31. Correlation coefficients between colour and all measured variables.

	Correlation Coefficient
	Color
Color	1.00
Ground Veg.	0.16
Temperature	-0.08
DO	-0.11
Dom. Tree	-0.13
$\log_{10}$EC	-0.22
EC	-0.27
pH	-0.43

Wetland classification for each study site showed generally good conformance between field measured and image determined wetlands, as discussed in Chapter 5 and Appendix V of this thesis. Correlations between actual, predicted and mapped water

colour revealed that actual and predicted colour related better than actual and mapped colour values (Table 32).

Table 32. Correlation coefficients for actual, predicted and mapped colour.

	Correlaton Coefficient
	Color Actual
Color Actual	1.00
Color Predicted	0.38
Color Mapped	0.29

The colour rasters created using the best fit multiple regression equation provided a data layers that reveal general visual conformance across both sites and all wetland classes (Figure 62).

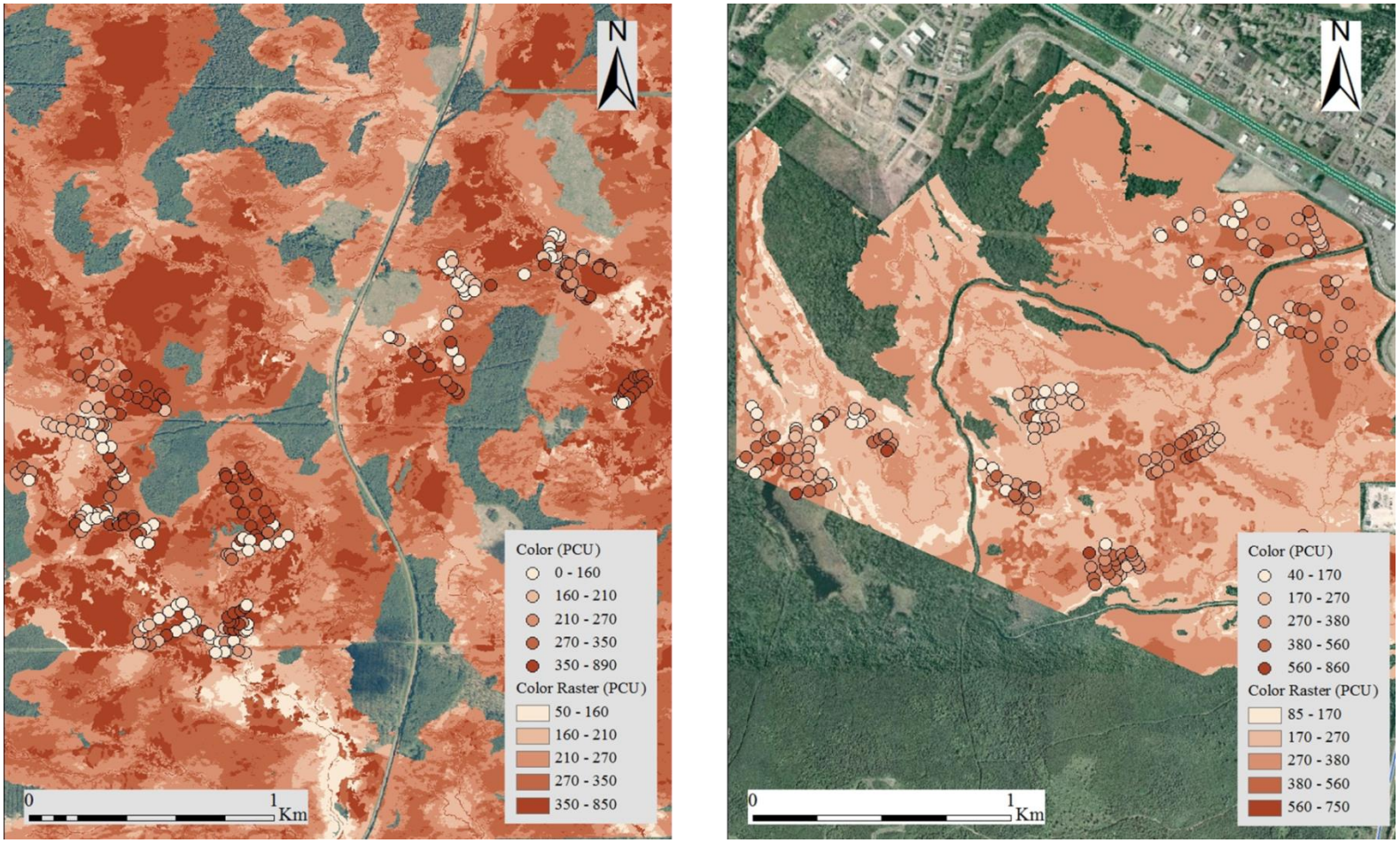


Figure 62. Water colour raster and field measured water colour values for the EMEND (left) and UNB Forest (right) sites.

Regression analysis comparing the colour of the test plots (100 extracted values) and the modelled values showed a very weak relationship (R^2 = 0.09;Figure 63). Average water colour values for each wetland class by location revealed a good relationship, with a correlation coefficient of 0.66 (Figure 64).

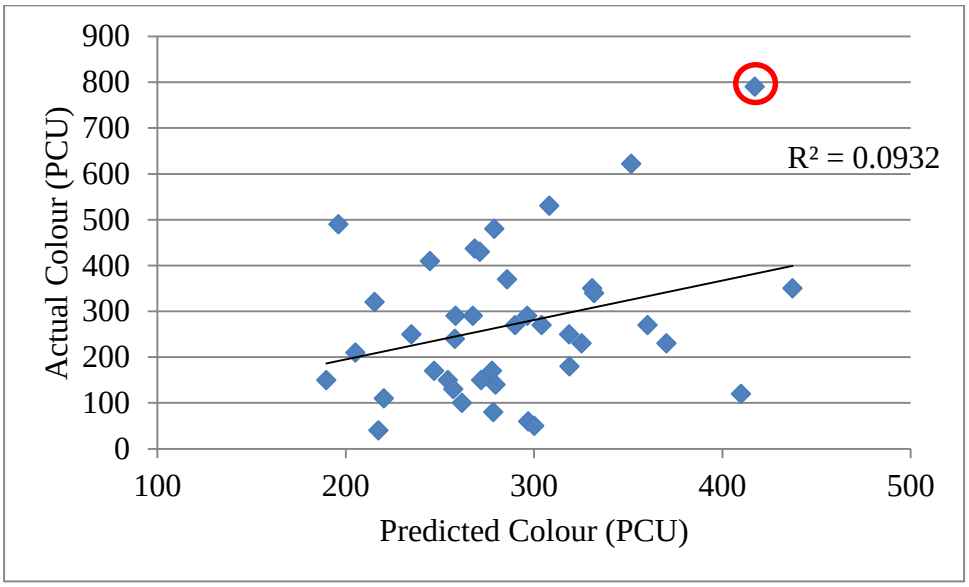


Figure 63. Actual versus predicted colour values for 100 extracted test plots.

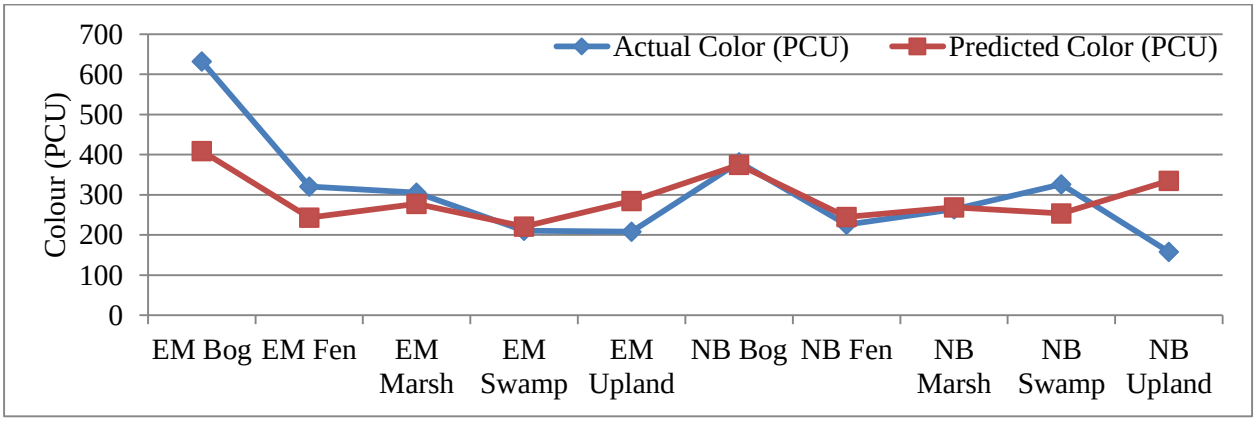


Figure 64. Average colour values by wetland class and location.

Comparison of actual versus predicted colour values within each wetland class showed the best results were found in fens, however the correlation coefficient was only 0.31; upland sites demonstrated the poorest relationship with colour, with a correlation coefficient of 0.01(Figure 65).

Frequency distributions of actual versus predicted results showed that while the most frequent colour values in fens were well represented with the predicted results, high values (> 400 PCU) were not accounted for (Figure 66). High colour values in bogs were also not represented with the predictive model, for example, a significant portion of actual bog colour values were between 600 PCU and 1000 PCU, however the predicted results did not represent these values, as they showed a high proportion of values in the 400 PCU range instead. The extreme low and high actual colour values in marshes and fens were not represented with the model, and upland actual and predicted values were of significantly different distributions, with the highest densities occurring at 100 and 300 PCU's respectively.

A literature review of water colour values found in wetlands showed that colour is higher in bogs, when compared with all other wetland classes (Table 33). Accompanying wetland details included class and vegetation type, however the colour values presented were generalized for each wetland, and a spatially explicit map of wetland water colour was not available.

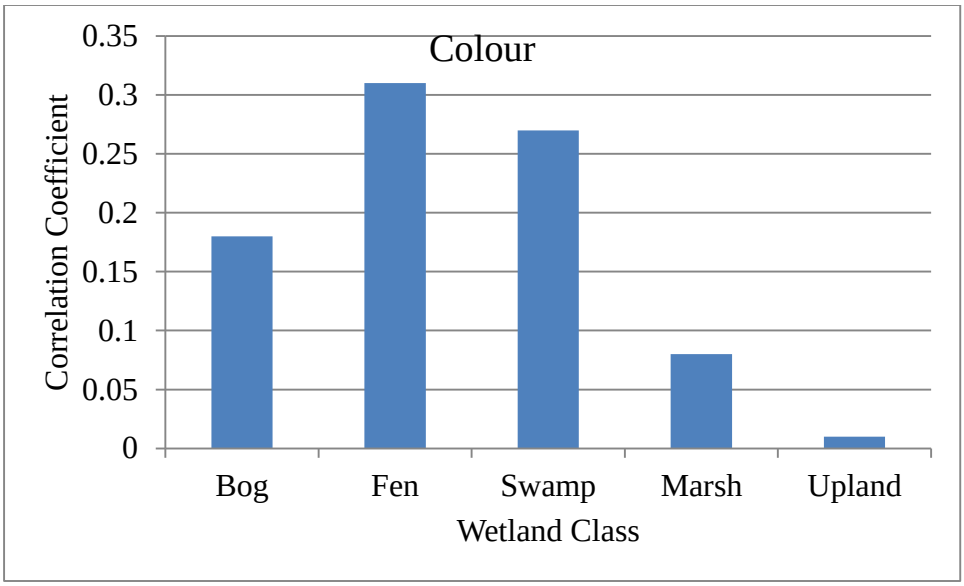


Figure 65. Correlation coefficients of actual versus predicted colour values by wetland class.

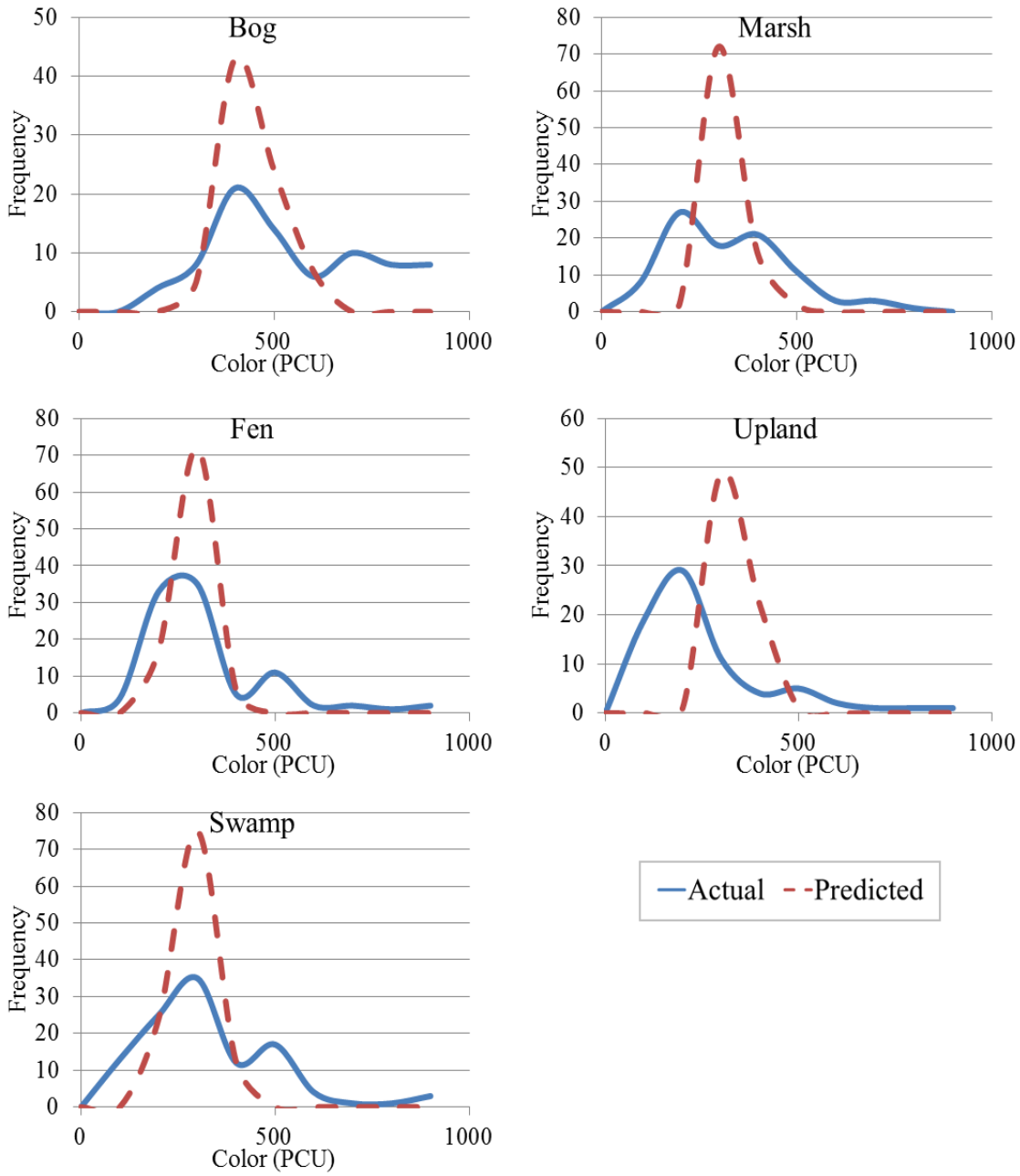


Figure 66. Frequency distributions for actual and predicted colour values by class.

Table 33. Colour values taken from a literature review compared with colour values measured for this thesis. Average and range of measured colour values are shown, excluding outliers.

Wetland / Forest Type	Water Colour (PCU)	Location	Source	Wetland Class	Water Colour (PCU)	Location
Bog	270	Lower Michigan, USA	Schwintzer and Tomberlin (1982)	Bog	632, 210 - 892	EMEND
Bog	400	N / A	Shotyk (1988)	Bog	381, 150 - 732	New Brunswick
Ombrotrophic Bog	334	Finland	McKnight et. al. (1985)			
Bog Water	122	Norway	McKnight et. al. (1985)			
Perched Bog	300 - 445	Minnesota, USA	Verry (1975)			
Fen	150 - 200	N / A	Shotyk (1988)	Fen	321, 110 - 851	EMEND
Fen	110	Lower Michigan, USA	Schwintzer and Tomberlin (1982)	Fen	225, 40 - 490	New Brunswick
Ground Water Fed Fen	100	Minnesota, USA	Verry (1975)			
Conifer Swamp	70	Lower Michigan, USA	Schwintzer and Tomberlin (1982)	Swamp	211, 0 - 874	EMEND
Hardwood Swamp	140	Lower Michigan, USA	Schwintzer and Tomberlin (1982)	Swamp	326, 50 - 860	New Brunswick
Thicket Swamp	100	Lower Michigan, USA	Schwintzer and Tomberlin (1982)			

Discussion

The similarity of water colour measured in EMEND and NB demonstrates the lack of a regional component for water colour determination. Colour was shown to vary significantly between bogs and remaining wetlands, due to the increased accumulation of fulvic and humic acids in bogs which are known to contribute to water colour (Verry, 1975; Clausen and Brooks, 1983).

The most influential variable for predicting water colour was field measured pH, with a correlation coefficient of -0.43. The pH raster presented in Chapter 7 of this thesis, was also shown to correlate with water colour (correlation coefficient = -0.21), and could be used to predict water colour across the study sites. Water colour increased with decreasing pH values, as cool temperatures, stagnation, and fungal decomposition lead to the accumulation of high molecular weight organic matter, with dark humic and fulvic acids being dissolved into the water (Schwintzer and Tomberlin, 1982; Clausen and Brooks, 1983).

Hydraulic conductivity and water colour were shown to increase concurrently, because easily decomposable vegetation and low HC values dominate in areas with available nutrients, such as fens and swamps, which receive mineral enriched water from outside sources (Schwintzer and Tomberlin, 1982). As slope increased, water colour decreased, which indicates groundwater discharge into wetlands along sloped surfaces, diluting water colour.

The result of the multiple regression analysis for predicting water colour revealed an R^2 value of 0.15, and was determined strongly by the high colour values found in bogs. The occurrence of localized variability which could not be determined by predictor variables included micro-topographic variation, tree species heterogeneity, and possible groundwater influence. Bogs have minimal groundwater influence and more consistent tree species presence; therefor colour is less variable than for non-bog wetlands. Micro-topographic variation can have a greater influence on non-bog water, due to the accumulation of organic material in pits versus that on mounds. This variability is demonstrated by the residual outliers from the multiple regression analysis, which were measured to have high colour values, but because HC was low and pH was high, colour was predicted to be low. Field measured variables, however, did not demonstrate a relationship with colour, aside from pH, which has been discussed, and EC; however pH and EC are correlated and both could not be used for predicting colour.

Discrepancy between predicted and mapped water colour results occurred where actual wetland classes differed from mapped wetland classes. While the majority of wetland plots were within 10m of mapped wetlands, colour values extracted from ArcGIS represented the colour within 5m of plot centre, thereby resulting in loss of conformance between predicted and mapped results. The use of HC as a predictor variable, which was spatially defined by wetland classes, caused discrepancy between predicted and mapped water colour results; however the average colour difference between predicted and mapped values, across all plots, was only 6 PCU. The majority of data analysis involved actual versus predicted results, instead of actual versus

mapped results in order to ensure clear viewing of the strengths and weaknesses of the model.

Further investigation into the results of the model predictions, beginning with the test plots, showed a significant trend between actual and predicted results, however the R^2 was low (0.09). Due to the random selection of test plots, only 40 colour plots were used for testing, which decreased the robustness of the test results. Visual assessment of residual values showed one outlier, a bog with a colour value of ~800 PCU, which was rare, as less than 3% of all 451 plots measured having values above 800 PCU. Although variance was high for measured test plots, all classes showed generally good conformance with best fit trends. As discussed earlier, the water colour predictive model, which was using very similar actual colour values for marshes, fens, and swamps (~250 PCU average) borrowed strength from the high bog colour values to develop the best fit regression equation, however bog colour values from the test data set were more random, resulting in reduced R^2 of the actual versus predicted test data set.

The average water colour values for each wetland class at EMEND and NB had a generally good relationship (correlation coefficient = 0.66); however, actual EMEND bog values were almost 200 PCU higher than average predicted results. Average bog colour was higher in EMEND than UNB due to the abundance of domed bogs, which have thick organic layers, and lower pH values than basin and NB bogs; therefore the model could not compensate for the high EMEND bog colour values. Further, average

water colour of NB uplands was significantly lower than predicted results due to low colour values measured in NB, which were represented by five plots.

Investigation into the wetland class specific relationships between actual and predicted results showed that fen and swamp had the highest correlation coefficients (~0.3), which shows that although average water colour values have been predicted with confidence, fine scale spatial predictions are of limited precision. Frequency distributions show that predicted results were normally distributed, with narrow ranges for each wetland class, when in actuality the measured colour values have a wider range. Low and high colour values were not well represented with the model. Upland colour values showed a very poor relationship, and frequency distributions show that measured colours were approximately 300 PCU lower than predicted values. This loss of accuracy in upland colour predictions is a result of the $\log_{10}$ HC predictor variable, which saw colour increase as HC increased; while this reflected the majority of plots, it was not the case for upland colour values.

Colour values taken from a literature review compare well with those measured in this thesis, with bog value having significantly higher colour values than non-bogs. The lowest bog value was recorded for bog water, which appears to have been diluted compared with the more concentrated values found below the soil surface. Although the colour values from the literature contain specific data, such as wetland class, form and type, a spatial representation of the colour data was not available.

In summary, the results of this chapter show that water colour can be modelled and mapped within and across wetlands, primarily based on LiDAR derived spatial pH

rasters, along with slope and hydraulic conductivity. Average actual and predicted colour values for each wetland class were well correlated, while colour values within each wetland class were not. Small scale variations in water colour, resulting from mound and pit topography, and the accumulation of organic acids in pits versus on mounds, may have caused a loss of accuracy across wetlands. The use of the spatial pH layer resulted in some loss of predictive strength due to some discrepancy between actual and mapped pH.

CHAPTER 10

SYNTHESIS AND APPLICATIONS

Synthesis

This thesis provides a framework for modelling and mapping shallow water properties as these vary by wetland class (bog, fen, marsh, swamp) from the nearby uplands to the open water bodies within and to the flow channels through these wetlands. The five water properties, DO, EC, pH, temperature, and colour were measured at 1198 transect points. These points were well distributed across the wetland classes and across the local depth to water zonations, with these zonations referring to DTW < 10 cm, 10-25 cm, 25-50 cm, 50-100 cm, and 100 to about 275 cm.

For the purpose of generalizability, this research included four study areas, one in northern Alberta, and three in New Brunswick, to see to what extent the properties could not only be modeled and mapped by topographic terrain conditions and wetland class but also across a major contrast in soil and climate conditions, i.e., temperate maritime podsolic to gleysolic and organic in New Brunswick versus boreal luvisolic to gleysolic and organic in northern Alberta.

The monitoring activities involved measuring water samples along upland to wetland transects using DO, pH, EC, and thermometre probes, and a colorimetre. For the modelling and mapping purpose, it was necessary to place transects into their elevational terrain, wetland class, and climatic contexts. This was done by deriving the

transect values for terrain (elevation, DTW, slope, flow accumulation, and PRR all from LiDAR-derived bare-earth DEMs), wetland class (through image analysis and classification), and climate (AET, ppt).

Presented in Table 34 is a basic statistical summary of all the variables used for the modelling and mapping purpose, with DO, EC, pH, temperature and colour used as dependent variables, and all other numeric variables used as independent regression variables. Presented in Table 35 are the correlation coefficients between these variables, classified by being significant or not.

Table 34. Variables used for modelling and mapping water properties.

	Min	**Max**	**Mean**	**Std dev**
DO (mg/L)	0.27	14.30	4.20	2.63
pH	3.39	7.80	5.14	0.90
Temperature (Deg C)	-0.30	26.05	10.20	3.89
EC (microS/cm)	10.00	5000.00	145.95	386.80
Color (PCU)	0.00	891.80	302.59	190.52
$\log_{10}$Slope (Rad)	-1.91	-0.71	-1.44	0.20
Dom. Veg.	1.00	8.00	6.40	1.74
Tree Ht. (m)	0.00	29.00	6.58	4.80
log10DTW (4ha) (cm)	-2.35	0.42	-0.82	0.54
$\log_{10}$FA (m2)	1.89	4.54	3.41	0.54
$\log_{10}$PRR	3.73	4.07	4.00	0.05
$\log_{10}$HC (cm/sec)	-5.00	-0.30	-3.65	1.63
Ratio*PRR	3770.60	8063.76	5995.79	769.52

Table 35. Correlation coefficients for variables; with significant correlations highlighted.

	DO	pH	Temp.	EC	Color	log_{10} Slope	Dom. Tree	Dom. Veg.	Tree Ht.	log10 DTW (4ha)	log_{10} FA	log_{10} PRR	log_{10} HC	Ratio x PRR	Bog	Fen	Marsh	Swamp
DO	1.00																	
pH	0.15	1.00																
Temp.	-0.35	-0.06	1.00															
EC	0.28	0.46	-0.14	1.00														
Color	-0.11	-0.44	-0.09	-0.25	1.00													
log_{10}Slope	-0.02	-0.13	0.04	-0.21	-0.15	1.00												
Dom. Tree	-0.24	0.01	0.24	-0.14	-0.11	0.15	1.00											
Dom. Veg.	-0.19	-0.45	0.11	-0.22	0.16	-0.10	-0.06	1.00										
Tree Ht.	0.18	0.30	-0.21	0.26	-0.21	-0.18	0.04	-0.17	1.00									
log10DTW (4ha)	0.45	0.29	-0.49	0.30	0.05	-0.04	-0.25	-0.28	0.30	1.00								
log_{10}FA	-0.06	0.48	0.24	0.15	-0.13	-0.08	0.19	-0.27	0.08	-0.11	1.00							
log_{10}PRR	-0.41	-0.42	0.41	-0.31	0.04	0.25	0.26	0.28	-0.27	-0.57	-0.05	1.00						
log_{10}HC	0.42	-0.23	-0.10	0.01	0.28	0.18	-0.16	-0.05	-0.18	0.17	-0.19	-0.08	1.00					
Ratio*PRR	0.27	0.38	-0.36	0.35	0.08	-0.38	-0.27	-0.20	0.07	0.58	0.04	-0.30	-0.04	1.00				
Bog	0.19	-0.54	-0.19	-0.11	0.45	-0.03	-0.35	0.27	-0.33	0.11	-0.55	0.01	0.43	0.07	1.00			
Fen	-0.26	0.15	0.06	-0.11	-0.09	-0.05	-0.06	0.01	-0.06	-0.11	0.08	0.01	-0.37	0.08	-0.29	1.00		
Marsh	-0.09	0.16	0.25	0.02	-0.06	0.29	0.20	-0.14	-0.39	-0.11	0.27	0.08	0.19	-0.13	-0.25	-0.28	1.00	
Swamp	-0.11	-0.03	0.07	-0.08	-0.07	-0.09	0.27	0.12	0.37	-0.14	0.19	0.17	-0.33	-0.14	-0.30	-0.33	-0.28	1.00

Highlighted cells are significant with P-Values < 0.0001

A principal component analysis was done to discern how all the variables in Table 34 associated with one another through correlation. The results of this analysis are shown in Table 36 by way of the factor loadings of Factor 1, 2 and 3, sorted by Factor 1, and with factor loadings > 0.25 and < - 0.25 shaded grey.

Table 36. Principle component analysis using modeling and mapping variables.

Variable	Factor 1	Factor 2	Factor 3	R^2
$\log_{10}$PRR	-0.74	-0.04	0.00	0.56
Temperature	-0.68	0.37	0.33	0.58
Dom. Veg.	-0.47	-0.39	-0.28	0.42
$\log_{10}$Slope	-0.42	0.14	0.22	0.21
Dom. Tree	-0.40	0.38	-0.06	0.28
Fen	-0.23	0.24	-0.16	0.14
Swamp	-0.18	0.12	-0.65	0.50
Marsh	-0.17	0.50	0.91	0.80
Colour	-0.01	-0.60	-0.04	0.34
Bog	0.04	-0.91	0.00	0.82
$\log_{10}$FA	0.16	0.70	0.22	0.49
$\log_{10}$HC	0.36	-0.57	0.52	0.83
Tree Ht.	0.46	0.03	-0.57	0.58
EC	0.58	0.18	0.11	0.39
pH	0.60	0.66	0.17	0.84
Ratio * PRR	0.64	0.06	0.07	0.42
DO	0.72	-0.13	0.03	0.51
$\log_{10}$DTW (4ha)	0.81	-0.11	-0.04	0.65

Variables with factor loading above 0.25 are shaded

Variables with near zero factor loadings, i.e. – 0.25 < factor loading < 0.25, indicate that these variables are not salient contributors to Factors 1, 2 and 3. In contrast, variables with factor loadings with more positive or negative numbers contribute highly

to these factors, and can therefore be used to ascertain the nature of the Factor-identified variable associations. Essentially:

Factor 1 identifies the variables which have high positive and negative upland contributions, i.e., Factor 1 = upland factor.

Factor 2 identifies the variables with high positive and negative contributions from bogs, i.e., Factor 2 = bog factor.

Factor 3 identifies the variables with high positive and negative contributions marshes and swamps, i.e., Factor 3 = marsh vs. swamp factor.

The regression analysis identified which of all the variables were best for modelling and mapping the water properties, as listed in Table 37. For the mapping purposes, these variables belonged to two categories: those that were already mapped based on their derivation from DEMs and by way of image classification, and those that generated by way of categorical assignments, which were region and season specific. Only a few variables were needed for DO, EC, pH, temperature, and colour to get a verifiable actual-to-mapped conformance levels ranging from about 15 to 60% as follows and as detailed in Chapters 5 to 9:

$$R^2(\text{EC}) = 0.60 > R^2(\text{pH, non-bog}) = 0.48 > R^2(\text{DO}) = 0.35 > R^2(\text{Temperature}) = 0.23$$

$$> R^2(\text{Colour}) = 0.15 > R^2(\text{pH,bog}) = 0.14.$$

Table 37. Mapped water property variables and their corresponding predictor variables.

DO	EC	pH (Non-Bog)	pH (Bog)	Temperature	Colour
$\log_{10}$DTW (4ha)[a]	Ratio*PRR[a,d]	$\log_{10}$DTW (4ha)[a]	Tree Ht[a]	$\log_{10}$DTW (4ha)[a]	pH Raster
$\log_{10}$PRR[a]	EM Marsh[b,d]	$\log_{10}$FA[a]	$\log_{10}$HC[b]	UNB Spring[c]	$\log_{10}$HC[b]
$\log_{10}$HC[b]	EM Swamp[b,d]	$\log_{10}$EC Raster		Bog[b]	$\log_{10}$Slope[a]
UNB Summer[c]	EM Upland[b,d]				
a = Digital Elevaton Model Derived					
b = Image Classification Derived					
c = Seasonal Category					
d = Regional Category					

Note that the field-generated information only allows the mapping of the shallow water properties to fall within the cartographically identified limit of DTW < 2.75 m. This was the limit by which water samples could be retrieved. Further, the water property maps generated represent static conditions, and do not account for daily and seasonal value fluctuations. An example of applying the DO, EC, pH, temperature and colour models for a wider area around the EMEND study areas is shown in Figure 67 to 69.

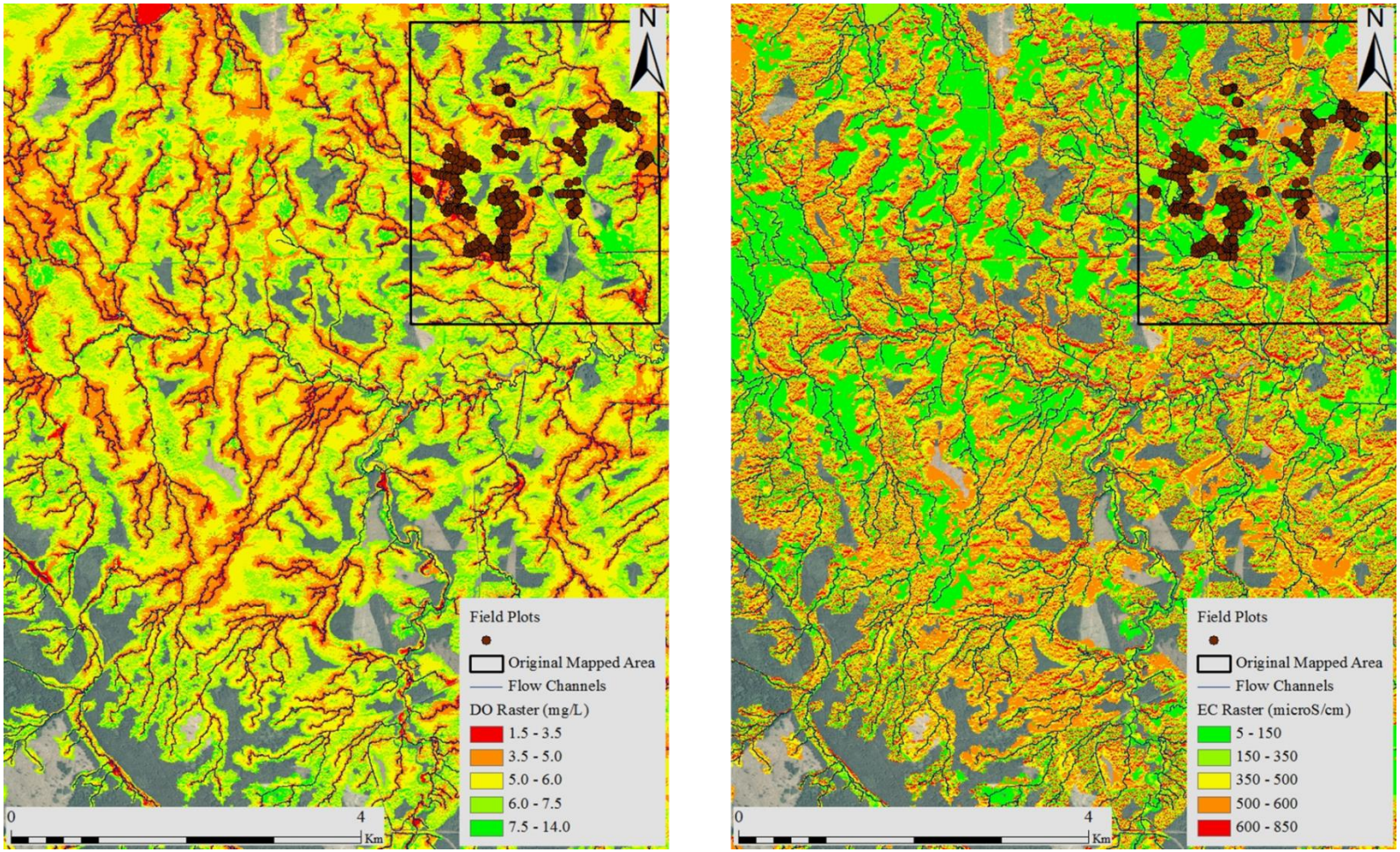


Figure 67. DO and EC predictive rasters expanded for the EMEND site.

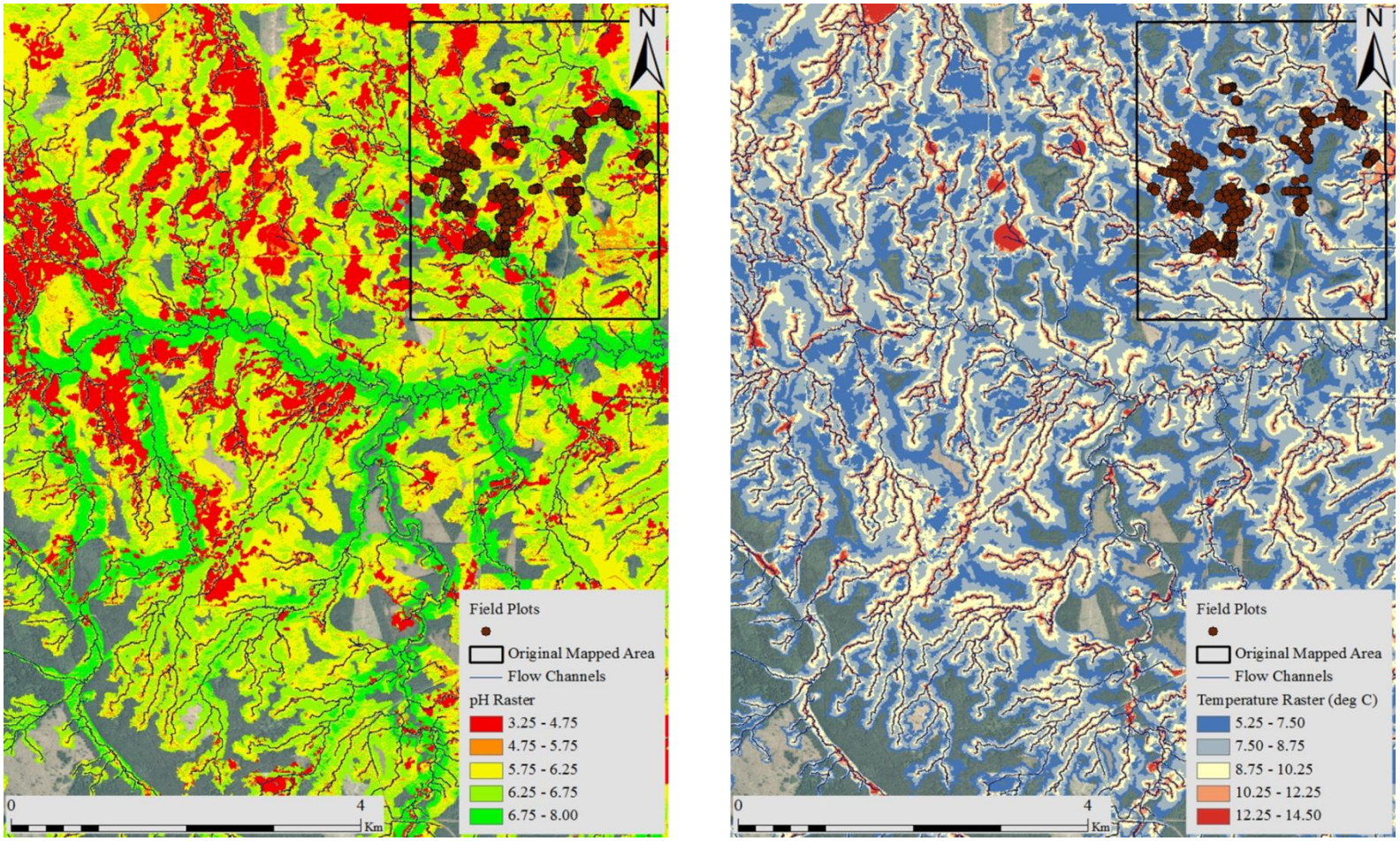


Figure 68. PH and Temperature predictive rasters expanded for the EMEND site.

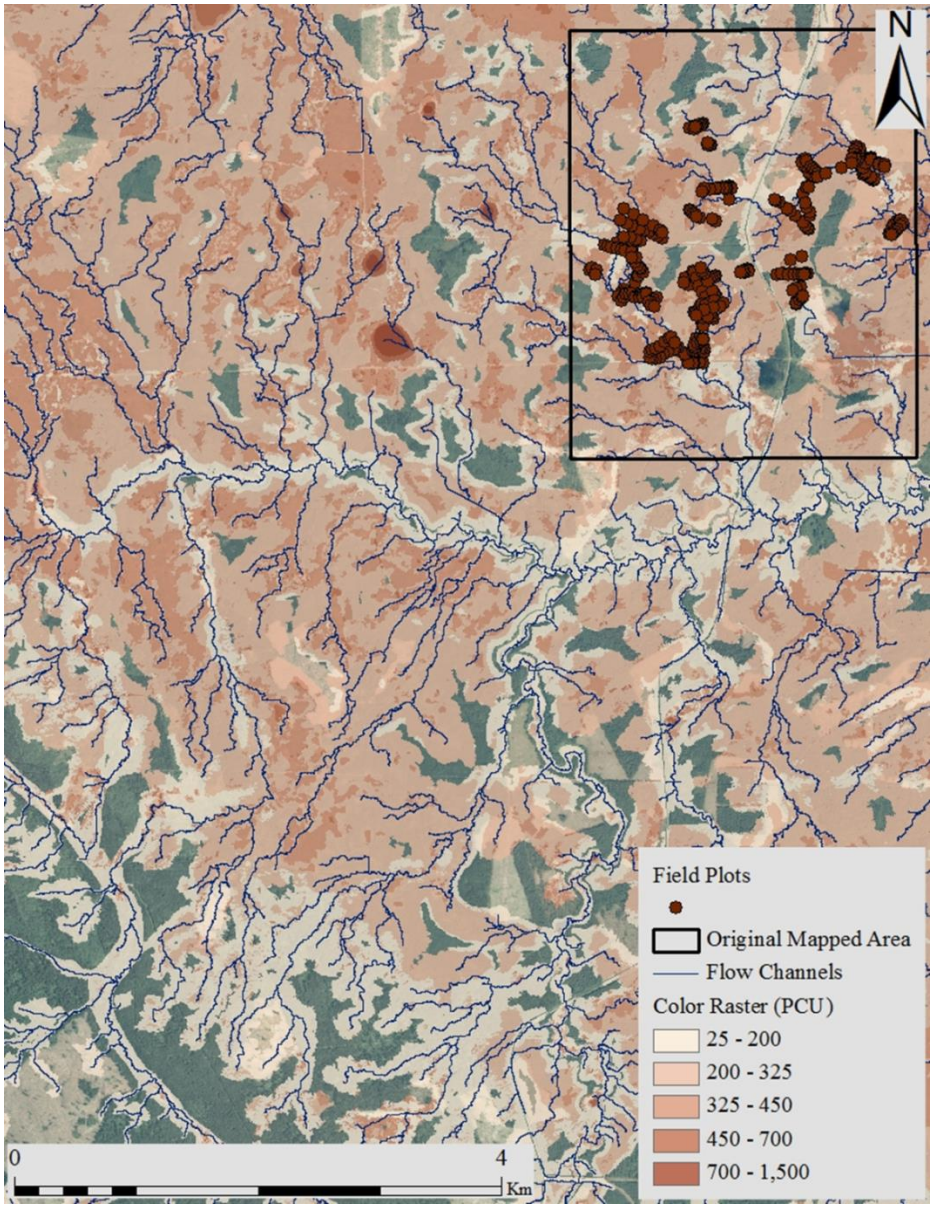


Figure 69. Colour predictive raster expanded for the EMEND site

Whether or not this modelling and mapping effort can be used beyond the study areas remains to be tested. Some of the restrictions about where and when the above results would not apply directly are as follows:

1. Tidal marshes, salt marshes and other areas of high soil salinity.
2. Areas dominated by seepage from deep water sources such as steep terrain.
3. Water conditions during high flow events, such as snowmelt and flooding.
4. Areas downstream from pollution sources (lagoons, retention ponds, chemical spills).
5. Developed areas and along traffic routes.

For the most part, the results could be applied where

1. The climate varies from temperate to boreal, throughout the growing season.
2. The upland and wetland vegetation cover is natural and remains undisturbed.
3. The terrain varies from generally flat to undulating.

Applications

Water quality management involves water resource protection through monitoring, modeling and mapping (MEE, 1994). To this end, the research of this thesis has shown that water properties such as DO, EC, pH, temperature, and colour can be mapped based on information derived from DEMs, image classification, and basic climate and regional specifications. At this stage, the results so obtained are limited to areas where there have been no major disturbances. Hence, the maps as developed could be used as development benchmarks, as follows:

1. In many cases, landscape and wetland restoration and reclamation is a required component of industry operating plans. An understanding of the water property conditions that should exist on a reclaimed land base could be extracted using the water property rasters presented in this thesis, which may assist with the reclamation of land to its original state, based primarily on the understanding of topographic controls on water properties and vegetation communities.
2. Environmental site assessments (ESAs) involve the gathering of information about potential development sites in order to determine potential impacts of development; whether this involves the expansion of urban and agricultural areas, oil and gas exploration, peat mining (Tiner, 2005; Government, 2007; Mitsch and Gosselink, 2007; Noble, et al., 2011)). Since monitoring efforts are typically expensive, it is suggested that the above mapping process, in combination with further water properties data additions, and local mapping refinements, might become an important complementary component of environmental site assessments.
3. The above mapping process could be useful for determining the extent of lingering effects of upstream spills or other disturbances relative to the pristine or control conditions as mapped (CVC, 2010). For example, where DO is much lower, or higher, than mapped, this could be a sign of water blockage or increased biological activity due to algal growth (lower during night and early morning, higher during the day). Where EC is higher than mapped the reason could be salt seepage from roads and salt depots. If pH is higher and temperature is lower than mapped there could be natural groundwater seepage;

and where temperature and EC is higher than mapped could be due to recent upstream forest harvesting.

4. Where monitored water quality data for pristine conditions are available, that information could be used to check and/or calibrate the DO, EC, pH, temperature, and colour maps to local situations as needed. Such data would reside with many agencies, such as those listed in Table 38, and their documents and data would be useful for refining the above mapping process for the mapping or re-mapping of pristine water properties in areas of historical, current and contemplated interests.

Table 38. Examples of agencies involved in the watershed/wet-areas/wetland water property monitoring and mapping.

Category	Department or Agency	Source
Government Agencies	USDA* Forest Service	Heinselman (1963)
	USDA Forest Service	Bay (1967)
	USDA Forest Service	Verry (1975)
	U.S. Geological Survey	McKnight et. al. (1985)
	USDA Forest Service	Nelson et al. (2011)
	Environment Canada	Bourbonniere (2011)
Environmental Organization	Credit Valley Conservation	CVC (2010)
Scientific Societies	Soil Science Society of America	Pierce (1953)
	Soil Science Society of America	Daniels et. al. (1973)
	The Royal Society of Canada	Gorham et al. (1984)
	Soil and Water Conservation Society	Campbell et al. (2013)
Universities	University of Toronto	Sparling (1966)
	University of Michigan	Schwintzer and Tomberlin (1982)
	University of Minnesota	Clausen and Brooks (1983)
	University of Michigan	Shotyk (1988)
	University of Alberta	Kuhry et al. (1993)
	University of New Brunswick	Jewett et al. (1995)
	Department of Plant Systematics and Geography	Malawska et al. (2006)
	University of New Brunswick	Murphy et al. (2011)
	University of Western Ontario	Ulanowski and Bran (2013)

* United States Department of Agriculture

CHAPTER 11

CONCLUSIONS

Closing Remarks

While there is much focus on monitoring water properties whether it relates to surface, shallow or groundwater, most efforts have dealt with measuring water properties over time at specific locations (CVC, 2010). The extent of this monitoring varies from one location, to systematic transects across the area of interest; referring to wetlands, toe slopes, or watersheds. Transects may be aligned with local hydraulic gradients, to determine how specific water properties such as DO, EC, pH, and colour vary over time along flow paths and in relation to one another. This thesis provides a framework by which point transects representative of the main wetland types of a particular area can be used to model and map the monitored shallow water properties (i) over the larger area of interest at high resolution, and (ii) how this mapping could be further extended using digital elevation models, surface images for wetland classification, and region-specific climate data. In this, the modelling component is simply based on best-fitting multiple regression procedures, but the mapping process uses the results so obtained to transform the point-based information across the wetlands into high-resolution maps. In detail, these maps are guided by the local variations including DEM-derived depth to water, flow accumulation, slope, etc., and by the thematic map for the individual wetland locations. The processes that guide the framework are not original, but the framework and the results so derived, i.e., the rasters for pH, EC, DO, temperature and

colour, are original in terms of the achieved resolution and also in terms of the overall conformance levels at that resolution. The claim of originality not only refers to the applicability and verifiability of the results for the immediate study areas, but also extends to the overall generalizability of the monitoring/modelling/mapping framework to similarly other undisturbed areas, as these would vary from temperate to boreal climate conditions. It is expected that the framework will provide similar performance levels, although the details of the regression results may differ in terms of the specific regression variables and coefficients by location.

Suggestions for further work

While the work presented in this thesis allows for the interpolation of remotely sensed data (LiDAR point cloud data, surface images), it also reveals additional work that needs to be done to complement and extrapolate the water property predictions as presented. For example, additional water property measurements and predictions could done for areas from eastern to western Canada and elsewhere, to determine to what extent water property predictions can be applied across regions, rather than just for each study location. This would help to determine how well the water property maps presented in this thesis conform to additional sites, and to what extent regional and climatic variables assist in providing local map conformances. Expanding the mapping coverage could be done through (i) additional transect studies, and (ii) by utilizing existing data sets from already existing monitoring studies (e.g., Table 38).

Water property measurements, modelling, and mapping could also be extended through soil and temperature transect sampling into upland conditions towards increasing DTW

zones. In this effort, water would be used to turn the collected soil samples into slurries, and the equilibrated slurries or their filtrates could then be used to determine DO, EC, pH, and colour. This would thereby present an empirical basis for soil and water property predictions across the entire landscape.

Further investigation into site specific nutrient and ion concentrations in water and soil could improve the usefulness of water property maps, as nutrients are known to correlate with, e.g., pH and EC as well as regional and climatic data (Schwintzer and Tomberlin, 1982; Clausen and Brooks, 1983; Nelson, Rhoades, and Dwire, 2011). Additionally, measurements could be taken in non-pristine wetlands, to create a database for (i) mapping the water property and nutrient conditions in these areas resulting from particular anthropogenic disturbance, such as spills or pollution, and (ii) comparing the resulting water properties maps with the pristine conditions maps.

Also, it would be beneficial to enact small scale water sampling within one wetland complex, rather than across a multitude of wetland complexes, in order to capture small scale water property variations by focusing on minute variations within individual wetlands. For this purpose, LiDAR point cloud data with < 25 cm horizontal accuracy and generated during leaf-off and snow-free seasons could be ideal for the purpose of generating highly-detailed topographic attributes for water property mapping.

REFERENCES

Andersson, J. O., & Nyberg, L. 2008. Spatial variation of wetlands and flux of dissolved organic carbon in boreal headwater streams. *Hydrological Processes*, *22*, 1965–1975.

Armstrong, W. 1967. The relationship between oxidation-reduction potentials and oxygen-diffusion levels in some waterlogged organic soils. *Journal of Soil Science*, *18*, 27–34.

Atekwana, E., Atekwana, E., Rowe, R. S., Werkema, D. D., & Legall, F. D. 2004. The relationship of total dissolved solids measurements to bulk electrical conductivity in an aquifer contaminated with hydrocarbon. *Journal of Applied Geophysics*, *56*, 281–294.

Baker, C., Lawrence, R., Montagne, C., & Patten, D. 2006. Mapping wetlands and riparian areas using Landsat ETM imagery and decision-tree-based models. *Wetlands*, *26*, 465–474.

Baker, C., Thompson, J. R., & Simpson, M. 2009. Hydrological Dynamics I: Surface waters, flood and sediment dynamics. In Maltby, E. & Barker, T. (Eds.), *The Wetlands Handbook*. New Jersey: Wiley-Blackwell. 120–168 pp.

Barker, T., & Maltby, E. 2009a. Introduction - The dynamics of wetlands. In Maltby, E. & Barker, T. (Eds.), *The Wetlands Handbook*. New Jersey: Wiley-Blackwell. 115–119 pp.

Barker, T., & Maltby, E. 2009b. Introduction - Using wetland functioning. In Maltby, E. & Barker, T. (Eds.), *The Wetlands Handbook*. New Jersey: Wiley-Blackwelll. 349–356 pp.

Bay, R. R. 1967. Ground water and vegetation in two peat bogs in northern Minnesota. *Ecology*, *48*, 308–310.

Beaudette, D. E., & O'Geen, a. T. 2009. Quantifying the aspect effect: An application of solar radiation modeling for soil survey. *Soil Science Society of America Journal*, *73*, 1755.

Berner, E. K., & Berner, R. A. 1987. *The Golbal Water Cycle; Geochemistry and the Environment*. New Jersey: Prentice Hall Inc. 397 pp.

Brady, N. C., & Weil, R. R. 2002. *The Nature and Properties of Soils*. (S. Helba, Ed.). New Jersey: Prentice Hall Inc. 13th ed., 960 pp.

Bridgham, S. D., & Lamberti, G. A. 2009. Ecological dynamics III: Decomposition in wetlands. In Maltby, E. & Barker, T. (Eds.), *The Wetlands Handbook*. New Jersey: Wiley-Blackwell. 326–345 pp.

Bridgham, S. D., Pastor, J., Updegraff, K., Malterer, T. J., Harth, C., & Chen, J. 1999. Ecosystem control over temperature and energy flux in northern peatlands. *Ecological Applications*, *9*, 1345–1358.

Campbell, D. M. H. 2012. TRAIL : Optimizing trail locations by terrain conditions and other considerations, at high resolution. Master's thesis. University of New Brunswick, Fredericton, New Brunswick.

Campbell, D. M. H., White, B., & Arp, P. A. 2013. Modeling and mapping soil resistance to penetration and rutting using LiDAR- derived digital elevation data. *Journal of Soil and Water Conservation*, *68*, 460 – 473.

Cerna, L., & Chytry, M. 2005. Supervised classification of plant communities with artificial neural networks. *Journal of Vegetation Science*, *16*, 407–414.

Chang, C., Sommerfeldt, J. M., Carefoot, J. M., & Schaalke, G. B. 1983. Relationships of electrical conductivity with total dissolved salts and cation concentrations of sulfate-dominant soil extracts. *Canadian Journal of Soil Science*, *63*, 79–86.

Clausen, J., & Brooks, K. 1983. Quality of runoff from Minnesota peatlands: A characterization. *Journal of the American Water Resources Association*, *19*, 763–767.

Clement, B., & Proctor, M. C. F. 2009. Ecological dynamics I: Vegetation as bioindicator and dynamic community. In Maltby, E. & Barker, T. (Eds.), *The Wetlands Handbook*. New Jersey: Wiley-Blackwell. 282–303 pp.

Corcoran, J., Knight, J., Brisco, B., Kaya, S., Cull, A., & Murnaghan, K. 2011. The integration of optical, topographic, and radar data for wetland mapping in northern Minnesota. *Canadian Journal of Remote Sensing*, *37*, 564–582.

Corcoran, J., Knight, J., & Gallant, A. 2013. Influence of multi-source and multi-temporal remotely sensed and ancillary data on the accuracy of random forest classification of wetlands in northern Minnesota. *Remote Sensing*, *5*, 3212–3238.

Cowardin, L. M., & Myers, V. I. 1974. Remote sensing for identification and classification of wetland vegetation. *The Journal of Wildlife Management*, *38*, 308–314.

Credit Valley Conservation. 2010. Monitoring wetland integrity within the Credit River Watershed. Chapter 1: Wetland Hydrology and Water Quality 2006 - 2008. Credit Valley Conservation.

Crepin, J., & Johnson, R. L. 1993. Soil Sampling for Environmental Assessment. In Carter, M. R. (Ed.), *Soil Sampling and Methods of Analysis*. Boca Raton: Lewis Publishers. 5–18 pp.

Daniels, R. B., Gamble, E. E., & Buol, S. W. 1973. Oxygen content in the ground water of some North Carolina aquults and udults. In Bruce, R. R. (Ed.), *Field Soil Water Regime; SSSA Special Publication*. Madison, WI, USA: Soil Science Society of America Inc. 153–166 pp.

Energy, M. O. E. and. 1994. Water management: Policies, guidelines, provincial water quality objectives of the Ministry of Environment and Energy. Ontario: Queen's Printer for Ontario.

Evans, J. S., Hudak, A. T., Faux, R., & Smith, A. M. S. 2009. Discrete return LiDAR in natural resources: Recommendations for project planning, data processing, and deliverables. *Remote Sensing*, *1*, 776–794.

Fang, C., & Moncrieff, J. B. 2001. The dependence of soil CO2 efflux on temperature, *33*, 155–165.

Finlayson, C. M., & VanDer Valk, A. G. 1995. Wetland classification and inventory : A summary. *Vegetation*, *118*, 185–192.

Fraser, D. A. 1957. Annual and seasonal march if soil moisture under a hardwood stand. Department of Northern Affairs and Natural Resources.

Gafni, A., & Brooks, K. N. 1990. Hydraulic characteristics of four peatlands in Minnesota. *Canadian Journal of Soil Science*, *70*, 239–253.

Genuer, R., Poggi, J.-M., & Tuleau, C. 2008, November 21. Random Forests: some methodological insights. Machine Learning.

Gopal, B. 2009. Biodiversity in Wetlands. In Maltby, E. & Barker, T. (Eds.), *The Wetlands Handbook*. New Jersey: Wiley-Blackwell. 65–95 pp.

Gorham, E., Bayley, S. E., & Schindler, D. W. 1984. Effects of acid deposition upon peatlands : A neglected field in " Acid-Rain " research. *Canadian Journal of Fish and Aquatic Science*, *41*, 1256–1268.

Government, A. 2007. Guideline for wetland establishment on reclaimed oil sands leases (2nd edition). Prepared by Harris, M.L. of Lorax Environmental for the

Wetlands and Aquatics Subgroup of the Reclamation Working Group of the Cumulative Environmental Management Association. *Environmental Management*. Alberta Environment, Environmental Service.

Group, E. S. W. 1995. *A National Ecological Framework for Canada*. Ottawa: Center for Land and Biological Resources Research Research Branch agriculture and Agri-Food Canada. 125 pp.

Group, N. W. W. 1997. *The Canadian Wetland Classification System*. (B. G. Warner & C. D. A. Rubec, Eds.). Waterloo, Ontario: Wetlands Research Center. 2nd ed., 68 pp.

Hebeler, F., & Purves, R. S. 2009. The influence of elevation uncertainty on derivation of topographic indices. *Geomorphology*, *111*, 4–16.

Heinselman, M. L. 1963. Forest Sites, Bog Processes, and Peatland Types in the Glacial Lake Agassiz Region, Minnesota. *Ecological Monographs*, *33*, 327–374.

Hiltz, D. 2014. Predictive vegetation type mapping using cartographic depth-to-water, slope, aspect, and elevation. Master's thesis. University of New Brunswick, Fredericton, New Brunswick. 257 pp.

Hiltz, D., Gould, J., White, B., Ogilvie, J., & Arp, P. A. 2012. Modeling and mapping vegetation type by soil moisture regime across boreal landscapes. In Vitt, D. & Bhatti, J. (Eds.), *Restoration and Reclamation of Boreal Ecosystems: Attaining Sustainable Development.* New York: Cambridge University Press. 56–75 pp.

Hopkinson, C., Chasmer, L., Lim, K., Treitz, P., & Creed, I. 2006. Towards a universal LiDAR canopy height indicator. *Canadian Journal of Remote Sensing*, *32*, 139–152.

Husson, O. 2013. Redox potential (Eh) and pH as drivers of soil/plant/microorganism systems: A transdisciplinary overview pointing to integrative opportunities for agronomy. *Plant and Soil*, *362*, 389–417.

Jassey, V. E. J., Chiapusio, G., Mitchell, E. a D., Binet, P., Toussaint, M.-L., & Gilbert, D. 2011. Fine-scale horizontal and vertical micro-distribution patterns of testate amoebae along a narrow Fen/Bog gradient. *Microbial Ecology*, *61*, 374–85.

Jewett, K., Daugharty, D., Krause, H. H., & Arp, P. A. 1995. Watershed responses to clear-cutting: Effects on soil solutions and stream water discharge in central New Brunswick. *Canadian Journal of Soil Science*, *75*, 475 – 490.

Kätterer, T., Reichstein, M., Andren, O., & Lomander, A. 1998. Temperature dependence of organic matter decomposition : a critical review using literature data analyzed with different models. *Biology and Fertility of Soils*, *27*, 258–262.

Kirschbaum, M. 1995. The temperature dependence of soil organic matter decomposition, and the effect of global warming on soil organic C storage. *Soil Biology and Biochemistry*, *27*, 753–760.

Kishchuk, B. E. 2004. *Soils of the Ecosystem Management Emulating Natural Disturbance (EMEND) experimental area, northwestern Alberta*. Edmonton: Canadian Forestry Service - Northern Forestry Center. 136 pp.

Knight, J. F., Tolcser, B. P., Corcoran, J. M., & Rampi, L. P. 2013. The effects of data selection and thematic detail on the accuracy of high spatial resolution wetland classifications. *Photogrammetric Engineering and Remote Sensing*, *79*(7), 613–623.

Kuhry, P., Nicholson, J. B., Gignac, L. D., Vitt, D. H., & Bayley, S. E. 1993. Development of Sphagnum-dominated peatlands in boreal continental Canada. *Canadian Journal of Botany*, *71*, 10–22.

Lee, R. 1980. *Forest Hydrology*. New York: Columbia University Press. 349 pp.

Lefsky, M. A., Cohen, W. B., Parker, G. G., & Harding, D. J. 2002. Lidar remote sensing for ecosystem studies. *BioScience*, *52*, 19–30.

Leonardi, S., & Fluckiger, W. 1987. Short-term canopy interactions of beech trees: mineral ion leaching and absorption during rainfall. *Tree Physiology*, *3*, 137–145.

Li, Z., & Zhu, Q. 2005. *Digital Terrain Modeling - Principles and Methodology*. Boca Raton: CRC Press. 318 pp.

Lloyd, J. W., & Heathcote, J. A. 1985. *Natural Inorganic Hydrochemistry in Relation to Groundwater*. Oxford: Clarendon Press. 296 pp.

Malawska, M., Ekonomiuk, A., & Wi, B. 2006. Chemical characteristics of some peatlands in southern Poland. *Mires and Peat*, *1*, 1–14.

Maxa, M., & Bolstad, P. 2009. Mapping northern wetlands with high resolution satellite images and LiDAR. *Wetlands*, *29*, 248–260.

McBratney, A. B., & Pringle, M. J. 1999. Estimating Average and Proportional Variograms of Soil Properties and Their Potential Use in Precision Agriculture. *Precision Agriculture*, *1*, 125–152.

McKnight, D., Thurman, E. M., & Wershaw, R. L. 1985. Biogeochemistry of aquatic humic substances in Thoreau's bog, Concord, Massachusetts. *Ecological Society of America*, *66*, 1339–1352.

Millard, K., & Richardson, M. 2013. Wetland mapping with LiDAR derivatives, SAR polarimetric decompositions, and LiDAR–SAR fusion using a random forest classifier. *Canadian Journal of Remote Sensing*, *39*, 290–307.

Mitsch, W. J., & Gosselink, J. G. 2007. *Wetlands*. New Jersey: John Wiley and Sons Inc. 4th ed., 582 pp.

Moore, T. R., & Jackson, R. J. 1989. Dynamics of Dissolved Organic Carbon in Forested and Disturbed Catchments, Westland, New Zealand. *Water Resources Research*, *25*, 1331–1339.

Moore, T. R., Young, A., Bubier, J. L., Humphreys, E. R., Lafleur, P. M., & Roulet, N. T. 2011. A multi-year record of methane flux at the Mer Bleue Bog, southern Canada. *Ecosystems*, *14*, 646–657.

Murphy, P. N. C., Ogilvie, J., & Arp, P. 2009. Topographic modelling of soil moisture conditions: A comparison and verification of two models. *European Journal of Soil Science*, *60*, 94–109.

Murphy, P. N. C., Ogilvie, J., Connor, K., & Arp, P. A. 2007. Mapping wetlands: A comparison of two different approaches for New Brunswick, Canada. *Wetlands*, *27*, 846–854.

Murphy, P. N. C., Ogilvie, J., Meng, F. R., White, B., Bhatti, J. S., & Arp, P. a. 2011. Modelling and mapping topographic variations in forest soils at high resolution: A case study. *Ecological Modelling*, *222*, 2314–2332.

Nelson, L. M., Rhoades, C. C., & Dwire, K. a. 2011. Influence of bedrock geology on water chemistry of slope wetlands and headwater streams in the southern rocky mountains. *Wetlands*, *31*, 251–261.

Noble, B., Hill, M., & Nielsen, J. 2011. Environmental assessment framework for identifying and mitigating the effects of linear development to wetlands. *Landscape and Urban Planning*, *99*, 133–140.

Ozesmi, S. L., & Bauer, M. E. 2002. Satellite remote sensing of wetlands. *Wetlands Ecology and Management*, *10*, 381–402.

Pearsall, W. H., & Mortimer, C. H. 1939. Oxidation-Reduction potentials in waterlogged soils , natural waters and muds. *Journal of Ecology*, *27*, 483–501.

Petrone, R. M., Devito, K. J., Silins, U., Mendoza, C., Brown, S. C., Kaufman, S. C., & Price, J. S. 2008. Transient peat properties in two pond-peatland complexes in the sub-humid Western Boreal Plain , Canada. *Mires and Peat*, *3*, 1–13.

Pierce, K. B., Lookingbill, T., & Urban, D. 2005. A simple method for estimating potential relative radiation (PRR) for landscape-scale vegetation analysis. *Landscape Ecology*, *20*, 137–147.

Pierce, R. S. 1953. Oxidation-reduction potential and specific conductance of ground water: Their influence on natural forest distribution. *Soil Science Society Proceedings*, 61–65.

Pongpetch, N., & Suwanwaree, P. 2012. Spatial water quality assessment and mapping of Lahan Swamp, Chaiyaphum, Thailand. *Procedia Environmental Sciences*, *13*, 655–659.

Rogers, S. R., Webster, T., Livingstone, W., & O'Driscoll, N. J. 2012. Airborne laser-induced fluorescence (LIF) light detection and ranging (LiDAR) for the quantification of dissolved organic matter concentration in natural waters. *Estuaries and Coasts*, *35*, 959–975.

Rousk, J., Brookes, P. C., & Baath, E. 2009. Contrasting soil pH effects on fungal and bacterial growth suggest functional redundancy in carbon mineralization. *Appl Ied Environmental Microbiology*, *75*, 1589–1596.

Sand-Jensen, K., Prahl, C., & Stokholm, H. 1982. Oxygen release from roots of submerged aquatic macrophytes. *Oikos*, *38*, 349–354.

Schwintzer, C. R., & Tomberlin, T. J. 1982. Chemical and physical characteristics of shallow ground waters in northern Michigan bogs, swamps, and fens. *American Journal of Botany*, *69*, 1231–1239.

Shotyk, W. 1988. Review of the inorganic geochemistry of peats and peatland waters. *Earth Sciences Reviews*, *25*, 95–176.

Šímová, I., Storch, D., Keil, P., Boyle, B., Phillips, O. L., & Enquist, B. J. 2011. Global species-energy relationship in forest plots: role of abundance, temperature and species climatic tolerances. *Global Ecology and Biogeography*, *20*, 842–856.

Stobbe, P. C. 1940. Soil survey of the Fredericton-Gagetown area New Brunswick. Ottawa: Department of Agriculture.

Swanson, F. J., Kratz, T. K., Caine, N., & Woodmansee, R. G. 1988. Landform effects on ecosystem patterns and processes. *American Institute of Biological Sciences*, *38*, 92–98.

Thomas, C. R., Miao, S., Sindhøj, E., Parkway, V., Beach, W. P., & Road, S. 2009. Environmental factors affecting temporal and spatial patterns of soil redox potential in Florida. *Wetlands*, *29*, 1133–1145.

Tiner, R. W. 2005. *In Search of Swampland*. New Jersey: Rutgers University Press. 2nd ed., 333 pp.

Touzi, R., Deschamps, A., & Rother, G. 2009. Phase of target scattering for wetland characterization using polarimetric C-band SAR. *IEEE Transactions on Geoscience and Remote Sensing*, *47*, 3241–3261.

Ulanowski, T. A., & Bran, B. A. 2013. Small-scale variability in peatland pore-water biogeochemistry , Hudson Bay Lowland , Canada. *Science of the Total Environment*, *455*, 211–218.

Van Den Wyngaert, I. J. J., & Bobbink, R. 2009. Ecological dynamics II: The influences of vertebrate herbivory on ecological dynamics in wetland ecosystems. In Maltby, E. & Barker, T. (Eds.), *The Wetlands Handbook*. New Jersey: Wiley-Blackwell. 304–325 pp.

Verhoeven, J. T. A. 2009. Wetland biogeochemical cycles and their interactions. In Maltby, E. & Barker, T. (Eds.), *The Wetlands Handbook*. New Jersey: Wiley-Blackwell. 266–281 pp.

Verry, E. S. 1975. Streamflow chemistry and nutrient yields from upland-peatland watersheds in Minnesota. *Ecology*, *56*, 1149–1157.

Walker, J. P., & Willgoose, G. R. 1999. On the effect of digital elevation model accuracy on hydrology and geomorphology, *35*, 2259–2268.

Wallage, Z. E., & Holden, J. 2010. Spatial and temporal variability in the relationship between water colour and dissolved organic carbon in blanket peat pore waters. *Science of the Total Environment*, *408*, 6235–6242.

Waske, B., & Braun, M. 2009. Classifier ensembles for land cover mapping using multitemporal SAR imagery. *ISPRS Journal of Photogrammetry and Remote Sensing*, *64*, 450–457.

Waske, B., Member, S., & Benediktsson, J. A. 2007. Fusion of support vector machines for classification of multisensor data. *IEEE Transactions on Geoscience and Remote Sensing*, *45*, 3858–3866.

Wdowinski, S., Kim, S., Amelung, F., Dixon, T. H., Miralles-wilhelm, F., & Sonenshein, R. 2008. Space-based detection of wetlands' surface water level

changes from L-band SAR interferometry. *Remote Sensing of Environment*, *112*, 681–696.

Whigham, D. F. 2009. Global distribution, diversity and human alterations of wetland resources. In Maltby, E. & Barker, T. (Eds.), *The Wetlands Handbook*. New Jersey: Wiley-Blackwell. 43–64 pp.

Whitcomb, J., Moghaddam, M., Mcdonald, K., Kellndorfer, J., & Podest, E. 2009. Mapping vegetated wetlands of Alaska using L-band radar satellite imagery. *Canadian Journal of Remote Sensing*, *35*, 54–72.

White, B., Ogilvie, J., Campbell, D. M. H., & Hiltz, D. 2012. Using the cartographic depth-to-water index to locate small streams and associated wet areas across landscapes. *Canadian Water Resources Journal*, *37*, 333–347.

White, J. R., & Reddy, K. R. 2009. Biogeochemical dynamics I: Nitrogen cycling in wetlands. In Maltby, E. & Barker, T. (Eds.), *The Wetlands Handbook*. New Jersey: Wiley-Blackwell. 213–227 pp.

Wicklund, R. E., & Langmaid, K. K. 1949. Soil survey of southwestern New Brunswick. Ottawa: Department of Agriculture.

Wolken, J. M., Landhäusser, S. M., Lieffers, V. J., & Silins, U. 2011. Seedling growth and water use of boreal conifers across different temperatures and near-flooded soil conditions. *Canadian Journal of Forest Research*, *41*, 2292–2300.

Xie, Y., Sha, Z., & Yu, M. 2008. Remote sensing imagery in vegetation mapping : a review. *Journal of Plant Ecology*, *1*, 9–23.

Zoltai, S. C., & Vitt, D. H. 1995. Canadian wetlands : Environmental gradients and classification. *Vegetation*, *118*, 131–137.

APPENDIX I

Plot	Site Name	DO	calc DO	pH	EC	log (ec)	Temp	Color	Sqrt (col)	log Slope	Class	Form	Type	Tree Ht	DTW (4ha)	DTW (log4ha)	DTW (1ha)	DTW (log1ha)	log fa 150m	Open Water	PRR	log (PRR)	log (HC)	evapo tran	ET/Ppt ratio	ratio x PRR
1	Emend	7.1	0.0	6.6	200	2.3	5.8	140.0	11.8	-1.6	swamp	lagg	swd	11.5	1.0	0.0	0.1	-0.9	4.1	0.0	9504.0	4.0	-5.0	340.0	0.8	7497.4
2	Emend	5.5	-0.2	6.1	180	2.3	6.6	450.0	21.2	-1.6	swamp	lagg	swd	9.0	0.9	-0.1	0.2	-0.7	4.2	0.0	9353.0	4.0	-5.0	340.0	0.8	7378.2
3	Emend	7.4	0.0	6.4	340	2.5	8.9	180.0	13.4	-1.6	swamp	drainageway	swd	7.0	0.8	-0.1	0.4	-0.4	4.2	0.0	8902.0	3.9	-5.0	340.0	0.8	7022.5
4	Emend	7.9	0.1	6.6	220	2.3	5.5	100.0	10.0	-1.6	swamp	lagg	swd	8.5	0.6	-0.2	0.6	-0.2	4.2	0.0	8881.0	3.9	-5.0	340.0	0.8	7005.9
5	Emend	4.7	-0.3	6.6	200	2.3	13.1	140.0	11.8	-1.6	fen	horizontal	shrub	5.0	0.6	-0.2	0.6	-0.2	4.3	0.0	8948.0	4.0	-5.0	340.0	0.8	7058.7
6	Emend	5.8	-0.2	6.2	330	2.5	11.1	190.0	13.8	-1.6	fen	horizontal	shrub	6.0	0.4	-0.4	0.4	-0.4	4.3	0.0	8896.0	3.9	-5.0	340.0	0.8	7017.7
7	Emend	5.6	-0.2	6.0	210	2.3	6.2	260.0	16.1	-1.6	swamp	lagg	swd	8.5	0.3	-0.5	0.3	-0.5	4.2	0.0	8832.0	3.9	-5.0	340.0	0.8	6967.2
8	Emend	6.0	-0.1	6.1	90	2.0	6.6	527.8	23.0	-1.6	swamp	lagg	swd	9.5	0.2	-0.8	0.2	-0.8	4.2	0.0	9519.0	4.0	-5.0	340.0	0.8	7509.2
9	Emend	7.6	0.1	6.6	180	2.3	7.5	230.0	15.2	-1.6	swamp	lagg	shrub	8.5	0.4	-0.3	0.4	-0.3	4.2	0.0	8915.0	4.0	-5.0	340.0	0.8	7032.7
10	Emend	4.9	-0.3	6.5	240	2.4	14.6	120.0	11.0	-1.6	fen	horizontal	swd	7.5	0.4	-0.4	0.4	-0.4	4.2	0.0	9236.0	4.0	-5.0	340.0	0.8	7285.9
11	Emend	5.0	-0.3	6.6	250	2.4	13.4	130.0	11.4	-1.6	fen	horizontal	shrub	7.5	0.5	-0.3	0.5	-0.3	4.2	0.0	9660.0	4.0	-5.0	340.0	0.8	7620.4
12	Emend	5.3	-0.2	6.6	310	2.5	10.0	140.0	11.8	-1.6	swamp	drainageway	swd	7.5	0.5	-0.3	0.4	-0.4	4.2	0.0	9740.0	4.0	-5.0	340.0	0.8	7683.5
13	Emend	5.4	-0.2	6.8	420	2.6	6.0	120.0	11.0	-1.6	swamp	lagg	swd	12.0	0.6	-0.3	0.3	-0.5	4.2	0.0	9720.0	4.0	-5.0	340.0	0.8	7667.7
14	Emend	4.5	-0.3	7.1	2800	3.4	8.0	100.0	10.0	-1.7	marsh	linked basin	shrub	4.5	0.3	-0.5	0.3	-0.6	4.2	0.0	10135.0	4.0	-3.7	340.0	0.8	7995.1
15	Emend	2.6	-0.7	7.2	630	2.8	13.6	360.0	19.0	-1.7	marsh	linked basin	shrub	2.0	0.3	-0.6	0.2	-0.7	4.2	0.0	9059.0	4.0	-3.7	340.0	0.8	7146.3
16	Emend	6.4	-0.1	6.8	1900	3.3	9.7	120.0	11.0	-1.7	marsh	linked basin	shrub	4.5	0.3	-0.6	0.2	-0.8	4.1	1.0	9466.0	4.0	-3.7	340.0	0.8	7467.4
17	Emend	2.8	-0.6	7.0	180	2.3	14.2	480.0	21.9	-1.7	marsh	linked basin	shrub	1.0	0.3	-0.6	0.1	-0.9	4.2	0.0	9132.0	4.0	-3.7	340.0	0.8	7203.9
18	Emend	0.7	-1.3	6.3	2700	3.4	9.3	370.0	19.2	-1.7	marsh	linked basin	shrub	7.5	0.6	-0.2	0.4	-0.4	4.0	0.0	10015.0	4.0	-3.7	340.0	0.8	7900.5
19	Emend	3.6	-0.5	6.4	620	2.8	12.5	410.0	20.2	-1.7	marsh	linked basin	shrub	4.0	0.4	-0.4	0.2	-0.7	4.0	0.0	10054.0	4.0	-3.7	340.0	0.8	7931.2
20	Emend	4.3	-0.4	6.9	160	2.2	14.8	564.2	23.8	-1.7	marsh	linked basin	shrub	1.0	0.3	-0.5	0.1	-0.9	4.1	0.0	9030.0	4.0	-3.7	340.0	0.8	7123.4
21	Emend	7.8	0.1	6.6	2600	3.4	8.3	320.0	17.9	-1.7	marsh	linked basin	shrub	5.0	0.5	-0.3	0.2	-0.6	3.7	0.0	9453.0	4.0	-3.7	340.0	0.8	7457.1
22	Emend	2.9	-0.6	6.3	190	2.3	10.7	691.6	26.3	-1.7	marsh	linked basin	shrub	2.5	0.4	-0.5	0.1	-0.9	3.9	0.0	9445.0	4.0	-3.7	340.0	0.8	7450.8
23	Emend	6.7	-0.1	5.8	1120	3.0	8.8	60.0	7.7	-1.5	swamp	lagg	shrub	8.0	0.6	-0.2	0.3	-0.5	2.4	0.0	10091.0	4.0	-5.0	340.0	0.8	7960.4
24	Emend	9.4	0.3	6.8	2600	3.4	9.1	70.0	8.4	-1.6	swamp	lagg	shrub	6.0	0.7	-0.2	0.4	-0.4	3.9	0.0	9069.0	4.0	-5.0	340.0	0.8	7154.2
25	Emend	1.9	-0.8	6.0	3100	3.5	11.2	340.0	18.4	-1.6	marsh	linked basin	shrub	4.5	0.4	-0.4	0.1	-1.0	4.1	0.0	9223.0	4.0	-3.7	340.0	0.8	7275.7
26	Emend	2.5	-0.7	6.7	210	2.3	15.9	491.4	22.2	-1.5	marsh	linked basin	none	0.0	0.4	-0.4	0.1	-0.9	4.1	0.0	9089.0	4.0	-3.7	340.0	0.8	7170.0
27	Emend	2.3	-0.7	6.5	220	2.3	11.5	130.0	11.4	-1.5	marsh	linked basin	shrub	4.0	0.8	-0.1	0.6	-0.2	4.1	0.0	8906.0	3.9	-3.7	340.0	0.8	7025.6
28	Emend	4.8	-0.3	5.7	1010	3.0	6.4	80.0	8.9	-1.5	swamp	lagg	shrub	3.0	0.8	-0.1	0.2	-0.7	4.1	0.0	9099.0	4.0	-5.0	340.0	0.8	7177.9
29	Emend	8.8	0.2	6.7	340	2.5	6.7	90.0	9.5	-1.5	upland	upland	shrub	21.0	0.5	-0.3	0.5	-0.3	3.6	0.0	5425.0	3.7	-3.6	340.0	0.8	4279.6
30	Emend	3.8	-0.4	6.3	200	2.3	9.2	330.0	18.2	-1.5	fen	horizontal	shrub	6.5	0.5	-0.3	0.5	-0.3	3.7	0.0	6940.0	3.8	-5.0	340.0	0.8	5474.7
31	Emend	1.5	-0.9	6.4	150	2.2	9.7	220.0	14.8	-1.5	fen	horizontal	shrub	3.0	0.2	-0.6	0.2	-0.6	3.8	0.0	8340.0	3.9	-5.0	340.0	0.8	6579.1
32	Emend	3.4	-0.5	6.4	170	2.2	10.2	140.0	11.8	-1.5	fen	horizontal	shrub	3.0	0.3	-0.6	0.3	-0.6	3.9	0.0	9169.0	4.0	-5.0	340.0	0.8	7233.1
33	Emend	6.0	-0.1	6.5	210	2.3	8.3	150.0	12.2	-1.4	fen	horizontal	shrub	5.0	0.8	-0.1	0.7	-0.2	4.0	0.0	9014.0	4.0	-5.0	340.0	0.8	7110.8
34	Emend	7.5	0.0	6.3	210	2.3	6.3	240.0	15.5	-1.4	swamp	drainageway	shrub	8.0	0.8	-0.1	0.7	-0.2	4.0	0.0	9518.0	4.0	-5.0	340.0	0.8	7508.4
35	Emend	3.2	-0.5	6.3	200	2.3	7.4	260.0	16.1	-1.4	swamp	drainageway	shrub	11.0	0.4	-0.4	0.4	-0.4	4.0	0.0	9123.0	4.0	-5.0	340.0	0.8	7196.8
36	Emend	6.6	-0.1	6.7	640	2.8	6.4	210.0	14.5	-1.5	swamp	drainageway	none	7.0	0.3	-0.6	0.3	-0.6	4.0	0.0	9328.0	4.0	-5.0	340.0	0.8	7358.5
37	Emend	4.7	-0.3	6.5	220	2.3	10.4	170.0	13.0	-1.5	swamp	drainageway	shrub	12.0	0.1	-0.9	0.1	-0.9	4.0	0.0	9403.0	4.0	-5.0	340.0	0.8	7417.7
38	Emend	6.2	-0.1	6.7	210	2.3	10.2	170.0	13.0	-1.5	swamp	drainageway	shrub	9.0	0.1	-0.9	0.1	-0.9	4.1	0.0	9208.0	4.0	-5.0	340.0	0.8	7263.9
39	Emend	7.4	0.0	7.0	950	3.0	5.4	180.0	13.4	-1.5	swamp	drainageway	shrub	7.0	0.2	-0.6	0.2	-0.6	4.1	0.0	9198.0	4.0	-5.0	340.0	0.8	7256.0
40	Emend	1.8	-0.8	6.9	190	2.3	10.4	210.0	14.5	-1.5	fen	horizontal	shrub	3.5	0.5	-0.3	0.5	-0.3	4.0	0.0	9377.0	4.0	-5.0	340.0	0.8	7397.2
41	Emend	3.0	-0.6	6.8	160	2.2	10.8	210.0	14.5	-1.5	fen	horizontal	shrub	3.5	0.2	-0.6	0.2	-0.6	4.0	0.0	9190.0	4.0	-5.0	340.0	0.8	7249.7
42	Emend	8.7	0.2	7.1	2500	3.4	6.4	40.0	6.3	-1.5	upland	upland	shrub	12.5	0.7	-0.2	0.7	-0.2	3.8	0.0	9055.0	4.0	-3.6	340.0	0.8	7143.2
43	Emend	7.9	0.1	7.0	110	2.0	1.4	460.0	21.4	-1.6	fen	horizontal	swd	10.0	0.3	-0.6	0.3	-0.6	3.6	0.0	7689.0	3.9	-5.0	340.0	0.8	6065.6
44	Emend	3.7	-0.5	6.6	150	2.2	9.9	240.0	15.5	-1.5	fen	horizontal	shrub	5.0	0.3	-0.6	0.3	-0.6	3.7	0.0	9134.0	4.0	-5.0	340.0	0.8	7205.5
45	Emend	2.3	-0.7	6.3	210	2.3	7.6	250.0	15.8	-1.5	fen	horizontal	shrub	4.0	0.7	-0.1	0.7	-0.2	3.8	0.0	9098.0	4.0	-5.0	340.0	0.8	7177.1

Plot	Site Name	DO	calc DO	pH	EC	log (ec)	Temp	Color	Sqrt (col)	log Slope	Class	Form	Type	Tree Ht	DTW (4ha)	DTW (log4ha)	DTW (1ha)	DTW (log1ha)	log fa 150m	Open Water	PRR	log (PRR)	log (HC)	evapo tran	ET/Ppt ratio	ratio x PRR
46	Emend	6.7	-0.1	6.4	210	2.3	8.4	200.0	14.1	-1.5	fen	horizontal	shrub	6.0	1.1	0.0	0.3	-0.5	3.7	0.0	8991.0	4.0	-5.0	340.0	0.8	7092.7
47	Emend	5.8	-0.2	6.0	760	2.9	3.9	210.0	14.5	-1.6	bog	basin	swd	14.0	1.1	0.0	0.3	-0.5	2.5	0.0	8742.0	3.9	-3.7	340.0	0.8	6896.2
48	Emend	6.1	-0.1	4.5	100	2.0	4.0	790.4	28.1	-1.7	bog	basin	swd	7.0	0.9	0.0	0.4	-0.4	3.2	0.0	8953.0	4.0	-3.7	340.0	0.8	7062.7
49	Emend	6.5	-0.1	5.3	70	1.8	5.4	800.8	28.3	-1.7	bog	basin	swd	6.0	0.6	-0.2	0.6	-0.2	3.4	0.0	8523.0	3.9	-3.7	340.0	0.8	6723.5
50	Emend	5.9	-0.2	4.1	130	2.1	4.3	746.2	27.3	-1.7	bog	basin	swd	6.0	0.3	-0.5	0.3	-0.5	3.6	0.0	9273.0	4.0	-3.7	340.0	0.8	7315.1
51	Emend	3.8	-0.4	5.9	350	2.5	6.5	450.0	21.2	-1.7	fen	horizontal	shrub	4.5	0.3	-0.5	0.3	-0.5	3.7	0.0	8804.0	3.9	-5.0	340.0	0.8	6945.2
52	Emend	2.9	-0.6	5.9	120	2.1	9.0	340.0	18.4	-1.7	fen	horizontal	shrub	3.5	0.3	-0.6	0.3	-0.6	3.7	0.0	9061.0	4.0	-5.0	340.0	0.8	7147.9
53	Emend	2.2	-0.7	5.9	170	2.2	8.9	280.0	16.7	-1.6	fen	horizontal	shrub	3.5	0.2	-0.6	0.2	-0.6	3.8	0.0	9238.0	4.0	-5.0	340.0	0.8	7287.5
54	Emend	4.4	-0.4	6.1	180	2.3	8.1	260.0	16.1	-1.5	fen	horizontal	shrub	4.5	0.4	-0.4	0.4	-0.5	3.6	0.0	9121.0	4.0	-5.0	340.0	0.8	7195.2
55	Emend	5.2	-0.2	5.8	180	2.3	9.1	310.0	17.6	-1.6	bog	basin	none	4.0	0.4	-0.4	0.3	-0.5	3.4	0.0	8992.0	4.0	-3.7	340.0	0.8	7093.5
56	Emend	5.8	-0.2	6.4	940	3.0	4.8	340.0	18.4	-1.6	bog	basin	none	10.0	0.6	-0.2	0.6	-0.2	3.6	0.0	9725.0	4.0	-3.7	340.0	0.8	7671.7
57	Emend	3.1	-0.6	6.7	200	2.3	3.0	260.0	16.1	-1.6	fen	horizontal	shrub	8.0	0.2	-0.8	0.2	-0.8	3.6	0.0	9875.0	4.0	-5.0	340.0	0.8	7790.0
58	Emend	5.2	-0.2	5.2	120	2.1	5.0	546.0	23.4	-1.6	bog	domed	none	3.0	0.2	-0.7	0.1	-1.0	3.7	0.0	9171.0	4.0	-1.6	340.0	0.8	7234.7
59	Emend	5.2	-0.2	4.9	90	2.0	3.2	600.6	24.5	-1.7	bog	domed	swd	6.5	0.6	-0.2	0.6	-0.2	3.4	0.0	8888.0	3.9	-1.6	340.0	0.8	7011.4
60	Emend	5.1	-0.3	4.2	90	2.0	4.1	764.4	27.6	-1.7	bog	domed	swd	5.0	1.0	0.0	0.6	-0.2	3.1	0.0	9295.0	4.0	-1.6	340.0	0.8	7332.5
61	Emend	3.8	-0.4	4.8	80	1.9	4.5	800.8	28.3	-1.7	bog	basin	swd	9.0	1.0	0.0	0.6	-0.2	2.8	0.0	8362.0	3.9	-3.7	340.0	0.8	6596.5
62	Emend	7.8	0.1	5.7	170	2.2	4.6	470.0	21.7	-1.5	bog	basin	swd	9.0	0.1	-1.0	0.1	-1.0	2.8	0.0	9283.0	4.0	-3.7	340.0	0.8	7323.0
63	Emend	5.7	-0.2	4.6	70	1.8	2.7	600.6	24.5	-1.4	bog	basin	swd	8.0	0.3	-0.5	0.3	-0.5	2.8	0.0	9656.0	4.0	-3.7	340.0	0.8	7617.3
64	Emend	4.5	-0.3	3.9	100	2.0	4.3	637.0	25.2	-1.3	bog	domed	swd	4.0	1.0	0.0	0.7	-0.1	2.8	0.0	8911.0	3.9	-1.6	340.0	0.8	7029.6
65	Emend	10.4	0.4	3.8	100	2.0	-0.3	618.8	24.9	-1.4	bog	domed	swd	1.5	1.8	0.2	1.3	0.1	2.7	0.0	8788.0	3.9	-1.6	340.0	0.8	6932.5
66	Emend	4.0	-0.4	3.8	90	2.0	6.7	473.2	21.8	-1.3	bog	domed	swd	2.0	1.8	0.3	1.3	0.1	2.1	0.0	8998.0	4.0	-1.6	340.0	0.8	7098.2
67	Emend	9.2	0.3	3.8	100	2.0	0.2	728.0	27.0	-1.5	bog	domed	swd	5.5	1.9	0.3	0.7	-0.1	2.6	0.0	8975.0	4.0	-1.6	340.0	0.8	7080.0
68	Emend	7.1	0.0	3.7	110	2.0	1.6	837.2	28.9	-1.5	bog	domed	swd	9.0	1.7	0.2	0.3	-0.5	3.1	0.0	8914.0	4.0	-1.6	340.0	0.8	7031.9
69	Emend	8.6	0.2	4.0	70	1.8	3.8	782.6	28.0	-1.5	bog	domed	swd	13.0	1.4	0.2	0.6	-0.2	3.1	0.0	7902.0	3.9	-1.6	340.0	0.8	6233.6
70	Emend	8.5	0.2	5.6	60	1.8	6.1	220.0	14.8	-1.7	upland	upland	swd	14.0	1.1	0.0	0.7	-0.2	3.2	0.0	8515.0	3.9	-3.6	340.0	0.8	6717.2
71	Emend	7.4	0.0	6.3	270	2.4	4.3	110.0	10.5	-1.7	upland	upland	swd	12.0	1.1	0.1	0.7	-0.2	3.2	0.0	7748.0	3.9	-3.6	340.0	0.8	6112.1
72	Emend	8.0	0.1	4.1	90	2.0	-0.2	820.8	28.6	-1.6	bog	domed	swd	4.5	1.4	0.2	1.0	0.0	3.1	0.0	8761.0	3.9	-1.6	340.0	0.8	6911.2
73	Emend	1.8	-0.8	3.9	100	2.0	9.4	790.4	28.1	-1.4	bog	domed	swd	4.5	1.9	0.3	1.4	0.2	3.0	0.0	9067.0	4.0	-1.6	340.0	0.8	7152.6
74	Emend	6.7	-0.1	3.9	90	2.0	3.6	509.6	22.6	-1.4	bog	domed	swd	3.0	0.8	-0.1	0.1	-0.8	2.9	0.0	8983.0	4.0	-1.6	340.0	0.8	7086.4
75	Emend	7.3	0.0	3.8	110	2.0	3.9	618.8	24.9	-1.4	bog	domed	swd	4.5	1.1	0.0	0.7	-0.1	3.0	0.0	9042.0	4.0	-1.6	340.0	0.8	7132.9
76	Emend	6.3	-0.1	4.5	60	1.8	4.4	800.8	28.3	-1.4	bog	domed	swd	9.0	0.3	-0.5	0.3	-0.5	3.0	0.0	9601.0	4.0	-1.6	340.0	0.8	7573.9
77	Emend	4.6	-0.3	5.3	530	2.7	6.2	420.0	20.5	-1.6	upland	upland	swd	13.0	0.2	-0.7	0.2	-0.7	3.0	0.0	9476.0	4.0	-3.6	340.0	0.8	7475.3
78	Emend	9.6	0.3	6.5	760	2.9	3.3	60.0	7.7	-1.5	swamp	lagg	shrub	8.0	0.3	-0.6	0.3	-0.6	4.5	0.0	9429.0	4.0	-5.0	340.0	0.8	7438.2
79	Emend	7.1	0.0	6.5	370	2.6	7.2	0.0	0.0	-1.5	swamp	drainageway	shrub	9.0	0.3	-0.5	0.3	-0.5	4.5	0.0	9742.0	4.0	-5.0	340.0	0.8	7685.1
80	Emend	4.6	-0.3	6.1	90	2.0	6.7	240.0	15.5	-1.4	swamp	lagg	shrub	17.0	0.6	-0.2	0.6	-0.2	4.5	0.0	8574.0	3.9	-5.0	340.0	0.8	6763.7
81	Emend	7.2	0.0	6.4	130	2.1	6.4	90.0	9.5	-1.4	swamp	lagg	shrub	15.0	0.5	-0.3	0.5	-0.3	4.4	0.0	9686.0	4.0	-5.0	340.0	0.8	7640.9
82	Emend	4.8	-0.3	6.3	130	2.1	8.3	210.0	14.5	-1.4	swamp	lagg	shrub	9.5	0.2	-0.6	0.2	-0.6	4.4	0.0	9229.0	4.0	-5.0	340.0	0.8	7280.4
83	Emend	3.8	-0.4	6.1	110	2.0	8.8	260.0	16.1	-1.4	swamp	lagg	shrub	9.5	0.6	-0.2	0.6	-0.2	4.5	0.0	9029.0	4.0	-5.0	340.0	0.8	7122.6
84	Emend	4.6	-0.3	7.0	690	2.8	3.6	30.0	5.5	-1.4	marsh	linked basin	none	9.0	0.8	-0.1	0.8	-0.1	4.5	0.0	9247.0	4.0	-3.7	340.0	0.8	7294.6
85	Emend	1.1	-1.1	7.0	1250	3.1	8.9	40.0	6.3	-1.4	marsh	linked basin	shrub	2.0	0.5	-0.3	0.5	-0.3	4.5	0.0	9227.0	4.0	-3.7	340.0	0.8	7278.8
86	Emend	6.2	-0.1	6.9	480	2.7	5.3	40.0	6.3	-1.4	swamp	lagg	shrub	8.0	0.7	-0.2	0.7	-0.2	4.5	0.0	9236.0	4.0	-5.0	340.0	0.8	7285.9
87	Emend	6.5	-0.1	6.1	160	2.2	2.1	310.0	17.6	-1.6	swamp	lagg	none	6.0	0.1	-0.9	0.1	-0.9	4.4	0.0	9124.0	4.0	-5.0	340.0	0.8	7197.6
88	Emend	5.5	-0.2	6.3	210	2.3	4.4	436.8	20.9	-1.6	swamp	lagg	shrub	12.0	0.3	-0.5	0.3	-0.5	4.4	0.0	8996.0	4.0	-5.0	340.0	0.8	7096.6
89	Emend	9.7	0.3	6.7	240	2.4	4.4	130.0	11.4	-1.6	swamp	lagg	swd	12.0	0.2	-0.6	0.2	-0.6	4.5	0.0	8911.0	3.9	-5.0	340.0	0.8	7029.6
90	Emend	8.7	0.2	6.7	320	2.5	4.1	110.0	10.5	-1.6	upland	upland	none	10.5	0.2	-0.6	0.2	-0.6	4.3	0.0	9923.0	4.0	-3.6	340.0	0.8	7827.9

Plot	Site Name	DO	calc DO	pH	EC	log (ec)	Temp	Color	Sqrt (col)	log Slope	Class	Form	Type	Tree Ht	DTW (4ha)	DTW (log4ha)	DTW (1ha)	DTW (log1ha)	log fa 150m	Open Water	PRR	log (PRR)	log (HC)	evapo tran	ET/Ppt ratio	ratio x PRR
91	Emend	5.5	-0.2	6.6	340	2.5	4.8	100.0	10.0	-1.6	marsh	linked basin	shrub	6.5	0.2	-0.7	0.2	-0.7	4.3	0.0	9350.0	4.0	-3.7	340.0	0.8	7375.9
92	Emend	3.5	-0.5	6.5	270	2.4	9.8	120.0	11.0	-1.7	marsh	linked basin	none	2.0	0.4	-0.4	0.4	-0.4	4.4	0.0	9187.0	4.0	-3.7	340.0	0.8	7247.3
93	Emend	1.5	-0.9	6.7	230	2.4	10.6	120.0	11.0	-1.7	marsh	linked basin	shrub	1.0	0.5	-0.3	0.5	-0.3	4.4	0.0	9123.0	4.0	-3.7	340.0	0.8	7196.8
94	Emend	2.2	-0.8	6.3	250	2.4	0.2	380.0	19.5	-1.7	bog	domed	shrub	4.0	0.6	-0.3	0.5	-0.3	4.3	0.0	9185.0	4.0	-3.7	340.0	0.8	7245.7
95	Emend	2.4	-0.7	6.5	200	2.3	11.0	170.0	13.0	-1.7	marsh	linked basin	shrub	1.0	0.2	-0.7	0.2	-0.7	4.1	0.0	9122.0	4.0	-3.7	340.0	0.8	7196.0
96	Emend	3.7	-0.5	6.5	230	2.4	9.8	280.0	16.7	-1.6	marsh	linked basin	shrub	1.0	0.1	-0.9	0.1	-0.9	4.1	0.0	9165.0	4.0	-3.7	340.0	0.8	7229.9
97	Emend	4.4	-0.4	6.4	230	2.4	10.0	220.0	14.8	-1.5	fen	horizontal	shrub	11.0	0.5	-0.3	0.5	-0.3	4.0	0.0	8649.0	3.9	-5.0	340.0	0.8	6822.9
98	Emend	1.1	-1.1	6.6	220	2.3	9.4	180.0	13.4	-1.4	swamp	lagg	none	11.0	0.4	-0.4	0.4	-0.4	4.0	0.0	8925.0	4.0	-5.0	340.0	0.8	7040.6
99	Emend	3.0	-0.6	6.5	180	2.3	9.3	240.0	15.5	-1.4	swamp	lagg	swd	12.0	0.7	-0.1	0.7	-0.1	4.0	0.0	9500.0	4.0	-5.0	340.0	0.8	7494.2
100	Emend	2.1	-0.8	6.4	190	2.3	9.2	160.0	12.6	-1.5	fen	horizontal	shrub	5.0	0.2	-0.7	0.2	-0.7	3.9	0.0	8994.0	4.0	-5.0	340.0	0.8	7095.0
101	Emend	1.8	-0.8	6.6	200	2.3	10.1	180.0	13.4	-1.5	marsh	linked basin	shrub	1.0	0.2	-0.7	0.2	-0.7	3.9	0.0	9141.0	4.0	-3.7	340.0	0.8	7211.0
102	Emend	0.8	-1.2	6.6	250	2.4	12.3	130.0	11.4	-1.7	marsh	linked basin	shrub	1.0	0.4	-0.4	0.1	-0.9	4.2	0.0	9094.0	4.0	-3.7	340.0	0.8	7173.9
103	Emend	0.7	-1.3	6.6	240	2.4	11.3	100.0	10.0	-1.7	marsh	linked basin	shrub	1.5	0.4	-0.4	0.4	-0.4	4.2	0.0	8953.0	4.0	-3.7	340.0	0.8	7062.7
104	Emend	2.9	-0.6	6.5	340	2.5	9.1	110.0	10.5	-1.6	fen	horizontal	shrub	5.0	0.4	-0.5	0.4	-0.5	4.2	0.0	8592.0	3.9	-5.0	340.0	0.8	6777.9
105	Emend	6.6	-0.1	6.5	390	2.6	2.7	80.0	8.9	-1.6	swamp	drainageway	none	10.0	0.1	-0.9	0.1	-0.9	4.2	1.0	9555.0	4.0	-5.0	340.0	0.8	7537.6
106	Emend	3.1	-0.6	6.2	330	2.5	6.4	120.0	11.0	-1.6	swamp	drainageway	none	9.5	0.1	-0.9	0.1	-0.9	4.2	0.0	9634.0	4.0	-5.0	340.0	0.8	7599.9
107	Emend	6.9	0.0	6.5	160	2.2	7.7	170.0	13.0	-1.5	upland	upland	shrub	12.0	0.1	-0.9	0.1	-0.9	4.4	1.0	10103.0	4.0	-3.6	340.0	0.8	7969.9
108	Emend	1.4	-1.0	6.3	120	2.1	7.7	436.8	20.9	-1.5	fen	horizontal	shrub	4.0	0.3	-0.5	0.3	-0.5	4.4	0.0	9832.0	4.0	-5.0	340.0	0.8	7756.1
109	Emend	1.5	-0.9	6.0	80	1.9	8.9	800.8	28.3	-1.5	fen	horizontal	shrub	3.0	0.4	-0.4	0.4	-0.4	4.3	0.0	8979.0	4.0	-5.0	340.0	0.8	7083.2
110	Emend	5.2	-0.2	6.2	130	2.1	7.3	470.0	21.7	-1.5	fen	horizontal	shrub	4.0	0.4	-0.4	0.4	-0.4	4.0	0.0	8775.0	3.9	-5.0	340.0	0.8	6922.3
111	Emend	5.5	-0.2	6.3	230	2.4	7.3	180.0	13.4	-1.5	fen	horizontal	shrub	10.0	0.4	-0.4	0.4	-0.4	3.9	0.0	9166.0	4.0	-5.0	340.0	0.8	7230.7
112	Emend	8.8	0.2	6.6	220	2.3	7.5	90.0	9.5	-1.5	upland	upland	shrub	11.5	0.3	-0.5	0.3	-0.5	3.8	0.0	9271.0	4.0	-3.6	340.0	0.8	7313.5
113	Emend	6.0	-0.1	6.0	220	2.3	7.7	150.0	12.2	-1.6	upland	upland	shrub	12.0	0.5	-0.3	0.5	-0.3	3.4	0.0	6755.0	3.8	-3.6	340.0	0.8	5328.8
114	Emend	2.7	-0.6	6.3	250	2.4	8.3	270.0	16.4	-1.6	fen	horizontal	shrub	4.5	0.4	-0.4	0.4	-0.4	3.4	0.0	8614.0	3.9	-5.0	340.0	0.8	6795.3
115	Emend	4.4	-0.4	6.1	80	1.9	8.8	564.2	23.8	-1.5	fen	horizontal	shrub	5.0	0.2	-0.6	0.2	-0.6	3.4	0.0	8718.0	3.9	-5.0	340.0	0.8	6877.3
116	Emend	1.9	-0.8	5.8	110	2.0	9.2	655.2	25.6	-1.5	fen	horizontal	shrub	4.0	0.3	-0.5	0.3	-0.5	3.8	0.0	8470.0	3.9	-5.0	340.0	0.8	6681.7
117	Emend	5.9	-0.2	5.8	110	2.0	7.2	564.2	23.8	-1.5	upland	upland	shrub	15.0	0.1	-0.9	0.1	-0.9	4.0	0.0	8502.0	3.9	-3.6	340.0	0.8	6706.9
118	Emend	6.2	-0.1	5.8	120	2.1	5.8	582.4	24.1	-1.6	upland	upland	swd	14.0	0.1	-1.0	0.1	-1.0	4.0	0.0	8083.0	3.9	-3.6	340.0	0.8	6376.4
119	Emend	3.4	-0.5	5.8	80	1.9	9.2	709.8	26.6	-1.6	fen	horizontal	shrub	8.5	0.2	-0.6	0.2	-0.6	3.5	0.0	8779.0	3.9	-5.0	340.0	0.8	6925.4
120	Emend	1.3	-1.0	5.7	70	1.8	9.3	582.4	24.1	-1.6	fen	horizontal	shrub	5.5	0.1	-0.8	0.1	-0.8	3.4	0.0	9210.0	4.0	-5.0	340.0	0.8	7265.4
121	Emend	2.9	-0.6	5.9	150	2.2	5.2	430.0	20.7	-1.6	fen	horizontal	shrub	7.0	0.2	-0.7	0.2	-0.7	3.4	0.0	9488.0	4.0	-5.0	340.0	0.8	7484.7
122	Emend	6.5	-0.1	6.2	660	2.8	6.7	70.0	8.4	-1.6	upland	upland	shrub	10.5	0.2	-0.7	0.2	-0.7	3.4	0.0	9297.0	4.0	-3.6	340.0	0.8	7334.1
123	Emend	2.6	-0.6	6.0	400	2.6	10.9	782.6	28.0	-1.6	marsh	linked basin	shrub	5.0	0.3	-0.5	0.3	-0.5	4.1	0.0	9703.0	4.0	-3.7	340.0	0.8	7654.3
124	Emend	5.6	-0.2	6.0	1090	3.0	9.9	618.8	24.9	-1.6	upland	upland	shrub	6.0	0.3	-0.5	0.3	-0.5	4.2	0.0	8991.0	4.0	-3.6	340.0	0.8	7092.7
125	Emend	2.3	-0.7	6.2	500	2.7	13.7	420.0	20.5	-1.6	marsh	linked basin	shrub	4.0	0.3	-0.5	0.3	-0.5	4.2	0.0	8881.0	3.9	-3.7	340.0	0.8	7005.9
126	Emend	2.2	-0.7	5.7	860	2.9	9.7	250.0	15.8	-1.6	marsh	linked basin	shrub	7.0	0.1	-0.9	0.1	-0.9	4.2	0.0	9326.0	4.0	-3.7	340.0	0.8	7356.9
127	Emend	3.1	-0.6	6.2	430	2.6	14.8	270.0	16.4	-1.6	marsh	linked basin	shrub	2.0	0.2	-0.8	0.2	-0.8	4.2	0.0	8296.0	3.9	-3.7	340.0	0.8	6544.4
128	Emend	4.1	-0.4	5.9	180	2.3	8.4	728.0	27.0	-1.6	upland	upland	shrub	5.5	0.1	-0.9	0.1	-0.9	4.1	0.0	7971.0	3.9	-3.6	340.0	0.8	6288.0
129	Emend	1.9	-0.8	6.5	580	2.8	14.3	509.6	22.6	-1.6	marsh	linked basin	shrub	5.5	0.3	-0.6	0.3	-0.6	4.1	0.0	8447.0	3.9	-3.7	340.0	0.8	6663.5
130	Emend	3.3	-0.5	6.8	270	2.4	15.3	270.0	16.4	-1.6	marsh	linked basin	shrub	2.0	0.3	-0.6	0.3	-0.6	4.2	0.0	8865.0	3.9	-3.7	340.0	0.8	6993.3
131	Emend	2.2	-0.7	6.3	1170	3.1	9.7	210.0	14.5	-1.6	swamp	lagg	shrub	8.0	0.4	-0.4	0.3	-0.5	4.2	0.0	9489.0	4.0	-5.0	340.0	0.8	7485.5
132	Emend	3.3	-0.5	6.5	450	2.7	15.1	370.0	19.2	-1.6	marsh	linked basin	shrub	3.5	0.3	-0.5	0.2	-0.7	4.2	0.0	8855.0	3.9	-3.7	340.0	0.8	6985.4
133	Emend	5.5	-0.2	6.7	390	2.6	17.3	260.0	16.1	-1.6	marsh	linked basin	shrub	1.0	0.2	-0.8	0.1	-1.1	4.2	1.0	8722.0	3.9	-3.7	340.0	0.8	6880.5
134	Emend	4.9	-0.3	6.9	580	2.8	11.1	90.0	9.5	-1.6	upland	upland	none	14.0	0.2	-0.7	0.2	-0.7	4.2	0.0	8677.0	3.9	-3.6	340.0	0.8	6845.0
135	Emend	1.2	-1.0	6.6	400	2.6	15.2	330.0	18.2	-1.6	marsh	linked basin	shrub	5.0	0.2	-0.8	0.2	-0.8	4.2	0.0	9719.0	4.0	-3.7	340.0	0.8	7667.0

Plot	Site Name	DO	calc DO	pH	EC	log (ec)	Temp	Color	Sqrt (col)	log Slope	Class	Form	Type	Tree Ht	DTW (4ha)	DTW (log4ha)	DTW (1ha)	DTW (log1ha)	log fa 150m	Open Water	PRR	log (PRR)	log (HC)	evapo tran	ET/Ppt ratio	ratio x PRR
136	Emend	8.1	0.1	7.1	350	2.5	18.8	320.0	17.9	-1.6	marsh	linked basin	shrub	1.0	0.0	-1.8	0.0	-1.8	4.2	1.0	8940.0	4.0	-3.7	340.0	0.8	7052.4
137	Emend	4.6	-0.3	6.7	510	2.7	10.4	90.0	9.5	-1.5	swamp	lagg	shrub	11.5	0.2	-0.7	0.2	-0.7	4.2	0.0	8795.0	3.9	-5.0	340.0	0.8	6938.1
138	Emend	1.2	-1.0	6.8	540	2.7	14.7	200.0	14.1	-1.6	marsh	linked basin	shrub	6.5	0.2	-0.7	0.2	-0.7	4.2	0.0	10157.0	4.0	-3.7	340.0	0.8	8012.5
139	Emend	12.2	0.8	7.3	380	2.6	21.4	170.0	13.0	-1.6	marsh	linked basin	shrub	1.0	0.1	-1.0	0.1	-1.0	4.2	1.0	9570.0	4.0	-3.7	340.0	0.8	7549.4
140	Emend	1.9	-0.8	6.3	1310	3.1	10.6	873.6	29.6	-1.6	swamp	lagg	shrub	6.0	0.3	-0.6	0.3	-0.6	4.2	0.0	9081.0	4.0	-5.0	340.0	0.8	7163.7
141	Emend	1.6	-0.9	6.3	730	2.9	15.1	564.2	23.8	-1.6	marsh	linked basin	shrub	2.0	0.2	-0.8	0.2	-0.8	4.2	0.0	9752.0	4.0	-3.7	340.0	0.8	7693.0
142	Emend	13.3	1.1	7.3	360	2.6	22.7	280.0	16.7	-1.7	marsh	linked basin	swd	0.8	0.2	-0.6	0.2	-0.6	4.2	1.0	9175.0	4.0	-3.7	340.0	0.8	7237.8
143	Emend	1.4	-1.0	6.4	920	3.0	14.9	709.8	26.6	-1.6	swamp	lagg	shrub	8.0	0.4	-0.3	0.3	-0.5	4.1	0.0	9157.0	4.0	-5.0	340.0	0.8	7223.6
144	Emend	12.4	0.8	7.1	360	2.6	22.7	260.0	16.1	-1.7	marsh	linked basin	shrub	1.0	0.3	-0.5	0.2	-0.8	4.2	1.0	9123.0	4.0	-3.7	340.0	0.8	7196.8
145	Emend	4.5	-0.3	6.7	500	2.7	9.6	160.0	12.6	-1.6	upland	upland	swd	16.0	0.2	-0.8	0.2	-0.8	4.2	0.0	6531.0	3.8	-3.6	340.0	0.8	5152.1
146	Emend	2.6	-0.6	6.5	230	2.4	11.2	210.0	14.5	-1.6	swamp	drainageway	shrub	4.0	0.1	-0.9	0.1	-0.9	4.1	0.0	7905.0	3.9	-5.0	340.0	0.8	6236.0
147	Emend	2.1	-0.8	6.3	190	2.3	13.6	410.0	20.2	-1.6	fen	horizontal	shrub	1.5	0.3	-0.5	0.3	-0.5	4.1	0.0	8853.0	3.9	-5.0	340.0	0.8	6983.8
148	Emend	5.7	-0.2	6.2	280	2.4	9.3	230.0	15.2	-1.6	fen	horizontal	none	0.0	0.1	-1.0	0.1	-1.0	4.1	0.0	9435.0	4.0	-5.0	340.0	0.8	7442.9
149	Emend	8.7	0.2	6.9	3000	3.5	8.6	50.0	7.1	-1.6	upland	upland	swd	14.0	0.3	-0.5	0.1	-1.0	4.1	0.0	9584.0	4.0	-3.6	340.0	0.8	7560.5
150	Emend	7.9	0.1	7.1	1390	3.1	5.1	50.0	7.1	-1.6	upland	upland	shrub	13.0	0.1	-0.8	0.1	-0.8	4.1	0.0	8614.0	3.9	-3.6	340.0	0.8	6795.3
151	Emend	1.9	-0.8	6.7	600	2.8	11.5	160.0	12.6	-1.6	fen	horizontal	shrub	10.0	0.2	-0.7	0.2	-0.7	4.1	0.0	9117.0	4.0	-5.0	340.0	0.8	7192.1
152	Emend	3.7	-0.5	6.9	330	2.5	12.4	260.0	16.1	-1.6	fen	horizontal	shrub	5.0	0.5	-0.3	0.2	-0.6	4.1	0.0	8725.0	3.9	-5.0	340.0	0.8	6882.8
153	Emend	2.6	-0.7	6.7	210	2.3	12.4	140.0	11.8	-1.5	fen	horizontal	none	7.0	0.4	-0.4	0.4	-0.4	4.1	0.0	8790.0	3.9	-5.0	340.0	0.8	6934.1
154	Emend	0.8	-1.3	6.6	240	2.4	11.4	160.0	12.6	-1.6	fen	horizontal	shrub	5.0	0.4	-0.4	0.4	-0.4	4.1	0.0	8822.0	3.9	-5.0	340.0	0.8	6959.4
155	Emend	4.7	-0.3	6.5	250	2.4	8.6	130.0	11.4	-1.6	upland	upland	none	14.0	0.1	-1.1	0.1	-1.1	4.1	0.0	6472.0	3.8	-3.6	340.0	0.8	5105.5
156	Emend	6.0	-0.1	6.7	280	2.4	6.8	120.0	11.0	-1.6	upland	upland	swd	15.0	0.1	-0.9	0.1	-0.9	4.1	0.0	5629.0	3.8	-3.6	340.0	0.8	4440.5
157	Emend	1.9	-0.8	6.6	250	2.4	11.5	210.0	14.5	-1.6	fen	horizontal	shrub	5.5	0.2	-0.8	0.2	-0.8	4.1	0.0	7608.0	3.9	-5.0	340.0	0.8	6001.7
158	Emend	8.4	0.2	7.0	1960	3.3	5.9	60.0	7.7	-1.6	upland	upland	swd	27.5	0.5	-0.3	0.5	-0.3	3.8	0.0	6318.0	3.8	-3.6	340.0	0.8	4984.0
159	Emend	8.5	0.2	6.7	1220	3.1	6.2	50.0	7.1	-1.6	upland	upland	swd	12.5	0.1	-0.9	0.1	-0.9	3.8	1.0	8098.0	3.9	-3.6	340.0	0.8	6388.2
160	Emend	4.9	-0.3	6.9	210	2.3	11.2	80.0	8.9	-1.6	swamp	drainageway	none	6.5	0.4	-0.4	0.4	-0.4	3.8	0.0	8027.0	3.9	-5.0	340.0	0.8	6332.2
161	Emend	3.7	-0.5	6.9	210	2.3	12.1	150.0	12.2	-1.5	swamp	drainageway	none	7.5	0.7	-0.2	0.7	-0.2	3.8	0.0	8743.0	3.9	-5.0	340.0	0.8	6897.0
162	Emend	3.6	-0.5	6.6	220	2.3	11.8	200.0	14.1	-1.7	swamp	drainageway	none	9.0	0.1	-1.0	0.1	-1.0	3.7	0.0	8950.0	4.0	-5.0	340.0	0.8	7060.3
163	Emend	8.4	0.2	7.0	1180	3.1	5.8	160.0	12.6	-1.7	upland	upland	swd	11.0	0.2	-0.7	0.2	-0.8	3.6	0.0	9420.0	4.0	-3.6	340.0	0.8	7431.1
164	Emend	9.1	0.2	7.5	3200	3.5	6.4	60.0	7.7	-1.7	upland	upland	swd	14.5	0.4	-0.4	0.2	-0.7	3.4	0.0	9195.0	4.0	-3.6	340.0	0.8	7253.6
165	Emend	7.6	0.1	7.1	3200	3.5	6.5	130.0	11.4	-1.7	upland	upland	swd	12.0	0.4	-0.4	0.1	-0.9	3.4	0.0	9576.0	4.0	-3.6	340.0	0.8	7554.2
166	Emend	4.9	-0.3	6.9	630	2.8	4.9	210.0	14.5	-1.7	swamp	lagg	none	8.0	0.4	-0.5	0.1	-1.0	3.6	0.0	9158.0	4.0	-5.0	340.0	0.8	7224.4
167	Emend	2.0	-0.8	6.9	210	2.3	12.3	170.0	13.0	-1.6	swamp	drainageway	none	11.5	0.2	-0.7	0.2	-0.7	3.7	0.0	9726.0	4.0	-5.0	340.0	0.8	7672.5
168	Emend	1.1	-1.1	6.5	210	2.3	11.6	100.0	10.0	-1.6	swamp	drainageway	shrub	7.0	0.3	-0.5	0.3	-0.5	3.8	0.0	9208.0	4.0	-5.0	340.0	0.8	7263.9
169	Emend	1.0	-1.1	6.5	220	2.3	11.4	190.0	13.8	-1.6	swamp	drainageway	none	11.0	0.3	-0.6	0.3	-0.6	3.8	0.0	9388.0	4.0	-5.0	340.0	0.8	7405.8
170	Emend	6.5	-0.1	6.4	460	2.7	6.8	180.0	13.4	-1.6	upland	upland	none	14.0	0.1	-0.9	0.1	-0.9	3.8	0.0	7059.0	3.8	-3.6	340.0	0.8	5568.6
171	Emend	5.5	-0.2	5.1	370	2.6	8.8	450.0	21.2	-1.8	upland	upland	swd	13.0	1.6	0.2	1.2	0.1	2.1	0.0	8551.0	3.9	-3.6	340.0	0.8	6745.6
172	Emend	4.7	-0.3	5.3	360	2.6	10.3	320.0	17.9	-1.8	bog	basin	swd	11.0	1.6	0.2	1.3	0.1	2.0	0.0	8516.0	3.9	-3.7	340.0	0.8	6718.0
173	Emend	5.0	-0.3	4.4	80	1.9	6.4	637.0	25.2	-1.7	bog	domed	swd	5.0	1.7	0.2	1.6	0.2	2.0	0.0	8911.0	3.9	-1.6	340.0	0.8	7029.6
174	Emend	6.1	-0.1	3.8	260	2.4	4.2	280.0	16.7	-1.6	bog	domed	swd	3.0	1.3	0.1	1.3	0.1	2.5	0.0	8984.0	4.0	-1.6	340.0	0.8	7087.1
175	Emend	4.9	-0.3	3.6	120	2.1	5.2	673.4	25.9	-1.6	bog	domed	swd	3.0	1.1	0.0	1.1	0.0	3.7	0.0	8986.0	4.0	-1.6	340.0	0.8	7088.7
176	Emend	4.6	-0.3	5.2	250	2.4	6.2	240.0	15.5	-1.6	fen	horizontal	none	5.0	0.3	-0.5	0.3	-0.5	3.8	0.0	9231.0	4.0	-5.0	340.0	0.8	7282.0
177	Emend	4.2	-0.4	5.6	160	2.2	11.4	410.0	20.2	-1.6	fen	horizontal	shrub	3.0	0.1	-0.8	0.1	-0.8	3.8	0.0	9218.0	4.0	-5.0	340.0	0.8	7271.7
178	Emend	1.9	-0.8	6.0	180	2.3	12.2	250.0	15.8	-1.4	fen	horizontal	shrub	5.0	0.7	-0.1	0.2	-0.7	3.7	0.0	9010.0	4.0	-5.0	340.0	0.8	7107.7
179	Emend	5.1	-0.3	6.2	1010	3.0	5.2	220.0	14.8	-1.4	upland	upland	shrub	9.0	0.8	-0.1	0.4	-0.4	3.7	0.0	9709.0	4.0	-3.6	340.0	0.8	7659.1
180	Emend	6.6	-0.1	6.7	2200	3.3	6.7	50.0	7.1	-1.4	upland	upland	swd	12.0	1.1	0.0	0.7	-0.1	3.7	0.0	8828.0	3.9	-3.6	340.0	0.8	6964.1

Plot	Site Name	DO	calc DO	pH	EC	log (ec)	Temp	Color	Sqrt (col)	log Slope	Class	Form	Type	Tree Ht	DTW (4ha)	DTW (log4ha)	DTW (1ha)	DTW (log1ha)	log fa 150m	Open Water	PRR	log (PRR)	log (HC)	evapo tran	ET/Ppt ratio	ratio x PRR
181	Emend	3.9	-0.4	5.9	340	2.5	6.6	220.0	14.8	-1.6	upland	upland	none	14.0	1.2	0.1	0.1	-0.9	3.1	0.0	8275.0	3.9	-3.6	340.0	0.8	6527.8
182	Emend	5.7	-0.2	6.0	320	2.5	6.5	270.0	16.4	-1.6	upland	upland	swd	14.0	1.1	0.0	0.2	-0.8	3.1	0.0	6497.0	3.8	-3.6	340.0	0.8	5125.2
183	Emend	9.9	0.4	7.1	530	2.7	7.3	50.0	7.1	-1.5	upland	upland	hwd	21.0	1.8	0.2	0.8	-0.1	3.0	0.0	8549.0	3.9	-3.6	340.0	0.8	6744.0
184	Emend	9.9	0.3	7.2	100	2.0	6.8	400.0	20.0	-1.5	upland	upland	none	20.0	2.2	0.3	0.7	-0.2	3.0	0.0	9337.0	4.0	-3.6	340.0	0.8	7365.6
185	Emend	9.3	0.3	7.2	1680	3.2	6.0	70.0	8.4	-1.5	upland	upland	swd	15.0	2.1	0.3	0.5	-0.3	3.0	0.0	8235.0	3.9	-3.6	340.0	0.8	6496.3
186	Emend	8.1	0.1	6.9	120	2.1	6.0	150.0	12.2	-1.5	upland	upland	swd	16.0	1.8	0.3	0.4	-0.4	3.1	0.0	7366.0	3.9	-3.6	340.0	0.8	5810.8
187	Emend	9.2	0.2	6.4	250	2.4	7.1	300.0	17.3	-1.7	upland	upland	none	15.0	1.3	0.1	0.6	-0.2	3.1	0.0	7667.0	3.9	-3.6	340.0	0.8	6048.2
188	Emend	8.9	0.2	6.9	630	2.8	7.0	110.0	10.5	-1.6	upland	upland	swd	15.0	0.5	-0.3	0.5	-0.3	3.2	0.0	9105.0	4.0	-3.6	340.0	0.8	7182.6
189	Emend	3.7	-0.5	6.7	500	2.7	6.3	150.0	12.2	-1.6	upland	upland	swd	17.0	0.4	-0.4	0.4	-0.4	3.1	0.0	10222.0	4.0	-3.6	340.0	0.8	8063.8
190	Emend	9.1	0.2	7.0	2600	3.4	7.6	100.0	10.0	-1.6	upland	upland	swd	15.0	0.6	-0.2	0.5	-0.3	3.1	0.0	9968.0	4.0	-3.6	340.0	0.8	7863.4
191	Emend	9.3	0.3	7.5	1150	3.1	7.2	140.0	11.8	-1.5	upland	upland	swd	15.0	0.7	-0.2	0.6	-0.2	3.1	0.0	10165.0	4.0	-3.6	340.0	0.8	8018.8
192	Emend	4.5	-0.3	6.7	270	2.4	7.0	340.0	18.4	-1.6	upland	upland	swd	16.0	0.6	-0.2	0.3	-0.5	3.1	0.0	9168.0	4.0	-3.6	340.0	0.8	7232.3
193	Emend	4.8	-0.3	6.7	180	2.3	6.7	300.0	17.3	-1.7	upland	upland	swd	12.5	0.7	-0.2	0.1	-1.0	3.6	0.0	8949.0	4.0	-3.6	340.0	0.8	7059.5
194	Emend	5.7	-0.2	6.3	320	2.5	6.5	390.0	19.7	-1.7	upland	upland	none	11.5	0.3	-0.5	0.3	-0.5	3.5	0.0	7259.0	3.9	-3.6	340.0	0.8	5726.4
195	Emend	6.9	0.0	6.1	200	2.3	7.1	300.0	17.3	-1.7	upland	upland	none	19.0	0.5	-0.3	0.4	-0.5	3.5	0.0	8858.0	3.9	-3.6	340.0	0.8	6987.7
196	Emend	7.3	0.0	6.5	540	2.7	6.8	140.0	11.8	-1.6	upland	upland	swd	15.5	0.8	-0.1	0.8	-0.1	3.3	0.0	8321.0	3.9	-3.6	340.0	0.8	6564.1
197	Emend	7.1	0.0	6.3	1020	3.0	6.6	120.0	11.0	-1.6	upland	upland	none	12.0	0.4	-0.4	0.4	-0.4	3.5	0.0	9513.0	4.0	-3.6	340.0	0.8	7504.5
198	Emend	5.0	-0.3	6.2	230	2.4	7.4	370.0	19.2	-1.6	upland	upland	none	11.5	0.1	-1.0	0.1	-1.0	3.5	0.0	8444.0	3.9	-3.6	340.0	0.8	6661.2
199	Emend	4.5	-0.3	6.1	250	2.4	7.2	240.0	15.5	-1.6	upland	upland	shrub	18.0	0.3	-0.5	0.3	-0.5	3.5	0.0	9595.0	4.0	-3.6	340.0	0.8	7569.1
200	Emend	8.7	0.2	6.5	120	2.1	8.5	410.0	20.2	-1.6	upland	upland	hwd	20.0	0.7	-0.1	0.7	-0.1	3.6	0.0	8478.0	3.9	-3.6	340.0	0.8	6688.0
201	Emend	9.0	0.2	6.8	30	1.5	7.9	150.0	12.2	-1.5	upland	upland	swd	22.0	1.4	0.2	0.7	-0.2	3.7	0.0	8031.0	3.9	-3.6	340.0	0.8	6335.4
202	Emend	9.4	0.3	7.0	3800	3.6	7.8	60.0	7.7	-1.5	upland	upland	swd	18.0	0.6	-0.2	0.6	-0.2	3.9	0.0	9329.0	4.0	-3.6	340.0	0.8	7359.3
203	Emend	4.0	-0.4	5.6	210	2.3	7.7	230.0	15.2	-1.6	upland	upland	none	17.0	0.8	-0.1	0.8	-0.1	3.0	0.0	8805.0	3.9	-3.6	340.0	0.8	6945.9
204	Emend	6.1	-0.1	6.1	320	2.5	6.8	280.0	16.7	-1.6	swamp	drainageway	swd	9.0	0.1	-1.0	0.1	-1.0	3.3	0.0	8720.0	3.9	-5.0	340.0	0.8	6878.9
205	Emend	5.6	-0.2	6.3	270	2.4	7.3	240.0	15.5	-1.6	swamp	drainageway	none	11.0	0.2	-0.7	0.2	-0.7	3.9	0.0	8431.0	3.9	-5.0	340.0	0.8	6650.9
206	Emend	9.3	0.3	6.7	360	2.6	7.0	120.0	11.0	-1.5	upland	upland	swd	10.0	1.0	0.0	0.9	0.0	3.8	0.0	8954.0	4.0	-3.6	340.0	0.8	7063.5
207	Emend	3.7	-0.5	6.3	170	2.2	9.5	230.0	15.2	-1.7	upland	upland	none	19.0	1.5	0.2	1.4	0.2	3.0	0.0	9249.0	4.0	-3.6	340.0	0.8	7296.2
208	Emend	8.8	0.2	7.0	1460	3.2	7.8	60.0	7.7	-1.7	upland	upland	swd	19.0	1.5	0.2	1.3	0.1	3.3	0.0	9637.0	4.0	-3.6	340.0	0.8	7602.3
209	Emend	6.6	-0.1	6.9	800	2.9	9.1	60.0	7.7	-1.7	upland	upland	none	20.0	0.9	0.0	0.7	-0.1	3.6	0.0	8852.0	3.9	-3.6	340.0	0.8	6983.0
210	Emend	4.8	-0.3	6.2	240	2.4	9.6	110.0	10.5	-1.7	upland	upland	swd	19.5	0.5	-0.3	0.2	-0.7	3.8	0.0	8498.0	3.9	-3.6	340.0	0.8	6703.8
211	Emend	5.8	-0.2	6.5	230	2.4	6.7	470.0	21.7	-1.6	upland	upland	swd	19.5	0.7	-0.2	0.2	-0.8	3.7	0.0	9612.0	4.0	-3.6	340.0	0.8	7582.6
212	Emend	5.7	-0.2	5.8	860	2.9	7.7	140.0	11.8	-1.6	upland	upland	swd	23.0	0.3	-0.5	0.3	-0.6	3.8	0.0	8773.0	3.9	-3.6	340.0	0.8	6920.7
213	Emend	7.9	0.1	5.1	1550	3.2	8.3	180.0	13.4	-1.7	upland	upland	swd	18.0	0.5	-0.3	0.4	-0.5	3.8	0.0	8744.0	3.9	-3.6	340.0	0.8	6897.8
214	Emend	8.5	0.2	7.0	5000	3.7	6.2	130.0	11.4	-1.6	upland	upland	swd	29.0	0.5	-0.3	0.5	-0.3	3.8	0.0	6665.0	3.8	-3.6	340.0	0.8	5257.8
215	Emend	8.8	0.2	6.6	680	2.8	6.9	410.0	20.2	-1.7	upland	upland	swd	21.0	0.6	-0.2	0.6	-0.2	3.8	0.0	7323.0	3.9	-3.6	340.0	0.8	5776.8
216	Emend	6.9	0.0	7.0	980	3.0	6.4	160.0	12.6	-1.7	upland	upland	swd	18.5	0.5	-0.3	0.5	-0.3	3.8	0.0	6653.0	3.8	-3.6	340.0	0.8	5248.3
217	Emend	6.1	-0.1	6.5	210	2.3	9.2	837.2	28.9	-1.6	upland	upland	swd	19.0	0.3	-0.5	0.3	-0.5	4.1	0.0	9234.0	4.0	-3.6	340.0	0.8	7284.4
218	Emend	8.6	0.2	7.5	3000	3.5	6.4	30.0	5.5	-1.6	upland	upland	none	16.0	1.2	0.1	0.7	-0.1	3.5	0.0	8423.0	3.9	-3.6	340.0	0.8	6644.6
219	Emend	9.2	0.3	7.2	1100	3.0	4.6	120.0	11.0	-1.6	upland	upland	swd	12.0	1.0	0.0	0.5	-0.3	3.8	0.0	6677.0	3.8	-3.6	340.0	0.8	5267.2
220	Emend	3.2	-0.5	6.7	330	2.5	4.5	340.0	18.4	-1.6	fen	horizontal	shrub	6.0	0.9	0.0	0.4	-0.4	4.0	0.0	8553.0	3.9	-5.0	340.0	0.8	6747.1
221	Emend	4.3	-0.4	5.8	80	1.9	6.7	851.2	29.2	-1.7	fen	horizontal	shrub	1.5	0.7	-0.1	0.2	-0.7	4.2	0.0	9358.0	4.0	-5.0	340.0	0.8	7382.2
222	Emend	6.7	-0.1	4.6	100	2.0	3.9	891.8	29.9	-1.7	bog	domed	swd	5.5	0.6	-0.2	0.4	-0.5	4.2	0.0	9355.0	4.0	-1.6	340.0	0.8	7379.8
223	Emend	3.5	-0.5	4.0	110	2.0	5.2	881.6	29.7	-1.7	bog	domed	swd	6.0	0.6	-0.2	0.4	-0.4	4.2	0.0	9131.0	4.0	-1.6	340.0	0.8	7203.1
224	Emend	2.8	-0.6	3.7	90	2.0	9.7	764.4	27.6	-1.7	bog	basin	swd	2.0	0.2	-0.7	0.2	-0.7	4.2	0.0	9083.0	4.0	-3.7	340.0	0.8	7165.2
225	Emend	2.6	-0.7	4.3	60	1.8	10.8	691.6	26.3	-1.8	bog	basin	shrub	1.0	0.2	-0.7	0.2	-0.7	4.2	0.0	9203.0	4.0	-3.7	340.0	0.8	7259.9

Plot	Site Name	DO	calc DO	pH	EC	log (ec)	Temp	Color	Sqrt (col)	log Slope	Class	Form	Type	Tree Ht	DTW (4ha)	DTW (log4ha)	DTW (1ha)	DTW (log1ha)	log fa 150m	Open Water	PRR	log (PRR)	log (HC)	evapo tran	ET/Ppt ratio	ratio x PRR
226	Emend	2.0	-0.8	5.1	280	2.4	13.8	400.0	20.0	-1.8	marsh	linked basin	swd	0.5	0.1	-1.2	0.1	-1.2	4.2	0.0	9205.0	4.0	-3.7	340.0	0.8	7261.5
227	Emend	2.9	-0.6	5.6	70	1.8	14.0	618.8	24.9	-1.9	marsh	linked basin	shrub	0.5	0.1	-1.2	0.1	-1.2	4.2	0.0	9176.0	4.0	-3.7	340.0	0.8	7238.6
228	Emend	2.2	-0.7	4.0	60	1.8	11.6	546.0	23.4	-1.9	bog	basin	shrub	1.0	0.2	-0.7	0.2	-0.7	4.2	0.0	9178.0	4.0	-3.7	340.0	0.8	7240.2
229	Emend	3.1	-0.6	4.3	60	1.8	6.3	837.2	28.9	-1.8	bog	basin	swd	2.0	0.5	-0.3	0.2	-0.6	4.2	0.0	9306.0	4.0	-3.7	340.0	0.8	7341.2
230	Emend	2.9	-0.6	5.8	90	2.0	10.8	600.6	24.5	-1.7	fen	horizontal	shrub	1.5	0.5	-0.3	0.1	-0.9	4.1	0.0	9072.0	4.0	-5.0	340.0	0.8	7156.6
231	Emend	7.1	0.0	6.6	670	2.8	2.9	120.0	11.0	-1.6	upland	upland	swd	8.0	0.7	-0.2	0.4	-0.4	3.9	0.0	8984.0	4.0	-3.6	340.0	0.8	7087.1
232	Emend	5.7	-0.2	7.0	2600	3.4	4.5	50.0	7.1	-1.6	upland	upland	swd	16.0	0.9	-0.1	0.5	-0.3	3.7	0.0	8683.0	3.9	-3.6	340.0	0.8	6849.7
233	Emend	6.7	-0.1	4.0	88	1.9	2.9			-1.4	bog	domed	swd	3.0	1.5	0.2	1.5	0.2	2.3	0.0	9057.0	4.0	-1.6	340.0	0.8	7144.7
234	Emend	6.2	-0.1	4.3	51	1.7	2.0			-1.6	bog	basin	swd	7.0	1.9	0.3	1.9	0.3	2.3	0.0	8211.0	3.9	-3.7	340.0	0.8	6477.4
235	Emend	7.2	0.0	4.0	71	1.8	1.3			-1.3	bog	domed	swd	3.5	2.0	0.3	2.0	0.3	2.1	0.0	8717.0	3.9	-1.6	340.0	0.8	6876.5
236	Emend	4.0	-0.4	3.9	80	1.9	1.7			-1.4	bog	domed	swd	4.0	1.3	0.1	1.3	0.1	2.2	0.0	9174.0	4.0	-1.6	340.0	0.8	7237.0
237	Emend	4.7	-0.6	3.9	76	1.9	3.0			-1.5	bog	basin	swd	3.0	1.4	0.1	1.4	0.1	2.1	0.0	9126.0	4.0	-3.7	340.0	0.8	7199.2
238	Emend	4.9	0.1	5.0	24	1.4	3.0			-1.5	upland	upland	hwd	23.3	1.6	0.2	1.6	0.2	2.2	0.0	9906.0	4.0	-3.6	340.0	0.8	7814.5
239	Emend	6.8	0.0	3.8	97	2.0	2.2			-1.7	bog	basin	swd	7.0	0.4	-0.4	0.4	-0.4	2.5	0.0	8963.0	4.0	-3.7	340.0	0.8	7070.6
240	Emend	7.6	0.1	3.9	61	1.8	1.7			-1.7	bog	basin	swd	5.0	0.2	-0.6	0.2	-0.6	2.5	0.0	8828.0	3.9	-3.7	340.0	0.8	6964.1
241	Emend	3.4	-0.5	5.0	44	1.6	1.7			-1.6	fen	horizontal	swd	6.0	0.2	-0.8	0.2	-0.8	2.6	0.0	9007.0	4.0	-5.0	340.0	0.8	7105.3
242	Emend	2.3	-0.7	5.2	66	1.8	2.6			-1.5	fen	horizontal	swd	8.5	0.3	-0.5	0.3	-0.5	2.6	0.0	9380.0	4.0	-5.0	340.0	0.8	7399.5
243	Emend	4.3	-0.4	3.8	90	2.0	3.6			-1.4	bog	domed	swd	3.5	1.2	0.1	1.2	0.1	2.3	0.0	8872.0	3.9	-1.6	340.0	0.8	6998.8
244	Emend	2.0	-0.8	6.0	94	2.0	1.4			-1.5	fen	horizontal	swd	13.0	0.2	-0.7	0.2	-0.7	3.0	0.0	9338.0	4.0	-5.0	340.0	0.8	7366.4
245	Emend	6.6	-0.1	3.8	77	1.9	1.7			-1.5	bog	basin	swd	6.3	1.8	0.2	1.8	0.2	3.1	0.0	8496.0	3.9	-3.7	340.0	0.8	6702.2
246	Emend	6.5	-0.1	4.6	36	1.6	0.5			-1.5	bog	basin	swd	7.0	0.4	-0.4	0.4	-0.4	3.2	0.0	9572.0	4.0	-3.7	340.0	0.8	7551.0
247	Emend	4.2	-0.4	4.3	42	1.6	2.0			-1.6	fen	horizontal	swd	5.0	0.1	-1.0	0.1	-1.0	3.2	0.0	9073.0	4.0	-5.0	340.0	0.8	7157.4
248	Emend	4.5	-0.3	3.9	61	1.8	2.4			-1.5	bog	basin	swd	1.5	0.9	-0.1	0.9	-0.1	1.9	0.0	8903.0	3.9	-3.7	340.0	0.8	7023.2
249	Emend	5.3	-0.2	3.8	74	1.9	4.2			-1.4	bog	domed	swd	2.5	1.3	0.1	1.3	0.1	2.3	0.0	8947.0	4.0	-1.6	340.0	0.8	7058.0
250	Emend	7.0	0.0	3.8	67	1.8	2.9			-1.4	bog	domed	swd	4.0	1.0	0.0	1.0	0.0	2.6	0.0	9313.0	4.0	-1.6	340.0	0.8	7346.7
251	Emend	4.8	-0.3	3.8	58	1.8	3.2			-1.7	bog	basin	swd	5.0	0.3	-0.5	0.3	-0.5	3.5	0.0	9179.0	4.0	-3.7	340.0	0.8	7241.0
252	Emend	2.2	-0.7	6.0	52	1.7	3.3			-1.7	fen	horizontal	swd	5.5	0.2	-0.7	0.2	-0.7	3.6	0.0	9284.0	4.0	-5.0	340.0	0.8	7323.8
253	Emend	3.0	-0.6	6.2	74	1.9	3.4			-1.7	fen	horizontal	swd	1.5	0.1	-1.0	0.1	-1.0	3.6	0.0	9489.0	4.0	-5.0	340.0	0.8	7485.5
254	Emend	1.5	-0.9	6.2	106	2.0	6.2			-1.4	fen	horizontal	shrub	5.0	0.4	-0.4	0.4	-0.4	3.6	0.0	9225.0	4.0	-5.0	340.0	0.8	7277.3
255	Emend	1.5	-0.9	6.2	113	2.1	2.5			-1.4	fen	horizontal	hwd	6.0	0.6	-0.2	0.6	-0.2	2.6	0.0	9895.0	4.0	-5.0	340.0	0.8	7805.8
256	Emend	4.0	-0.4	6.0	135	2.1	0.8			-1.4	upland	upland	hwd	6.0	0.7	-0.1	0.7	-0.1	2.6	0.0	9906.0	4.0	-3.6	340.0	0.8	7814.5
257	Emend	4.5	-0.3	6.0	85	1.9	3.0			-1.4	upland	upland	hwd	9.5	0.3	-0.5	0.3	-0.5	2.6	0.0	10009.0	4.0	-3.6	340.0	0.8	7895.7
258	Emend	8.4	0.2	4.6	30	1.5	1.4			-1.5	fen	horizontal	swd	8.0	1.2	0.1	1.2	0.1	2.2	0.0	7777.0	3.9	-5.0	340.0	0.8	6135.0
259	Emend	8.7	0.2	5.2	28	1.4	1.2			-1.5	fen	horizontal	swd	9.0	1.3	0.1	1.3	0.1	2.2	0.0	8289.0	3.9	-5.0	340.0	0.8	6538.9
260	Emend	8.7	0.2	5.2	28	1.4	1.2			-1.5	bog	basin	swd	8.0	1.3	0.1	1.3	0.1	2.2	0.0	8371.0	3.9	-3.7	340.0	0.8	6603.6
261	Emend	7.7	0.1	6.4	358	2.6	2.1			-1.4	fen	horizontal	swd	17.3	0.5	-0.3	0.5	-0.3	2.4	0.0	10099.0	4.0	-5.0	340.0	0.8	7966.7
262	Emend	6.5	-0.1	3.9	46	1.7	2.1			-1.4	bog	domed	swd	4.0	1.1	0.0	1.1	0.0	2.3	0.0	9155.0	4.0	-1.6	340.0	0.8	7222.0
263	Emend	9.9	0.4	3.8	70	1.8	2.0			-1.5	bog	domed	swd	8.0	1.6	0.2	1.6	0.2	3.1	0.0	8415.0	3.9	-1.6	340.0	0.8	6638.3
264	Emend	5.5	-0.2	3.8	68	1.8	1.7			-1.6	bog	basin	swd	5.0	1.7	0.2	1.7	0.2	3.0	0.0	9091.0	4.0	-3.7	340.0	0.8	7171.6
265	Emend	3.6	-0.5	5.8	191	2.3	0.6			-1.5	upland	upland	swd	9.8	0.2	-0.8	0.2	-0.8	2.7	0.0	10212.0	4.0	-3.6	340.0	0.8	8055.9
266	Emend	3.0	-0.6	6.0	240	2.4	4.5			-1.4	fen	horizontal	shrub	8.0	0.6	-0.2	0.6	-0.2	3.6	0.0	9239.0	4.0	-5.0	340.0	0.8	7288.3
267	Emend	4.9	-0.3	6.0	139	2.1	4.3			-1.4	fen	horizontal	shrub	5.0	0.5	-0.3	0.5	-0.3	3.6	0.0	9024.0	4.0	-5.0	340.0	0.8	7118.7
268	Emend	4.0	-0.4	6.0	192	2.3	3.9			-1.4	fen	horizontal	shrub	5.0	0.5	-0.3	0.5	-0.3	3.6	0.0	8955.0	4.0	-5.0	340.0	0.8	7064.3
269	Emend	3.2	-0.5	6.6	451	2.7	0.8			-1.6	upland	upland	swd	18.8	0.3	-0.5	0.3	-0.5	2.8	0.0	8832.0	3.9	-3.6	340.0	0.8	6967.2
270	Emend	6.2	-0.1	4.6	95	2.0	2.8			-1.6	fen	horizontal	shrub	1.5	0.3	-0.5	0.3	-0.5	2.8	0.0	8335.0	3.9	-5.0	340.0	0.8	6575.2

Plot	Site Name	DO	calc DO	pH	EC	log (ec)	Temp	Color	Sqrt (col)	log Slope	Class	Form	Type	Tree Ht	DTW (4ha)	DTW (log4ha)	DTW (1ha)	DTW (log1ha)	log fa 150m	Open Water	PRR	log (PRR)	log (HC)	evapo tran	ET/Ppt ratio	ratio x PRR
271	Emend	4.4	-0.4	5.5	86	1.9	4.0			-1.6	fen	horizontal	shrub	18.0	0.1	-0.9	0.1	-0.9	2.8	0.0	8213.0	3.9	-5.0	340.0	0.8	6478.9
272	Emend	3.8	-0.4	5.7	77	1.9	3.6			-1.6	fen	horizontal	shrub	17.5	0.2	-0.8	0.2	-0.8	2.8	0.0	7745.0	3.9	-5.0	340.0	0.8	6109.7
273	Emend	3.4	-0.5	4.4	117	2.1	1.8			-1.6	fen	horizontal	shrub	14.0	0.1	-1.1	0.1	-1.1	2.8	0.0	7758.0	3.9	-5.0	340.0	0.8	6120.0
274	Emend	3.5	-0.5	5.3	103	2.0	4.2			-1.6	fen	horizontal	shrub	8.3	0.2	-0.7	0.2	-0.7	2.8	0.0	9066.0	4.0	-5.0	340.0	0.8	7151.8
275	Emend	7.3	0.0	6.4	697	2.8	1.8			-1.6	upland	upland	swd	13.5	0.6	-0.2	0.6	-0.2	2.8	0.0	7934.0	3.9	-3.6	340.0	0.8	6258.8
276	Emend	4.2	-0.4	6.7	451	2.7	2.0			-1.6	fen	horizontal	swd	4.0	0.4	-0.4	0.4	-0.4	2.8	0.0	9019.0	4.0	-5.0	340.0	0.8	7114.8
277	Emend	3.7	-0.5	5.6	281	2.4	1.7			-1.6	fen	horizontal	shrub	12.8	0.1	-1.0	0.1	-1.0	2.8	0.0	8669.0	3.9	-5.0	340.0	0.8	6838.7
278	Emend	7.1	0.0	3.8	67	1.8	3.3			-1.5	bog	domed	swd	7.0	1.0	0.0	1.0	0.0	2.7	0.0	8105.0	3.9	-1.6	340.0	0.8	6393.7
279	Emend	10.6	0.5	3.7	81	1.9	1.4			-1.5	upland	upland	swd	7.0	0.8	-0.1	0.8	-0.1	2.7	0.0	8557.0	3.9	-3.6	340.0	0.8	6750.3
280	Emend	8.8	0.2	4.0	88	1.9	1.6			-1.5	bog	domed	swd	6.0	0.9	0.0	0.9	0.0	2.7	0.0	9146.0	4.0	-1.6	340.0	0.8	7214.9
281	Emend	8.2	0.1	3.7	85	1.9	1.3			-1.5	bog	domed	swd	6.0	0.8	-0.1	0.8	-0.1	2.7	0.0	8972.0	4.0	-1.6	340.0	0.8	7077.7
282	Emend	6.0	-0.1	4.1	73	1.9	3.0			-1.6	upland	upland	swd	10.3	1.2	0.1	1.2	0.1	2.4	0.0	8084.0	3.9	-3.6	340.0	0.8	6377.2
283	Emend	6.2	-0.1	3.8	75	1.9	1.7			-1.5	upland	upland	swd	11.3	1.5	0.2	1.5	0.2	2.3	0.0	9989.0	4.0	-3.6	340.0	0.8	7880.0
284	Emend	6.2	-0.1	3.9	50	1.7	1.1			-1.5	bog	domed	swd	4.0	1.9	0.3	1.9	0.3	2.4	0.0	8531.0	3.9	-1.6	340.0	0.8	6729.8
285	Emend	7.3	0.0	4.9	54	1.7	2.2			-1.6	upland	upland	swd	11.5	1.3	0.1	1.3	0.1	2.3	0.0	6796.0	3.8	-3.6	340.0	0.8	5361.1
286	Emend	9.8	0.3	4.3	56	1.7	1.1			-1.5	bog	domed	swd	11.5	1.3	0.1	1.3	0.1	2.4	0.0	6683.0	3.8	-1.6	340.0	0.8	5272.0
287	Emend	11.3	0.6	3.9	58	1.8	2.0			-1.5	bog	domed	swd	4.0	1.9	0.3	1.9	0.3	2.4	0.0	7910.0	3.9	-1.6	340.0	0.8	6239.9
288	Emend	5.2	-0.2	3.9	69	1.8	1.3			-1.5	bog	domed	swd	8.0	1.8	0.3	1.8	0.3	2.4	0.0	9642.0	4.0	-1.6	340.0	0.8	7606.2
289	Emend	5.9	-0.2	4.4	66	1.8	1.6			-1.5	bog	domed	swd	14.0	1.8	0.2	1.8	0.2	2.4	0.0	9433.0	4.0	-1.6	340.0	0.8	7441.3
290	Emend	4.4	-0.3	5.2	81	1.9	2.0			-1.5	upland	upland	swd	23.5	1.3	0.1	1.3	0.1	2.5	0.0	9729.0	4.0	-3.6	340.0	0.8	7674.8
291	Emend	1.0	-1.1	5.9	169	2.2	6.9			-1.5	fen	horizontal	swd	5.0	0.1	-0.8	0.1	-0.8	3.6	0.0	9044.0	4.0	-5.0	340.0	0.8	7134.5
292	Emend	2.9	-0.6	6.0	170	2.2	8.5			-1.6	fen	horizontal	swd	5.0	0.1	-1.0	0.1	-1.0	3.6	0.0	9141.0	4.0	-5.0	340.0	0.8	7211.0
293	Emend	3.1	-0.6	5.9	105	2.0	7.2			-1.7	fen	horizontal	swd	1.5	0.0	-1.4	0.0	-1.4	3.6	0.0	9147.0	4.0	-5.0	340.0	0.8	7215.7
294	Emend	1.5	-0.9	6.1	126	2.1	9.2			-1.7	fen	horizontal	swd	3.0	0.1	-1.2	0.1	-1.2	3.6	0.0	9094.0	4.0	-5.0	340.0	0.8	7173.9
295	Emend	5.5	-0.2	4.3	58	1.8	6.3			-1.7	bog	basin	swd	5.0	0.1	-1.0	0.1	-1.0	3.6	0.0	9108.0	4.0	-3.7	340.0	0.8	7185.0
296	Emend	6.2	-0.1	3.6	120	2.1	11.8			-1.7	bog	basin	swd	5.0	0.3	-0.6	0.3	-0.6	3.5	0.0	9174.0	4.0	-3.7	340.0	0.8	7237.0
297	Emend	2.0	-0.8	5.5	116	2.1	8.1			-1.7	fen	horizontal	swd	5.0	0.5	-0.3	0.5	-0.3	3.5	0.0	8901.0	3.9	-5.0	340.0	0.8	7021.7
298	Emend	1.6	-0.9	5.9	105	2.0	6.7			-1.6	fen	horizontal	shrub	5.0	0.4	-0.4	0.4	-0.4	3.4	0.0	8787.0	3.9	-5.0	340.0	0.8	6931.7
299	Emend	0.5	-1.4	5.6	235	2.4	10.0			-1.3	fen	horizontal	shrub	7.0	0.5	-0.3	0.5	-0.3	3.6	0.0	8755.0	3.9	-5.0	340.0	0.8	6906.5
300	Emend	10.5	0.4	4.2	169	2.2	11.2			-1.5	bog	basin	swd	8.0	0.2	-0.6	0.2	-0.6	2.7	0.0	9411.0	4.0	-3.7	340.0	0.8	7424.0
301	Emend	4.9	-0.3	3.7	105	2.0	10.9			-1.6	bog	basin	swd	4.0	0.2	-0.7	0.2	-0.7	2.7	0.0	9177.0	4.0	-3.7	340.0	0.8	7239.4
302	Emend	7.8	0.1	3.8	100	2.0	12.7			-1.5	bog	domed	swd	4.0	0.3	-0.5	0.3	-0.5	2.6	0.0	8802.0	3.9	-1.6	340.0	0.8	6943.6
303	Emend	9.9	0.3	3.6	103	2.0	10.3			-1.5	bog	domed	swd	4.0	0.5	-0.3	0.5	-0.3	2.6	0.0	9547.0	4.0	-1.6	340.0	0.8	7531.3
304	Emend	0.6	-1.3	6.6	390	2.6	6.3			-1.5	fen	horizontal	shrub	9.0	0.2	-0.8	0.2	-0.8	3.0	0.0	9088.0	4.0	-5.0	340.0	0.8	7169.2
305	Emend	3.9	-0.4	5.7	82	1.9	5.6			-1.5	fen	horizontal	shrub	4.0	0.2	-0.8	0.2	-0.8	3.0	0.0	8504.0	3.9	-5.0	340.0	0.8	6708.5
306	Emend	9.8	0.3	3.7	128	2.1	7.3			-1.4	bog	domed	swd	4.5	0.9	-0.1	0.9	-0.1	3.0	0.0	9230.0	4.0	-1.6	340.0	0.8	7281.2
307	Emend	8.7	0.2	3.5	85	1.9	4.4			-1.4	bog	domed	swd	4.0	1.1	0.0	1.1	0.0	3.0	0.0	9297.0	4.0	-1.6	340.0	0.8	7334.1
308	Emend	8.5	0.2	3.4	108	2.0	9.4			-1.4	bog	domed	swd	3.5	1.0	0.0	1.0	0.0	2.9	0.0	9055.0	4.0	-1.6	340.0	0.8	7143.2
309	Emend	5.6	-0.2	5.0	139	2.1	12.2			-1.7	fen	horizontal	shrub	9.0	0.1	-0.9	0.1	-0.9	3.3	0.0	8823.0	3.9	-5.0	340.0	0.8	6960.1
310	Emend	1.7	-0.9	4.6	68	1.8	9.7			-1.7	fen	horizontal	shrub	6.0	0.1	-1.1	0.1	-1.1	3.3	0.0	9190.0	4.0	-5.0	340.0	0.8	7249.7
311	Emend	3.4	-0.5	5.2	83	1.9	7.2			-1.7	fen	horizontal	shrub	4.0	0.2	-0.7	0.2	-0.7	3.4	0.0	8589.0	3.9	-5.0	340.0	0.8	6775.5
312	Emend	3.0	-0.6	5.5	104	2.0	8.7			-1.7	fen	horizontal	swd	8.5	0.2	-0.6	0.2	-0.6	3.4	0.0	8723.0	3.9	-5.0	340.0	0.8	6881.3
313	Emend	0.6	-1.4	6.0	314	2.5	5.4			-1.7	fen	horizontal	shrub	4.0	0.3	-0.6	0.3	-0.6	3.3	0.0	9097.0	4.0	-5.0	340.0	0.8	7176.3
314	Emend	2.3	-0.7	5.4	156	2.2	6.6			-1.6	fen	horizontal	shrub	3.5	0.3	-0.6	0.3	-0.6	3.3	0.0	9175.0	4.0	-5.0	340.0	0.8	7237.8
315	Emend	2.7	-0.6	4.9	110	2.0	10.7			-1.6	fen	horizontal	swd	8.0	0.1	-0.8	0.1	-0.8	3.2	0.0	8725.0	3.9	-5.0	340.0	0.8	6882.8

Plot	Site Name	DO	calc DO	pH	EC	log (ec)	Temp	Color	Sqrt (col)	log Slope	Class	Form	Type	Tree Ht	DTW (4ha)	DTW (log4ha)	DTW (1ha)	DTW (log1ha)	log fa 150m	Open Water	PRR	log (PRR)	log (HC)	evapo tran	ET/Ppt ratio	ratio x PRR
316	Emend	3.9	-0.4	4.2	81	1.9	5.3			-1.5	fen	horizontal	swd	8.0	0.3	-0.6	0.3	-0.6	3.2	0.0	9041.0	4.0	-5.0	340.0	0.8	7132.1
317	Emend	9.5	0.3	3.5	127	2.1	7.6			-1.4	bog	domed	swd	10.5	2.1	0.3	2.1	0.3	2.0	0.0	9147.0	4.0	-1.6	340.0	0.8	7215.7
318	Emend	9.9	0.3	3.4	99	2.0	6.6			-1.3	bog	domed	swd	5.0	2.3	0.4	2.3	0.4	2.1	0.0	8783.0	3.9	-1.6	340.0	0.8	6928.6
319	Emend	9.8	0.3	3.4	108	2.0	8.3			-1.4	bog	domed	swd	4.0	1.5	0.2	1.5	0.2	2.2	0.0	9087.0	4.0	-1.6	340.0	0.8	7168.4
320	Emend	9.5	0.3	3.5	91	2.0	7.7			-1.5	bog	basin	swd	4.0	1.2	0.1	1.2	0.1	2.1	0.0	8784.0	3.9	-3.7	340.0	0.8	6929.4
321	Emend	2.6	-0.7	5.8	241	2.4	6.0			-1.6	bog	basin	swd	4.0	1.0	0.0	1.0	0.0	2.1	0.0	9019.0	4.0	-3.7	340.0	0.8	7114.8
322	Emend	10.5	0.4	5.6	78	1.9	9.2			-1.5	bog	basin	swd	4.0	1.1	0.0	1.1	0.0	2.1	0.0	9025.0	4.0	-3.7	340.0	0.8	7119.5
323	Emend	10.3	0.4	3.6	93	2.0	9.7			-1.5	bog	basin	swd	8.5	1.2	0.1	1.2	0.1	2.2	0.0	8278.0	3.9	-3.7	340.0	0.8	6530.2
324	Emend	6.7	-0.1	3.7	87	1.9	9.6			-1.7	bog	basin	swd	6.0	0.4	-0.4	0.4	-0.4	2.5	0.0	8962.0	4.0	-3.7	340.0	0.8	7069.8
325	Emend	9.4	0.3	3.4	115	2.1	10.3			-1.7	bog	basin	swd	8.0	0.4	-0.4	0.4	-0.4	2.5	0.0	9340.0	4.0	-3.7	340.0	0.8	7368.0
326	Emend	3.1	-0.6	6.0	435	2.6	5.6			-1.7	fen	horizontal	swd	10.0	0.3	-0.5	0.3	-0.5	2.5	0.0	8933.0	4.0	-5.0	340.0	0.8	7046.9
327	Emend	1.1	-1.1	6.0	158	2.2	8.6			-1.5	fen	horizontal	shrub	6.0	0.2	-0.6	0.2	-0.6	2.6	0.0	8927.0	4.0	-5.0	340.0	0.8	7042.2
328	Emend	2.7	-0.6	3.9	87	1.9	7.8			-1.6	fen	horizontal	swd	6.0	0.4	-0.4	0.4	-0.4	2.6	0.0	9212.0	4.0	-5.0	340.0	0.8	7267.0
329	Emend	7.0	0.0	3.5	119	2.1	10.5			-1.6	fen	horizontal	swd	12.0	0.5	-0.3	0.5	-0.3	2.6	0.0	8884.0	3.9	-5.0	340.0	0.8	7008.3
330	Emend	5.9	-0.2	5.8	85	1.9	7.4			-1.7	fen	horizontal	shrub	6.0	0.3	-0.6	0.3	-0.6	3.4	0.0	8630.0	3.9	-5.0	340.0	0.8	6807.9
331	Emend	3.1	-0.6	6.1	192	2.3	6.6			-1.6	fen	horizontal	shrub	6.0	0.1	-0.9	0.1	-0.9	3.4	0.0	8780.0	3.9	-5.0	340.0	0.8	6926.2
332	Emend	4.3	-0.4	5.8	215	2.3	6.3			-1.6	fen	horizontal	shrub	11.0	0.2	-0.7	0.2	-0.7	3.4	0.0	9542.0	4.0	-5.0	340.0	0.8	7527.3
333	Emend	6.4	-0.1	6.0	149	2.2	7.3			-1.5	fen	horizontal	shrub	5.0	0.3	-0.6	0.3	-0.6	3.5	0.0	8656.0	3.9	-5.0	340.0	0.8	6828.4
334	Emend	4.1	-0.4	5.0	80	1.9	6.8			-1.7	fen	horizontal	shrub	6.0	0.1	-0.9	0.1	-0.9	3.3	0.0	8145.0	3.9	-5.0	340.0	0.8	6425.3
335	Emend	2.4	-0.7	5.2	80	1.9	5.7			-1.6	fen	horizontal	shrub	4.0	0.1	-0.8	0.1	-0.8	3.3	0.0	8348.0	3.9	-5.0	340.0	0.8	6585.4
336	UNB	1.7	-0.9	4.5	50	1.7	6.8			-1.5	bog	basin	swd	12.8	0.1	-0.9	0.1	-1.0	2.4	0.0	9262.0	4.0	-3.7	600.0	0.5	4861.9
337	UNB	3.3	-0.5	4.1	40	1.6	13.1			-1.6	bog	basin	swd	2.9	0.1	-1.2	0.0	-1.4	2.2	0.0	10069.0	4.0	-3.7	600.0	0.5	5285.6
338	UNB	2.6	-0.7	4.1	40	1.6	5.2			-1.6	bog	basin	swd	0.9	0.1	-1.1	0.1	-1.3	2.1	0.0	10792.0	4.0	-3.7	600.0	0.5	5665.1
339	UNB	5.5	-0.2	4.1	40	1.6	6.9			-1.6	bog	basin	swd	0.2	0.0	-1.5	0.0	-1.6	2.8	0.0	10818.0	4.0	-3.7	600.0	0.5	5678.7
340	UNB	1.9	-0.8	4.2	40	1.6	10.5			-1.6	bog	basin	none	0.2	0.0	-1.8	0.0	-2.2	3.0	0.0	10813.0	4.0	-3.7	600.0	0.5	5676.1
341	UNB	2.8	-0.6	5.8	90	2.0	15.9			-1.5	marsh	linked basin	none	1.7	0.1	-1.2	0.1	-1.2	3.0	1.0	10758.0	4.0	-3.7	600.0	0.5	5647.2
342	UNB	3.0	-0.6	5.8	70	1.8	15.7			-1.6	marsh	linked basin	none	0.2	0.1	-1.3	0.0	-1.3	3.4	1.0	10800.0	4.0	-3.7	600.0	0.5	5669.3
343	UNB	3.4	-0.5	4.3	30	1.5	6.5			-1.6	bog	basin	swd	0.2	0.0	-1.7	0.0	-1.9	3.2	0.0	10813.0	4.0	-3.7	600.0	0.5	5676.1
344	UNB	4.6	-0.3	4.2	40	1.6	5.8			-1.6	bog	basin	swd	0.4	0.0	-1.5	0.0	-1.6	3.1	0.0	10819.0	4.0	-3.7	600.0	0.5	5679.3
345	UNB	4.7	-0.3	4.0	50	1.7	2.7			-1.6	bog	basin	swd	0.2	0.0	-1.6	0.0	-2.3	2.6	0.0	10861.0	4.0	-3.7	600.0	0.5	5701.3
346	UNB	2.6	-0.7	4.5	30	1.5	10.6			-1.6	bog	basin	none	0.7	0.0	-1.4	0.0	-1.8	2.2	0.0	10792.0	4.0	-3.7	600.0	0.5	5665.1
347	UNB	2.0	-0.8	4.7	30	1.5	9.6			-1.6	bog	basin	none	5.6	0.0	-1.5	0.0	-2.2	2.2	0.0	9854.0	4.0	-3.7	600.0	0.5	5172.7
348	UNB	1.2	-1.0	5.8	50	1.7	8.5			-1.5	marsh	linked basin	swd	4.5	0.1	-1.1	0.1	-1.1	3.5	0.0	10158.0	4.0	-3.7	600.0	0.5	5332.3
349	UNB	2.0	-0.8	4.7	30	1.5	8.0			-1.4	marsh	linked basin	none	4.7	0.0	-1.4	0.0	-1.4	3.6	0.0	9502.0	4.0	-3.7	600.0	0.5	4987.9
350	UNB	4.1	-0.4	4.5	40	1.6	9.3			-1.5	marsh	linked basin	none	0.2	0.0	-1.8	0.0	-1.8	3.6	1.0	10713.0	4.0	-3.7	600.0	0.5	5623.6
351	UNB	1.5	-0.9	5.2	30	1.5	7.8			-1.5	marsh	linked basin	none	1.7	0.1	-1.1	0.1	-1.1	3.7	0.0	10218.0	4.0	-3.7	600.0	0.5	5363.8
352	UNB	2.1	-0.8	5.0	30	1.5	13.6			-1.5	marsh	linked basin	swd	0.2	0.0	-1.8	0.0	-1.8	3.7	1.0	10660.0	4.0	-3.7	600.0	0.5	5595.8
353	UNB	0.5	-1.4	5.3	30	1.5	8.4			-1.5	swamp	lagg	none	11.2	0.1	-1.0	0.1	-1.0	3.5	0.0	11319.0	4.1	-5.0	600.0	0.5	5941.7
354	UNB	4.3	-0.4	4.9	30	1.5	8.9			-1.4	marsh	linked basin	shrub	1.8	0.1	-1.1	0.1	-1.1	3.5	1.0	11199.0	4.0	-3.7	600.0	0.5	5878.7
355	UNB	2.4	-0.7	4.1	30	1.5	8.7			-1.5	swamp	lagg	none	14.6	0.0	-1.3	0.0	-1.3	3.5	0.0	11781.0	4.1	-5.0	600.0	0.5	6184.3
356	UNB	2.8	-0.6	4.7	30	1.5	12.2			-1.5	marsh	linked basin	shrub	0.2	0.0	-1.5	0.0	-1.5	3.5	1.0	10836.0	4.0	-3.7	600.0	0.5	5688.2
357	UNB	3.6	-0.5	4.9	20	1.3	9.2			-1.4	fen	horizontal	none	6.5	0.1	-1.0	0.1	-1.1	3.4	0.0	11560.0	4.1	-5.0	600.0	0.5	6068.2
358	UNB	4.0	-0.4	4.5	70	1.8	15.3			-1.5	marsh	linked basin	none	0.3	0.1	-1.0	0.1	-1.0	3.5	1.0	11251.0	4.1	-3.7	600.0	0.5	5906.0
359	UNB	0.5	-1.4	5.8	20	1.3	8.4			-1.6	swamp	lagg	shrub	10.3	0.1	-1.2	0.1	-1.2	3.7	0.0	11552.0	4.1	-5.0	600.0	0.5	6064.0
360	UNB	2.7	-0.6	4.7	30	1.5	8.3			-1.6	swamp	drainageway	none	6.7	0.0	-1.5	0.0	-1.5	3.8	0.0	11046.0	4.0	-5.0	600.0	0.5	5798.4

Plot	Site Name	DO	calc DO	pH	EC	log (ec)	Temp	Color	Sqrt (col)	log Slope	Class	Form	Type	Tree Ht	DTW (4ha)	DTW (log4ha)	DTW (1ha)	DTW (log1ha)	log fa 150m	Open Water	PRR	log (PRR)	log (HC)	evapo tran	ET/Ppt ratio	ratio x PRR
361	UNB	1.0	-1.1	4.5	30	1.5	9.4			-1.6	swamp	lagg	shrub	9.6	0.1	-1.0	0.1	-1.0	3.8	0.0	9836.0	4.0	-5.0	600.0	0.5	5163.3
362	UNB	0.9	-1.2	5.4	30	1.5	6.7			-1.6	swamp	lagg	none	12.3	0.1	-1.2	0.1	-1.2	3.8	0.0	10638.0	4.0	-5.0	600.0	0.5	5584.3
363	UNB	2.7	-0.6	4.7	20	1.3	7.9			-1.6	swamp	drainageway	none	8.9	0.0	-2.0	0.0	-2.0	3.8	0.0	10850.0	4.0	-5.0	600.0	0.5	5695.5
364	UNB	5.6	-0.2	5.0	20	1.3	8.7			-1.6	swamp	drainageway	none	10.5	0.1	-1.3	0.1	-1.3	3.7	0.0	11235.0	4.1	-5.0	600.0	0.5	5897.6
365	UNB	4.1	-0.4	5.9	50	1.7	3.5			-1.5	swamp	lagg	none	13.6	0.1	-1.0	0.1	-1.2	3.7	0.0	11210.0	4.0	-5.0	600.0	0.5	5884.5
366	UNB	4.4	-0.4	5.4	20	1.3	8.6			-1.4	swamp	lagg	hwd	13.1	0.1	-1.3	0.0	-1.4	3.7	0.0	11663.0	4.1	-5.0	600.0	0.5	6122.3
367	UNB	0.5	-1.4	6.2	80	1.9	7.4			-1.5	swamp	drainageway	swd	9.4	0.0	-1.4	0.0	-1.4	3.8	0.0	9716.0	4.0	-5.0	600.0	0.5	5100.3
368	UNB	4.7	-0.3	6.5	90	2.0	8.8			-1.5	swamp	lagg	swd	12.1	0.1	-0.8	0.1	-0.8	3.8	0.0	10856.0	4.0	-5.0	600.0	0.5	5698.7
369	UNB	2.7	-0.6	5.3	20	1.3	9.1			-1.5	swamp	lagg	swd	12.8	0.3	-0.5	0.3	-0.5	3.9	0.0	9395.0	4.0	-5.0	600.0	0.5	4931.8
370	UNB	5.5	-0.2	5.8	30	1.5	8.6			-1.4	swamp	drainageway	swd	7.2	0.0	-1.4	0.0	-1.4	3.9	0.0	10352.0	4.0	-5.0	600.0	0.5	5434.1
371	UNB	5.8	-0.2	5.2	20	1.3	8.4			-1.4	swamp	drainageway	swd	16.8	0.2	-0.6	0.2	-0.6	3.9	0.0	10844.0	4.0	-5.0	600.0	0.5	5692.4
372	UNB	4.2	-0.4	5.8	30	1.5	7.7			-1.3	marsh	linked basin	swd	7.3	0.1	-1.1	0.1	-1.1	3.9	0.0	11345.0	4.1	-3.7	600.0	0.5	5955.4
373	UNB	0.6	-1.4	5.7	40	1.6	5.4			-1.3	marsh	linked basin	swd	1.1	0.1	-1.0	0.1	-1.0	3.9	0.0	10569.0	4.0	-3.7	600.0	0.5	5548.0
374	UNB	3.0	-0.6	5.8	30	1.5	6.7			-1.3	marsh	linked basin	none	0.2	0.1	-1.2	0.1	-1.2	4.0	0.0	10599.0	4.0	-3.7	600.0	0.5	5563.8
375	UNB	4.4	-0.3	5.5	20	1.3	7.9			-1.4	marsh	linked basin	none	0.5	0.0	-1.7	0.0	-1.7	4.0	0.0	10827.0	4.0	-3.7	600.0	0.5	5683.5
376	UNB	4.7	-0.3	4.9	30	1.5	6.6			-1.4	marsh	linked basin	none	0.4	0.2	-0.8	0.2	-0.8	3.9	0.0	10768.0	4.0	-3.7	600.0	0.5	5652.5
377	UNB	5.4	-0.2	4.6	20	1.3	0.7			-1.3	bog	domed	none	0.6	0.1	-0.9	0.1	-1.0	3.9	0.0	10871.0	4.0	-1.6	600.0	0.5	5706.6
378	UNB	2.8	-0.6	5.6	20	1.3	9.7			-1.3	marsh	linked basin	none	0.3	0.2	-0.8	0.1	-0.8	3.9	0.0	10815.0	4.0	-3.7	600.0	0.5	5677.2
379	UNB	4.8	-0.3	5.2	30	1.5	6.2			-1.3	marsh	linked basin	none	7.7	0.2	-0.7	0.2	-0.7	3.9	0.0	9345.0	4.0	-3.7	600.0	0.5	4905.5
380	UNB	7.1	0.0	5.4	80	1.9	6.1			-1.4	marsh	linked basin	shrub	1.1	0.1	-1.0	0.1	-1.1	3.3	0.0	10223.0	4.0	-3.7	600.0	0.5	5366.4
381	UNB	5.1	-0.3	5.1	20	1.3	1.5			-1.4	marsh	linked basin	shrub	0.3	0.1	-1.0	0.1	-1.1	3.4	0.0	10807.0	4.0	-3.7	600.0	0.5	5673.0
382	UNB	6.5	-0.1	5.2	20	1.3	1.9			-1.4	fen	horizontal	shrub	0.5	0.1	-1.0	0.1	-1.1	3.7	0.0	10785.0	4.0	-5.0	600.0	0.5	5661.4
383	UNB	6.7	-0.1	5.1	30	1.5	6.2			-1.3	marsh	linked basin	none	0.2	0.2	-0.7	0.2	-0.8	3.8	0.0	10716.0	4.0	-3.7	600.0	0.5	5625.2
384	UNB	3.4	-0.5	4.8	30	1.5	8.3			-1.3	marsh	linked basin	none	0.2	0.2	-0.7	0.2	-0.7	3.8	0.0	10754.0	4.0	-3.7	600.0	0.5	5645.1
385	UNB	8.3	0.1	5.5	30	1.5	6.1			-1.3	marsh	linked basin	shrub	9.8	0.2	-0.7	0.2	-0.7	3.8	0.0	11342.0	4.1	-3.7	600.0	0.5	5953.8
386	UNB	1.8	-0.8	5.2	50	1.7	6.4			-1.4	fen	horizontal	shrub	7.9	0.1	-0.8	0.1	-0.8	3.1	0.0	11699.0	4.1	-5.0	600.0	0.5	6141.2
387	UNB	0.8	-1.2	5.8	30	1.5	10.2			-1.3	fen	horizontal	shrub	0.8	0.0	-1.8	0.0	-1.8	3.1	0.0	10761.0	4.0	-5.0	600.0	0.5	5648.8
388	UNB	1.0	-1.1	5.9	30	1.5	11.9			-1.3	marsh	linked basin	none	0.5	0.1	-0.9	0.1	-0.9	3.1	0.0	10830.0	4.0	-3.7	600.0	0.5	5685.0
389	UNB	0.5	-1.5	5.6	30	1.5	8.3			-1.5	fen	horizontal	none	8.8	0.1	-1.2	0.1	-1.2	3.6	0.0	10290.0	4.0	-5.0	600.0	0.5	5401.6
390	UNB	2.1	-0.8	5.2	20	1.3	10.9			-1.5	fen	horizontal	shrub	3.1	0.0	-1.8	0.0	-1.8	3.6	1.0	10619.0	4.0	-5.0	600.0	0.5	5574.3
391	UNB	3.5	-0.5	5.4	20	1.3	10.2			-1.6	fen	horizontal	shrub	4.1	0.0	-1.4	0.0	-1.4	3.6	1.0	10938.0	4.0	-5.0	600.0	0.5	5741.7
392	UNB	1.3	-1.0	5.1	30	1.5	10.1			-1.6	fen	horizontal	shrub	7.8	0.1	-1.3	0.1	-1.3	3.6	1.0	10618.0	4.0	-5.0	600.0	0.5	5573.8
393	UNB	1.4	-1.0	5.2	20	1.3	10.2			-1.6	fen	horizontal	shrub	3.7	0.1	-1.1	0.1	-1.2	3.6	1.0	10970.0	4.0	-5.0	600.0	0.5	5758.5
394	UNB	0.8	-1.2	5.1	30	1.5	9.9			-1.5	fen	horizontal	shrub	4.2	0.1	-1.1	0.1	-1.1	3.0	1.0	10823.0	4.0	-5.0	600.0	0.5	5681.4
395	UNB	2.9	-0.6	4.8	30	1.5	10.4			-1.5	swamp	drainageway	shrub	12.4	0.1	-1.0	0.1	-1.1	2.4	0.0	10405.0	4.0	-5.0	600.0	0.5	5461.9
396	UNB	1.0	-1.1	5.3	30	1.5	10.4			-1.5	fen	horizontal	shrub	3.8	0.1	-1.1	0.1	-1.2	3.3	1.0	10784.0	4.0	-5.0	600.0	0.5	5660.9
397	UNB	1.2	-1.0	5.2	40	1.6	10.3			-1.6	fen	horizontal	none	5.4	0.1	-1.1	0.1	-1.3	3.5	1.0	11088.0	4.0	-5.0	600.0	0.5	5820.5
398	UNB	1.2	-1.0	5.2	20	1.3	10.3			-1.5	fen	horizontal	shrub	9.0	0.1	-1.2	0.1	-1.2	3.6	1.0	10590.0	4.0	-5.0	600.0	0.5	5559.1
399	UNB	1.0	-1.1	5.1	30	1.5	10.8			-1.6	fen	horizontal	shrub	4.2	0.0	-1.7	0.0	-1.7	3.6	1.0	10835.0	4.0	-5.0	600.0	0.5	5687.7
400	UNB	1.8	-0.9	5.0	20	1.3	10.8			-1.5	fen	horizontal	shrub	2.4	0.0	-2.0	0.0	-2.1	3.6	1.0	10721.0	4.0	-5.0	600.0	0.5	5627.8
401	UNB	0.5	-1.4	4.8	20	1.3	9.4			-1.4	fen	horizontal	shrub	5.9	0.1	-1.2	0.1	-1.3	3.6	0.0	10790.0	4.0	-5.0	600.0	0.5	5664.0
402	UNB	1.9	-0.8	5.1	30	1.5	7.8			-1.5	fen	horizontal	none	14.7	0.1	-1.2	0.1	-1.2	2.9	0.0	11417.0	4.1	-5.0	600.0	0.5	5993.2
403	UNB	3.6	-0.5	4.4	90	2.0	9.0			-1.5	bog	basin	shrub	5.0	0.1	-1.2	0.1	-1.3	2.9	0.0	10941.0	4.0	-3.7	600.0	0.5	5743.3
404	UNB	5.4	-0.2	4.0	60	1.8	6.7			-1.5	bog	domed	swd	2.9	0.0	-1.3	0.0	-1.4	2.9	0.0	10849.0	4.0	-1.6	600.0	0.5	5695.0
405	UNB	5.9	-0.2	4.2	40	1.6	8.9			-1.6	bog	domed	swd	0.1	0.0	-1.8	0.0	-2.4	2.9	0.0	10808.0	4.0	-1.6	600.0	0.5	5673.5

Plot	Site Name	DO	calc DO	pH	EC	log (ec)	Temp	Color	Sqrt (col)	log Slope	Class	Form	Type	Tree Ht	DTW (4ha)	DTW (log4ha)	DTW (1ha)	DTW (log1ha)	log fa 150m	Open Water	PRR	log (PRR)	log (HC)	evapo tran	ET/Ppt ratio	ratio x PRR
406	UNB	5.4	-0.2	3.9	50	1.7	6.8			-1.4	bog	domed	swd	0.6	0.1	-1.2	0.1	-1.3	3.0	0.0	10795.0	4.0	-1.6	600.0	0.5	5666.7
407	UNB	5.9	-0.2	4.1	100	2.0	7.4			-1.4	bog	domed	swd	0.3	0.1	-1.2	0.1	-1.2	3.1	0.0	10850.0	4.0	-1.6	600.0	0.5	5695.5
408	UNB	7.3	0.0	3.9	150	2.2	6.3			-1.5	bog	domed	swd	1.1	0.1	-1.3	0.0	-1.4	2.6	0.0	10980.0	4.0	-1.6	600.0	0.5	5763.8
409	UNB	4.1	-0.4	4.6	150	2.2	7.6			-1.5	bog	basin	shrub	5.5	0.1	-1.1	0.1	-1.1	2.7	0.0	11199.0	4.0	-3.7	600.0	0.5	5878.7
410	UNB	0.7	-1.3	5.8	50	1.7	6.6			-1.5	fen	horizontal	none	11.6	0.1	-0.9	0.1	-1.0	2.7	1.0	11709.0	4.1	-5.0	600.0	0.5	6146.5
411	UNB	1.0	-1.1	5.7	40	1.6	6.8			-1.5	fen	horizontal	none	6.3	0.0	-1.6	0.0	-1.6	2.6	0.0	11340.0	4.1	-5.0	600.0	0.5	5952.8
412	UNB	0.4	-1.6	5.6	20	1.3	7.5			-1.3	marsh	linked basin	shrub	8.0	0.2	-0.7	0.2	-0.7	3.2	0.0	9459.0	4.0	-3.7	600.0	0.5	4965.4
413	UNB	2.1	-0.8	5.7	30	1.5	9.1			-1.3	marsh	linked basin	shrub	1.9	0.1	-1.3	0.1	-1.3	3.5	1.0	10573.0	4.0	-3.7	600.0	0.5	5550.1
414	UNB	3.0	-0.6	5.7	20	1.3	9.9			-1.4	marsh	linked basin	shrub	1.0	0.0	-1.3	0.0	-1.3	3.9	1.0	10709.0	4.0	-3.7	600.0	0.5	5621.5
415	UNB	3.0	-0.6	5.6	20	1.3	10.0			-1.4	marsh	linked basin	none	1.0	0.0	-1.7	0.0	-1.7	3.9	1.0	10721.0	4.0	-3.7	600.0	0.5	5627.8
416	UNB	1.0	-1.1	5.7	30	1.5	10.2			-1.3	marsh	linked basin	shrub	1.7	0.1	-0.9	0.1	-0.9	3.3	1.0	10295.0	4.0	-3.7	600.0	0.5	5404.2
417	UNB	3.3	-0.5	5.7	30	1.5	6.1			-1.3	marsh	linked basin	shrub	7.2	0.1	-0.9	0.1	-0.9	3.2	1.0	8661.0	3.9	-3.7	600.0	0.5	4546.5
418	UNB	3.1	-0.6	5.9	20	1.3	8.7			-1.2	fen	horizontal	shrub	8.7	0.0	-1.3	0.0	-1.3	3.2	0.0	9639.0	4.0	-5.0	600.0	0.5	5059.8
419	UNB	5.0	-0.3	5.7	20	1.3	9.1			-1.2	marsh	linked basin	shrub	1.9	0.1	-1.1	0.1	-1.1	3.2	1.0	10259.0	4.0	-3.7	600.0	0.5	5385.3
420	UNB	1.1	-1.1	5.3	40	1.6	8.1			-1.2	marsh	linked basin	none	7.5	0.3	-0.5	0.3	-0.5	3.2	0.0	9786.0	4.0	-3.7	600.0	0.5	5137.0
421	UNB	2.2	-0.7	5.5	40	1.6	9.3			-1.2	marsh	linked basin	shrub	0.9	0.0	-1.5	0.0	-1.5	3.5	1.0	10334.0	4.0	-3.7	600.0	0.5	5424.7
422	UNB	9.7	0.3	5.5	20	1.3	7.9			-1.3	fen	horizontal	none	5.6	0.1	-1.0	0.1	-1.0	3.7	0.0	9529.0	4.0	-5.0	600.0	0.5	5002.1
423	UNB	2.8	-0.6	4.9	30	1.5	10.3			-1.4	marsh	linked basin	shrub	0.6	0.0	-1.6	0.0	-1.6	3.8	1.0	10775.0	4.0	-3.7	600.0	0.5	5656.2
424	UNB	2.3	-0.7	5.5	40	1.6	6.8			-1.5	fen	horizontal	shrub	7.3	0.0	-1.4	0.0	-1.4	3.9	1.0	9553.0	4.0	-5.0	600.0	0.5	5014.7
425	UNB	5.1	-0.3	4.6	30	1.5	9.5			-1.5	fen	horizontal	shrub	2.7	0.0	-1.5	0.0	-1.5	4.0	1.0	10518.0	4.0	-5.0	600.0	0.5	5521.3
426	UNB	5.8	-0.2	4.2	40	1.6	8.2			-1.4	fen	horizontal	shrub	1.1	0.1	-1.0	0.1	-1.0	4.0	0.0	10813.0	4.0	-5.0	600.0	0.5	5676.1
427	UNB	5.7	-0.2	4.2	40	1.6	8.2			-1.4	bog	basin	shrub	1.1	0.1	-1.0	0.1	-1.0	4.0	0.0	10809.0	4.0	-3.7	600.0	0.5	5674.0
428	UNB	1.0	-1.1	5.1	20	1.3	7.5			-1.3	swamp	lagg	shrub	8.6	0.1	-1.0	0.1	-1.0	3.1	0.0	9847.0	4.0	-5.0	600.0	0.5	5169.0
429	UNB	2.1	-0.8	4.9	30	1.5	7.0			-1.5	swamp	drainageway	none	7.8	0.1	-1.0	0.1	-1.0	3.1	0.0	11181.0	4.0	-5.0	600.0	0.5	5869.3
430	UNB	2.1	-0.8	4.4	40	1.6	8.6			-1.6	swamp	drainageway	shrub	8.3	0.0	-1.3	0.0	-1.3	3.1	0.0	10510.0	4.0	-5.0	600.0	0.5	5517.1
431	UNB	1.8	-0.8	4.3	40	1.6	8.0			-1.6	swamp	drainageway	none	6.0	0.1	-1.0	0.1	-1.0	3.1	1.0	10742.0	4.0	-5.0	600.0	0.5	5638.8
432	UNB	0.9	-1.2	5.0	20	1.3	6.9			-1.5	swamp	lagg	shrub	12.3	0.2	-0.7	0.2	-0.7	3.1	0.0	11429.0	4.1	-5.0	600.0	0.5	5999.5
433	UNB	1.9	-0.8	5.0	20	1.3	7.0			-1.5	swamp	drainageway	shrub	15.3	0.1	-1.0	0.1	-1.0	3.1	0.0	11567.0	4.1	-5.0	600.0	0.5	6071.9
434	UNB	3.0	-0.6	4.4	30	1.5	7.8			-1.5	swamp	drainageway	shrub	7.0	0.0	-1.4	0.0	-1.4	3.1	0.0	10112.0	4.0	-5.0	600.0	0.5	5308.1
435	UNB	0.5	-1.4	4.7	30	1.5	7.8			-1.5	swamp	drainageway	none	7.4	0.1	-1.2	0.1	-1.2	3.1	1.0	11376.0	4.1	-5.0	600.0	0.5	5971.7
436	UNB	7.1	0.0	5.0	30	1.5	6.7			-1.4	swamp	drainageway	shrub	4.8	0.0	-1.4	0.0	-1.4	3.1	0.0	11096.0	4.0	-5.0	600.0	0.5	5824.7
437	UNB	0.9	-1.2	4.8	20	1.3	6.8			-1.5	swamp	lagg	shrub	9.8	0.1	-0.9	0.1	-1.0	3.1	0.0	9066.0	4.0	-5.0	600.0	0.5	4759.1
438	UNB	3.6	-0.5	4.9	20	1.3	7.7			-1.5	swamp	drainageway	shrub	5.0	0.0	-1.3	0.0	-1.3	3.1	0.0	10817.0	4.0	-5.0	600.0	0.5	5678.2
439	UNB	3.5	-0.5	4.6	30	1.5	7.8			-1.5	swamp	drainageway	none	6.3	0.1	-0.9	0.1	-0.9	3.1	1.0	11072.0	4.0	-5.0	600.0	0.5	5812.1
440	UNB	2.9	-0.6	4.0	30	1.5	7.0			-1.5	swamp	drainageway	none	7.7	0.1	-0.9	0.1	-0.9	3.1	0.0	11081.0	4.0	-5.0	600.0	0.5	5816.8
441	UNB	1.1	-1.1	4.6	30	1.5	7.8			-1.5	swamp	lagg	none	12.9	0.1	-0.9	0.1	-0.9	3.1	1.0	11568.0	4.1	-5.0	600.0	0.5	6072.4
442	UNB	4.0	-0.4	5.1	30	1.5	9.1			-1.6	swamp	lagg	none	12.5	0.0	-1.6	0.0	-1.6	3.7	0.0	9436.0	4.0	-5.0	600.0	0.5	4953.3
443	UNB	5.1	-0.3	5.0	30	1.5	9.1			-1.6	swamp	drainageway	swd	7.9	0.1	-1.3	0.1	-1.3	3.7	1.0	9026.0	4.0	-5.0	600.0	0.5	4738.1
444	UNB	4.6	-0.3	4.6	30	1.5	7.3			-1.6	swamp	lagg	hwd	7.0	0.0	-1.6	0.0	-1.6	3.8	0.0	10973.0	4.0	-5.0	600.0	0.5	5760.1
445	UNB	5.5	-0.2	4.6	30	1.5	7.3			-1.6	swamp	lagg	none	10.1	0.1	-1.2	0.1	-1.2	3.7	0.0	11140.0	4.0	-5.0	600.0	0.5	5847.8
446	UNB	7.0	0.0	4.7	30	1.5	8.3			-1.7	swamp	drainageway	none	8.8	0.1	-1.1	0.1	-1.1	3.7	0.0	10430.0	4.0	-5.0	600.0	0.5	5475.1
447	UNB	6.2	-0.1	4.7	30	1.5	9.3			-1.7	swamp	drainageway	none	12.5	0.0	-1.4	0.0	-1.4	3.7	0.0	9162.0	4.0	-5.0	600.0	0.5	4809.4
448	UNB	3.3	-0.5	4.3	30	1.5	8.5			-1.7	swamp	lagg	none	9.5	0.0	-2.1	0.0	-2.1	3.6	0.0	11221.0	4.1	-5.0	600.0	0.5	5890.3
449	UNB	3.0	-0.6	4.2	40	1.6	7.4			-1.6	swamp	lagg	swd	10.5	0.2	-0.8	0.2	-0.8	3.6	0.0	11243.0	4.1	-5.0	600.0	0.5	5901.8
450	UNB	4.1	-0.4	4.6	30	1.5	7.6			-1.6	swamp	lagg	none	10.7	0.0	-1.8	0.0	-1.8	3.5	0.0	9811.0	4.0	-5.0	600.0	0.5	5150.1

Plot	Site Name	DO	calc DO	pH	EC	log (ec)	Temp	Color	Sqrt (col)	log Slope	Class	Form	Type	Tree Ht	DTW (4ha)	DTW (log4ha)	DTW (1ha)	DTW (log1ha)	log fa 150m	Open Water	PRR	log (PRR)	log (HC)	evapo tran	ET/Ppt ratio	ratio x PRR
451	UNB	7.7	0.1	4.7	30	1.5	10.6			-1.6	swamp	drainageway	none	10.7	0.0	-1.3	0.0	-1.3	3.7	0.0	9955.0	4.0	-5.0	600.0	0.5	5225.7
452	UNB	7.1	0.0	4.8	20	1.3	10.0			-1.6	swamp	lagg	shrub	7.6	0.1	-1.3	0.1	-1.3	3.7	0.0	11355.0	4.1	-5.0	600.0	0.5	5960.6
453	UNB	1.1	-1.1	5.2	90	2.0	11.7			-1.6	fen	horizontal	shrub	10.5	0.1	-1.0	0.1	-1.0	3.9	0.0	10969.0	4.0	-5.0	600.0	0.5	5758.0
454	UNB	0.7	-1.3	5.5	30	1.5	13.3			-1.6	fen	horizontal	shrub	7.7	0.0	-1.4	0.0	-1.4	3.9	1.0	11148.0	4.0	-5.0	600.0	0.5	5852.0
455	UNB	0.8	-1.2	5.1	20	1.3	13.1			-1.6	fen	horizontal	shrub	6.7	0.1	-1.2	0.1	-1.2	3.9	1.0	11027.0	4.0	-5.0	600.0	0.5	5788.5
456	UNB	2.8	-0.6	4.7	20	1.3	12.1			-1.6	fen	horizontal	none	8.1	0.1	-1.0	0.1	-1.0	3.9	0.0	11123.0	4.0	-5.0	600.0	0.5	5838.8
457	UNB	2.6	-0.6	5.2	40	1.6	9.8			-1.6	swamp	drainageway	none	13.2	0.1	-1.3	0.1	-1.3	3.8	0.0	11689.0	4.1	-5.0	600.0	0.5	6136.0
458	UNB	3.5	-0.5	4.1	50	1.7	8.0			-1.5	bog	basin	shrub	6.5	0.1	-0.9	0.1	-0.9	3.8	0.0	11190.0	4.0	-3.7	600.0	0.5	5874.0
459	UNB	7.1	0.0	4.0	50	1.7	6.2			-1.4	bog	basin	swd	4.8	0.2	-0.7	0.2	-0.8	3.7	0.0	10966.0	4.0	-3.7	600.0	0.5	5756.4
460	UNB	3.4	-0.5	4.0	50	1.7	7.8			-1.3	bog	domed	swd	1.7	0.2	-0.8	0.1	-1.0	2.6	0.0	10814.0	4.0	-1.6	600.0	0.5	5676.6
461	UNB	3.1	-0.6	4.1	50	1.7	7.8			-1.4	bog	basin	swd	4.0	0.1	-0.8	0.1	-1.0	2.3	0.0	10729.0	4.0	-3.7	600.0	0.5	5632.0
462	UNB	3.0	-0.6	4.2	40	1.6	10.0			-1.4	bog	basin	none	4.5	0.1	-0.9	0.0	-1.3	2.3	0.0	10888.0	4.0	-3.7	600.0	0.5	5715.5
463	UNB	3.6	-0.5	4.2	40	1.6	11.0			-1.4	bog	basin	none	2.9	0.1	-1.0	0.0	-1.5	2.4	0.0	10952.0	4.0	-3.7	600.0	0.5	5749.1
464	UNB	5.0	-0.3	4.2	40	1.6	6.7			-1.3	bog	domed	swd	1.0	0.1	-0.9	0.0	-1.3	2.4	0.0	10907.0	4.0	-1.6	600.0	0.5	5725.5
465	UNB	6.0	-0.1	4.2	30	1.5	5.8			-1.3	bog	domed	swd	0.4	0.1	-0.8	0.1	-1.1	2.2	0.0	10815.0	4.0	-1.6	600.0	0.5	5677.2
466	UNB	4.6	-0.3	4.1	50	1.7	8.2			-1.3	bog	basin	swd	4.2	0.1	-0.8	0.0	-1.4	3.7	0.0	11053.0	4.0	-3.7	600.0	0.5	5802.1
467	UNB	5.6	-0.2	4.1	50	1.7	7.7			-1.4	bog	basin	swd	6.4	0.2	-0.8	0.2	-0.8	3.7	0.0	10733.0	4.0	-3.7	600.0	0.5	5634.1
468	UNB	2.9	-0.6	4.1	50	1.7	8.8			-1.5	fen	horizontal	shrub	8.1	0.1	-1.1	0.1	-1.1	3.8	0.0	10801.0	4.0	-5.0	600.0	0.5	5669.8
469	UNB	4.0	-0.4	4.6	20	1.3	14.2			-1.6	fen	horizontal	shrub	18.9	0.1	-1.1	0.1	-1.1	3.9	1.0	10931.0	4.0	-5.0	600.0	0.5	5738.1
470	UNB	4.3	-0.4	5.0	30	1.5	16.0			-1.6	fen	horizontal	shrub	9.3	0.0	-1.5	0.0	-1.5	3.9	1.0	10517.0	4.0	-5.0	600.0	0.5	5520.7
471	UNB	3.7	-0.5	5.2	30	1.5	15.7			-1.6	fen	horizontal	shrub	6.7	0.0	-1.6	0.0	-1.6	3.9	1.0	11107.0	4.0	-5.0	600.0	0.5	5830.4
472	UNB	3.5	-0.5	4.9	90	2.0	11.2			-1.6	swamp	drainageway	shrub	13.6	0.0	-1.4	0.0	-1.4	4.0	1.0	11131.0	4.0	-5.0	600.0	0.5	5843.0
473	UNB	1.6	-0.9	5.7	110	2.0	6.9			-1.6	bog	basin	none	9.4	0.1	-1.0	0.1	-1.2	2.2	0.0	9574.0	4.0	-3.7	600.0	0.5	5025.7
474	UNB	1.8	-0.8	3.9	40	1.6	8.5			-1.6	bog	basin	swd	2.2	0.1	-1.1	0.0	-1.4	2.2	0.0	10589.0	4.0	-3.7	600.0	0.5	5558.5
475	UNB	5.1	-0.3	3.7	40	1.6	3.5			-1.6	bog	basin	swd	0.2	0.1	-1.1	0.1	-1.2	2.3	0.0	10818.0	4.0	-3.7	600.0	0.5	5678.7
476	UNB	2.5	-0.7	3.7	50	1.7	5.4			-1.5	bog	basin	swd	0.2	0.1	-1.0	0.1	-1.2	2.3	0.0	10833.0	4.0	-3.7	600.0	0.5	5686.6
477	UNB	2.4	-0.7	3.8	40	1.6	3.7			-1.5	bog	basin	swd	0.2	0.1	-1.0	0.1	-1.1	2.4	0.0	10855.0	4.0	-3.7	600.0	0.5	5698.2
478	UNB	2.1	-0.8	3.8	60	1.8	7.3			-1.5	bog	basin	swd	1.7	0.1	-1.0	0.1	-1.2	2.4	0.0	10787.0	4.0	-3.7	600.0	0.5	5662.5
479	UNB	1.9	-0.8	4.1	50	1.7	2.4			-1.5	bog	basin	swd	1.4	0.1	-1.1	0.1	-1.3	2.5	0.0	10783.0	4.0	-3.7	600.0	0.5	5660.4
480	UNB	4.0	-0.4	3.8	50	1.7	6.6			-1.5	bog	basin	swd	1.3	0.1	-1.1	0.1	-1.3	2.5	0.0	10861.0	4.0	-3.7	600.0	0.5	5701.3
481	UNB	5.2	-0.2	4.9	30	1.5	6.9			-1.4	upland	upland	swd	10.6	0.3	-0.5	0.3	-0.5	3.5	0.0	11200.0	4.0	-2.5	600.0	0.5	5879.3
482	UNB	2.3	-0.7	5.0	50	1.7	8.9			-1.4	marsh	linked basin	swd	12.4	0.2	-0.7	0.2	-0.7	3.6	0.0	10619.0	4.0	-3.7	600.0	0.5	5574.3
483	UNB	1.6	-0.9	5.0	40	1.6	8.7			-1.4	marsh	linked basin	swd	6.8	0.3	-0.6	0.3	-0.6	3.6	0.0	11507.0	4.1	-3.7	600.0	0.5	6040.4
484	UNB	2.3	-0.7	5.3	50	1.7	8.7			-1.4	upland	upland	swd	8.7	0.1	-1.2	0.1	-1.2	3.6	0.0	10704.0	4.0	-2.5	600.0	0.5	5618.9
485	UNB	3.1	-0.6	4.9	30	1.5	10.5			-1.4	marsh	linked basin	none	5.5	0.4	-0.4	0.4	-0.4	3.6	0.0	11441.0	4.1	-3.7	600.0	0.5	6005.8
486	UNB	2.0	-0.8	4.5	30	1.5	10.1			-1.3	fen	horizontal	none	0.6	0.1	-1.0	0.1	-1.0	3.6	0.0	10771.0	4.0	-5.0	600.0	0.5	5654.1
487	UNB	2.2	-0.7	4.9	30	1.5	10.2			-1.4	fen	horizontal	swd	1.5	0.2	-0.7	0.2	-0.7	3.6	0.0	10273.0	4.0	-5.0	600.0	0.5	5392.7
488	UNB	1.1	-1.1	4.9	30	1.5	9.9			-1.6	fen	horizontal	swd	10.1	0.1	-1.0	0.1	-1.0	3.7	0.0	11389.0	4.1	-5.0	600.0	0.5	5978.5
489	UNB	0.3	-1.7	5.1	60	1.8	8.9			-1.6	fen	horizontal	shrub	9.3	0.0	-1.6	0.0	-1.6	3.7	0.0	10736.0	4.0	-5.0	600.0	0.5	5635.7
490	UNB	4.0	-0.4	4.4	40	1.6	8.6			-1.4	swamp	drainageway	none	10.7	0.2	-0.6	0.2	-0.6	3.9	0.0	9801.0	4.0	-5.0	600.0	0.5	5144.9
491	UNB	1.2	-1.0	5.2	80	1.9	8.9			-1.4	swamp	drainageway	shrub	10.1	0.1	-1.3	0.1	-1.3	3.9	0.0	11186.0	4.0	-5.0	600.0	0.5	5871.9
492	UNB	1.1	-1.1	6.1	140	2.1	7.7			-1.4	swamp	drainageway	shrub	13.9	0.1	-1.3	0.1	-1.3	3.9	0.0	10393.0	4.0	-5.0	600.0	0.5	5455.6
493	UNB	1.9	-0.8	5.8	10	1.0	5.9			-1.2	marsh	linked basin	shrub	12.2	0.1	-1.1	0.1	-1.1	3.9	0.0	10442.0	4.0	-3.7	600.0	0.5	5481.4
494	UNB	3.5	-0.5	5.2	20	1.3	8.3			-1.2	marsh	linked basin	none	0.3	0.1	-1.1	0.1	-1.1	3.9	0.0	10568.0	4.0	-3.7	600.0	0.5	5547.5
495	UNB	2.8	-0.6	5.0	20	1.3	6.1			-1.3	marsh	linked basin	none	0.3	0.0	-1.6	0.0	-1.6	3.9	0.0	10640.0	4.0	-3.7	600.0	0.5	5585.3

Plot	Site Name	DO	calc DO	pH	EC	log (ec)	Temp	Color	Sqrt (col)	log Slope	Class	Form	Type	Tree Ht	DTW (4ha)	DTW (log4ha)	DTW (1ha)	DTW (log1ha)	log fa 150m	Open Water	PRR	log (PRR)	log (HC)	evapo tran	ET/Ppt ratio	ratio x PRR
496	UNB	2.4	-0.7	4.8	20	1.3	11.1			-1.4	marsh	linked basin	none	0.4	0.0	-1.4	0.0	-1.6	4.0	0.0	10828.0	4.0	-3.7	600.0	0.5	5684.0
497	UNB	3.9	-0.4	3.9	20	1.3	8.3			-1.4	marsh	linked basin	none	0.1	0.0	-1.4	0.0	-1.4	4.0	0.0	10784.0	4.0	-3.7	600.0	0.5	5660.9
498	UNB	4.8	-0.3	3.9	30	1.5	5.0			-1.4	marsh	linked basin	none	0.4	0.1	-1.0	0.1	-1.2	4.0	0.0	10790.0	4.0	-3.7	600.0	0.5	5664.0
499	UNB	5.6	-0.2	4.3	20	1.3	7.9			-1.4	marsh	linked basin	swd	0.7	0.1	-1.0	0.1	-1.1	3.9	0.0	10788.0	4.0	-3.7	600.0	0.5	5663.0
500	UNB	3.3	-0.5	4.8	20	1.3	8.1			-1.2	fen	horizontal	shrub	1.9	0.1	-0.9	0.1	-0.9	3.6	0.0	10873.0	4.0	-5.0	600.0	0.5	5707.6
501	UNB	3.3	-0.5	5.2	30	1.5	8.2			-1.1	fen	horizontal	none	9.8	0.8	-0.1	0.7	-0.1	2.0	0.0	11272.0	4.1	-5.0	600.0	0.5	5917.1
502	UNB	3.7	-0.5	4.3	30	1.5	7.7			-1.1	marsh	linked basin	none	2.4	0.1	-1.0	0.1	-1.2	1.9	0.0	10758.0	4.0	-3.7	600.0	0.5	5647.2
503	UNB	4.5	-0.3	4.0	30	1.5	7.6			-1.4	marsh	linked basin	shrub	0.7	0.1	-1.0	0.0	-1.4	2.5	0.0	10794.0	4.0	-3.7	600.0	0.5	5666.1
504	UNB	4.2	-0.4	7.3	30	1.5	7.3			-1.5	marsh	linked basin	swd	1.9	0.1	-1.0	0.0	-1.5	3.7	0.0	10821.0	4.0	-3.7	600.0	0.5	5680.3
505	UNB	2.8	-0.6	3.5	70	1.8	4.5			-1.4	bog	domed	swd	1.1	0.2	-0.8	0.1	-1.0	3.9	0.0	10826.0	4.0	-1.6	600.0	0.5	5682.9
506	UNB	1.9	-0.8	4.5	40	1.6	8.0			-1.3	swamp	lagg	none	14.5	0.3	-0.6	0.3	-0.6	3.6	0.0	9617.0	4.0	-5.0	600.0	0.5	5048.3
507	UNB	2.7	-0.6	4.7	30	1.5	7.5			-1.4	fen	horizontal	shrub	9.6	0.0	-1.4	0.0	-1.4	3.6	0.0	10746.0	4.0	-5.0	600.0	0.5	5640.9
508	UNB	4.9	-0.3	4.4	30	1.5	10.5			-1.5	fen	horizontal	shrub	4.6	0.0	-1.4	0.0	-1.4	3.6	0.0	10596.0	4.0	-5.0	600.0	0.5	5562.2
509	UNB	3.4	-0.5	4.4	20	1.3	10.0			-1.6	fen	horizontal	none	5.5	0.1	-1.2	0.1	-1.3	3.6	0.0	11087.0	4.0	-5.0	600.0	0.5	5819.9
510	UNB	2.5	-0.7	4.3	30	1.5	9.7			-1.6	swamp	drainageway	shrub	14.9	0.1	-1.1	0.1	-1.2	3.6	0.0	10748.0	4.0	-5.0	600.0	0.5	5642.0
511	UNB	2.7	-0.6	4.5	30	1.5	9.8			-1.5	fen	horizontal	shrub	10.6	0.0	-1.3	0.0	-1.5	3.6	0.0	11125.0	4.0	-5.0	600.0	0.5	5839.9
512	UNB	3.8	-0.4	4.4	40	1.6	10.6			-1.5	fen	horizontal	shrub	3.9	0.0	-1.8	0.0	-1.8	3.6	0.0	10981.0	4.0	-5.0	600.0	0.5	5764.3
513	UNB	1.3	-1.0	4.6	30	1.5	11.1			-1.4	fen	horizontal	none	3.8	0.0	-1.9	0.0	-1.9	3.6	0.0	10676.0	4.0	-5.0	600.0	0.5	5604.2
514	UNB	1.3	-1.0	4.5	20	1.3	8.6			-1.4	fen	horizontal	shrub	4.4	0.1	-1.1	0.1	-1.1	3.6	0.0	10379.0	4.0	-5.0	600.0	0.5	5448.3
515	UNB	0.3	-1.7	5.1	30	1.5	7.3			-1.4	fen	horizontal	shrub	14.1	0.1	-1.1	0.1	-1.1	3.6	0.0	10134.0	4.0	-5.0	600.0	0.5	5319.7
516	UNB	2.1	-0.8	4.4	30	1.5	7.8			-1.6	upland	upland	none	12.8	0.2	-0.7	0.1	-1.1	3.6	0.0	11045.0	4.0	-2.5	600.0	0.5	5797.9
517	UNB	1.1	-1.1	4.6	20	1.3	7.4			-1.6	fen	horizontal	swd	7.5	0.0	-1.3	0.0	-1.6	3.5	0.0	11242.0	4.1	-5.0	600.0	0.5	5901.3
518	UNB	2.5	-0.7	5.2	150	2.2	9.7			-1.6	fen	horizontal	shrub	4.8	0.1	-1.1	0.1	-1.1	3.5	0.0	10379.0	4.0	-5.0	600.0	0.5	5448.3
519	UNB	1.5	-0.9	4.4	60	1.8	9.3			-1.6	bog	basin	shrub	3.0	0.1	-1.2	0.1	-1.2	3.4	0.0	10740.0	4.0	-3.7	600.0	0.5	5637.8
520	UNB	5.7	-0.2	4.0	50	1.7	8.0			-1.6	bog	basin	swd	3.1	0.0	-1.7	0.0	-1.7	3.0	0.0	10822.0	4.0	-3.7	600.0	0.5	5680.8
521	UNB	6.4	-0.1	4.1	30	1.5	9.9			-1.7	bog	basin	none	0.1	0.0	-1.9	0.0	-2.1	2.9	0.0	10816.0	4.0	-3.7	600.0	0.5	5677.7
522	UNB	7.4	0.0	3.9	40	1.6	8.2			-1.5	bog	basin	swd	1.1	0.1	-1.3	0.1	-1.3	3.1	0.0	10829.0	4.0	-3.7	600.0	0.5	5684.5
523	UNB	3.6	-0.5	4.1	40	1.6	8.9			-1.4	bog	basin	shrub	1.6	0.0	-1.4	0.0	-1.4	3.2	0.0	10812.0	4.0	-3.7	600.0	0.5	5675.6
524	UNB	3.3	-0.5	5.6	170	2.2	8.1			-1.3	fen	horizontal	swd	4.0	0.1	-1.1	0.1	-1.1	3.2	0.0	10732.0	4.0	-5.0	600.0	0.5	5633.6
525	UNB	5.0	-0.3	4.5	40	1.6	8.7			-1.5	bog	basin	swd	0.2	0.0	-1.4	0.0	-1.4	3.2	0.0	10843.0	4.0	-3.7	600.0	0.5	5691.9
526	UNB	6.4	-0.1	4.1	40	1.6	9.3			-1.6	bog	basin	swd	0.2	0.0	-2.3	0.0	-2.3	3.1	0.0	10829.0	4.0	-3.7	600.0	0.5	5684.5
527	UNB	5.3	-0.2	4.9	20	1.3	6.2			-1.2	upland	upland	none	10.4	1.7	0.2	1.7	0.2	3.3	0.0	10687.0	4.0	-2.5	600.0	0.5	5610.0
528	UNB	3.5	-0.5	4.7	30	1.5	7.8			-1.3	marsh	linked basin	none	0.7	0.0	-1.6	0.0	-1.6	3.9	0.0	10820.0	4.0	-3.7	600.0	0.5	5679.8
529	UNB	3.1	-0.6	4.7	50	1.7	7.9			-1.3	marsh	linked basin	hwd	3.7	0.1	-1.0	0.1	-1.0	3.9	0.0	9569.0	4.0	-3.7	600.0	0.5	5023.1
530	UNB	7.1	0.0	5.1	30	1.5	5.5			-1.3	upland	upland	swd	10.5	0.3	-0.6	0.3	-0.6	3.8	0.0	8112.0	3.9	-2.5	600.0	0.5	4258.3
531	UNB	4.3	-0.4	4.6	60	1.8	7.5			-1.3	marsh	linked basin	none	8.7	0.1	-1.1	0.1	-1.1	3.9	0.0	8596.0	3.9	-3.7	600.0	0.5	4512.3
532	UNB	2.1	-0.8	4.8	40	1.6	7.6			-1.3	marsh	linked basin	none	0.9	0.1	-1.3	0.1	-1.3	4.1	0.0	10371.0	4.0	-3.7	600.0	0.5	5444.1
533	UNB	2.0	-0.8	5.1	80	1.9	6.5			-1.3	upland	upland	swd	9.3	0.1	-1.2	0.1	-1.2	4.1	0.0	7979.0	3.9	-2.5	600.0	0.5	4188.5
534	UNB	4.3	-0.4	5.3	40	1.6	7.7			-1.3	upland	upland	none	12.0	0.6	-0.2	0.6	-0.2	3.7	0.0	10655.0	4.0	-2.5	600.0	0.5	5593.2
535	UNB	1.6	-0.9	5.1	50	1.7	7.8			-1.4	marsh	linked basin	none	1.4	0.1	-1.2	0.1	-1.2	4.2	0.0	8847.0	3.9	-3.7	600.0	0.5	4644.1
536	UNB	3.3	-0.5	5.7	50	1.7	8.3			-1.4	marsh	linked basin	none	11.0	0.3	-0.5	0.3	-0.5	4.1	0.0	8455.0	3.9	-3.7	600.0	0.5	4438.3
537	UNB	2.2	-0.7	4.2	40	1.6	6.9			-1.3	swamp	lagg	none	12.5	0.3	-0.5	0.3	-0.5	3.1	0.0	9790.0	4.0	-5.0	600.0	0.5	5139.1
538	UNB	2.5	-0.7	4.6	30	1.5	8.8			-1.5	swamp	drainageway	none	8.1	0.0	-1.6	0.0	-1.6	3.1	0.0	10809.0	4.0	-5.0	600.0	0.5	5674.0
539	UNB	2.2	-0.7	4.3	30	1.5	8.5			-1.6	swamp	drainageway	none	8.7	0.1	-1.1	0.1	-1.1	3.1	0.0	10498.0	4.0	-5.0	600.0	0.5	5510.8
540	UNB	1.2	-1.1	4.4	30	1.5	8.1			-1.6	swamp	drainageway	none	6.0	0.1	-1.3	0.1	-1.3	3.1	0.0	11029.0	4.0	-5.0	600.0	0.5	5789.5

Plot	Site Name	DO	calc DO	pH	EC	log (ec)	Temp	Color	Sqrt (col)	log Slope	Class	Form	Type	Tree Ht	DTW (4ha)	DTW (log4ha)	DTW (1ha)	DTW (log1ha)	log fa 150m	Open Water	PRR	log (PRR)	log (HC)	evapo tran	ET/Ppt ratio	ratio x PRR
541	UNB	1.9	-0.8	4.9	20	1.3	6.7			-1.4	swamp	lagg	none	9.5	0.2	-0.7	0.2	-0.7	3.1	0.0	10448.0	4.0	-5.0	600.0	0.5	5484.5
542	UNB	1.6	-0.9	5.4	30	1.5	6.4			-1.3	swamp	lagg	swd	9.7	0.2	-0.8	0.2	-0.8	3.0	0.0	10536.0	4.0	-5.0	600.0	0.5	5530.7
543	UNB	2.7	-0.6	4.8	20	1.3	7.6			-1.6	swamp	lagg	none	13.5	0.1	-1.0	0.1	-1.1	3.2	0.0	11248.0	4.1	-5.0	600.0	0.5	5904.5
544	UNB	4.4	-0.4	4.4	40	1.6	7.0			-1.7	swamp	drainageway	none	8.1	0.1	-0.9	0.1	-1.0	3.3	0.0	10632.0	4.0	-5.0	600.0	0.5	5581.1
545	UNB	4.1	-0.4	4.3	40	1.6	8.4			-1.6	swamp	drainageway	shrub	7.1	0.1	-1.1	0.1	-1.1	3.3	0.0	10850.0	4.0	-5.0	600.0	0.5	5695.5
546	UNB	1.8	-0.8	4.7	20	1.3	7.3			-1.3	swamp	lagg	none	9.6	0.0	-1.4	0.0	-1.4	3.3	0.0	9257.0	4.0	-5.0	600.0	0.5	4859.3
547	UNB	7.8	0.1	5.2	20	1.3	7.7			-1.3	upland	upland	none	12.1	0.3	-0.6	0.3	-0.6	3.7	0.0	10391.0	4.0	-2.5	600.0	0.5	5454.6
548	UNB	5.9	-0.2	4.5	30	1.5	8.6			-1.4	swamp	lagg	none	10.9	0.1	-1.0	0.1	-1.0	3.7	0.0	10890.0	4.0	-5.0	600.0	0.5	5716.5
549	UNB	4.5	-0.3	4.8	20	1.3	7.7			-1.4	swamp	lagg	none	11.0	0.5	-0.3	0.5	-0.3	3.7	0.0	10568.0	4.0	-5.0	600.0	0.5	5547.5
550	UNB	4.0	-0.4	4.5	30	1.5	8.2			-1.3	swamp	lagg	none	9.7	0.3	-0.6	0.3	-0.6	3.7	0.0	10293.0	4.0	-5.0	600.0	0.5	5403.1
551	UNB	4.6	-0.3	4.4	30	1.5	8.5			-1.4	swamp	drainageway	none	10.2	0.1	-1.2	0.1	-1.2	3.7	0.0	10084.0	4.0	-5.0	600.0	0.5	5293.4
552	UNB	6.2	-0.1	4.5	30	1.5	8.8			-1.4	swamp	lagg	none	12.8	0.1	-1.0	0.1	-1.0	3.7	0.0	10025.0	4.0	-5.0	600.0	0.5	5262.5
553	UNB	6.0	-0.1	4.7	20	1.3	7.9			-1.4	upland	upland	none	11.9	0.3	-0.5	0.3	-0.5	3.7	0.0	10771.0	4.0	-2.5	600.0	0.5	5654.1
554	UNB	4.9	-0.3	4.5	20	1.3	8.3			-1.5	swamp	drainageway	none	10.4	0.2	-0.8	0.2	-0.8	3.7	0.0	10763.0	4.0	-5.0	600.0	0.5	5649.9
555	UNB	6.1	-0.1	4.6	20	1.3	6.9			-1.5	upland	upland	swd	12.6	0.3	-0.6	0.3	-0.6	3.6	0.0	11308.0	4.1	-2.5	600.0	0.5	5936.0
556	UNB	3.7	-0.5	4.3	30	1.5	7.5			-1.6	swamp	lagg	none	9.4	0.1	-0.9	0.1	-0.9	3.7	0.0	10871.0	4.0	-5.0	600.0	0.5	5706.6
557	UNB	1.3	-1.0	4.4	70	1.8	10.4			-1.5	bog	basin	swd	12.8	0.1	-0.9	0.1	-1.0	2.4	0.0	9262.0	4.0	-3.7	600.0	0.5	4861.9
558	UNB	3.6	-0.5	4.0	50	1.7	14.4			-1.6	bog	basin	swd	2.9	0.1	-1.2	0.0	-1.4	2.2	0.0	10069.0	4.0	-3.7	600.0	0.5	5285.6
559	UNB	3.8	-0.4	3.9	50	1.7	10.7			-1.6	bog	basin	swd	0.9	0.1	-1.1	0.1	-1.3	2.1	0.0	10792.0	4.0	-3.7	600.0	0.5	5665.1
560	UNB	3.5	-0.5	4.0	40	1.6	9.5			-1.6	bog	basin	swd	0.2	0.0	-1.5	0.0	-1.6	2.8	0.0	10818.0	4.0	-3.7	600.0	0.5	5678.7
561	UNB	2.6	-0.7	4.1	30	1.5	15.3			-1.6	bog	basin	none	0.2	0.0	-1.8	0.0	-2.2	3.0	0.0	10813.0	4.0	-3.7	600.0	0.5	5676.1
562	UNB	2.7	-0.6	5.2	30	1.5	15.4			-1.5	marsh	linked basin	none	1.7	0.1	-1.2	0.1	-1.2	3.0	1.0	10758.0	4.0	-3.7	600.0	0.5	5647.2
563	UNB	1.6	-0.9	5.1	50	1.7	15.3			-1.6	marsh	linked basin	none	0.2	0.1	-1.3	0.0	-1.3	3.4	1.0	10800.0	4.0	-3.7	600.0	0.5	5669.3
564	UNB	1.6	-0.9	4.1	30	1.5	13.1			-1.6	bog	basin	swd	0.2	0.0	-1.7	0.0	-1.9	3.2	0.0	10813.0	4.0	-3.7	600.0	0.5	5676.1
565	UNB	1.7	-0.9	3.9	40	1.6	12.1			-1.6	bog	basin	swd	0.4	0.0	-1.5	0.0	-1.6	3.1	0.0	10819.0	4.0	-3.7	600.0	0.5	5679.3
566	UNB	1.8	-0.8	4.0	40	1.6	11.5			-1.6	bog	basin	swd	0.2	0.0	-1.6	0.0	-2.3	2.7	0.0	10861.0	4.0	-3.7	600.0	0.5	5701.3
567	UNB	1.7	-0.9	4.0	50	1.7	13.3			-1.6	bog	basin	none	0.7	0.0	-1.4	0.0	-1.8	2.2	0.0	10792.0	4.0	-3.7	600.0	0.5	5665.1
568	UNB	2.6	-0.7	4.1	50	1.7	10.7			-1.6	bog	basin	none	5.6	0.0	-1.5	0.0	-2.2	2.2	0.0	9854.0	4.0	-3.7	600.0	0.5	5172.7
569	UNB	1.7	-0.9	5.1	40	1.6	12.1			-1.5	marsh	linked basin	swd	4.5	0.1	-1.1	0.1	-1.1	3.5	0.0	10158.0	4.0	-3.7	600.0	0.5	5332.3
570	UNB	1.9	-0.8	4.4	40	1.6	12.1			-1.4	marsh	linked basin	none	4.7	0.0	-1.4	0.0	-1.4	3.6	0.0	9502.0	4.0	-3.7	600.0	0.5	4987.9
571	UNB	3.4	-0.5	4.1	40	1.6	16.4			-1.5	marsh	linked basin	none	0.2	0.0	-1.8	0.0	-1.8	3.6	1.0	10713.0	4.0	-3.7	600.0	0.5	5623.6
572	UNB	3.5	-0.5	4.4	50	1.7	13.5			-1.5	marsh	linked basin	none	1.7	0.1	-1.1	0.1	-1.1	3.7	0.0	10218.0	4.0	-3.7	600.0	0.5	5363.8
573	UNB	1.7	-0.9	5.1	40	1.6	15.3			-1.5	marsh	linked basin	swd	0.2	0.0	-1.8	0.0	-1.8	3.7	1.0	10660.0	4.0	-3.7	600.0	0.5	5595.8
574	UNB	0.6	-1.3	5.0	40	1.6	11.5			-1.5	swamp	lagg	none	11.2	0.1	-1.0	0.1	-1.0	3.5	0.0	11319.0	4.1	-5.0	600.0	0.5	5941.7
575	UNB	4.0	-0.4	4.6	50	1.7	17.3			-1.4	marsh	linked basin	shrub	1.8	0.1	-1.1	0.1	-1.1	3.5	1.0	11199.0	4.0	-3.7	600.0	0.5	5878.7
576	UNB	1.4	-1.0	4.5	40	1.6	12.7			-1.5	swamp	lagg	none	14.6	0.0	-1.3	0.0	-1.3	3.5	0.0	11781.0	4.1	-5.0	600.0	0.5	6184.3
577	UNB	2.4	-0.7	4.5	20	1.3	15.6			-1.5	marsh	linked basin	shrub	0.2	0.0	-1.5	0.0	-1.5	3.5	1.0	10836.0	4.0	-3.7	600.0	0.5	5688.2
578	UNB	2.4	-0.7	4.9	30	1.5	18.6			-1.4	fen	horizontal	none	6.5	0.1	-1.0	0.1	-1.1	3.4	0.0	11560.0	4.1	-5.0	600.0	0.5	6068.2
579	UNB	2.4	-0.7	4.1	50	1.7	16.1			-1.5	marsh	linked basin	none	0.3	0.1	-1.0	0.1	-1.0	3.5	1.0	11251.0	4.1	-3.7	600.0	0.5	5906.0
580	UNB	0.6	-1.4	5.3	30	1.5	12.8			-1.6	swamp	lagg	shrub	10.3	0.1	-1.2	0.1	-1.2	3.7	0.0	11552.0	4.1	-5.0	600.0	0.5	6064.0
581	UNB	2.0	-0.8	4.2	40	1.6	12.6			-1.6	swamp	drainageway	none	6.7	0.0	-1.5	0.0	-1.5	3.8	0.0	11046.0	4.0	-5.0	600.0	0.5	5798.4
582	UNB	1.8	-0.8	4.5	40	1.6	12.8			-1.6	swamp	lagg	shrub	9.6	0.1	-1.0	0.1	-1.0	3.8	0.0	9836.0	4.0	-5.0	600.0	0.5	5163.3
583	UNB	0.8	-1.2	5.2	50	1.7	7.8			-1.6	swamp	lagg	none	12.3	0.1	-1.2	0.1	-1.2	3.8	0.0	10638.0	4.0	-5.0	600.0	0.5	5584.3
584	UNB	3.7	-0.5	4.7	40	1.6	11.2			-1.6	swamp	drainageway	none	8.9	0.0	-2.0	0.0	-2.0	3.8	0.0	10850.0	4.0	-5.0	600.0	0.5	5695.5
585	UNB	1.0	-1.1	5.4	60	1.8	10.0			-1.6	swamp	drainageway	none	10.5	0.1	-1.3	0.1	-1.3	3.7	0.0	11235.0	4.1	-5.0	600.0	0.5	5897.6

Plot	Site Name	DO	calc DO	pH	EC	log (ec)	Temp	Color	Sqrt (col)	log Slope	Class	Form	Type	Tree Ht	DTW (4ha)	DTW (log4ha)	DTW (1ha)	DTW (log1ha)	log fa 150m	Open Water	PRR	log (PRR)	log (HC)	evapo tran	ET/Ppt ratio	ratio x PRR
586	UNB	1.2	-1.1	5.5	50	1.7	7.8			-1.5	swamp	lagg	none	13.6	0.1	-1.0	0.1	-1.2	3.7	0.0	11210.0	4.0	-5.0	600.0	0.5	5884.5
587	UNB	1.7	-0.9	5.0	50	1.7	11.8			-1.4	swamp	lagg	hwd	13.1	0.1	-1.3	0.0	-1.4	3.7	0.0	11663.0	4.1	-5.0	600.0	0.5	6122.3
588	UNB	0.4	-1.5	6.2	110	2.0	10.0			-1.5	swamp	drainageway	swd	9.4	0.0	-1.4	0.0	-1.4	3.8	0.0	9716.0	4.0	-5.0	600.0	0.5	5100.3
589	UNB	7.4	0.0	6.6	220	2.3	12.3			-1.5	swamp	lagg	swd	12.1	0.1	-0.8	0.1	-0.8	3.8	0.0	10856.0	4.0	-5.0	600.0	0.5	5698.7
590	UNB	5.0	-0.3	5.4	30	1.5	10.6			-1.5	swamp	lagg	swd	12.8	0.3	-0.5	0.3	-0.5	3.9	0.0	9395.0	4.0	-5.0	600.0	0.5	4931.8
591	UNB	4.4	-0.4	5.5	60	1.8	10.8			-1.4	swamp	drainageway	swd	7.2	0.0	-1.4	0.0	-1.4	3.9	0.0	10352.0	4.0	-5.0	600.0	0.5	5434.1
592	UNB	8.0	0.1	6.2	80	1.9	10.9			-1.4	swamp	drainageway	swd	16.8	0.2	-0.6	0.2	-0.6	3.9	0.0	10844.0	4.0	-5.0	600.0	0.5	5692.4
593	UNB	3.2	-0.5	5.4	50	1.7	15.0			-1.3	marsh	linked basin	swd	7.3	0.1	-1.1	0.1	-1.1	3.9	0.0	11345.0	4.1	-3.7	600.0	0.5	5955.4
594	UNB	1.1	-1.1	5.3	80	1.9	9.5			-1.3	marsh	linked basin	swd	1.1	0.1	-1.0	0.1	-1.0	3.9	0.0	10569.0	4.0	-3.7	600.0	0.5	5548.0
595	UNB	1.8	-0.8	5.4	30	1.5	10.0			-1.3	marsh	linked basin	none	0.2	0.1	-1.2	0.1	-1.2	4.0	0.0	10599.0	4.0	-3.7	600.0	0.5	5563.8
596	UNB	1.1	-1.1	5.1	40	1.6	16.5			-1.4	marsh	linked basin	none	0.5	0.0	-1.7	0.0	-1.7	4.0	0.0	10827.0	4.0	-3.7	600.0	0.5	5683.5
597	UNB	0.8	-1.3	4.8	40	1.6	14.0			-1.4	marsh	linked basin	none	0.4	0.2	-0.8	0.2	-0.8	3.9	0.0	10768.0	4.0	-3.7	600.0	0.5	5652.5
598	UNB	3.8	-0.4	4.6	30	1.5	11.0			-1.3	bog	domed	none	0.6	0.1	-0.9	0.1	-1.0	3.9	0.0	10871.0	4.0	-1.6	600.0	0.5	5706.6
599	UNB	1.9	-0.8	4.8	40	1.6	15.0			-1.3	marsh	linked basin	none	0.3	0.2	-0.8	0.1	-0.8	3.9	0.0	10815.0	4.0	-3.7	600.0	0.5	5677.2
600	UNB	2.0	-0.8	4.3	30	1.5	9.5			-1.4	marsh	linked basin	shrub	0.3	0.1	-1.0	0.1	-1.1	3.4	0.0	10807.0	4.0	-3.7	600.0	0.5	5673.0
601	UNB	0.6	-1.4	4.5	30	1.5	13.0			-1.4	fen	horizontal	shrub	0.5	0.1	-1.0	0.1	-1.1	3.7	0.0	10785.0	4.0	-5.0	600.0	0.5	5661.4
602	UNB	1.2	-1.1	4.7	30	1.5	13.0			-1.3	marsh	linked basin	none	0.2	0.2	-0.7	0.2	-0.8	3.8	0.0	10716.0	4.0	-3.7	600.0	0.5	5625.2
603	UNB	0.7	-1.3	5.1	60	1.8	16.0			-1.3	marsh	linked basin	none	0.2	0.2	-0.7	0.2	-0.7	3.8	0.0	10754.0	4.0	-3.7	600.0	0.5	5645.1
604	UNB	3.6	-0.5	5.7	70	1.8	12.0			-1.4	fen	horizontal	shrub	7.9	0.1	-0.8	0.1	-0.8	3.1	0.0	11699.0	4.1	-5.0	600.0	0.5	6141.2
605	UNB	0.8	-1.2	5.4	30	1.5	17.0			-1.3	fen	horizontal	shrub	0.8	0.0	-1.8	0.0	-1.8	3.1	0.0	10761.0	4.0	-5.0	600.0	0.5	5648.8
606	UNB	0.9	-1.2	5.3	40	1.6	15.0			-1.3	marsh	linked basin	none	0.5	0.1	-0.9	0.1	-0.9	3.1	0.0	10830.0	4.0	-3.7	600.0	0.5	5685.0
607	UNB	0.9	-1.2	5.0	60	1.8	14.0			-1.5	fen	horizontal	none	8.8	0.1	-1.2	0.1	-1.2	3.6	0.0	10290.0	4.0	-5.0	600.0	0.5	5401.6
608	UNB	1.0	-1.1	4.7	70	1.8	16.5			-1.5	fen	horizontal	shrub	3.1	0.0	-1.8	0.0	-1.8	3.6	1.0	10619.0	4.0	-5.0	600.0	0.5	5574.3
609	UNB	1.3	-1.0	4.6	50	1.7	16.5			-1.6	fen	horizontal	shrub	4.1	0.0	-1.4	0.0	-1.4	3.6	1.0	10938.0	4.0	-5.0	600.0	0.5	5741.7
610	UNB	1.4	-1.0	4.7	40	1.6	16.0			-1.6	fen	horizontal	shrub	7.8	0.1	-1.3	0.1	-1.3	3.6	1.0	10618.0	4.0	-5.0	600.0	0.5	5573.8
611	UNB	1.6	-0.9	4.9	50	1.7	16.5			-1.6	fen	horizontal	shrub	3.7	0.1	-1.1	0.1	-1.2	3.6	1.0	10970.0	4.0	-5.0	600.0	0.5	5758.5
612	UNB	1.4	-1.0	4.6	60	1.8	17.0			-1.5	fen	horizontal	shrub	4.2	0.1	-1.1	0.1	-1.1	3.0	1.0	10823.0	4.0	-5.0	600.0	0.5	5681.4
613	UNB	2.8	-0.6	4.7	40	1.6	17.5			-1.5	swamp	drainageway	shrub	12.4	0.1	-1.0	0.1	-1.1	2.4	0.0	10405.0	4.0	-5.0	600.0	0.5	5461.9
614	UNB	1.2	-1.1	5.2	30	1.5	16.5			-1.5	fen	horizontal	shrub	3.8	0.1	-1.1	0.1	-1.2	3.3	1.0	10784.0	4.0	-5.0	600.0	0.5	5660.9
615	UNB	1.1	-1.1	5.0	50	1.7	17.5			-1.6	fen	horizontal	none	5.4	0.1	-1.1	0.1	-1.3	3.5	1.0	11088.0	4.0	-5.0	600.0	0.5	5820.5
616	UNB	0.7	-1.3	5.1	40	1.6	17.0			-1.5	fen	horizontal	shrub	9.0	0.1	-1.2	0.1	-1.2	3.6	1.0	10590.0	4.0	-5.0	600.0	0.5	5559.1
617	UNB	1.4	-1.0	5.0	20	1.3	16.0			-1.6	fen	horizontal	shrub	4.2	0.0	-1.7	0.0	-1.7	3.6	1.0	10835.0	4.0	-5.0	600.0	0.5	5687.7
618	UNB	0.7	-1.3	4.8	30	1.5	16.5			-1.5	fen	horizontal	shrub	2.4	0.0	-2.0	0.0	-2.1	3.6	1.0	10721.0	4.0	-5.0	600.0	0.5	5627.8
619	UNB	0.7	-1.3	4.9	20	1.3	14.0			-1.4	fen	horizontal	shrub	5.9	0.1	-1.2	0.1	-1.3	3.6	0.0	10790.0	4.0	-5.0	600.0	0.5	5664.0
620	UNB	2.0	-0.8	4.8	50	1.7	11.5			-1.5	fen	horizontal	none	14.7	0.1	-1.2	0.1	-1.2	2.9	0.0	11417.0	4.1	-5.0	600.0	0.5	5993.2
621	UNB	3.4	-0.5	4.4	60	1.8	13.0			-1.5	bog	basin	shrub	5.0	0.1	-1.2	0.1	-1.3	2.9	0.0	10941.0	4.0	-3.7	600.0	0.5	5743.3
622	UNB	5.0	-0.3	3.8	60	1.8	12.0			-1.5	bog	domed	swd	2.9	0.0	-1.3	0.0	-1.4	2.9	0.0	10849.0	4.0	-1.6	600.0	0.5	5695.0
623	UNB	5.8	-0.2	3.9	40	1.6	14.0			-1.6	bog	domed	swd	0.1	0.0	-1.8	0.0	-2.4	2.9	0.0	10808.0	4.0	-1.6	600.0	0.5	5673.5
624	UNB	3.0	-0.6	3.8	40	1.6	13.0			-1.4	bog	domed	swd	0.6	0.1	-1.2	0.1	-1.3	3.0	0.0	10795.0	4.0	-1.6	600.0	0.5	5666.7
625	UNB	4.6	-0.3	3.8	80	1.9	13.0			-1.4	bog	domed	swd	0.3	0.1	-1.2	0.1	-1.2	3.1	0.0	10850.0	4.0	-1.6	600.0	0.5	5695.5
626	UNB	7.0	0.0	3.8	100	2.0	12.0			-1.5	bog	domed	swd	1.1	0.1	-1.3	0.0	-1.4	2.6	0.0	10980.0	4.0	-1.6	600.0	0.5	5763.8
627	UNB	3.0	-0.6	4.4	120	2.1	12.5			-1.5	bog	basin	shrub	5.5	0.1	-1.1	0.1	-1.1	2.7	0.0	11199.0	4.0	-3.7	600.0	0.5	5878.7
628	UNB	0.6	-1.3	5.6	80	1.9	11.5			-1.5	fen	horizontal	none	11.6	0.1	-0.9	0.1	-1.0	2.7	1.0	11709.0	4.1	-5.0	600.0	0.5	6146.5
629	UNB	0.8	-1.3	5.4	80	1.9	10.5			-1.5	fen	horizontal	none	6.3	0.0	-1.6	0.0	-1.6	2.6	0.0	11340.0	4.1	-5.0	600.0	0.5	5952.8
630	UNB	1.0	-1.1	5.2	90	2.0	13.0			-1.3	marsh	linked basin	shrub	8.0	0.2	-0.7	0.2	-0.7	3.2	0.0	9459.0	4.0	-3.7	600.0	0.5	4965.4

Plot	Site Name	DO	calc DO	pH	EC	log (ec)	Temp	Color	Sqrt (col)	log Slope	Class	Form	Type	Tree Ht	DTW (4ha)	DTW (log4ha)	DTW (1ha)	DTW (log1ha)	log fa 150m	Open Water	PRR	log (PRR)	log (HC)	evapo tran	ET/Ppt ratio	ratio x PRR
631	UNB	0.9	-1.2	5.1	190	2.3	14.5			-1.3	marsh	linked basin	shrub	7.2	0.1	-0.9	0.1	-0.9	3.2	1.0	8661.0	3.9	-3.7	600.0	0.5	4546.5
632	UNB	1.9	-0.8	4.8	190	2.3	15.0			-1.2	fen	horizontal	shrub	8.7	0.0	-1.3	0.0	-1.3	3.2	0.0	9639.0	4.0	-5.0	600.0	0.5	5059.8
633	UNB	1.7	-0.9	4.4	190	2.3	14.0			-1.2	marsh	linked basin	none	7.5	0.3	-0.5	0.3	-0.5	3.2	0.0	9786.0	4.0	-3.7	600.0	0.5	5137.0
634	UNB	1.0	-1.1	4.6	170	2.2	15.0			-1.3	fen	horizontal	none	5.6	0.1	-1.0	0.1	-1.0	3.7	0.0	9529.0	4.0	-5.0	600.0	0.5	5002.1
635	UNB	0.5	-1.4	5.3	110	2.0	14.0			-1.5	fen	horizontal	shrub	7.3	0.0	-1.4	0.0	-1.4	3.9	1.0	9553.0	4.0	-5.0	600.0	0.5	5014.7
636	UNB	0.4	-1.5	4.7	30	1.5	12.0			-1.3	swamp	lagg	shrub	8.6	0.1	-1.0	0.1	-1.0	3.1	0.0	9847.0	4.0	-5.0	600.0	0.5	5169.0
637	UNB	0.5	-1.4	4.6	30	1.5	12.0			-1.5	swamp	drainageway	none	7.8	0.1	-1.0	0.1	-1.0	3.1	0.0	11181.0	4.0	-5.0	600.0	0.5	5869.3
638	UNB	1.1	-1.1	4.2	40	1.6	13.0			-1.6	swamp	drainageway	shrub	8.3	0.0	-1.3	0.0	-1.3	3.1	0.0	10510.0	4.0	-5.0	600.0	0.5	5517.1
639	UNB	2.9	-0.6	4.2	40	1.6	13.0			-1.6	swamp	drainageway	none	6.0	0.1	-1.0	0.1	-1.0	3.1	1.0	10742.0	4.0	-5.0	600.0	0.5	5638.8
640	UNB	0.6	-1.4	5.0	40	1.6	12.0			-1.5	swamp	lagg	shrub	12.3	0.2	-0.7	0.2	-0.7	3.1	0.0	11429.0	4.1	-5.0	600.0	0.5	5999.5
641	UNB	0.8	-1.2	4.9	30	1.5	12.5			-1.5	swamp	drainageway	shrub	15.3	0.1	-1.0	0.1	-1.0	3.1	0.0	11567.0	4.1	-5.0	600.0	0.5	6071.9
642	UNB	2.7	-0.6	4.1	40	1.6	12.0			-1.5	swamp	drainageway	shrub	7.0	0.0	-1.4	0.0	-1.4	3.1	0.0	10112.0	4.0	-5.0	600.0	0.5	5308.1
643	UNB	0.5	-1.5	4.5	50	1.7	13.0			-1.5	swamp	drainageway	none	7.4	0.1	-1.2	0.1	-1.2	3.1	1.0	11376.0	4.1	-5.0	600.0	0.5	5971.7
644	UNB	2.4	-0.7	4.7	20	1.3	10.5			-1.4	swamp	drainageway	shrub	4.8	0.0	-1.4	0.0	-1.4	3.1	0.0	11096.0	4.0	-5.0	600.0	0.5	5824.7
645	UNB	0.6	-1.4	4.6	30	1.5	11.5			-1.5	swamp	lagg	shrub	9.8	0.1	-0.9	0.1	-1.0	3.1	0.0	9066.0	4.0	-5.0	600.0	0.5	4759.1
646	UNB	0.4	-1.5	4.6	40	1.6	13.0			-1.5	swamp	drainageway	shrub	5.0	0.0	-1.3	0.0	-1.3	3.1	0.0	10817.0	4.0	-5.0	600.0	0.5	5678.2
647	UNB	2.0	-0.8	4.4	30	1.5	13.5			-1.5	swamp	drainageway	none	6.3	0.1	-0.9	0.1	-0.9	3.1	1.0	11072.0	4.0	-5.0	600.0	0.5	5812.1
648	UNB	2.0	-0.8	4.1	40	1.6	12.5			-1.5	swamp	drainageway	none	7.7	0.1	-0.9	0.1	-0.9	3.1	0.0	11081.0	4.0	-5.0	600.0	0.5	5816.8
649	UNB	1.1	-1.1	4.2	40	1.6	12.0			-1.5	swamp	lagg	none	12.9	0.1	-0.9	0.1	-0.9	3.1	1.0	11568.0	4.1	-5.0	600.0	0.5	6072.4
650	UNB	0.8	-1.2	4.2	40	1.6	14.4			-1.6	swamp	lagg	none	12.5	0.0	-1.6	0.0	-1.6	3.7	0.0	9436.0	4.0	-5.0	600.0	0.5	4953.3
651	UNB	2.6	-0.6	4.5	40	1.6	14.2			-1.6	swamp	drainageway	swd	7.9	0.1	-1.3	0.1	-1.3	3.7	1.0	9026.0	4.0	-5.0	600.0	0.5	4738.1
652	UNB	0.6	-1.4	4.6	30	1.5	10.8			-1.6	swamp	lagg	hwd	7.0	0.0	-1.6	0.0	-1.6	3.8	0.0	10973.0	4.0	-5.0	600.0	0.5	5760.1
653	UNB	3.1	-0.6	4.6	30	1.5	12.1			-1.6	swamp	lagg	none	10.1	0.1	-1.2	0.1	-1.2	3.7	0.0	11140.0	4.0	-5.0	600.0	0.5	5847.8
654	UNB	0.4	-1.5	4.5	30	1.5	12.9			-1.7	swamp	drainageway	none	8.8	0.1	-1.1	0.1	-1.1	3.7	0.0	10430.0	4.0	-5.0	600.0	0.5	5475.1
655	UNB	1.2	-1.1	4.4	30	1.5	14.6			-1.7	swamp	drainageway	none	12.5	0.0	-1.4	0.0	-1.4	3.7	0.0	9162.0	4.0	-5.0	600.0	0.5	4809.4
656	UNB	1.1	-1.1	4.0	40	1.6	10.8			-1.7	swamp	lagg	none	9.5	0.0	-2.1	0.0	-2.1	3.6	0.0	11221.0	4.1	-5.0	600.0	0.5	5890.3
657	UNB	2.3	-0.7	3.9	60	1.8	10.7			-1.6	swamp	lagg	swd	10.5	0.2	-0.8	0.2	-0.8	3.6	0.0	11243.0	4.1	-5.0	600.0	0.5	5901.8
658	UNB	1.2	-1.0	4.1	60	1.8	10.8			-1.6	swamp	lagg	none	10.7	0.0	-1.8	0.0	-1.8	3.5	0.0	9811.0	4.0	-5.0	600.0	0.5	5150.1
659	UNB	0.5	-1.5	4.6	40	1.6	12.9			-1.6	swamp	drainageway	none	10.7	0.0	-1.3	0.0	-1.3	3.7	0.0	9955.0	4.0	-5.0	600.0	0.5	5225.7
660	UNB	1.6	-0.9	4.6	30	1.5	12.8			-1.6	swamp	lagg	shrub	7.6	0.1	-1.3	0.1	-1.3	3.7	0.0	11355.0	4.1	-5.0	600.0	0.5	5960.6
661	UNB	0.9	-1.2	5.1	80	1.9	15.0			-1.6	fen	horizontal	shrub	10.5	0.1	-1.0	0.1	-1.0	3.9	0.0	10969.0	4.0	-5.0	600.0	0.5	5758.0
662	UNB	1.3	-1.0	5.4	50	1.7	16.5			-1.6	fen	horizontal	shrub	7.7	0.0	-1.4	0.0	-1.4	3.9	1.0	11148.0	4.0	-5.0	600.0	0.5	5852.0
663	UNB	0.5	-1.4	4.7	30	1.5	16.5			-1.6	fen	horizontal	shrub	6.7	0.1	-1.2	0.1	-1.2	3.9	1.0	11027.0	4.0	-5.0	600.0	0.5	5788.5
664	UNB	2.5	-0.7	4.3	40	1.6	16.0			-1.6	fen	horizontal	none	8.1	0.1	-1.0	0.1	-1.0	3.9	0.0	11123.0	4.0	-5.0	600.0	0.5	5838.8
665	UNB	3.4	-0.5	3.9	50	1.7	14.5			-1.6	swamp	drainageway	none	13.2	0.1	-1.3	0.1	-1.3	3.8	0.0	11689.0	4.1	-5.0	600.0	0.5	6136.0
666	UNB	1.7	-0.9	3.7	60	1.8	13.5			-1.5	bog	basin	shrub	6.5	0.1	-0.9	0.1	-0.9	3.8	0.0	11190.0	4.0	-3.7	600.0	0.5	5874.0
667	UNB	3.1	-0.6	3.7	60	1.8	12.0			-1.4	bog	basin	swd	4.8	0.2	-0.7	0.2	-0.8	3.7	0.0	10966.0	4.0	-3.7	600.0	0.5	5756.4
668	UNB	4.1	-0.4	3.7	60	1.8	12.0			-1.3	bog	domed	swd	1.7	0.2	-0.8	0.1	-1.0	2.6	0.0	10814.0	4.0	-1.6	600.0	0.5	5676.6
669	UNB	2.4	-0.7	3.7	60	1.8	14.0			-1.4	bog	basin	swd	4.0	0.1	-0.8	0.1	-1.0	2.3	0.0	10729.0	4.0	-3.7	600.0	0.5	5632.0
670	UNB	4.2	-0.4	3.9	50	1.7	15.0			-1.4	bog	basin	none	4.5	0.1	-0.9	0.0	-1.3	2.3	0.0	10888.0	4.0	-3.7	600.0	0.5	5715.5
671	UNB	3.0	-0.6	3.9	50	1.7	16.0			-1.4	bog	basin	none	2.9	0.1	-1.0	0.0	-1.5	2.4	0.0	10952.0	4.0	-3.7	600.0	0.5	5749.1
672	UNB	4.8	-0.3	3.8	50	1.7	14.0			-1.3	bog	domed	swd	1.0	0.1	-0.9	0.0	-1.3	2.4	0.0	10907.0	4.0	-1.6	600.0	0.5	5725.5
673	UNB	1.4	-1.0	3.8	40	1.6	10.5			-1.3	bog	domed	swd	0.4	0.1	-0.8	0.1	-1.1	2.2	0.0	10815.0	4.0	-1.6	600.0	0.5	5677.2
674	UNB	3.6	-0.5	3.8	50	1.7	13.0			-1.3	bog	basin	swd	4.2	0.1	-0.8	0.0	-1.4	3.7	0.0	11053.0	4.0	-3.7	600.0	0.5	5802.1
675	UNB	3.0	-0.6	3.7	60	1.8	12.0			-1.4	bog	basin	swd	6.4	0.2	-0.8	0.2	-0.8	3.7	0.0	10733.0	4.0	-3.7	600.0	0.5	5634.1

Plot	Site Name	DO	calc DO	pH	EC	log (ec)	Temp	Color	Sqrt (col)	log Slope	Class	Form	Type	Tree Ht	DTW (4ha)	DTW (log4ha)	DTW (1ha)	DTW (log1ha)	log fa 150m	Open Water	PRR	log (PRR)	log (HC)	evapo tran	ET/Ppt ratio	ratio x PRR
676	UNB	1.5	-0.9	3.7	50	1.7	12.0			-1.5	fen	horizontal	shrub	8.1	0.1	-1.1	0.1	-1.1	3.8	0.0	10801.0	4.0	-5.0	600.0	0.5	5669.8
677	UNB	1.7	-0.9	4.3	30	1.5	15.5			-1.6	fen	horizontal	shrub	18.9	0.1	-1.1	0.1	-1.1	3.9	1.0	10931.0	4.0	-5.0	600.0	0.5	5738.1
678	UNB	0.9	-1.2	4.9	40	1.6	16.5			-1.6	fen	horizontal	shrub	9.3	0.0	-1.5	0.0	-1.5	3.9	1.0	10517.0	4.0	-5.0	600.0	0.5	5520.7
679	UNB	1.0	-1.1	5.1	60	1.8	16.0			-1.6	fen	horizontal	shrub	6.7	0.0	-1.6	0.0	-1.6	3.9	1.0	11107.0	4.0	-5.0	600.0	0.5	5830.4
680	UNB	3.3	-0.5	4.8	70	1.8	15.0			-1.6	swamp	drainageway	shrub	13.6	0.0	-1.4	0.0	-1.4	4.0	1.0	11131.0	4.0	-5.0	600.0	0.5	5843.0
681	UNB	1.1	-1.1	5.0	50	1.7	11.4	622.2	24.9	-1.5	bog	basin	swd	12.8	0.1	-0.9	0.1	-1.0	2.4	0.0	9262.0	4.0	-3.7	600.0	0.5	4861.9
682	UNB	4.4	-0.4	4.4	50	1.7	12.5	230.0	15.2	-1.6	bog	basin	swd	2.9	0.1	-1.2	0.0	-1.4	2.2	0.0	10069.0	4.0	-3.7	600.0	0.5	5285.6
683	UNB	3.8	-0.4	4.3	50	1.7	12.2	310.0	17.6	-1.6	bog	basin	swd	0.9	0.1	-1.1	0.1	-1.3	2.1	0.0	10792.0	4.0	-3.7	600.0	0.5	5665.1
684	UNB	3.6	-0.5	4.0	50	1.7	13.2	320.0	17.9	-1.6	bog	basin	swd	0.2	0.0	-1.5	0.0	-1.6	2.8	0.0	10818.0	4.0	-3.7	600.0	0.5	5678.7
685	UNB	2.6	-0.6	4.1	40	1.6	13.9	150.0	12.2	-1.6	bog	basin	none	0.2	0.0	-1.8	0.0	-2.2	3.0	0.0	10813.0	4.0	-3.7	600.0	0.5	5676.1
686	UNB	2.3	-0.7	5.0	40	1.6	12.6	150.0	12.2	-1.5	marsh	linked basin	none	1.7	0.1	-1.2	0.1	-1.2	3.0	1.0	10758.0	4.0	-3.7	600.0	0.5	5647.2
687	UNB	2.0	-0.8	5.2	80	1.9	14.8	110.0	10.5	-1.6	marsh	linked basin	none	0.2	0.1	-1.3	0.0	-1.3	3.4	1.0	10800.0	4.0	-3.7	600.0	0.5	5669.3
688	UNB	1.6	-0.9	4.0	40	1.6	13.5	170.0	13.0	-1.6	bog	basin	swd	0.2	0.0	-1.7	0.0	-1.9	3.2	0.0	10813.0	4.0	-3.7	600.0	0.5	5676.1
689	UNB	3.5	-0.5	3.8	40	1.6	12.7	200.0	14.1	-1.6	bog	basin	swd	0.4	0.0	-1.5	0.0	-1.6	3.1	0.0	10819.0	4.0	-3.7	600.0	0.5	5679.3
690	UNB	2.2	-0.7	3.9	40	1.6	12.9	240.0	15.5	-1.6	bog	basin	swd	0.2	0.0	-1.6	0.0	-2.3	2.6	0.0	10861.0	4.0	-3.7	600.0	0.5	5701.3
691	UNB	2.6	-0.7	3.9	40	1.6	11.9	330.0	18.2	-1.6	bog	basin	none	0.7	0.0	-1.4	0.0	-1.8	2.2	0.0	10792.0	4.0	-3.7	600.0	0.5	5665.1
692	UNB	1.9	-0.8	3.7	50	1.7	11.6	640.5	25.3	-1.6	bog	basin	none	5.6	0.0	-1.5	0.0	-2.2	2.2	0.0	9854.0	4.0	-3.7	600.0	0.5	5172.7
693	UNB	4.1	-0.4	4.7	20	1.3	12.1	180.0	13.4	-1.5	marsh	linked basin	swd	4.5	0.1	-1.1	0.1	-1.1	3.5	0.0	10158.0	4.0	-3.7	600.0	0.5	5332.3
694	UNB	1.3	-1.0	4.4	30	1.5	11.9	410.0	20.2	-1.4	marsh	linked basin	none	4.7	0.0	-1.4	0.0	-1.4	3.6	0.0	9502.0	4.0	-3.7	600.0	0.5	4987.9
695	UNB	3.3	-0.5	4.3	30	1.5	14.1	140.0	11.8	-1.5	marsh	linked basin	none	0.2	0.0	-1.8	0.0	-1.8	3.6	1.0	10713.0	4.0	-3.7	600.0	0.5	5623.6
696	UNB	2.0	-0.8	4.5	40	1.6	12.8	240.0	15.5	-1.5	marsh	linked basin	none	1.7	0.1	-1.1	0.1	-1.1	3.7	0.0	10218.0	4.0	-3.7	600.0	0.5	5363.8
697	UNB	4.6	-0.3	4.7	30	1.5	14.2	140.0	11.8	-1.5	marsh	linked basin	swd	0.2	0.0	-1.8	0.0	-1.8	3.7	1.0	10660.0	4.0	-3.7	600.0	0.5	5595.8
698	UNB	0.9	-1.2	5.1	30	1.5	12.3	110.0	10.5	-1.5	swamp	lagg	none	11.2	0.1	-1.0	0.1	-1.0	3.5	0.0	11319.0	4.1	-5.0	600.0	0.5	5941.7
699	UNB	4.0	-0.4	4.6	20	1.3	13.3	170.0	13.0	-1.4	marsh	linked basin	shrub	1.8	0.1	-1.1	0.1	-1.1	3.5	1.0	11199.0	4.0	-3.7	600.0	0.5	5878.7
700	UNB	1.2	-1.0	4.1	40	1.6	12.9	320.0	17.9	-1.5	swamp	lagg	none	14.6	0.0	-1.3	0.0	-1.3	3.5	0.0	11781.0	4.1	-5.0	600.0	0.5	6184.3
701	UNB	2.6	-0.7	3.9	30	1.5	14.2	160.0	12.6	-1.5	marsh	linked basin	shrub	0.2	0.0	-1.5	0.0	-1.5	3.5	1.0	10836.0	4.0	-3.7	600.0	0.5	5688.2
702	UNB	2.5	-0.7	4.1	20	1.3	12.2	200.0	14.1	-1.4	fen	horizontal	none	6.5	0.1	-1.0	0.1	-1.1	3.4	0.0	11560.0	4.1	-5.0	600.0	0.5	6068.2
703	UNB	4.0	-0.4	4.3	30	1.5	14.3	270.0	16.4	-1.5	marsh	linked basin	none	0.3	0.1	-1.0	0.1	-1.0	3.5	1.0	11251.0	4.1	-3.7	600.0	0.5	5906.0
704	UNB	1.7	-0.9	5.7	30	1.5	13.3	380.0	19.5	-1.6	swamp	lagg	shrub	10.3	0.1	-1.2	0.1	-1.2	3.7	0.0	11552.0	4.1	-5.0	600.0	0.5	6064.0
705	UNB	2.5	-0.7	4.5	30	1.5	13.2	480.0	21.9	-1.6	swamp	drainageway	none	6.7	0.0	-1.5	0.0	-1.5	3.8	0.0	11046.0	4.0	-5.0	600.0	0.5	5798.4
706	UNB	0.7	-1.3	4.7	30	1.5	13.2	603.9	24.6	-1.6	swamp	lagg	shrub	9.6	0.1	-1.0	0.1	-1.0	3.8	0.0	9836.0	4.0	-5.0	600.0	0.5	5163.3
707	UNB	0.9	-1.2	5.0	40	1.6	12.8	530.7	23.0	-1.6	swamp	lagg	none	12.3	0.1	-1.2	0.1	-1.2	3.8	0.0	10638.0	4.0	-5.0	600.0	0.5	5584.3
708	UNB	4.4	-0.4	4.4	30	1.5	12.6	440.0	21.0	-1.6	swamp	drainageway	none	8.9	0.0	-2.0	0.0	-2.0	3.8	0.0	10850.0	4.0	-5.0	600.0	0.5	5695.5
709	UNB	2.1	-0.8	5.1	40	1.6	12.9	512.4	22.6	-1.6	swamp	drainageway	none	10.5	0.1	-1.3	0.1	-1.3	3.7	0.0	11235.0	4.1	-5.0	600.0	0.5	5897.6
710	UNB	2.8	-0.6	5.3	40	1.6	12.5	300.0	17.3	-1.5	swamp	lagg	none	13.6	0.1	-1.0	0.1	-1.2	3.7	0.0	11210.0	4.0	-5.0	600.0	0.5	5884.5
711	UNB	1.4	-1.0	4.6	30	1.5	12.5	320.0	17.9	-1.4	swamp	lagg	hwd	13.1	0.1	-1.3	0.0	-1.4	3.7	0.0	11663.0	4.1	-5.0	600.0	0.5	6122.3
712	UNB	0.7	-1.3	5.6	90	2.0	12.2	160.0	12.6	-1.5	swamp	drainageway	swd	9.4	0.0	-1.4	0.0	-1.4	3.8	0.0	9716.0	4.0	-5.0	600.0	0.5	5100.3
713	UNB	8.0	0.1	6.4	230	2.4	12.3	140.0	11.8	-1.5	swamp	lagg	swd	12.1	0.1	-0.8	0.1	-0.8	3.8	0.0	10856.0	4.0	-5.0	600.0	0.5	5698.7
714	UNB	6.6	-0.1	5.2	30	1.5	12.9	110.0	10.5	-1.5	swamp	lagg	swd	12.8	0.3	-0.5	0.3	-0.5	3.9	0.0	9395.0	4.0	-5.0	600.0	0.5	4931.8
715	UNB	3.5	-0.5	5.3	70	1.8	13.3	140.0	11.8	-1.4	swamp	drainageway	swd	7.2	0.0	-1.4	0.0	-1.4	3.9	0.0	10352.0	4.0	-5.0	600.0	0.5	5434.1
716	UNB	4.3	-0.4	4.9	30	1.5	12.9	200.0	14.1	-1.4	swamp	drainageway	swd	16.8	0.2	-0.6	0.2	-0.6	3.9	0.0	10844.0	4.0	-5.0	600.0	0.5	5692.4
717	UNB	2.2	-0.7	5.3	40	1.6	12.8	150.0	12.2	-1.3	marsh	linked basin	swd	7.3	0.1	-1.1	0.1	-1.1	3.9	0.0	11345.0	4.1	-3.7	600.0	0.5	5955.4
718	UNB	2.6	-0.7	5.4	40	1.6	11.7	380.0	19.5	-1.3	marsh	linked basin	swd	1.1	0.1	-1.0	0.1	-1.0	3.9	0.0	10569.0	4.0	-3.7	600.0	0.5	5548.0
719	UNB	2.8	-0.6	5.5	30	1.5	11.0	250.0	15.8	-1.3	marsh	linked basin	none	0.2	0.1	-1.2	0.1	-1.2	4.0	0.0	10599.0	4.0	-3.7	600.0	0.5	5563.8
720	UNB	0.8	-1.2	5.3	40	1.6	12.5	350.0	18.7	-1.4	marsh	linked basin	none	0.5	0.0	-1.7	0.0	-1.7	4.0	0.0	10827.0	4.0	-3.7	600.0	0.5	5683.5

Plot	Site Name	DO	calc DO	pH	EC	log (ec)	Temp	Color	Sqrt (col)	log Slope	Class	Form	Type	Tree Ht	DTW (4ha)	DTW (log4ha)	DTW (1ha)	DTW (log1ha)	log fa 150m	Open Water	PRR	log (PRR)	log (HC)	evapo tran	ET/Ppt ratio	ratio x PRR
721	UNB	1.9	-0.8	4.5	30	1.5	12.9	695.4	26.4	-1.4	marsh	linked basin	none	0.4	0.2	-0.8	0.2	-0.8	3.9	0.0	10768.0	4.0	-3.7	600.0	0.5	5652.5
722	UNB	3.6	-0.5	4.0	40	1.6	11.1	439.2	21.0	-1.3	bog	domed	none	0.6	0.1	-0.9	0.1	-1.0	3.9	0.0	10871.0	4.0	-1.6	600.0	0.5	5706.6
723	UNB	2.6	-0.6	4.8	30	1.5	11.1	380.0	19.5	-1.3	marsh	linked basin	none	0.3	0.2	-0.8	0.1	-0.8	3.9	0.0	10815.0	4.0	-3.7	600.0	0.5	5677.2
724	UNB	9.6	0.3	5.8	30	1.5	11.8	170.0	13.0	-1.3	marsh	linked basin	none	7.7	0.2	-0.7	0.2	-0.7	3.9	0.0	9345.0	4.0	-3.7	600.0	0.5	4905.5
725	UNB	3.1	-0.6	5.9	170	2.2	11.2	60.0	7.7	-1.4	marsh	linked basin	shrub	1.1	0.1	-1.0	0.1	-1.1	3.3	0.0	10223.0	4.0	-3.7	600.0	0.5	5366.4
726	UNB	2.3	-0.7	4.1	40	1.6	10.6	410.0	20.2	-1.4	marsh	linked basin	shrub	0.3	0.1	-1.0	0.1	-1.1	3.4	0.0	10807.0	4.0	-3.7	600.0	0.5	5673.0
727	UNB	3.5	-0.5	4.4	30	1.5	11.9	490.0	22.1	-1.4	fen	horizontal	shrub	0.5	0.1	-1.0	0.1	-1.1	3.7	0.0	10785.0	4.0	-5.0	600.0	0.5	5661.4
728	UNB	3.4	-0.5	4.2	40	1.6	11.7	490.0	22.1	-1.3	marsh	linked basin	none	0.2	0.2	-0.7	0.2	-0.8	3.8	0.0	10716.0	4.0	-3.7	600.0	0.5	5625.2
729	UNB	2.3	-0.7	5.1	50	1.7	11.7	230.0	15.2	-1.3	marsh	linked basin	none	0.2	0.2	-0.7	0.2	-0.7	3.8	0.0	10754.0	4.0	-3.7	600.0	0.5	5645.1
730	UNB	6.6	-0.1	6.4	450	2.7	11.8	440.0	21.0	-1.3	marsh	linked basin	shrub	9.8	0.2	-0.7	0.2	-0.7	3.8	0.0	11342.0	4.1	-3.7	600.0	0.5	5953.8
731	UNB	5.1	-0.3	5.9	120	2.1	11.5	90.0	9.5	-1.4	fen	horizontal	shrub	7.9	0.1	-0.8	0.1	-0.8	3.1	0.0	11699.0	4.1	-5.0	600.0	0.5	6141.2
732	UNB	1.9	-0.8	5.5	30	1.5	13.5	170.0	13.0	-1.3	fen	horizontal	shrub	0.8	0.0	-1.8	0.0	-1.8	3.1	0.0	10761.0	4.0	-5.0	600.0	0.5	5648.8
733	UNB	2.8	-0.6	5.5	50	1.7	12.1	230.0	15.2	-1.3	marsh	linked basin	none	0.5	0.1	-0.9	0.1	-0.9	3.1	0.0	10830.0	4.0	-3.7	600.0	0.5	5685.0
734	UNB	3.7	-0.5	5.3	50	1.7	12.2	220.0	14.8	-1.5	fen	horizontal	none	8.8	0.1	-1.2	0.1	-1.2	3.6	0.0	10290.0	4.0	-5.0	600.0	0.5	5401.6
735	UNB	2.8	-0.6	5.0	20	1.3	9.7	170.0	13.0	-1.5	fen	horizontal	shrub	3.1	0.0	-1.8	0.0	-1.8	3.6	1.0	10619.0	4.0	-5.0	600.0	0.5	5574.3
736	UNB	2.7	-0.6	5.3	30	1.5	11.4	150.0	12.2	-1.6	fen	horizontal	shrub	4.1	0.0	-1.4	0.0	-1.4	3.6	1.0	10938.0	4.0	-5.0	600.0	0.5	5741.7
737	UNB	1.1	-1.1	5.2	30	1.5	11.0	270.0	16.4	-1.6	fen	horizontal	shrub	7.8	0.1	-1.3	0.1	-1.3	3.6	1.0	10618.0	4.0	-5.0	600.0	0.5	5573.8
738	UNB	1.8	-0.8	4.9	40	1.6	9.6	250.0	15.8	-1.6	fen	horizontal	shrub	3.7	0.1	-1.1	0.1	-1.2	3.6	1.0	10970.0	4.0	-5.0	600.0	0.5	5758.5
739	UNB	1.1	-1.1	5.0	30	1.5	11.2	190.0	13.8	-1.5	fen	horizontal	shrub	4.2	0.1	-1.1	0.1	-1.1	3.0	1.0	10823.0	4.0	-5.0	600.0	0.5	5681.4
740	UNB	1.3	-1.0	4.7	30	1.5	10.8	210.0	14.5	-1.5	swamp	drainageway	shrub	12.4	0.1	-1.0	0.1	-1.1	2.4	0.0	10405.0	4.0	-5.0	600.0	0.5	5461.9
741	UNB	1.1	-1.1	5.5	60	1.8	10.9	130.0	11.4	-1.5	fen	horizontal	shrub	3.8	0.1	-1.1	0.1	-1.2	3.3	1.0	10784.0	4.0	-5.0	600.0	0.5	5660.9
742	UNB	1.2	-1.1	5.5	40	1.6	9.6	170.0	13.0	-1.6	fen	horizontal	none	5.4	0.1	-1.1	0.1	-1.3	3.5	1.0	11088.0	4.0	-5.0	600.0	0.5	5820.5
743	UNB	0.8	-1.2	5.4	30	1.5	11.3	150.0	12.2	-1.5	fen	horizontal	shrub	9.0	0.1	-1.2	0.1	-1.2	3.6	1.0	10590.0	4.0	-5.0	600.0	0.5	5559.1
744	UNB	2.3	-0.7	4.6	30	1.5	12.3	200.0	14.1	-1.6	fen	horizontal	shrub	4.2	0.0	-1.7	0.0	-1.7	3.6	1.0	10835.0	4.0	-5.0	600.0	0.5	5687.7
745	UNB	2.2	-0.7	4.7	30	1.5	9.5	290.0	17.0	-1.5	fen	horizontal	shrub	2.4	0.0	-2.0	0.0	-2.1	3.6	1.0	10721.0	4.0	-5.0	600.0	0.5	5627.8
746	UNB	1.2	-1.0	4.2	30	1.5	11.8	190.0	13.8	-1.4	fen	horizontal	shrub	5.9	0.1	-1.2	0.1	-1.3	3.6	0.0	10790.0	4.0	-5.0	600.0	0.5	5664.0
747	UNB	1.8	-0.8	4.8	30	1.5	12.2	190.0	13.8	-1.5	fen	horizontal	none	14.7	0.1	-1.2	0.1	-1.2	2.9	0.0	11417.0	4.1	-5.0	600.0	0.5	5993.2
748	UNB	2.8	-0.6	4.6	70	1.8	12.4	470.0	21.7	-1.5	bog	basin	shrub	5.0	0.1	-1.2	0.1	-1.3	2.9	0.0	10941.0	4.0	-3.7	600.0	0.5	5743.3
749	UNB	5.0	-0.3	4.0	50	1.7	13.0	490.0	22.1	-1.5	bog	domed	swd	2.9	0.0	-1.3	0.0	-1.4	2.9	0.0	10849.0	4.0	-1.6	600.0	0.5	5695.0
750	UNB	4.8	-0.3	4.1	30	1.5	13.5	250.0	15.8	-1.6	bog	domed	swd	0.1	0.0	-1.8	0.0	-2.4	2.9	0.0	10808.0	4.0	-1.6	600.0	0.5	5673.5
751	UNB	3.8	-0.4	3.8	50	1.7	12.1	350.0	18.7	-1.4	bog	domed	swd	0.6	0.1	-1.2	0.1	-1.3	3.0	0.0	10795.0	4.0	-1.6	600.0	0.5	5666.7
752	UNB	5.0	-0.3	4.2	60	1.8	13.0	400.0	20.0	-1.4	bog	domed	swd	0.3	0.1	-1.2	0.1	-1.2	3.1	0.0	10850.0	4.0	-1.6	600.0	0.5	5695.5
753	UNB	3.6	-0.5	4.1	60	1.8	12.4	380.0	19.5	-1.5	bog	domed	swd	1.1	0.1	-1.3	0.0	-1.4	2.6	0.0	10980.0	4.0	-1.6	600.0	0.5	5763.8
754	UNB	1.6	-0.9	4.7	70	1.8	13.0	460.0	21.4	-1.5	bog	basin	shrub	5.5	0.1	-1.1	0.1	-1.1	2.7	0.0	11199.0	4.0	-3.7	600.0	0.5	5878.7
755	UNB	0.5	-1.4	5.3	40	1.6	11.8	450.0	21.2	-1.5	fen	horizontal	none	11.6	0.1	-0.9	0.1	-1.0	2.7	1.0	11709.0	4.1	-5.0	600.0	0.5	6146.5
756	UNB	0.8	-1.2	5.4	40	1.6	11.8	210.0	14.5	-1.5	fen	horizontal	none	6.3	0.0	-1.6	0.0	-1.6	2.6	0.0	11340.0	4.1	-5.0	600.0	0.5	5952.8
757	UNB	5.2	-0.2	6.0	20	1.3	13.0	120.0	11.0	-1.3	marsh	linked basin	shrub	8.0	0.2	-0.7	0.2	-0.7	3.2	0.0	9459.0	4.0	-3.7	600.0	0.5	4965.4
758	UNB	1.2	-1.0	6.3	30	1.5	11.9	250.0	15.8	-1.3	marsh	linked basin	shrub	1.9	0.1	-1.3	0.1	-1.3	3.5	1.0	10573.0	4.0	-3.7	600.0	0.5	5550.1
759	UNB	1.9	-0.8	6.3	30	1.5	12.2	240.0	15.5	-1.4	marsh	linked basin	shrub	1.0	0.0	-1.3	0.0	-1.3	3.9	1.0	10709.0	4.0	-3.7	600.0	0.5	5621.5
760	UNB	2.6	-0.7	5.7	20	1.3	12.0	100.0	10.0	-1.4	marsh	linked basin	none	1.0	0.0	-1.7	0.0	-1.7	3.9	1.0	10721.0	4.0	-3.7	600.0	0.5	5627.8
761	UNB	1.4	-1.0	5.9	30	1.5	11.9	260.0	16.1	-1.3	marsh	linked basin	shrub	1.7	0.1	-0.9	0.1	-0.9	3.3	1.0	10295.0	4.0	-3.7	600.0	0.5	5404.2
762	UNB	3.2	-0.5	5.5	20	1.3	12.2	110.0	10.5	-1.3	marsh	linked basin	shrub	7.2	0.1	-0.9	0.1	-0.9	3.2	1.0	8661.0	3.9	-3.7	600.0	0.5	4546.5
763	UNB	4.8	-0.3	5.9	30	1.5	12.9	40.0	6.3	-1.2	fen	horizontal	shrub	8.7	0.0	-1.3	0.0	-1.3	3.2	0.0	9639.0	4.0	-5.0	600.0	0.5	5059.8
764	UNB	7.5	0.0	6.0	20	1.3	12.0	120.0	11.0	-1.2	marsh	linked basin	shrub	1.9	0.1	-1.1	0.1	-1.1	3.2	1.0	10259.0	4.0	-3.7	600.0	0.5	5385.3
765	UNB	3.1	-0.6	5.9	150	2.2	13.1	170.0	13.0	-1.2	marsh	linked basin	none	7.5	0.3	-0.5	0.3	-0.5	3.2	0.0	9786.0	4.0	-3.7	600.0	0.5	5137.0

Plot	Site Name	DO	calc DO	pH	EC	log (ec)	Temp	Color	Sqrt (col)	log Slope	Class	Form	Type	Tree Ht	DTW (4ha)	DTW (log4ha)	DTW (1ha)	DTW (log1ha)	log fa 150m	Open Water	PRR	log (PRR)	log (HC)	evapo tran	ET/Ppt ratio	ratio x PRR
766	UNB	2.4	-0.7	5.7	20	1.3	12.9	200.0	14.1	-1.2	marsh	linked basin	shrub	0.9	0.0	-1.5	0.0	-1.5	3.5	1.0	10334.0	4.0	-3.7	600.0	0.5	5424.7
767	UNB	4.9	-0.3	5.9	20	1.3	11.9	80.0	8.9	-1.3	fen	horizontal	none	5.6	0.1	-1.0	0.1	-1.0	3.7	0.0	9529.0	4.0	-5.0	600.0	0.5	5002.1
768	UNB	1.3	-1.0	4.8	30	1.5	13.2	370.0	19.2	-1.4	marsh	linked basin	shrub	0.6	0.0	-1.6	0.0	-1.6	3.8	0.0	10775.0	4.0	-3.7	600.0	0.5	5656.2
769	UNB	1.2	-1.1	4.9	20	1.3	12.5	250.0	15.8	-1.5	fen	horizontal	shrub	7.3	0.0	-1.4	0.0	-1.4	3.9	1.0	9553.0	4.0	-5.0	600.0	0.5	5014.7
770	UNB	4.3	-0.4	4.5	20	1.3	12.9	260.0	16.1	-1.5	fen	horizontal	shrub	2.7	0.0	-1.5	0.0	-1.5	4.0	1.0	10518.0	4.0	-5.0	600.0	0.5	5521.3
771	UNB	2.2	-0.7	4.2	30	1.5	13.7	370.0	19.2	-1.4	fen	horizontal	shrub	1.1	0.1	-1.0	0.1	-1.0	4.0	0.0	10813.0	4.0	-5.0	600.0	0.5	5676.1
772	UNB	4.3	-0.4	4.0	40	1.6	13.7	320.0	17.9	-1.4	bog	basin	shrub	1.1	0.1	-1.0	0.1	-1.0	4.0	0.0	10809.0	4.0	-3.7	600.0	0.5	5674.0
773	UNB	0.5	-1.4	4.5	30	1.5	12.2	270.0	16.4	-1.3	swamp	lagg	shrub	8.6	0.1	-1.0	0.1	-1.0	3.1	0.0	9847.0	4.0	-5.0	600.0	0.5	5169.0
774	UNB	3.0	-0.6	4.4	20	1.3	12.1	280.0	16.7	-1.5	swamp	drainageway	none	7.8	0.1	-1.0	0.1	-1.0	3.1	0.0	11181.0	4.0	-5.0	600.0	0.5	5869.3
775	UNB	2.9	-0.6	4.0	40	1.6	12.5	480.0	21.9	-1.6	swamp	drainageway	shrub	8.3	0.0	-1.3	0.0	-1.3	3.1	0.0	10510.0	4.0	-5.0	600.0	0.5	5517.1
776	UNB	4.1	-0.4	4.1	40	1.6	12.6	420.0	20.5	-1.6	swamp	drainageway	none	6.0	0.1	-1.0	0.1	-1.0	3.1	1.0	10742.0	4.0	-5.0	600.0	0.5	5638.8
777	UNB	1.2	-1.0	4.3	30	1.5	12.1	390.0	19.7	-1.5	swamp	lagg	shrub	12.3	0.2	-0.7	0.2	-0.7	3.1	0.0	11429.0	4.1	-5.0	600.0	0.5	5999.5
778	UNB	2.0	-0.8	4.4	30	1.5	12.2	280.0	16.7	-1.5	swamp	drainageway	shrub	15.3	0.1	-1.0	0.1	-1.0	3.1	0.0	11567.0	4.1	-5.0	600.0	0.5	6071.9
779	UNB	2.8	-0.6	4.0	40	1.6	12.4	494.1	22.2	-1.5	swamp	drainageway	shrub	7.0	0.0	-1.4	0.0	-1.4	3.1	0.0	10112.0	4.0	-5.0	600.0	0.5	5308.1
780	UNB	3.9	-0.4	4.3	20	1.3	12.1	240.0	15.5	-1.5	swamp	drainageway	none	7.4	0.1	-1.2	0.1	-1.2	3.1	1.0	11376.0	4.1	-5.0	600.0	0.5	5971.7
781	UNB	3.6	-0.5	4.3	20	1.3	11.6	240.0	15.5	-1.4	swamp	drainageway	shrub	4.8	0.0	-1.4	0.0	-1.4	3.1	0.0	11096.0	4.0	-5.0	600.0	0.5	5824.7
782	UNB	0.5	-1.4	4.3	30	1.5	11.5	290.0	17.0	-1.5	swamp	lagg	shrub	9.8	0.1	-0.9	0.1	-1.0	3.1	0.0	9066.0	4.0	-5.0	600.0	0.5	4759.1
783	UNB	0.6	-1.3	4.4	30	1.5	11.8	320.0	17.9	-1.5	swamp	drainageway	shrub	5.0	0.0	-1.3	0.0	-1.3	3.1	0.0	10817.0	4.0	-5.0	600.0	0.5	5678.2
784	UNB	2.5	-0.7	4.3	30	1.5	11.8	320.0	17.9	-1.5	swamp	drainageway	none	6.3	0.1	-0.9	0.1	-0.9	3.1	1.0	11072.0	4.0	-5.0	600.0	0.5	5812.1
785	UNB	1.0	-1.1	4.0	40	1.6	12.5	290.0	17.0	-1.5	swamp	drainageway	none	7.7	0.1	-0.9	0.1	-0.9	3.1	0.0	11081.0	4.0	-5.0	600.0	0.5	5816.8
786	UNB	2.1	-0.8	4.0	40	1.6	12.5	420.0	20.5	-1.5	swamp	lagg	none	12.9	0.1	-0.9	0.1	-0.9	3.1	1.0	11568.0	4.1	-5.0	600.0	0.5	6072.4
787	UNB	1.5	-0.9	4.7	30	1.5	10.0	220.0	14.8	-1.6	swamp	lagg	none	12.5	0.0	-1.6	0.0	-1.6	3.7	0.0	9436.0	4.0	-5.0	600.0	0.5	4953.3
788	UNB	3.3	-0.5	4.7	20	1.3	9.7	230.0	15.2	-1.6	swamp	drainageway	swd	7.9	0.1	-1.3	0.1	-1.3	3.7	1.0	9026.0	4.0	-5.0	600.0	0.5	4738.1
789	UNB	0.5	-1.4	4.3	30	1.5	11.8	280.0	16.7	-1.6	swamp	lagg	hwd	7.0	0.0	-1.6	0.0	-1.6	3.8	0.0	10973.0	4.0	-5.0	600.0	0.5	5760.1
790	UNB	1.3	-1.0	4.4	30	1.5	11.6	410.0	20.2	-1.6	swamp	lagg	none	10.1	0.1	-1.2	0.1	-1.2	3.7	0.0	11140.0	4.0	-5.0	600.0	0.5	5847.8
791	UNB	3.1	-0.6	4.7	20	1.3	9.2	250.0	15.8	-1.7	swamp	drainageway	none	8.8	0.1	-1.1	0.1	-1.1	3.7	0.0	10430.0	4.0	-5.0	600.0	0.5	5475.1
792	UNB	1.4	-1.0	4.7	20	1.3	9.6	250.0	15.8	-1.7	swamp	drainageway	none	12.5	0.0	-1.4	0.0	-1.4	3.7	0.0	9162.0	4.0	-5.0	600.0	0.5	4809.4
793	UNB	2.2	-0.7	4.0	40	1.6	11.1	430.0	20.7	-1.7	swamp	lagg	none	9.5	0.0	-2.1	0.0	-2.1	3.6	0.0	11221.0	4.1	-5.0	600.0	0.5	5890.3
794	UNB	1.3	-1.0	4.1	40	1.6	11.4	490.0	22.1	-1.6	swamp	lagg	swd	10.5	0.2	-0.8	0.2	-0.8	3.6	0.0	11243.0	4.1	-5.0	600.0	0.5	5901.8
795	UNB	1.7	-0.9	4.3	30	1.5	11.1	290.0	17.0	-1.6	swamp	lagg	none	10.7	0.0	-1.8	0.0	-1.8	3.5	0.0	9811.0	4.0	-5.0	600.0	0.5	5150.1
796	UNB	2.8	-0.6	4.5	20	1.3	9.8	260.0	16.1	-1.6	swamp	drainageway	none	10.7	0.0	-1.3	0.0	-1.3	3.7	0.0	9955.0	4.0	-5.0	600.0	0.5	5225.7
797	UNB	1.8	-0.9	4.4	20	1.3	10.4	420.0	20.5	-1.6	swamp	lagg	shrub	7.6	0.1	-1.3	0.1	-1.3	3.7	0.0	11355.0	4.1	-5.0	600.0	0.5	5960.6
798	UNB	1.1	-1.1	5.4	80	1.9	12.0	250.0	15.8	-1.6	fen	horizontal	shrub	10.5	0.1	-1.0	0.1	-1.0	3.9	0.0	10969.0	4.0	-5.0	600.0	0.5	5758.0
799	UNB	0.6	-1.3	5.6	50	1.7	12.4	230.0	15.2	-1.6	fen	horizontal	shrub	7.7	0.0	-1.4	0.0	-1.4	3.9	1.0	11148.0	4.0	-5.0	600.0	0.5	5852.0
800	UNB	0.7	-1.3	5.1	30	1.5	12.4	280.0	16.7	-1.6	fen	horizontal	shrub	6.7	0.1	-1.2	0.1	-1.2	3.9	1.0	11027.0	4.0	-5.0	600.0	0.5	5788.5
801	UNB	2.1	-0.8	4.5	30	1.5	12.3	240.0	15.5	-1.6	fen	horizontal	none	8.1	0.1	-1.0	0.1	-1.0	3.9	0.0	11123.0	4.0	-5.0	600.0	0.5	5838.8
802	UNB	2.5	-0.7	4.1	40	1.6	11.9	400.0	20.0	-1.6	swamp	drainageway	none	13.2	0.1	-1.3	0.1	-1.3	3.8	0.0	11689.0	4.1	-5.0	600.0	0.5	6136.0
803	UNB	2.9	-0.6	3.8	60	1.8	12.0	470.0	21.7	-1.5	bog	basin	shrub	6.5	0.1	-0.9	0.1	-0.9	3.8	0.0	11190.0	4.0	-3.7	600.0	0.5	5874.0
804	UNB	2.0	-0.8	3.9	50	1.7	11.5	450.0	21.2	-1.4	bog	basin	swd	4.8	0.2	-0.7	0.2	-0.8	3.7	0.0	10966.0	4.0	-3.7	600.0	0.5	5756.4
805	UNB	3.5	-0.5	3.8	60	1.8	11.5	420.0	20.5	-1.3	bog	domed	swd	1.7	0.2	-0.8	0.1	-1.0	2.6	0.0	10814.0	4.0	-1.6	600.0	0.5	5676.6
806	UNB	2.6	-0.6	3.9	50	1.7	11.2	350.0	18.7	-1.4	bog	basin	swd	4.0	0.1	-0.8	0.1	-1.0	2.3	0.0	10729.0	4.0	-3.7	600.0	0.5	5632.0
807	UNB	2.0	-0.8	4.1	40	1.6	12.1	340.0	18.4	-1.4	bog	basin	none	4.5	0.1	-0.9	0.0	-1.3	2.3	0.0	10888.0	4.0	-3.7	600.0	0.5	5715.5
808	UNB	5.1	-0.3	4.0	50	1.7	12.5	470.0	21.7	-1.4	bog	basin	none	2.9	0.1	-1.0	0.0	-1.5	2.4	0.0	10952.0	4.0	-3.7	600.0	0.5	5749.1
809	UNB	3.3	-0.5	3.9	40	1.6	12.2	310.0	17.6	-1.3	bog	domed	swd	1.0	0.1	-0.9	0.0	-1.3	2.4	0.0	10907.0	4.0	-1.6	600.0	0.5	5725.5
810	UNB	3.8	-0.4	3.8	40	1.6	12.0	280.0	16.7	-1.3	bog	domed	swd	0.4	0.1	-0.8	0.1	-1.1	2.2	0.0	10815.0	4.0	-1.6	600.0	0.5	5677.2

Plot	Site Name	DO	calc DO	pH	EC	log (ec)	Temp	Color	Sqrt (col)	log Slope	Class	Form	Type	Tree Ht	DTW (4ha)	DTW (log4ha)	DTW (1ha)	DTW (log1ha)	log fa 150m	Open Water	PRR	log (PRR)	log (HC)	evapo tran	ET/Ppt ratio	ratio x PRR
811	UNB	3.3	-0.5	3.9	50	1.7	11.4	400.0	20.0	-1.3	bog	basin	swd	4.2	0.1	-0.8	0.0	-1.4	3.7	0.0	11053.0	4.0	-3.7	600.0	0.5	5802.1
812	UNB	5.5	-0.2	3.9	50	1.7	13.6	732.0	27.1	-1.4	bog	basin	swd	6.4	0.2	-0.8	0.2	-0.8	3.7	0.0	10733.0	4.0	-3.7	600.0	0.5	5634.1
813	UNB	1.1	-1.1	3.9	50	1.7	12.1	460.0	21.4	-1.5	fen	horizontal	shrub	8.1	0.1	-1.1	0.1	-1.1	3.8	0.0	10801.0	4.0	-5.0	600.0	0.5	5669.8
814	UNB	3.5	-0.5	4.1	30	1.5	12.7	320.0	17.9	-1.6	fen	horizontal	shrub	18.9	0.1	-1.1	0.1	-1.1	3.9	1.0	10931.0	4.0	-5.0	600.0	0.5	5738.1
815	UNB	1.2	-1.0	4.8	40	1.6	13.2	260.0	16.1	-1.6	fen	horizontal	shrub	9.3	0.0	-1.5	0.0	-1.5	3.9	1.0	10517.0	4.0	-5.0	600.0	0.5	5520.7
816	UNB	0.9	-1.2	5.1	70	1.8	12.8	270.0	16.4	-1.6	fen	horizontal	shrub	6.7	0.0	-1.6	0.0	-1.6	3.9	1.0	11107.0	4.0	-5.0	600.0	0.5	5830.4
817	UNB	0.6	-1.3	4.9	80	1.9	13.2	240.0	15.5	-1.6	swamp	drainageway	shrub	13.6	0.0	-1.4	0.0	-1.4	4.0	1.0	11131.0	4.0	-5.0	600.0	0.5	5843.0
818	UNB	2.4	-0.7	5.2	80	1.9	10.6	320.0	17.9	-1.6	bog	basin	none	9.4	0.1	-1.2	0.1	-1.2	2.2	0.0	9574.0	4.0	-3.7	600.0	0.5	5025.7
819	UNB	2.2	-0.7	4.4	50	1.7	11.2	180.0	13.4	-1.6	bog	basin	swd	2.2	0.0	-1.4	0.0	-1.4	2.2	0.0	10589.0	4.0	-3.7	600.0	0.5	5558.5
820	UNB	3.2	-0.5	4.2	40	1.6	11.7	230.0	15.2	-1.6	bog	basin	swd	0.2	0.1	-1.2	0.1	-1.2	2.3	0.0	10818.0	4.0	-3.7	600.0	0.5	5678.7
821	UNB	5.5	-0.2	4.1	50	1.7	11.2	330.0	18.2	-1.5	bog	basin	swd	0.2	0.1	-1.2	0.1	-1.2	2.3	0.0	10833.0	4.0	-3.7	600.0	0.5	5686.6
822	UNB	3.7	-0.5	4.0	50	1.7	11.3	270.0	16.4	-1.5	bog	basin	swd	0.2	0.1	-1.1	0.1	-1.1	2.4	0.0	10855.0	4.0	-3.7	600.0	0.5	5698.2
823	UNB	2.7	-0.6	4.0	50	1.7	11.1	340.0	18.4	-1.5	bog	basin	swd	1.7	0.1	-1.2	0.1	-1.2	2.4	0.0	10787.0	4.0	-3.7	600.0	0.5	5662.5
824	UNB	3.0	-0.6	4.0	40	1.6	11.2	500.0	22.4	-1.5	bog	basin	swd	1.4	0.1	-1.3	0.1	-1.3	2.5	0.0	10783.0	4.0	-3.7	600.0	0.5	5660.4
825	UNB	4.2	-0.4	4.1	60	1.8	11.7	350.0	18.7	-1.5	bog	basin	swd	1.3	0.1	-1.3	0.1	-1.3	2.5	0.0	10861.0	4.0	-3.7	600.0	0.5	5701.3
826	UNB	6.2	-0.1	5.2	20	1.3	11.6	190.0	13.8	-1.4	upland	upland	swd	10.6	0.3	-0.5	0.3	-0.5	3.5	0.0	11200.0	4.0	-2.5	600.0	0.5	5879.3
827	UNB	2.8	-0.6	5.3	60	1.8	12.9	270.0	16.4	-1.4	marsh	linked basin	swd	12.4	0.2	-0.7	0.2	-0.7	3.6	0.0	10619.0	4.0	-3.7	600.0	0.5	5574.3
828	UNB	0.6	-1.4	5.3	30	1.5	12.9	130.0	11.4	-1.4	marsh	linked basin	swd	6.8	0.3	-0.6	0.3	-0.6	3.6	0.0	11507.0	4.1	-3.7	600.0	0.5	6040.4
829	UNB	7.4	0.0	5.5	20	1.3	11.5	210.0	14.5	-1.4	upland	upland	swd	8.7	0.1	-1.2	0.1	-1.2	3.6	0.0	10704.0	4.0	-2.5	600.0	0.5	5618.9
830	UNB	1.2	-1.0	5.1	60	1.8	12.5	400.0	20.0	-1.4	marsh	linked basin	swd	12.1	0.4	-0.4	0.4	-0.4	3.6	0.0	10575.0	4.0	-3.7	600.0	0.5	5551.2
831	UNB	0.5	-1.4	5.6	70	1.8	13.3	350.0	18.7	-1.4	marsh	linked basin	none	5.5	0.4	-0.4	0.4	-0.4	3.6	0.0	11441.0	4.1	-3.7	600.0	0.5	6005.8
832	UNB	4.8	-0.3	5.7	30	1.5	12.5	200.0	14.1	-1.3	fen	horizontal	none	0.6	0.1	-1.0	0.1	-1.0	3.6	0.0	10771.0	4.0	-5.0	600.0	0.5	5654.1
833	UNB	10.3	0.4	6.1	90	2.0	12.4	150.0	12.2	-1.4	fen	horizontal	swd	1.5	0.2	-0.7	0.2	-0.7	3.6	0.0	10273.0	4.0	-5.0	600.0	0.5	5392.7
834	UNB	1.7	-0.9	5.6	30	1.5	12.5	220.0	14.8	-1.6	fen	horizontal	swd	10.1	0.1	-1.0	0.1	-1.0	3.7	0.0	11389.0	4.1	-5.0	600.0	0.5	5978.5
835	UNB	0.6	-1.4	5.6	50	1.7	10.8	120.0	11.0	-1.6	fen	horizontal	shrub	9.3	0.0	-1.6	0.0	-1.6	3.7	0.0	10736.0	4.0	-5.0	600.0	0.5	5635.7
836	UNB	5.5	-0.2	5.3	40	1.6	11.7	280.0	16.7	-1.5	swamp	drainageway	shrub	13.2	0.1	-0.9	0.1	-0.9	3.9	0.0	9613.0	4.0	-5.0	600.0	0.5	5046.2
837	UNB	7.9	0.1	5.9	50	1.7	11.2	200.0	14.1	-1.4	swamp	drainageway	none	10.7	0.2	-0.6	0.2	-0.6	3.9	0.0	9801.0	4.0	-5.0	600.0	0.5	5144.9
838	UNB	3.7	-0.5	5.7	110	2.0	12.2	210.0	14.5	-1.4	swamp	drainageway	shrub	10.1	0.1	-1.3	0.1	-1.3	3.9	0.0	11186.0	4.0	-5.0	600.0	0.5	5871.9
839	UNB	9.6	0.3	6.1	30	1.5	11.5	860.1	29.3	-1.4	swamp	drainageway	none	10.8	0.3	-0.5	0.3	-0.5	3.9	0.0	10301.0	4.0	-5.0	600.0	0.5	5407.3
840	UNB	1.0	-1.1	6.2	160	2.2	11.3	50.0	7.1	-1.4	swamp	drainageway	shrub	13.9	0.1	-1.3	0.1	-1.3	3.9	0.0	10393.0	4.0	-5.0	600.0	0.5	5455.6
841	UNB	6.4	-0.1	6.1	140	2.1	10.5	180.0	13.4	-1.2	marsh	linked basin	shrub	12.2	0.1	-1.1	0.1	-1.1	3.9	0.0	10442.0	4.0	-3.7	600.0	0.5	5481.4
842	UNB	0.5	-1.4	5.6	30	1.5	10.5	250.0	15.8	-1.2	marsh	linked basin	none	0.3	0.1	-1.1	0.1	-1.1	3.9	0.0	10568.0	4.0	-3.7	600.0	0.5	5547.5
843	UNB	3.5	-0.5	5.0	30	1.5	10.5	320.0	17.9	-1.3	marsh	linked basin	none	0.3	0.0	-1.6	0.0	-1.6	3.9	0.0	10640.0	4.0	-3.7	600.0	0.5	5585.3
844	UNB	1.8	-0.8	4.8	30	1.5	11.2	310.0	17.6	-1.4	marsh	linked basin	none	0.4	0.0	-1.6	0.0	-1.6	4.0	0.0	10828.0	4.0	-3.7	600.0	0.5	5684.0
845	UNB	4.5	-0.3	4.3	40	1.6	11.5	310.0	17.6	-1.4	marsh	linked basin	none	0.1	0.0	-1.4	0.0	-1.4	4.0	0.0	10784.0	4.0	-3.7	600.0	0.5	5660.9
846	UNB	3.2	-0.5	4.0	40	1.6	11.3	350.0	18.7	-1.4	marsh	linked basin	none	0.4	0.1	-1.2	0.1	-1.2	4.0	0.0	10790.0	4.0	-3.7	600.0	0.5	5664.0
847	UNB	3.8	-0.4	4.7	30	1.5	11.5	340.0	18.4	-1.4	marsh	linked basin	swd	0.7	0.1	-1.1	0.1	-1.1	3.9	0.0	10788.0	4.0	-3.7	600.0	0.5	5663.0
848	UNB	3.5	-0.5	5.1	20	1.3	10.5	190.0	13.8	-1.2	fen	horizontal	shrub	1.9	0.1	-0.9	0.1	-0.9	3.6	0.0	10873.0	4.0	-5.0	600.0	0.5	5707.6
849	UNB	2.7	-0.6	5.1	30	1.5	10.2	230.0	15.2	-1.1	fen	horizontal	none	8.4	0.1	-1.1	0.1	-1.1	3.6	0.0	11168.0	4.0	-5.0	600.0	0.5	5862.5
850	UNB	1.2	-1.1	5.8	40	1.6	9.8	70.0	8.4	-1.1	fen	horizontal	none	9.8	0.7	-0.1	0.7	-0.1	2.0	0.0	11272.0	4.1	-5.0	600.0	0.5	5917.1
851	UNB	3.4	-0.5	5.2	30	1.5	10.8	320.0	17.9	-1.1	marsh	linked basin	none	2.4	0.1	-1.2	0.1	-1.2	1.9	0.0	10758.0	4.0	-3.7	600.0	0.5	5647.2
852	UNB	4.5	-0.3	4.5	40	1.6	10.4	410.0	20.2	-1.4	marsh	linked basin	shrub	0.7	0.0	-1.4	0.0	-1.4	2.5	0.0	10794.0	4.0	-3.7	600.0	0.5	5666.1
853	UNB	2.6	-0.6	4.2	40	1.6	9.8	440.0	21.0	-1.5	marsh	linked basin	swd	1.9	0.0	-1.5	0.0	-1.5	3.7	0.0	10821.0	4.0	-3.7	600.0	0.5	5680.3
854	UNB	5.7	-0.2	3.5	100	2.0	11.3	567.3	23.8	-1.4	bog	domed	swd	1.1	0.1	-1.0	0.1	-1.0	3.9	0.0	10826.0	4.0	-1.6	600.0	0.5	5682.9
855	UNB	2.0	-0.8	4.7	30	1.5	10.9	310.0	17.6	-1.3	swamp	lagg	none	14.5	0.3	-0.6	0.3	-0.6	3.6	0.0	9617.0	4.0	-5.0	600.0	0.5	5048.3

Plot	Site Name	DO	calc DO	pH	EC	log (ec)	Temp	Color	Sqrt (col)	log Slope	Class	Form	Type	Tree Ht	DTW (4ha)	DTW (log4ha)	DTW (1ha)	DTW (log1ha)	log fa 150m	Open Water	PRR	log (PRR)	log (HC)	evapo tran	ET/Ppt ratio	ratio x PRR
856	UNB	1.2	-1.0	4.7	50	1.7	10.5	410.0	20.2	-1.4	fen	horizontal	shrub	9.6	0.0	-1.4	0.0	-1.4	3.6	0.0	10746.0	4.0	-5.0	600.0	0.5	5640.9
857	UNB	1.1	-1.1	5.2	20	1.3	11.3	160.0	12.6	-1.5	fen	horizontal	shrub	4.6	0.0	-1.4	0.0	-1.4	3.6	0.0	10596.0	4.0	-5.0	600.0	0.5	5562.2
858	UNB	2.2	-0.7	5.2	30	1.5	11.4	180.0	13.4	-1.6	fen	horizontal	none	5.5	0.1	-1.3	0.1	-1.3	3.6	0.0	11087.0	4.0	-5.0	600.0	0.5	5819.9
859	UNB	1.2	-1.0	5.1	30	1.5	11.1	200.0	14.1	-1.6	swamp	drainageway	shrub	14.9	0.1	-1.2	0.1	-1.2	3.6	0.0	10748.0	4.0	-5.0	600.0	0.5	5642.0
860	UNB	1.8	-0.8	4.9	30	1.5	11.8	250.0	15.8	-1.5	fen	horizontal	shrub	10.6	0.0	-1.5	0.0	-1.5	3.6	0.0	11125.0	4.0	-5.0	600.0	0.5	5839.9
861	UNB	2.0	-0.8	5.1	30	1.5	10.5	290.0	17.0	-1.5	fen	horizontal	shrub	3.9	0.0	-1.8	0.0	-1.8	3.6	0.0	10981.0	4.0	-5.0	600.0	0.5	5764.3
862	UNB	1.2	-1.0	5.1	20	1.3	11.3	200.0	14.1	-1.4	fen	horizontal	none	3.8	0.0	-1.9	0.0	-1.9	3.6	0.0	10676.0	4.0	-5.0	600.0	0.5	5604.2
863	UNB	1.0	-1.1	5.0	20	1.3	10.9	240.0	15.5	-1.4	fen	horizontal	shrub	4.4	0.1	-1.1	0.1	-1.1	3.6	0.0	10379.0	4.0	-5.0	600.0	0.5	5448.3
864	UNB	1.2	-1.0	4.6	30	1.5	10.8	180.0	13.4	-1.4	fen	horizontal	shrub	14.1	0.1	-1.1	0.1	-1.1	3.6	0.0	10134.0	4.0	-5.0	600.0	0.5	5319.7
865	UNB	4.4	-0.3	5.3	10	1.0	11.7	160.0	12.6	-1.6	upland	upland	none	12.8	0.1	-1.1	0.1	-1.1	3.6	0.0	11045.0	4.0	-2.5	600.0	0.5	5797.9
866	UNB	0.9	-1.2	5.0	40	1.6	11.5	280.0	16.7	-1.6	fen	horizontal	swd	7.5	0.0	-1.6	0.0	-1.6	3.5	0.0	11242.0	4.1	-5.0	600.0	0.5	5901.3
867	UNB	1.0	-1.1	5.7	130	2.1	11.2	140.0	11.8	-1.6	fen	horizontal	shrub	4.8	0.1	-1.1	0.1	-1.1	3.5	0.0	10379.0	4.0	-5.0	600.0	0.5	5448.3
868	UNB	3.4	-0.5	4.4	70	1.8	11.3	512.4	22.6	-1.6	bog	basin	shrub	3.0	0.1	-1.2	0.1	-1.2	3.4	0.0	10740.0	4.0	-3.7	600.0	0.5	5637.8
869	UNB	4.7	-0.3	4.1	50	1.7	12.6	530.7	23.0	-1.6	bog	basin	swd	3.1	0.0	-1.7	0.0	-1.7	3.0	0.0	10822.0	4.0	-3.7	600.0	0.5	5680.8
870	UNB	4.3	-0.4	4.4	30	1.5	13.5	350.0	18.7	-1.7	bog	basin	none	0.1	0.0	-2.1	0.0	-2.1	2.9	0.0	10816.0	4.0	-3.7	600.0	0.5	5677.7
871	UNB	3.7	-0.5	4.1	50	1.7	12.6	410.0	20.2	-1.5	bog	basin	swd	1.1	0.1	-1.3	0.1	-1.3	3.1	0.0	10829.0	4.0	-3.7	600.0	0.5	5684.5
872	UNB	4.5	-0.3	4.2	50	1.7	10.5	350.0	18.7	-1.4	bog	basin	shrub	1.6	0.0	-1.4	0.0	-1.4	3.2	0.0	10812.0	4.0	-3.7	600.0	0.5	5675.6
873	UNB	2.7	-0.6	5.7	160	2.2	9.8	290.0	17.0	-1.3	fen	horizontal	swd	4.0	0.1	-1.1	0.1	-1.1	3.2	0.0	10732.0	4.0	-5.0	600.0	0.5	5633.6
874	UNB	3.1	-0.6	4.6	40	1.6	11.8	440.0	21.0	-1.5	bog	basin	swd	0.2	0.0	-1.4	0.0	-1.4	3.2	0.0	10843.0	4.0	-3.7	600.0	0.5	5691.9
875	UNB	3.0	-0.6	4.3	40	1.6	12.8	470.0	21.7	-1.6	bog	basin	swd	0.2	0.0	-2.3	0.0	-2.3	3.1	0.0	10829.0	4.0	-3.7	600.0	0.5	5684.5
876	UNB	2.4	-0.7	5.8	20	1.3	7.3	170.0	13.0	-1.3	marsh	linked basin	none	0.7	0.0	-1.6	0.0	-1.6	3.9	0.0	10820.0	4.0	-3.7	600.0	0.5	5679.8
877	UNB	4.4	-0.4	5.1	40	1.6	10.7	430.0	20.7	-1.3	marsh	linked basin	hwd	3.7	0.1	-1.0	0.1	-1.0	3.9	0.0	9569.0	4.0	-3.7	600.0	0.5	5023.1
878	UNB	0.9	-1.2	5.5	90	2.0	10.3	150.0	12.2	-1.3	marsh	linked basin	none	8.7	0.1	-1.1	0.1	-1.1	3.9	0.0	8596.0	3.9	-3.7	600.0	0.5	4512.3
879	UNB	4.5	-0.3	5.3	30	1.5	9.4	270.0	16.4	-1.3	marsh	linked basin	none	0.9	0.1	-1.3	0.1	-1.3	4.1	0.0	10371.0	4.0	-3.7	600.0	0.5	5444.1
880	UNB	5.8	-0.2	5.3	130	2.1	10.8	110.0	10.5	-1.3	upland	upland	swd	9.3	0.1	-1.2	0.1	-1.2	4.1	0.0	7979.0	3.9	-2.5	600.0	0.5	4188.5
881	UNB	5.1	-0.3	5.7	30	1.5	9.1	70.0	8.4	-1.4	marsh	linked basin	none	1.4	0.1	-1.2	0.1	-1.2	4.2	0.0	8847.0	3.9	-3.7	600.0	0.5	4644.1
882	UNB	7.9	0.1	5.6	110	2.0	10.4	380.0	19.5	-1.4	marsh	linked basin	none	11.0	0.3	-0.5	0.3	-0.5	4.1	0.0	8455.0	3.9	-3.7	600.0	0.5	4438.3
883	UNB	2.2	-0.7	4.5	30	1.5	10.2	330.0	18.2	-1.3	swamp	lagg	none	12.5	0.3	-0.5	0.3	-0.5	3.1	0.0	9790.0	4.0	-5.0	600.0	0.5	5139.1
884	UNB	1.3	-1.0	4.6	30	1.5	10.7	410.0	20.2	-1.5	swamp	drainageway	none	8.1	0.0	-1.6	0.0	-1.6	3.1	0.0	10809.0	4.0	-5.0	600.0	0.5	5674.0
885	UNB	2.6	-0.6	4.4	30	1.5	10.6	530.7	23.0	-1.6	swamp	drainageway	none	8.7	0.1	-1.1	0.1	-1.1	3.1	0.0	10498.0	4.0	-5.0	600.0	0.5	5510.8
886	UNB	2.2	-0.7	4.2	30	1.5	10.6	370.0	19.2	-1.6	swamp	drainageway	none	6.0	0.1	-1.3	0.1	-1.3	3.1	0.0	11029.0	4.0	-5.0	600.0	0.5	5789.5
887	UNB	1.1	-1.1	4.8	20	1.3	10.8	290.0	17.0	-1.4	swamp	lagg	none	9.5	0.2	-0.7	0.2	-0.7	3.1	0.0	10448.0	4.0	-5.0	600.0	0.5	5484.5
888	UNB	0.9	-1.2	5.4	30	1.5	10.9	130.0	11.4	-1.3	swamp	lagg	swd	9.7	0.2	-0.8	0.2	-0.8	3.0	0.0	10536.0	4.0	-5.0	600.0	0.5	5530.7
889	UNB	1.3	-1.0	5.2	20	1.3	11.1	805.2	28.4	-1.6	swamp	lagg	none	13.5	0.1	-1.1	0.1	-1.1	3.2	0.0	11248.0	4.1	-5.0	600.0	0.5	5904.5
890	UNB	1.9	-0.8	4.4	70	1.8	10.5	340.0	18.4	-1.7	swamp	drainageway	none	8.1	0.1	-1.0	0.1	-1.0	3.3	0.0	10632.0	4.0	-5.0	600.0	0.5	5581.1
891	UNB	3.4	-0.5	4.5	30	1.5	10.6	470.0	21.7	-1.6	swamp	drainageway	shrub	7.1	0.1	-1.1	0.1	-1.1	3.3	0.0	10850.0	4.0	-5.0	600.0	0.5	5695.5
892	UNB	4.7	-0.3	5.5	40	1.6	9.9	410.0	20.2	-1.3	swamp	lagg	none	9.6	0.0	-1.4	0.0	-1.4	3.3	0.0	9257.0	4.0	-5.0	600.0	0.5	4859.3
893	UNB	10.1	0.4	4.9	20	1.3	12.2			-1.3	upland	upland	none	12.1	0.3	-0.6	0.3	-0.6	3.7	0.0	10391.0	4.0	-2.5	600.0	0.5	5454.6
894	UNB	2.4	-0.7	5.1	20	1.3	11.6	60.0	7.7	-1.4	swamp	lagg	none	10.9	0.1	-1.0	0.1	-1.0	3.7	0.0	10890.0	4.0	-5.0	600.0	0.5	5716.5
895	UNB	2.6	-0.6	4.8	20	1.3	11.1	110.0	10.5	-1.4	swamp	lagg	none	11.0	0.5	-0.3	0.5	-0.3	3.7	0.0	10568.0	4.0	-5.0	600.0	0.5	5547.5
896	UNB	4.8	-0.3	4.7	30	1.5	10.3	280.0	16.7	-1.4	swamp	drainageway	none	10.2	0.1	-1.2	0.1	-1.2	3.7	0.0	10084.0	4.0	-5.0	600.0	0.5	5293.4
897	UNB	3.7	-0.5	4.8	20	1.3	11.0	410.0	20.2	-1.4	swamp	lagg	none	12.8	0.1	-1.0	0.1	-1.0	3.7	0.0	10025.0	4.0	-5.0	600.0	0.5	5262.5
898	UNB	4.3	-0.4	5.0	20	1.3	11.7			-1.4	upland	upland	none	11.9	0.3	-0.5	0.3	-0.5	3.7	0.0	10771.0	4.0	-2.5	600.0	0.5	5654.1
899	UNB	1.7	-0.9	4.7	20	1.3	12.2	190.0	13.8	-1.5	swamp	drainageway	none	10.4	0.2	-0.8	0.2	-0.8	3.7	0.0	10763.0	4.0	-5.0	600.0	0.5	5649.9
900	UNB	5.2	-0.2	4.1	30	1.5	11.3	120.0	11.0	-1.5	upland	upland	swd	12.6	0.3	-0.6	0.3	-0.6	3.6	0.0	11308.0	4.1	-2.5	600.0	0.5	5936.0

Plot	Site Name	DO	calc DO	pH	EC	log (ec)	Temp	Color	Sqrt (col)	log Slope	Class	Form	Type	Tree Ht	DTW (4ha)	DTW (log4ha)	DTW (1ha)	DTW (log1ha)	log fa 150m	Open Water	PRR	log (PRR)	log (HC)	evapo tran	ET/Ppt ratio	ratio x PRR
901	UNB	1.3	-1.0	4.4	30	1.5	10.6	430.0	20.7	-1.6	swamp	lagg	none	9.4	0.1	-0.9	0.1	-0.9	3.7	0.0	10871.0	4.0	-5.0	600.0	0.5	5706.6
902	UNB	9.4	0.3	5.8	10	1.0	8.8			-1.2	fen	horizontal	shrub	8.7	0.0	-1.3	0.0	-1.3	3.2	1.0	9639.0	4.0	-0.3	600.0	0.5	5059.8
903	UNB	4.7	-0.3	4.6	30	1.5	8.3			-1.6	swamp	drainageway	swd	7.9	0.1	-1.3	0.1	-1.3	3.7	1.0	9026.0	4.0	-0.3	600.0	0.5	4738.1
904	UNB	6.9	0.0	4.7	30	1.5	9.0			-1.7	swamp	lagg	none	12.5	0.0	-1.6	0.0	-1.6	3.7	1.0	10430.0	4.0	-0.3	600.0	0.5	5475.1
905	UNB	4.2	-0.4	5.4	20	1.3	10.4			-1.3	upland	upland	none	10.4	1.7	0.2	1.7	0.2	3.9	1.0	10820.0	4.0	-0.3	600.0	0.5	5679.8
906	UNB	6.5	-0.1	5.5	30	1.5	11.2			-1.3	marsh	linked basin	hwd	3.7	0.1	-1.0	0.1	-1.0	3.9	1.0	9569.0	4.0	-0.3	600.0	0.5	5023.1
907	UNB	5.8	-0.2	5.6	70	1.8	11.3			-1.3	marsh	linked basin	none	8.7	0.1	-1.1	0.1	-1.1	3.9	1.0	8596.0	3.9	-0.3	600.0	0.5	4512.3
908	UNB	6.3	-0.1	5.4	90	2.0	10.4			-1.3	marsh	linked basin	none	0.9	0.1	-1.3	0.1	-1.3	4.1	1.0	10371.0	4.0	-0.3	600.0	0.5	5444.1
909	UNB	8.9	0.2	5.9	250	2.4	13.2			-1.4	marsh	linked basin	none	1.4	0.1	-1.2	0.1	-1.2	4.2	1.0	8847.0	3.9	-0.3	600.0	0.5	4644.1
910	UNB	9.4	0.3	6.0	460	2.7	14.3			-1.4	marsh	linked basin	none	11.0	0.3	-0.5	0.3	-0.5	4.1	1.0	8455.0	3.9	-0.3	600.0	0.5	4438.3
911	UNB	7.2	0.0	4.6	20	1.3	9.0			-1.3	upland	upland	none	12.1	0.3	-0.6	0.3	-0.6	3.7	1.0	10391.0	4.0	-0.3	600.0	0.5	5454.6
912	UNB	8.6	0.2	4.5	20	1.3	8.7			-1.4	swamp	lagg	none	11.0	0.5	-0.3	0.5	-0.3	3.7	1.0	10568.0	4.0	-0.3	600.0	0.5	5547.5
913	UNB	9.2	0.2	4.5	30	1.5	8.8			-1.3	swamp	lagg	none	9.7	0.3	-0.6	0.3	-0.6	3.7	1.0	10293.0	4.0	-0.3	600.0	0.5	5403.1
914	UNB	10.0	0.4	4.6	20	1.3	11.4			-1.4	swamp	lagg	none	12.8	0.1	-1.0	0.1	-1.0	3.7	1.0	10025.0	4.0	-0.3	600.0	0.5	5262.5
915	UNB	8.2	0.1	5.1	20	1.3	12.1			-1.4	marsh	linked basin	none	0.1	0.0	-1.3	0.0	-1.3	4.0	1.0	10809.0	4.0	-0.3	600.0	0.5	5674.0
916	UNB	8.1	0.1	5.0	20	1.3	12.3			-1.3	marsh	linked basin	none	0.7	0.0	-1.3	0.0	-1.3	4.0	1.0	10778.0	4.0	-0.3	600.0	0.5	5657.7
917	UNB	7.9	0.1	5.0	20	1.3	12.7			-1.2	swamp	drainageway	none	2.6	0.1	-1.2	0.1	-1.2	4.0	1.0	10837.0	4.0	-0.3	600.0	0.5	5688.7
918	UNB	7.7	0.1	4.9	20	1.3	12.8			-1.4	swamp	drainageway	none	12.1	0.2	-0.7	0.2	-0.7	4.0	1.0	10036.0	4.0	-0.3	600.0	0.5	5268.2
919	UNB	7.3	0.0	5.2	20	1.3	13.1			-1.4	swamp	drainageway	none	6.7	0.1	-0.9	0.1	-0.9	3.9	1.0	8944.0	4.0	-0.3	600.0	0.5	4695.0
920	UNB	6.7	-0.1	4.8	20	1.3	13.2			-1.4	swamp	drainageway	none	13.9	0.1	-1.2	0.1	-1.2	3.9	1.0	10218.0	4.0	-0.3	600.0	0.5	5363.8
921	UNB	6.6	-0.1	4.8	20	1.3	13.8			-1.5	swamp	drainageway	none	11.8	0.1	-1.0	0.1	-1.0	3.9	1.0	11401.0	4.1	-0.3	600.0	0.5	5984.8
922	UNB	6.3	-0.1	4.8	20	1.3	14.0			-1.4	swamp	drainageway	none	14.9	0.2	-0.8	0.2	-0.8	3.9	1.0	10145.0	4.0	-0.3	600.0	0.5	5325.5
923	UNB	6.0	-0.1	4.8	20	1.3	14.8			-1.4	swamp	drainageway	none	5.2	0.1	-1.2	0.1	-1.2	3.9	1.0	10830.0	4.0	-0.3	600.0	0.5	5685.0
924	UNB	5.8	-0.2	4.6	20	1.3	13.4			-1.5	swamp	drainageway	none	9.0	0.0	-1.3	0.0	-1.3	3.8	1.0	10244.0	4.0	-0.3	600.0	0.5	5377.4
925	UNB	5.8	-0.2	4.6	30	1.5	13.8			-1.5	swamp	drainageway	none	6.3	0.0	-1.4	0.0	-1.4	3.7	1.0	10616.0	4.0	-0.3	600.0	0.5	5572.7
926	UNB	5.4	-0.2	4.5	30	1.5	13.0			-1.6	swamp	drainageway	none	8.3	0.0	-1.9	0.0	-1.9	3.8	1.0	9796.0	4.0	-0.3	600.0	0.5	5142.3
927	UNB	5.2	-0.2	4.5	30	1.5	13.8			-1.6	swamp	drainageway	none	13.2	0.0	-1.8	0.0	-1.8	3.8	1.0	10845.0	4.0	-0.3	600.0	0.5	5692.9
928	UNB	8.4	0.1	5.2	40	1.6	14.7			-1.4	fen	horizontal	none	20.3	0.4	-0.4	0.4	-0.4	3.3	1.0	10704.0	4.0	-0.3	600.0	0.5	5618.9
929	UNB	4.2	-0.4	5.8	140	2.1	15.2			-1.5	fen	horizontal	none	15.4	0.0	-1.5	0.0	-1.5	3.4	1.0	11100.0	4.0	-0.3	600.0	0.5	5826.8
930	UNB	6.2	-0.1	6.1	30	1.5	13.7			-1.5	fen	horizontal	none	14.3	0.1	-1.3	0.1	-1.3	3.4	1.0	11020.0	4.0	-0.3	600.0	0.5	5784.8
931	UNB	3.1	-0.6	5.7	80	1.9	13.8			-1.5	fen	horizontal	none	10.9	0.1	-1.2	0.1	-1.2	3.4	1.0	11041.0	4.0	-0.3	600.0	0.5	5795.8
932	UNB	2.5	-0.7	5.8	30	1.5	13.6			-1.4	fen	horizontal	none	11.5	0.1	-1.2	0.1	-1.2	3.4	1.0	10267.0	4.0	-0.3	600.0	0.5	5389.5
933	UNB	4.4	-0.3	5.6	60	1.8	16.8			-1.4	fen	horizontal	none	9.5	0.3	-0.5	0.3	-0.5	3.5	1.0	10937.0	4.0	-0.3	600.0	0.5	5741.2
934	UNB	2.9	-0.6	5.5	30	1.5	14.0			-1.4	fen	horizontal	none	9.1	0.1	-1.1	0.1	-1.1	3.5	1.0	11401.0	4.1	-0.3	600.0	0.5	5984.8
935	UNB	5.6	-0.2	5.4	120	2.1	17.1			-1.5	fen	horizontal	none	7.6	0.1	-0.9	0.1	-0.9	3.6	1.0	10861.0	4.0	-0.3	600.0	0.5	5701.3
936	UNB	8.4	0.1	5.6	20	1.3	17.7			-1.5	fen	horizontal	none	9.3	0.1	-1.3	0.1	-1.3	3.5	1.0	10695.0	4.0	-0.3	600.0	0.5	5614.2
937	UNB	3.6	-0.5	5.3	100	2.0	13.8			-1.6	fen	horizontal	none	9.1	0.0	-1.7	0.0	-1.7	3.5	1.0	10399.0	4.0	-0.3	600.0	0.5	5458.8
938	UNB	4.7	-0.3	4.9	100	2.0	18.9			-1.6	fen	horizontal	none	6.7	0.0	-1.3	0.0	-1.3	3.6	1.0	11075.0	4.0	-0.3	600.0	0.5	5813.6
939	UNB	6.1	-0.1	4.7	50	1.7	12.2			-1.6	swamp	drainageway	none	9.9	0.0	-1.7	0.0	-1.7	3.8	1.0	9801.0	4.0	-0.3	600.0	0.5	5144.9
940	UNB	4.9	-0.3	4.7	40	1.6	11.9			-1.5	swamp	drainageway	none	9.4	0.0	-1.4	0.0	-1.4	3.8	1.0	9581.0	4.0	-0.3	600.0	0.5	5029.4
941	UNB	3.4	-0.5	5.0	30	1.5	11.1			-1.5	swamp	drainageway	none	10.0	0.1	-1.2	0.1	-1.2	3.9	1.0	11562.0	4.1	-0.3	600.0	0.5	6069.3
942	UNB	4.4	-0.4	5.0	20	1.3	10.7			-1.5	swamp	drainageway	none	11.6	0.0	-1.3	0.0	-1.3	3.9	1.0	11354.0	4.1	-0.3	600.0	0.5	5960.1
943	UNB	5.8	-0.2	5.3	20	1.3	14.1			-1.5	swamp	drainageway	none	8.0	0.0	-1.8	0.0	-1.8	4.0	1.0	10727.0	4.0	-0.3	600.0	0.5	5631.0
944	UNB	3.5	-0.5	5.1	20	1.3	13.1			-1.5	swamp	drainageway	none	7.0	0.1	-1.2	0.1	-1.2	3.9	1.0	11157.0	4.0	-0.3	600.0	0.5	5856.7
945	UNB	4.9	-0.3	5.8	30	1.5	12.1			-1.4	swamp	drainageway	none	6.9	0.1	-1.1	0.1	-1.1	3.9	1.0	10072.0	4.0	-0.3	600.0	0.5	5287.1

Plot	Site Name	DO	calc DO	pH	EC	log (ec)	Temp	Color	Sqrt (col)	log Slope	Class	Form	Type	Tree Ht	DTW (4ha)	DTW (log4ha)	DTW (1ha)	DTW (log1ha)	log fa 150m	Open Water	PRR	log (PRR)	log (HC)	evapo tran	ET/Ppt ratio	ratio x PRR
946	UNB	4.5	-0.3	5.7	20	1.3	13.0			-1.5	swamp	drainageway	none	4.5	0.1	-1.2	0.1	-1.2	3.8	1.0	10566.0	4.0	-0.3	600.0	0.5	5546.5
947	UNB	3.8	-0.4	4.8	30	1.5	13.9			-1.5	swamp	drainageway	none	12.0	0.0	-1.4	0.0	-1.4	3.9	1.0	10418.0	4.0	-0.3	600.0	0.5	5468.8
948	UNB	4.3	-0.4	4.6	40	1.6	12.4			-1.6	swamp	drainageway	none	13.4	0.0	-1.4	0.0	-1.4	3.9	1.0	10458.0	4.0	-0.3	600.0	0.5	5489.8
949	UNB	4.2	-0.4	4.7	30	1.5	13.5			-1.6	swamp	drainageway	none	8.9	0.0	-1.6	0.0	-1.6	3.8	1.0	10268.0	4.0	-0.3	600.0	0.5	5390.0
950	UNB	4.6	-0.3	4.5	30	1.5	12.0			-1.6	swamp	drainageway	none	12.0	0.0	-1.6	0.0	-1.6	3.8	1.0	10814.0	4.0	-0.3	600.0	0.5	5676.6
951	UNB	5.7	-0.2	4.7	30	1.5	13.0			-1.6	swamp	drainageway	none	11.3	0.1	-1.3	0.1	-1.3	3.8	1.0	11242.0	4.1	-0.3	600.0	0.5	5901.3
952	UNB	6.7	-0.1	4.6	30	1.5	15.0			-1.4	fen	horizontal	none	11.2	0.0	-1.3	0.0	-1.3	3.7	1.0	11367.0	4.1	-0.3	600.0	0.5	5966.9
953	UNB	4.9	-0.3	4.6	40	1.6	14.1			-1.4	fen	horizontal	none	10.2	0.1	-1.0	0.1	-1.0	3.7	1.0	10898.0	4.0	-0.3	600.0	0.5	5720.7
954	UNB	4.9	-0.3	4.8	30	1.5	17.0			-1.5	fen	horizontal	none	10.6	0.0	-1.3	0.0	-1.3	3.7	1.0	11518.0	4.1	-0.3	600.0	0.5	6046.2
955	UNB	5.0	-0.3	4.8	30	1.5	18.5			-1.6	fen	horizontal	none	11.3	0.1	-1.2	0.1	-1.2	3.7	1.0	11304.0	4.1	-0.3	600.0	0.5	5933.9
956	UNB	5.5	-0.2	4.9	30	1.5	18.9			-1.6	fen	horizontal	none	8.6	0.0	-1.3	0.0	-1.3	3.7	1.0	10245.0	4.0	-0.3	600.0	0.5	5378.0
957	UNB	5.8	-0.2	4.9	30	1.5	19.2			-1.5	fen	horizontal	none	5.3	0.0	-1.4	0.0	-1.4	3.7	1.0	10422.0	4.0	-0.3	600.0	0.5	5470.9
958	UNB	6.2	-0.1	5.0	30	1.5	19.4			-1.5	fen	horizontal	none	7.1	0.1	-1.2	0.1	-1.2	3.7	1.0	9885.0	4.0	-0.3	600.0	0.5	5189.0
959	UNB	7.3	0.0	5.1	20	1.3	20.1			-1.4	fen	horizontal	none	3.0	0.1	-1.1	0.1	-1.1	3.7	1.0	10683.0	4.0	-0.3	600.0	0.5	5607.9
960	UNB	5.8	-0.2	4.8	50	1.7	19.6			-1.4	fen	horizontal	none	6.8	0.0	-1.7	0.0	-1.7	3.6	1.0	10364.0	4.0	-0.3	600.0	0.5	5440.4
961	UNB	6.3	-0.1	5.0	30	1.5	20.2			-1.4	fen	horizontal	none	4.1	0.0	-1.9	0.0	-1.9	3.6	1.0	10675.0	4.0	-0.3	600.0	0.5	5603.7
962	UNB	5.6	-0.2	5.0	30	1.5	26.1			-1.5	fen	horizontal	none	2.8	0.0	-1.4	0.0	-1.4	3.6	1.0	10599.0	4.0	-0.3	600.0	0.5	5563.8
963	UNB	3.2	-0.5	5.0	30	1.5	25.9			-1.5	fen	horizontal	none	2.8	0.0	-1.5	0.0	-1.5	3.6	1.0	10462.0	4.0	-0.3	600.0	0.5	5491.9
964	UNB	8.3	0.1	5.2	20	1.3	15.5			-1.4	marsh	linked basin	none	0.1	0.0	-1.3	0.0	-1.3	4.0	1.0	10809.0	4.0	-0.3	600.0	0.5	5674.0
965	UNB	8.3	0.1	5.3	20	1.3	15.3			-1.3	marsh	linked basin	none	0.7	0.0	-1.3	0.0	-1.3	4.0	1.0	10778.0	4.0	-0.3	600.0	0.5	5657.7
966	UNB	8.0	0.1	5.3	20	1.3	15.2			-1.2	marsh	linked basin	none	2.6	0.1	-1.2	0.1	-1.2	4.0	1.0	10837.0	4.0	-0.3	600.0	0.5	5688.7
967	UNB	7.8	0.1	5.2	20	1.3	15.1			-1.4	swamp	drainageway	none	12.1	0.2	-0.7	0.2	-0.7	4.0	1.0	10036.0	4.0	-0.3	600.0	0.5	5268.2
968	UNB	7.5	0.0	5.2	20	1.3	13.8			-1.4	swamp	drainageway	none	6.7	0.1	-0.9	0.1	-0.9	3.9	1.0	8944.0	4.0	-0.3	600.0	0.5	4695.0
969	UNB	7.2	0.0	4.7	20	1.3	15.7			-1.4	swamp	drainageway	none	13.9	0.1	-1.2	0.1	-1.2	3.9	1.0	10218.0	4.0	-0.3	600.0	0.5	5363.8
970	UNB	6.7	-0.1	4.8	20	1.3	15.8			-1.5	swamp	drainageway	none	11.8	0.1	-1.0	0.1	-1.0	3.9	1.0	11401.0	4.1	-0.3	600.0	0.5	5984.8
971	UNB	6.3	-0.1	4.7	20	1.3	15.6			-1.4	swamp	drainageway	none	14.9	0.2	-0.8	0.2	-0.8	3.9	1.0	10145.0	4.0	-0.3	600.0	0.5	5325.5
972	UNB	6.0	-0.1	4.7	20	1.3	14.7			-1.4	swamp	drainageway	none	5.2	0.1	-1.2	0.1	-1.2	3.9	1.0	10830.0	4.0	-0.3	600.0	0.5	5685.0
973	UNB	5.7	-0.2	4.7	20	1.3	15.6			-1.5	swamp	drainageway	none	9.0	0.0	-1.3	0.0	-1.3	3.8	1.0	10244.0	4.0	-0.3	600.0	0.5	5377.4
974	UNB	5.6	-0.2	4.5	30	1.5	14.2			-1.5	swamp	drainageway	none	6.3	0.0	-1.4	0.0	-1.4	3.7	1.0	10616.0	4.0	-0.3	600.0	0.5	5572.7
975	UNB	5.2	-0.2	4.6	30	1.5	14.6			-1.6	swamp	drainageway	none	8.3	0.0	-1.9	0.0	-1.9	3.8	1.0	9796.0	4.0	-0.3	600.0	0.5	5142.3
976	UNB	4.7	-0.3	4.6	30	1.5	14.6			-1.6	swamp	drainageway	none	13.2	0.0	-1.8	0.0	-1.8	3.8	1.0	10845.0	4.0	-0.3	600.0	0.5	5692.9
977	UNB	3.3	-0.5	4.8	30	1.5	13.3			-1.6	swamp	drainageway	none	9.9	0.0	-1.7	0.0	-1.7	3.8	1.0	9801.0	4.0	-0.3	600.0	0.5	5144.9
978	UNB	2.4	-0.7	4.6	30	1.5	14.3			-1.5	swamp	drainageway	none	9.4	0.0	-1.4	0.0	-1.4	3.8	1.0	9581.0	4.0	-0.3	600.0	0.5	5029.4
979	UNB	3.2	-0.5	4.9	20	1.3	13.7			-1.5	swamp	drainageway	none	10.0	0.1	-1.2	0.1	-1.2	3.9	1.0	11562.0	4.1	-0.3	600.0	0.5	6069.3
980	UNB	2.7	-0.6	4.9	20	1.3	14.2			-1.5	swamp	drainageway	none	11.6	0.0	-1.3	0.0	-1.3	3.9	1.0	11354.0	4.1	-0.3	600.0	0.5	5960.1
981	UNB	3.5	-0.5	5.2	20	1.3	10.7			-1.5	swamp	drainageway	none	8.0	0.0	-1.8	0.0	-1.8	4.0	1.0	10727.0	4.0	-0.3	600.0	0.5	5631.0
982	UNB	3.7	-0.5	5.0	30	1.5	14.7			-1.5	swamp	drainageway	none	7.0	0.1	-1.2	0.1	-1.2	3.9	1.0	11157.0	4.0	-0.3	600.0	0.5	5856.7
983	UNB	4.6	-0.3	5.4	20	1.3	15.7			-1.4	swamp	drainageway	none	6.9	0.1	-1.1	0.1	-1.1	3.9	1.0	10072.0	4.0	-0.3	600.0	0.5	5287.1
984	UNB	1.3	-1.0	5.5	20	1.3	10.5			-1.5	swamp	drainageway	none	4.5	0.1	-1.2	0.1	-1.2	3.8	1.0	10566.0	4.0	-0.3	600.0	0.5	5546.5
985	UNB	2.6	-0.7	5.2	20	1.3	16.7			-1.5	swamp	drainageway	none	12.0	0.0	-1.4	0.0	-1.4	3.9	1.0	10418.0	4.0	-0.3	600.0	0.5	5468.8
986	UNB	4.4	-0.3	4.4	30	1.5	13.8			-1.6	swamp	drainageway	none	13.4	0.0	-1.4	0.0	-1.4	3.9	1.0	10458.0	4.0	-0.3	600.0	0.5	5489.8
987	UNB	2.8	-0.6	4.5	30	1.5	14.6			-1.6	swamp	drainageway	none	8.9	0.0	-1.6	0.0	-1.6	3.8	1.0	10268.0	4.0	-0.3	600.0	0.5	5390.0
988	UNB	3.6	-0.5	4.5	30	1.5	14.1			-1.6	swamp	drainageway	none	12.0	0.0	-1.6	0.0	-1.6	3.8	1.0	10814.0	4.0	-0.3	600.0	0.5	5676.6
989	UNB	4.5	-0.3	4.5	30	1.5	15.2			-1.6	swamp	drainageway	none	11.3	0.1	-1.3	0.1	-1.3	3.8	1.0	11242.0	4.1	-0.3	600.0	0.5	5901.3
990	UNB	1.6	-0.9	4.5	50	1.7	12.6			-1.6	marsh	linked basin	none	0.2	0.1	-1.3	0.0	-1.3	3.4	1.0	10800.0	4.0	-0.3	600.0	0.5	5669.3

Plot	Site Name	DO	calc DO	pH	EC	log (ec)	Temp	Color	Sqrt (col)	log Slope	Class	Form	Type	Tree Ht	DTW (4ha)	DTW (log4ha)	DTW (1ha)	DTW (log1ha)	log fa 150m	Open Water	PRR	log (PRR)	log (HC)	evapo tran	ET/Ppt ratio	ratio x PRR
991	UNB	11.8	0.7	5.7	20	1.3	15.9			-1.4	marsh	linked basin	shrub	1.8	0.1	-1.1	0.1	-1.1	3.5	1.0	11199.0	4.0	-0.3	600.0	0.5	5878.7
992	UNB	2.8	-0.6	5.2	20	1.3	11.9			-1.6	swamp	lagg	shrub	10.3	0.1	-1.2	0.1	-1.2	3.7	1.0	11552.0	4.1	-0.3	600.0	0.5	6064.0
993	UNB	5.2	-0.2	4.2	30	1.5	12.3			-1.6	swamp	lagg	none	12.3	0.1	-1.2	0.1	-1.2	3.8	1.0	10638.0	4.0	-0.3	600.0	0.5	5584.3
994	UNB	3.7	-0.5	4.5	20	1.3	12.3			-1.6	swamp	drainageway	none	10.5	0.1	-1.3	0.1	-1.3	3.7	1.0	11235.0	4.1	-0.3	600.0	0.5	5897.6
995	UNB	6.4	-0.1	4.6	20	1.3	12.6			-1.5	swamp	drainageway	swd	9.4	0.0	-1.4	0.0	-1.4	3.8	1.0	9716.0	4.0	-0.3	600.0	0.5	5100.3
996	UNB	6.7	-0.1	4.6	20	1.3	12.4			-1.4	swamp	drainageway	swd	7.2	0.0	-1.4	0.0	-1.4	3.9	1.0	10352.0	4.0	-0.3	600.0	0.5	5434.1
997	UNB	4.2	-0.4	5.6	30	1.5	13.2			-1.4	marsh	linked basin	none	0.5	0.0	-1.7	0.0	-1.7	4.0	1.0	10827.0	4.0	-0.3	600.0	0.5	5683.5
998	UNB	7.3	0.0	5.4	30	1.5	14.3			-1.3	marsh	linked basin	none	0.2	0.2	-0.7	0.2	-0.7	3.8	1.0	10754.0	4.0	-0.3	600.0	0.5	5645.1
999	UNB	2.1	-0.8	4.7	20	1.3	9.4			-1.5	fen	horizontal	shrub	3.1	0.0	-1.8	0.0	-1.8	3.6	1.0	10619.0	4.0	-0.3	600.0	0.5	5574.3
1000	UNB	8.3	0.1	5.6	20	1.3	11.9			-1.2	fen	horizontal	shrub	8.7	0.0	-1.3	0.0	-1.3	3.2	1.0	9639.0	4.0	-0.3	600.0	0.5	5059.8
1001	UNB	3.0	-0.6	4.1	20	1.3	12.0			-1.5	swamp	drainageway	none	6.3	0.1	-0.9	0.1	-0.9	3.1	1.0	11072.0	4.0	-0.3	600.0	0.5	5812.1
1002	UNB	4.2	-0.4	4.5	20	1.3	9.6			-1.6	swamp	drainageway	swd	7.9	0.1	-1.3	0.1	-1.3	3.7	1.0	9026.0	4.0	-0.3	600.0	0.5	4738.1
1003	UNB	3.6	-0.5	4.7	20	1.3	9.4			-1.7	swamp	drainageway	none	8.8	0.1	-1.1	0.1	-1.1	3.7	1.0	10430.0	4.0	-0.3	600.0	0.5	5475.1
1004	UNB	1.5	-0.9	5.5	50	1.7	12.5			-1.6	fen	horizontal	shrub	7.7	0.0	-1.4	0.0	-1.4	3.9	1.0	11148.0	4.0	-0.3	600.0	0.5	5852.0
1005	UNB	1.9	-0.8	5.0	20	1.3	12.7			-1.6	fen	horizontal	shrub	6.7	0.1	-1.2	0.1	-1.2	3.9	1.0	11027.0	4.0	-0.3	600.0	0.5	5788.5
1006	UNB	2.6	-0.7	5.0	30	1.5	13.6			-1.6	fen	horizontal	shrub	9.3	0.0	-1.5	0.0	-1.5	3.9	1.0	10517.0	4.0	-0.3	600.0	0.5	5520.7
1007	UNB	8.8	0.2	5.6	20	1.3	12.3			-1.4	marsh	linked basin	swd	12.4	0.2	-0.7	0.2	-0.7	3.6	1.0	10619.0	4.0	-0.3	600.0	0.5	5574.3
1008	UNB	9.8	0.3	5.4	20	1.3	10.9			-1.4	upland	upland	swd	8.7	0.1	-1.2	0.1	-1.2	3.6	1.0	10704.0	4.0	-0.3	600.0	0.5	5618.9
1009	UNB	8.8	0.2	6.1	20	1.3	11.9			-1.3	fen	horizontal	none	0.6	0.1	-1.0	0.1	-1.0	3.6	1.0	10771.0	4.0	-0.3	600.0	0.5	5654.1
1010	UNB	6.2	-0.1	5.6	30	1.5	11.2			-1.4	fen	horizontal	swd	1.5	0.2	-0.7	0.2	-0.7	3.6	1.0	10273.0	4.0	-0.3	600.0	0.5	5392.7
1011	UNB	7.5	0.0	4.7	20	1.3	12.3			-1.5	swamp	drainageway	shrub	13.2	0.1	-0.9	0.1	-0.9	3.9	1.0	9613.0	4.0	-0.3	600.0	0.5	5046.2
1012	UNB	8.0	0.1	6.0	20	1.3	11.2			-1.4	swamp	drainageway	shrub	13.9	0.1	-1.3	0.1	-1.3	3.9	1.0	10393.0	4.0	-0.3	600.0	0.5	5455.6
1013	UNB	9.1	0.2	4.2	30	1.5	11.4			-1.4	marsh	linked basin	none	0.1	0.0	-1.4	0.0	-1.4	4.0	1.0	10784.0	4.0	-0.3	600.0	0.5	5660.9
1014	UNB	2.2	-0.7	5.0	20	1.3	9.3			-1.5	fen	horizontal	shrub	4.6	0.0	-1.4	0.0	-1.4	3.6	1.0	10596.0	4.0	-0.3	600.0	0.5	5562.2
1015	UNB	4.5	-0.3	4.9	30	1.5	10.7			-1.5	fen	horizontal	shrub	3.9	0.0	-1.8	0.0	-1.8	3.6	1.0	10981.0	4.0	-0.3	600.0	0.5	5764.3
1016	UNB	5.5	-0.2	4.3	30	1.5	11.0			-1.4	marsh	linked basin	none	10.2	0.1	-1.2	0.1	-1.2	3.7	1.0	10084.0	4.0	-0.3	600.0	0.5	5293.4
1017	StJohn	0.5	-1.5	5.9	50	1.7	10.7			-0.8	fen	horizontal	none	3.0	0.3	-0.5	0.3	-0.5	3.0	0.0	11172.0	4.0	-5.0	600.0	0.5	5864.6
1018	StJohn	0.5	-1.4	5.8	40	1.6	8.9			-0.8	fen	horizontal	none	5.0	0.6	-0.2	0.6	-0.2	3.0	0.0	11597.0	4.1	-5.0	600.0	0.5	6087.7
1019	StJohn	3.8	-0.4	5.1	30	1.5	9.3			-0.9	fen	horizontal	shrub	6.0	0.1	-0.8	0.1	-0.8	3.1	0.0	10716.0	4.0	-5.0	600.0	0.5	5625.2
1020	StJohn	1.2	-1.0	5.3	30	1.5	8.6			-0.9	fen	horizontal	shrub	8.0	0.5	-0.3	0.5	-0.3	3.1	0.0	10718.0	4.0	-5.0	600.0	0.5	5626.2
1021	StJohn	8.8	0.2	5.4	30	1.5	10.0			-1.1	fen	horizontal	shrub	7.0	0.3	-0.5	0.3	-0.5	3.1	1.0	10719.0	4.0	-5.0	600.0	0.5	5626.8
1022	StJohn	0.7	-1.3	4.9	30	1.5	9.5			-0.9	fen	horizontal	shrub	6.0	0.5	-0.3	0.5	-0.3	3.1	0.0	10636.0	4.0	-5.0	600.0	0.5	5583.2
1023	StJohn	1.0	-1.1	4.8	30	1.5	8.3			-0.9	fen	horizontal	shrub	8.5	0.5	-0.3	0.5	-0.3	3.2	0.0	10532.0	4.0	-5.0	600.0	0.5	5528.6
1024	StJohn	4.2	-0.4	5.0	30	1.5	9.7			-0.9	fen	horizontal	shrub	4.0	0.4	-0.4	0.4	-0.4	3.2	0.0	10527.0	4.0	-5.0	600.0	0.5	5526.0
1025	StJohn	3.8	-0.4	5.0	30	1.5	11.1			-1.0	fen	horizontal	shrub	4.0	0.2	-0.7	0.2	-0.7	3.2	0.0	10654.0	4.0	-5.0	600.0	0.5	5592.7
1026	StJohn	0.5	-1.5	5.5	30	1.5	9.9			-1.1	fen	horizontal	none	2.5	0.4	-0.4	0.4	-0.4	3.2	0.0	10791.0	4.0	-5.0	600.0	0.5	5664.6
1027	StJohn	0.4	-1.5	5.8	30	1.5	8.3			-1.0	fen	horizontal	none	8.0	0.9	-0.1	0.9	-0.1	3.3	0.0	10597.0	4.0	-5.0	600.0	0.5	5562.7
1028	StJohn	0.5	-1.4	6.5	130	2.1	7.8			-1.0	fen	horizontal	shrub	0.8	0.3	-0.5	0.3	-0.5	3.3	0.0	10675.0	4.0	-5.0	600.0	0.5	5603.7
1029	StJohn	6.0	-0.1	5.7	40	1.6	9.0			-1.0	fen	horizontal	shrub	1.0	0.4	-0.4	0.4	-0.4	3.3	0.0	10635.0	4.0	-5.0	600.0	0.5	5582.7
1030	StJohn	2.9	-0.6	6.0	80	1.9	9.7			-1.0	fen	horizontal	none	1.0	0.3	-0.5	0.3	-0.5	3.3	0.0	10842.0	4.0	-5.0	600.0	0.5	5691.3
1031	StJohn	1.7	-0.9	5.5	40	1.6	10.3			-0.9	fen	horizontal	shrub	0.5	0.5	-0.3	0.5	-0.3	3.2	0.0	10873.0	4.0	-5.0	600.0	0.5	5707.6
1032	StJohn	0.6	-1.3	5.7	40	1.6	8.3			-0.9	fen	horizontal	shrub	1.5	0.5	-0.3	0.5	-0.3	3.2	0.0	10697.0	4.0	-5.0	600.0	0.5	5615.2
1033	StJohn	2.7	-0.6	5.9	60	1.8	7.3			-1.0	fen	horizontal	shrub	1.5	0.6	-0.2	0.6	-0.2	3.3	0.0	10737.0	4.0	-5.0	600.0	0.5	5636.2
1034	StJohn	0.4	-1.5	5.3	40	1.6	7.8			-1.1	swamp	lagg	shrub	5.0	0.7	-0.1	0.7	-0.1	3.3	0.0	10769.0	4.0	-5.0	600.0	0.5	5653.0
1035	StJohn	1.8	-0.8	6.2	110	2.0	7.3			-1.0	fen	horizontal	shrub	6.0	1.0	0.0	1.0	0.0	3.3	0.0	10361.0	4.0	-5.0	600.0	0.5	5438.8

Plot	Site Name	DO	calc DO	pH	EC	log (ec)	Temp	Color	Sqrt (col)	log Slope	Class	Form	Type	Tree Ht	DTW (4ha)	DTW (log4ha)	DTW (1ha)	DTW (log1ha)	log fa 150m	Open Water	PRR	log (PRR)	log (HC)	evapo tran	ET/Ppt ratio	ratio x PRR
1036	StJohn	6.4	-0.1	5.7	50	1.7	8.3			-1.1	fen	horizontal	none	1.0	0.3	-0.5	0.3	-0.5	3.3	0.0	10687.0	4.0	-5.0	600.0	0.5	5610.0
1037	StJohn	2.0	-0.8	5.6	40	1.6	7.5			-1.0	fen	horizontal	shrub	0.5	0.6	-0.2	0.6	-0.2	3.3	0.0	10274.0	4.0	-5.0	600.0	0.5	5393.2
1038	StJohn	1.4	-1.0	5.7	40	1.6	8.3			-0.9	fen	horizontal	shrub	3.0	0.2	-0.6	0.2	-0.6	3.2	0.0	10442.0	4.0	-5.0	600.0	0.5	5481.4
1039	StJohn	3.7	-0.5	4.6	30	1.5	8.1			-0.9	bog	basin	shrub	1.5	0.6	-0.3	0.6	-0.3	3.3	0.0	10213.0	4.0	-3.7	600.0	0.5	5361.2
1040	StJohn	3.7	-0.5	4.3	40	1.6	8.1			-1.0	bog	basin	shrub	5.0	1.0	0.0	1.0	0.0	3.3	0.0	9923.0	4.0	-3.7	600.0	0.5	5208.9
1041	StJohn	6.3	-0.1	4.7	30	1.5	7.1			-1.0	bog	basin	shrub	5.0	1.5	0.2	1.5	0.2	3.4	0.0	10441.0	4.0	-3.7	600.0	0.5	5480.8
1042	StJohn	2.7	-0.6	5.7	40	1.6	9.1			-1.0	fen	horizontal	none	3.0	0.8	-0.1	0.8	-0.1	3.4	0.0	10459.0	4.0	-5.0	600.0	0.5	5490.3
1043	StJohn	5.0	-0.3	5.0	30	1.5	9.2			-0.9	fen	horizontal	shrub	1.0	1.2	0.1	1.2	0.1	3.4	0.0	9842.0	4.0	-5.0	600.0	0.5	5166.4
1044	StJohn	11.2	0.6	5.0	30	1.5	9.2			-0.8	fen	horizontal	shrub	1.0	0.2	-0.7	0.2	-0.7	2.9	1.0	10810.0	4.0	-5.0	600.0	0.5	5674.5
1045	StJohn	7.7	0.1	5.8	30	1.5	9.3			-0.9	bog	basin	none	1.0	0.3	-0.5	0.3	-0.5	3.0	0.0	10585.0	4.0	-3.7	600.0	0.5	5556.4
1046	StJohn	7.3	0.0	4.0	50	1.7	7.6			-1.1	bog	basin	none	6.0	0.8	-0.1	0.8	-0.1	3.0	0.0	10690.0	4.0	-3.7	600.0	0.5	5611.5
1047	StJohn	7.6	0.1	3.9	60	1.8	6.4			-1.2	bog	basin	swd	4.0	1.3	0.1	1.3	0.1	3.0	0.0	10609.0	4.0	-3.7	600.0	0.5	5569.0
1048	StJohn	8.1	0.1	4.0	50	1.7	7.6			-1.1	bog	basin	swd	7.0	1.4	0.2	1.2	0.1	3.0	0.0	10955.0	4.0	-3.7	600.0	0.5	5750.7
1049	StJohn	3.6	-0.5	4.0	40	1.6	8.6			-1.0	bog	basin	shrub	10.0	1.9	0.3	1.5	0.2	3.0	0.0	9627.0	4.0	-3.7	600.0	0.5	5053.5
1050	StJohn	2.7	-0.6	4.7	30	1.5	8.6			-1.2	bog	basin	swd	7.0	1.5	0.2	1.1	0.0	3.1	0.0	10999.0	4.0	-3.7	600.0	0.5	5773.8
1051	StJohn	5.7	-0.2	3.8	60	1.8	7.0			-1.2	bog	basin	swd	2.0	1.0	0.0	1.0	0.0	3.1	0.0	10692.0	4.0	-3.7	600.0	0.5	5612.6
1052	StJohn	6.5	-0.1	3.9	50	1.7	7.8			-1.3	bog	basin	none	2.0	0.4	-0.4	0.4	-0.4	3.1	0.0	10718.0	4.0	-3.7	600.0	0.5	5626.2
1053	StJohn	1.8	-0.8	3.9	40	1.6	8.8			-1.3	fen	horizontal	none	3.5	0.3	-0.6	0.3	-0.6	3.1	0.0	10638.0	4.0	-5.0	600.0	0.5	5584.3
1054	StJohn	6.2	-0.1	4.1	40	1.6	9.0			-1.2	fen	horizontal	none	3.5	0.1	-0.9	0.1	-0.9	3.1	0.0	10702.0	4.0	-5.0	600.0	0.5	5617.8
1055	StJohn	3.9	-0.4	4.5	40	1.6	8.0			-1.1	fen	horizontal	none	6.0	0.4	-0.4	0.4	-0.4	3.1	0.0	10745.0	4.0	-5.0	600.0	0.5	5640.4
1056	StJohn	7.6	0.0	4.9	20	1.3	10.8			-1.0	swamp	lagg	none	6.0	0.6	-0.2	0.6	-0.2	3.1	0.0	10647.0	4.0	-5.0	600.0	0.5	5589.0
1057	StJohn	5.5	-0.2	5.1	20	1.3	9.8			-0.9	swamp	lagg	swd	8.0	0.3	-0.6	0.3	-0.6	3.1	0.0	10720.0	4.0	-5.0	600.0	0.5	5627.3
1058	StJohn	5.9	-0.2	4.9	30	1.5	9.0			-1.0	fen	horizontal	none	3.0	0.4	-0.4	0.4	-0.4	3.1	0.0	10610.0	4.0	-5.0	600.0	0.5	5569.6
1059	StJohn	3.5	-0.5	5.5	30	1.5	10.8			-1.0	fen	horizontal	none	2.0	0.4	-0.4	0.4	-0.4	3.0	0.0	10604.0	4.0	-5.0	600.0	0.5	5566.4
1060	StJohn	3.5	-0.5	4.0	40	1.6	8.6			-0.9	fen	horizontal	shrub	5.0	0.2	-0.6	0.2	-0.6	2.9	0.0	10672.0	4.0	-5.0	600.0	0.5	5602.1
1061	StJohn	5.6	-0.2	4.1	40	1.6	9.8			-0.8	swamp	lagg	swd	5.5	0.2	-0.6	0.2	-0.6	2.9	0.0	11446.0	4.1	-5.0	600.0	0.5	6008.4
1062	StJohn	3.6	-0.5	4.8	40	1.6	9.7			-0.8	swamp	lagg	none	5.0	0.1	-1.0	0.1	-1.0	2.8	0.0	10624.0	4.0	-5.0	600.0	0.5	5576.9
1063	StJohn	2.9	-0.6	4.8	30	1.5	9.5			-0.8	swamp	lagg	none	6.0	0.2	-0.7	0.2	-0.7	2.7	0.0	10628.0	4.0	-5.0	600.0	0.5	5579.0
1064	StJohn	1.2	-1.1	5.4	30	1.5	10.5			-0.9	swamp	lagg	none	8.5	0.2	-0.6	0.2	-0.6	2.6	0.0	10671.0	4.0	-5.0	600.0	0.5	5601.6
1065	StJohn	6.5	-0.1	5.2	50	1.7	13.2			-1.2	swamp	lagg	none	5.0	0.4	-0.4	0.4	-0.4	2.7	0.0	10812.0	4.0	-5.0	600.0	0.5	5675.6
1066	StJohn	1.0	-1.1	5.6	40	1.6	11.5			-1.2	fen	horizontal	shrub	8.0	0.7	-0.2	0.4	-0.4	2.7	0.0	10836.0	4.0	-5.0	600.0	0.5	5688.2
1067	StJohn	12.6	0.9	4.7	30	1.5	13.3			-1.2	bog	basin	shrub	7.5	0.8	-0.1	0.5	-0.3	2.8	0.0	10837.0	4.0	-3.7	600.0	0.5	5688.7
1068	StJohn	1.6	-0.9	4.1	50	1.7	12.1			-1.1	bog	basin	swd	4.5	1.2	0.1	0.9	0.0	2.9	0.0	10864.0	4.0	-3.7	600.0	0.5	5702.9
1069	StJohn	7.3	0.0	4.3	60	1.8	12.1			-1.1	bog	basin	none	5.0	1.5	0.2	1.2	0.1	3.0	0.0	10823.0	4.0	-3.7	600.0	0.5	5681.4
1070	StJohn	5.6	-0.2	4.5	40	1.6	12.0			-1.1	bog	basin	none	5.0	1.2	0.1	0.7	-0.1	3.2	0.0	10881.0	4.0	-3.7	600.0	0.5	5711.8
1071	StJohn	2.8	-0.6	4.2	50	1.7	12.5			-1.2	bog	basin	none	4.5	1.1	0.0	0.6	-0.2	3.2	0.0	10997.0	4.0	-3.7	600.0	0.5	5772.7
1072	StJohn	3.7	-0.5	4.6	40	1.6	14.0			-1.1	swamp	lagg	none	8.0	1.1	0.1	0.7	-0.2	3.4	0.0	10661.0	4.0	-5.0	600.0	0.5	5596.3
1073	StJohn	1.5	-0.9	5.4	40	1.6	13.6			-1.1	fen	horizontal	shrub	1.2	0.9	0.0	0.9	0.0	3.4	0.0	11078.0	4.0	-5.0	600.0	0.5	5815.2
1074	StJohn	2.2	-0.8	5.0	40	1.6	13.7			-1.1	fen	horizontal	none		1.1	0.0	1.1	0.0	3.4	0.0	11433.0	4.1	-5.0	600.0	0.5	6001.6
1075	StJohn	3.0	-0.6	4.9	30	1.5	12.3			-1.1	fen	horizontal	none	0.6	1.1	0.0	1.1	0.0	3.4	0.0	11288.0	4.1	-5.0	600.0	0.5	5925.5
1076	StJohn	5.5	-0.2	5.3	40	1.6	11.9			-1.0	fen	horizontal	none	1.0	1.2	0.1	1.2	0.1	3.4	0.0	11340.0	4.1	-5.0	600.0	0.5	5952.8
1077	StJohn	4.6	-0.3	5.5	30	1.5	12.6			-0.9	fen	horizontal	none	1.0	1.2	0.1	1.2	0.1	3.4	0.0	11812.0	4.1	-5.0	600.0	0.5	6200.5
1078	StJohn	6.2	-0.1	6.1	60	1.8	14.9			-0.9	fen	horizontal	shrub	4.7	2.2	0.3	2.2	0.3	3.4	0.0	11651.0	4.1	-5.0	600.0	0.5	6116.0
1079	StJohn	9.0	0.2	6.3	70	1.8	12.7			-0.8	fen	horizontal	shrub	11.0	1.7	0.2	1.7	0.2	3.4	0.0	11763.0	4.1	-5.0	600.0	0.5	6174.8
1080	StJohn	4.5	-0.3	5.4	40	1.6	14.7			-0.8	fen	horizontal	shrub	1.0	0.9	-0.1	0.9	-0.1	3.4	0.0	11162.0	4.0	-5.0	600.0	0.5	5859.3

Plot	Site Name	DO	calc DO	pH	EC	log (ec)	Temp	Color	Sqrt (col)	log Slope	Class	Form	Type	Tree Ht	DTW (4ha)	DTW (log4ha)	DTW (1ha)	DTW (log1ha)	log fa 150m	Open Water	PRR	log (PRR)	log (HC)	evapo tran	ET/Ppt ratio	ratio x PRR
1081	StJohn	4.2	-0.4	4.9	40	1.6	20.3			-0.8	upland	upland	none	5.0	0.8	-0.1	0.8	-0.1	3.5	0.0	10349.0	4.0	-3.2	600.0	0.5	5432.5
1082	StJohn	9.0	0.2	4.4	60	1.8	14.7			-0.9	upland	upland	swd	3.0	2.6	0.4	2.6	0.4	3.5	0.0	7183.0	3.9	-3.2	600.0	0.5	3770.6
1083	StJohn	8.9	0.2	5.8	40	1.6	9.0			-0.9	swamp	lagg	swd	4.5	0.5	-0.3	0.4	-0.4	2.6	0.0	10816.0	4.0	-5.0	600.0	0.5	5677.7
1084	StJohn	5.6	-0.2	5.0	30	1.5	10.7			-1.0	swamp	lagg	swd	5.0	0.3	-0.5	0.2	-0.6	2.6	0.0	10732.0	4.0	-5.0	600.0	0.5	5633.6
1085	StJohn	5.6	-0.2	5.2	30	1.5	10.1			-1.0	swamp	lagg	none	4.5	0.3	-0.5	0.3	-0.5	2.6	0.0	10816.0	4.0	-5.0	600.0	0.5	5677.7
1086	StJohn	2.2	-0.7	5.3	30	1.5	8.8			-1.2	fen	horizontal	none	5.0	0.4	-0.4	0.4	-0.4	2.7	0.0	10813.0	4.0	-5.0	600.0	0.5	5676.1
1087	StJohn	4.3	-0.4	4.0	40	1.6	8.7			-1.2	bog	basin	shrub	5.5	0.8	-0.1	0.7	-0.2	2.8	0.0	10823.0	4.0	-3.7	600.0	0.5	5681.4
1088	StJohn	3.8	-0.4	3.7	70	1.8	8.8			-1.2	bog	basin	swd	6.5	1.1	0.0	0.9	-0.1	2.9	0.0	10634.0	4.0	-3.7	600.0	0.5	5582.2
1089	StJohn	5.1	-0.3	3.8	50	1.7	7.4			-1.2	bog	basin	swd	3.5	1.4	0.2	1.4	0.2	3.0	0.0	10677.0	4.0	-3.7	600.0	0.5	5604.7
1090	StJohn	7.4	0.0	3.9	70	1.8	6.5			-1.3	bog	basin	swd	1.1	0.8	-0.1	0.6	-0.2	3.1	0.0	10740.0	4.0	-3.7	600.0	0.5	5637.8
1091	StJohn	3.9	-0.4	3.8	50	1.7	7.5			-1.3	bog	basin	swd	2.2	0.7	-0.2	0.5	-0.3	3.2	0.0	10774.0	4.0	-3.7	600.0	0.5	5655.6
1092	StJohn	5.1	-0.3	4.1	40	1.6	10.7			-1.3	fen	horizontal	none	2.1	0.4	-0.4	0.4	-0.4	3.2	0.0	10803.0	4.0	-5.0	600.0	0.5	5670.9
1093	StJohn	5.4	-0.2	4.2	50	1.7	11.2			-1.3	fen	horizontal	none	1.6	0.5	-0.3	0.5	-0.3	3.2	0.0	10764.0	4.0	-5.0	600.0	0.5	5650.4
1094	StJohn	6.6	-0.1	4.4	30	1.5	9.3			-1.2	fen	horizontal	none	1.2	0.3	-0.6	0.3	-0.6	3.2	0.0	10743.0	4.0	-5.0	600.0	0.5	5639.4
1095	StJohn	7.1	0.0	5.0	30	1.5	11.1			-0.9	fen	horizontal	shrub	1.6	0.4	-0.4	0.4	-0.4	3.2	0.0	10733.0	4.0	-5.0	600.0	0.5	5634.1
1096	StJohn	2.5	-0.7	5.6	30	1.5	10.7			-0.8	swamp	lagg	shrub	2.5	0.6	-0.2	0.6	-0.2	3.1	0.0	11483.0	4.1	-5.0	600.0	0.5	6027.8
1097	StJohn	2.6	-0.6	5.1	30	1.5	10.2			-1.2	fen	horizontal	none	0.8	0.2	-0.8	0.2	-0.8	3.2	0.0	10771.0	4.0	-5.0	600.0	0.5	5654.1
1098	StJohn	3.8	-0.4	4.3	40	1.6	12.3			-1.2	fen	horizontal	swd	2.5	0.4	-0.4	0.2	-0.7	3.2	0.0	10764.0	4.0	-5.0	600.0	0.5	5650.4
1099	StJohn	5.6	-0.2	4.3	40	1.6	10.6			-1.3	fen	horizontal	none	3.0	0.5	-0.3	0.2	-0.6	3.2	0.0	10821.0	4.0	-5.0	600.0	0.5	5680.3
1100	StJohn	4.1	-0.4	4.1	50	1.7	9.8			-1.3	fen	horizontal	swd	0.8	0.4	-0.4	0.1	-0.9	3.2	0.0	10821.0	4.0	-5.0	600.0	0.5	5680.3
1101	StJohn	6.4	-0.1	5.6	30	1.5	9.8			-0.8	swamp	lagg	none	8.5	0.3	-0.5	0.3	-0.5	2.6	1.0	11317.0	4.1	-0.3	600.0	0.5	5940.7
1102	StJohn	7.2	0.0	5.5	30	1.5	9.8			-0.7	swamp	lagg	none	8.0	2.1	0.3	1.9	0.3	2.7	1.0	11642.0	4.1	-0.3	600.0	0.5	6111.3
1103	StJohn	7.8	0.1	5.5	30	1.5	10.7			-0.9	swamp	lagg	none	4.0	0.1	-1.0	0.1	-1.0	2.8	1.0	10654.0	4.0	-0.3	600.0	0.5	5592.7
1104	StJohn	7.2	0.0	5.4	30	1.5	9.2			-0.8	swamp	lagg	none	5.0	0.2	-0.7	0.2	-0.7	2.9	1.0	11029.0	4.0	-0.3	600.0	0.5	5789.5
1105	StJohn	7.5	0.0	5.6	30	1.5	10.7			-0.9	fen	horizontal	none	1.0	0.2	-0.7	0.2	-0.7	3.0	1.0	10659.0	4.0	-0.3	600.0	0.5	5595.3
1106	StJohn	1.3	-1.0	5.2	30	1.5	12.7			-1.0	fen	horizontal	none	1.0	0.3	-0.6	0.3	-0.6	3.1	1.0	10634.0	4.0	-0.3	600.0	0.5	5582.2
1107	StJohn	6.9	0.0	5.2	20	1.3	22.1			-1.1	fen	horizontal	none	0.0	0.3	-0.5	0.3	-0.5	3.1	1.0	10666.0	4.0	-0.3	600.0	0.5	5599.0
1108	StJohn	1.2	-1.0	5.4	30	1.5	15.5			-1.2	fen	horizontal	none	0.0	0.1	-0.9	0.1	-0.9	3.1	1.0	10706.0	4.0	-0.3	600.0	0.5	5619.9
1109	StJohn	10.7	0.5	6.0	20	1.3	10.7			-1.2	fen	horizontal	none	0.0	0.3	-0.6	0.3	-0.6	3.1	1.0	10690.0	4.0	-0.3	600.0	0.5	5611.5
1110	StJohn	10.4	0.4	5.8	20	1.3	10.3			-0.9	upland	upland	none	6.0	0.6	-0.2	0.6	-0.2	3.1	1.0	10644.0	4.0	-0.3	600.0	0.5	5587.4
1111	StJohn	8.9	0.2	5.6	20	1.3	10.3			-1.2	fen	horizontal	none	0.0	0.3	-0.5	0.3	-0.5	3.1	1.0	10703.0	4.0	-0.3	600.0	0.5	5618.4
1112	StJohn	6.0	-0.1	5.5	30	1.5	9.7			-1.3	fen	horizontal	none	0.0	0.2	-0.7	0.2	-0.7	3.2	1.0	10779.0	4.0	-0.3	600.0	0.5	5658.3
1113	StJohn	6.6	-0.1	5.7	30	1.5	12.3			-1.3	fen	horizontal	none	0.0	0.3	-0.5	0.3	-0.5	3.2	1.0	10811.0	4.0	-0.3	600.0	0.5	5675.1
1114	StJohn	7.0	0.0	5.4	20	1.3	11.3			-0.8	upland	upland	none	7.0	0.2	-0.6	0.2	-0.6	3.1	1.0	10536.0	4.0	-0.3	600.0	0.5	5530.7
1115	StJohn	2.5	-0.7	5.1	20	1.3	10.3			-1.0	fen	horizontal	none	1.0	0.2	-0.6	0.2	-0.6	3.2	1.0	10716.0	4.0	-0.3	600.0	0.5	5625.2
1116	StJohn	4.8	-0.3	5.2	20	1.3	12.7			-1.1	fen	horizontal	none	0.0	0.2	-0.7	0.2	-0.7	3.2	1.0	10707.0	4.0	-0.3	600.0	0.5	5620.5
1117	StJohn	6.5	-0.1	5.2	20	1.3	12.3			-1.2	fen	horizontal	none	0.0	0.3	-0.5	0.3	-0.5	3.2	1.0	10731.0	4.0	-0.3	600.0	0.5	5633.1
1118	StJohn	8.1	0.1	5.6	30	1.5	14.3			-1.2	fen	horizontal	none	0.0	0.2	-0.7	0.2	-0.7	3.2	1.0	10803.0	4.0	-0.3	600.0	0.5	5670.9
1119	StJohn	10.1	0.4	5.7	30	1.5	18.3			-1.2	fen	horizontal	none	0.0	0.2	-0.7	0.2	-0.7	3.2	1.0	10806.0	4.0	-0.3	600.0	0.5	5672.4
1120	StJohn	9.5	0.3	5.8	30	1.5	18.1			-1.1	fen	horizontal	none	4.0	0.2	-0.6	0.2	-0.6	3.3	1.0	10762.0	4.0	-0.3	600.0	0.5	5649.3
1121	StJohn	9.4	0.3	5.9	30	1.5	17.3			-1.0	fen	horizontal	none	6.0	0.3	-0.6	0.3	-0.6	3.3	1.0	10797.0	4.0	-0.3	600.0	0.5	5667.7
1122	StJohn	9.5	0.3	5.9	30	1.5	18.1			-1.0	fen	horizontal	none	6.0	0.5	-0.3	0.5	-0.3	3.3	1.0	10528.0	4.0	-0.3	600.0	0.5	5526.5
1123	StJohn	9.9	0.3	6.0	30	1.5	18.0			-1.0	fen	horizontal	none	5.0	0.5	-0.3	0.5	-0.3	3.3	1.0	10653.0	4.0	-0.3	600.0	0.5	5592.1
1124	StJohn	9.8	0.3	6.1	30	1.5	18.5			-1.0	fen	horizontal	none	1.0	0.2	-0.8	0.2	-0.8	3.4	1.0	10770.0	4.0	-0.3	600.0	0.5	5653.5
1125	StJohn	8.6	0.2	5.7	30	1.5	18.8			-0.8	upland	upland	none	12.0	0.7	-0.1	0.7	-0.1	3.5	1.0	11369.0	4.1	-0.3	600.0	0.5	5968.0

Plot	Site Name	DO	calc DO	pH	EC	log (ec)	Temp	Color	Sqrt (col)	log Slope	Class	Form	Type	Tree Ht	DTW (4ha)	DTW (log4ha)	DTW (1ha)	DTW (log1ha)	log fa 150m	Open Water	PRR	log (PRR)	log (HC)	evapo tran	ET/Ppt ratio	ratio x PRR
1126	StJohn	7.9	0.1	5.9	30	1.5	18.3			-0.8	swamp	lagg	none	9.0	1.2	0.1	1.2	0.1	3.5	1.0	11206.0	4.0	-0.3	600.0	0.5	5882.4
1127	StJohn	8.4	0.2	5.9	30	1.5	18.8			-0.8	swamp	lagg	none	5.0	0.7	-0.2	0.7	-0.2	3.5	1.0	10711.0	4.0	-0.3	600.0	0.5	5622.6
1128	StJohn	5.9	-0.1	5.4	30	1.5	19.1			-0.8	upland	upland	none	8.0	1.1	0.0	1.1	0.0	3.5	1.0	10440.0	4.0	-0.3	600.0	0.5	5480.3
1129	StJohn	5.4	-0.2	5.4	30	1.5	19.7			-0.8	upland	upland	none	5.0	1.3	0.1	1.3	0.1	3.5	1.0	9283.0	4.0	-0.3	600.0	0.5	4873.0
1130	StJohn	9.0	0.2	5.8	30	1.5	19.6			-0.8	fen	horizontal	none	1.0	0.8	-0.1	0.8	-0.1	3.4	1.0	10814.0	4.0	-0.3	600.0	0.5	5676.6
1131	StJohn	8.4	0.2	5.8	30	1.5	19.7			-0.9	fen	horizontal	none	3.0	0.8	-0.1	0.8	-0.1	3.4	1.0	9753.0	4.0	-0.3	600.0	0.5	5119.7
1132	StJohn	6.5	-0.1	5.9	30	1.5	20.5			-0.9	fen	horizontal	none	0.0	0.3	-0.6	0.3	-0.6	3.4	1.0	10825.0	4.0	-0.3	600.0	0.5	5682.4
1133	StJohn	14.3		4.9	40	1.6	22.2			-1.0	fen	horizontal	none	0.0	0.5	-0.3	0.5	-0.3	3.4	1.0	10610.0	4.0	-0.3	600.0	0.5	5569.6
1134	StJohn	10.3	0.4	5.7	30	1.5	20.1			-1.1	fen	horizontal	none	0.0	0.3	-0.5	0.3	-0.5	3.4	1.0	10786.0	4.0	-0.3	600.0	0.5	5661.9
1135	StJohn	9.3	0.3	5.8	30	1.5	18.7			-1.2	fen	horizontal	none	0.0	0.6	-0.2	0.6	-0.2	3.4	1.0	10653.0	4.0	-0.3	600.0	0.5	5592.1
1136	StJohn	12.0	0.7	5.7	30	1.5	19.0			-1.1	fen	horizontal	none	0.0	0.5	-0.3	0.5	-0.3	3.4	1.0	10752.0	4.0	-0.3	600.0	0.5	5644.1
1137	StJohn	11.5	0.6	5.7	30	1.5	17.2			-1.1	fen	horizontal	none	0.0	0.3	-0.5	0.3	-0.5	3.4	1.0	10842.0	4.0	-0.3	600.0	0.5	5691.3
1138	StJohn	10.9	0.5	6.0	30	1.5	18.6			-1.2	fen	horizontal	none	0.0	0.7	-0.2	0.7	-0.2	3.4	1.0	10698.0	4.0	-0.3	600.0	0.5	5615.7
1139	StJohn	9.8	0.3	6.0	30	1.5	16.9			-1.2	fen	horizontal	none	0.0	0.5	-0.3	0.5	-0.3	3.3	1.0	10678.0	4.0	-0.3	600.0	0.5	5605.2
1140	StJohn	9.8	0.3	6.0	30	1.5	17.7			-1.1	fen	horizontal	none	0.0	0.1	-0.9	0.1	-0.9	3.3	1.0	10663.0	4.0	-0.3	600.0	0.5	5597.4
1141	StJohn	11.1	0.5	6.2	30	1.5	21.2			-1.1	fen	horizontal	none	0.0	0.4	-0.4	0.4	-0.4	3.4	1.0	10763.0	4.0	-0.3	600.0	0.5	5649.9
1142	StJohn	12.7	0.9	6.2	30	1.5	23.0			-1.1	fen	horizontal	none	0.0	0.4	-0.4	0.4	-0.4	3.4	1.0	10726.0	4.0	-0.3	600.0	0.5	5630.4
1143	JackPine	6.7	-0.1				5.9			-1.4	upland	upland	0.0	7.6	0.8	-0.1	0.7	-0.1	2.6	0.0	11238.0	4.1	-3.2	600.0	0.5	5899.2
1144	JackPine	2.5	-0.7				6.2			-1.4	swamp	lagg	0.0	6.9	0.5	-0.3	0.4	-0.4	2.6	0.0	10988.0	4.0	-5.0	600.0	0.5	5768.0
1145	JackPine	1.9	-0.8				10.8			-1.3	swamp	drainageway	0.0	4.7	0.1	-0.9	0.1	-0.9	2.5	0.0	11046.0	4.0	-5.0	600.0	0.5	5798.4
1146	JackPine	0.9	-1.2				7.6			-1.3	swamp	drainageway	0.0	4.8	0.3	-0.5	0.2	-0.7	2.5	0.0	9825.0	4.0	-5.0	600.0	0.5	5157.5
1147	JackPine	0.8	-1.3				4.9			-1.3	swamp	lagg	0.0	5.5	0.7	-0.2	0.6	-0.3	2.5	0.0	9917.0	4.0	-5.0	600.0	0.5	5205.8
1148	JackPine	0.5	-1.5				7.4			-1.2	swamp	lagg	0.0	4.8	1.7	0.2	0.6	-0.2	2.5	0.0	11377.0	4.1	-5.0	600.0	0.5	5972.2
1149	JackPine	0.5	-1.4				8.4			-1.2	swamp	drainageway	0.0	2.2	2.0	0.3	0.2	-0.7	2.5	0.0	10753.0	4.0	-5.0	600.0	0.5	5644.6
1150	JackPine	3.9	-0.4				6.2			-1.2	swamp	lagg	0.0	7.0	2.3	0.4	0.7	-0.1	2.5	0.0	11211.0	4.0	-5.0	600.0	0.5	5885.0
1151	JackPine	4.0	-0.4				7.2			-1.2	upland	upland	0.0	5.4	1.4	0.2	1.0	0.0	2.5	0.0	11222.0	4.1	-3.2	600.0	0.5	5890.8
1152	JackPine	9.8	0.3	6.3			14.1			-1.2	swamp	drainageway	0.0	3.1	0.4	-0.4	0.2	-0.7	2.6	1.0	10998.0	4.0	-5.0	600.0	0.5	5773.2
1153	JackPine	7.6	0.1	6.0			11.6			-1.2	swamp	drainageway	0.0	4.5	0.2	-0.7	0.2	-0.7	2.8	1.0	10759.0	4.0	-5.0	600.0	0.5	5647.8
1154	JackPine	9.5	0.3	5.8			14.6			-1.3	swamp	drainageway	0.0	3.9	0.3	-0.5	0.3	-0.5	2.8	1.0	10696.0	4.0	-5.0	600.0	0.5	5614.7
1155	JackPine	7.9	0.1	5.7			13.8			-1.2	swamp	drainageway	0.0	3.6	0.2	-0.8	0.2	-0.8	2.9	1.0	10544.0	4.0	-5.0	600.0	0.5	5534.9
1156	JackPine	6.6	-0.1	5.7			13.9			-1.2	swamp	drainageway	0.0	5.6	0.3	-0.6	0.3	-0.6	2.9	1.0	10101.0	4.0	-5.0	600.0	0.5	5302.4
1157	JackPine	6.4	-0.1	5.7			12.8			-1.2	swamp	drainageway	0.0	5.7	0.3	-0.5	0.3	-0.5	2.9	1.0	10571.0	4.0	-5.0	600.0	0.5	5549.1
1158	JackPine	7.6	0.0	5.8			11.5			-1.1	swamp	drainageway	0.0	11.6	0.4	-0.4	0.4	-0.4	3.0	1.0	10733.0	4.0	-5.0	600.0	0.5	5634.1
1159	JackPine	8.1	0.1	5.8			10.3			-1.1	swamp	drainageway	0.0	8.2	0.4	-0.4	0.4	-0.4	3.1	1.0	10176.0	4.0	-5.0	600.0	0.5	5341.7
1160	JackPine	1.4	-1.0	6.1	70	1.8	9.4			-1.2	upland	upland	0.0	7.1	1.5	0.2	1.5	0.2	3.3	0.0	9791.0	4.0	-3.2	600.0	0.5	5139.6
1161	JackPine	3.9	-0.4	6.0	50	1.7	8.9			-1.3	upland	upland	0.0	8.1	1.3	0.1	1.3	0.1	3.3	0.0	10492.0	4.0	-3.2	600.0	0.5	5507.6
1162	JackPine	3.9	-0.4	5.9	50	1.7	7.9			-1.3	upland	upland	0.0	8.1	1.0	0.0	1.0	0.0	3.3	0.0	11045.0	4.0	-3.2	600.0	0.5	5797.9
1163	JackPine	4.5	-0.3	5.6	40	1.6	8.2			-1.3	upland	upland	0.0	7.8	0.6	-0.2	0.6	-0.2	3.2	0.0	10549.0	4.0	-3.2	600.0	0.5	5537.5
1164	JackPine	6.7	-0.1	5.5	50	1.7	8.5			-1.3	upland	upland	0.0	8.6	0.3	-0.5	0.3	-0.5	2.9	0.0	10379.0	4.0	-3.2	600.0	0.5	5448.3
1165	JackPine	6.5	-0.1	5.4	40	1.6	8.9			-1.4	upland	upland	0.0	7.5	0.1	-1.1	0.1	-1.1	2.9	0.0	11639.0	4.1	-3.2	600.0	0.5	6109.7
1166	JackPine	3.7	-0.5	5.5	30	1.5	9.8			-1.4	swamp	lagg	0.0	3.7	0.2	-0.6	0.2	-0.6	2.9	0.0	11075.0	4.0	-5.0	600.0	0.5	5813.6
1167	JackPine	4.7	-0.3	5.7	20	1.3	10.3			-1.4	swamp	lagg	0.0	3.5	0.2	-0.7	0.2	-0.7	2.9	0.0	11084.0	4.0	-5.0	600.0	0.5	5818.4
1168	JackPine	7.3	0.0	5.8	20	1.3	11.1			-1.4	swamp	drainageway	0.0	2.0	0.4	-0.4	0.4	-0.4	2.9	1.0	10694.0	4.0	-5.0	600.0	0.5	5613.6
1169	JackPine	3.1	-0.6	5.6	20	1.3	9.4			-1.4	swamp	lagg	0.0	6.7	0.3	-0.5	0.3	-0.5	2.9	0.0	9657.0	4.0	-5.0	600.0	0.5	5069.3
1170	JackPine	3.5	-0.5	5.7	20	1.3	9.4			-1.4	swamp	lagg	0.0	5.4	0.5	-0.3	0.5	-0.3	2.9	0.0	9636.0	4.0	-5.0	600.0	0.5	5058.3

Plot	Site Name	DO	calc DO	pH	EC	log (ec)	Temp	Color	Sqrt (col)	log Slope	Class	Form	Type	Tree Ht	DTW (4ha)	DTW (log4ha)	DTW (1ha)	DTW (log1ha)	log fa 150m	Open Water	PRR	log (PRR)	log (HC)	evapo tran	ET/Ppt ratio	ratio x PRR
1171	JackPine	6.8	0.0	5.7	20	1.3	8.7			-1.4	upland	upland	0.0	4.9	0.3	-0.5	0.3	-0.5	2.9	0.0	9644.0	4.0	-3.2	600.0	0.5	5062.5
1172	JackPine	5.0	-0.3	5.5	20	1.3	8.9			-1.4	upland	upland	0.0	7.3	0.8	-0.1	0.8	-0.1	2.8	0.0	10153.0	4.0	-3.2	600.0	0.5	5329.7
1173	JackPine	6.8	0.0	5.4	20	1.3	8.0			-1.4	upland	upland	0.0	5.5	1.1	0.0	1.1	0.0	2.8	0.0	10670.0	4.0	-3.2	600.0	0.5	5601.0
1174	JackPine	5.4	-0.2	5.6	20	1.3	8.9			-1.4	upland	upland	0.0	5.0	1.6	0.2	1.6	0.2	2.8	0.0	10598.0	4.0	-3.2	600.0	0.5	5563.3
1175	JackPine	4.3	-0.4	5.5	20	1.3	9.3			-1.4	upland	upland	0.0	8.1	1.7	0.2	1.7	0.2	2.8	0.0	10404.0	4.0	-3.2	600.0	0.5	5461.4
1176	JackPine	5.7	-0.2	5.4	20	1.3	9.1			-1.4	upland	upland	0.0	7.7	2.2	0.3	2.1	0.3	2.7	0.0	10474.0	4.0	-3.2	600.0	0.5	5498.2
1177	JackPine	5.5	-0.2	5.2	20	1.3	17.6			-1.4	swamp	drainageway	0.0	4.1	1.5	0.2	0.1	-0.9	2.3	1.0	11120.0	4.0	-5.0	600.0	0.5	5837.3
1178	JackPine	4.7	-0.3	5.3	20	1.3	13.5			-1.4	swamp	drainageway	0.0	2.6	1.1	0.0	0.3	-0.5	2.4	1.0	10962.0	4.0	-5.0	600.0	0.5	5754.3
1179	JackPine	5.6	-0.2	4.4	20	1.3	14.0			-1.4	swamp	drainageway	0.0	3.9	1.0	0.0	0.5	-0.3	2.5	1.0	10509.0	4.0	-5.0	600.0	0.5	5516.5
1180	JackPine	5.8	-0.2	5.5	20	1.3	14.9			-1.4	swamp	drainageway	0.0	1.5	0.4	-0.4	0.4	-0.4	2.6	1.0	10623.0	4.0	-5.0	600.0	0.5	5576.4
1181	JackPine	5.7	-0.2	5.3	20	1.3	14.7			-1.4	swamp	drainageway	0.0	4.1	0.4	-0.4	0.4	-0.4	2.7	1.0	11081.0	4.0	-5.0	600.0	0.5	5816.8
1182	JackPine	5.8	-0.2	5.4	20	1.3	13.4			-1.4	swamp	drainageway	0.0	6.3	0.2	-0.6	0.2	-0.7	2.7	1.0	10364.0	4.0	-5.0	600.0	0.5	5440.4
1183	JackPine	5.5	-0.2	5.4	20	1.3	12.5			-1.4	swamp	drainageway	0.0	5.2	0.5	-0.3	0.4	-0.4	2.8	1.0	8255.0	3.9	-5.0	600.0	0.5	4333.3
1184	JackPine	6.2	-0.1	5.6	20	1.3	14.2			-1.4	swamp	drainageway	0.0	2.9	0.4	-0.4	0.4	-0.4	2.9	1.0	10360.0	4.0	-5.0	600.0	0.5	5438.3
1185	JackPine	7.0	0.0	5.5	20	1.3	14.1			-1.4	swamp	drainageway	0.0	5.6	0.6	-0.2	0.6	-0.2	2.9	1.0	10895.0	4.0	-5.0	600.0	0.5	5719.2
1186	JackPine	6.3	-0.1	5.5	30	1.5	14.2			-1.2	swamp	drainageway	0.0	1.1	0.1	-0.9	0.1	-0.9	3.3	1.0	9802.0	4.0	-5.0	600.0	0.5	5145.4
1187	JackPine	7.8	0.1	5.4	20	1.3	14.7			-1.1	swamp	drainageway	0.0	4.7	0.3	-0.5	0.3	-0.5	3.3	1.0	9947.0	4.0	-5.0	600.0	0.5	5221.5
1188	JackPine	8.8	0.2	6.9	140	2.1	14.1			-1.1	swamp	drainageway	0.0	3.2	1.2	0.1	1.2	0.1	3.3	1.0	9004.0	4.0	-5.0	600.0	0.5	4726.5
1189	Emend	6.8	0.0	7.0	110	2.0	10.4			-1.4	marsh	linked basin	shrub	2.0	0.3	-0.6	0.2	-0.7	4.5	1.0	9227.0	4.0	-0.3	340.0	0.8	7278.8
1190	Emend	3.0	-0.6	6.5	340	2.5	13.8			-1.6	marsh	linked basin	shrub	5.0	0.2	-0.8	0.0	-1.4	4.1	1.0	9703.0	4.0	-0.3	340.0	0.8	7654.3
1191	Emend	3.7	-0.5	6.7	340	2.5	12.3			-1.5	fen	horizontal	none	7.0	0.2	-0.7	0.2	-0.8	4.1	1.0	8790.0	3.9	-0.3	340.0	0.8	6934.1
1192	Emend	5.6	-0.2	7.8	250	2.4	9.0			-1.7	marsh	linked basin	shrub	1.0	0.1	-1.0	0.1	-1.1	4.4	1.0	9123.0	4.0	-0.3	340.0	0.8	7196.8
1193	StJohn	3.6	-0.5	4.8	40	1.6	9.7			-0.8	swamp	lagg	none	5.0	0.1	-1.0	0.1	-1.0	2.8	0.0	10624.0	4.0	-0.3	600.0	0.5	5576.9
1194	StJohn	2.9	-0.6	4.8	30	1.5	9.5			-0.8	swamp	lagg	none	6.0	0.2	-0.7	0.2	-0.7	2.7	0.0	10628.0	4.0	-0.3	600.0	0.5	5579.0
1195	StJohn	4.6	-0.3	5.5	30	1.5	12.6			-0.9	fen	horizontal	none	1.0	1.2	0.1	1.2	0.1	3.4	0.0	11812.0	4.1	-0.3	600.0	0.5	6200.5
1196	StJohn	6.2	-0.1	6.1	60	1.8	14.9			-0.9	fen	horizontal	shrub	4.7	2.2	0.3	2.2	0.3	3.4	0.0	11651.0	4.1	-0.3	600.0	0.5	6116.0
1197	StJohn	5.1	-0.3	4.1	40	1.6	10.7			-1.3	fen	horizontal	none	2.1	0.4	-0.4	0.4	-0.4	3.2	0.0	10803.0	4.0	-0.3	600.0	0.5	5670.9
1198	StJohn	6.6	-0.1	4.4	30	1.5	9.3			-1.2	fen	horizontal	none	1.2	0.3	-0.6	0.3	-0.6	3.2	0.0	10743.0	4.0	-0.3	600.0	0.5	5639.4

APPENDIX II

Wetlands

The National Wetlands Working Group of Canada defines a wetland as, "Land that is saturated with water long enough to promote wetland or aquatic processes as indicated by poorly drained soils, hydrophytic vegetation, and various kinds of biological activity which are adapted to a wet environment" (N. W. W. Group, 1997). Wetlands exhibit characteristics of both aquatic and terrestrial ecosystems, often considered transition zones between each (Tiner, 2005; Mitsch and Gosselink, 2007). As a result, wetlands are rich in biological diversity, often containing species that cannot be found elsewhere (Gopal, 2009).

Wetlands have ecological, social and economic values.

Wetland ecological values include water storage, habitat provision, nutrient cycling, and sediment filtration (Tiner, 2005; Mitsch and Gosselink, 2007). Water stored in wetlands i) inhibits the movement of oxygen to and from soil and ii) regulates temperature of soil, with wet soils taking longer to heat up, and when heated, taking longer to cool down; resulting in increased biological oxygen demand (BOD), and the creation of niche habitats for wetland adapted flora and fauna (Bridgham and Lamberti, 2009; Clement and Proctor, 2009). In temperate Canadian forests, tree species such as maple, cedar, tamarack, spruce, and shrubs such as willow and alder, provide the overstory of most freshwater wetlands, while mesic to hydric ground vegetation species grow either below the forest canopy or in open light; with species location being

controlled by factors such as temperature, shade, nutrient status, available water and available oxygen (Mitsch and Gosselink, 2007). Vegetation communities formed in wetlands provide habitat for fauna, from micro-organisms, to higher trophic level species such as beaver and moose (Van Den Wyngaert and Bobbink, 2009).

The process of nutrient cycling can involve chemical transformation and chemical transportation (Mitsch and Gosselink, 2007). Nitrogen, iron, manganese, sulfur, carbon, and phosphorus are involved in complex chemical transformations in wetlands, spurred by a lack of oxygen and the low redox potential that results (Mitsch and Gosselink, 2007). Transportation of nutrients to and from wetlands occurs along flow regimes. Wetlands act as sediment traps when water passes through depressions and heavy material falls out of suspension (Baker et. al., 2009; Tiner, 2005). As such, while reduced forms of some nutrients can have a negative effect on downstream ecosystems, sediment filtration can benefit downstream water quality by decreasing abrasion or pollution transportation.

Wetland social values, which may be spiritual, recreational and aesthetic, are determined by people and communities that have some connection to the land, and as a result, can vary from one community to the next and change over time (Barker and Maltby, 2009b). Wetlands social value depends on a communities' proximity to, and association with wetlands; including knowledge of wetland ecology and function, occurrence of wetlands in given area, and the hunting population (Tiner, 2005).

Wetland economic value may be derived from timber harvesting, peat production, land conversion, and environmental hazard reduction (Mitsch and Gosselink, 2007; Barker

and Maltby, 2009b). While rates of timber harvesting in riparian zones and wetlands have decreased in recent years, the harvesting of cedar, maple, spruce and pine for lumber, firewood and pulp production in the past has resulted in long term alterations to forest composition, vegetation communities, and drainage patterns of many wetlands (Tiner, 2005).

Peat from ombrotrophic bogs can be burned for fuel or it can be utilized in horticultural practices, most often as a growing medium (Mitsch and Gosselink, 2007). Canada is currently the 5th leading producer of peat in the world, with that peat being primarily used for horticultural purposes.

The most common form of wetland conversion is transition to agricultural land, with the U.S, having an average drainage rate of 490,000 ha/year between 1900 and 1985(Mitsch and Gosselink, 2007). Periodically flooded wetlands have traditionally supported soil rich in nutrients due to an annual influx of nutrients. An increase in land use and development has resulted in an increase in transportation corridors and the intersection and alteration of wetland drainage patterns (Mitsch and Gosselink, 2007).

The economic value of wetlands pertaining to the control of downstream effects is being increasing realized; this includes regulation of downstream nutrient inundation, flood control, and polluted water filtration (Barker and Maltby, 2009a).

Wetland Classification

Wetlands are classified into broad groups primarily based on whether they contain fresh or saline water; and are further classified based on hydrological and physiological

attributes (Tiner, 2005). Classification schemes and definitions vary across the country and around the world, primarily due to the history and purpose of classification.

Regional definitions of wetlands developed when communication across long distances was slow and lacking. As multiple terms for the same wetland classes have persisted, and communication across wider regions has increased, the need to standardize wetland terminology has become more important. Three of the foremost wetland classification bodies are the U.S. Fish and Wildlife Services, Ramsar (International), and the National Wetlands Working Group of Canada (Mitsch and Gosselink, 2007).

Wetlands definitions can also vary based on the objective of the user, most notably the distinction between a scientific viewpoint and a regulation viewpoint. A scientific definition of a wetland, one that includes all available information about ecological characteristics, biota and hydrological patterns, will remain unchanged unless new information becomes available for updating the definition, while a regulatory or legal definition of a wetland is developed and altered to meet policy and the needs of society (Tiner, 2005).

For a wetland classification scheme to be applicable for scientific study it must be repeatable and consistent across a variety of eco regions and locations, and it must be based on ecological features, as opposed to interpretation based on land use, which allows users the ability to map wetland classes (NWWG, 1997). The Canadian Wetland Classification System (CWCS) was chosen for use in this project because it provides a consistent classification system for the two study sites, in Alberta and New Brunswick.

The CWCS uses a hierarchy approach to identifying wetlands, beginning with wetland class, then wetland form and finally wetland type. Wetland class is determined by wetland development and the ecosystem in which it exists; wetland form is determined by morphological characteristics, and wetland type is specific to the vegetation or physiological characteristics of the vegetation on the wetland (Zoltai and Vitt, 1995; NWWG, 1997).

Based on the Canadian Wetland Classification System there are five classes of freshwater wetlands; bogs, fens, swamps, marshes and shallow open water. Swamps, marshes, fens and bogs have been included in the analysis of this project, along with their adjacent uplands.

Specific features for determining wetland classes are as follows (Zoltai and Vitt, 1995; NWWG, 1997):

- Bogs: Sphagnum moss is the dominant vegetation; acidic; ombrotrophic.
- Fens: Dominated by bryophyte vegetation; often minerotrophic; poor fens can be similar to bogs, except for having better decomposition and productivity; thinner forest floor layer than bogs; often deciduous vegetation.
- Swamps: Contain trees and/or tall shrubs; minerotrophic water; little peat accumulation (often peat contains woody material); drier than marshes, fens and open bogs.
- Marshes: Do not have trees; contain vascular plants; little peat accumulation; shallow minerotrophic water; fast decomposition,

Wetland forms are numerous, however only six were included in the study area, they are as follows (NWWG, 1997):

- Basin Bog: flat surface, not raised above surrounding terrain
- Domed Bog: convex surface, raised above surrounding terrain
- Horizontal Fen: flat surface, containing water that is part of drainage system
- Drainageway Swamp: drainage paths are somewhat sloped, may or may not have distinct flow
- Lagg Swamp: between upland and peatland
- Linked-basin Marsh: confined to shallow depressions, receive both surface and groundwater

APPENDIX III

Remote Sensing

Natural resource managers and scientists have been using remotely sensed data for decades in order to expand data collection and view landscape patterns, while saving time and money (Cowardin and Myers, 1974; Knight et al., 2013). Currently three distinct sources of remote sensing are available for wetland mapping, i) photo, ii) radar, and iii) laser (Campbell, 2012; Knight et al., 2013; Millard and Richardson, 2013).

Photogrammetry, which can be aerial or satellite based, provides users with visible and infrared image bands from which digital terrain models can be extrapolated (Li and Zhu, 2005). While photogrammetric methods are commonly applied for mapping large areas of land, primarily based on supervised and unsupervised classification, problems arise when extrapolating DEMs from image bands due to poor image resolution, lack of ancillary verification data, and variation in height of above ground objects (Walker and Willgoose, 1999; Hebeler and Purves, 2009; Campbell, 2012).

Synthetic Aperture Radar (SAR), which can also be aerial or satellite based, involves measuring the strength of the reflection of electromagnetic waves reflected by terrestrial objects, and uses the data to determine landscape attributes such as topography and standing water locations (Ozesmi and Bauer, 2002; Li and Zhu, 2005; Campbell, 2012). Benefits of SAR include being able to penetrate canopy and cloud cover, and being able to collect data during any time of the day; thus allowing for more accurate

representation of the bare earth elevation than photogrammetric DEM interpolation (Ozesmi and Bauer, 2002).

Light Detection and Ranging (LiDAR) sensors, which are commonly aircraft based, emit and receive laser pulses, then calculate distance by multiplying the time interval by the speed of light (Lefsky et. al., 2002). Continuous pulse returns provide vegetation height and bare earth representation, at 10 – 100 cm resolution, which allows for the development of a 3D spatial pattern; this being important for a variety of ecological studies, including specific species habitat, and forest development (Evans et. al., 2009; Lefsky et al., 2002). LiDAR provides a more accurate representation of the earth's surface and objects upon it, and therefore has become the foremost tool for remote sensing with respect to natural resource management (Evans et al., 2009).

Need for Remote Sensing

In Canada there are more than 150 million hectares of wetlands, approximately 25% of the earth's total (N. W. W. Group, 1997). Due to their vast expanse, remote sensing is widely used to delineate and classify wetlands (Baker et. al., 2006; Corcoran et. al., 2013; Millard and Richardson, 2013). Remote sensing is preferred over field collected data for saving time and money, and because field collected data is often more detailed than what is required for landscape level mapping and planning (Baker et al., 2006). Further, as development, such as road building and other infrastructure occurs, wetland form and flow patterns may change, resulting in a need for updated wetland maps (Corcoran et al., 2011).

Types of wetland mapping, including remote sensing and modelling

Currently, the most commonly used approach for wetland mapping is classification of optical satellite images, however, disadvantages arise due to the inability to distinguish terrain and resulting wet versus dry areas accurately (Ozesmi and Bauer, 2002; Baker et al., 2006; Millard and Richardson, 2013). While wetland mapping based on satellite images has been show to improve with the incorporation of aerial images and ancillary data, Corocan (2011) notes that aerial images are often outdated, and do not accurately represent the ever changing nature of wetlands, while ancillary data use is often time consuming and expensive. Manual classification of wetlands can reveal inconsistencies between outputs, resulting in a need for an automated wetland mapping process, based primarily on quantitative landscape derivatives (Finlayson and VanDer Valk, 1995; Baker et al., 2006).

Automated classification of optical imagery is traditionally based on supervised and unsupervised classification techniques, both of which interpret image color, texture, and pattern, among a variety of other variables (Xie et. al., 2008). Unsupervised classification, which employs iterative self-organizing data analysis technique (ISODATA) algorithms, classifies image pixels based on spectral data patterns, and can be applied relatively quickly over wide ranging terrain, while supervised classification assigns spectral values primarily based on a training dataset, which designates prior classes to image samples based on predictor variables (Cerna and Chytry, 2005; Xie et al., 2008). The advantage of using supervised over unsupervised image classification is

that supervised methods can be applied to new sampling units, without having to be re-trained.

Synthetic aperture radar has been show to improve wetland identification and classification compared with photogrammetric images, with improvements in the areas of forest canopy penetration and surface water identification (Wdowinski et al., 2008; Whitcomb et. al., 2009) Radar wavelengths, specifically C-band (~5.6cm) and L-band (~23cm), can be used to distinguish the location of short flooded areas with short vegetation and taller vegetation respectively (Whitcomb et al., 2009). Due to the short wavelength of C-band SAR the scattering in forested areas occurs at the tree tops, not allowing for canopy penetration, while L-band wavelengths are able to penetrate and reflect tree stems and forest floor. The identification of wetlands using L-band SAR is improved when the forest surface is flooded, as the smooth surface creates a more distinguishable radar backscatter than a rough surface (Touzi et. al., 2009; Whitcomb et al., 2009). Both Touzi (2009) and Corocan (2013) have reported that the use L-band and C-band in combination would assist with best wetland identification practices, with Corocan concluding that L-band use in spring is optimal for locating wet versus dry forested areas, while C-band, when used over a broad seasonal coverage, offers insight into more specific wetland classification.

The use of LiDAR derivatives, involving laser pulse return metrics, have been found to accurately represent wetland location and vegetation structure (Hopkinson et. al., 2006; Maxa and Bolstad, 2009; Millard and Richardson, 2013). Millard (2013) found that LiDAR better identified wetland structure than SAR data as the geomorphic form of the

landscape was better represented, which is closely related to wetland hydrology and structure, while Maxa (2009) found that the combination of image with LiDAR data provided wetland mapping results that were superior to manual delineation of aerial photos, mainly due to the use of LiDAR topographic data for identifying depressions in the landscape. Further, Murphy (2009) found that depth to water mapping accuracy, and the resulting wetland identification, improved with the use of LiDAR DEM's, particularly in areas of subtle topographic relief.

Remote Sensing Data Analysis

While the use of SAR and LiDAR have resulted in higher accuracy in wetland identification and classification, both are not as widely used as photogrammetric images, possibly due to traditional classification techniques not being applicable to the often non-parametric and multisource SAR and LiDAR datasets (Millard and Richardson, 2013). Self-learning decision trees (DT), which involve a hierarchical data partitioning approach that uses both continuous and categorical data, have been shown to produce accurate wetland classification maps based on multi-source datasets (Baker et al., 2006; Waske and Braun, 2009; Millard and Richardson, 2013). Bagging and boosting decision trees, which involved iterative tree development using random subsets of the data, and emphasis on improperly classified samples respectively, have shown an improvement in the use of DT's (Baker et al., 2006; Waske and Braun, 2009; Waske et. al., 2007). The random forest (RF) approach takes the bagging approach further as it uses many decision trees, not only reiterating a bootstrap sample of the data

but also using a random subset of predictors at each node, and then aggregating the predictions for all trees (Genuer, Poggi, and Tuleau, 2008). Millard (2013) demonstrated the use of RF with SAR and LiDAR derivatives and concluded that it offerd a more robust classification, in terms of processing time and accuracy, than traditional parametric or simple DT classification approaches.

APPENDIX IV

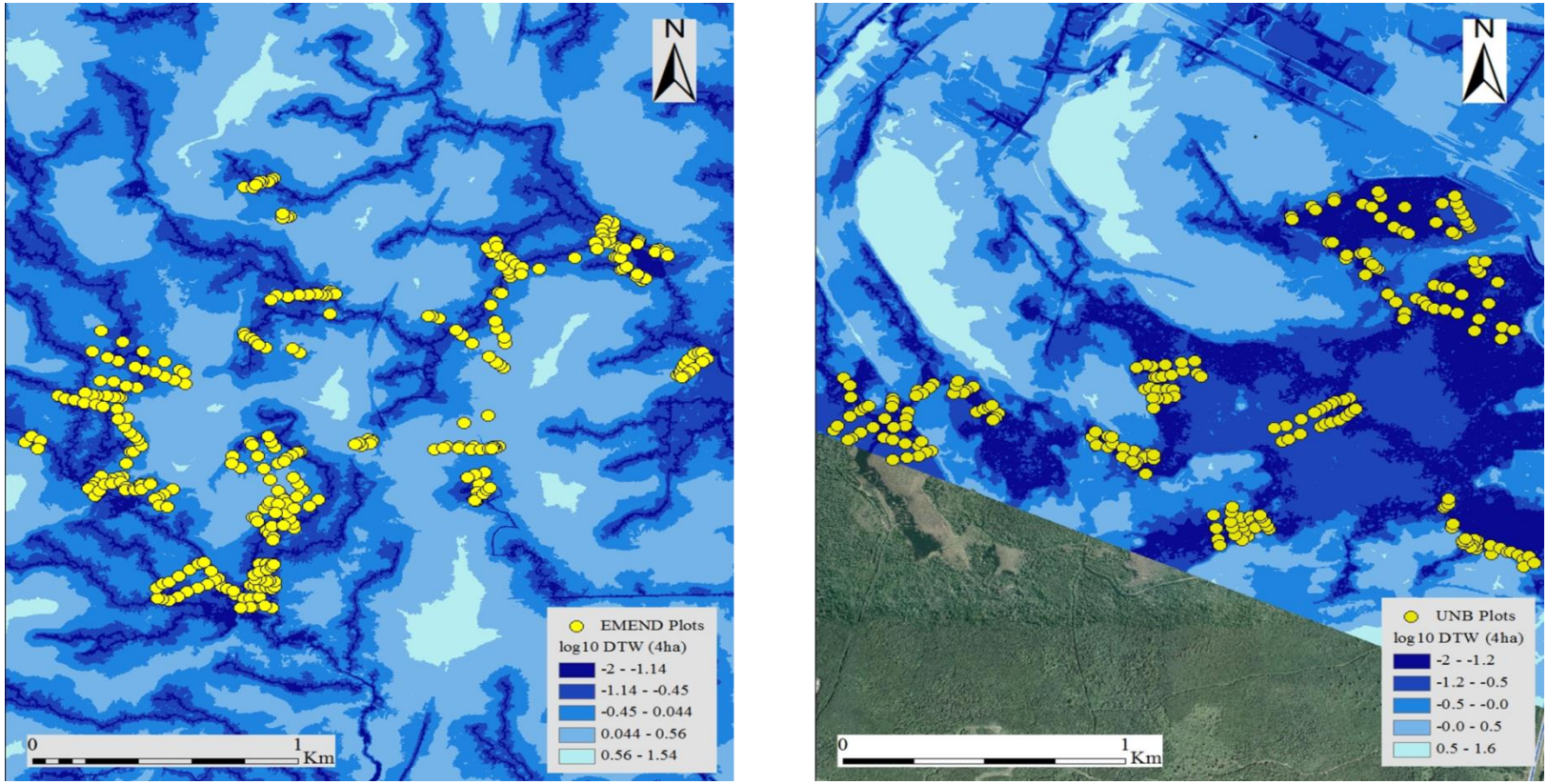


Figure 70. EMEND (left) and UNB (right) sites showing $\log_{10}$DTW and plot locations.

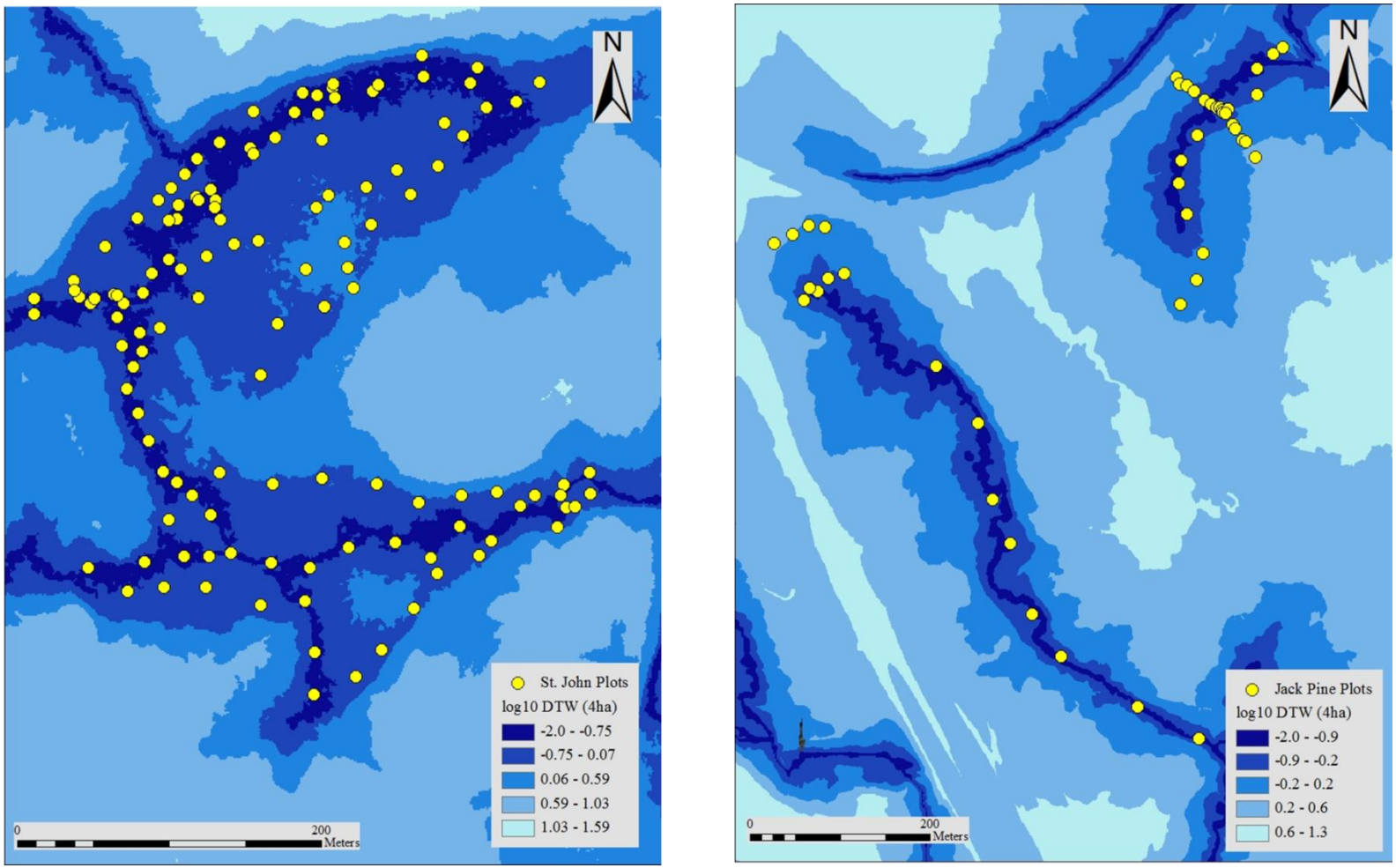


Figure 71. Saint John (left) and Jack Pine (right) sites showing $\log_{10}$DTW and plots.

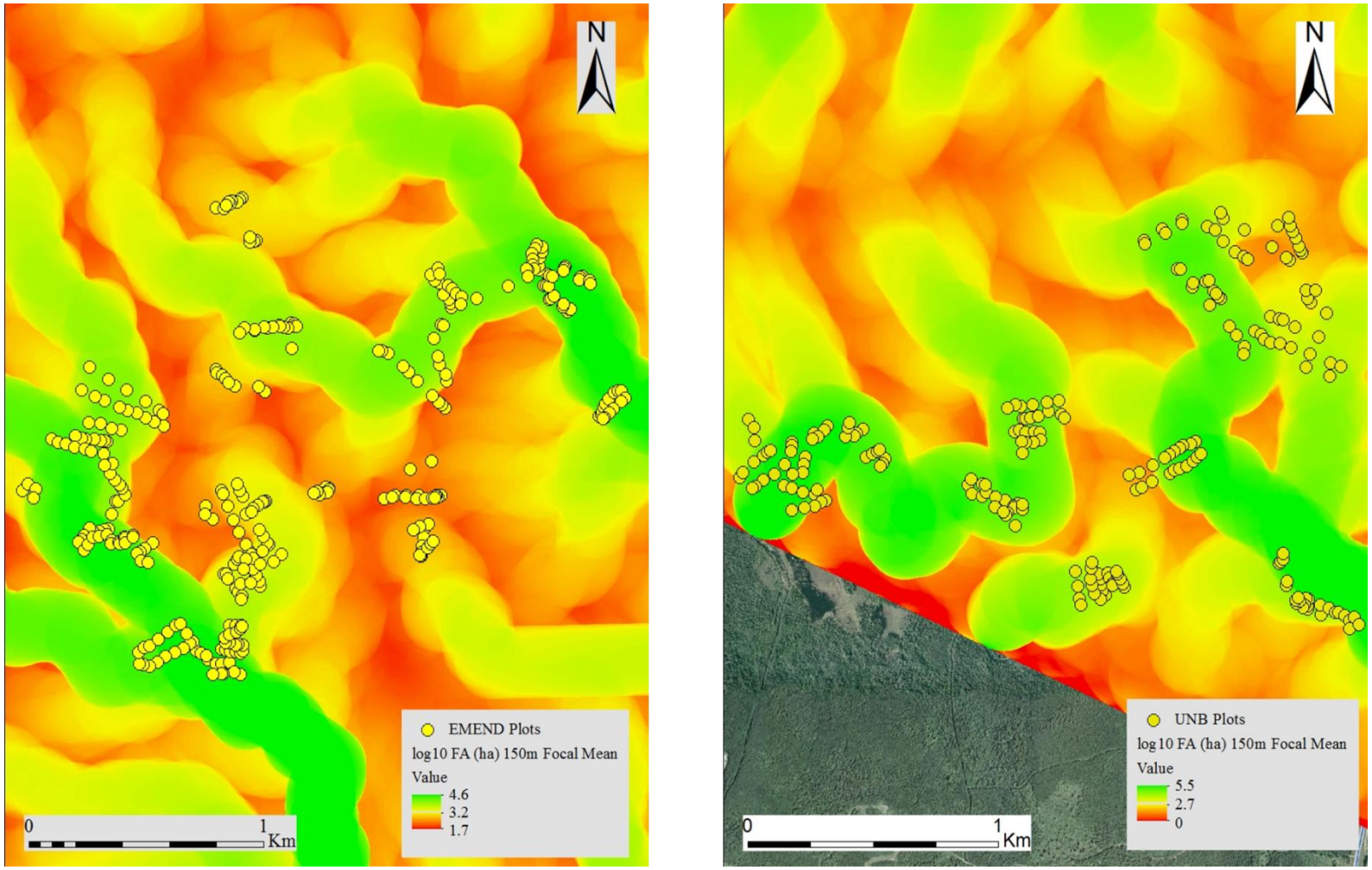


Figure 72. EMEND (left) and UNB (right) sites showing $\log_{10}$FA and plot locations.

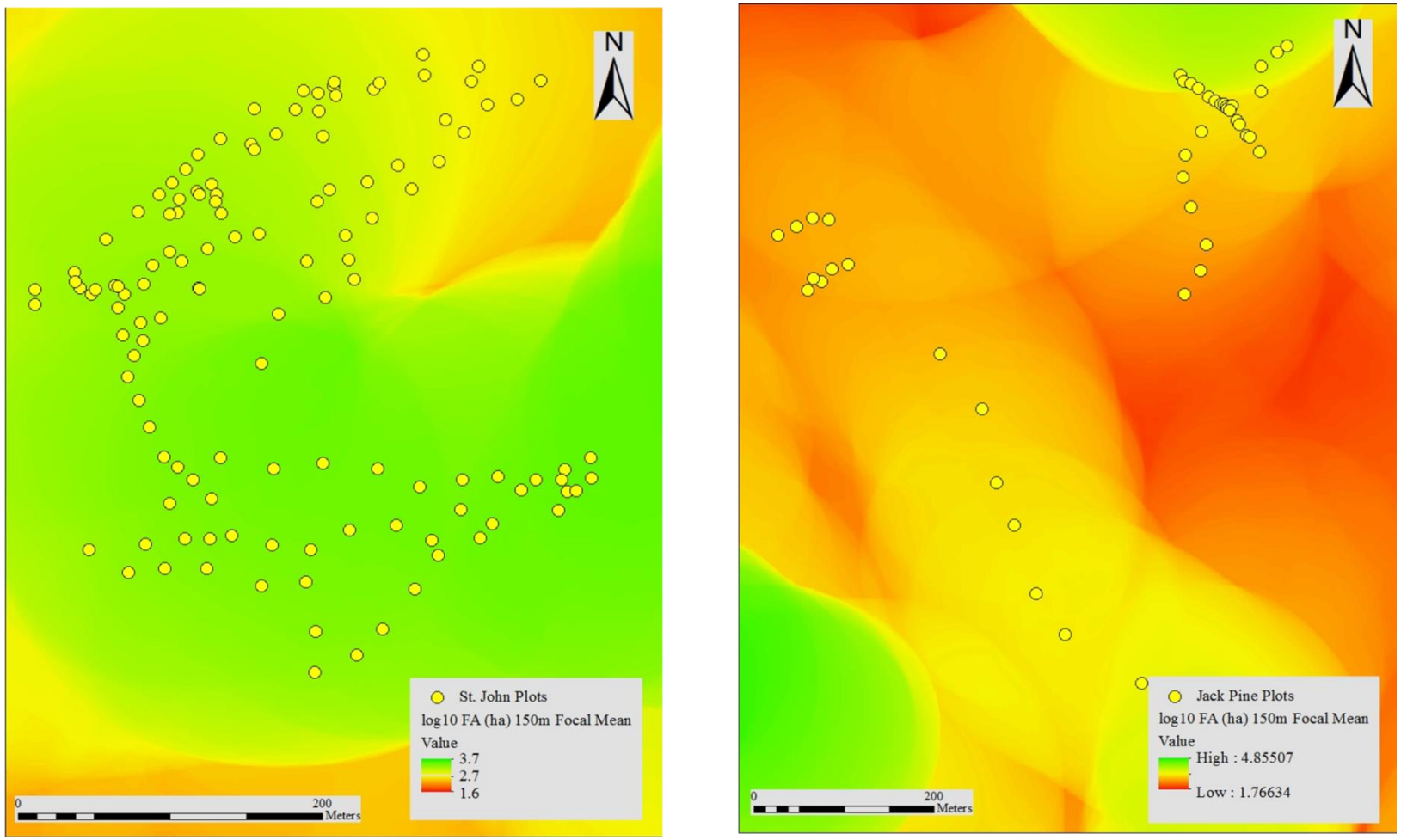


Figure 73. Saint John (left) and Jack Pine plantation (right) showing $\log_{10}$FA (150m Focal Mean) and plot locations.

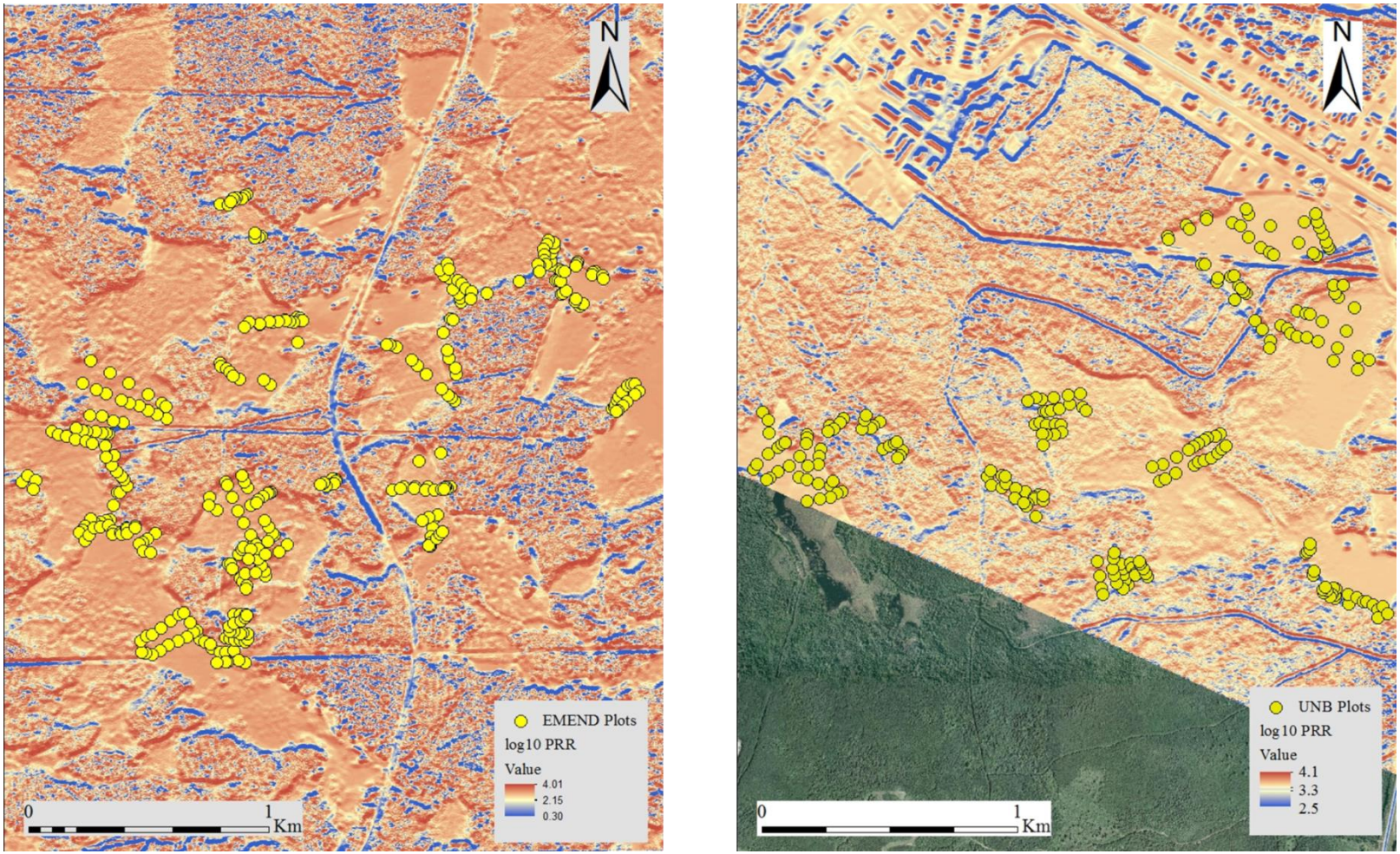


Figure 74. EMEND (left) and UNB (right) sites showing $\log_{10}$PRR and plot locations.

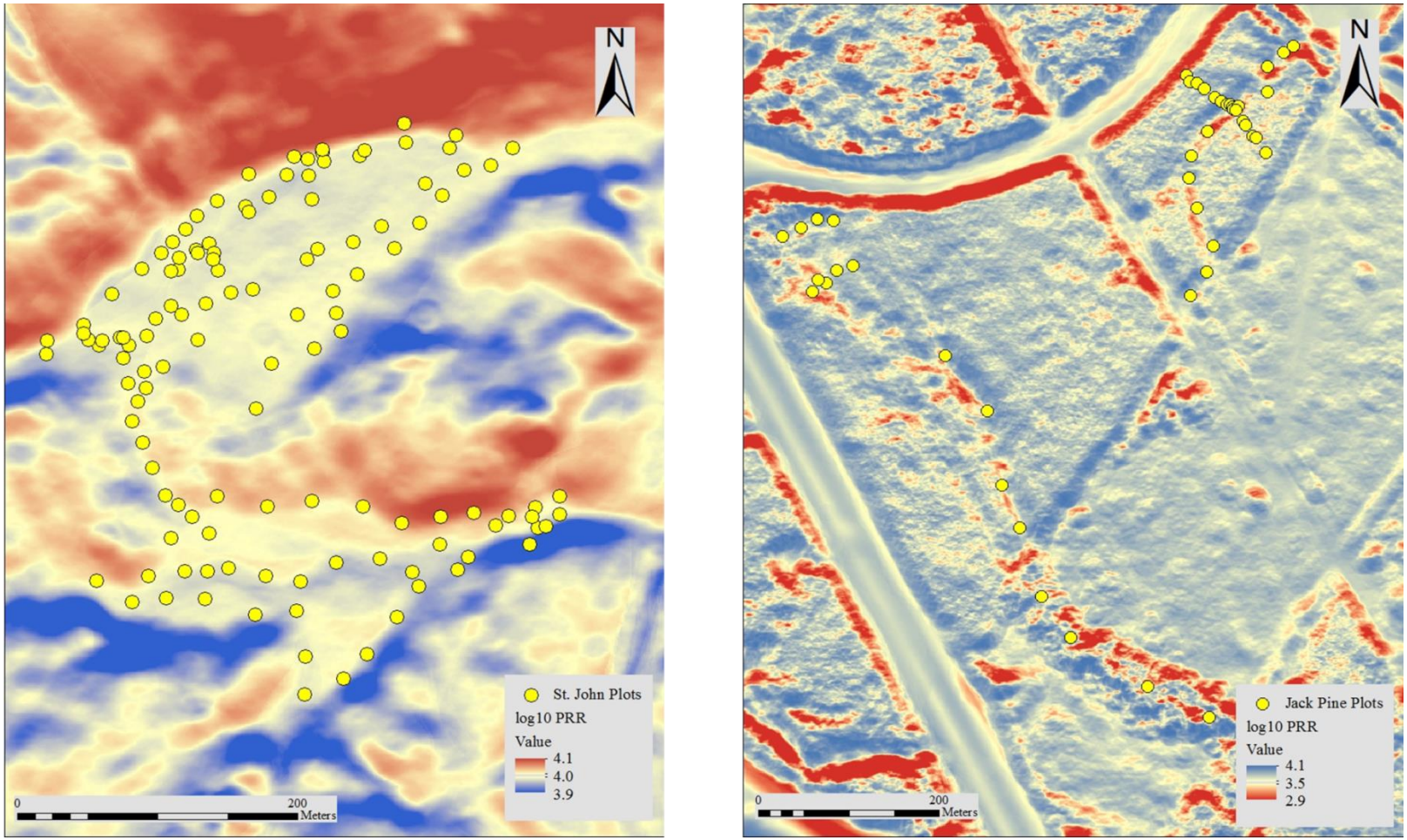


Figure 75. Saint John (left) and Jack Pine (right) showing $\log_{10}$PRR and plot locations.

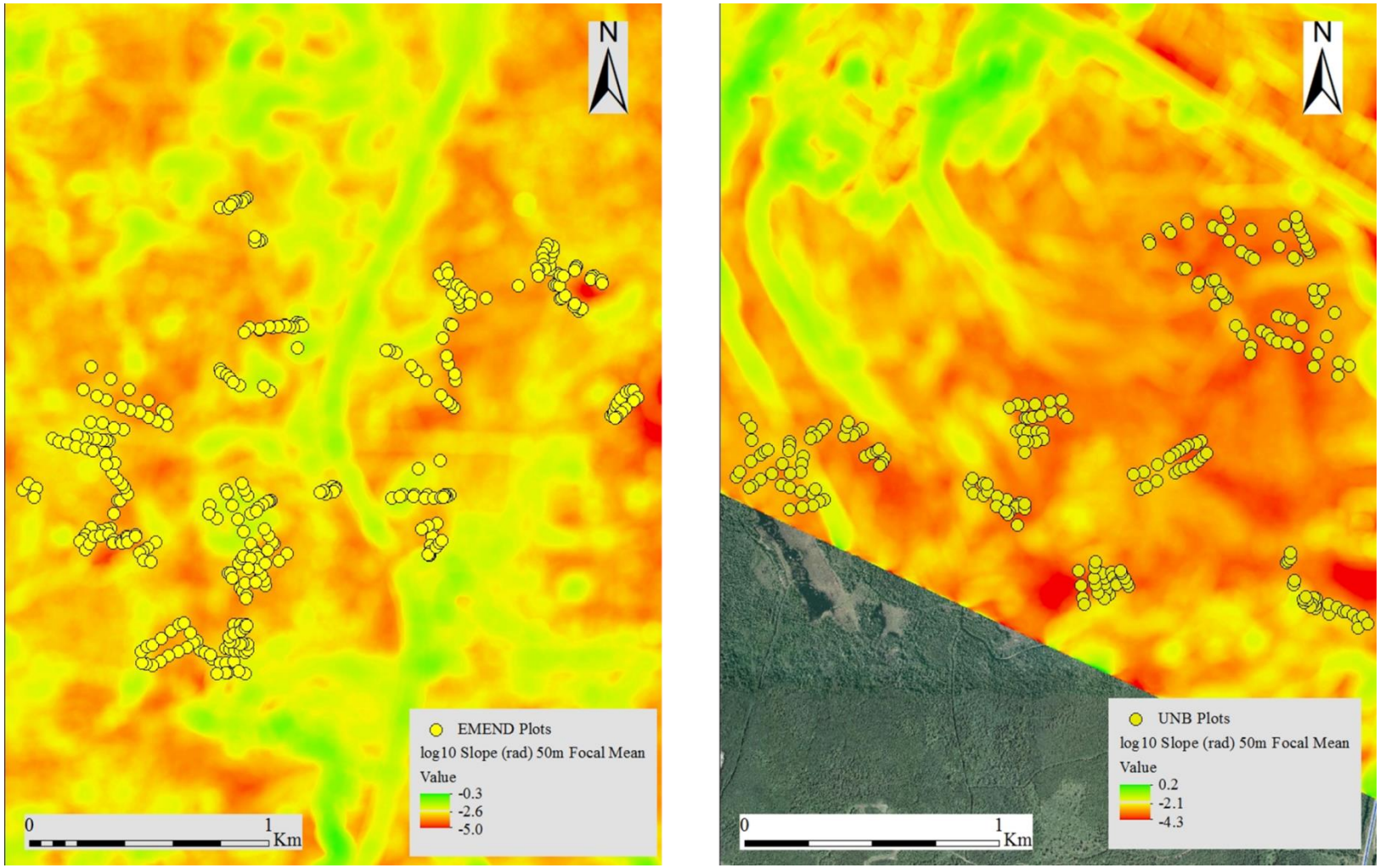
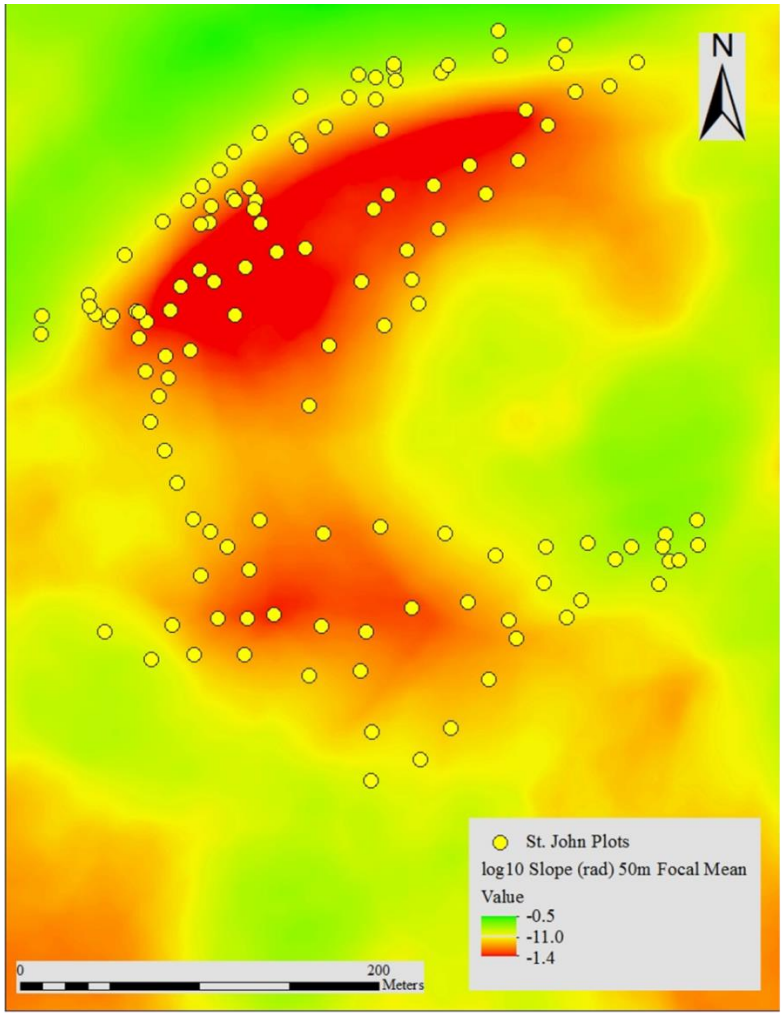


Figure 76. EMEND (left) and UNB (right) sites showing $\log_{10}$Slope and plot locations.



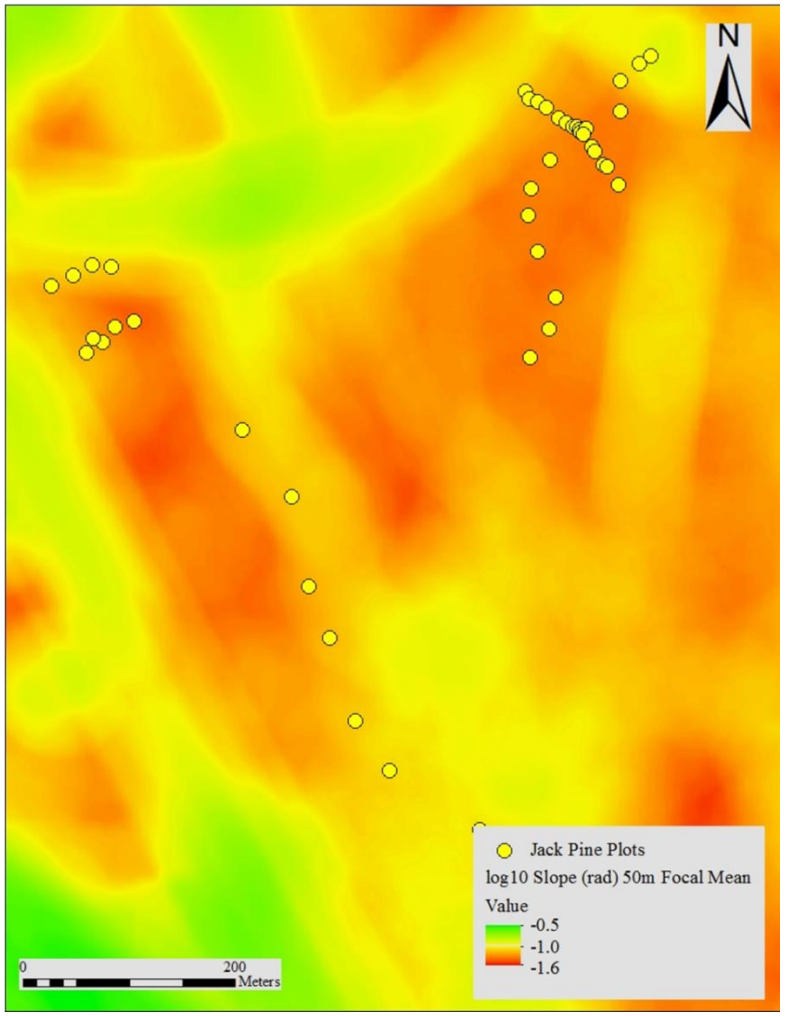


Figure 77. Saint John (left) and Jack Pine (right) showing $\log_{10}$Slope and plot locations.

Figure 78. EMEND (left) and UNB (right) sites showing Tree Height and plot locations.

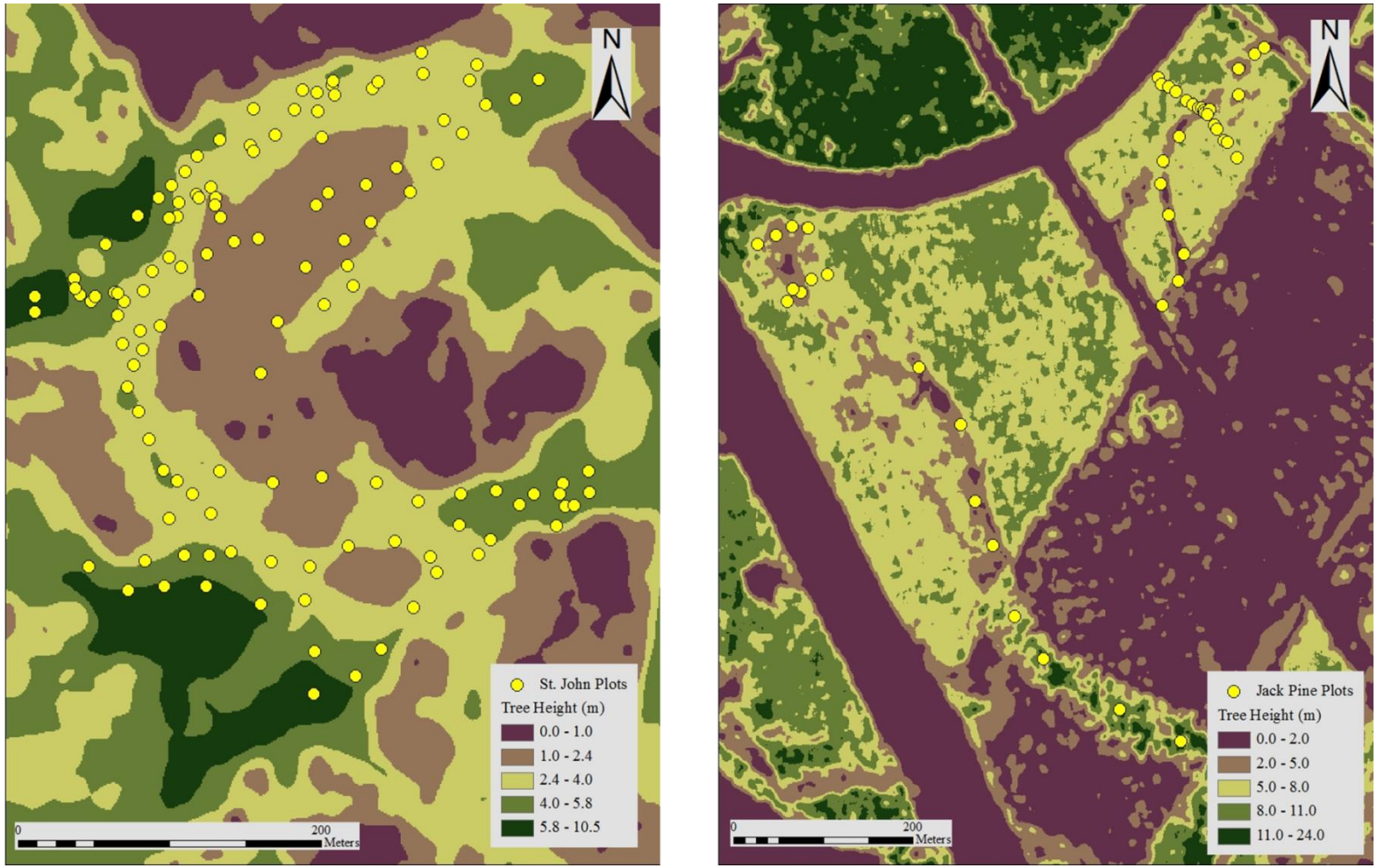


Figure 79. Saint John (left) and Jack Pine (right) showing Tree Height and plot locations.

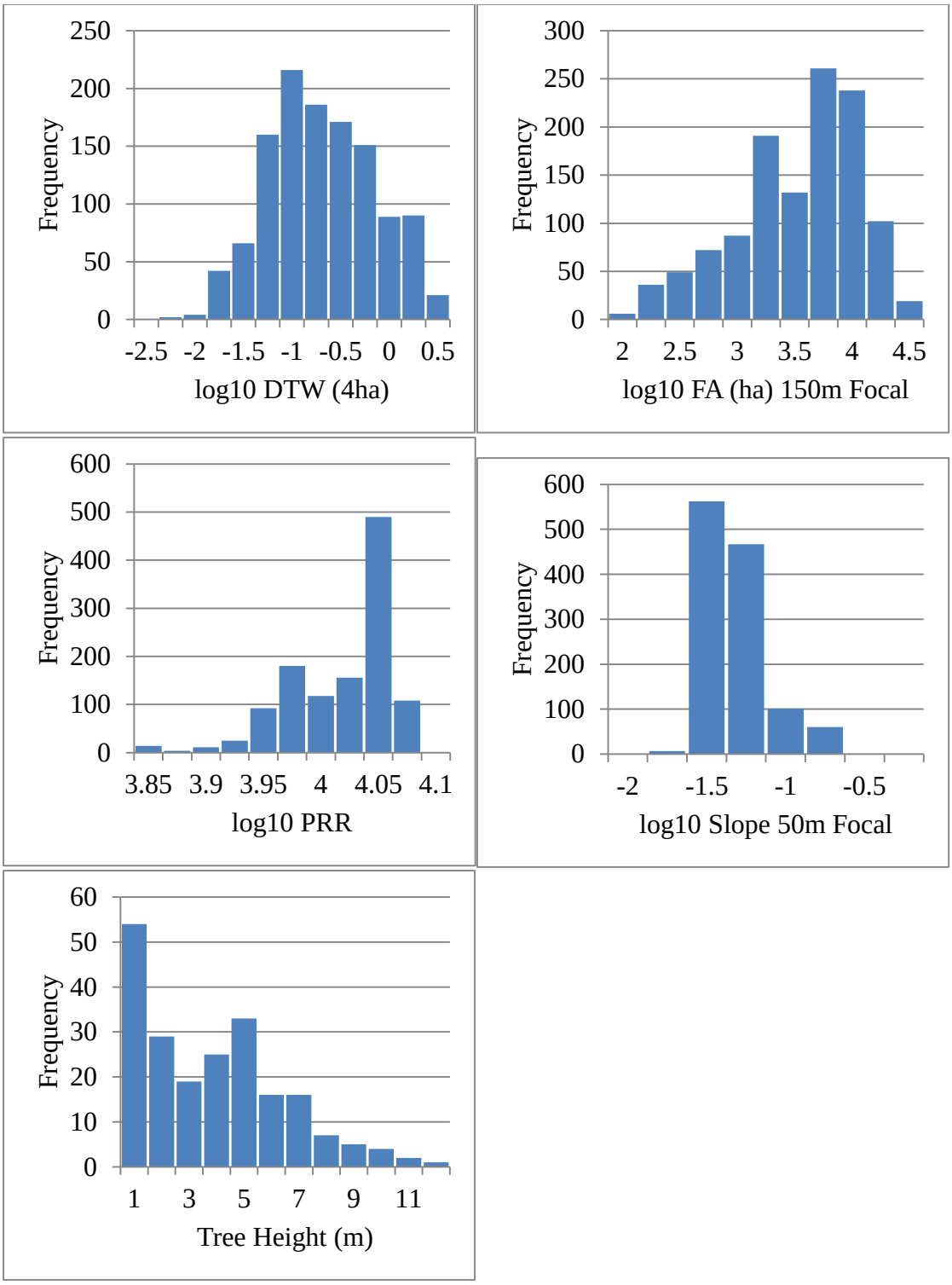


Figure 80. Frequency distributions for all continuous variables used to predict water properties.

APPENDIX V

Introduction

This document demonstrates the results of the spatial wetland classification procedure; which includes visual and quantitative analysis of classification accuracy. Wetland classes were determined based on the Canadian Wetland Classification guidelines for 335 EMEND plots and 446 NB plots using field collected data, water properties, and vegetation information.

Spatial wetland classification was necessary for mapping water properties; bog (including domed), fen/swamp, marsh, upland, and open water classes were displayed across each study site. Supervised classification techniques were applied using a training data set, which requires user selected wetland classes to be chosen from aerial images, after which wetland class data was extrapolated for the remainder of the study areas.

Narrow fen/swamp zones and domed bogs could not be identified using image analysis, and therefore, were determined using wet areas mapping as well as topographic data. Fen/swamp areas and open water (flow channels) were classified using wet areas mapping data, with zones having less than 10cm depth to water (DTW) identified as riparian (fen/swamp) areas, and zones with 0 DTW deemed to be open water. Standard deviation of bare earth values were used to assess locations of domed bogs, with areas having STD > 0.1m within a 10m radius being classified as domed bogs.

Results

Spatial projections of wetland classes across each site were more accurate for wetland classes than for open water and domed bogs. Field measured wetland classes were within 10m of image class determined wetlands >80% of the time. Specific wetland forms; domed bogs, and open water, were within 60m of ArcGIS determined wetland forms >80% of the time.

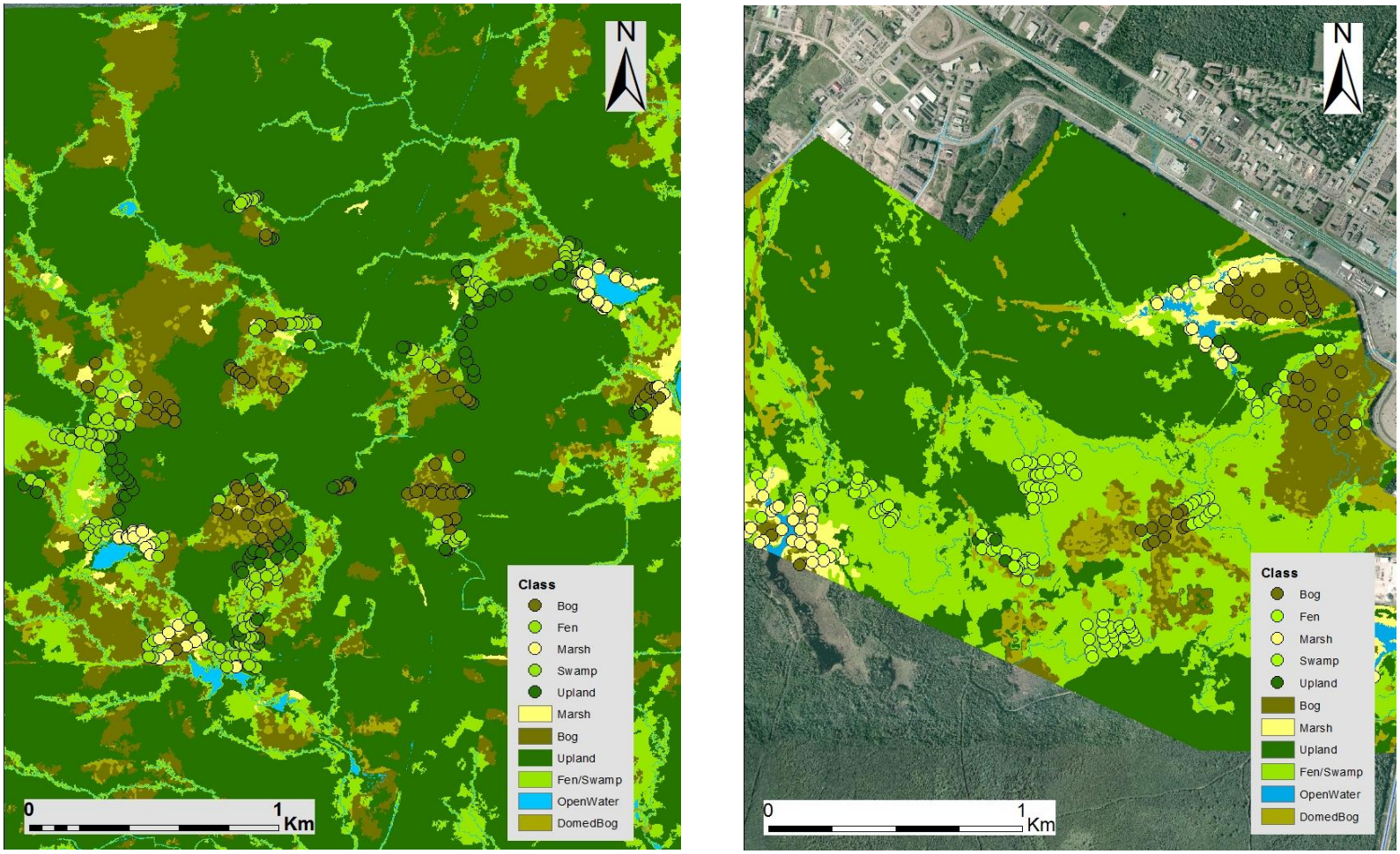


Figure 81. Field verified wetland classes and wetland class raster for EMEND (left) and UNB Forest (right).

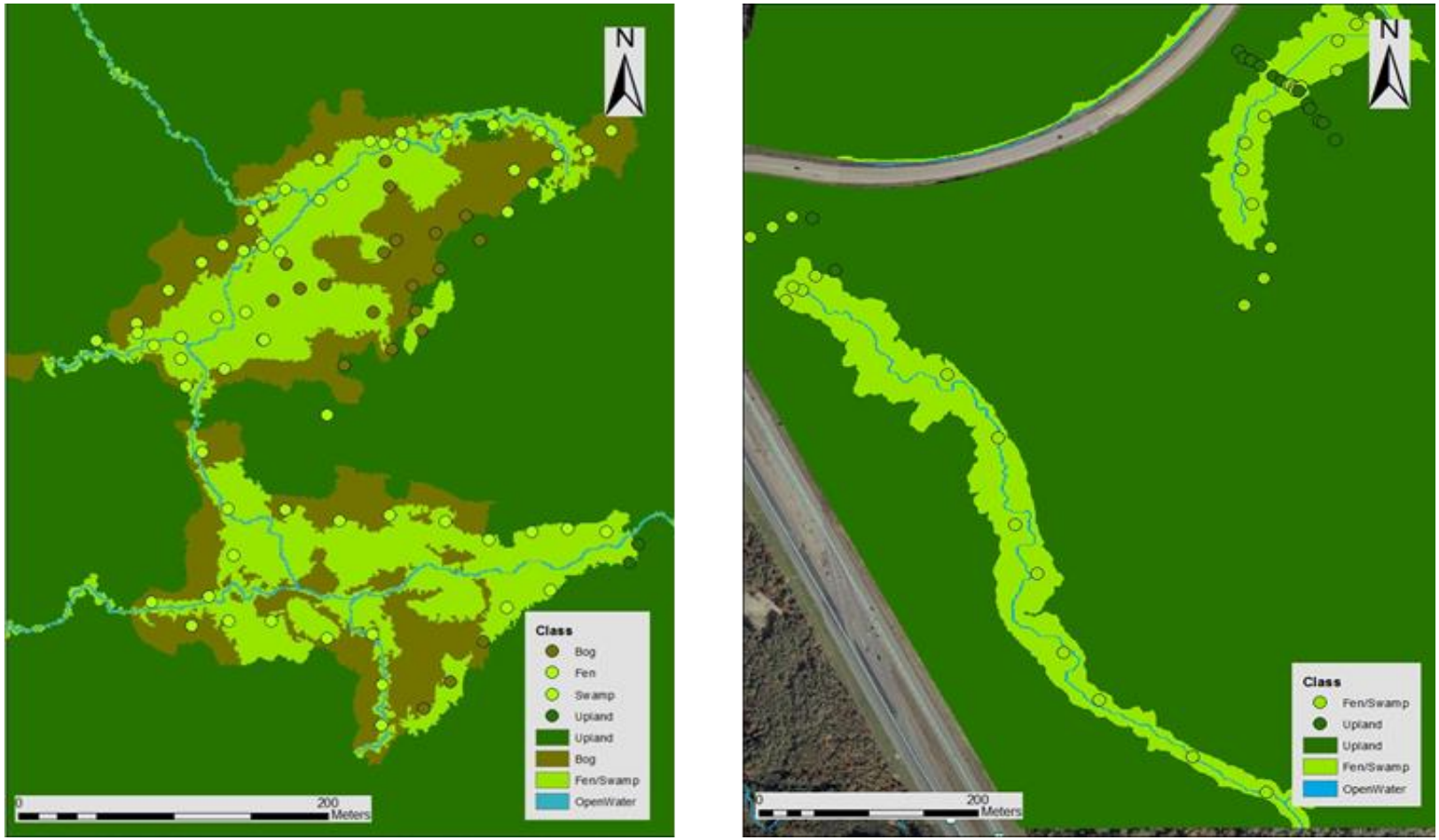


Figure 82. Field verified wetland classes and wetland class raster for Saint John Wetland (left) and Jack Pine Plantation (right).

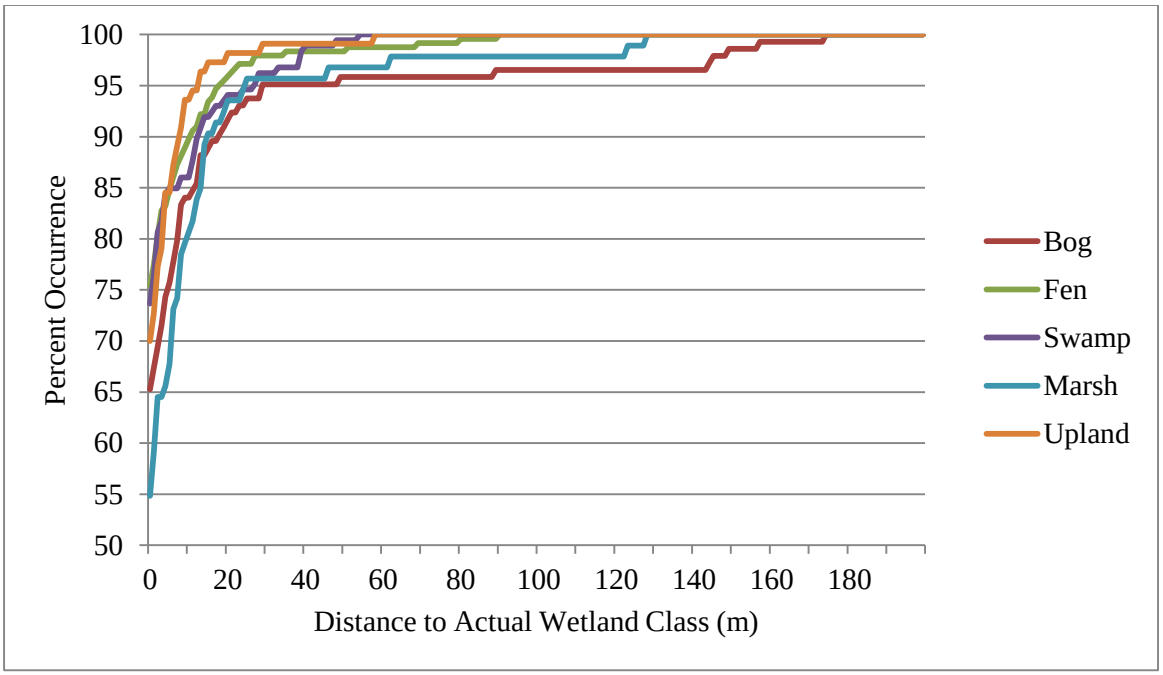


Figure 83. Distance between GPS plot location and image derived wetland class raster values for bogs, fens, swamps, marshes and uplands.

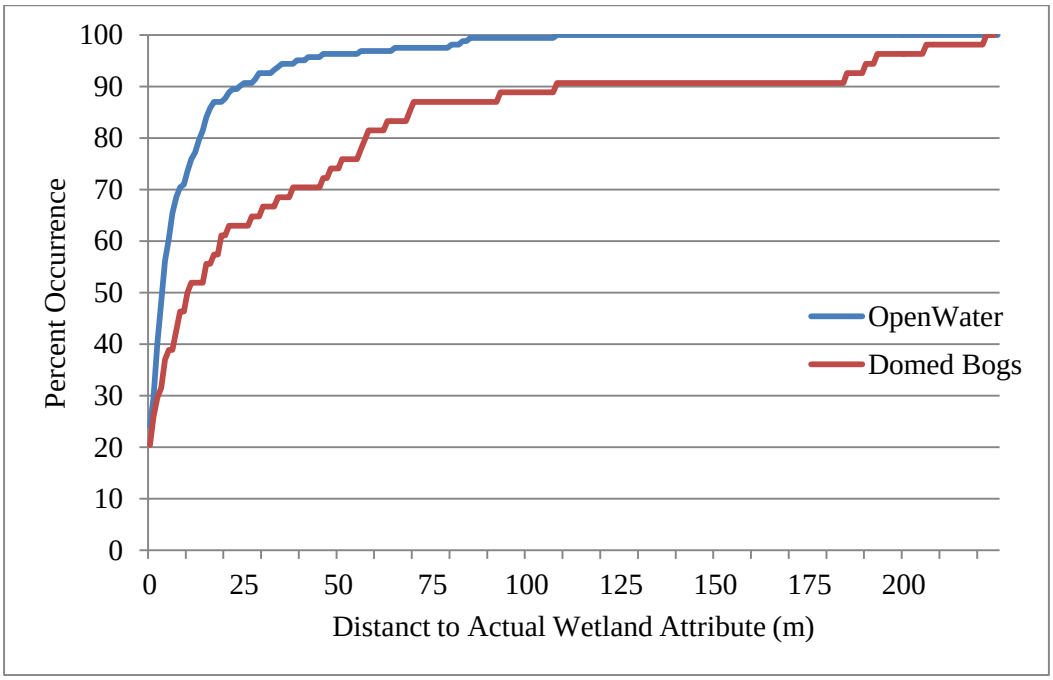


Figure 84.Distance between GPS plot location and image derived wetland class raster values for open water and domed bogs.

Table 39. Correlation coefficients for predicted versus mapped water property values.

	Correlation Coefficient
	DO Mapped
DO Predicted	**0.64**
	pH Mapped
pH Predicted	**0.70**
	EC Mapped
EC Predicted	**0.77**
	Temperature Mapped
Temperature Predicted	**0.90**
	Color Mapped
Color Predicted	**0.80**

Conclusion

Wetland classes were included as categorical variables for water quality predictions, therefore it was required that they be interpreted across the study sites, in order to map water properties. Further, hydraulic conductivity values were directly related to wetland class and form, and as such, their values also were required to be spatially defined. While perfect conformance was not achieved between actual and ArcGIS determined wetland classes, correlation between predicted and mapped water properties demonstrated that the wetland classification was suitable. The application of a more robust wetland classification scheme would better suit water property mapping, relieving inconsistencies between predicted and mapped water property values.

CURRICULUM VITAE

Highlights of Qualifications

- Proficient at modelling and mapping environmental attributes; which combines technical field skills, analytical analyses, remote sensing, and ArcGIS mapping abilities
- Skilled in the use and verification of Wet Area Maps for the province of Alberta
- More than ten years' background in the forestry field, with a unique mixture of field experience and education
- Adept at collaborating with members of other disciplines in order to meet goals
- Strong math, analytical and problem solving abilities
- Excellent verbal and written communication skills

Relevant Experience

Research Project Leader

University of New Brunswick (2012 - 2014)

- Modelled and mapped soil water properties (Dissolved Oxygen, pH, Electrical Conductivity, and Temperature) for wetlands in New Brunswick and Alberta using LiDAR derived Wet Areas Maps
- Verified accuracy of Wet Areas Maps in Alberta for Environmental and Sustainable Resource Development
- Organized and lead teams of up to six summer students for data collection and analysis

Forest Soils and Watershed Management Graduate Teaching Assistant

University of New Brunswick (2012 - 2014)

- Organized and planned lab sessions
- Evaluated student progress and aided student development by providing constructive feedback
- Facilitated demonstrations of lab procedures to assist in student learning

Certified Arborist

Urban Landscape Solutions and Arborcare, Calgary AB (2007 - 2010)

- Evaluated and maintained trees in urban areas
- Climbed and pruned trees; properly identified tree species
- Supervised small work crews and consulted with clients on best tree care procedures

Forest Technician

Forest Floor Consultants, Fort St. John BC (2006 – 2007)

- Executed timber cruising in variety of terrain
- Compiled data and populated maps
- Identified and tracked forest stand transitions; located sensitive areas

Forest Technician

Scott and Stewart Forestry Consultants, Antigonish NS (2005)

- Completed stem density counts for silviculture
- Established silviculture block boundaries

Education, Certificates and Achievements

Masters of Science in Forestry (2014)

University of New Brunswick, Fredericton NB

Bachelor of Science in Forestry (2012)

University of New Brunswick, Fredericton NB

- William Haliburton Memorial Scholarship
- Edwin Jacob Special University Scholarship
- Elaine MacKay Bancroft Scholarship
- Dean's List 2011 and 2012; Graduated with a GPA of 3.7

Arborist Certification (2007)

International Society of Arboriculture, Calgary AB

Forest Technician Diploma (2006)

Maritime College of Forest Technology, Fredericton NB