Miami Wetlands Enhancement Project:

Baseline Monitoring Report

Tillamook
Estuaries
Partnership
A National Estuary Project

Prepared by

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Executive Summary

This document provides information on pre-construction conditions at the site of Tillamook Estuaries Partnership's (TEP) Miami Wetlands Project (the project). It includes general background information on the project and the project site, information on the methods used to collect data on physical and biological attributes of the site, and the results of our pre-construction data collection efforts. The document primarily incorporates information from work completed by TEP and Vigil Agrimis, Inc (VAI) staff. The primary purpose of the data collection effort reported here was to document baseline conditions at the site to allow us to evaluate the effectiveness of our efforts relative to project goals.

The Miami River watershed is one of five 5th-field watersheds that drain into Tillamook Bay on Oregon's north coast. Areas near the mouths of coastal rivers, where freshwater intermingles with ocean water, provide important habitats for juvenile salmonids as they transition from freshwater to marine existence. This area of the Miami basin has been dramatically affected by past agricultural uses and development of transportation and utility infrastructure. Several salmonid species are known to rear in the lower Miami basin but, given the above, the quantity and quality of rearing habitats are low. In 2004, Tillamook Estuaries Partnership (TEP) began working with landowners at the mouth of the Miami River to develop a project to improve habitat conditions for salmonids in this area. Through this effort, TEP identified properties along both banks of the river totaling approximately 58 acres on which to conduct such a project.

The site straddles the river and is bounded to the north, west and south by transportation corridors and on the east largely by the north bank of the river. This area has been substantially affected by human activities and even the oldest known aerial photograph of the site (ca. 1939) depicts considerable anthropogenic alterations. Several structures occur on and adjacent to the project site, Hobson and Struby creeks were routed into a constructed channel where they pass through the property during the early 1900s, and a series of drainage channels were constructed sometime during the mid- 1900's. The portion of the project site north of the Miami River was used primarily for agricultural purposes (livestock grazing and grass hay production) for much of the 1900's and the early years of this century. The portion of the project site south of the river also was used for livestock grazing throughout much of the 20th century. However, grazing ceased on the property when it was purchased by the current owners in 2000.

We collected information on a variety of physical and biological attributes of the site to establish baseline conditions. These included water levels, water quality, soil qualities, vegetation structure and composition, and fish and wildlife resources. This information provides a foundation from which we can evaluate the effects of restoration actions at the site.

To gather the aforementioned data, we established nine linear transects at the project site (six running approximately east-west on the parcel north of the river and three running approximately north-south on the parcel south of the river). To improve data collection efficiency and allow us to look for relationships among studied variables, we collected the bulk of our data along these transects.

Several factors appear to influence water levels at the site including ground surface elevation, proximity to the Hobson-Struby Channel, precipitation and tides. It appears that ground surface elevation continuously and steadily influenced water surface elevations across the site. On the other hand, tides and the Hobson-Struby channel only appeared to affect water levels at a few of the wells,

and tidal influences are cyclical. Precipitation strongly influences water surface elevations at the site. It affected seasonal base water levels and episodically affected water surface elevations at all wells, sometimes dramatically.

Several factors likely influence water temperatures at the site including ambient air temperature; precipitation; water temperatures in Tillamook Bay, the Miami River and its tributaries; vegetation type and cover; and others. We lack data to evaluate the influence of all of these factors on water temperatures at the site. However, based on our analyses, ambient air temperature appeared to be one of the prime influences on water temperatures at the site. Surface water temperatures fluctuated daily and mirrored the rise and fall of ambient temperatures. Ground water temperatures did not fluctuate daily, but did vary seasonally (as did average ambient air temperature). During all seasons, water temperatures at the site generally remained below Oregon Department of Environmental Quality standards established to maintain the cold water environments needed to support salmonids and other aquatic life.

Salinity data from near the confluence of the Miami River mainstem and on-site channels suggests that saline water from the bay entered the site only when tides exceeded eight feet during periods of low precipitation. Although we lack salinity data from other portions of the site, our data suggest that, under most conditions and during all seasons, a majority of the site provides fresh water habitats.

Dissolved oxygen concentrations of surface waters near the confluence of the Miami River mainstem and on-site channels fluctuated regularly during both summer and winter. It appears that tides and precipitation substantially influence dissolved oxygen concentrations and our data suggest that dissolved oxygen concentrations were typically at sufficient levels to support salmonids and other aquatic species.

We collected and analyzed soil samples from throughout the site to determine organic matter content and salinity levels. Our data indicates that soils from throughout the site were high in organic matter and non-saline. This information provides further support to our contention that the site generally provides fresh water habitats.

Prior to construction, the Miami Wetlands Project site was very densely vegetated. Mean percent total cover for nine line intercept transects completed during June 2010 was approximately 95 percent. While we encountered a fairly large number of plant species along these transects, a few species accounted for most of the vegetative cover. Patches dominated by Reed canary grass (*Phalaris arundinacea*) were by far the most commonly encountered vegetation type along the nine transects. Mean relative cover for this type was approximately 62 percent. It was encountered along all nine transects and accounted for a majority of the vegetative cover on seven transects.

We identified 10 different plant communities in five different general categories: four Palustrine emergent wetland communities, two riparian communities, one Palustrine scrub shrub community, two upland communities and a community that occurred on disturbed areas. The emergent wetland communities were dominated by herbaceous species and distinguished from one another primarily based on species diversity (particularly the relative dominance of Reed canarygrass) and percent total cover. Riparian communities were dominated by trees and shrubs and were distinguished from one another based on the structure and composition of understory vegetation and diversity of tree and shrub species. The Palustrine scrub shrub community was dominated by woody perennial species (shrubs and small trees) and had a dense understory consisting primarily of Reed canarygrass. Upland communities were dominated by herbaceous species and, in terms of structure and composition, were similar to the emergent communities. However, these communities occurred on portions of the site that lacked wetland hydrology. The disturbed community was dominated by herbaceous species and occurred primarily along an overhead utility corridor and adjacent to residential and agricultural areas.

We identified 69 unique macroinvertebrate taxa in samples collected at the Miami Wetlands site. Most (75 percent) were insects (51 unique insect taxa). True flies accounted for a majority of insect taxa (38 dipteran taxa, 75 percent of all insects identified), approximately 75 percent of which were non-biting midges (Chironomids - 29 unique taxa). Small crustaceans (amphipods, copepods, isopods and ostracods) and insects (especially the larvae of chironomids and other dipterans) are important components of the diets of juvenile Chinook, Chum, and Coho salmon. These groups were well represented in the samples obtained from the Miami Wetlands.

We conducted surveys for five secretive marsh bird species: American bittern, American coot, Pied-billed grebe, Sora, and Virginia rail. Sora was the only one of these species detected at the Miami Wetlands site. Sora is the most widely distributed North American rail and the species is likely a year-round resident at the site. The other four species generally occupy habitats that differ somewhat from those at the Miami Wetlands site. However, given the range and mobility of these other species it is not out of the question for any of them to occur at the site.

We obtained fish data through a variety of sources (Tillamook Bay Watershed Rapid Bio-Assessments 2005-2007, a 2010 summer snorkel survey, and summer 2010 and 2011 fish salvage operations conducted during the construction phase of this restoration project). Juvenile Coho salmon were recorded during all of these efforts, as were juvenile and adult Cutthroat trout. Juvenile Steelhead trout were observed only during the 2007 RBA survey effort. Adult Brook lamprey and unidentified lamprey ammocetes (juvenile lamprey) were documented during the 2010 snorkel survey and fish salvage operations, respectively. Other fish species recorded at the site during these efforts include Three-spined stickleback and sculpin (probably Prickly sculpin, but we did not identify sculpin to species during our work at the site).

We recorded incidental observations of a variety of other wildlife species during our work at the site. A list of these species as well as a list of plant species occurring on the site, photos of soil samples, and numerous photos of vegetation at the site are provided as appendices to this document.

The work reported in this document provides a foundation from which we can evaluate the effectiveness of the restoration actions taken at the site. Over the coming years, we will continue to collect information on the attributes reported in this document (and possibly others) and evaluate the observed changes relative to project goals. This will in turn inform future wetland restoration projects completed by TEP and others working to improve tidal wetland habitat conditions on Oregon’s north coast.

1.0 Introduction

This document provides information on pre-construction conditions at the site of Tillamook Estuaries Partnership's (TEP) Miami Wetlands Project (the project). It includes general background information on the project and the project site, information on the methods used to collect data on physical and biological attributes of the site, and the results of our pre-construction data collection efforts. The document primarily incorporates information from work completed by TEP and Vigil Agrimis, Inc (VAI) staff.

The primary goals of the project as identified in the Habitat Enhancement Plan prepared for the project (VAI 2008) are to:

- improve connectivity between on-site wetlands and the mainstem Miami River,
- increase the quantity and quality of on-site aquatic habitats,
- restore the historical character of on-site vegetation, and
- enhance riparian vegetation along the Miami River to increase shading and provide a source of wood for in-channel large woody debris recruitment.

The primary purpose of the data collection effort reported here was to document baseline conditions at the site to allow us to evaluate the effectiveness of our efforts at the site relative to project goals. In addition, this data has been used to inform construction and planting efforts at the site and will allow us to look at relationships among the many variables for which we are collecting data.

1.1. Background

The Miami River watershed is one of five 5th-field watersheds that drain into Tillamook Bay on Oregon's north coast (Figure 1) Five species of anadromous salmonids are known to occur in the watershed: Coho salmon (*Oncorhynchus kisutch*), Chinook salmon (*O. tshawytscha*), Chum salmon (*O. keta*), Steelhead trout (*O. mykiss*), and Cutthroat trout (*O. clarkii*). Reduced habitat complexity and degraded water quality have been identified as primary factors affecting salmonid populations along the Oregon coast. These factors are evident in the Miami River watershed and can largely be attributed to historical and current land use practices. Bio-Surveys, LLC (2007) reported that salmonid production within the Miami basin is largely dependent on the lower mainstem, but that land use impacts have reduced the production potential of this area.

Areas near the mouths of coastal rivers, where freshwater intermingles with ocean water, provide important habitats for juvenile salmonids as they transition from freshwater to marine existence. Due to the size of the area it drains and its isolation from the other four rivers that feed into Tillamook Bay (Figure 1), the transitional area at the mouth of the Miami River is small relative to that of the other four rivers. Further, this area of the Miami basin has been dramatically affected by past agricultural uses and development of transportation and utility infrastructure. Several salmonid species are known to rear in the lower Miami basin but, given the above, the quantity and quality of rearing habitats are low.

In 2004, TEP began working with landowners at the mouth of the Miami River to develop a project to improve habitat conditions for salmonids in this area. Through this effort, TEP identified properties along both banks of the river totaling approximately 58 acres on which to conduct such a project (figures 1 and 2).

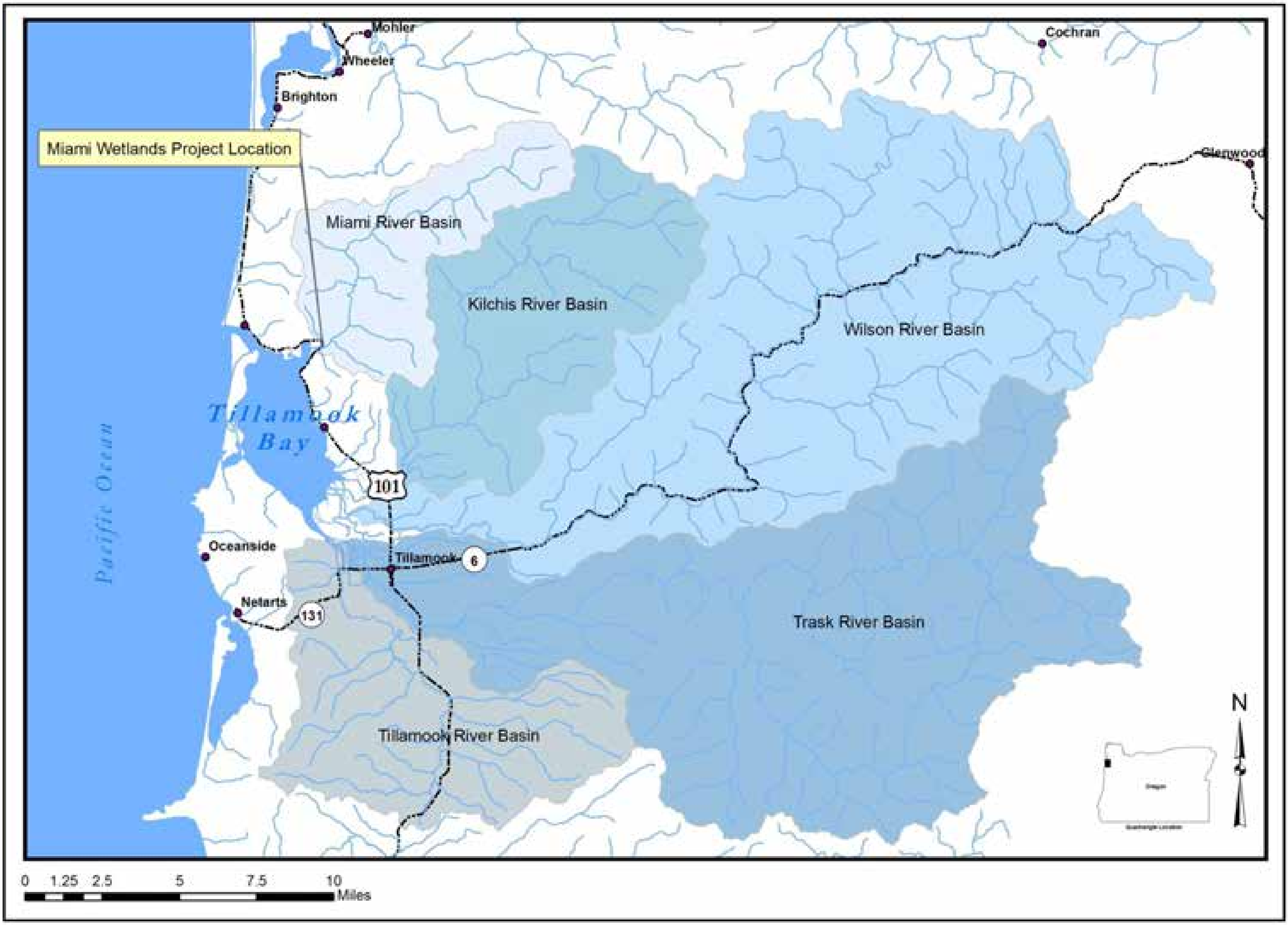
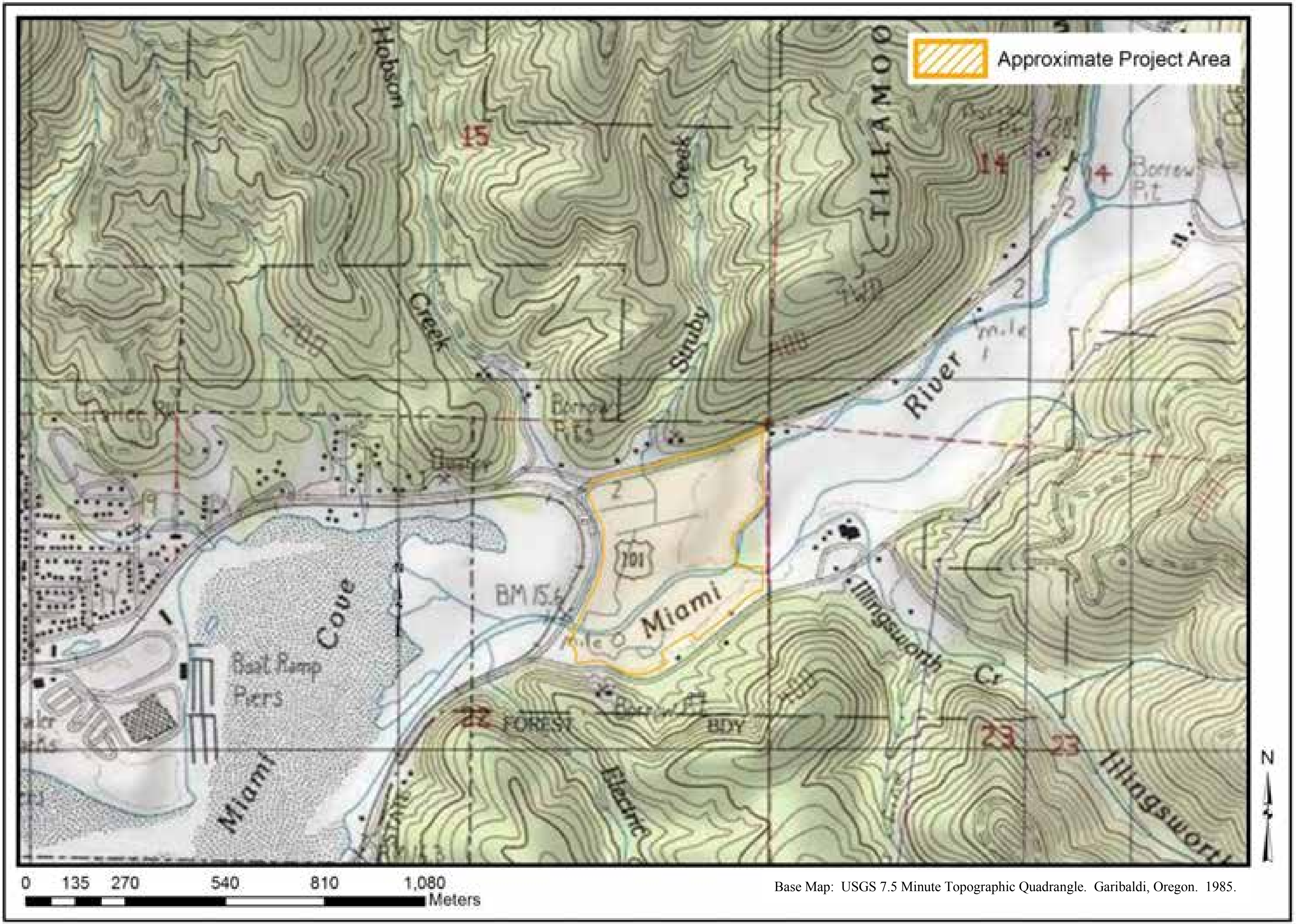


Figure 1. Overview of Tillamook Bay Watershed and location of Miami Wetlands Project.



Base Map: USGS 7.5 Minute Topographic Quadrangle. Garibaldi, Oregon. 1985.

Figure 2. Miami Wetland Project site.

In 2008, VAI completed a site assessment and habitat enhancement plan for the aforementioned properties (VAI 2008). This plan identified existing and historical on-site habitats, opportunities and constraints for enhancement, and a variety of preliminary enhancement alternatives. Associated with this effort, VAI compiled existing relevant data and began some on-site data collection.

In 2009, VAI completed a plan to monitor the effectiveness of habitat enhancement actions at the site (VAI 2009). Along with providing some background information and outlining the proposed enhancement actions, this plan identified existing data, data gaps, monitoring questions and indicator categories, and data collection and analysis methods. This plan is discussed in more detail below.

In 2010, plans for habitat enhancement actions at the site were finalized, additional pre-construction data was collected to supplement existing data, and construction activities were initiated. Initial plans were to complete construction activities during summer 2010. However, weather and other complications slowed progress and, although a majority of construction activities were completed, some construction was needed during summer 2011 to complete this phase of the project. Preparation for planting of native herbaceous and woody vegetation began during fall 2010 and planting began in early 2011. Additional planting will occur during winter 2011-12, and maintenance of plantings (e.g., weed control, replanting of individual plants that die, etc.) will be performed for a minimum of three years post-planting. Details regarding the habitat enhancement plan are not included in this document.

1.2. Project Site Description

The approximately 58-acre Miami Wetlands Project site occurs near the mouth of the Miami River in Tillamook County, Oregon (Figure 2). The site straddles the river and is bounded to the north, west, and south by transportation corridors and on the east largely by the north bank of the river. A majority of the site is under private ownership, but a portion is within the Oregon Department of Transportation's Highway 101 right-of-way.

This area has been substantially affected by human activities and even the oldest known aerial photograph of the site (ca. 1939) depicts considerable anthropogenic alterations (Figure 3). This photo clearly shows transportation infrastructure and agricultural and residential development on and adjacent to the project site. It depicts essentially treeless river banks in the project area, and meandering channels on both sides of the river. It also appears that Hobson and Struby creeks had been diverted and are flowing in a constructed channel along the east side of Highway 101 in this photograph (but the channel is less evident than in later aerial photographs – see below). Based on this photo and a 1924 map of the area (Figure 4), it appears that the tidal channel located south of the river was connected to the bay prior to construction of the highway. VAI (2008) speculated that this channel may have been widened and deepened to function as a log pond.

A more recent pre-project, aerial photo was taken in 2005 (Figure 5). This photo depicts additional human alterations to the project area (most notably a network of drainage ditches, a house and detached garage on the north parcel and an overhead, utility line corridor that spans the entire project area) and other changes from earlier conditions (e.g., more riparian vegetation along the Miami River, reduced size and distinctiveness of the tidal channel and pond on south parcel, etc.). We do not know exactly when the ditch network was constructed. However, the channels

Figure 3. Historical aerial photograph of Miami Wetlands Project site (ca. 1939). Note the U.S. Highway 101 and railroad rights-of-way, other road corridors and agricultural and residential development. Also note the paucity of riparian vegetation along the river. Photo not-to-scale.

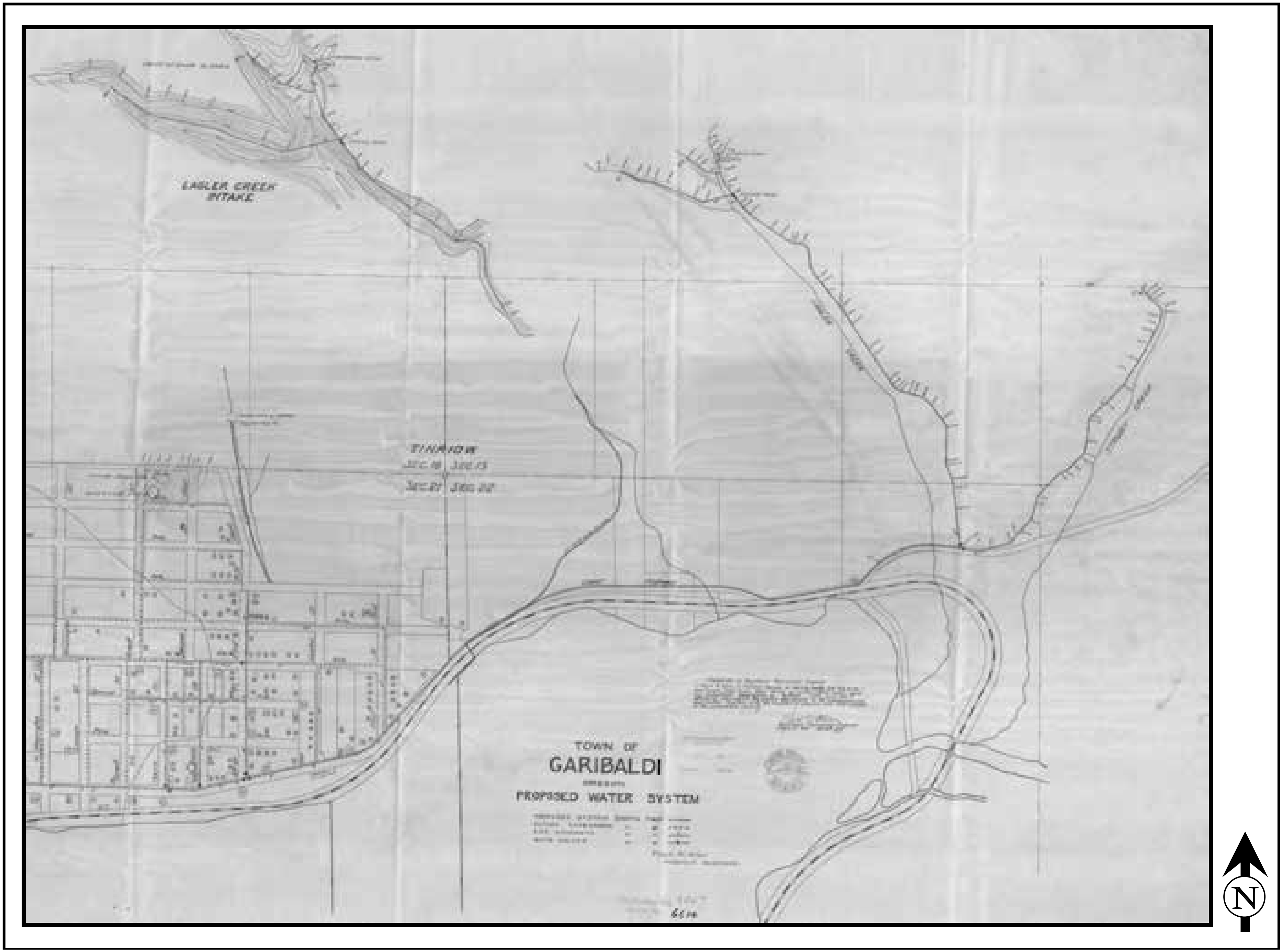


Figure 4. Historical map of the Town of Garibaldi (ca. 1924). Note that Hobson Creek (referred to as Lagler Creek on this map) crosses the Highway 101 Right-of-Way and empties directly into Tillamook Bay, unlike its current configuration where it empties into the Miami River upstream of the river's confluence with the Bay. Not-to-scale.

Figure 5. Recent, pre-project aerial photograph of Miami Wetlands Project site (ca. 2005). Note the two structures, the network of drainage ditches and the Hobson-Struby channel on the northern parcel. Also note the overhead utility corridor running southeast to northwest across the entire project area and the increase in riparian vegetation along the river as compared to Figure 3. Photo not-to-scale.

are depicted on a 1985 U.S. Geological Survey topographic map of the area (Figure 2) and it seems likely that they were constructed during the mid 1900's. Modern-looking, flexible, perforated, plastic drain pipes unearthed during the construction phase of the wetland enhancement project indicate that actions designed to facilitate drainage of the site continued into the latter 20th century. The Hobson-Struby channel paralleling Highway 101 is clearly evident in this photograph.

Given the condition of vegetation along the Hobson-Struby and drainage channels and the presence of numerous in-channel beaver dams, it appears that none of the channels was actively maintained for many years prior to 2010. Although these channels were connected to the Miami River, the beaver dams and other obstructions impeded flows to the river and allowed water to move out of the channels and perennially saturate a substantial portion of the parcel (predominantly in the northern and western portions of the parcel north of the river).

The portion of the project site north of the Miami River was used primarily for agricultural purposes (livestock grazing and grass hay production) for much of the 1900's and the early years of this century (grass hay was being harvested as recently as 2009). The portion of the project site south of the river also was used for livestock grazing throughout much of the 20th century. However, grazing ceased on the property when it was purchased by the current owners in 2000.

Small levees occur along both banks of the river within the project boundaries. It is unclear exactly when these levees were constructed, but the paucity of riparian vegetation along the river banks in the 1939 aerial suggests that levee construction occurred around that time (possibly in conjunction with construction of Highway 101 and the bridge spanning the Miami River). An apparent lack of levee maintenance allowed the return of riparian vegetation evident in the 2005 aerial. Small mammals (beaver, nutria, muskrat, etc.) and/or hydraulic actions also have created a number of breaches in these levees since their construction (particularly on the south bank).

Elevations within the project area range from approximately 6-14 ft above mean sea level. At a coarse-scale the northern parcel gradually rises upward from west to east with much of the property occurring in the 10-14 ft elevation zone. However, when standing on this parcel a microtopography of low hummocks, shallow depressions, small potholes, and narrow channels was evident (not to mention the network of 4-6 ft deep, steep-sided, constructed channels). Elevations on the southern parcel range from approximately 6 ft along the river to approximately 14 ft near the Ekroth Road right-of-way. In general, the terrain on this parcel slopes gently upward from north to south with a shallow depression running east-west through the central portion of the parcel (the historical channel and pond depicted in the 1939 aerial photograph). VAI (2008) compared elevations on either side of U.S. Highway 101 to determine if construction of the highway had influenced sediment accumulation in the area. They concluded that elevations in the area are consistent with a landform that generally slopes uphill from the bay in an easterly direction and that construction of the highway has not resulted in measurable soil accumulation (accretion) east of the highway.

Four different soils occur within the project area: Brenner silt loam, Condorbridge gravelly medial loam, Coquille silt loam, and Nehalem silt loam (Figure 6 – USDA Natural Resources

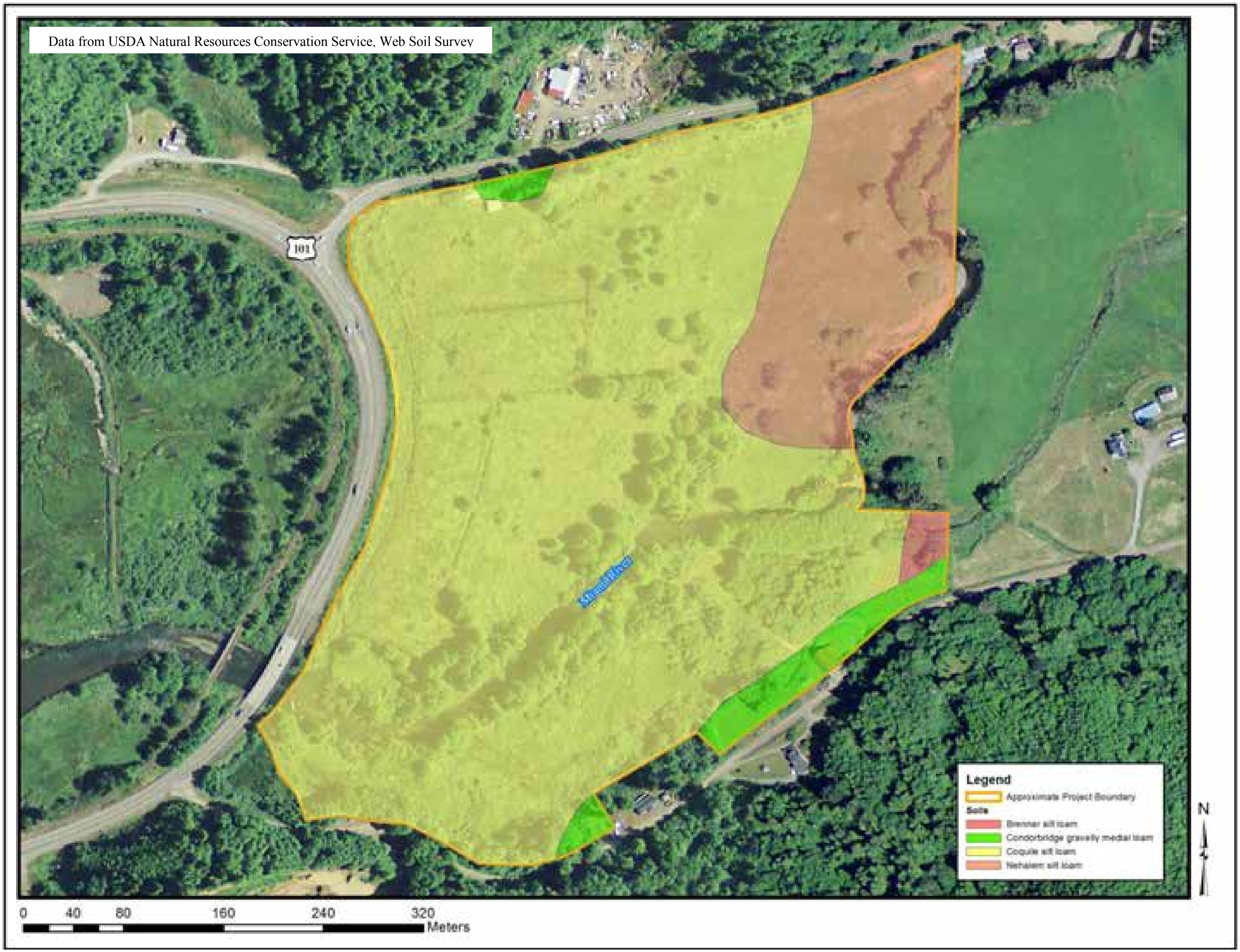

Data from USDA Natural Resources Conservation Service, Web Soil Survey

Figure 6. Approximate distribution of soil types within the Miami Wetlands Project site.

Conservation Service, Web Soil Survey, *http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx*). Condorbridge gravelly medial loam is a well-drained soil of fan-type depositional areas. It is derived from alluvium and/or debris flow deposits of igneous and sedimentary rock. This soil is rare within the project area, occurring only along its north and south margins (at the toe of slopes that bound the Miami River valley). Nehalem silt loam and Brenner silt loam are floodplain soils whose parent materials are alluvium derived from igneous and sedimentary rock. Both occur in the eastern portion of the project area. Nehalem silt loam is a well-drained soil, whereas Brenner silt loam is poorly drained. Coquille silt loam is the predominate soil within the project area, occurring on approximately 80 percent of the site. It is a very poorly-drained, tidal marsh soil whose parent material is estuarine deposits. This soil type is typically nonsaline to very slightly saline. (0.0 to 4.0 dS/m – 0.0 to 4,000 μS/cm).

With the exception of a borrow pit dug within the portion of the project site where Nehalem silt loam occurs, all activities associated with the project to date are occurring within the portion of the site where Coquille silt loam occurs. Soil from this pit was used to fill drainage ditches during project construction.

More detailed information on the pre-construction state of the project area is provided in the results section of this report.

2.0. Methods

This section summarizes the methods used to collect data on physical and biological attributes reported in this document. We established nine linear transects at the project site: six running approximately east-west on the parcel north of the river and three running approximately north-south on the parcel south of the river (Figure 7). To improve data collection efficiency and allow us to look for relationships among studied variables, we collected the bulk of our data on a number of different variables along these transects.

2.1. Physical Attributes

We collected data on a variety of physical attributes at the site including ground water and surface water levels, water quality (temperature, conductivity and dissolved oxygen), soils (organic matter and salinity), and channel profiles. We obtained tide and precipitation data used in analyses from external sources, not on-site measurements. The following sections detail methods used to collect these physical data.

2.1.1. Tide and Weather Data

We used tide and weather data to help determine how tides, precipitation and air temperature influence water elevations and water quality at the site. As noted above, we did not measure tide and weather data at the project site. Instead, we obtained these data from publicly available sources.

We obtained tidal data for the Garibaldi Tide Gage (Station ID: 9437540) from the National Oceanic and Atmospheric Administration (NOAA), Tides and Currents website (*http://tidesandcurrents.noaa.gov/geo.shtml?locatioN = 9437540*). This gage is located at the Port of Garibaldi, approximately one mile west of the Project site.

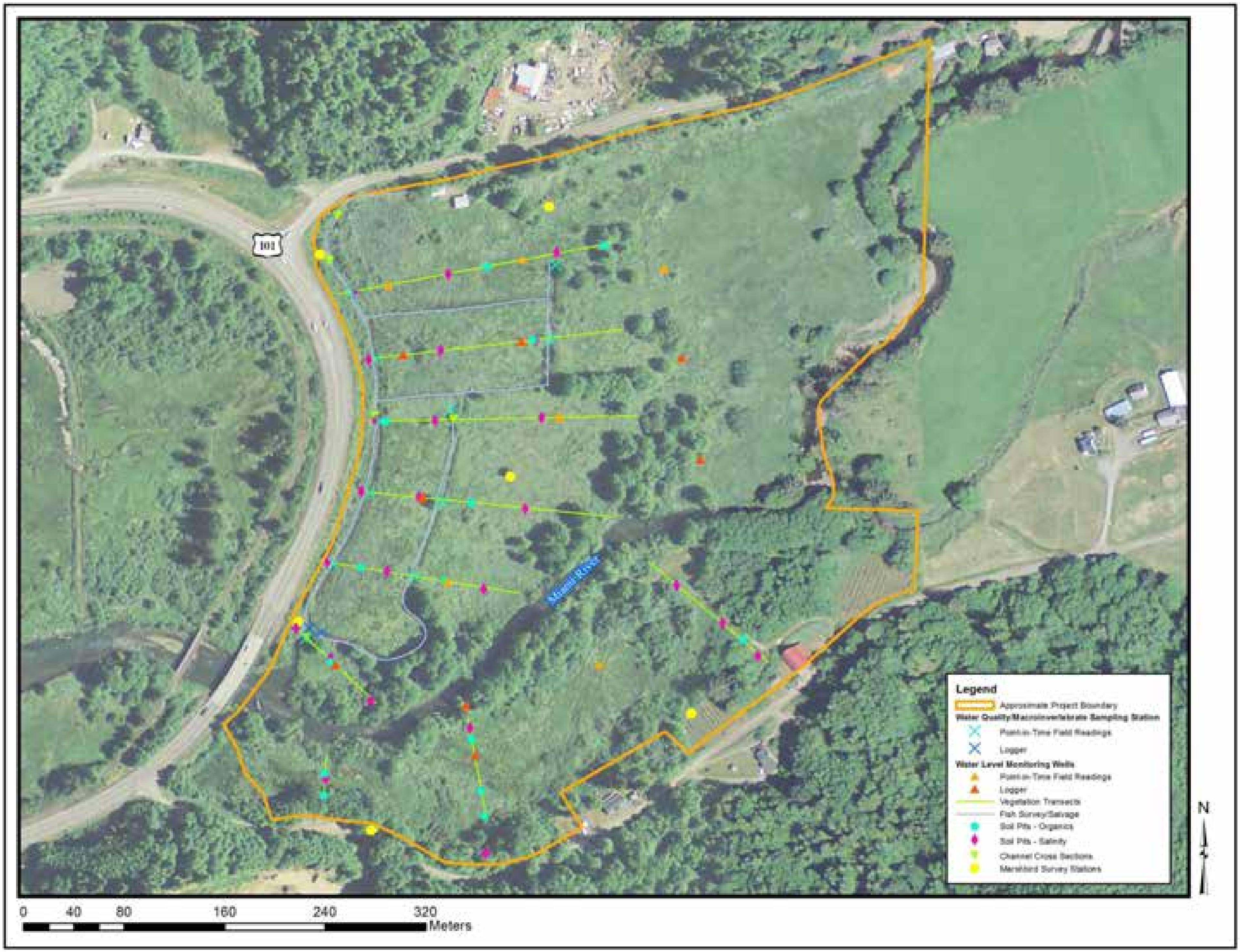


Figure 7. Transects and stations where data was collected for monitoring of physical and biological attributes of Miami Wetlands Project site.

We obtained precipitation data through the Fire and Aviation Management Web Applications website (FAMW-EB - *http://famtest.nwcg.gov/fam-web*), a website administered by the National Interagency Fire Center in Boise, Idaho. There are no official weather stations within the Miami Basin. As a result, we had to rely on data from a few north coast stations from north and south of the basin (Figure 8). Data from these stations allowed us to look for regional precipitation events and then look for correlations with data collected on-site. When data from multiple stations was available, we used the mean precipitation from all available stations in our analyses. We submitted a request to the FAMW-EB helpdesk for daily precipitation data from the Cedar, Miller, South Fork and Tillamook stations and received historical data from these four sites from January 2006 through December 2010. We also made a request for future monthly data from these four sites and will use these data for our ongoing monitoring efforts at the site.

Daily historical air temperature data was obtained from the Weather Underground website (*wunderground.com*). Temperature data was obtained for the Tillamook Airport weather station only.

2.1.2. Water Elevation Monitoring

We collected water elevation data at 14 monitoring wells scattered throughout the project area (Figure 9, Table 1). Two of the wells were installed by U.S. Fish and Wildlife Service (USFWS) staff in 2006 (LL-1 and LL-2) and the remainder were installed by VAI staff in 2008 (MW-1 through 12). Each well site was surveyed by VAI staff to establish its elevation and coordinates.

Table 1. Sampling method, ground surface elevations and sensor elevations for water level monitoring wells at the Miami Wetlands Project Site.

Well ID	Sampling Method	Ground Surface Elevation (ft)	Sensor Elevation (ft)
MW-1	Manual	8.55	
MW-2	Manual	10.31	
MW-3	Manual	10.34	
MW-4	Logger	9.96	8.04
MW-5	Logger	9.90	7.98
MW-6	Logger	10.66	8.74
MW-7	Logger	10.69	
MW-8	Manual	11.27	
MW-9	Logger	10.65	8.73
MW-10	Manual	9.84	
MW-11	Manual	9.11	
MW-12	Logger	8.50	6.58
LL-1	Logger	4.64	4.90
LL-2	Logger	5.10	5.54

LL-1 was located within the active channel of the Miami River and LL-2 within the pond/channel south of the river that is evident in the 1939 aerial photograph (Figure 3). These two wells were constructed from 1.5-inch, slotted, PVC pipe (four-foot long pieces) held in place by two t-posts.

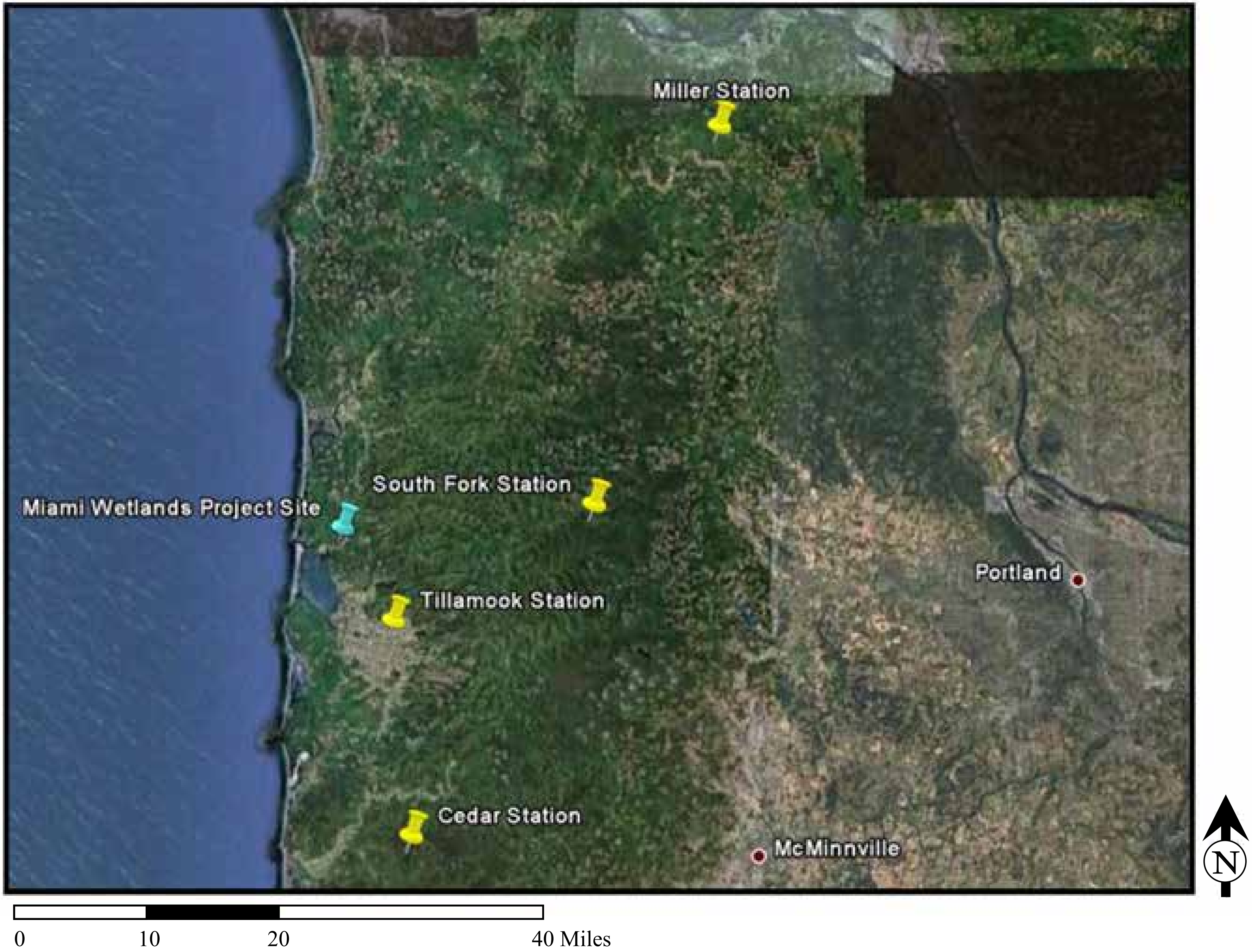


Figure 8. Location of weather stations used to compile regional precipitation data.

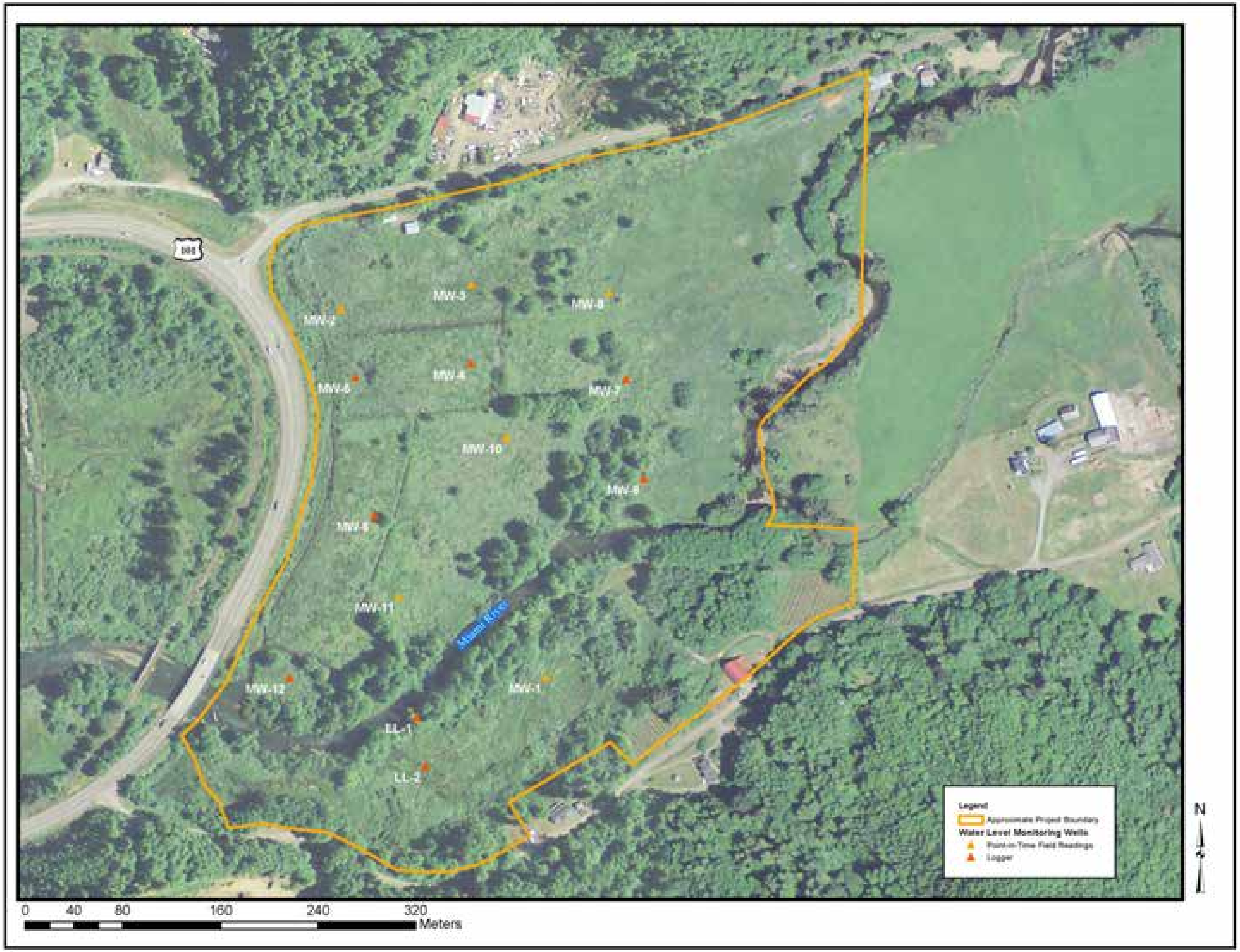


Figure 9. Locations of water level monitoring wells at Miami Wetlands Project site.

These were installed such that the bottom of each pipe was level with the bottom of the channel in which it was located. Unlike the USFWS wells, the VAI wells were constructed in areas outside of active stream/tidal channels. These wells were made from 1.5-inch, solid-wall PVC pipe (four foot pieces). The lower half of each pipe was perforated and the bottoms were capped, screened and sealed with bentonite. The pipes were installed such that the bottom two-feet was imbedded into the soil and top two-feet remained above ground.

Two different methods were used to obtain water elevation data at the 14 well sites. Eight of the wells (LL-1 and 2 and MW-4 through 7, 9, and 12) were equipped with continuous data loggers (Solinst Model 3001 Levelogger Gold®, hereafter "levelogger") and the remaining six wells (MW-1 through 3, 8, 10 and 11) were measured manually.

Leveloggers were initially programmed with a 15-minute sampling interval, which was subsequently extended to a one-hour sampling interval. These devices have a pressure transducer that measures the collective pressure of the atmosphere and liquid above the sensor. As a result, atmospheric pressure data is needed for calculations to determine the level of the liquid above the sensor. We deployed a continuous data logger to measure atmospheric pressure at the project site (Solinst Model 3001 Barrologger Gold®, hereafter "barrologger"). We programmed the barrologger with a sampling interval synchronous to the levelogger sampling intervals. This provided for direct compensation of levelogger data with Solinst's Levelogger software (versions 3.1.0 and 3.4.0). This proprietary software directly communicates with the loggers for evaluation and programming purposes and downloading of stored logger data. It also allows for easy and rapid compensation of levelogger data, by subtracting atmospheric pressure measured with the barrologger from the collective pressure measured by the leveloggers. The software also converts the levelogger pressure data and reports the height of the water column above the sensor (in metric [cm] or standard units [inches]). We calculated sensor elevation for each well by subtracting sensor depth from the surveyed surface elevation.

We calculated water surface elevations at these wells by adding the recorded height of the water column above the sensor to the sensor elevation. We determined the level of the water surface relative to ground surface elevation by calculating the difference between the water surface elevation and ground surface elevation at each well site.

To manually sample the six wells not equipped with continuous data loggers, we measured the distance from the top of the well pipe (two feet about the ground surface) down to the surface of the water within the well pipe with a tape measure. The sampling schedule for these manual wells was variable: data were collected weekly to inform the engineering design phase and latter data collection was opportunistic (samples were taken primarily when levelogger data was retrieved – approximately quarterly).

2.1.3. Water Quality Monitoring

We collected data on three water quality parameters during the pre-construction phase of the project: temperature, conductivity (salinity) and dissolved oxygen. We used continuous data loggers and point-in-time, field readings to collect this data at several locations on the parcel north of the river (Figure 10). In addition, the leveloggers deployed in the water level monitoring wells (see above and Figure 9) collected temperature data simultaneous to water level data. Two of these wells were located in open water channels (LL-1 and LL-2) and the remainder monitored primarily ground water temperatures (MW-4 through 7, MW-9, and MW-12).

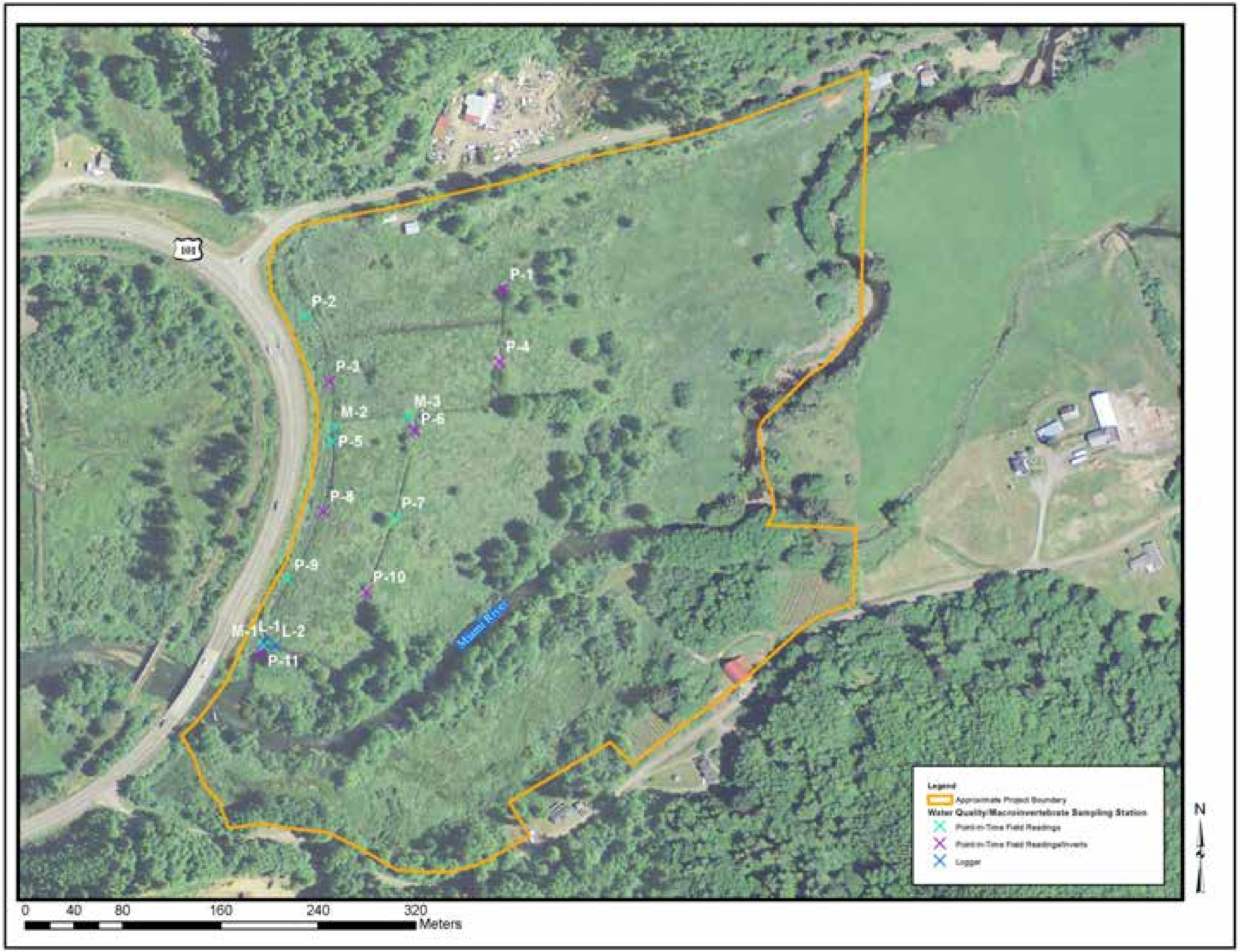


Figure 10. Locations of water quality and macroinvertebrate sampling stations at Miami Wetlands Project site.

Point-in-time field readings were obtained using hand held meters with cabled, submersible probes (YSI Model 30 Conductivity/Salinity/Temperature System® and YSI Model 95 Dissolved Oxygen/Temperature System®). Data was collected in this manner several times per week during summer 2009, once during winter 2010 and when macroinvertebrate samples were collected in spring 2010 (see below).

We obtained two dissolved oxygen (DO) loggers (RBR Model DO-1050®) and two level/temperature/conductivity (LTC) loggers (Solinst Model 3001 LTC Levelogger Junior®) during late spring 2010 (shortly before enhancement construction activities began). We deployed these loggers in pairs (one DO logger and one LTC logger) at two locations near the confluence of the channels on the north parcel with the mainstem Miami River (one at the mouth of the Hobson-Struby channel along the Highway 101 right-of-way and one at the mouth of the tidal/drainage channels). Due to the late date of acquiring these loggers, we have very limited pre-construction logger data for these water quality variables. We used the salinity scale developed by Cowardin, et al (1979) to define water salinity levels (Table 2).

2.1.4. Soils

We collected soil samples at several locations north and south of the river (Figure 11) and completed analyses for two different soil quality variables (organic matter and salinity). All of the samples were collected from along the nine transects established on the site and depicted in Figure 6. Soil samples for organic matter analysis were collected concurrent with vegetation sampling completed during June 2010. Soil samples for the salinity analysis were collected during September 2010.

2.1.4.1. Soil Organic Matter - Soil samples collected during the June 2010 vegetation sampling effort were analyzed for organic matter content by A&L western Agricultural Laboratories in Portland, Oregon (A&L). These samples were obtained from within the top six inches of the soil profile and care was taken to exclude above ground organic matter from the sample. A&L used the Loss-on-Ignition (LOI) method to analyze these samples. This method estimates the amount of organic matter in a soil sample by determining the weight change of the sample resulting from prolonged exposure to very high temperatures (360 ^{o}C). Details regarding this method are included in the Western States Laboratory Plant, Soil and Water Analysis Manual, 2nd Edition, (Gavlak et al. 2003 - *http://cropandsoil.oregonstate.edu/wera103/soil_methods*).

2.1.4.2. Soil Salinity - Soluble salt content of soils (soil salinity) is typically determined by examining the electrical conductivity (EC) of soil-deionized water solutions/extracts (ASCE 1990). As the salt load in the soil increases, the value for electrical conductivity also increases.

Laboratories specializing in soils analyses most often use the Saturated Paste Extract (SP) method to assess soil salinity. Gavlak et al. (2003) provide details for this method. This method provides a direct measure of total soluble salts in the soil because it closely approximates the water content of soils under field conditions, and the results are thought to be the best predictor of plant response. Most scientific literature reporting soil salinities present results based on this method. However, the technique is time consuming, susceptible to error due to variability between analysts in the preparation of the saturated paste, and requires specialized equipment. Therefore, it is not typically performed outside of labs specializing in soil quality analyses.

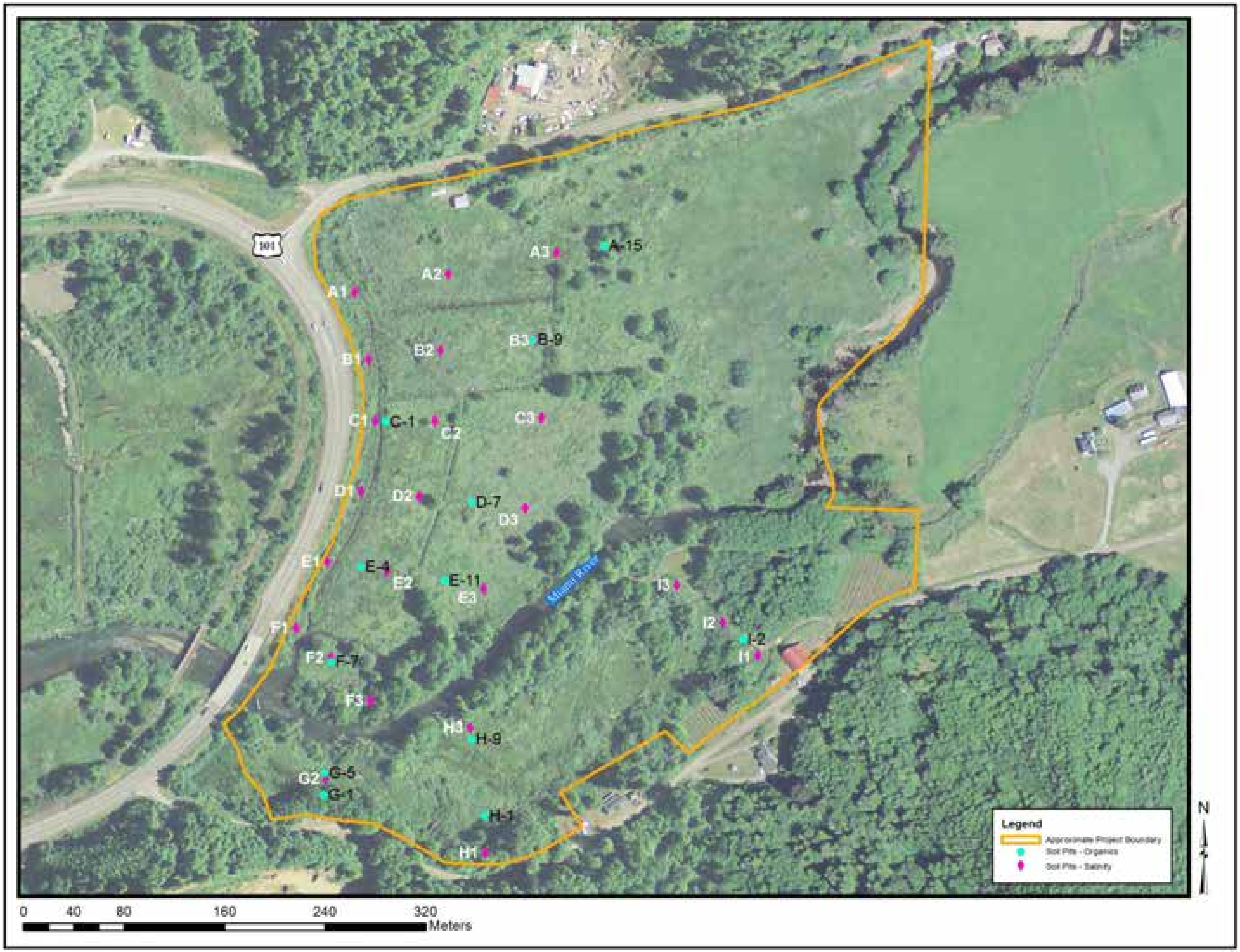


Figure 11. Location of soil organic matter and soil salinity sampling stations at Miami Wetlands Project site.

Other solution/extract techniques have been developed that are more easily performed outside of soils laboratories (e.g., Dahnke and Whitney 1988, Gartley 2003, Zhang et al. 2005, etc.). These methods are less costly than SP and often require limited special equipment or training to conduct. However, because these methods rely on dilute extracts/suspensions they provide only indirect measurements of soluble salts, making interpretation of the results less straightforward and more subject to error than determinations based on the SP method. Given that they are easy to conduct and require limited specialized equipment, these techniques are widely used and the relationships of the results of these methods to the SP methods have been quantified by several authors (Hogg and Henry 1984, Pittman et al. 2001, Zhang et al. 2005). The types of salt present and soil texture can influence the relationship between EC results obtained through these alternative methods and SP (Hogg and Henry 1984, Pittman et al. 2001).

Due to budget constraints, TEP staff conducted the salinity analysis for soil samples collected during September 2010. To prepare soil samples for analysis, we oven-dried the samples at approximately 71°C (160°F) and passed them through a #10 (2mm) sieve. We determined soil texture for each sample using standard Texture by Feel analyses (soil ribbon and wetted palm tests) *(http://soils.usda.gov/education/resources/lessons/texture/*). We used a 1:2 (soil:deionized water) suspension to obtain conductivity measurements ($EC_{1:2}$): we added 20 mL of deionized water and 10 grams of soil to small, lidded plastic vials and repeatedly agitated each sample over a one hour period before testing for EC. We used a YSI Model 30 Conductivity/Salinity/Temperature System® to test for EC of the suspension and recorded the Specific Conductance (SC) value reported by the meter (SC = conductivity normalized to a temperature of 25 ºC). To allow for comparison of the results of this analysis to studies where the SP method was used to assess soil salinity, we converted our results using a regression equation for fine textured soils ($EC_{SP} = 3.12EC_{1:2} - 0.59$ [Hogg and Henry 1984]). We report both the measured ($EC_{1:2}$) and converted values (in deciSiemens per meter [dS/m] and microSeimens per centimeter (µS/cm) in the results section of this document. We used salinity classes developed by Cowardin et al. (1979) and USDA, NRCS Soil Salinity Classes to categorize the salinity of water and soil at the Miami Wetlands Project site (Table 2).

Table 2. Cowardin salinity classes for wetland and deepwater habitats and NRCS Soil Salinity Classes.

Cowardin

	Coastal Modifiers[1]	**Inland Modifiers[2]**	**Specific Conductance (dS/m / µS/cm)**
	Fresh	Fresh	<0.8 / <800
Mixohaline (Brackish)	Oligohaline	Oligosaline	0.8-8 / 800-8,000
	Mesohaline	Mesosaline	8-30 / 8,000-30,000
	Polyhaline	Polysaline	30-45 / 30,000-45,000
	Euhaline	Eusaline	45-60 / 45,000-60,000
	Hyperhaline	Hypersaline	>60 / >60,000

NRCS

Specific Conductance (dS/m / µS/cm)	**Soil Salinity Class**
<2 / <2,000	Non-Saline
2 to <4 / 2,000-<4,000	Very Slightly Saline
4 to <8 / 4,000-<8,000	Slightly Saline
8 to <16 / 8,000-<16,000	Moderately Saline
>16 / >16,000	Strongly Saline

[1] Coastal modifiers are used for Marine and Estuarine systems. [2] Inland modifiers are used for riverine, lacuastrine and Palustrine systems

[3] The term “Brackish” should not be used for inland wetlands or deepwater habitats.

2.1.5. *Channel Cross Sections*

Limited channel cross sectional data was collected prior to construction. Land surveys completed by VAI in preparation for engineering design work collected elevations along a few transects

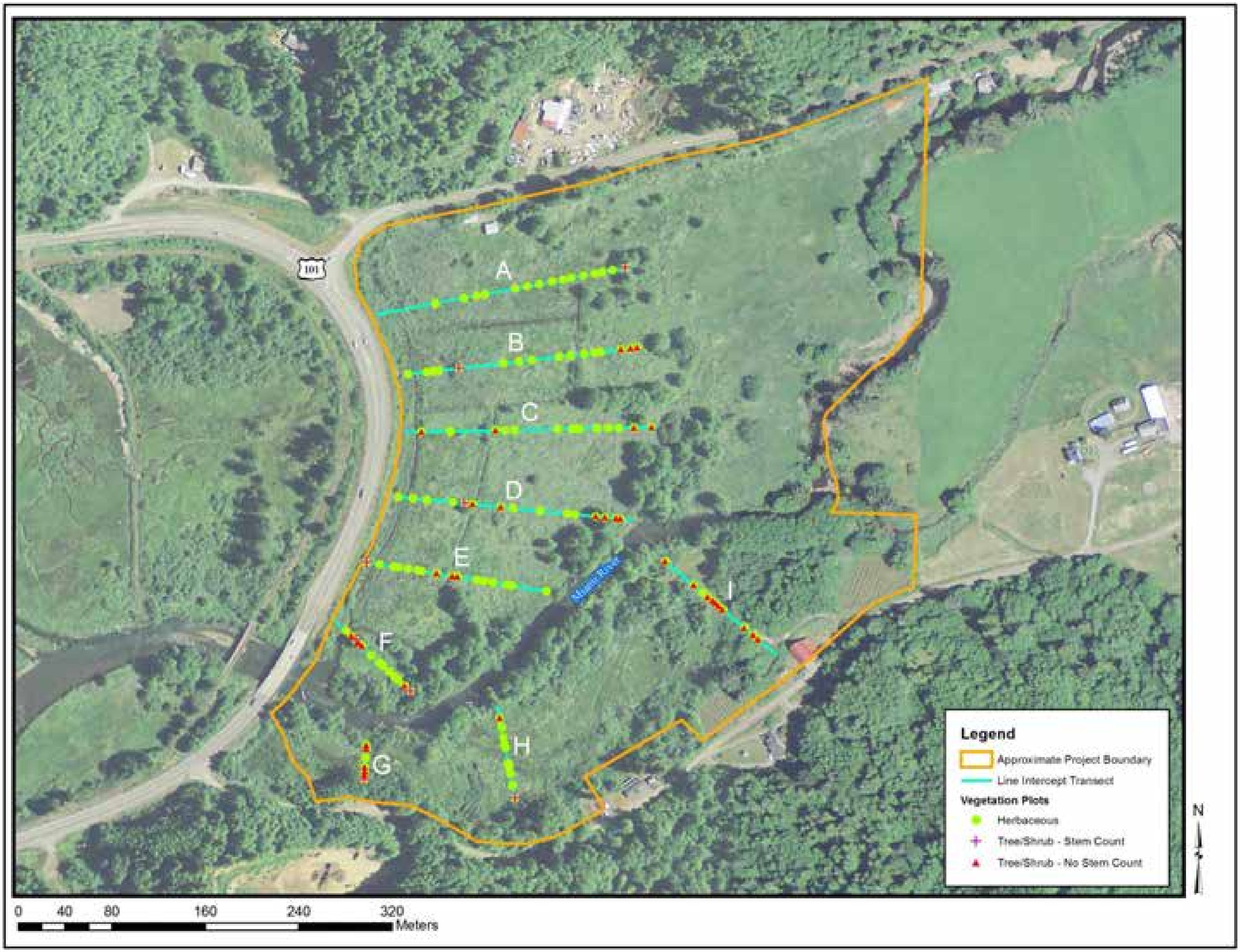


Figure 12. Location of line-intercept transects and vegetation sampling plots at Miami Wetlands Project site.

north of the Miami River (Figure 7). We originally believed that these data would provide sufficient information to determine the cross-sectional shape of the intercepted channels. However, upon review we discovered that the survey stations were too widely spaced to fully define the cross section of any of the historical drainage channels on the property. Unfortunately our review was completed after construction work had begun on the property and so we were unable to gather cross sectional data from the drainage channels.

2.2. Biological Attributes

We collected data on a variety of biological resources at the site including vegetation, macroinvertebrates, secretive marsh birds, and fishes. The following sections detail methods used to collect data for these resources. In addition to the formal data collection efforts detailed below, we recorded observations of birds and other wildlife made incidental to other activities at the site.

2.2.1. Vegetation

We collected a suite of vegetation data to allow us to better understand pre-construction plant communities at the site. Long-term replication of these efforts after enhancement actions have been completed will allow us to quantify changes to vegetation at the site associated with enhancement actions and evaluate the success of plantings completed as part of the enhancement process.

All vegetation data was collected along the linear transects depicted in figures 7 and 12. We used several different methods to obtain data to evaluate species composition and distribution relative abundance, and percent cover, including line-intercept transects, 1-m^2 quadrats for herbaceous species, and 5m radius circular plots for tree and shrub species.

2.2.1.1 Line Intercept - Line intercept data was collected along each transect depicted in Figure 12. This method is suitable for evaluating foliar cover and species composition (by cover) for shrubs, trees, grasses, and forbs and consists of horizontal measurements of plant intercepts along the course of a tautly-stretched tape measure. It is best suited for use in plant communities where individual plants are easy to distinguish and is less well-suited for use in dense grasslands or other communities where it is difficult to discern individuals. At the time of our work for this report, much of the Miami site was densely vegetated (cover was nearly 100 percent over the entire site) and often there were multiple species growing together, their foliage intermingled. As a result, we modified the method somewhat. Typically, such transects are 50-100 m long, but because we wanted to understand the gross distribution and composition of vegetation at the site we completed the method along the entire length of the data collection transects that had been established during the early planning stages of the project. Rather than record each individual intersect (something that would have been impossible in the dense and tangled vegetation on the site) we recorded intercepts of clusters or clumps of similar vegetation. For example, Reed Canary-grass (*Phalaris arundinacea* - PHAR) and Slough Sedge (*Carex obnupta* - CAOB) were common on the site. Each species occurred as single-species clusters and together in mixed-species clusters, with one or the other species being dominant. These different clusters often occurred along a single transect, transitioning from one to another. As the tape passed through these areas we would record the beginning and end of each cluster that intersected the tape (e.g., PHAR, PHAR/CAOB, CAOB, CAOB/PHAR). Where transects crossed open water (with no overhanging vegetation) we recorded “open water.” We encountered few areas with sufficient bare ground to warrant recording “bare ground”. We recorded tree and shrub species encountered along transects, but in most cases these species were overhanging areas where other species clearly provided the greatest ground cover (e.g., an alder branch overhanging a very, dense patch of Reed Canary-grass). In such cases, the species that clearly provided the dominant ground cover was considered dominant in our analysis (and for display purposes – see below). Tree and shrub species were considered dominant for analysis purposes only when they were the only species encountered or when understory vegetation beneath them was sparse (which wasn't often).

We entered line intercept data into an Excel® spreadsheet file for analysis. For each transect we calculated Percent Total Cover for each dominant species by dividing the total of all intercepts for that type by total transect length and multiplying by 100. We calculated Percent Relative Cover for each vegetation type by dividing the sum of the encounters for each type by the sum of all vegetation intercepts and multiplying by 100.

We also used intercept data from these transects to develop segmented polylines for visual display of vegetation types using ArcGIS® software: each recorded intercept was identified as a unique segment along the transect line. We color coded each polyline segment based on dominant species to visually display the actual distribution of vegetation intercepted along each transect (e.g., all intercept segments in which Reed Canarygrass was identified as the dominant species were uniquely colored, etc.).

We recognize that the above methodology provides an oversimplified view of plant community composition and does a poor job of capturing and expressing the variation and complexity of vegetation at the site. However, we believe it has value in that it provides for a solid understanding of the distribution of dominant plant species and a good estimate of vegetative cover over large portions of the site. We utilized other methods to gather data to better understand and evaluate the variation and complexity of vegetation at the site (see below).

2.2.1.2 1-m^2 Herbaceous Vegetation Plots – We established 112 1-m^2 quadrats to sample herbaceous vegetation (Figure 12). We selected plot locations using a random number generator to identify twenty points along each transect (based on distance from transect start point in feet). This method resulted in some cases where plots were spaced too closely (10 feet or less), or a number was duplicated. These points were eliminated and the total number of plots per transect was reduced accordingly. For each plot the quadrat (constructed from ¾" PVC pipe) was placed on the tape with the bottom left corner aligned with the correct point on the tape. We identified all herbaceous plant species within the quadrat to species (except when lack of key characteristics precluded identification to this level-because the work was done during late spring, some species were identifiable only to genus) and visually estimated the percent cover associated with each species. Woody plants less than one meter in height were included in this assessment. We also estimated the percentage of bare ground, organic litter, and open water within each plot. We entered all data from these plots into an Excel® spreadsheet file for further analyses.

We used data from these plots (and other efforts) to identify distinct plant communities occurring within the site (based primarily on species dominance and diversity). We used this information along with review of aerial photographs and on-the-ground visual assessment to map plant community distribution for the site (see Results) and assigned each 1m^2 plot to a specific plant community based on this distribution. For each species within a plant community, we calculated mean Percent Total Cover and mean Percent Relative Cover. We also calculated Species Richness, two diversity indices (Simpson's Index of Diversity and Shannon-Weiner Index), and Evenness for each identified plant community.

Species Richness (S) is the simplest of all the measures of species diversity. It is simply the number of species found in a community. As such, this measure does not indicate how the diversity of the population is distributed among those particular species.

Simpson's Index of Diversity (D) is a measure that accounts for both species richness and the relative abundance of each species in a community. This index represents the probability that two individuals randomly selected from within a community will belong to different species. In this equation, D ranges from 0.0 to 1.0, with 0.0 representing no diversity and 1.0 representing infinite diversity. As species richness and evenness increase, diversity increases. The formula for Simpson's Index of Diversity is:

$$D = 1 - \frac{\sum_{i=1}^{S} n_i\,(n_i - 1)}{N(N-1)}$$

where *S* is the number of species (Species Richness), *N* is the mean Percent Total Cover for the community and *n* is the mean Percent Total Cover of a species within that community.

The Shannon-Wiener Index (H') is a diversity measure that originated with information theory and is based on measuring the uncertainty observed within a particular system. Like Simpson's index, this index accounts for both abundance and evenness of the species present. The degree of uncertainty of predicting the species of a random sample is related to the diversity of a community. If a community is overwhelmingly dominated by one species (low diversity), the uncertainty of prediction is low (a randomly-sampled species is most likely going to be the dominant species). However, if diversity is high, uncertainty is high. For ecological studies, the value of the index typically ranges from 0.0 (low diversity) to 4.0 (high diversity). The formula for the Shannon-Wiener Index is:

$$H' = -\sum_{i=1}^{S} p_i \, ln p_i$$

where *S* is the number of species (Species Richness), p_i is the proportion of the total sample belonging to the *i*th species, and *ln* is natural logarithm.

Evenness (E) is a measure of how similar the abundance of different species is within a community. The value for this measure ranges from 0.0 to 1.0, with 1.0 being complete evenness. Evenness (*E*) is computed using species richness (S) and the Shannon-Wiener index (H'). The formula for Evenness is:

$$E = H'/lnS$$

where *H'* is the Shannon-Wiener Index Value, *S* is the total number of species (Species Richness), and *ln* is natural logarithm.

2.2.1.3 5m Radius Tree and Shrub Plots – We established 5m radius circular plots at the same randomly generated points where the 1m^2 quadrats were established (Figure 12). Trees were not present within 5m of many of these points, so at most plot locations we collected no data. Where trees and/or shrubs occurred within this 5m radius area (44 total locations – Figure 10), we estimated Percent Canopy Cover for each tree and shrub species present. When the stems/trunks of trees or shrubs occurred within the 5-meter radius plot (7 of the 44 5m radius plot locations), we completed a stem count and measured diameter at breast height (DBH) for each stem. On Figure 10 we depict plots where tree/shrub data was collected but no stem counts were completed with a solid red triangle (▲) and those where stem counts were completed with a pink cross (+).

We completed many of the same analyses for this data that we did for the herbaceous plot data discussed above. Together these data sets were used to describe vegetation communities on the site.

2.2.2. Macroinvertebrates

Macroinvertebrates include freshwater insects, crustaceans, mollusks, bivalves and other invertebrates greater than one half millimeter in size. They play important roles in food chains and ecosystem processes, are easy to collect and inexpensive to process and analyze, and show strong responses to many stressors. As a result, macroinvertebrates are commonly used for assessing the biological integrity of aquatic systems.

We sampled for aquatic macroinvertebrates on May 14 and 15, 2010 at seven locations where our study transects crossed the existing channels north of the Miami River (Figure 10). We also collected water quality data (salinity/conductivity, dissolved oxygen, and temperature), using the point-in-time methodology described above, simultaneous to each macroinvertebrate sample.

We used methodology similar to that described by Mazzacano (2009) to collect macroinvertebrate samples. We used a one foot wide D-frame dip net with 500 µm mesh to collect the samples. At each station, we collected a composite sample of nine separate one meter long net sweeps (all collected from along the bank on which we were standing). Individual sweeps were spaced 1 meter apart, beginning four meters downstream of the transect crossing point and ending four meters upstream of the crossing point (a nine meter bank segment). For each sweep, we pulled the net upwards along the soil bank material and into the submerged lower portion of bankside vegetation.

To reduce the volume of sediment in the net bag after all of the composite sweeps were taken, we submerged the bottom of the net bag in the water and stirred the contents by hand while swirling and bouncing the net in the water. Samples were placed in a bucket and the net was rinsed with clean water over the bucket. Any fish or amphibians were removed, and larger pieces of debris were rinsed and discarded. The material was then poured through a sieve with 500 µm mesh, and rinsed further to remove sediment. All rinse water was collected from the adjacent channel and was poured through a 500 µm mesh sieve prior to use, to avoid introducing additional invertebrates into the sample. Following these procedures, the sample material was transferred to a one liter Nalgene jar and 95% ethanol was added as a preservative. For maximum preservation, sample volume comprised no more than 75% of the jar and ethanol was added until the container was at maximum capacity. After an approximately 24 hour period, the ethanol in each sample was poured off and replaced with fresh ethanol.

We sent the preserved samples to ABR, Inc. – Environmental Research and Services in Forest Grove, Oregon (ABR) for processing and classification. ABR first sorted a 300-organism subsample from each sample using a 30-square Caton gridded tray (Caton 1991) or an 8-cell sieve. When fewer than 300 organisms occurred in a sample, the entire sample was sorted. Organisms were sorted into a series of vials, arranged taxonomically. Following subsampling, a scan was performed for a maximum of 15 minutes on each sample that was not sorted in its entirety to remove representative specimens of any larger taxa that were not encountered during subsampling. Large/rare organisms were placed in a separate vial. Following sorting, ABR identified the sorted macroinvertebrates to the lowest practical levels of taxonomic resolution. Target taxonomic levels of resolution were generally genus/species for most aquatic insects (as much as condition and maturity allowed), family/genus/species for mollusks, order for microcrustaceans, genus/species for crustaceans, order for mites (Trombidiformes), and class for aquatic worms (Oligochaeta). Samples were all identified by NABS-certified taxonomist, Michael Cole. ABR entered raw taxonomic and count data into an Excel® spreadsheet file and returned this data and the sorted and classified macroinvertebrates to TEP.

We calculated mean count and percent relative abundance for each species and compared the species assemblage to the limited information available for similar environments in Oregon. Oregon Department of Environmental Quality (DEQ) and others have developed models that use aquatic macroinvertebrates as indicators of biological conditions and surrogates for watershed health. However, western Oregon reference data for these models currently have only been developed for fast moving, wadeable streams. As a result, these models are not currently applicable for sites like the Miami Wetlands and we did not conduct such analyses.

2.2.3. Secretive Marsh Bird Surveys

Expected changes in the structure and composition of vegetation at the project site may affect the suitability of the site for waterbirds that typically occupy emergent wetlands. As a result we conducted surveys for selected marsh birds on 29 May, 18 June, and 30 June, 2010 following protocols developed by Conway (2009). We obtained recorded calls of focal species (MP3 format) for this area from the author of the protocol. The MP3 file included five minutes of silence followed by exactly 30 seconds of calls for each of the focal marsh bird species that are expected breeders in this area (Sora [*Porzana carolina*], Virginia Rail [*Rallus limicola*], American Bittern [*Botaurus lentiginosus*], American Coot [*Fulica americana*], and Pied-billed Grebe [*Podilymbus podiceps*]) interspersed with 30 seconds of silence between each species' calls (total length of the recording was 10 minutes). For each species, the 30 seconds of calls consist of a series of the most common calls interspersed with approximately five seconds of silence.

We began each survey session approximately 30 minutes before official sunrise and concluded each session within two hours after sunrise. Tidal elevations varied somewhat among the three sessions, but each was conducted during an outgoing tide. Weather conditions and background noise during each of the three sessions were within acceptable limits as identified in the protocol. We established six calling stations at the site before conducting the surveys (Figure 13) and we broadcasted the recording described above from each station using an MP3 player connected to a

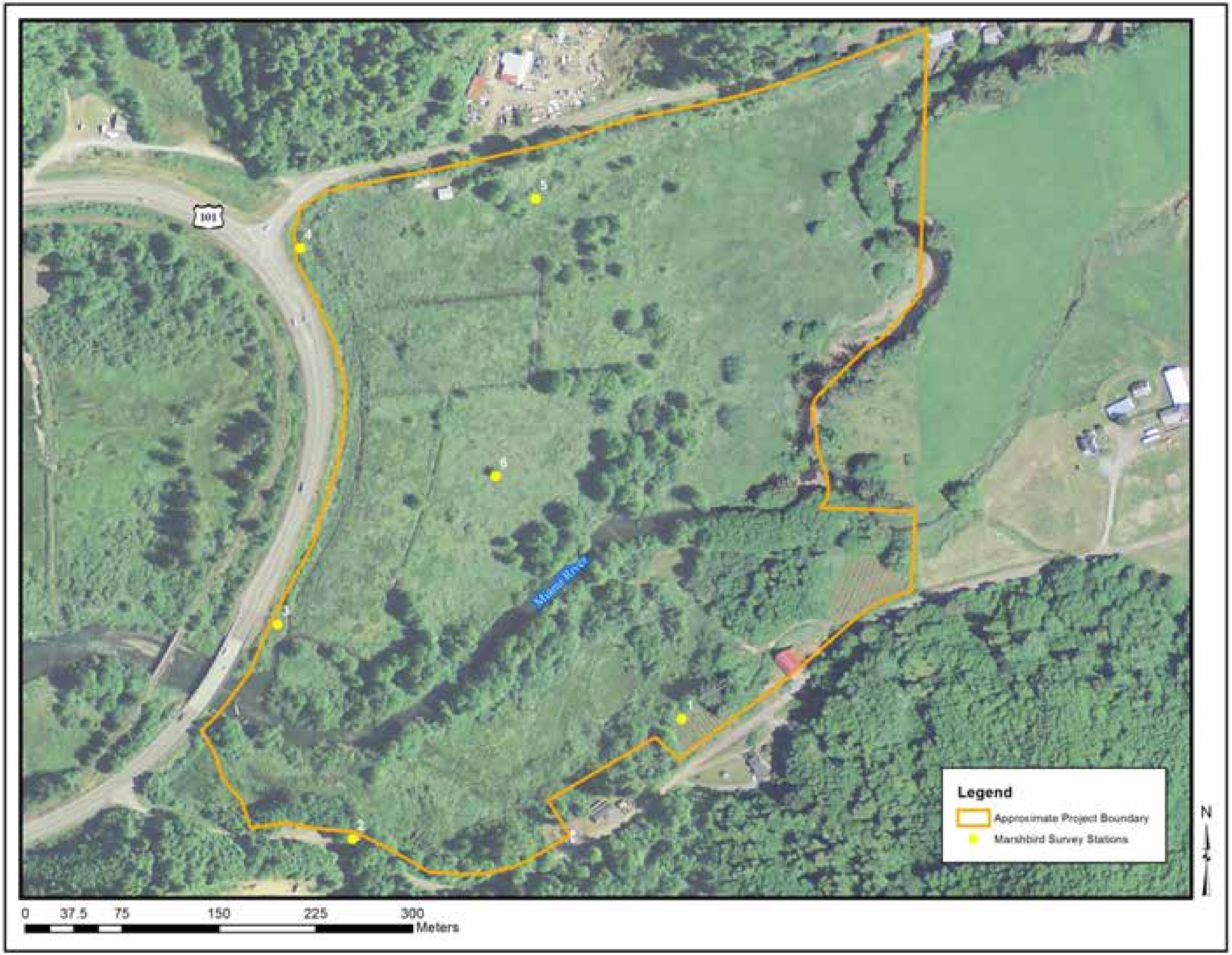


Figure 13. Location of marsh bird survey stations at Miami Wetlands Project site.

battery operated bullhorn during each session. We surveyed the stations in numerical order (as depicted on Figure 13) and, per the protocol, followed the same order during each session.

2.2.4. Fishes

We obtained pre-construction fish data through a variety of methods and sources: Tillamook Bay Rapid Bio-Assessment data (RBA), spring 2010 snorkel survey, and summer 2010 fish salvage. In the following paragraphs we briefly discuss the scope and methods used for each of these efforts.

The Tillamook Bay Rapid Bio-Assessment was an extensive survey effort conducted during the summers of 2005, 2006 and 2007. The project was designed to gather information on the status of juvenile salmonid summer distributions and summer rearing densities (Bio-Surveys, LLC 2005, 2006 and 2007). It consisted, primarily, of 20 percent snorkel surveys[1] in each basin within the Tillamook Bay Watershed beginning at the head of tidal influence and continuing to the end of juvenile Coho distribution in each stream and its tributaries (under most circumstances the end of juvenile Coho distribution was determined when no Coho were detected in two consecutive pool searches). Several survey stations during each of the three years were within or adjacent to the Miami Wetlands Project Site (Figure 14). Data available from this project include number of individual juvenile salmonids observed (by species) at each surveyed pool and estimated per pool densities.

On June 22, 2010, just before construction activities began at the site, ODFW Habitat Restoration Biologist, Phil Simpson, conducted a snorkel survey of the channels north of the Miami River (Figure 14). During this effort, Simpson searched most of the channels in their entirety (unlike the RBA survey which focused efforts at pools only) with the aim of "identifying and/or confirming the fish species and various life stages of those species that will potentially benefit from restoration activities at the site." In his report, Simpson noted that his survey effort "should not be viewed as a quantifiable pre-project population characterization targeted for post-project analyses that will ultimately measure success or failure of the project." He went on to add that both seasonal and annual climatic variations, yearly variations in Cohort size, and temporal variation in use of tidal wetlands by different anadromous species also affect the utility of the data. Finally, he stated that what his effort really provided was a "snapshot of the Miami Wetlands fish community" and general anecdotal observations of existing habitats, and "perhaps one point of reference for future comparisons." With the exception of the officially named Hobson and Struby creeks, channel names depicted on Figure 14 reflect the identification scheme used by Simpson in the report he prepared documenting his survey effort.

The final source of pre-construction fish data available for the site is the results of fish salvage operations completed during summers 2010 and 2011. Before construction activities began in each of the channels being filled, TEP and ODFW staff trapped and relocated fish and other aquatic vertebrates from within the channels. Trapping was completed using block nets, pole

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[1] A 20 percent snorkel survey is conducted by searching every fifth pool along a stream. It is initiated by randomly selecting one of the first five pools upstream of the mouth of the stream (or its confluence with another stream) as the starting pool and proceeing upstream in the aforementioned fashion. The method collects a random sample from 20 percent of the pools within the surveyed reach of a stream.

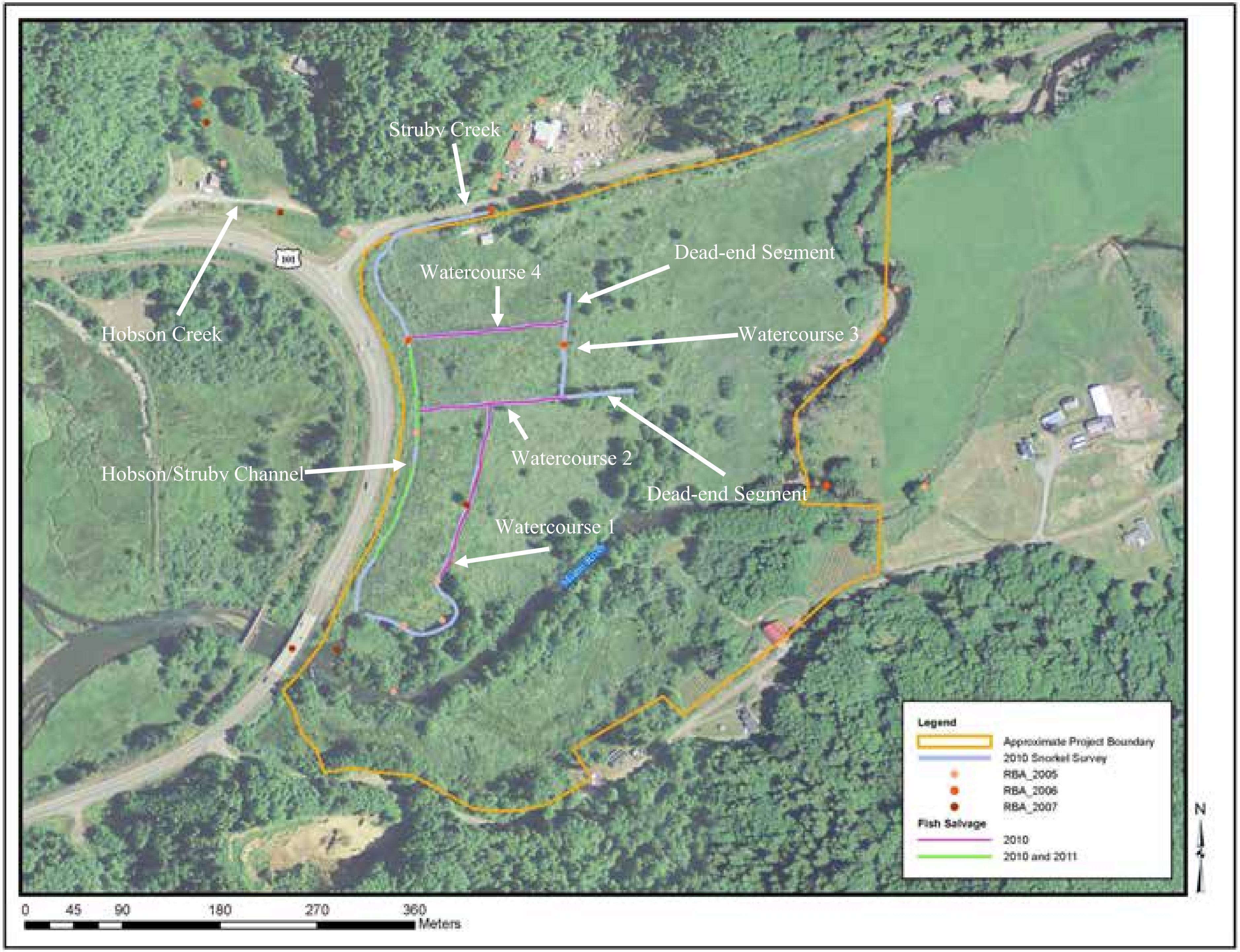


Figure 14. Location of fish data collection efforts at Miami Wetlands Project site.

seines, fine-mesh dip nets, backpack electrofishing equipment, and minnow traps. In 2010, minnow traps were set out over night prior to seining operations. During both years, seining and electrofishing were conducted simultaneous to channel dewatering (channels to be drained were isolated from incoming flows and then water was pumped from the channel using gas-powered pumps with screened intakes). This lowered the volume of water in the areas being salvaged, concentrating free-swimming fishes into smaller areas and making for easier herding with pole seines and capture with dip nets. In addition, because larval lamprey (ammocetes) live in bottom sediments and sculpin are bottom dwellers, neither were visible until water began receding from bottom sediments in the channels. During seining efforts, salmonids and lamprey were priority targets. We are confident that we captured a majority of salmonids occurring in the channels. However, due to the life history of lamprey, we assume that we did not account for a majority of individuals occupying the site. Extremely large numbers of Three-spined stickleback and sculpins were observed during these efforts. Many were captured for relocation, but it was not possible to capture all individuals of these species. As a result, the numbers recorded as salvaged are a fraction of the total number of individuals of these species observed in the channels. Data available from this source are the number of each species removed from each channel where salvage operations were conducted.

3.0. Results and Discussion

This section summarizes the results of our pre-construction data collection efforts. These data describe baseline conditions at the Miami Wetlands Project site. Future data collection efforts will build off of this foundation and will document the effects of wetland restoration activities at the site.

3.1. Physical Attributes

Below we report the results of our efforts to document pre-construction physical attributes at the Miami Wetlands Project site. As noted earlier, we collected data on a variety of physical attributes at the site including ground water elevations, surface water elevations (river and side channel levels), water quality (temperature, conductivity and dissolved oxygen), soils (organic matter and salinity), and channel profiles. The following sections summarize these physical data.

3.1.1. Water Elevation Monitoring

This section reports baseline water surface elevations at the site and discusses the influence of tides, precipitation and other factors on these levels. We report data from monitoring wells distributed across the project site: eight equipped with continuous data loggers and six recorded manually (Figure 8, Table 1). Wells varied with respect to the ambient conditions in which they existed. Wells LL-1 and LL-2 were located in areas with perennial open water: LL-1 was located in the mainstem Miami River channel and LL-2 sampled the side channel on the southern portion of the site (upstream of a beaver dam that separated this channel from the mainstem). The remaining wells were located at terrestrial sites and primarily monitored groundwater elevations (although some sampled portions of the site that were regularly inundated).

As noted in the Methods section of this report, we began collecting water level data using leveloggers at two stations in 2006 and added loggers at six additional stations in 2008. Data has been collected nearly continuously at these eight stations since 2008. Data collection intervals have ranged from 15 minutes to 4.0 hours over this period. As a result, the loggers have generated an enormous amount of data making it impractical to graph the data in its entirety. Therefore, for this report we elected to visually depict data from selected five-day intervals (one interval for each of the four seasons) that exemplify water levels in different portions of the site and demonstrate the influences of elevation, tides and precipitation on water levels (figures 15-18). The graph representing Spring 2008 actually depicts data from a few days prior to the official start of Spring (March 10-15, 2008). This was intentional. We used the selected period because it better depicts the effects of moderate precipitation events on water elevations following a period of little rainfall better than data from a few weeks later that year. The following paragraphs discuss the information presented in these graphs and additional analyses performed with the data.

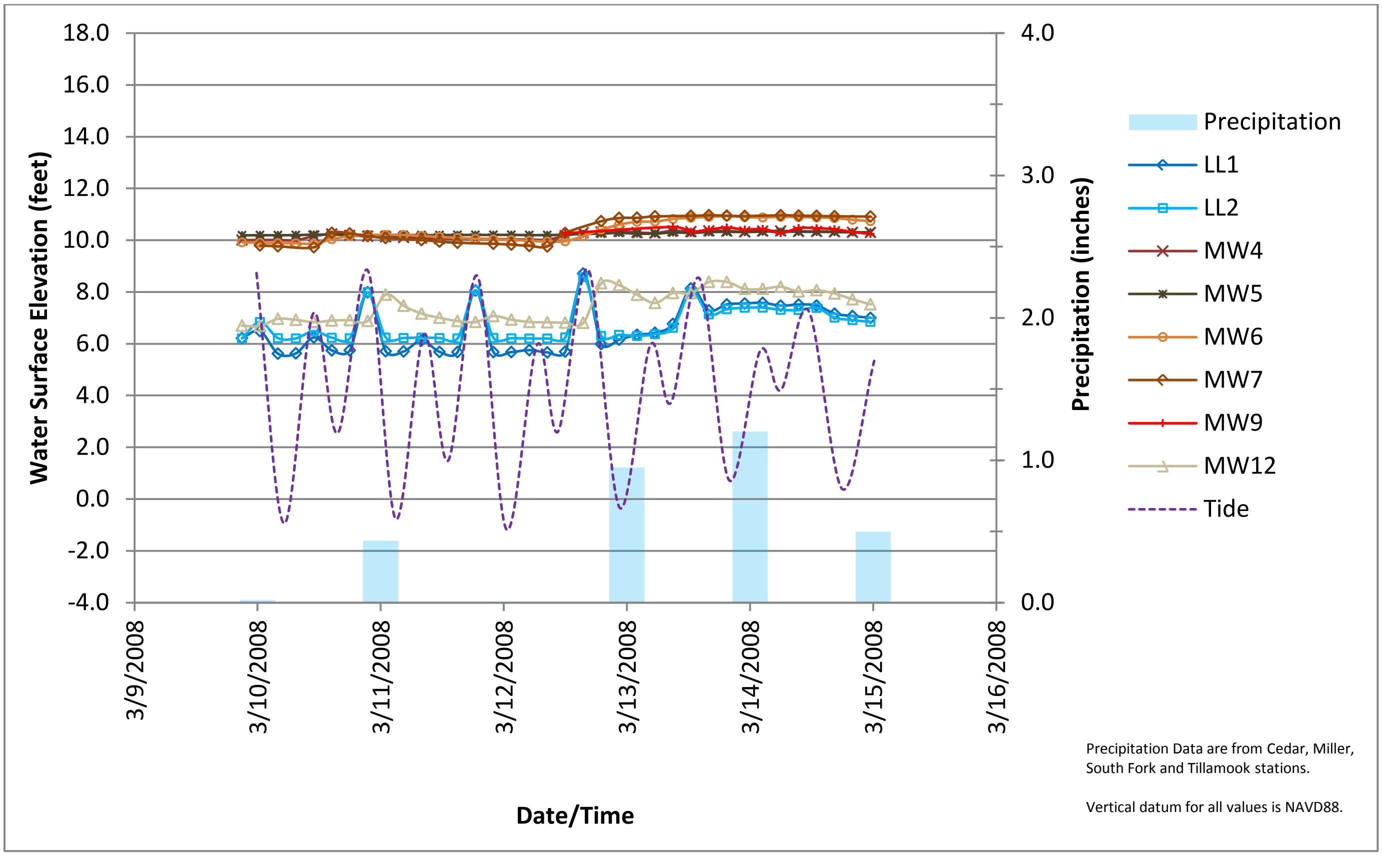
Several factors appear to influence water surface elevations at the site including ground surface elevation, proximity to the Hobson-Struby Channel, precipitation and tides. It appears that ground surface elevation continuously and steadily influenced water surface elevations across the site. On the other hand, tides and the Hobson-Struby channel only appeared to affect water levels at a few of the wells, and tidal influences are cyclical. Precipitation strongly influences water surface elevations at the site. It affected seasonal base water levels and episodically affected water surface elevations at all wells, sometimes dramatically (figures 15-18).

Mean water surface elevation was positively correlated to ground surface elevation during all seasons (Spring - $r^2 = 0.772$, $P_{\text{two-tailed}} = 0.004$; Summer - $r^2 = 0.731$, $P_{\text{two-tailed}} = 0.006$; Fall - $r^2 = 0.794$, $P_{\text{two-tailed}} = 0.003$; and Winter - $r^2 = 0.794$, $P_{\text{two-tailed}} = 0.003$). During all seasons, the highest mean water surface elevations were recorded at the five wells with ground surface elevations above 9.00 ft (figures 15-18, Table 3 - wells MW-4 through 7 and 9).

During most periods, it appears that proximity to the Hobson-Struby channel (which supported a series of beaver dams) strongly influenced mean water surface elevation among wells MW-4 through 7 and 9. Mean water surface elevations tended to be higher at the wells closest to the channel and lower at wells further removed (Table 3). For example, although MW-5 had the lowest ground surface elevation of these five wells; water surface elevations at this site were consistently among the highest recorded (figures 15-18, Table 3). This pattern makes sense considering the beaver dams that occurred along the Hobson-Struby channel (and in the nearby drainage channels) during these monitoring periods. These dams raised water levels in the channel(s) and, as a result, much of the northwest portion of the site was regularly inundated.

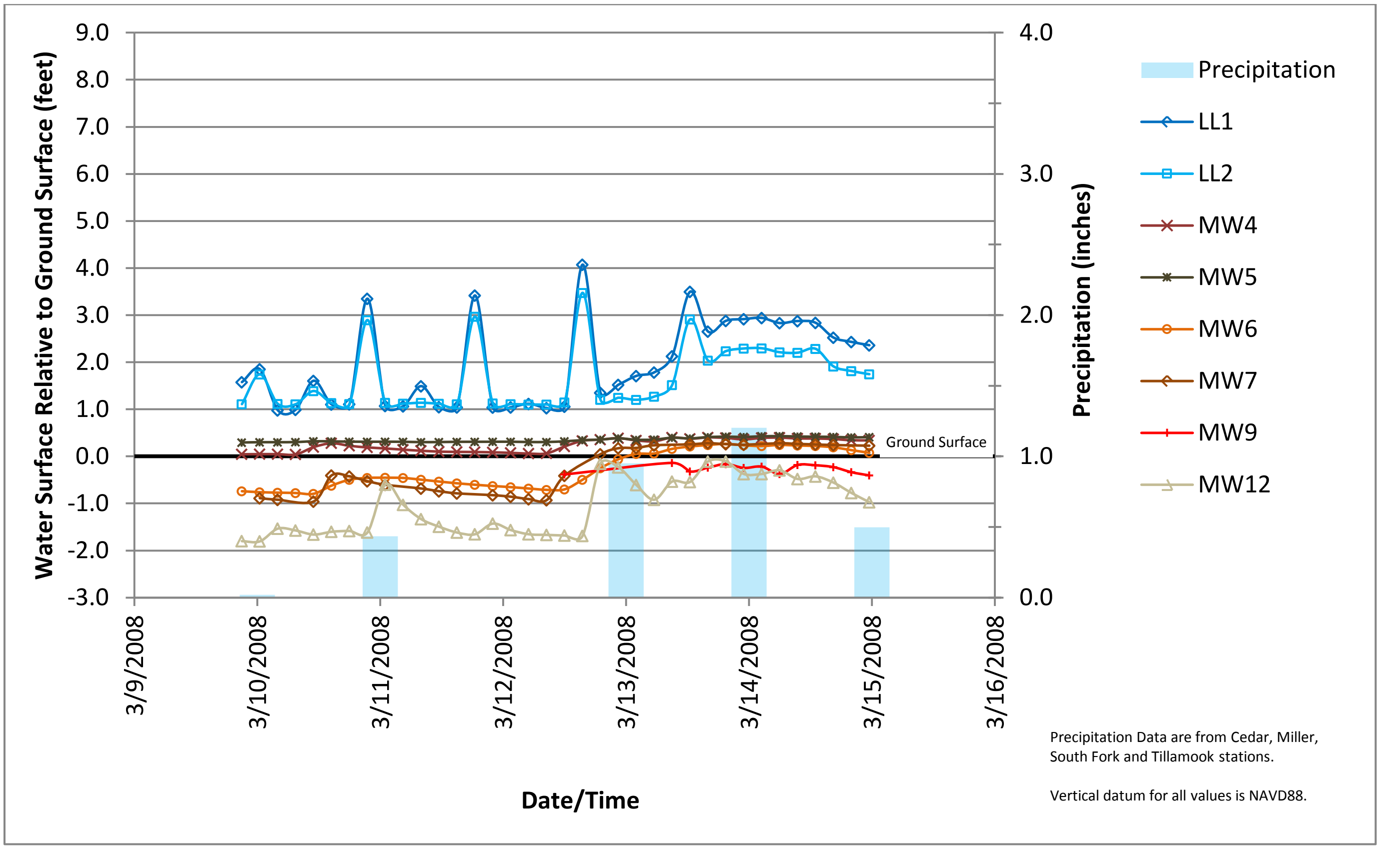
The lowest mean water surface elevations were recorded at the three stations with ground surface elevations below 8.5 ft asl (Table 3). Two of these wells were located in open water channels (LL-1 and LL-2) and one was located at a terrestrial site, all were located in close proximity to the mainstem Miami River channel. Ground surface elevation appears to be a strong influencing factor contributing to mean water surface elevations among these three sites (Table 3).

In general, water levels at wells MW-4 through 7 remained within a few inches of the ground surface during all seasons (lower graphs figures 15-18). During wet periods, water levels at these wells were above ground surface levels, but during dry periods water levels at many of these wells were a few inches subsurface. Water levels at wells MW-9 and MW-12 were often above ground surface levels during periods of high rainfall. However, during most seasons levels at these wells were generally subsurface, often between one and two feet below ground surface levels.



Precipitation Data are from Cedar, Miller, South Fork and Tillamook stations.

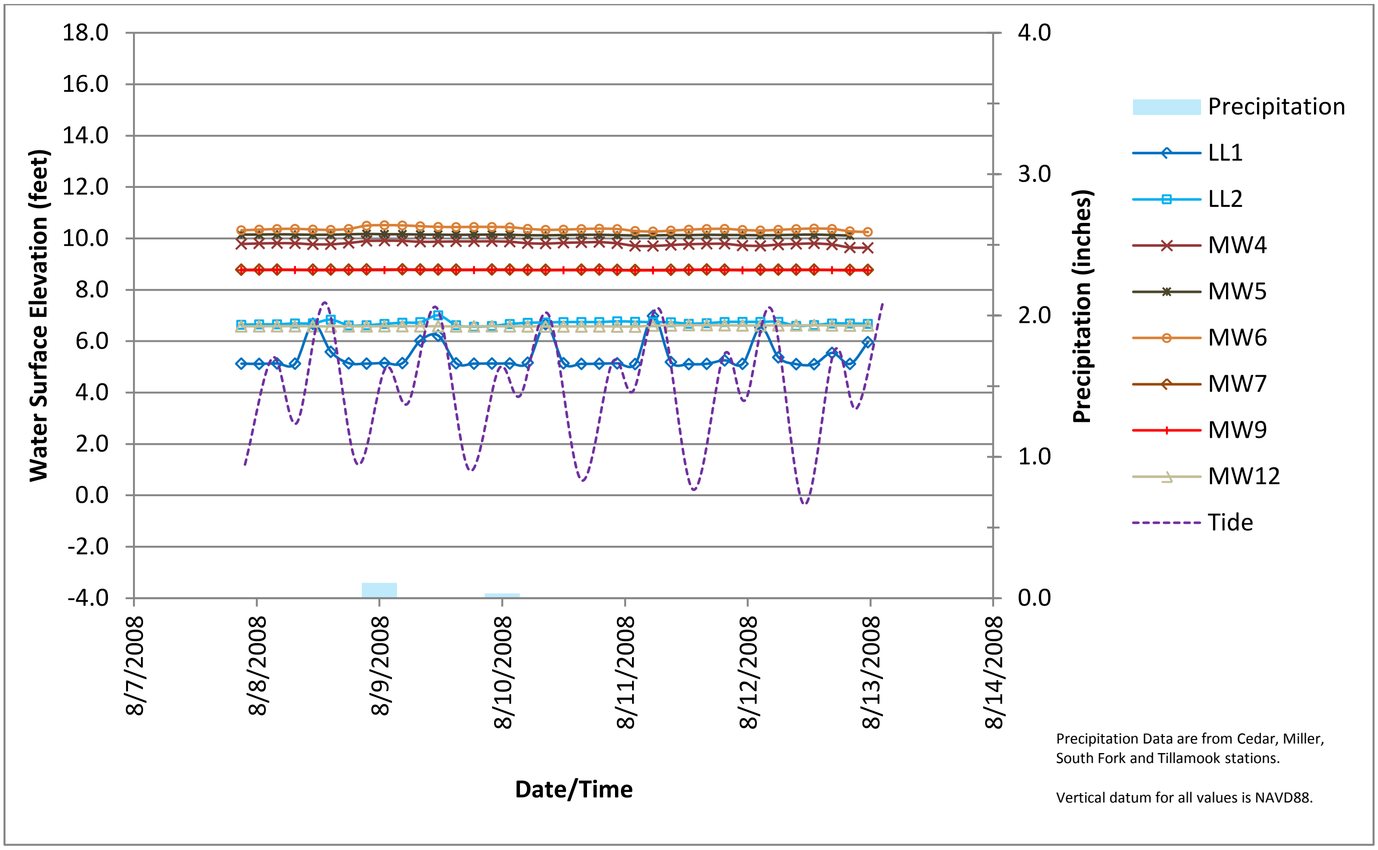
Vertical datum for all values is NAVD88.



Precipitation Data are from Cedar, Miller, South Fork and Tillamook stations.

Vertical datum for all values is NAVD88.

Figure 15. Water surface elevations at monitoring wells on the Miami Wetlands Project site during March 2008. Also included are tidal elevations at the Garibaldi Gage and mean precipitation from four north coast weather stations. Upper graph depicts water surface elevations for each well and lower graph depicts well water levels relative to ground surface elevation for each well.



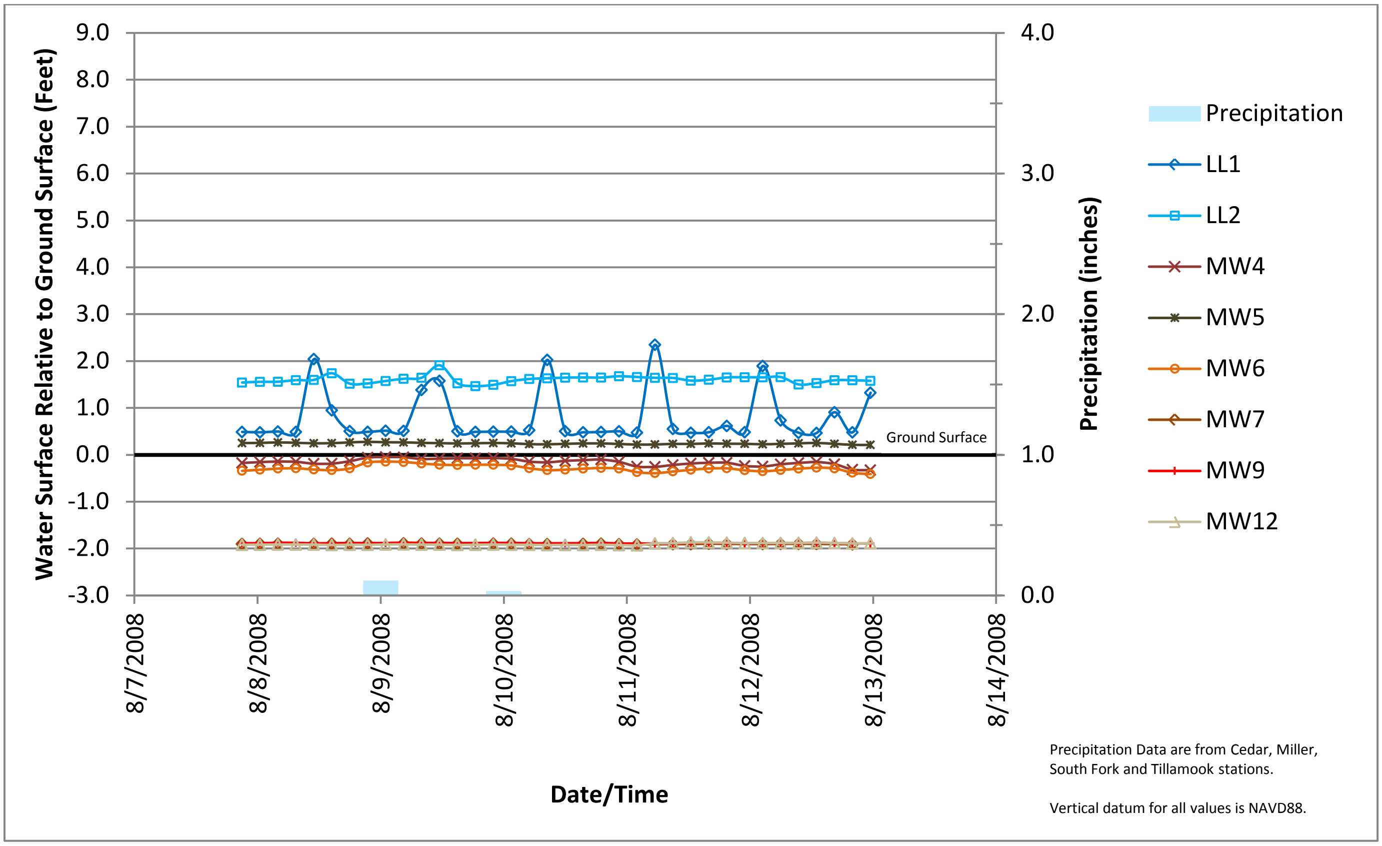
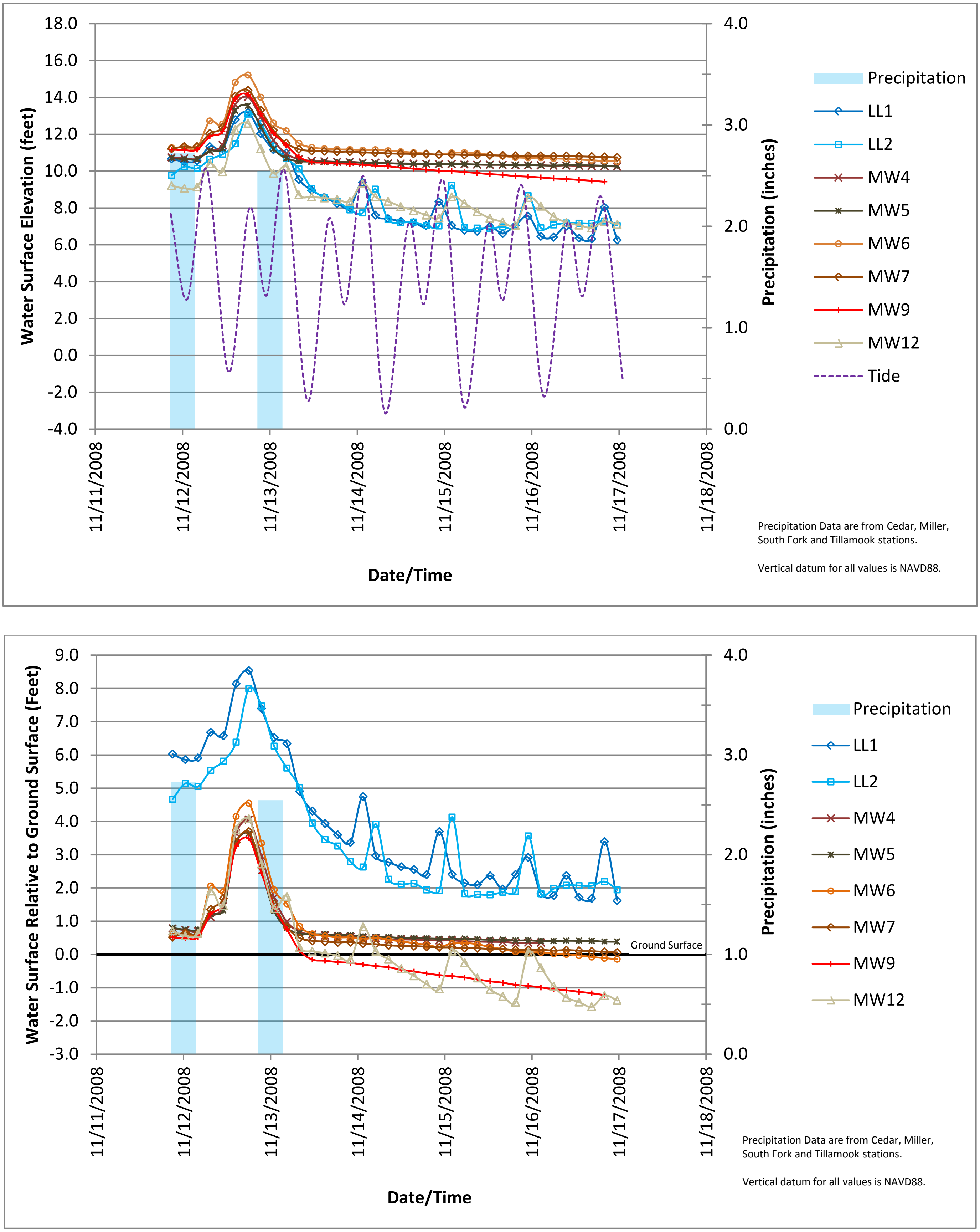


Figure 16. Water surface elevations at monitoring wells on the Miami Wetlands Project site during August 2008. Also included are tidal elevations at the Garibaldi Gage and mean precipitation for four north coast weather stations. Upper graph depicts water surface elevations for each well and lower graph depicts well water levels relative to ground surface elevation for each well.



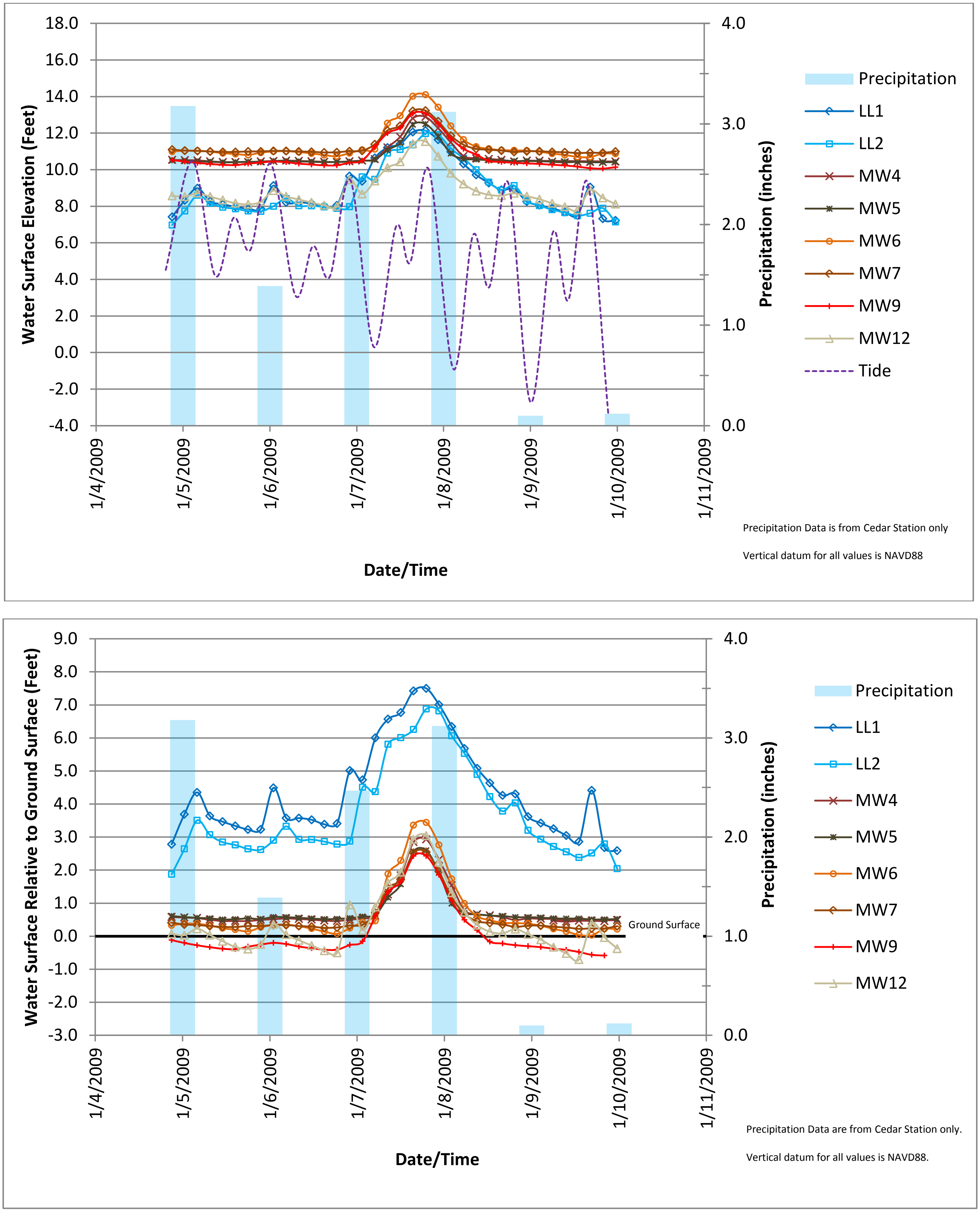
Precipitation Data are from Cedar, Miller, South Fork and Tillamook stations.

Vertical datum for all values is NAVD88.

Precipitation Data are from Cedar, Miller, South Fork and Tillamook stations.

Vertical datum for all values is NAVD88.

Figure 17. Water surface elevations at monitoring wells on the Miami Wetlands Project site during November 2008. Also included are tidal elevations at the Garibaldi Gage and mean precipitation for four north coast weather stations. Upper graph depicts water surface elevations for each well and lower graph depicts well water levels relative to ground surface elevation for each well.



Precipitation Data is from Cedar Station only

Vertical datum for all values is NAVD88

Precipitation Data are from Cedar Station only.

Vertical datum for all values is NAVD88.

Figure 18. Water surface elevations at monitoring wells on the Miami Wetlands Project site during January 2009. Also included are tidal elevations at the Garibaldi Gage and precipitation for one north coast weather station. Upper graph depicts water surface elevations for each well and lower graph depicts well water levels relative to ground surface elevation for each well.

Table 3. Mean seasonal water surface elevations for eight monitoring wells equipped with continuous data loggers at the Miami Wetlands Project Site.

	Seasonal Water Surface Elevation ($\overline{X}$ ± 1SE)			
Well ID*	**Spring 2008 (ft)**	**Summer 2008 (ft)**	**Fall 2008 (ft)**	**Winter 2008-09 (ft)**
MW-7	10.11 ± 0.03 N = 446	8.86± 0.003 N = 1323	10.18 ± 0.012 N = 4,320	10.41 ± 0.009 N = 4,224
MW-6	9.99 ± 0.019 N = 558	10.44 ± 0.009 N = 1,409	10.74 ± 0.007 N = 4,320	10.35 ± 0.009 N = 4,224
MW-9	9.10 ± 0.019 N = 558	8.77 ± 0.001 N = 1,410	9.16 ± 0.01 N = 4,320	9.30 ± 0.012 N = 4,224
MW-5	10.33 ± 0.002 N = 558	10.07 ± 0.002 N = 1409	10.18 ± 0.004 N = 4,320	10.31 ± 0.003 N = 4,224
MW-4	10.20 ± 0.004 N = 558	9.75 ± 0.004 N = 1,409	10.18 ± 0.005 N = 4,320	10.28 ± 0.004 N = 4,224
MW-12	6.88 ± 0.019 N = 558	6.71 ± 0.008 N = 1,409	7.05 ± 0.011 N = 4,320	7.23 ± 0.013 N = 4,224
LL-2	6.80 ± 0.003 N = 8,928	6.73 ± 0.005 N = 9,025	6.81 ± 0.009 N = 8,640	6.99 ± 0.011 N = 8,448
LL-1	6.20 ± 0.006 N = 8,928	5.70 ± 0.008 N = 9,025	6.31 ± 0.012 N = 8,640	6.63 ± 0.014 N = 8,448
Seasonal Means	8.70.20 ± 0.625	8.38 ± 0.628	8.83 ± 0.638	8.94 ± 0.598

*Listed in order from highest to lowest ground surface elevation. Ground surface elevations at stations MW-4 – 7 and MW-9 range from 9.90 to 10.69 ft asl. Ground surface elevations at LL-1, LL-2 and MW-12 are <8.5 ft asl. Spring = Mar. 20-June 20, Summer = June 21-Sept. 22, Fall = Sept. 23-Dec. 21, Winter = Dec. 22-Mar 19.

Tides did not appear to measurably affect water levels over most of the site (figures 15-18). In fact, the only wells where tidal influences were apparent were the lower elevation wells in or adjacent to the mainstem Miami River (MW-12, LL-1 and LL-2). During all seasons and under most circumstances, water levels near the mouth of the Miami River (LL-1) were affected by tidal waters. Under most circumstances, high tides greater than 6.0 ft resulted in a marked increase in water surface elevation at this well site. Conversely, low tides (even minus tides) did not appear to result in a marked decrease in water surface elevations below seasonal base flow levels. Well LL-2 exhibited a similar pattern to LL-1. However, during summer when base water surface elevations in the river were below six feet, the magnitude of the effects of high tides on LL-2 were muted (Figure 16). This was likely a result of the beaver dam that separated the channel in which LL-2 was located from the mainstem Miami River. The dam undoubtedly influenced water elevation in this side channel and moderated the influence of "downstream" effects such as tidal waters. Well MW-12, located in close proximity to the Miami River mainstem and the lower tidal channel (see Figure 9), was the only "terrestrial well" that appeared to be affected by tidal waters. Tidal influences become apparent at this well during periods when water surface elevations in the river were near or above eight feet (figures 15, 17 and 18). During periods when river base flows were low, no tidal influence was apparent at this well site (Figure 16). Tides did not appear to influence water levels at the other "terrestrial wells" (i.e., MW-4 through 7 and MW-9). During periods of abundant rainfall, tidal influences at LL-1, LL-2 and MW-12 were most often overshadowed by the effects of stormwater (figures 15, 17, and 18).

Precipitation appears to be the most influential external variable affecting water levels at the site. Unlike tidal influences, precipitation affected water levels across the site. It had a marked effect on base water levels and, during heavy precipitation events, dramatically increased water levels across the entire site (figures 15-18). During periods of regular rainfall (spring, fall and winter) base water surface elevations were typically higher than during summer when rainfall was less abundant (figures 15-18, Table 3). During storm events that resulted in moderate amounts of precipitation (i.e., approximately one inch of rainfall during two or more consecutive days), marked increases in water surface elevations were noted (Figure 15). However, during these events water surface elevations still reflected ground surface elevations at the wells (i.e., water levels at lower elevation well sites remained substantially lower than water levels at higher elevation wells). During storm events that resulted in enough precipitation to trigger flooding, water levels increased dramatically across the site. During these events water levels at lower elevation wells typically approached levels at the higher elevation wells (figures 17 and 18). The effects of such events were typically short-lived and water levels quickly returned to base levels.

We used a One-Way ANOVA for Correlated Samples (http://faculty.vassar.edu/lowry/webtext.html - Chapter 15) to evaluate the Null Hypothesis (H_o) that mean water surface elevation at the Miami Wetlands site (Table 3) did not differ seasonally. We also used Tukey's HSD (Honestly Significant Difference) Test to evaluate pairwise comparisons among seasonal mean water surface elevations. Based on these tests, there was significant seasonal variation in mean water surface elevation at the site ($F = 7.27$, $df = 3$, $P = 0.002$), but levels were similar during most seasons. Specifically, mean elevations during spring 2008 were not significantly different from summer 2008, fall 2008, and winter 2008-9 levels. Likewise, fall and winter 2008-9 levels did not differ significantly from one another. However, mean water surface elevations during summer 2008 were significantly lower than elevations recorded during Fall and Winter 2008-9 ($P < 0.05$ and $P < 0.01$, respectively).

Data from the manually-sampled wells was extremely limited as compared to the logger data discussed above. Regardless, data from these wells tends to reflect the results from the logger data presented above: wells at higher ground surface elevations and closest to the Hobson-Struby Channel and drainage channels typically had the highest water surface elevations, while those at lower elevations typically had lower water surface elevations (Table 4). Similar seasonal differences in water surface elevations also are evident in this data set (Table 4). It was not possible to evaluate the effects of tides and precipitation events with this data set.

3.1.2. Water Quality Monitoring

This section reports baseline water quality data collected at the site and discusses the influence of tides, precipitation, temperature and other factors on these variables. We report water quality temperature data from eight monitoring wells distributed across the project site equipped with continuous data loggers (Figure 8, Table 1). As discussed above, wells varied with respect to the ambient conditions in which they existed. Wells LL-1 and LL-2 were located in areas with perennial open water: LL-1 was located in the mainstem Miami River channel and LL-2 sampled the side channel on the southern portion of the site (upstream of a beaver dam that separated this channel from the mainstem). The remaining wells were located at terrestrial sites and primarily monitored groundwater temperatures (although some sampled portions of the site that were regularly inundated). We also report results of point-in-time field sampling and logger data for dissolved oxygen and conductivity. Point-in-time field sampling was sporadic and loggers for these variables were not acquired and installed until 2010. As a result only limited data is available from these sources.

Table 4. Mean seasonal water surface elevations for six monitoring wells not equipped with continuous data loggers at the Miami Wetlands Project Site.

	Seasonal Water Surface Elevation ($\overline{X}$ ± 1SE)			
Well ID*	**Mar-Jun 2008 (ft)**	**Jul-Sep 2008, 09 and 10 (ft)**	**Sep-Nov 2008 (ft)**	**Dec-Feb 2008, 09 and 10 (ft)**
MW-8	10.01 ± 0.24 N = 8	9.37 ± 0.12 N = 5	10.10 ± 0.36 N = 3	10.57 ± 0.33 N = 3
MW-3	10.61 ± 0.03 N = 8	10.27 ± 0.06 N = 9	10.39 ± 0.08 N = 4	10.33 ± 0.21 N = 3
MW-2	10.63 ± 0.07 N = 8	10.45 ± 0.03 N = 9	10.57 ± 0.06 N = 5	10.30 ± 0.33 N = 3
MW-10	9.08 ± 0.30 N = 8	7.98 ± 0.21 N = 6	9.42 ± 0.22 N = 4	9.76 ± 0.08 N= 3
MW-11	8.24 ± 0.27 N = 8	8.13 ± 0.62 N = 6	8.50 ± 0.46 N = 4	8.94 ± 0.09 N = 3
MW-1	8.05 ± 0.24 N = 8	7.57 ± 0.19 N = 8	8.34 ± 0.12 N = 5	8.49 ± 0.02 N = 2

*Listed in order from highest to lowest ground surface elevation. Ground surface elevations at stations MW-2, 3, 8, 10, and 11 ranged from 9.11 to 11.27 ft asl. Ground surface elevation at MW-1 was 8.55 ft asl.

3.1.2.1. Water Temperature - Water temperature in streams and other aquatic environments is affected by numerous factors including air temperature, solar angle, stream configuration and channel morphology, stream origin, velocity, vegetation types and coverage, land-use, percentage of impervious area, and others. Typically there are multiple factors influencing water temperature at a given site (including both on-site and off-site influences) and it is difficult to isolate these influences and identify the extent to which individual factors affect observed temperatures.

Several factors likely influenced water temperatures at the Miami Wetlands site including air temperature, precipitation, tides, vegetation coverage, upstream conditions, and others. Many of these individual factors are not independent of one another. For example, the temperature of precipitation is influenced by ambient air temperature, and air temperature in coastal areas is correlated with ocean temperature. In addition, we lack sufficient data from external sources that likely affect water temperatures at the site. For example, we have very limited water temperature data from Tillamook Bay and from upstream in the Miami River and Hobson and Struby creeks. These data would be needed to better understand the influences that tide water and fresh water flowing onto the site have on on-site water temperatures. Given the above, we limit our analyses on pre-construction water temperature data collected at the site to seasonal comparisons and how these relate to regulatory standards and salmonid habitat requirements. We also discuss the possible effects of selected external influences.

We used a One-Way ANOVA for Correlated Samples to evaluate the Null Hypothesis that mean water temperature at the Miami Wetlands site did not differ seasonally. We also used Tukey's HSD Test to evaluate pairwise comparisons among seasonal mean water temperatures. Based on these tests, there was significant seasonal variation in mean water temperature at the site during the 2008-2009 sampling period (F = 162.6, df = 3, $P < 0.0001$). In fact, all pairwise comparisons differed significantly from one another. Mean water temperature during Spring 2008 was significantly lower ($P < 0.01$) than Summer and Fall, 2008 and significantly higher ($P < 0.01$) than Winter 2008-9 (Table 5). Mean water temperature during Summer 2008 was significantly higher than both Fall and Winter temperatures ($P < 0.01$). Mean water temperature during Fall 2008 was significantly higher ($P < 0.01$) than Winter, 2008-9 (Table 5).

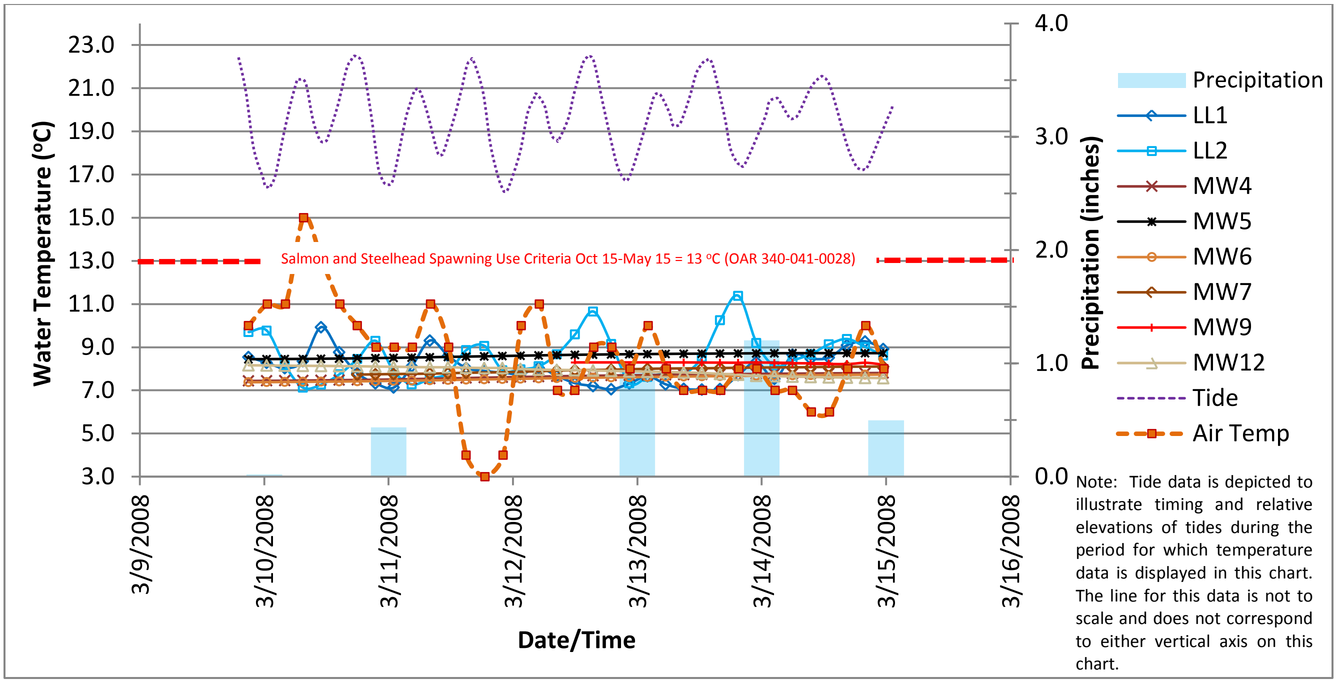
Table 5. Mean seasonal water temperatures for eight monitoring wells equipped with continuous data loggers at the Miami Wetlands Project Site.

	Seasonal Mean Water Temperature ($\bar{X}$ ± 1SE)			
Well ID	**Spring 2008 (°C)**	**Summer 2008 (°C)**	**Fall 2008 (°C)**	**Winter 2008-09 (°C)**
LL-1	9.1 ± 0.02 N = 8,928	13.0 ± 0.02 N = 9,025	9.7 ± 0.01 N = 8,640	7.2 ± 0.01 N = 8,448
LL-2	10.49 ± 0.02 N = 8,928	13.98 ± 0.01 N = 9,025	9.8 ± 0.02 N = 8,640	6.8 ± 0.01 N = 8,448
MW-4	9.2 ± 0.06 N = 558	13.0 ± 0.01 N = 1,409	10.05 ± 0.02 N = 4,320	6.7 ± 0.01 N = 4,224
MW-5	9.2 ± 0.04 N = 558	12.2 ± 0.02 N = 1,409	10.2 ± 0.02 N = 4,320	8.0 ± 0.01 N = 4,224
MW-6	8.8 ± 0.05 N = 558	12.5 ± 0.01 N = 1,409	10.3 ± 0.02 N = 4,320	6.8 ± 0.01 N = 4,224
MW-7	9.8 ± 0.07 N = 446	13.9 ± 0.01 N = 1,323	11.3 ± 0.03 N = 4,320	7.0 ± 0.01 N = 4,224
MW-9	10.0 ± 0.07 N = 558	14.4 ± 0.02 N = 1,410	11.8 ± 0.03 N = 4,320	7.3 ± 0.01 N = 4,224
MW-12	9.6 ± 0.06 N = 558	14.1 ± 0.02 N = 1,409	11.5 ± 0.03 N = 4,320	6.8 ± 0.01 N = 4,224
Seasonal Means	**9.5 ± 0.19**	**13.4 ± 0.29**	**10.7 ± 0.28**	**7.1 ± 0.16**

Spring = Mar. 20-June 20, Summer = June 21-Sept. 22, Fall = Sept. 23-Dec. 21, Winter = Dec. 22-Mar 19

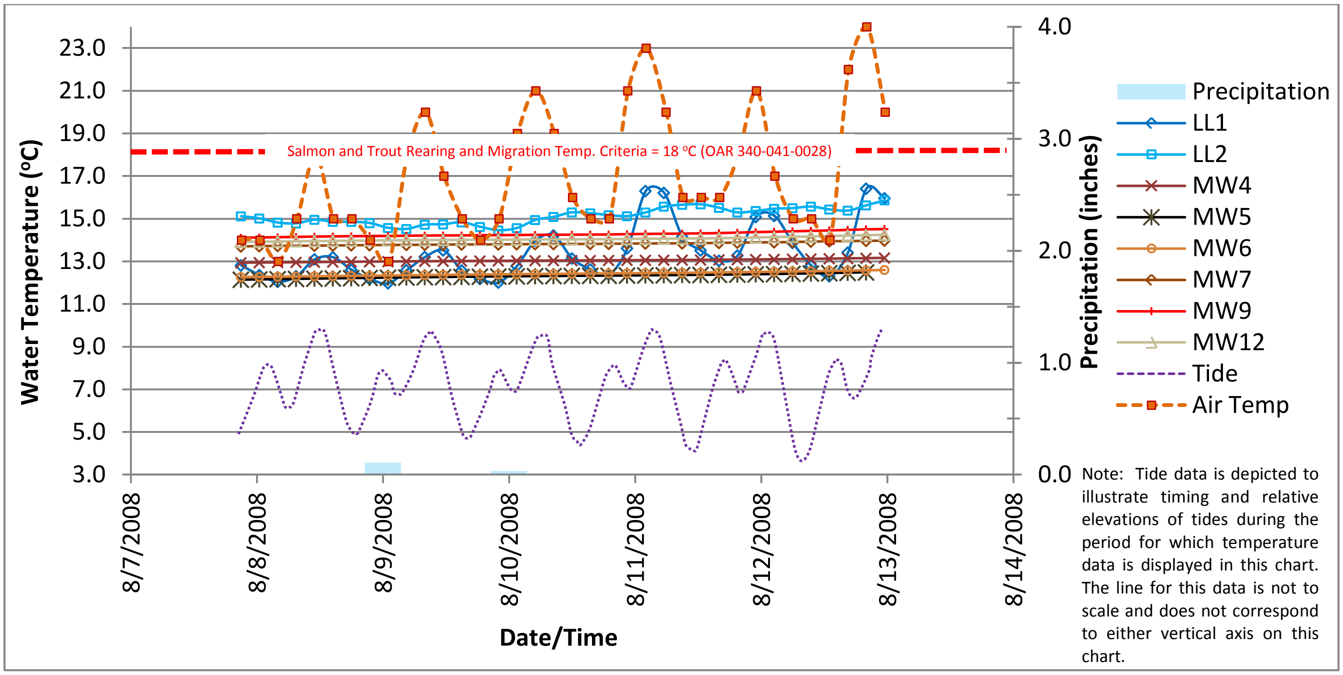
During most seasons, water temperatures at the wells monitoring surface water in open channels (LL-1 and LL-2) fluctuated markedly over the course of each 24 hour period (figures 19-22). The magnitude and timing of this fluctuation often varied between these two stations (and among seasons), and there were periods where this pattern was not apparent. Unlike surface water temperatures, ground water temperatures monitored at wells MW-4 through 7, 9 and 12 fluctuated very little during the periods depicted in Figures 19-22. In fact, over the course of most of these five day periods, water temperatures at these wells remained essentially static.

Ambient air temperature appeared to substantially influence water temperatures at the Miami Wetlands site, but it seemed to affect surface water differently than ground water. Daily fluctuations in water temperature at wells LL-1 and LL-2 (surface water wells) were positively correlated with ambient air temperatures recorded at the Tillamook Airport over the periods



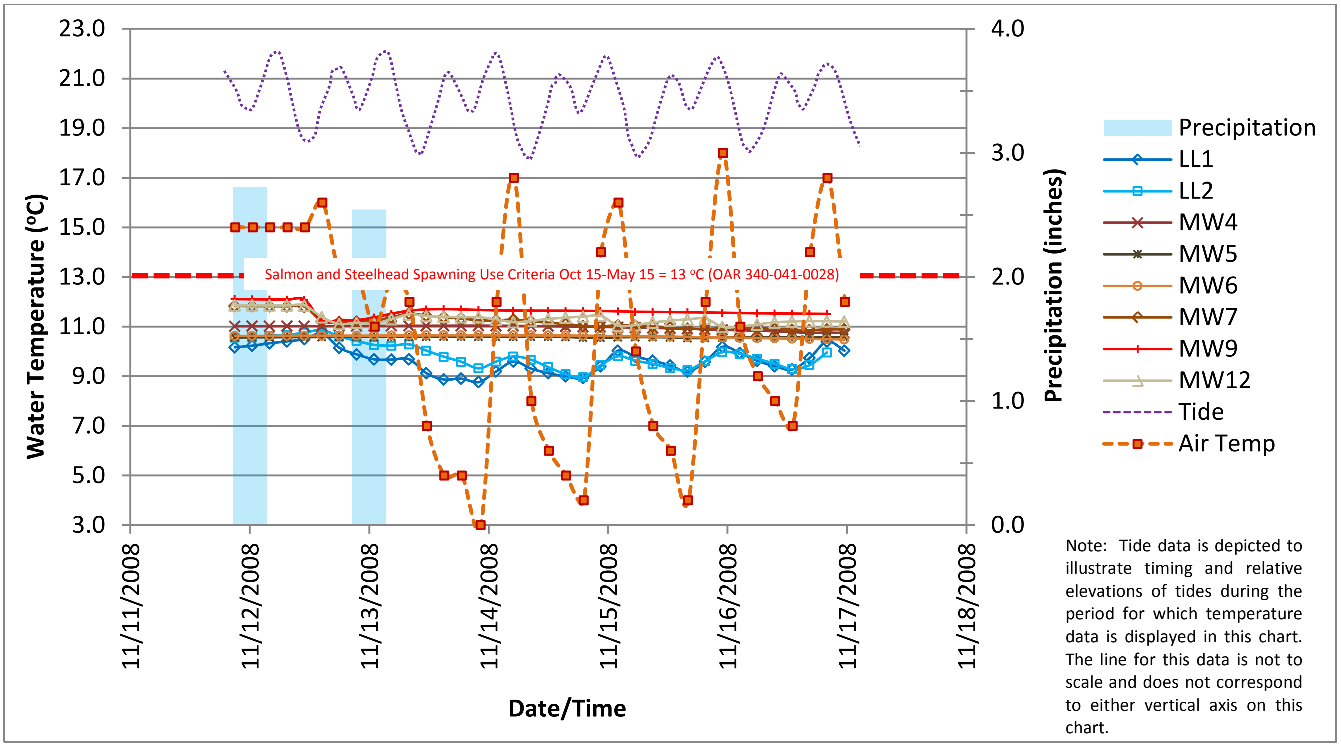
Note: Tide data is depicted to illustrate timing and relative elevations of tides during the period for which temperature data is displayed in this chart. The line for this data is not to scale and does not correspond to either vertical axis on this chart.

Figure 19. Water temperatures at monitoring wells on the Miami Wetlands Project site during March 2008. Also included are tidal elevations at the Garibaldi Gage, mean precipitation for four north coast weather stations, and ambient air temperature at the Tillamook Airport weather station.



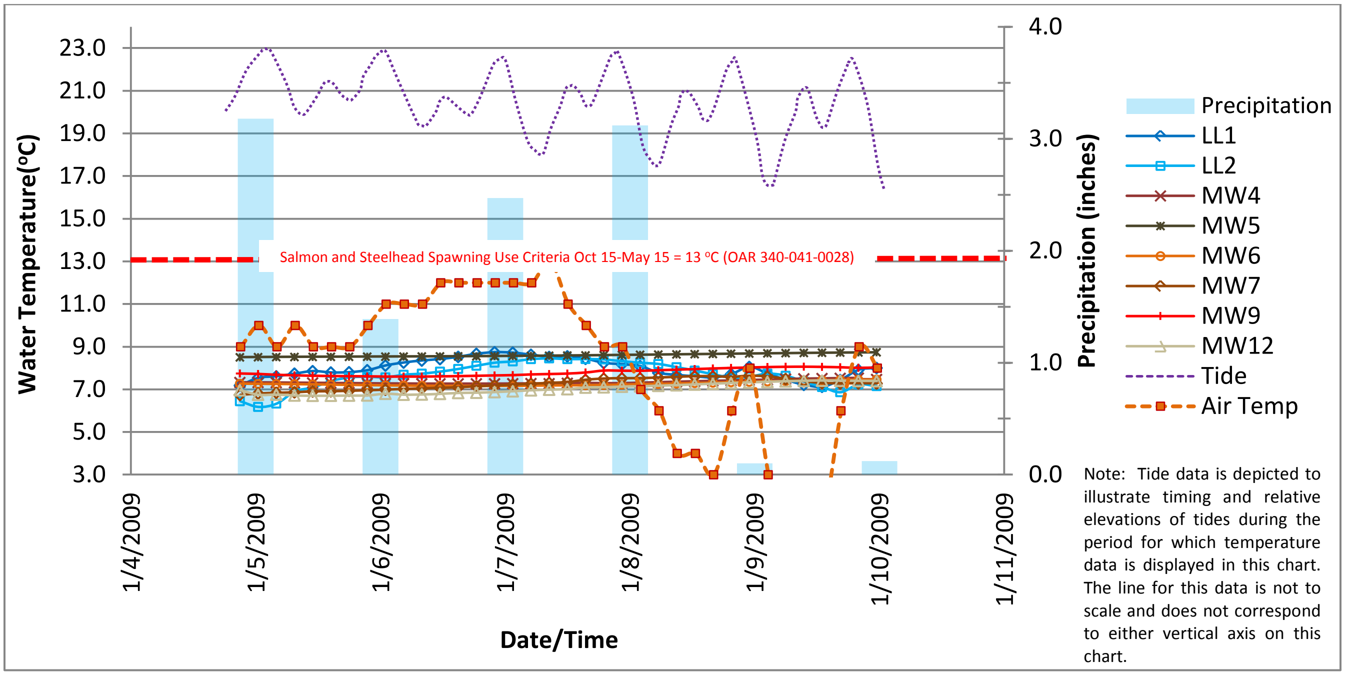
Note: Tide data is depicted to illustrate timing and relative elevations of tides during the period for which temperature data is displayed in this chart. The line for this data is not to scale and does not correspond to either vertical axis on this chart.

Figure 20. Water temperatures at monitoring wells on the Miami Wetlands Project site during August 2008. Also included are tidal elevations at the Garibaldi Gage, mean precipitation for four north coast weather stations, and ambient air temperature at the Tillamook Airport weather station.



Note: Tide data is depicted to illustrate timing and relative elevations of tides during the period for which temperature data is displayed in this chart. The line for this data is not to scale and does not correspond to either vertical axis on this chart.

Figure 21. Water temperatures at monitoring wells on the Miami Wetlands Project site during November 2008. Also included are tidal elevations at the Garibaldi Gage, mean precipitation for four north coast weather stations, and ambient air temperature at the Tillamook Airport weather station.



Note: Tide data is depicted to illustrate timing and relative elevations of tides during the period for which temperature data is displayed in this chart. The line for this data is not to scale and does not correspond to either vertical axis on this chart.

Figure 22. Water temperatures at monitoring wells on the Miami Wetlands Project site during January 2009. Also included are tidal elevations at the Garibaldi Gage, precipitation for one north coast weather station, and ambient air temperature at the Tillamook Airport weather station.

depicted in figures 19-22 (Table 6) and water temperature fluctuations at these stations often mirrored the daily rise and fall of ambient air temperatures (figures 19-22). Approximately 70 percent of the variability in observed water temperatures at well LL-1 can be explained by variations in ambient air temperature, but only approximately 56 percent of the variability at LL-2 can be explained by this factor (Table 6). Other factors potentially accounting for the remaining temperature variability at these wells include tidal flows, groundwater inputs (including hyporheic exchange), precipitation, solar radiation, and others.

Table 6. Results of linear correlation analysis for ambient air temperatures and water temperatures at the Miami Wetlands Project site. Data are the combined data sets used to generate figures 19-22.

Well ID	r^2	P value ($_{\text{two-tailed}}$)
LL-1	0.703	<0.0001
LL-2	0.564	<0.0001
MW-4	0.452	<0.0001
MW-5	0.480	<0.0001
MW-6	0.448	<0.0001
MW-7	0.437	<0.0001
MW-9	0.480	<0.0001
MW-12	0.452	<0.0001

Well LL-1 sampled the mainstem Miami River and was located in a heavily shaded area adjacent to the river's south bank. The river flowed freely through the area, although flows were restricted somewhat during incoming tides. Well LL-2 sampled a slow-moving side channel. Flows through this channel were restricted by beaver activities and vegetation and there was no tree canopy to shade most of the channel (including at the well site which had full solar exposure). The degree to which these other factors affected water temperatures at these well undoubtedly varies. For example, solar radiation likely had a much greater influence on temperatures at LL-2 than at LL-1 because of vast differences in canopy cover at the two well sites. Similarly, tidal water likely affected LL-1 much more than LL-2 because a beaver dam impeded tidal flows into the channel where LL-2 was located.

Although daily fluctuations in water temperature were not noted for wells sampling ground water (figures 19-22), there was still a significant positive correlation between ambient air temperatures and water temperatures at these wells (Table 6). However, less than half of the variability in water temperatures at these wells could be attributed to variations in ambient air temperatures (Table 6). Many other factors likely contributed to the remaining variability in temperatures recorded at these wells. These include, but are not limited to, soil temperature, soil type, precipitation, vegetative cover, groundwater flow patterns, and solar radiation. Many of these factors are correlated with one another and we lack data to evaluate the influence that these other factors may have had on ground water temperatures at the site. However, soil temperatures in the upper few feet of soil are correlated with ambient air temperatures and, as depicted in figures 19-22, the range of water temperatures at ground water wells varied from season to season. Ambient air temperatures during these same periods often fluctuated over wide ranges and there was considerable seasonal overlap of maximum and minimum daily temperatures (figures 19-22). However, average daily ambient air temperatures at this same weather station varied significantly among seasons (ANOVA – F = 116.74, df = 3, P <0.0001). Pairwise comparisons using Tukey's HSD indicate that: average daily air temperatures during Spring 2008 (8.9 ± 0.62 °C) were significantly lower ($P < 0.01$) than Summer 2008 (14.5 ± 0.62 °C) and significantly higher ($P < 0.01$) than Winter 2008-9 (5.8 ± 0.54 °C); average daily air temperatures during Summer 2008 were significantly higher ($P < 0.01$) than both Fall 2008 (9.1 ± 0.66 °C) and Winter 2008-9; and average daily temperatures during Fall 2008 were significantly higher than during Winter 2008-9. Average daily ambient air temperatures during Spring 2008 and Fall 2008 did not differ significantly. Given these facts, it appears that the seasonal variation in ground water temperatures observed in Figures 19-22 can be explained, in part, by seasonal variation in average daily ambient air temperatures.

One important finding with respect to water temperatures at the Miami Wetlands site is the relationship of observed temperatures to State of Oregon water quality standards (ODEQ 2007). Specifically, those standards related to water temperature and its effects on the biological cycles of salmonids. The purpose of these standards is to protect designated temperature-sensitive, beneficial uses, including specific salmonid life cycle stages in waters of the State. Two standards are applicable to the Miami River basin: 1) Salmon and Trout Rearing and Migration Temperature Criteria, and 2) Salmon and Steelhead Spawning Use Criteria. The rearing and migration criterion is a year-round standard, but it is superseded by the spawning use criterion from Oct 15-May 15. Under these standards, the seven day running average for water temperature in a stream cannot exceed 18 °C for rearing and migration and 13 °C for spawning. Based on our data from 2008-2010, water temperatures at the Miami Wetlands site (including in the lower mainstem Miami River) did not exceed these temperature standards.

3.1.2.2. Conductivity – We measured conductivity with data loggers during two approximately 10-day periods late in the data collection process for this report. The first period was during construction, but before newly created channels had been connected and stream flows rerouted. The second period was during the winter of 2010, after much of the construction work had been completed (new channels had been connected and stream flows rerouted). Data loggers were placed at the same two stations during both sampling periods: one was located in the extreme lower portion of the existing Hobson-Struby channel and the other at the extreme lower end of the existing tidal channels (Figure 10 – stations L-1 [lower Hobson-struby channel] and L-2 [lower tidal channel]). We also measured specific conductance using a handheld meter several times weekly for an approximately six-week period during summer 2009 (Figure 10 – stations M-1 through M-3), during a single outing in February 2010, and during collection of macroinvertebrate samples in May 2010 (Figure 10 – stations P-1 through P-10).

Specific conductance at stations M-1 through M-3 and P-1 through P-10 (Figure 10) measured using a handheld meter during July and August 2009 ranged from 86 – 20,700 µS/cm (Fresh to Mesohaline – see Table 2). Several measurements taken at station M-1 (at the mouth of Hobson-Struby channel) were at levels well above the upper limit for fresh water. Most measurements exceeding freshwater levels at this station were taken on incoming tides and within a few hours of high tide events. All conductivity measurements at stations M-2 and M-3 were well below the upper limit for fresh water (800 µS/cm).

Specific conductance at stations P-1 through P-10 (Figure 10) measured using a handheld meter during February and May 2010 ranged from approximately 65 - 345 µS/cm, all well below the upper limit for fresh water (800 µS/cm). These measurements were taken at stations distributed throughout the portion of the project site north of the Miami River, but did not include the extreme lower portions of the Hobson-Struby or tidal channels.

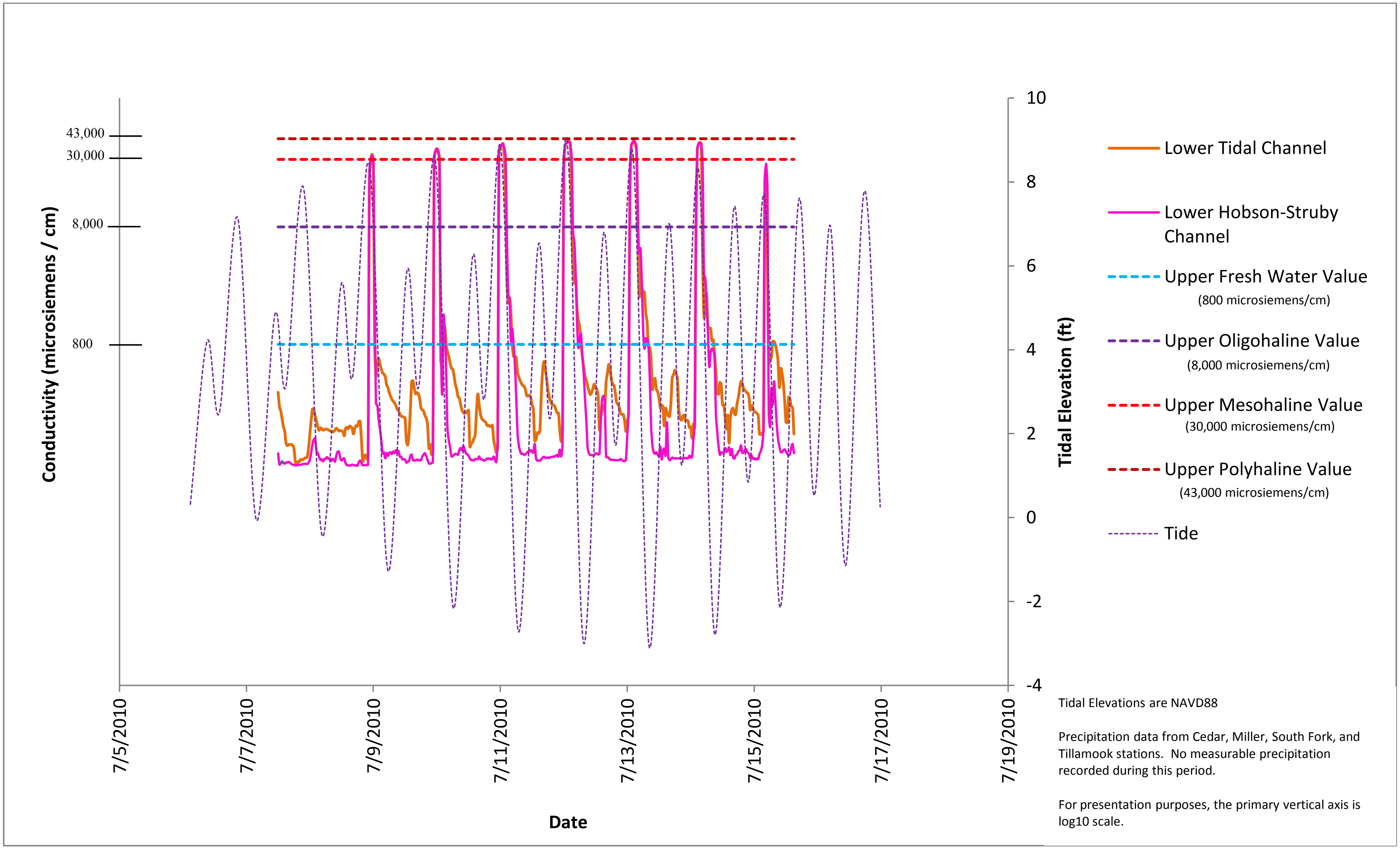
Specific conductance at stations L-1 and L-2 (Figure 10) measured using conductivity data loggers ranged from approximately 74 - 43,000 µS/cm (Fresh to Polyhaline) during July 2010 and from approximately 44 – 27,000 µS/cm (Fresh to Mesohaline) during December 2010 (figures 23 and 24). As noted above, these stations were at the extreme downstream ends of the Miami Wetlands channels, very near their confluence with the lower mainstem Miami River.

Prior to restoration actions at the Miami Wetlands site, it appears that freshwater filled the channels and covered inundated areas under most circumstances. However, on occasion, saline water from Tillamook Bay penetrated at least the lower portions of both the tidal and Hobson-Struby channels and may have flooded adjacent lands in the vicinity (figures 23 and 24). Based on our data, it appears that saline waters only entered the site when tides exceeded eight feet asl (NAVD88) during extended periods with little or no precipitation (figures 23 and 24). During these periods, specific conductance within both the lower tidal and lower Hobson-Struby channels peaked at levels near the upper limits for brackish water. It is interesting to note that even during traditionally wet periods (e.g., winter) a “dry spell” of only five days apparently reduced freshwater flows enough that saline water could inundate the lower portions of the channels during high tide events (Figure 24).

During periods when rainfall was plentiful, it appears that freshwater flows were sufficient to preclude inundation by saline water, even during high tides of nearly 10 ft asl (Figure 24). During these wet periods, salinity in the channels remained well below the upper limit for freshwater.

It is interesting to note that during the July 2010 sampling period, water in the lower tidal channel remained slightly more saline than water in the lower Hobson-Struby channel during periods between 8+ ft tides (Figure 23). In contrast, specific conductivity at both stations were nearly identical during the December 2010 sampling period (Figure 24). This phenomenon can likely be attributed to the fact that the Hobson-Struby channel had not yet been rerouted into its new channel in July and, therefore, was still conveying the combined freshwater flows of both of these streams. This flow apparently displaced tidal water in the lower channel at a faster rate than it was displaced from the tidal channel, which was limited to passive draining and mixing of tide water and freshwater at this time. The December sampling period occurred after the Hobson-Struby flows had been redirected. The Hobson-Struby flows were redirected such that they were flowing into the tidal channel upstream of both the L-1 and L-2 sampling stations and were able to mix with any incoming saline water well above both logger stations.

3.1.2.3. Dissolved Oxygen - We measured dissolved oxygen concentrations with data loggers during two approximately two week periods late in the data collection process for this report. The first period was during construction, but before newly created channels had been connected and stream flows rerouted. The second period was during the winter of 2010-11, after much of the construction work had been completed (new channels had been connected and stream flows rerouted).

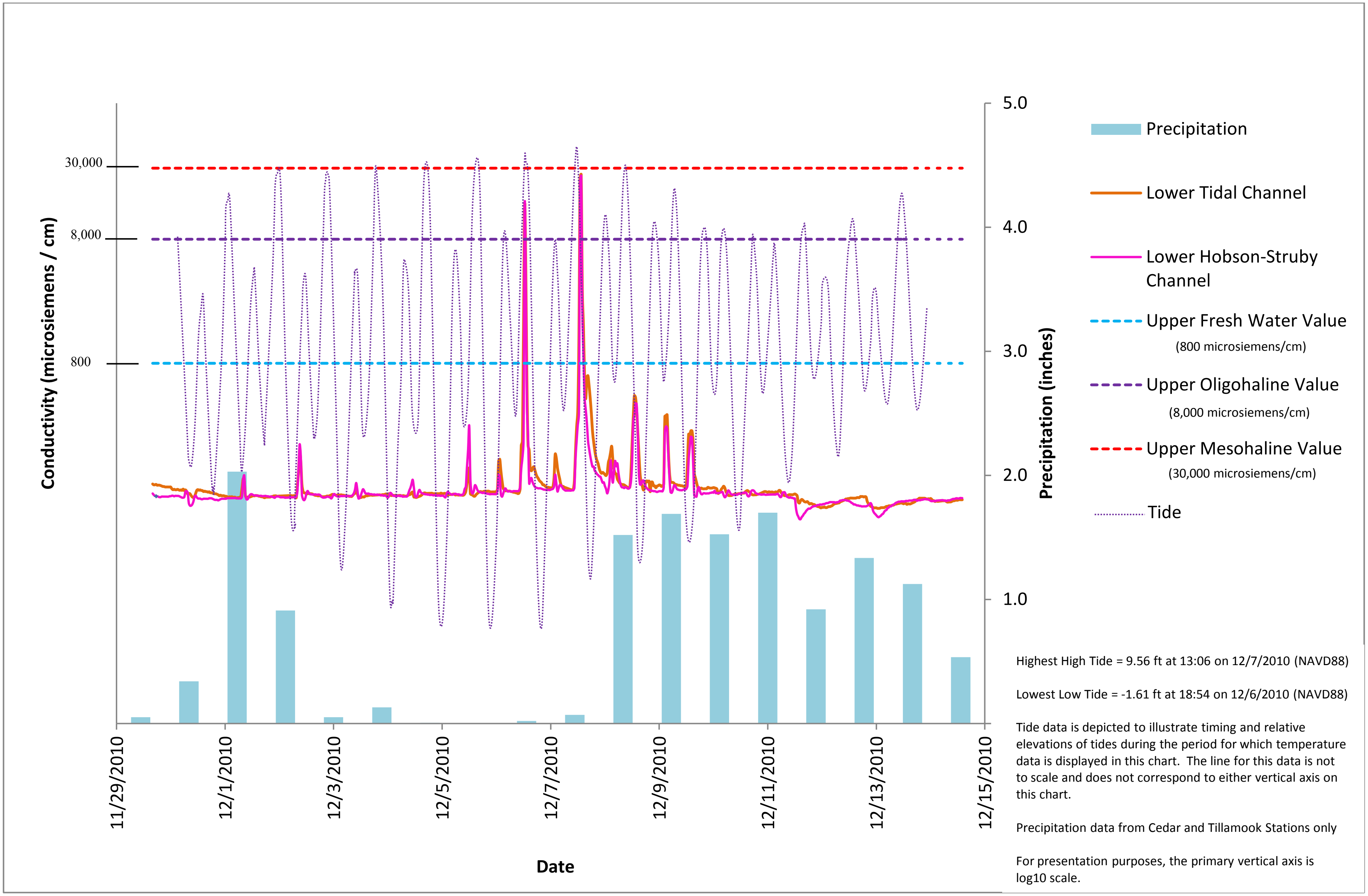


Tidal Elevations are NAVD88

Precipitation data from Cedar, Miller, South Fork, and Tillamook stations. No measurable precipitation recorded during this period.

For presentation purposes, the primary vertical axis is log10 scale.

Figure 23. Specific conductance of water in lower channels at the Miami Wetlands Project site during July 2010. Also included are tidal elevations at the Garibaldi Gage and specific conductance values for several Cowardian salinity classes.



Highest High Tide = 9.56 ft at 13:06 on 12/7/2010 (NAVD88)

Lowest Low Tide = -1.61 ft at 18:54 on 12/6/2010 (NAVD88)

Tide data is depicted to illustrate timing and relative elevations of tides during the period for which temperature data is displayed in this chart. The line for this data is not to scale and does not correspond to either vertical axis on this chart.

Precipitation data from Cedar and Tillamook Stations only

For presentation purposes, the primary vertical axis is log10 scale.

Figure 24. Specific conductance of water in lower channels at the Miami Wetlands Project site during December 2010. Also included are average precipitation from two north coast weather stations, and specific conductance values for several Cowardian salinity classes.

Dissolved oxygen concentrations at stations M-1 through M-3 (Figure 10) measured using a handheld meter during July and August 2009 ranged from approximately 4 – 18 mg/L. These measurements were taken at stations on channels throughout the portion of the project site north of the Miami River, including the extreme lower portion of the Hobson-Struby channel. We recorded dissolved oxygen concentrations below 6.5 mg/L[2] at each station during these sampling sessions and mean concentrations for stations M-2 and M-3 were below this threshold. Although we measured concentrations below the 6.5 mg/L standard at Station M-1, the mean concentration for this station during summer 2009 (7.6 mg/L) exceeded this standard.

Dissolved oxygen concentrations at stations P-1 through P-10 (Figure 10) measured using a handheld meter during February and May 2010 ranged from approximately 5 – 13 mg/L. These measurements were taken at stations distributed throughout the portion of the project site north of the Miami River, but did not include the extreme lower portions of the Hobson-Struby or tidal channels. Dissolved oxygen concentrations were below 6.5 mg/L at only one station during these sampling sessions, P-1 (during both sampling sessions). This station was located in a dead end segment of one of the drainage channels (Figure 14), an area that Simpson identified for its noticeably higher water temperatures and turbidity and lack of fishes (see Section 3.2.4, below). Only one other point-in-time measurement was below the 8.0 mg/L cold-water standard during these sampling sessions (7.6 mg/L at station P-7 during February 2010). Because the Miami Wetlands site does not appear to provide suitable spawning habitat salmonids, the 11 mg/L standard should not apply to this location. However, approximately half of the February measurements fell below this standard. All of the stations where concentrations below 11 mg/L were recorded were located in the existing drainage channels (stations P-1, P-4, P-6, P-7, and P-10). Measured dissolved oxygen concentrations at stations along the Hobson-Struby channel (P-2, P-3, P-5, P-8, P-9, and P-11) all exceeded the 11mg/L standard.

Dissolved oxygen concentrations at stations L-1 and L-2 (Figure 10) measured using dissolved oxygen data loggers ranged from approximately 5 – 19 mg/L during July 2010 and from approximately 7.5 – 11 mg/L during December 2010 (figures 25 and 26). As noted above, these stations are at the extreme downstream ends of the Miami Wetlands channels, very near their confluence with the lower mainstem Miami River.

During the July 2010 sampling period dissolved oxygen concentrations at stations L-1 and L-2 fluctuated dramatically (Figure 25). Dissolved oxygen concentrations during this period were consistently at or near the 6.5 mg/L standard during periods when tidal elevations were less than approximately six feet asl. However, during periods with higher tidal elevations (when saline water from Tillamook Bay penetrated at least the lower portions of both the tidal and Hobson-Struby channels – see Section 3.1.2.2 above) dissolved oxygen concentrations increased substantially, often exceeding 12 mg/L. During the winter 2010-11 sampling period, dissolved oxygen concentrations at stations L-1 and L-2 consistently exceeded 8.0 mg/L at both stations, increasing to approximately 11.0 mg/L during high tides when rainfall amounts were low. A peak in dissolved oxygen concentrations was associated with heavier rainfall beginning on

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[2] State of Oregon water quality standard for estuarine waters and waterbodies identified as providing habitat for cool-water aquatic life (OAR 340-041-0016). For water bodies identified by ODEQ as providing habitat for cold-water aquatic life, the dissolved oxygen concentration may not be < 8.0 mg/L and for water bodies identified as active spawning areas for anadromous salmonids and resident trout species (spawning through fry emergence periods) the dissolved oxygen content may not be < 11.0 mg/L.

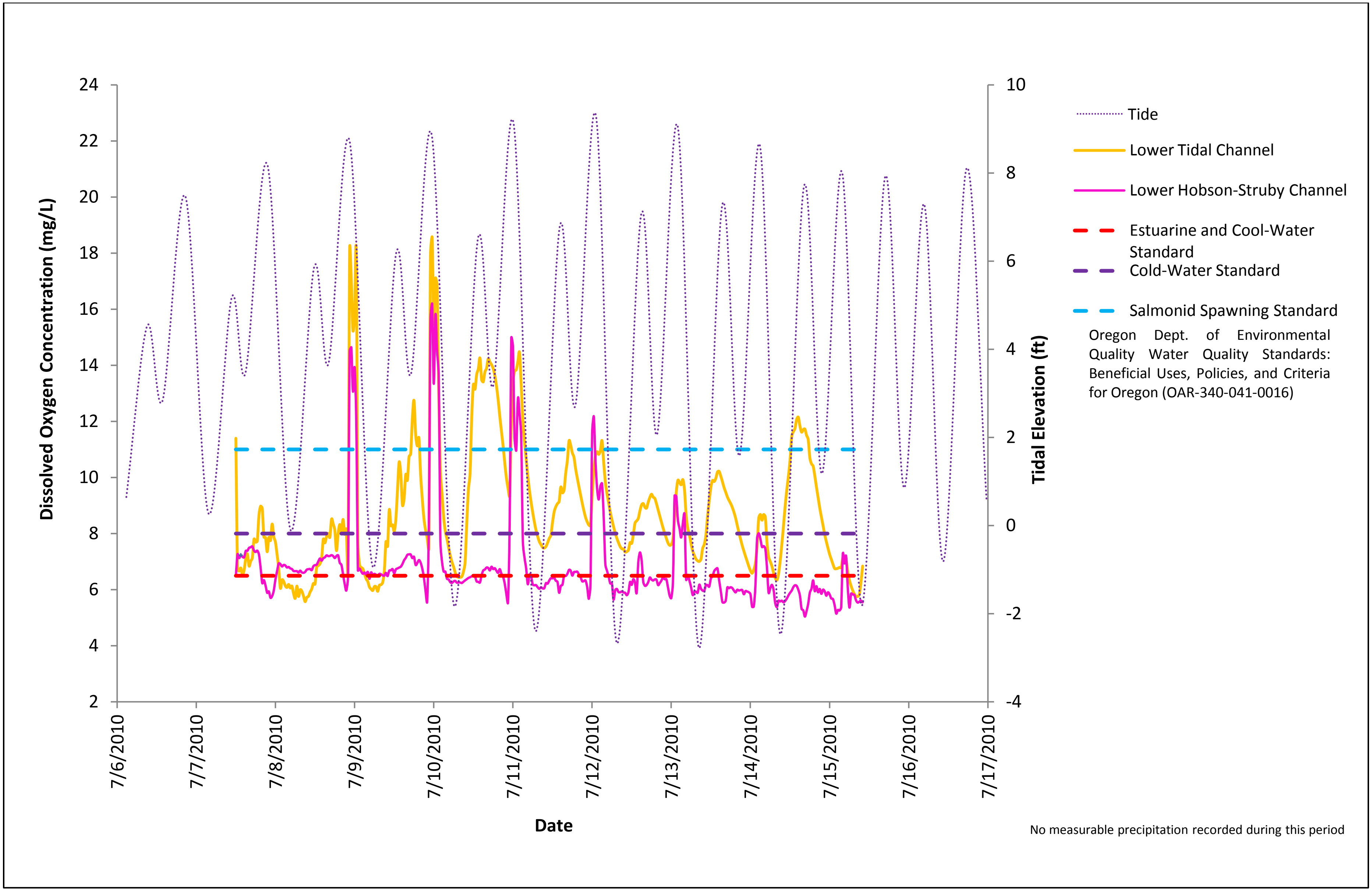
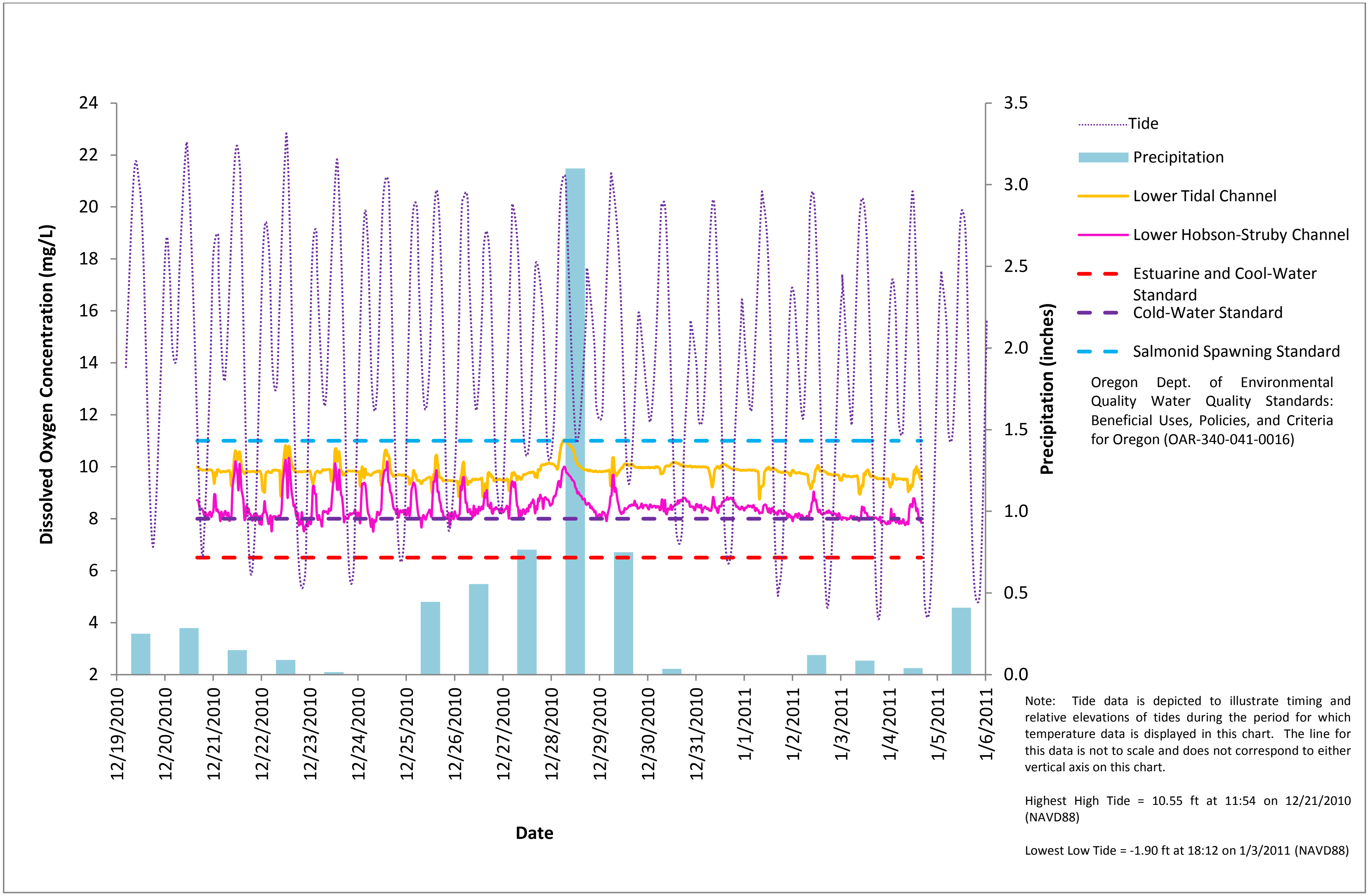


Figure 25. Dissolved oxygen concentration of water in lower channels at the Miami Wetlands Project site during July 2010. Also included are tidal elevations at the Garibaldi Gage.



Oregon Dept. of Environmental Quality Water Quality Standards: Beneficial Uses, Policies, and Criteria for Oregon (OAR-340-041-0016)

Note: Tide data is depicted to illustrate timing and relative elevations of tides during the period for which temperature data is displayed in this chart. The line for this data is not to scale and does not correspond to either vertical axis on this chart.

Highest High Tide = 10.55 ft at 11:54 on 12/21/2010 (NAVD88)

Lowest Low Tide = -1.90 ft at 18:12 on 1/3/2011 (NAVD88)

Figure 26. Dissolved oxygen concentration of water in lower channels at the Miami Wetlands Project site during December 2010 and January 2011. Also included are average precipitation for two north coast weather stations and tidal elevations at the Garibaldi Gage.

December 27. Following this period of high precipitation, dissolved oxygen concentrations were somewhat higher and more stable and tidal influences were less evident (Figure 26). These data suggest that: 1) dissolved oxygen concentrations in the saline water of Tillamook Bay were often higher than concentrations in the freshwater that predominated at the Miami Wetlands site, and 2) high precipitation events increased the dissolved oxygen concentration of freshwater on and entering the site from upstream sources.

It is interesting to note that during both the July 2010 and winter 2010-11 sampling periods, dissolved oxygen concentrations at the lower tidal channel station were consistently higher than those in the lower Hobson-Struby channel. We cannot fully explain this phenomenon. However, the lingering of oxygen-rich saline waters in the lower tidal channel described above (see Section 3.1.2.2) may account for the higher dissolved oxygen concentrations recorded at this location during July 2010. During the winter sampling period, the lower tidal channel apparently benefitted from the input of oxygen-rich freshwater from abundant rainfall and higher flows in Hobson and Struby creeks, while the lower Hobson-Struby station was now sampling a short, dead-end channel with little or no upstream inputs.

3.1.3. Soils

It is anticipated that the Miami Wetlands Project will modify vegetation composition and structure, inundation patterns (for both fresh and brackish waters), and soil moisture content at the site. These changes may alter soil characteristics and influence other physical and biological factors at the site. The following subsections present information on pre-construction soil organic matter, texture, and salinity.

2.1.4.1. Soil Organic Matter - Soil organic matter influences many of the physical, chemical and biological properties of soil. It contributes to soil structure, water holding capacity, nutrient cycles, biological activity, water and air infiltration rates, cation exchange capacity and other soil properties.

There are two general types of wetland soils, mineral and organic. Organic soils have lower bulk densities (weight per unit of volume) than mineral soils. As a result, organic soils have more pore space and greater water holding capacity than mineral soils. Water often moves slower through organic soils, which can reduce the extent and severity of downstream flooding, increase and prolong groundwater contributions to stream baseflows during drought periods, and ameliorate water temperatures in adjacent water bodies. In addition, organic soils have a greater potential to remove excess nutrients and other pollutants and, as a result, can alter the chemistry of the waters moving through them and transform nutrients into other forms.

In general, soil samples collected at the site had very high organic matter content, ranging from approximately 9-31 percent (Table 7). Mean soil organic matter content for these 12 samples was 18.9 + 1.5 percent (mean ± 1SE). All of these samples were collected from within the upper 12 inches of Coquille Silt Loam soils (Figure 6). Notable characteristics of the upper horizons of this soil series include an abundance of slightly decomposed plant material and fine and medium roots. Therefore, the results of this analysis are not unexpected.

2.1.4.2. Soil Texture and Salinity – Soluble salts can accumulate in soils and affect soil physical and chemical properties and plant growth and vegetation composition. Significant salt accumulation is uncommon in areas where rainfall exceeds 20 inches per year. However, salt deposition can occur due to sea spray and tidal inundation in coastal areas and along brackish rivers and estuaries. Because the Miami Wetlands site is tidally influenced and the restoration project substantially increases the amount of tidal channels, it will likely alter tidal inundation patterns at the site. This could potentially alter soil salinity at the site and affect plant species composition, distribution and growth. Soil texture is an important consideration when evaluating salinity. Coarser soils hold less water to dilute the salts than fine soils and this can affect conductivity readings. As a result, we evaluated soil texture in conjunction with our conductivity analysis.

Table 7. Results of Loss on Ignition analysis to determine percent organic matter of soil samples collected at the Miami Wetlands Project site during June 2010.

Soil Pit ID*	Percent Organic Matter
A-15	18.7
B-9	19.4
C-1	22.3
D-7	16.7
E-4	16.3
E-11	22.5
F-7	8.9
G-1	17.9
G-5	18.4
H-1	31.1
H-9	19.8
I-2	15.3

*See Figure 11. Pit ID's correspond to vegetation sampling plot ID's. These soil samples were collected simultaneous to vegetation sampling and within the areas sampled by herbaceous vegetation plots.

Analysis of 24 pre-construction soil samples indicates that, prior to initiation of the Miami Wetlands Project, soils in the upper horizon at the site were primarily fine-textured silt and overwhelmingly non-saline (Table 8). The one exception with respect to salinity was a sample collected in a perennially wet area south of the Miami River (Pit H1). Soils in this area were moderately-saline, suggesting that saline tidal waters contribute to the water that inundates this area.

As with the soil organic matter samples discussed above, all of the samples collected for these analyses were from within the area identified by the USDA Soil Survey as Coquille Silt Loam. The USDA, NRCS Web Soil Survey Map Unit Description for this soil describes it as silt loams or silty clay loams that are typically non-saline to very slightly saline. However, Brophy et al. (2011) reports soil salinities from tidal wetland sites at other Oregon estuaries. Three of these sites were on Coquille Silt Loam soils and had measured soil salinities in the Mesohaline and Polyhaline ranges. Photos of soil samples used in this analysis are included as Appendix 1.

3.2. Biological Attributes

Below we report the results of our efforts to document pre-construction biological attributes at the Miami Wetlands Project site. As noted earlier, we collected data on a variety of biological attributes at the site including vegetation, macroinvertebrates, secretive marsh birds, and fishes. The following sections summarize these data.

Table 8. Results of soil texture, color, and specific conductance analyses for 24 soil samples collected during September 2010 at the Miami Wetlands Project Site.

Station ID	Approximate Percent Sand / Silt / Clay	Soil Texture Class[1]	Color	Specific Conductance 1:2 suspension (µS/cm / dS/m)	Approx ECsp[2] (dS/m)	Salinity Class[3]
A1	0 / 100 / 0	Silt	10YR4/2-Grayish Yellow Brown	265.7 / 0.27	0.24	Fresh / Non-Saline
A2	0 / 100 / 0	Silt	10YR4/2-Grayish Yellow Brown	133.7 / 0.13	-0.17	Fresh / Non-Saline
A3	0 / 100 / 0	Silt	10YR4/3-Dull Yellowish Brown	88.7 / 0.09	-0.31	Fresh / Non-Saline
B1	5 /90 / 5	Silt	10YR4/2-Grayish Yellow Brown	215.5 / 0.22	0.08	Fresh / Non-Saline
B2	0 / 95 / 5	Silt	10YR4/2-Grayish Yellow Brown	125.7 / 0.13	-0.20	Fresh / Non-Saline
B3	0 / 100 / 0	Silt	10YR4/3-Dull Yellowish Brown	107.1 / 0.11	-0.26	Fresh / Non-Saline
C1	0 /95/ 5	Silt	10YR4/3-Dull Yellowish Brown	151.1 / 0.15	-0.12	Fresh / Non-Saline
C2	0 / 100 / 0	Silt	10YR4/3-Dull Yellowish Brown	135.5 / 0.14	-0.17	Fresh / Non-Saline
C3	0 / 100 / 0	Silt	10YR4/3-Dull Yellowish Brown	105.1 / 0.11	-0.26	Fresh / Non-Saline
D1	5 / 95 / 0	Silt	10YR4/1-Brownish Gray	441.8 / 0.44	0.79	Fresh / Non-Saline
D2	0 / 95 / 5	Silt	10YR4/3-Dull Yellowish Brown	140.9 / 0.14	-0.15	Fresh / Non-Saline
D3	0 / 95 / 5	Silt	10YR4/3-Dull Yellowish Brown	97.0 / 0.10	-0.29	Fresh / Non-Saline
E1	0 / 95 / 5	Silt	10YR4/2-Grayish Yellow Brown	460.5 / 0.46	0.85	Fresh / Non-Saline
E2	0 / 95 / 5	Silt	10YR4/3-Dull Yellowish Brown	161.3 / 0.16	-0.09	Fresh / Non-Saline
E3	0 / 100 / 0	Silt	10YR4/3-Dull Yellowish Brown	197.0 / 0.20	0.02	Fresh / Non-Saline
F1	0 / 95 / 5	Silt	10YR4/3-Dull Yellowish Brown	166.1 / 0.17	-0.07	Fresh / Non-Saline
F2	0 / 100 / 0	Silt	10YR4/3-Dull Yellowish Brown	340.1 / 0.34	0.47	Fresh / Non-Saline
F3	5 / 95 / 0	Silt	10YR4/3-Dull Yellowish Brown	76.5 / 0.08	-0.35	Fresh / Non-Saline
G2	0 / 100 / 0	Silt	10YR4/3-Dull Yellowish Brown	765.0 / 0.77	1.80	Fresh / Non-Saline
H1	0 / 100 / 0	Silt	10YR4/1-Brownish Gray	1493.0 / 1.49	4.07	Oligosaline / Moderately saline
H3	0 / 100 / 0	Silt	10YR4/3-Dull Yellowish Brown	224.1 / 0.69	0.11	Fresh / Non-Saline
I1	60 / 35 / 5	Sandy Loam[4]	10YR4/3-Dull Yellowish Brown	97.9 / 0.10	-0.28	Fresh / Non-Saline
I2	5 / 95 / 0	Silt	10YR4/3-Dull Yellowish Brown	115.4 / 0.12	-0.23	Fresh / Non-Saline
I3	5 / 95 / 0	Silt	10YR4/3-Dull Yellowish Brown	81.3 / 0.08	-0.34	Fresh / Non-Saline

[1] See Soil Texture Triangle in Appendix 1.
[2] Relationship between EC values of a saturated paste and a 1:2 soil water suspension for fine soils: $\sim EC_{SP} = (3.12 * EC_{1:2}) - 0.59$. Hogg and Henry 1984.
[3] See Table 2.
[4] Sample contained sand and gravel.

3.2.1. Vegetation

The following are results of line-intercept transects, 1-m^2 quadrats for herbaceous species, and 5m radius circular plots for tree and shrub species completed during June 2010 at the Miami Wetlands Project site.

3.2.1.1. Line Intercept - Prior to construction, the Miami Wetlands Project site was very densely vegetated. Mean percent total cover for the nine line intercept transects completed during June 2010 was approximately 95 percent (Table 9). In fact, no bare ground was recorded on eight of the nine transects (Table 10). On these transects, the only segments that did not intercept vegetation were where transects crossed open water. Open water was encountered along eight of the nine transects. Transect E intercepted a single segment of 0.7 ft where no vegetation covered the ground surface (bare ground).

While we encountered a fairly large number of plant species along these transects, a few species accounted for most of the vegetative cover. Patches dominated by Reed canary grass (*Phalaris arundinacea*) were by far the most commonly encountered vegetation type along the nine transects. Mean total cover for this type was approximately 62 percent (Table 10). It was encountered along all nine transects and accounted for a majority of the vegetative cover on seven transects. The distribution and dominance of this species varied between portions of the site north and south of the Miami River. It was extremely common north of the river, but less so south of the river. The only other vegetation type encountered along all nine transects was slough sedge (*Carex obnupta*) dominated patches. Mean total cover for this type was only approximately 14 percent (Table 10). All remaining species were encountered on fewer than half of the nine transects and mean total cover for most of these were less than 10 percent (Table 10). Several species were encountered only along a single transect.

Table 9. Total transect length and percent total cover for nine line intercept transects completed during June 2010 at the Miami Wetlands Project Site.

Transect ID	Total Transect Length (ft)	Total Cover (%)
A	730.0	99.3
B	674.0	96.7
C	706.0	97.7
D	673.7	97.4
E	525.3	94.0
F	299.9	91.1
G	111.6	84.9
H	264.0	94.7
I	412.0	100.0
	Mean + 1SE	**95.1 ± 1.6**

In general, transects south of the river passed through areas with greater species diversity than transects north of the river. Mean number of dominant species for transects north of the river was 5.8, whereas mean number of dominant species for transects south of the river was 10.3.

Figure 27 depicts the distribution of vegetation types (by dominant species) identified along each of the nine transects. A list of plant species recorded at the site is included as Appendix 2. Photographs taken from the end of each vegetation transect during sampling are included in Appendix 3.

Table 10. Percent total cover for dominant species encountered along nine line intercept transects completed at the Miami Wetlands Project site during June 2010.

Species*		Percent Total Cover by Transect									Mean ± 1SE (%)
Scientific Name	**Common Name**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	
Bare Ground						0.1					
Open H_2O		0.7	3.3	2.3	2.6	5.9	8.9	15.1	5.3		5.5 ± 1.6
Agrostis sp.	Bentgrass									0.4	
Alnus rubra	Red alder							3.6			
Argentina anserine	Silverweed cinquefoil								2.6		
Athyrium filix-femina	Lady fern									2.4	
Carex deweyana	Dewey sedge									0.1	
Carex obnupta	Slough sedge	7.3	5.6	10.9	5.5	11.5	6.5	42.5	10.2	24.2	13.8 ± 4.1
Callitriche sp.	Water-starwort								0.6		
Digitalis sp.	Foxglove			0.6							
Eleocharis ovate	Ovoid spikerush							2.2	3.0		2.6 ± 0.4
Epilobium watsonii	Watson willowherb									0.2	
Equisetum arvense	Field horsetail									0.2	
Festuca arundinacea	Tall fescue					6.4	18.0				12.2 ± 5.8
Gallium sp.	Bedstraw								1.3		
Impatiens spp.	Touch-me-not									1.9	
Juncus balticus	Baltic rush					2.0					
Juncus effuses	Soft rush	0.3	5.9	0.4		0.1					1.7 ± 1.4
Unknown	Ornamental Lawn									4.4	
Lonicera involucrate	Black twinberry									4.0	
Lotus corniculatus	Birdsfoot trefoil		2.4								
Lysichiton americanum	Skunk-cabbage	1.6	1.9						0.5		1.3 ± 0.4
Phalaris arundinacea	Reed canarygrass	90.2	72.1	85.8	89.5	74.0	48.2	35.3	45.6	18.4	62.1 ± 8.7
Poa trivialis	Rough bluegrass						2.5				
Ranunculus repens	Creeping buttercup									19.4	
Rubus spp.	Blackberry		6.7		2.5				3.0	19.3	7.9 ± 3.9
Salix spp.	Willow		2.1				16.0			3.3	7.1 ± 4.4
Sambucus racemosa	Red elderberry									1.9	
Scirpus microcarpus	Small-fruited bulrush								13.6		
Typha latifolia	Cattail								14.3		
Vicia gigantean	Giant vetch							1.4			
Number of Dominant Species Intercepted		**4**	**7**	**4**	**3**	**5**	**5**	**5**	**10**	**14**	

[*] As described in the Methods Section of this report, we identified dominant species within patches of vegetation along the line-intercept transects

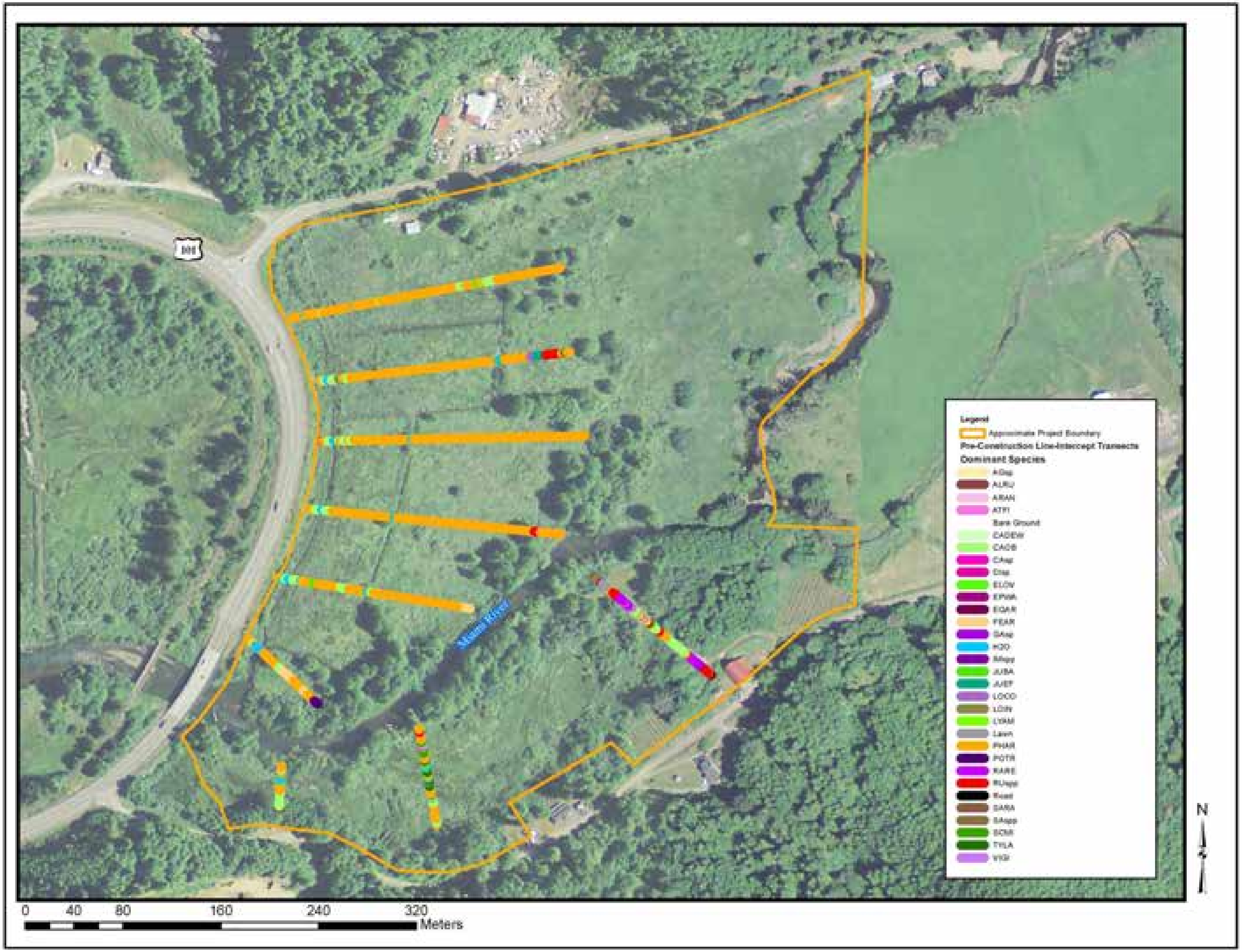


Figure 27. Map depicting distribution of dominant species along line-intercept transects conducted during June 2010. See Appendix 1 for species codes.

3.2.1.2. $1m^2$ Herbaceous Vegetation Plots and 5m radius circular tree and shrub plots – As noted earlier, we completed 112 - $1m^2$ herbaceous vegetation plots and 44 - 5m radius circular tree and shrub plots (Figure 12) and used the results of these plots along with aerial photographs and on-the-ground evaluations to describe and delineate vegetation communities on the project site. Through this suite of methods, we identified 10 different communities in five different general categories. These are: Palustrine Emergent Wetland 1 (PEM1), Palustrine Emergent Wetland 2 (PEM2), Palustrine Emergent Wetland 3 (PEM3), Palustrine Emergent Wetland 4 (PEM4), Palustrine Scrub Shrub (PSS), Riparian 1, Riparian 2, Upland 1, Upland 2, and Disturbed. Our transects sampled only within the portions of the project area where habitat enhancement actions were planned. As a result, we did not complete any $1m^2$ or 5m radius plots within the upland communities. Therefore, descriptions of the upland communities in this report are based on visual assessment only.

The following paragraphs and tables 11, 12, 13, and 14 describe each of these 10 communities and summarize the results of the $1m^2$ and 5m radius plots (5m plots hereafter referred to as tree/shrub plots). Figure 24 depicts the distribution of these communities and areas within and adjacent to the project site where agricultural fields, lawns, and residential structures occur. Appendix 4 provides representative photographs of vegetation communities occurring at the site.

Palustrine Emergent Wetland 1 (PEM1) was the most widely distributed emergent wetland community and covered large portions of the site on both sides of the river (Figure 24). It occurred primarily on drier portions of the wetland. We completed 46 - $1m^2$ herbaceous vegetation plots and 10 tree/shrub plots within areas covered by this community (tables 12a and 13a).

Percent total cover for herbaceous species in this community was very high (approximately 98 percent) and we encountered a moderate number of herbaceous species on plots in this community (Table 11). However, in terms of Diversity and Evenness of herbaceous vegetation this was a fairly simple community (Table 11). Reed canarygrass was by far the most dominant herbaceous species in this community (approximately 94 percent relative cover, Table 12a). Other species were generally present in trace amounts, but sometimes formed small islands within the larger reed canarygrass-dominated area. These included slough sedge, soft rush (*Juncus effusus*), Baltic rush (*J. balticus*), and small-fruited bulrush (*Scirpus microcarpus*). Relative cover did not exceed two percent for any other herbaceous species (Table 12a). No measurable bare ground or standing water was encountered on 1m2 plots in this community, but vegetative litter was recorded on portions of a few plots where standing live vegetation was not present.

There was a very limited tree/shrub component in community PEM1 (tables 13a and 14). Only two tree species were present in the tree/shrub plots conducted in this community. Mean percent cover for was approximately 25 percent, a majority of which was provided by red alder (Table 13a). For the most part, trees recorded in these plots were overhanging the plot and did not originate inside of the plot boundaries. The one exception was plot D5 which had a single, large (50-90cm dbh size class) red alder originating from within the plot. Only two shrub species were encountered in these plots, Armenian blackberry (*Rubus armenicus*) and cut-leaf blackberry (*R. lacinatus*). Together, these two species accounted for less than 10 percent total cover.

Table 11. Values for Simpson's Diversity Index (D), Shannon-Wiener Diversity Index (H'), Evenness (E), and Species Richness (S) for plant communities occurring on the Miami Wetlands Project site during June 2010. Based on data collected at 112 1-m^2 herbaceous vegetation plots.

Plant Community	Number of Plots	D	H'	E	S
PEM1	46	0.1	0.8	0.3	12
PEM2	31	0.7	1.5	0.5	15
PEM3	7	0.8	2.1	0.8	16
PEM4	2	0.7	1.2	0.5	9
PSS	7	0.8	1.9	0.7	19
Riparian 1	12	0.2	0.3	0.1	5
Riparian 2	4	0.8	2.1	0.8	14
Upland 1		N/A	N/A	N/A	N/A
Upland 2		N/A	N/A	N/A	N/A
Disturbed	2	0.8	2.0	0.8	15

Palustrine Emergent Wetland 2 (PEM2) was the second most widely distributed emergent wetland community and covered a large portion of the site north of the river (Figure 24). It occurred primarily on wetter portions of the wetland. We completed 31 - 1m^2 herbaceous vegetation plots and seven tree/shrub plots within areas covered by this community (tables 12b and 13b).

Percent total cover of herbaceous species for this community was high (approximately 85 percent), and Species Richness, Diversity and Evenness were considerably higher for this community than for PEM1 (Table 11). Reed canarygrass dominated this community (approximately 52 percent relative cover), but other large grasslike species (i.e., slough sedge, soft rush, and small-fruited bulrush) also provided substantial cover (approximately 36 combined relative cover, Table 12b). Other species encountered in this community were generally present in trace amounts. Percent relative cover was typically less than two percent for these species (Table 12b). Measurable amounts of bare ground, standing water, and vegetative litter were encountered on portions of several plots in this community where standing live vegetation was not present.

Shrubs and trees were a limited component of this community (tables 13b and 14). A single tree species, red alder, and six shrub species were present in the tree/shrub plots conducted in this community. Mean percent cover for tree species in these seven plots was approximately three percent, provided entirely by red alder (Table 13b). Like PEM1, most trees recorded in these plots were overhanging the plot and did not originate inside of the plot boundaries (only a single

Table 12. Data from 1-m^2 herbaceous vegetation plots for vegetation communities at the Miami Wetlands site. Table provides information on percent total cover, percent total cover by species, percent relative cover by species, and the number of plots completed within each vegetation community. Species codes are provided in the project plant list included as Appendix A. No plots were completed in the upland plant communities, so those communities are not represented in this table.

a).

PEM1		Species Encountered in Plots											Total Cover (%)
		PHAR	**CAOB**	**IMspp**	**SCMI**	**LOCO**	**LOUL**	**RUAR**	**RULA**	**FEAR**	**CIAR**	**POPA**	
N = 46	**Total Cover (%)**	91.3	1.9	0.0	0.2	0.4	0.1	0.5	1.0	1.5	0.3	0.3	97.6
	Relative Cover (%)	93.5	1.9	0.0	0.2	0.4	0.1	0.6	1.0	1.6	0.3	0.3	

b).

PEM2		Species Encountered in Plots													Total Cover (%)
		PHAR	**CAOB**	**JUEF**	**IMspp**	**SCMI**	**LYAM**	**LOUL**	**VIGI**	**GAsp.**	**COSY**	**RULA**	**JUBA**	**ARAN**	
N = 31	**Total Cover (%)**	44.1	17.3	7.7	2.4	5.3	1.6	1.0	0.9	1.0	0.3	0.6	0.5	1.6	84.5
	Relative Cover (%)	52.1	20.5	9.2	2.8	6.2	1.9	1.2	1.1	1.2	0.3	0.8	0.6	1.9	

c).

PEM3		Species Encountered in Plots																Total Cover (%)
		PHAR	**CAOB**	**IMspp**	**SCMI**	**LYAM**	**LOCO**	**GAsp.**	**EPCI**	**CAsp.**	**TYLA**	**SAHO**	**ELOB**	**JUBA**	**FEAR**	**ARAN**	***Poa* sp.**	
N = 7	**Total Cover (%)**	20.1	3.6	0.1	7.5	3.6	0.1	0.3	0.1	1.4	10.1	0.1	5.7	11.7	3.6	0.1	1.4	68.7
	Relative Cover (%)	29.3	5.2	0.2	10.9	5.2	0.2	0.4	0.2	2.1	14.8	0.2	8.3	17.0	5.2	0.2	2.1	

d).

PEM4		Species Encountered in Plots									Total Cover (%)
		PHAR	**CAOB**	**JUEF**	**LOCO**	**FEAR**	**CIAR**	**POPA**	**POTR**	**ARAN**	
N = 2	**Total Cover (%)**	0.5	49.5	2.5	0.5	17.5	1.0	0.5	0.5	27.5	100.0
	Relative Cover (%)	0.5	49.5	2.5	0.5	17.5	1.0	0.5	0.5	27.5	

Table 12. (continued)

e).

PSS		Species Encountered in Plots																			Total Cover (%)
		PHAR	CAOB	IMspp	LYAM	LOUL	GLBO	CAST	RUCR	RARE	AGsp	HOLA	VEAM	COSY	EQAR	RULA	SAHO	ATFI	POTR	TOME	
N = 7	Total Cover (%)	43.6	6.6	1.3	9.1	1.6	0.1	4.3	0.1	8.6	2.9	0.7	0.1	0.9	2.3	3.7	1.4	4.3	0.1	0.1	91.9
	Relative Cover (%)	47.4	7.2	1.4	10.0	1.7	0.2	4.7	0.2	9.3	3.1	0.8	0.2	0.9	2.5	4.0	1.6	4.7	0.2	0.2	

f).

Riparian 1		Species Encountered in Plots							Total Cover (%)
		PHAR	CAOB	JUEF	IMspp	RUspp	ATFI	CIAR	
N = 12	Total Cover (%)	87.7	0.1	0.4	1.8	0.4	1.7	0.1	92.1
	Relative Cover (%)	95.2	0.1	0.5	1.9	0.5	1.8	0.1	

g).

Riparian 2																Total Cover (%)
		PHAR	CAOB	LOCO	VIGI	HELA	COSY	EQAR	RULA	POPA	POTR	TOME	POMU	BLSP	DAGL	
N = 4	Total Cover (%)	1.3	12.5	5.0	7.5	2.5	0.8	0.5	0.3	2.5	19.8	2.5	5.0	3.8	0.3	64.0
	Relative Cover (%)	2.0	19.5	7.8	11.7	3.9	1.2	0.8	0.4	3.9	30.9	3.9	7.8	5.9	0.4	

h).

Disturbed		Species Encountered in Plots															Total Cover (%)
		PHAR	CAOB	IMspp	LOUL	RUCR	RARE	AGsp	SASI	EPCI	HOLA	VEAM	COSY	EQAR	RULA	ATFI	
N = 3	Total Cover (%)	1.7	8.3	3.7	1.7	0.3	42.3	10.0	1.7	3.3	3.3	7.0	0.7	6.7	5.0	3.3	99.0
	Relative Cover (%)	1.7	8.4	3.7	1.7	0.3	42.8	10.1	1.7	3.4	3.4	7.1	0.7	6.7	5.1	3.4	

Table 13. Data from 5-m radius circular tree/shrub plots for vegetation communities at the Miami Wetlands site. Table provides information on percent total cover, percent total cover by species, percent relative cover by species, and the number of plots completed within each vegetation community. Species codes are provided in the project plant list included as Appendix A. No plots were completed in the upland plant communities, so those communities are not represented in this table. No tree/shrub plots were completed in communities PEM3 and PEM4 and, as a result, these communities are not respresented in this table.

a).

PEM1		Tree Species			Shrub Species		
		ALRU	SASI	Total Tree Cover (%)	RUAR	RULA	Total Shrub Cover (%)
N = 10	Total Cover (%)	23	1.5	24.5	6.0	3.5	9.5
	Relative Cover (%)	93.9	6.1		63.2	36.8	

b).

PEM2		Tree Species		Shrub Species						
		ALRU	Total Tree Cover (%)	SAHO	SASI	RUAR	RULA	LOIN	MAFU	Total Shrub Cover (%)
N = 7	Total Cover (%)	2.9	2.9	2.9	5.0	2.1	5.0	1.4	0.7	17.1
	Relative Cover (%)	100.0		16.7	29.2	12.5	29.2	8.3	4.2	

c).

PSS		Trees Species		Shrub Species							
		ALRU	Total Tree Cover (%)	SAHO	SASI	RUAR	RULA	SALU	SARA	LOIN	Total Shrub Cover (%)
N = 7	Total Cover (%)	2.1	2.1	20.0	12.9	0.7	3.6	0.1	0.1	0.1	37.6
	Relative Cover (%)	100.0		53.2	34.2	1.9	9.5	0.4	0.4	0.4	

Table 13. (continued)

d).

Riparian 1		Tree Species		Shrub Species	
		ALRU	Total Tree Cover (%)	RUAR	Total Shrub Cover (%)
N = 11	Total Cover (%)	26.8	26.8	21.4	21.4
	Relative Cover (%)	100.0		100.0	

e).

Riparian 2		Tree Species			Shrub Species						
		ALRU	PISI	Total Tree Cover (%)	SAHO	RUAR	RULA	SALU	SARA	LOIN	Total Shrub Cover (%)
N = 4	Total Cover (%)	7.5	1.3	8.8	22.5	1.3	6.3	12.5	13.8	8.8	65.0
	Relative Cover (%)	85.2	14.7		34.6	1.9	9.6	19.2	21.2	13.5	

f).

Disturbed		Shrub Species				
N = 2		SAHO	SASI	RUAR	SARA	Total Shrub Cover (%)
	Total Cover (%)	0.5	2.5	25.0	3.0	31.0
	Relative Cover (%)	1.6	8.1	80.6	9.7	

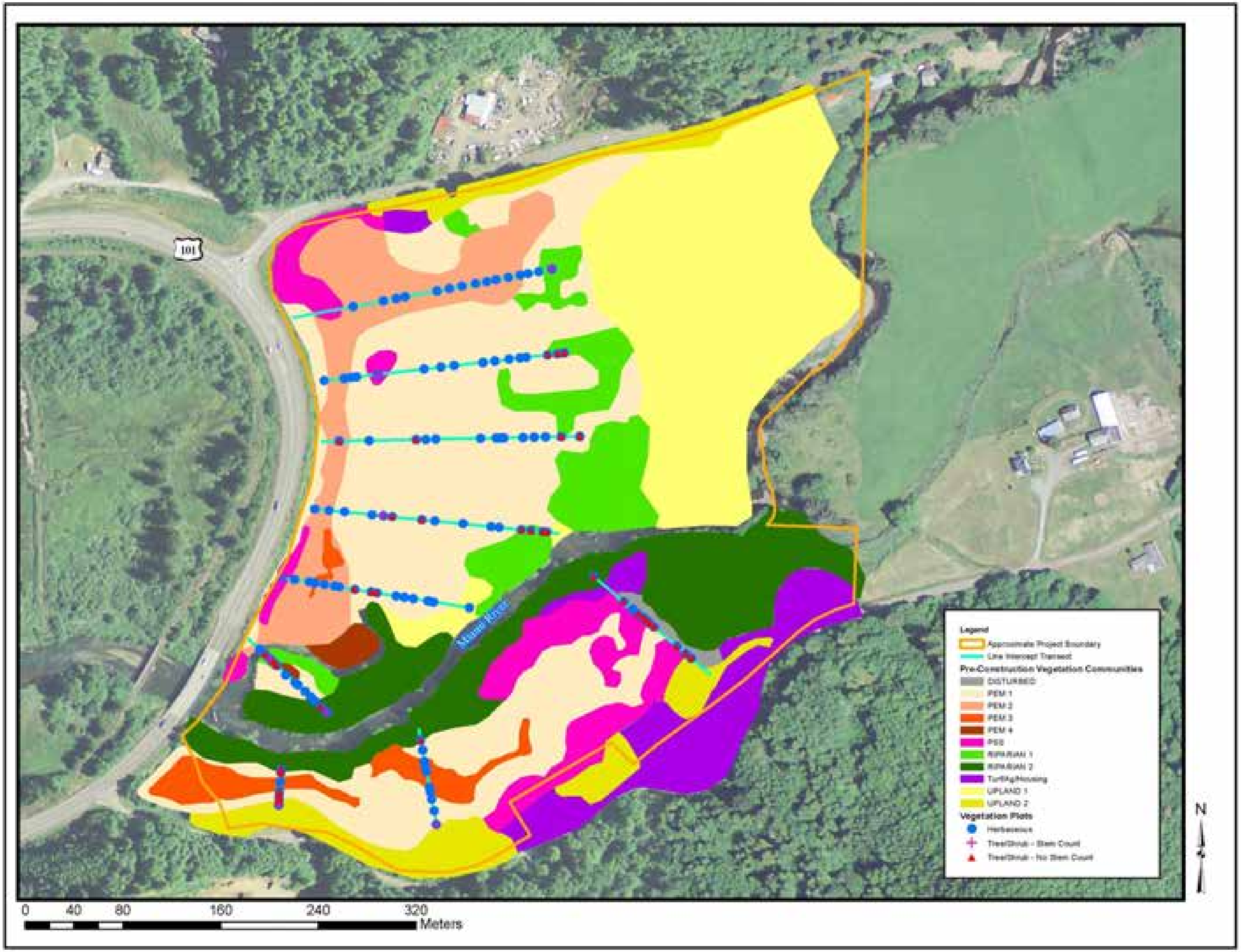


Figure 28. Map depicting vegetation community distribution at the Miami Wetlands Project site during June 2010.

Table 14. Values for Simpson's Diversity Index (D), Shannon-Wiener Diversity Index (H'), Evenness (E), and Species Richness (S) for plant communities occurring on the Miami Wetlands Project site during June 2010. Based on data collected at 41 5-m radius circular tree/shrub plots.

Plant Community	Trees				Shrubs			
	D	H'	E	S	D	H'	E	S
PEM1	0.1	0.2	0.3	2	0.5	0.7	0.9	2
PEM2	N/A				0.8	1.6	0.9	6
PEM3[1]	N/A				N/A			
PEM4[1]	N/A				N/A			
PSS[2]	N/A				0.6	1.1	0.5	8
R1[2]	N/A				N/A			
R2[2]	N/A				0.8	1.0	0.6	6
UP1[1]	N/A				N/A			
UP2[1]	N/A				N/A			
Dist[3]	N/A				0.3	0.7	0.5	4

[1] = No 5m radius plots completed in these communities. [2]= Single tree or shrub species encountered, diversity not calculated. [3] = No trees encountered.

stem in the 3-15 cm dbh size class was recorded in this plot and this was a Sitka willow classified as a shrub). Six different shrub species were encountered in these plots (Table 13b and 14). Total cover provided by shrubs was approximately 17 percent (Table 13b) and most shrub species provided between 8 and 30 percent relative cover (Table 13b). Three of the shrub species recorded in these plots (Hooker's willow [*Salix hookeriana*], Sitka willow [*S. sitchensis*], and Pacific crabapple [*Malus fusca*]) also can grow in more tree-like forms. However, all plants of these species encountered in the plots were multi-trunked and shrublike and most had stems smaller than three cm dbh.

Palustrine Emergent Wetland 3 (PEM3) occurred on very wet portions of the wetland (at the margins of pools and channels) in two large patches south of the river and a single small patch north of the river (Figure 24). We completed seven - 1m^2 herbaceous vegetation plots within areas covered by this community (Table 12c). No tree/shrub plots were completed in this community (Table 14).

Percent total cover of herbaceous species for this community was low relative to PEM1 and PEM2 (approximately 69 percent), but Species Richness, Diversity and Evenness were comparatively high (Table 11). Unlike PEM1 and PEM2 no single species accounted for a majority of the herbaceous vegetative cover in this community. Reed canarygrass, Baltic rush, cattail (*Typha latifolia*), and small fruited bulrush all exceeded 10 percent relative cover. Ovoid spikerush (*Eleocharis ovata*), skunk cabbage (*Lysichiton americanum*), slough sedge, and tall fescue (*Festuca arundinacea*) all had greater than five percent relative cover (Table 12c). A number of other species encountered in this community were generally present in trace amounts. Percent relative cover was typically less than two percent for these species (Table 12c). Measurable amounts of standing water, and vegetative litter were encountered on portions of several plots in this community where standing live vegetation was not present.

Palustrine Emergent Wetland 4 (PEM4) occurred on two moist areas north of the river (Figure 24). We completed two - 1m^2 herbaceous vegetation plots within areas covered by this community (Table 12d). No tree/shrub plots were completed in this community (Table 14).

Percent total cover of herbaceous species for this community was extremely high (100 percent), and Diversity and Evenness were comparable to PEM2 (Table 11). Species Richness was low relative to the other three Palustrine Emergent Wetland communities, but this may be an artifact of having data from only two 1m^2 plots. Three species, slough sedge, tall fescue, and Pacific silverweed (*Argentina anserina*), accounted for approximately 90 percent of the vegetative cover within this community. Slough sedge accounted for over half of the cover provided by these species. Unlike other PEM communities at the site, reed canarygrass was only present in trace amounts in this community. All other species also were recorded only in trace amounts in this community.

Palustrine Scrub Shrub (PSS) occurred primarily on perennially wet areas on both sides of the river (Figure 24). We completed seven 1m^2 herbaceous vegetation plots and seven tree/shrub plots within areas covered by this community (Table 12e and 13c).

Percent total cover of herbaceous species for this community was high (approximately 92 percent), as were Species Richness, Diversity and Evenness (Table 11). The herbaceous portion of this community was dominated by reed canarygrass (approximately 47 percent relative cover - Table 12e). Percent relative cover for the remaining 18 herbaceous species recorded in this community was less than 10 percent (Table 12e). No measurable amounts of bare ground or standing water were recorded in plots in this community, and vegetative litter was only encountered on a single plot where standing live vegetation was not present.

Shrubs are an important component of this community, but trees were rare (tables 13c and 14). A single tree species and seven shrub species were present in the tree/shrub plots conducted in this community. Mean percent cover for tree species in these seven plots was approximately two percent, provided entirely by red alder (Table 13c). No trees originated within the plot boundaries. Total cover provided by shrub species was approximately 38 percent. Although seven shrub species were recorded in these plots, two species of willow (Hooker's willow and Sitka willow) accounted for majority of shrub cover in this community (tables 13c and 14). Other shrub species were present in trace amounts. Eight Hooker's willow stems in the 3-15 cm dbh size class were recorded in one of the seven plots completed within this community.

Riparian 1 occurred as discrete patches adjacent to channels north of the river (Figure 24). We completed seven 1m^2 herbaceous vegetation plots and 11 5m radius tree/shrub plots within areas covered by this community (tables 12f and 13d).

Percent total cover of herbaceous species for this community was high (approximately 92 percent), but Species Richness, Diversity and Evenness were very low (Table 11). The herbaceous portion of this community was overwhelmingly dominated by reed canarygrass (approximately 95 percent relative cover - Table 12f). All remaining herbaceous species recorded in this community were present only in trace amounts (Table 12f). No measurable amounts of bare ground, standing water, or vegetative litter were recorded in plots in this community.

Shrubs and trees were an important component of this community, but diversity and species richness are very low (tables 13d and 14). Only one tree and one shrub species were encountered in the 11 tree/shrub plots completed in this community. Mean percent cover for trees was approximately 27 percent, provided entirely by red alder (Table 13d). Three red alders originated within the plot boundaries (one in the 3-15 cm dbh class, one in the 15-30 dbh class and one in the 50-90 dbh class). Total cover provided by shrubs was approximately 21 percent, almost entirely Armenian blackberry (Table 13d).

Riparian 2 occurred adjacent to both banks of the river (Figure 24). We completed four $1m^2$ herbaceous vegetation plots and four 5m radius plots for woody vegetation within areas covered by this community (tables 12g and 13e). Our transects largely missed this community because it occurs primarily along the banks of the Miami River.

Percent total cover of herbaceous species for this community was low relative to other communities identified at the site (64 percent), but Species Richness, Diversity and Evenness were relatively high (Table 11). No single herbaceous species was clearly dominant throughout the herbaceous portion of this community. In fact, only one species, rough bluegrass (*Poa trivialis*), had a relative cover that exceeded 20 percent (Table 12g). Slough sedge was the next most common species in this community with a relative cover of just under 20 percent. Most remaining herbaceous species recorded in this community had between 2 and 12 percent relative cover, while only a few species were present in trace amounts (Table 12g). Measurable amounts of bare ground and vegetative litter were encountered on portions of a few plots where standing live vegetation was not present, but standing water was not recorded for this community.

Shrubs and trees were an important component of this community (tables 13e and 14). Two tree species were recorded in this community. Mean percent cover for trees was approximately nine percent, provided primarily by red alder (Table 13e). Total cover provided by shrubs was approximately 65 percent (Table 13d). Diversity and evenness were moderate for shrubs in this community with most species providing between 10 and 35 percent relative cover (tables 13e and 14). Only one plot contained tree/shrub stems. Eight Hooker's willow stems in the 3-15 cm dbh class and two 15-30 cm dbh class red alder were recorded in this plot.

Upland 1 occurred north of the Miami River, primarily on nearly level terrain in the eastern half of this portion of the project site (Figure 24). This portion of the site lacks wetland hydrology and was not classified as wetland during wetland delineation of the site and, under most conditions, soil moisture is lower here than on wetland portions of the site. We did not complete any $1m^2$ vegetation plots or tree/shrub plots within areas covered by this community because it primarily occurred outside of areas where project construction actions would occur. As a result no cover data is available for this community and description of the community is based solely on visual assessment.

The herbaceous component of this community was very dense and variously dominated by tall fescue and reed canarygrass. Several other herbaceous species including Canada thistle (*Cirsium arvense*), birdsfoot trefoil (*Lotus corniculatus*), colonial bentgrass (*Agrostis capillaries*), soft rush, and small-fruited bulrush also are present in this community. A few single, red alder were scattered through areas covered by this community and Armenian and cut-leaf blackberries were dominant in some portions of this community.

Upland 2 occurred both north and south of the Miami River, primarily on slopes adjacent to roads that bound the project area (Figure 24). We did not complete any 1m^2 herbaceous vegetation plots or tree/shrub plots within areas covered by this community because it primarily occurred outside of areas where project construction actions would occur. As a result no cover data is available for this community and description of the community is based solely on visual assessment.

This community was dominated by trees and shrubs, but includes a limited herbaceous component. Common and conspicuous herbaceous plants include sword fern (*Polystichum minitum*), Bracken fern (*Pteridium aquilinum*), and piggy back plant (*Tolmeia menziesii*). The tree canopy was dominated by red alder, with Sitka spruce (*Picea sitchensis*) present throughout the community. The shrub layer was dominated by black twinberry (*Lonicera involucrata*), red elderberry (*Sambucus racemosa*), and salmonberry (*Rubus spectabilis*).

Disturbed occurred along the overhead utility line right-of-way where it crossed the portion of the project site south of the river (Figure 24). We completed three 1m^2 herbaceous vegetation plots and two tree/shrub plots within the area covered by this community (Table 12h and 13f).

Percent total cover of herbaceous species for this community was very high (99 percent), and Species Richness, Diversity and Evenness also were high relative to other communities on the site (Table 11). Creeping buttercup (*Ranunculus repens*) was by far the most abundant herbaceous species in this community, account for approximately 43 percent of the total vegetative cover (Table 12h). A variety of other grasses, forbs, and ferns also occur in this community but none account for more than 10 percent of the total vegetative cover (Table 12h).

Because the utility right-of-way where this community occurred was regularly cleared to provide access, shrubs and trees were minor components of this community. No tree species were recorded in this community and most shrub species occurred primarily along its margins. Mean total cover for shrubs was approximately 31 percent (Table 13f). Armenian blackberry accounted for a majority of the shrub cover in this community (approximately 80 percent relative cover). Diversity and evenness were low in this community, with most shrub species having less than 10 percent relative cover (tables 13f and 14). No plots contained tree/shrub stems greater than three cm.

3.2.2. Macroinvertebrates

Table 15 is a list of all macroinvertebrates identified in samples from the Miami Wetlands. It includes information on taxonomy and life stages and identifies the number of individuals in each taxon by sample. As noted earlier, we used 300 organism subsamples to evaluate macroinvertebrates at the site. Three of the seven samples contained sufficient numbers that only a portion of the sample was processed to obtain 300 organisms (Table 15). Two of these samples (stations P4 and P11) required only half of the sample to obtain 300 organism, while 75 percent of the Station 8 sample was needed. The four remaining samples were processed in their entirety and none contained 300 organisms.

We identified 69 unique macroinvertebrate taxa in samples collected at the Miami Wetlands site (Table 15 and Figure 29). Most (75 percent) were insects (51 unique insect taxa). True flies

Table 15. Macroinvertebrate taxa recorded from benthic samples obtained during May 2010 at the Miami Wetlands Project Site.

Taxonomic Classification						Station ID						
						P-1[1]	P-4[3]	P-10[1]	P-6[1]	P-3[1]	P-8[2]	P-11[3]
Phylum	**Class**	**Order**	**Family**	**Genus/species**	**Life stage**	(count)						
Annelida	Oligochaeta			Oligochaeta		2	5	6	8	6	3	6
Arthropoda	Arachnida	Sacoptiformes		Oribatei								1
		Trombidiformes		Trombidiformes		18	4	6	9	1	10	
	Crustacea			Copepoda		13	4		61	9	5	2
				Ostracoda		17	29	3	74	1	3	14
		Amphipoda	Corophidae	*Americorophium* sp.				4				
			Crangonyctidae	*Crangonyx* sp.					2			
			Gammaridae	*Gammarus* sp.				4				40
		Isopoda	Asellidae	*Caecidotea* sp.			8	2	12	5	61	32
				Gnorimosphaeroma sp.				1				
			Idoteidae	Idoteidae				5				10
	Entognatha	Collembola		Collembola		1	1				2	
	Insecta	Coleoptera	Dytiscidae	Agabus sp.	Adult						1	
				Dytiscidae	Immature		1		4	1		
				Hydroporinae	Larva					1		
			Haliplidae	*Haliplus* sp.	Adult		1					
				Haliplus sp.	Larva	1						
			Scirtidae	Scirtidae	Larva					1		
		Diptera	Ceratopogonidae	Ceratopogoninae	Larva	2	4	11	13		2	9
			Chironomidae	*Brillia* sp.	Larva	5	5		1	13	2	4
				Chironomidae	Pupa	2	1	1		2	9	4
				Chironomus sp.	Larva	9	6	24	1	8	6	1
				Cladopelma sp.	Larva	13	2					
				Corynoneura sp.	Larva		2		3	9	3	
				Cryptotendipes sp.	Larva		1					
				Dicrotendipes sp.	Larva	6					2	1
				Endochironomus sp.	Larva	8	1		1		1	1
				Glyptotendipes sp.	Larva	1						
				Heterotanytarsus sp.	Larva		3	1	3	2	9	9
				Heterotrissocladius sp.	Larva		6	1	5	3	10	27
				Larsia sp.	Larva		2			1		
				Limnophyes sp.	Larva	3			3	2		
				Macropelopiini/Procladiini	Larva	79	60		2	18	38	8
				Metriocnemus sp.	Larva					2		

Table 15. (continued)

				Micropsectra/*Tanytarsus* sp.	Larva	5	26	11	13	5	57	45
				Omissus sp.	Larva		2		1	1	6	10
				Orthocladiinae	Immature							2
				Orthocladiinae	Larva							1
				Orthocladius complex	Larva				1			7
				Paramerina sp.	Larva					6		
				Parametriocnemus sp.	Larva							5
				Paratanytarsus sp.	Larva	3	6	15			1	12
				Prodiamesa sp.	Larva					2	1	
				Psectrocladius sp.	Larva							2
				Rheocricotopus sp.	Larva	1			1	2	2	3
				Sergentia sp.	Larva	1	6	5	7		6	1
				Stempellina sp.	Larva							1
				Stempellinella sp.	Larva		1		1	3	4	
				Thienemanniella sp.	Larva					1		
				Thienemannimyia Gr.	Larva	1	4		2	12	2	6
			Dixidae	*Dixa* sp.	Larva						1	
				Dixella sp.	Larva	2	4			2		
			Empididae	*Chelifera*/*Metachela* sp.	Larva							2
				Neoplasta sp.	Larva			1				1
			Phoridae	Phoridae	Larva	1		1		1		6
			Simuliidae	*Simulium* sp.	Larva							1
			Tabanidae	Tabanidae	Larva						1	
		Ephemeroptera	Baetidae	Baetis tricaudatus	Larva					1		3
				Callibaetis sp.	Larva					1		
				Pseudocloeon sp.	Larva				1	9	2	1
		Megaloptera	Sialidae	*Sialis* sp.	Larva		3			1		2
		Odonata	Coenagrionidae	Coenagrionidae	Immature		1		1			
		Plecoptera	Nemouridae	*Amphinemura* sp.	Larva					1		1
		Trichoptera	Hydroptilidae	*Oxyethira* sp.	Larva			1				
			Limnephilidae	*Limnephilus* sp.	Larva	22	19	5	2		7	22
Mollusca	Gastropoda		Ancylidae	*Ferrissia* sp.		7	7		2	6	6	
			Planorbidae	*Menetus opercularis*		69	76		12	24	45	
				Planorbidae	Immature				26		6	2
			Pleuroceridae	*Juga* sp.			3			2	3	
	Pelecypoda		Pisidiidae	Pisidiidae		5	13		10	18	1	
Nemata				Nemata				1		1		5
Total Number of Individuals Obtained from Sample						**297**	**317**	**109**	**282**	**184**	**318**	**310**

Percent of full sample needed to obtain 300 individuals: ^{1} = 100%, ^{2} = 75%, ^{3} = 50%

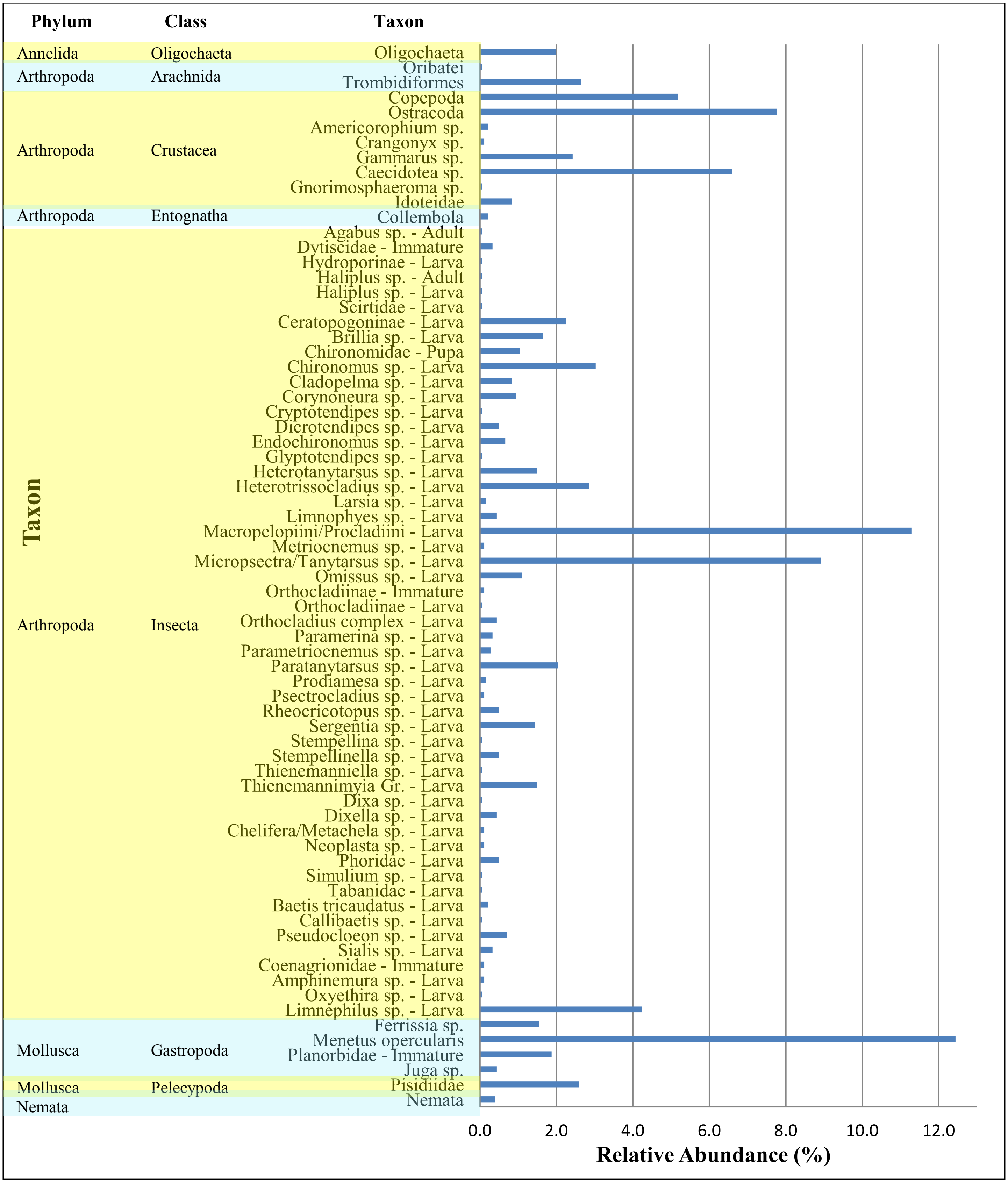


Figure 29. Relative abundance of macroinvertebrate taxa recorded from benthic samples obtained during May 2010 at the Miami Wetlands Project Site

accounted for a majority of insect taxa (38 dipteran taxa, 75 percent of all insects identified), approximately 75 percent of which were non-biting midges (Chironomids - 29 unique taxa).

In terms of number of individuals recorded, the single most abundant taxon was the gastropod, *Menetus opercularis* (12.5 percent relative abundance; Figure 29). This species (an air-breathing, freshwater snail) occurred in all but two samples (P-10 and P-11) and was particularly abundant at Stations P-1 and P-4 (Table 15). The stations where this species was absent were the two downstream-most stations sampled and, thus, most likely to regularly have brackish water conditions. The fact that this species was absent from these stations suggests that brackish, estuarine waters regularly occupied the lower portions of these channels. The next two most abundant taxa were Chironomids in the related tribes Macropelopiini/Procladiini and the related genera *Micropsectra*/*Tanytarsus* with relative abundances of 11.3 and 8.9 percent, respectively (Figure 29). The former was found in all but one sample and the latter occurred in all samples. No other taxa had greater than eight percent relative abundance and many had very low relative abundances (Figure 29).

Several studies have reported diets of juvenile salmonids (Loftus and Lenon 1977, Murphy et al. 1988, Brennan et al 2004, and Sather et al. 2008 to name a few). Small crustaceans (amphipods, copepods, isopods and ostracods) and insects (especially the larvae of chironomids and other dipterans) are important components of the diets of juvenile Chinook, Chum, and Coho salmon. These groups were well represented in the samples obtained from the Miami Wetlands.

3.2.3. Secretive Marsh Birds

As noted earlier, we conducted breeding season surveys specifically for five secretive marsh bird species: American bittern, American coot, Pied-billed grebe, Sora, and Virginia rail. Sora was the only one of these species detected during three survey sessions conducted during Spring 2010 at the Miami Wetlands site. We detected a single individual during the 29 May survey and two individuals during the 18 June survey. None was detected during the 30 June session. We also observed or heard this species incidental to other work at the site on several other occasions. None of the other four species were detected during surveys or during other work at the site.

Sora is the most widely distributed North American rail. The species generally occupies freshwater wetlands with shallow to intermediate water depths, dominated by grass-like emergent vegetation, especially cattails (*Typha* spp.), sedges (*Carex* spp., *Cyperus* spp.), burreeds (*Sparganium* spp.) and bulrushes (*Scirpus* spp.) (Melvin and Gibbs 1996). Habitats at the Miami Wetlands meet this general description, the site is within the general distribution of the species, and the species is known from other Tillamook County and Oregon coastal areas (Combs 2006a, East Cascade Audubon Society Tillamook County Checklist, North Oregon Coast Birding Trail Checklist). As a result, it is not surprising that Sora were detected at the site during breeding season surveys. Records for the species in western Oregon suggest that the species is likely a year-round resident at the site.

American coots and Pied-billed grebes are most often found at water bodies with heavy stands of emergent aquatic vegetation and moderately-deep, standing water within those stands of vegetation (Muller and Storer 1999, Brisbin et al. 2002). Both species regularly occur along the Oregon coast during non-breeding periods, but are uncommon breeders in the area (Combs 2006b, Spencer 2006, North Oregon Coast Birding Trail Checklist). Given that these are common species in western Oregon it would not be unusual to encounter them at or near the site, but neither have been confirmed on-site to date.

American Bitterns generally occupy large, freshwater wetlands with tall, emergent vegetation (Lowther et al. 2009). These authors report that the species rarely occurs in tidal marshes and Herziger and Ivey (2006) and the North Oregon Coast Birding Trail Checklist both consider the species uncommon along the Oregon Coast during all seasons. Virginia rails prefer wetlands where upright emergent vegetation is interspersed with open water, mudflats, and/or matted vegetation and typically avoid emergent stands with high stem densities or large amounts of residual vegetation (Conway 1995, Combs 2006c). The species is considered uncommon along the north Oregon coast during all seasons (North Oregon Coast Birding Trail Checklist). Given, the above it appears that the Miami Wetlands site is less suitable for these species than for Sora. However, both species were observed at other tidal wetlands in Tillamook Bay approximately 10 miles south of the Miami Wetlands site during October 2011 (D. Mandell pers. comm. via Oregon Birders Online Listserve). Given this information, it is possible for either to occur at the Miami Wetlands site, but neither has been confirmed on-site to date.

3.2.4. Fishes

As noted above, we obtained pre-construction fish data through a variety of methods and sources: Tillamook Bay Rapid Bio-Assessment data (RBA) for 2005-7, spring 2010 snorkel survey, and summer 2010 and 2011 fish salvage. The following paragraphs provide a general discussion of fishes known or expected to occur at the Miami Wetlands site, followed by specific results of each of the aforementioned studies.

To our knowledge no comprehensive study of the fish community of the Miami River basin has been conducted. However, two studies have evaluated the fish community of Tillamook Bay, including tidal wetlands (Bottom and Forsberg 1978, Ellis 1999 and 2002) and two other documents provide information on fishes from the nearby Wilson River (Rose 2000, Duck Creek Associates 2008). These four documents list a number of different species that could potentially occur at the Miami Wetlands site. These include, but are not limited to, five salmonids (Chinook, Coho and Chum salmon and Steelhead and Cutthroat trout), two sturgeons (Green sturgeon [*Acipenser medirostris*] and White sturgeon [*A. transmontana*]), three lampreys (Pacific lamprey [*Lampetra tridentata*], Western brook lamprey [*L. richardsoni*], and River lamprey [*L. ayresi*]), several sculpins (including Prickly sculpin [*Cottus asper*], Torrent sculpin [*C. rhotheus*], Reticulate sculpin [*C. perplexus*], Coastrange sculpin [*C. aleuticus*], Riffle sculpin [*C. gulosus*], and Pacific staghorn sculpin [*Leptocottus armatus*]), and the three-spined stickleback (*Gasterosteus aculeatus*). Given that the site is very low in the Miami River drainage and brackish estuarine water regularly inundates a portion of the site a variety of other marine and estuarine species may also venture onto the site. However, these species are expected to be only occasional visitors and a full accounting of them is beyond the scope of this document.

Prior to restoration actions, three general aquatic habitat types suitable for use by fishes were present at the site. The lower channel segments north of the river (extreme lower Hobson-Struby Channel and lower portion of Watercourse 1 [Figure 14]) and a portion of the channel south of the river had slow moving, moderately deep water (3-6 ft deep depending on location, tide phase, and precipitation); silty bottoms; and were occasionally inundated with brackish estuarine waters. The upper portions of the drainage ditch system north of the river (Watercourses 1, 2, 3, and 4 [Figure 14]), the middle portion of the Hobson-Struby channel, and portions of the channel south of the river had slow moving water that was generally 2-4 ft deep (depending on tide and precipitation), had silty bottoms and fresh water. The upper portion of the Hobson-Struby Channel and the segment of Struby Creek that occurs on the property had swifter flowing water that was generally 3 ft or less deep, gravel bottoms in many places, and fresh water. There also were two dead-end segments of channels north of the river (portions of Watercourses 2 and 3 [Figure 14]). These segments had shallow, still waters (generally 2 ft deep or less) and silty bottoms and the water was often warmer and murkier and contained more submergent vegetation than other portions of the channels. These segments provided only marginal fish habitat and were likely rarely used by salmonids.

During the Tillamook Bay Rapid Bio-Assessment (RBA) surveyors conducted snorkel counts within and adjacent to the Miami Wetlands project area during each of three summers (2005-7). This effort was designed primarily to survey juvenile Coho and the summer survey timing precluded observation of juvenile Chum and greatly limited potential for juvenile Chinook observations (both species out-migrate to marine and/or estuarine waters shortly after emerging from gravel nests during spring months). As a result, Coho, Cutthroat and Steelhead were the primary salmonids recorded during these surveys. Observations of non-salmonid fishes were not recorded by observers.

Juvenile Coho were observed within the Miami Wetlands Project Site during each of the three RBA survey efforts (Bio-Surveys, LLC 2007). Average density of juvenile Coho in pools during these efforts was approximately 0.4 fish/m^2. RBA surveyors observed juvenile Steelhead trout at the Miami Wetlands site only during the 2007 effort. Average density of juvenile Steelhead during this period was approximately 0.4 fish/m^2. Cutthroat trout were observed during each of the three survey efforts. Average Cutthroat density also was approximately 0.4 fish/m^2. Zero+ trout (young of the year trout not identified to species) were observed during all three survey efforts. Average density of 0+ trout within Miami Wetlands pools was approximately 0.5 fish/m^2. No juvenile Chinook or Chum salmon were observed during these surveys (not surprising given that these survey efforts were completed during summer – after juvenile Chinook and Chum have migrated out of their natal freshwater habitats). Based on these numbers, pools at the Miami Wetlands site typically contained approximately two juvenile salmonids per square meter of surface area during the summers of 2005-7.

Bio-Surveys, LLC (2007) reports that spawning habitats were very limited in both Hobson and Struby creeks and speculated that most salmonids observed in these streams during the surveys were upstream migrants from the mainstem Miami River, not fish that hatched from redds within these streams. They also report that although habitats in the wetland were degraded due to past conversion of the site for agricultural purposes, the creeks provide fresh water inputs into the lower Miami system and, if restored, the wetlands could provide "high quality summer and winter salmonid habitat" and a "low saline refugia for juvenile salmonids."

During June 2010, ODFW Biologist, Phil Simpson completed a snorkel survey of the channels within the portion of the Miami Wetlands site north of the Miami River. During this effort, he recorded all salmonids and lamprey observed and where observations occurred. Although he noted the presence of large numbers of Three-spined stickleback throughout the areas he surveyed, he did not report numbers for this species nor did he record observations of any other non-salmonid fishes.

Simpson observed juvenile Coho in all surveyed channels with the exception of the dead-end segments of Watercourses 2 and 3 (Figure 14, Table 16). Coho observations were not distributed evenly throughout the surveyed channels. Instead, they were concentrated primarily on the downstream sides of beaver dams or other in-stream structures. For example, 67 of the 71 juvenile Coho observed in the Hobson-Struby Channel were recorded on the downstream side of a beaver dam located near the mouth of the channel. Simpson also observed Cutthroat trout in all of the surveyed channels (except the dead-end segments). These fish ranged in age from juvenile to adult. Many of the adults appeared to be sea-run fish and these individuals made up a majority of the Cutthroat trout observed in Watercourse 4. Unlike Coho which were observed in clusters, Cutthroat trout were distributed throughout the reaches where they were observed. Simpson observed only one Steelhead trout during his survey. This was a juvenile fish in Watercourse 3. Simpson observed nine adult Brook lamprey in the upper portion of the Hobson-Struby channel. All of these fish were actively spawning and were associated with two redds constructed in the gravel substrate of this portion of the channel. Three-spined stickleback occurred in all surveyed channels. Simpson did not attempt to record numbers for this species, but did note that the species was abundant throughout all surveyed reaches. Simpson made special note of the dead-end segments of watercourses 2 and 3 (Figure 14). He reported that no fish were observed in these segments and that water temperature increased and visibility decreased notably in these segments.

Table 16. Fish observations made during June 2010 snorkel survey at Miami Wetlands Project site.

Channel ID	Surveyed Length (ft)	Number of Individuals Observed				
		Coho	Cutthroat	Steelhead	Brook Lamprey	Three-spined Stickleback
Hobson-Struby Channel	412	71	16		9	Present throughout
Struby Creek*	192	Not Surveyed – No pools				
Watercourse 1	366	120	3			Present throughout
Watercourse 2	128	2	4			Present throughout
Watercourse 3	61	26	4	1		Present throughout
Watercourse 4	153	4	16			Present throughout
Dead-end Segments	174	No Fish Observed				

*upstream of its confluence with Hobson Creek, but south of Miami-Foley Road.

It should be noted at this time that the channels at the Miami Wetlands site were not ideally suited for snorkel surveys and this is likely not the most appropriate method to survey for fishes at this site. In general, the channels were straight, constructed channels with fairly uniform depths and slow flowing water. In addition, bottom substrates were very soft and mobile, predominantly composed of silt and decaying organic matter. These features are not conducive to pool formation, and, in general, pools on the site were not the classic lateral scour or plunge pools seen on more swiftly flowing streams with coarser substrates. Instead, most pool-like features in these channels were associated with beaver dams and beaver activities that widened and further slowed water in the channels. Water in the channels also contained large amounts of suspended organic matter (plankton, etc.) and tannins, which limited visibility under all circumstances. Further, visibility could be reduced to near zero if bottom sediments were disturbed during a survey. These sediments would enter the water column as a plume and cloud the water such that it would take on the color of chocolate milk. Because water in the channels was generally slow moving, once a sediment plume entered the water column it would take a long period of time for these sediments to settle out and visibility to return to pre-disturbance conditions.

The final source of pre-construction fish data available to us are the results of fish salvage efforts needed to remove fish from existing channels before they could be cleared of bankside vegetation and filled with soil. Due to weather and other unforeseen circumstances, all construction activities were not completed over the course of a single summer (as originally planned). As a result, two separate fish salvage efforts were completed (July and September 2010 and August 2011).

During the 2010 effort, we completed salvage actions in all of the existing channels that were to be filled as part of the restoration project (Figure 14). In most channels, minnow trap deployment was followed by pole seining and dip netting (block nets also were deployed to exclude fish from cleared areas). Fish were captured and relocated from most of the channels north of the Miami River. However, to minimize potential for capture mortality we primarily used pole seines to flush fish downstream and out of the construction zone along the Hobson-Struby channel (without capturing and handling them). As a result, we handled and counted fish captured in Watercourses 1-4, but did not enumerate fish flushed from the Hobson-Struby channel.

We recorded five separate fish taxa during the 2010 salvage effort (Coho, Cutthroat, Lamprey, Three-spined stickleback, and Sculpin – we did not identify Lamprey or Sculpin to species during this effort). Juvenile Coho were the most abundant salmonid salvaged during the 2010 operation (approximately 400 were captured and relocated during 2010). The species occurred in all of the channels where salvage operations were conducted, but most (approximately 70 percent) were captured in Watercourse 1. Cutthroat trout were uncommon during the 2010 salvage effort. Only 12 Cutthroat were captured and relocated (all from watercourses 2 and 4). Approximately 50 lamprey were captured and relocated from watercourses 2 and 4 during 2010. Given that Brook Lamprey were observed spawning on site during June 2010, it seems likely that the ammocetes observed during salvage operations belonged to this taxa. However, because it is very difficult to differentiate juvenile lamprey, we made no attempt to identify ammocetes to species. Three-spined stickleback was by far the most numerous species captured during this salvage effort. While we captured and relocated approximately 1,000 individual stickleback, many, many more were not salvaged. We captured and relocated approximately 350 sculpins during 2010. Similar to stickleback, we observed many more sculpin that we were able to capture and relocate. Based on habitat preferences, the sculpin species most likely to regularly occur at the Miami Wetlands site is the Prickly sculpin (*C. asper*). However, many coastal sculpin species appear similar and we did not attempt to identify sculpin captured during salvage. All fish captured in channels during 2010 were relocated to the mouth of Illingsworth Creek, a tributary of the Miami River located just upstream of the Miami Wetlands site.

In 2010, construction of a new Hobson-Struby channel was completed and the waters of these creeks were directed into this new channel. Although plugs were constructed at the upstream and downstream ends of the old channel (the Hobson-Struby channel depicted on aerial photographs in this report), we were unable to completely fill the old channel during 2010. As a result, this activity was scheduled for completion during summer 2011. Although this channel was drained and prepped for filling during 2010, it was inundated during winter floods and needed to be drained and cleared of fishes before any construction actions could occur in 2011. We used backpack electrofishing equipment and dip nets to conduct this salvage action. Because minnow traps proved ineffective at capturing salmonids during 2010 (only two were captured and relocated in this manner), we did not employ this technique during 2011. Similar to 2010, we initiated salvage operations in conjunction with pumping of water from this remnant channel.

Results of the 2011 fish salvage effort were similar to those of the 2010 operations, but we only captured four separate fish taxa during the 2011 salvage effort (Coho, Lamprey, Sculpin, and Three-spined stickleback). Coho were abundant in the 2011 sample (approximately 320 were captured and relocated). We captured approximately 35 lamprey ammocetes during 2011. As in 2010, we did not identify these to species. Sculpin and Three-spined stickleback also were abundant in 2011. We captured approximately 225 sculpin (not identified to species) and just over 1,400 sticklebacks. Similar to 2010, we observed far more of each of these species than we were able to capture and relocate. All fishes captured during the 2011 salvage operation were immediately released into the newly constructed Hobson-Struby channel.

3.2.5. Other Vertebrate Species

We recorded incidental observations (including sign (e.g., tracks, scat, etc.) and actual observations of individuals) of reptiles and amphibians, birds, and mammals while conducting field work at the site. Appendix 5 provides a list of these species. This list is not intended as an exhaustive list of vertebrate species potentially occurring at the site and no species specific surveys or specialized sampling techniques (other than those discussed in previous sections).

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Appendix 1

Photographs of soil samples used for soil salinity analysis.
Container on left is larger organic matter and, in one case, gravels that did not pass through sieve. Container on right is the portion of sample that passed through sieve.


A1


A2


A3


B1


B2


B3


C1


C2


C3


D1


D2


E1


E2


E3


F1


F3


G2


H1

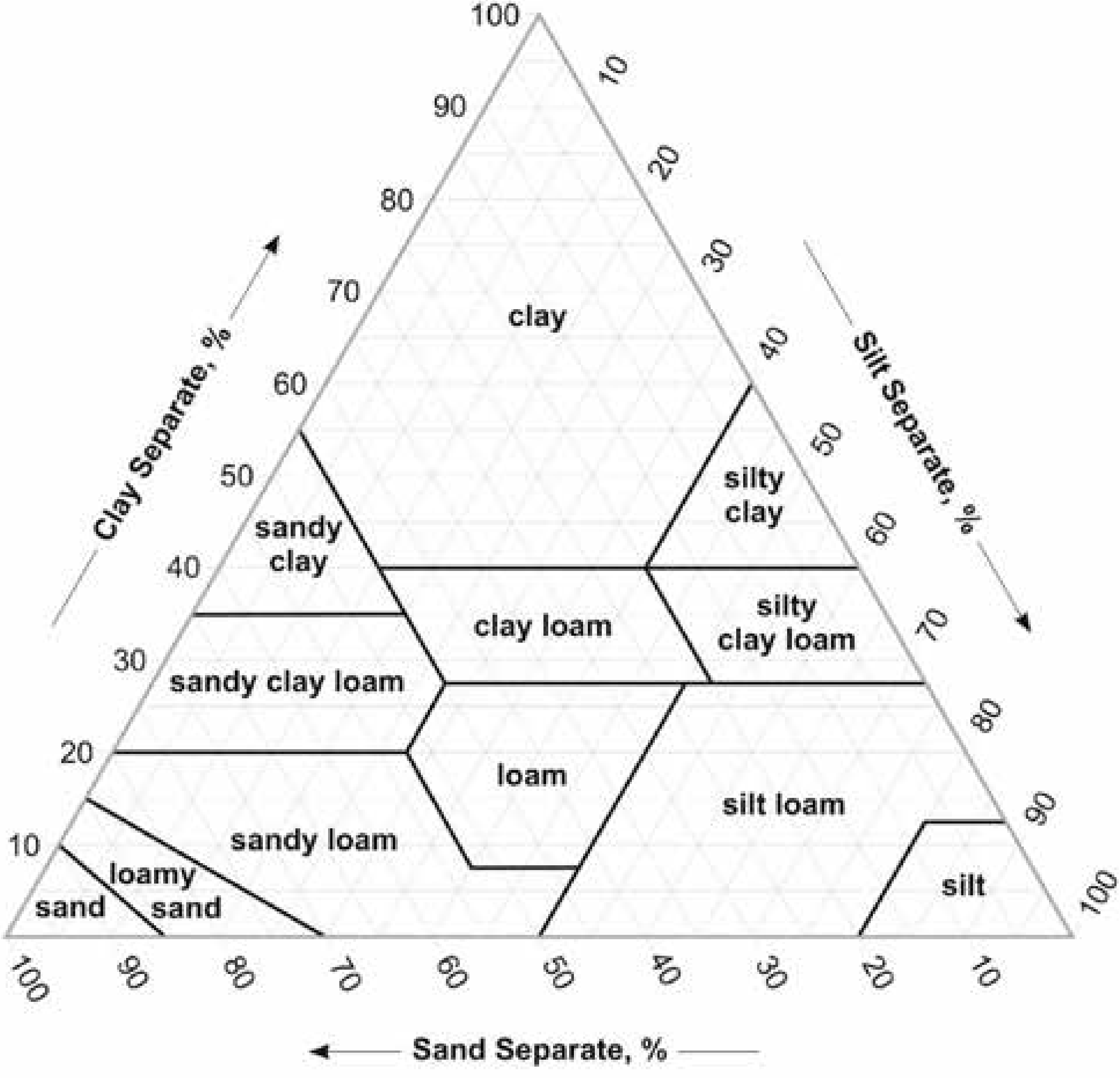

H3


I1


I2


I3

Soil Textural Triangle



Appendix 2

Plant species known to occur at Miami Wetlands Project site

Four Letter Code	Latin Name	Common Name	Wetland Indicator Status
ACCI	*Acer circinatum*	Vine maple	FAC
AGCA	*Agrostis capillaris*	Colonial bentgrass	FAC
ALRU	*Alnus rubra*	Red alder	FAC
ALPR	*Aloperurus pratensis*	Meadow foxtail	FACW
ANOD	*Anthoxanthum odoratum*	Sweet vernal grass	FACU
ATFI	*Athyrium filix-femina*	Lady fern	FAC
BLSP	*Blechnum spicant*	Deer fern	FAC
CAsp	*Callitriche* sp.	Water-starwort	OBL
CADEW	*Carex deweyana*	Dewey's sedge	FACU
CAOB	*Carex obnupta*	Slough sedge	OBL
CAST	*Carex stipata*	Saw-beak sedge	OBL
CIAR	*Cirsium arvense*	Canada thistle	FACU
CLSI	*Claytonia sibirica*	Siberian spring beauty	FAC
COAR	*Convulvulus arvensis*	Field bindweed	UPL
COSE	*Convulvulus sepium*	Hedge bindweed	UPL
CRDO	*Craetaegus douglasii*	Douglas hawthorn	FAC
DAGL	*Dactylis glomerata*	Orchardgrass	FACU
ELOV	*Eleocharis ovata*	Ovoid spikerush	OBL
ELPA	*Eleocharis palustris*	Common spikerush	OBL
EPCI	*Epilobium ciliatum (watsonii)*	Watson willowherb	FACW
EQAR	*Equisetum arvense*	Common horsetail	FAC
FEAR	*Festuca arundinacea*	Tall fescue	FAC
GAsp	*Gallium* sp.	Bedstraw	
GEMA	*Geum macrophyllum*	Oregon avens	FACW
GLBO	*Glyceria borealis*	Northern mannagrass	OBL
HEHE	*Hedera helix*	English ivy	
HELA	*Heracleum lanatum*	Cow parsnip	FAC
HOLA	*Holcus lanatus*	Velvetgrass	FAC
IMCA	*Impatiens capensis*	Spotted touch-me-not	FACW
IMNO	*Impatiens noli-tangere*	Yellow touch me not	FACW
IRPS	*Iris pseudoacorus*	Yellow flag iris	OBL
JUBA	*Juncus balticus*	Baltic rush	FACW
JUEF	*Juncus effuses*	Soft rush	FACW
JUPA	*Juncus patens*	Grooved rush	FACW
LOIN	*Lonicera involucrata*	Black twinberry	FAC
LOCO	*Lotus corniculatus*	Birdsfoot trefoil	FAC
LOUL	*Lotus ulignosus*	Large birdsfoot trefoil	FAC
LYAM	*Lysichiton americanum*	Skunk-cabbage	OBL
MAFU	*Malus fusca*	Crabapple	FACW
PHAR	*Phalaris arundinacea*	Reed canarygrass	FACW
PHCA	*Physocarpus capitatus*	Pacific ninebark	FACW
PISI	*Picea sitchensis*	Sitka spruce	FAC
PLMA	*Plantago major*	Common plantain	FACU
POPA	*Poa palustris*	Fowl bluegrass	FAC

Four Letter Code	Latin Name	Common Name	Wetland Indicator Status
POTR	*Poa trivialis*	Rough bluegrass	FACW
POCU	*Polygonum cuspidatum*	Japanese knotweed	FACU
POMU	*Polystichum munitum*	Western sword fern	FACU
POTR	*Populus trichocarpa [balsamifera]*	Black cottonwood	FAC
POAN	*Potentilla anserina ssp. Pacifica*	Pacific silverweed	OBL
PSME	*Pseudotsuga menziesii*	Douglas fir	FACU
PTAQ	*Pteridium aquilinum*	Bracken fern	FACU
RAOC	*Ranunculus occidentalis*	Common buttercup	FAC
RARE	*Ranunculus repens*	Creeping buttercup	FACW
RUAR	*Rubus armenicus*	Armenian blackberry	FACU
RULA	*Rubus lacinatus*	Cut-leaf blackberry	FACU
RUPA	*Rubus parviflorus*	Thimbleberry	FAC
RUSP	*Rubus spectabilis*	Salmonberry	FAC
RUUR	*Rubus ursinus*	Trailing blackberry	FAC
RUAC	*Rumex acetosella*	Sheep sorrel	FACU
RUCR	*Rumex crispus*	Curly dock	FAC
RUOB	*Rumex obtusifolius*	Broadleaved dock	FAC
SAHO	*Salix hookeriana*	Hooker's willow	FACW
SALU	*Salix lucida ssp lasiandra*	Pacific willow	FACW
SAPI	*Salix piperi*	Scouler willow	FACW
SASI	*Salix sitchensis*	Sitka willow	FACW
SARA	*Sambucus racemosa*	Red elderberry	FACU
SCMI	*Scirpus microcarpus*	Small-fruited bulrush	OBL
SPEM	*Sparganium emersum*	Narrowleaf burreed	OBL
STCO	*Stachys chamissonis var. cooleyae*	Coast hedge nettle	FACW
TOME	*Tolmeia menziesii*	Piggy-back plant	FAC
TYLA	*Typha latifolia*	Cattail	OBL
URDI	*Urtica dioica*	Stinging nettle	FAC
VAAM	*Vallisneria americana*	Tapegrass	OBL
VIAM	*Vicia americana*	American vetch	FAC
VIGI	*Vicia gigantea*	Giant vetch	FAC

OBL	Obligate Wetland	Occurs almost always (estimated probability 99%) under natural conditions in wetlands.
FACW	Facultative Wetland	Usually occurs in wetlands (estimated probability 67%-99%), but occasionally found in non-wetlands.
FAC	Facultative	Equally likely to occur in wetlands or non-wetlands (estimated probability 34%-66%).
FACU	Facultative Upland	Usually occurs in non-wetlands (estimated probability 67%-99%), but occasionally found on wetlands (estimated probability 1%-33%).

Appendix 3

Photographs of vegetation transects

Transect A – East to West June 15, 2010

Transect A – West to East June 15, 2010

Transect B – East to West June 15, 2010


Transect B – West to East June 15, 2010


Transect C – West to East June 15, 2010

Transect C – East to West June 15, 2010

Transect D – West to East June 15, 2010


Transect D – East to West June 15, 2010

Transect E – West to East June 16, 2010

Transect F – West to East June 16, 2010

Transect G – North to South June 14, 2010

Transect G – South to North June 14, 2010

Transect H – North to South June 14, 2010

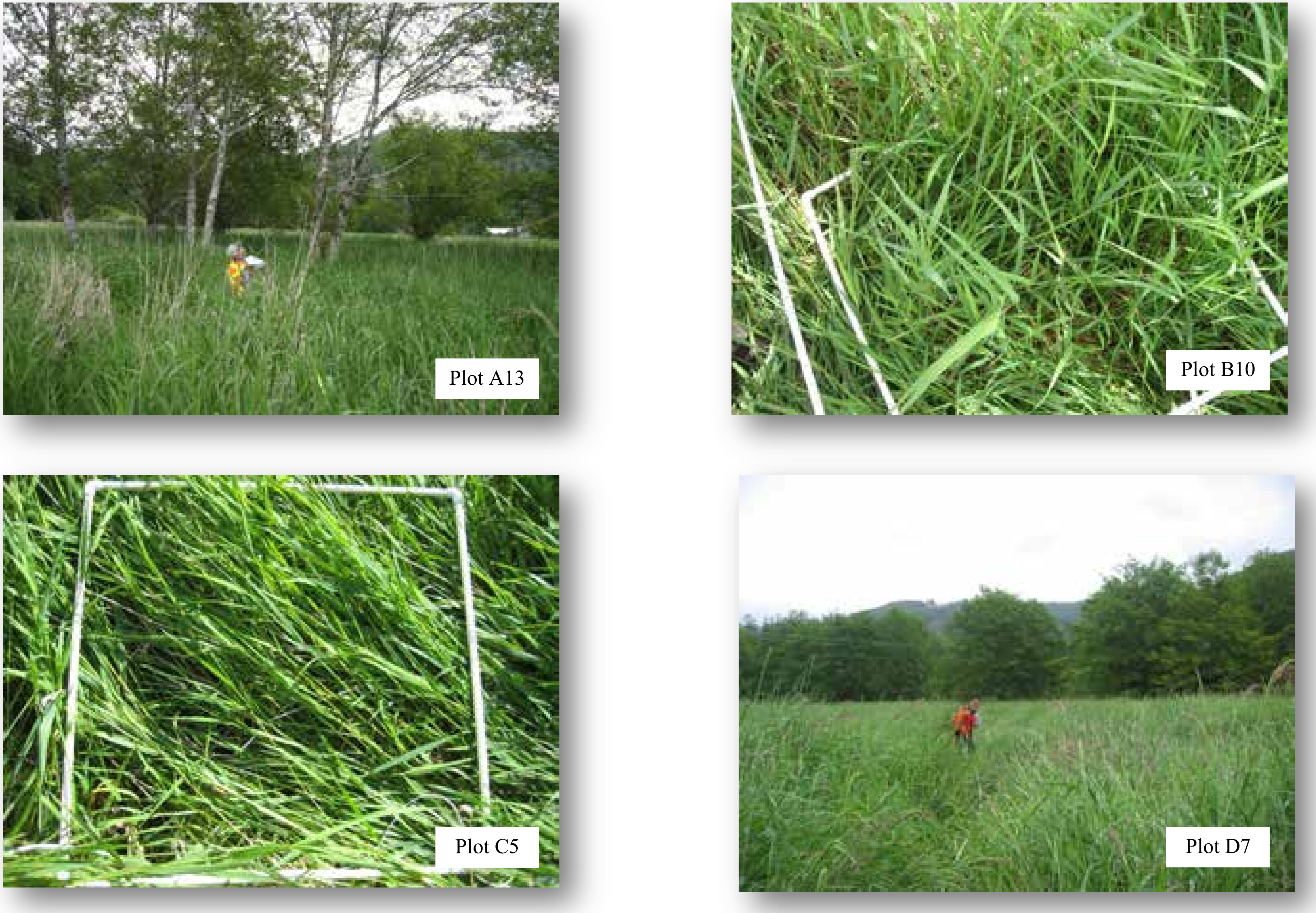
Transect H – South to North June 14, 2010

Transect I – North to South June 14, 2010

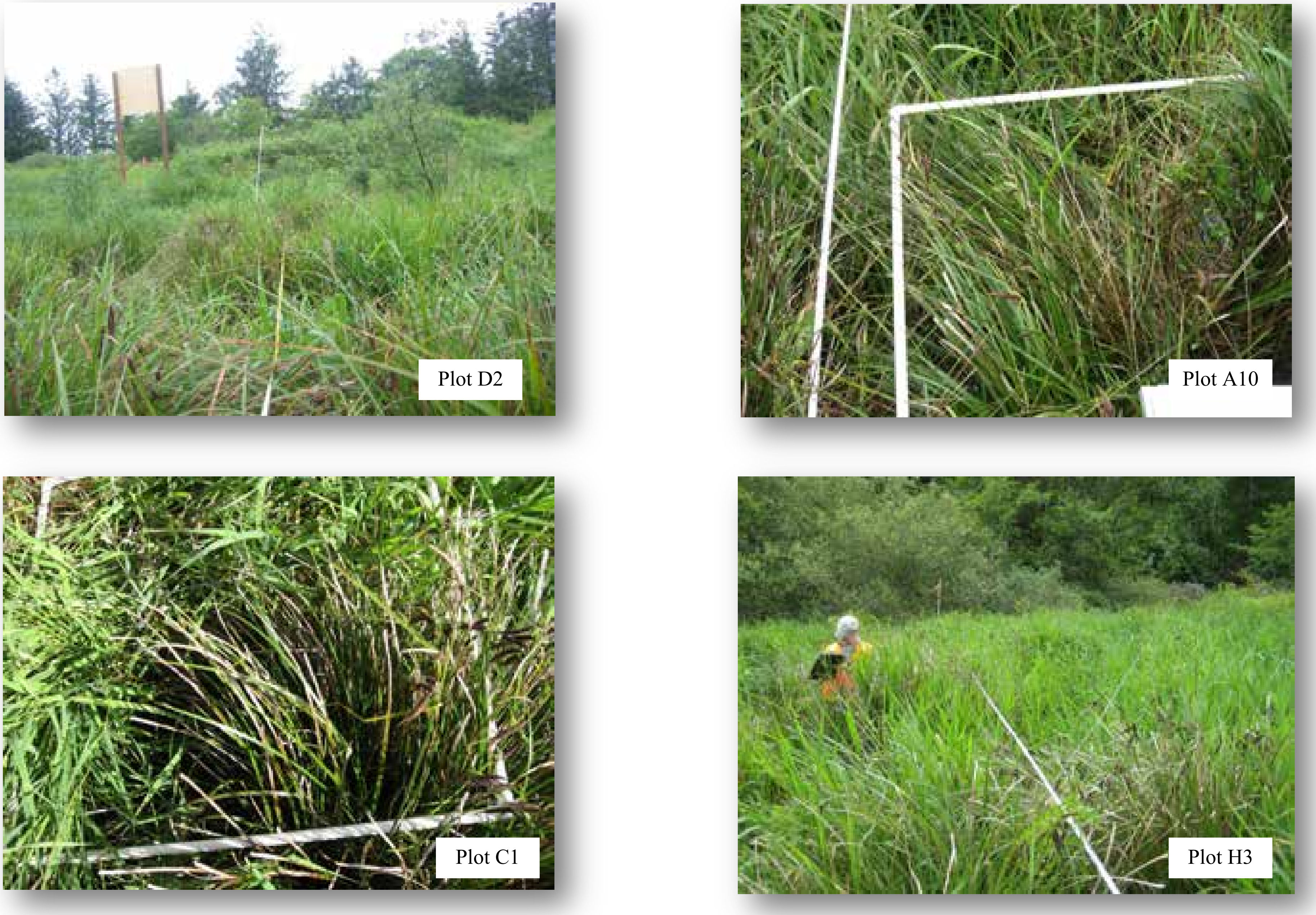
Transect I – South to North June 14, 2010

Appendix 4

Representative photos of vegetation communities at Miami Wetlands Project site



Close-up and overview photos of PEM1 Vegetation Community



Plot D2

Plot A10

Plot C1

Plot H3

Close-up and overview photos of PEM2 Vegetation Community

Plot H4

Plot H5

Plot G5

Plot G5

Close-up and overview photos of PEM3 Vegetation Community

Plot F7

Plot F6

Plot F7

Close-up and overview photos of PEM4 Vegetation Community

Plot I6

Plot B5

Plot I8

Plot I8

Close-up and overview photos of PSS Vegetation Community


Plot D14

Plot F2

Plot B15

Plot D12

Close-up and overview photos of Riparian 1 Vegetation Community


Plot G7


Plot F12


Plot I11


Plot I11

Close-up and overview photos of Riparian 2 Vegetation Community

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Appendix 5

Vertebrate species observed at Miami Wetlands Project site (excluding fishes)

Latin Name	**Common Name**
REPTILES and AMPHIBIANS	
Ambystoma gracile	Northwestern salamander
Taricha granulose	Rough-skinned newt
Hyla regilla	Pacific treefrog
Rana aurora ssp. *aurora*	Northern red-legged frog
Thamnophis sirtalis ssp. *concinnus*	Red-spotted garter snake
BIRDS	
Phalacrocorax auritus	Double-crested cormorant
Ardea herodias	Great blue heron
Cathartes aura	Turkey vulture
Buteo jamaicensis	Red-tailed hawk
Haliaeetus leucocephalus	Bald eagle
Pandion haliaetus	Osprey
Porzana carolina	Sora
Charadrius vociferous	Killdeer
Actitis macularia	Spotted sandpiper
Tyto alba	Barn owl
Bubo virginiana	Great horned owl
Ceryle alcyon	Belted kingfisher
Colaptes auratus	Northern flicker
Contopus sordidulus	Western wood-pewee
Empidonax difficilis	Pacific-slope flycatcher
Empidonax traillii	Willow flycatcher
Vireo gilvus	Warbling vireo
Corvus brachyrhynchos	American crow
Corvus corax	Common raven
Aphelocoma californica	Western scrub-jay
Tachycineta thalassina	Violet-green swallow
Poecile atricapillus	Black-capped chickadee
Cistothorus palustris	Marsh wren
Regulus calendula	Ruby-crowned kinglet
Catharus ustulatus	Swainson’s thrush
Turdus migratorius	American robin
Bombycilla cedorum	Cedar waxwing
Vermivora celata	Orange-crowned warbler
Dendroica coronate	Yellow-rumped warbler
Dendroica petechia	Yellow warbler
Geothlypis trichas	Common yellowthroat
Pipilo maculates	Spotted towhee
Melospiza melodia	Song sparrow
Zonotrichia leucophrys	White-crowned sparrow
Zonotrichia atricapilla	Golden-crowned sparrow
Junco hyemalis	Dark-eyed junco
Pheucticus melanocephalus	Black-headed grosbeak

Agelaius phoeniceus	Red-winged blackbird

MAMMALS

Canis latrans	Coyote
Odocoileus hemionus ssp. *columbianus*	Columbian black-tailed deer
Ursa americanus	American black bear
Procyon lotor	Northern raccoon
Thomomys mazama	Western pocket gopher
Castor canadensis	American beaver
Microtus townsendii	Townsend’s vole
Ondatra zibethicus	Muskrat