



Wetland Inventory and Mapping Report

Hopewell Furnace National Historic Site

Natural Resource Report NPS/MIDN/NRR—2017/1386



ON THE COVER

Wetland-20 located adjacent to SR 345 within an existing livestock grazing area 6 October 2014.

Photograph by: Peter J. Sharpe

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Abstract

The objective of this inventory was to delineate and map all palustrine wetlands subject to jurisdiction under Section 404 of the Clean Water Act and all wetlands subject to National Park Service (NPS) procedures for implementing *Director's Order #77-1: Wetland Protection* at Hopewell Furnace National Historic Site (HOFU). This investigation adhered to the U.S. Army Corps of Engineers (USACE) Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Eastern Mountains and Piedmont as the primary methodology for making wetland determinations in the field. Under National Park Service D.O. #77.1 guidelines the USACE methodology is appropriate for wetland features possessing vegetation and soils. This inventory only provides data for land-based (palustrine) wetland features, no attempts were made to delineate waterway (riverine systems). A total of 31 unique palustrine wetland features totaling 77.53 ac (31.38 ha) of land were identified and delineated from August-October 2014 and October 2015. All of the identified and mapped palustrine wetland systems meet both the U.S. Army Corps of Engineers criteria and the Cowardin et al. (1979) definitions. No new riverine systems were identified and mapped over the course of this investigation within the park boundary. The majority of the larger wetland systems were located in areas previously identified by park staff and USGS/NPS vegetation mapping (i.e. French Creek floodplain); however, a significant number of previously unmapped smaller wetland areas were identified over the course of this investigation including the identification and verification of several vernal pool habitats. The improved boundary information and field delineated wetland mapping will significantly improve the park's ability to effectively manage, protect, and monitor these unique resources.

Acknowledgments

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Introduction

The primary objective of this report is to describe and document the wetland inventory and mapping work performed from August-October 2014 and October 2015 within a 848 ac (343 ha) study area of the Hopewell Furnace National Historic Site (HOFU). This report was prepared, in part, to satisfy the regulatory requirements of the U.S. Army Corps of Engineers (USACE), which has jurisdictional authority over wetlands and waterways of the United States under the purview of Section 404 of the Clean Water Act and the NPS under Director's Order #77.1, and the Organic Act of 1916. This whole park inventory of palustrine wetland features was also conducted in response to a Technical Assistance request made by the park to the National Park Service – Water Resources Division to assist with their compliance and park planning efforts.

The results of this report will provide the park with a definitive inventory of all of the existing palustrine wetland systems and their associated boundaries with sub-meter accuracy within the study area boundary, excluding any in-holdings. These efforts will assist the park with their environmental compliance needs, as well as, long term planning efforts such as French Creek floodplain management within the historic village, the Natural Resource Condition Assessment, and Foundation Document for the park. Additional benefits of this work may also include participation in multi-park assessments of wetland remote sensing efforts (see Sharpe et al. 2016), which can help inform and improve these techniques service wide.

Study Area Description

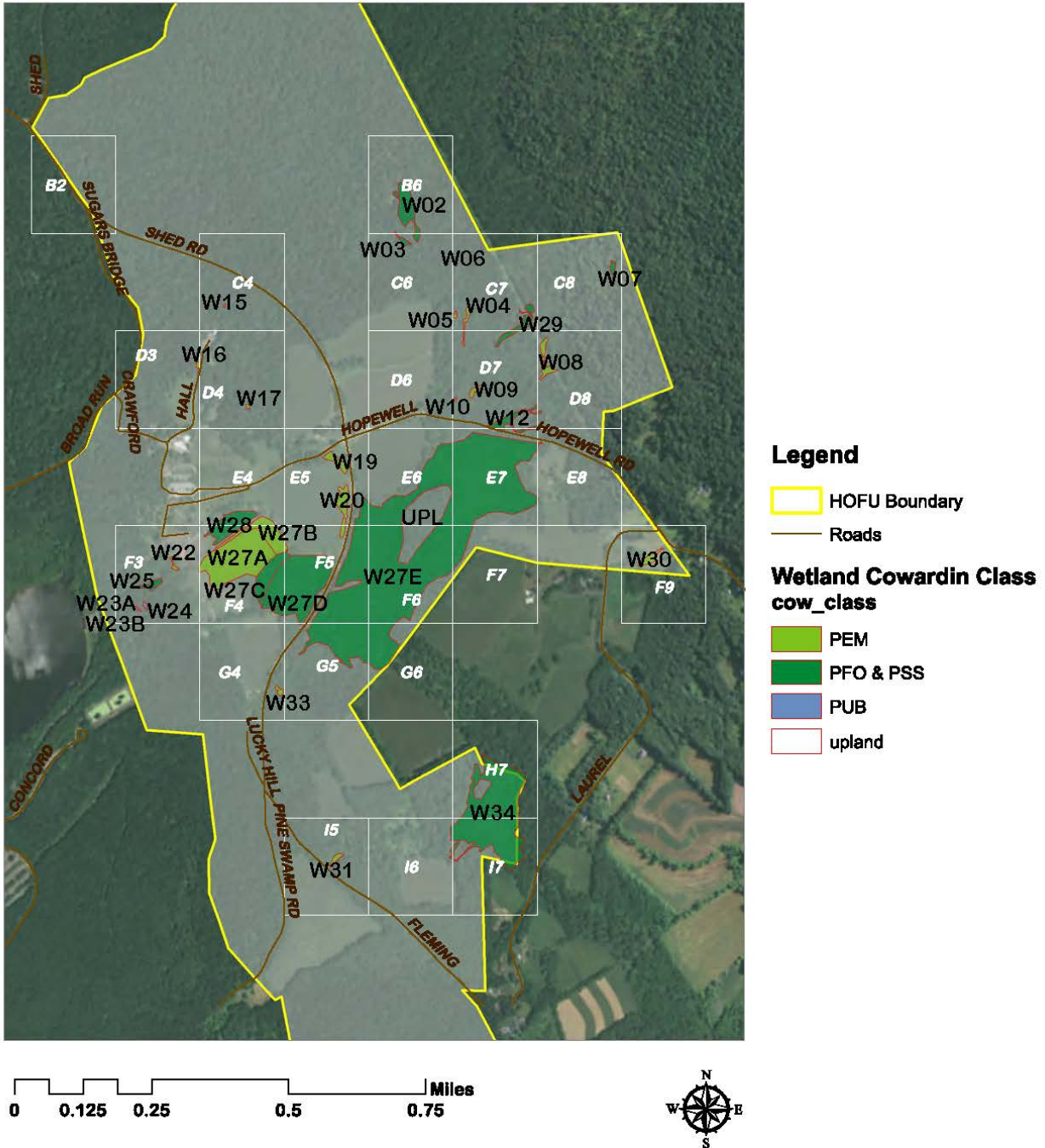
The study area described below and shown in Figure 1 represents a total of 848 ac (343 ha) of National Park Service lands located in Berks and Chester Counties, near the town of Elverson, PA.

"Hopewell Furnace is an early American industrial community that operated from 1771 to 1883. The cold-blast iron furnace and accompanying community has been restored to the way it looked during the 1830s and 1840s, when the furnace was at its height of activity. Like the better known agricultural plantations in the American south, these early industrial enterprises were typically isolated, largely self-sufficient communities centered around the production of iron as its saleable product. Furnace owners built dwellings, stores and other structures not normally required of a business, to provide for their workers' daily needs. Though built on different social and economic foundations from their southern counterparts, there were parallels in size, rural setting and concentration on one product. The Hopewell Furnace property was purchased by the federal government on 1935 to become part of a "Recreation Demonstration Area" developed by the Work Projects Administration (WPA). Some restoration and development work was performed by the Civilian Conservation Corps (CCC) between 1935 and 1942. On August 3, 1938, a "core" historic area of the property was designated a National Historic Site. The remainder of the property was transferred to the State of Pennsylvania in 1946 and today makes up most of neighboring French Creek State Park (NPS 2016 – online <http://www.nps.gov/hofu/faqs.htm>)."

Hopewell Furnace National Historic Site



2014-2015 Wetland Study Area



Date: 5/3/2016

Northeast Region Natural Resource Science - P. Sharpe, J. Farrell

Figure 1. Site location map of Hopewell Furnace National Historic Site (HOFU) wetlands inventory broken out into grids which correspond to photograph and wetland locations in the Appendix B photo captions.

The park is situated within the French Creek sub-watershed within the greater Schuylkill River basin of southeastern Pennsylvania. Mapped tributaries to French Creek within the park include Spout Run and Baptism Creek. The landscape at HOFU is comprised of roughly 78% forested lands the majority of which have been historically disturbed from logging and other activities associated with the site's furnace operations that used trees for charcoal production (Thornberry-Ehrlich 2010, Podniesinski et al. 2005). The remainder of the park landscape is comprised of 14% managed grasslands and cropland, and 8% developed land and infrastructure (Podniesinski et al. 2005). Today, six broadly defined vegetation groups can be found within the park: tulip poplar forest, dry oak–mixed hardwood forest, dry oak–heath forest, successional forest, palustrine shrublands, and palustrine forests. The distribution and plant species composition of these communities receives detailed treatment in Podniesinski et al. (2005) and as such is not described extensively in this report.

Ground surface elevations within the park range from 280 m (920 ft) in the north to 140 m (460 ft) in the east where French Creek exits the park (Thornberry-Ehrlich 2010). The northern end of the park is a low rolling hill of erosion-resistant quartz conglomerate and sandstone of the Triassic Hammer Creek Formation (Podniesinski et al. 2005). The lower elevations within the park's center are comprised of the more easily weathered Triassic Stockton Formation (arkosic sandstone, sandstone, siltstone, and mudstone). The hills along the southern end of the park are comprised of Precambrian mafic, felsic, and graphitic gneiss, along with the Cambrian Chickies Formation (quartzite, quartz schist, slate, and conglomerate). The Chickies Formation is noteworthy as it gives rise to a steep boulder field formation along the west-central edge of the park (Podniesinski et al. 2005).

The underlying geology, resulting geomorphology, and current/past anthropogenic disturbances within the park have greatly influenced the type and distribution of vegetation. The erosion resistant bedrock of the northern and southern thirds of the park has given rise to thin, rocky, well drained, and excessively well drained soils favoring oak-dominated forests and woodlands (Podniesinski et al. 2005). The softer (more easily weathered) bedrock in the park center favors the formation of deeper, richer soils favoring mesic and wet forest/wetland vegetation. Associated with the valley are mid- and low-slope areas of groundwater discharge which favor forested seeps and shrub wetlands.

The floodplain of French Creek is characterized by poorly drained and frequently flooded, alluvial soils, favoring development of forested wetland, shrubland, and emergent wetland habitats within the cultural meadows and active pasture lands contained therein (Figure 2).



Figure 1. View west of a typical HOFU Wetland within the floodplain of French Creek (Wetland-27E photographed here) 19 June 2014. The livestock fencing shown in the photograph delineates the forested wetland from the grazed emergent portion of the wetland system.

Methods

The NPS through Director's Order #77-1 requires mapping of wetlands and all other "waters of the United States" via different criteria than the USACE 1987 manual and associated regional supplements. The NPS wetland identification and mapping criteria follow the

Cowardin et al. (1979) classification scheme. Under the Cowardin definition a wetland must possess one or more of the following general attributes:

1. at least periodically, the land supports predominantly hydrophytes (wetland vegetation);
2. the substrate is predominantly undrained hydric soil; or
3. the substrate is non-soil and is saturated with water or covered by shallow water at some time during the growing season of each year.

It is important to note that following this procedure is not advocating for a one-parameter approach to wetland determinations and delineations in the field. The NPS uses the Cowardin et al. (1979) classification as the basis for wetland determinations because it encompasses more aquatic habitat types than the definition (33 CFR 328.3) and delineation manual used by the Corps of Engineers for identifying wetlands subject to Section 404 of the Clean Water Act. The 1987 "Corps of Engineers Wetlands Delineation Manual" requires that *all three* of the parameters listed above (hydrophytic vegetation, hydric soil, wetland hydrology) be present in order for an area to be considered a wetland (with some exceptions for "atypical situations" and "problem areas"). The Cowardin wetland definition includes such wetlands, but also adds some areas that, though lacking vegetation and/or soils *due to natural physical or chemical factors* such as wave action or high salinity, are still saturated or shallow inundated environments that support aquatic life (e.g., unvegetated stream shallows, mudflats, and rocky shores). However the NPS recognizes that most wetlands on NPS lands will have all three parameters required by the 1987 Corps Manual. Therefore, D.O. #77-1 provides procedures for field biologists to follow so that that wetland delineation and mapping projects on NPS lands will satisfy both the Clean Water Act wetland definition (Environmental Laboratory 1987) and the NPS standard for identifying wetlands (Cowardin et al. 1979), for brevity only the two most applicable standards for HOFU are described below:

1. For sites with vegetation and soils, use the most recent version (and any approved regional supplements) of the 1987 Corps Manual, including "problem area" and "atypical situation" procedures (this procedure was utilized at HOFU)
2. For naturally unvegetated or non-soil sites, such as many stream channels, tidal mudflats, playas, wave-active shorelines, and so on, use the "limits" of these systems as described in Cowardin et al. (1979) and briefly summarized below. In some cases, modification of the 1987 Corps Manual procedures may be necessary to delineate boundaries for these wetland types. In such cases, *clear evidence of wetland hydrology is always required*. However, the absence of vegetation or hydric soil characteristics due to natural physical or chemical conditions such as fluvial processes, wave action, or high salinity may make it appropriate to

waive the hydrophytic vegetation and/or hydric soil requirements. Such modifications must be explained on data sheets and in wetland delineation/mapping reports.

As all of the palustrine (in-land and non-tidal) wetland systems within HOFU possessed vegetation and soils the U.S. Army Corps of Engineers Wetlands Delineation Manual (Environmental Laboratory 1987), and the Interim Regional Supplement – Eastern Mountains and Piedmont Region (2012 protocols were followed to make all wetland determinations. Due to funding and time constraints no attempts were made to identify and map riverine (i.e. stream channel) features within the park.

Interim Regional Supplement USACE Method

The USACE method for identifying the wetland / upland boundary uses the definition as outlined in the U.S. Army Corps of Engineers *Wetlands Delineation Manual, 1987*, which defines a wetland as:

“Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.”

Wetland boundaries were primarily determined by establishing a series of transects from a known wetland into known upland locations surrounding the wetland under examination. At random intervals along the transect investigators looked for evidence of hydric soils, hydrophytic vegetation, and wetland hydrology. The wetland/upland boundary line was thus delineated using the transect data and any obvious topographic changes (e.g. abrupt toe-of-slope line) along the wetland/upland perimeter that might occur.

Hydrophytic Vegetation Criteria

For determining the presence of hydrophytic vegetation, plant species within each community were visually identified by strata (e.g. trees, saplings/shrubs, herbs and woody vines) and listed in descending order of dominance. The USACE defined sampling stratum has 5 percent or more total plant cover. If a stratum had less than 5 percent cover during the growing season, then those species and their cover values were recorded on the data form, assuming application of Indicator 3 (Prevalence Test) was necessary. However, these species were not generally included on the data sheets if the wetland determination could be made via Indicator 1 (Rapid Test) or Indicator 2 (Dominance Test). For Indicators 1 and 2 only those species that comprised 5% or more of a given strata were assessed. Vegetation survey plots conformed to current USACE interim supplement guidelines and involved the use of a series of nested circular plots radiating outward from the soil/hydrology test pit (Figure 3). Plot sizes were as follows:

1. Tree stratum – 30 ft (9.1 m) radius
2. Woody vines – 30 ft (9.1 m) radius
3. Herb stratum – 5 ft (1.5 m) radius
4. Sapling/shrub stratum – 15 ft (4.6 m) radius

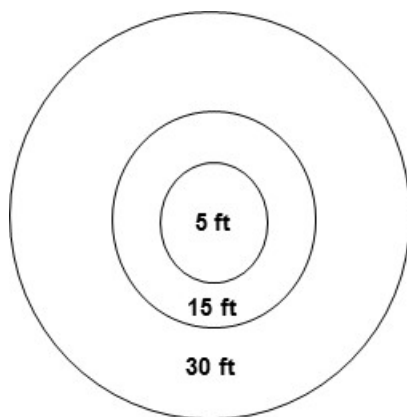


Figure 2. Typical wetland vegetation survey plot conforming to USACE interim regional supplement Eastern Mountains and Piedmont (2012) guidelines.

The wetland indicator status of observed dominant plant species was determined using the U.S. Army Corps of Engineers Atlantic and Gulf Coastal Plain National Wetland Plant Species List, 2012 with additional verification through the USDA plants database and are listed below:

- **OBL** (Obligate Wetland Plants) occur greater than 99 percent of the time in wetlands under natural conditions.
- **FACW** (Facultative Wetland Plants) occur between 67 and 99 percent of the time in wetlands under natural conditions.
- **FAC** (Facultative Plants) occur between 33 and 67 percent of the time in wetlands under natural conditions.
- **FACU** (Facultative Upland Plants) occur between 1 and 33 percent of the time in wetlands under natural conditions.
- **UPL** (Obligate Upland Plants) occur less than 1 percent of the time in wetlands under natural conditions.

The wetland plant indicators were given for each dominant plant species identified on the attached Routine Wetland Determination forms in Appendix A. Dominance was determined as the most abundant species that individually or collectively accounted for more than 50 percent of the total absolute coverage of vegetation in the stratum, plus any other species that, by itself, accounts for at least 20 percent of the total (i.e. the 50/20 Rule).

The interim regional supplement to the original 1987 USACE manual identifies 4 primary indicators of hydrophytic vegetation, any of which, when met, signifies that the community indicates a wetland plant community. For purposes of brevity this section will only cover the two most commonly encountered indicators at HOFU (e.g. Indicators 1 and 2). For a complete description of all of the

indicators the reader is directed to view the U.S Army Corps of Engineers (USACE) Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Eastern Mountains and Piedmont Region (2012).

For a plant community to meet the vegetation criteria under Indicator 1 the following description must be met: “All dominant species across all strata are rated OBL or FACW, or a combination of these two categories, based on a visual assessment.” Under Indicator 2 (the most commonly employed indicator at HOFU) more than 50 percent of the dominant plant species across all strata must be rated OBL, FACW, or FAC.

Hydrology Criteria

Wetland hydrology indicators provide evidence that episodes of inundation or soil saturation lasting more than a few days during the growing season have occurred repeatedly over a period of years and that the timing, duration, and frequency of wet conditions have been sufficient to produce a characteristic wetland plant community and hydric soil morphology. The growing season begins when two or more non-evergreen vascular plant species growing within the study area exhibit one or more of the following biological indicators:

1. Emergence of herbaceous plants from the ground
2. Appearance of new growth from vegetative crowns (e.g., in graminoids, bulbs, and corms)
3. Coleoptile/cotyledon emergence from seed
4. Bud burst on woody plants (i.e., some green foliage is visible between
5. spreading bud scales)
6. Emergence or elongation of leaves of woody plants
7. Emergence or opening of flowers

Growing season conditions can also be met if soil temperatures measured at 12 in. (30 cm) depth is 41 °F (5 °C) or higher. Hydrologic indicators of wetland conditions are based on the direct observation of surface water or groundwater during a site visit (Group A indicators), evidence that the site is subject to flooding or ponding, although the inundation need not be directly observed at the time of the investigation (Group B indicators). The inundation (Group B) indicators include water marks, drift deposits, sediment deposits, and similar features. Other hydrologic indicators consist of evidence that the soil is saturated currently or was saturated recently such as oxidized rhizospheres and the presence of reduced iron or sulfur in the soil profile (Group C indicators), which indicate that the soil has been saturated for an extended period. The final group of hydrologic indicators (Group D) consists of landscape, vegetation, and soil features that indicate contemporary rather than historical wet conditions. Wetland hydrology indicators are intended as one-time observations of site conditions that are sufficient evidence of wetland hydrology in areas where hydric soils and

hydrophytic vegetation are present. For a site to meet the wetland hydrologic criteria it need only possess one primary indicator or two secondary indicators from one of the aforementioned groups.

An assessment of potential drought/non-drought conditions was also conducted for HOFU using data derived Palmer Drought Severity Index (PDSI) mapping. The PDSI is useful as a general means of assessing whether or not wetlands mapped over the study were potentially experiencing abnormally wet or dry conditions which may affect the accuracy of the wetlands delineations. The PDSI maps for HOFUs climatic division were assessed three months prior to data collection (May-June 2014 and July-September 2015) in keeping with USACE suggested protocols (USACE 2012).

Hydric Soil Criteria

The National Technical Committee for Hydric Soils defines a hydric soil as a soil that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part (USDA Soil Conservation Service 1994). One of the most significant changes to the original 1987 USACE manual with regards to wetland boundary determinations is in the area of hydric soil recognition and characterization. The new regional supplement still requires low chroma color soils and the presence of redoximorphic features, however, the revised indicators are much more specific and cover a broader range of potential wetland types than the original 1987 manual criteria. For a detailed description of each of the potential hydric soil indicators within the Atlantic and Gulf Coastal Plain Region please refer to Table 7 located within the regional supplement.

Soil pits were excavated to a maximum depth of 18 inches (45.72 cm) using a sharpshooter shovel with a 16 inch (40.64 cm) blade, unless on-site conditions such as shallow bedrock prohibited excavation or one or more of the hydric soil indicators were met. The data sheets (Appendix A attached under separate cover) for each mapped wetland include information on the soil profile colors, presence/absence of redoximorphic features, texture, and presence/absence of any shallow confining layers and their depths on-site.

Application of the Cowardin et al. (1979) Method:

In this inventory, HOFU wetland areas delineated according to criteria in the USACE regional supplement were further assessed and classified by applying wetland descriptions outlined in the USFWS publication entitled *Classification of Wetlands and Deep Water Habitats of the United States* (Cowardin et al. 1979).

The U.S. Fish and Wildlife Service Publication FWS/OBS-79/31 uses the taxonomic classification of systems to categorize wetlands by their geographic setting. The Cowardin wetland classifications are as follows: Marine, Estuarine, Riverine, Lacustrine and Palustrine. Of these systems, only the palustrine category was mapped within the HOFU study area. Four of the five above-mentioned wetland systems possess subordinate subsystems that address their geologic setting and all five systems can be refined to taxonomic descriptive units of class, subclass and dominance type. The class taxonomic component is subordinate to subsystem and provides a general description of the dominant existing vegetative life forms of the ecological community, the geomorphic setting, flooding regime and the substrate composition. The taxonomic level of subclass provides a refined

description of the plant community. For example, Cowardin et al. (1979) identify the following subclasses: Palustrine Broad-Leaved Deciduous forest (PF01) and a Palustrine Unconsolidated Bottom Mud (PUB3). Water regime modifiers were also added to the USFWS subclass definitions.

Palustrine systems are typically represented by all nontidal wetlands dominated by trees, shrubs, and emergent vegetation. Wetlands that have traditionally been called marshes, bogs, and swamps are collectively categorized under the Palustrine system. The Palustrine system also includes shallow, intermittent, or permanent bodies of water commonly referred to as ponds. Palustrine wetlands such as those occurring within HOFU were generally located within the floodplains of the park's stream systems. The maximum depth of water associated with a Palustrine system is 6.6 feet (1.98 meters), which is defined by the USFWS as the maximum water depth associated with the presence of non-persistent emergent vegetation.

GPS Survey of Wetland Boundaries

Wetland inventory work involved a total traverse of the inventory boundary of the park by foot. Areas of high wetland probability (i.e. floodplains, toe-of-slopes, mapped hydric soil zones, and mapped NWI/VegMap wetland areas) were visually assessed during the growing season. Once the areas of high wetland probability were cleared a traverse and visual assessment of the low probability areas of wetland occurrence was conducted. The areas of the park that were considered to have a low probability of wetland occurrence included steep slopes, non-hydric soils areas, and areas not previously mapped as wetlands by either NWI or VegMap. The primary goal of this effort was to physically map every palustrine wetland that was 0.1 acre in size or greater.

Pink wetland delineation flags were marked with a unique alpha numeric code and hung at regular intervals around the perimeter of each identified wetland habitat. The representative upland and wetland test pits were also located using GPS (Global Positioning System). GPS-based coordinates were collected at each wetland test pit and boundary flag from August-October 2014 and October 2015, using a Trimble 12 channel Pro XR receiver with an external Pro XR integrated GPS/MSK antenna in datum NAD83, UTM – zone 18, meter coordinates and TerraSync software. A minimum of 4 satellites were tracked. A maximum Position Dilution of Precision (PDOP) of 6 was maintained for each set and a minimum of 60 positions were taken at each point feature. The data were post-processed and differentially corrected using Pathfinder Office 5.70. The data were then exported to shapefile format. Following this procedure we estimated accuracies in the X and Y direction of 0 to 1 meters, using the above standards while selective availability (SA) was set to zero. No tests were done to confirm the X/Y direction accuracy during this investigation. Upon completion of the GPS survey work the wetland flagging was removed from the field to minimize impacts to the cultural and natural landscape within the park and to prevent boundary tampering in areas of HOFU subject to high visitor use.

Data Analysis and Management

Descriptive summaries of the wetland data were developed using Sigma Plot 12 (Systat Software, Inc., San Jose, CA). The total number and size class distribution of the mapped HOFU wetlands were calculated along with basic summary statistics (e.g., means, medians, range, etc.). Size classes were based on the minimum mapping criteria for National Wetland Inventory maps and were assigned

values of 1-5 (smallest to largest) as follows: Class 1 (0.01-0.10 ac), Class 2 (0.11-0.50 ac), Class 3 (0.51-1.00 ac), Class 4 (1.10-5.00 ac), Class 5 (> 5.10 ac). An examination of the differences between NWI and USGS/NPS Vegetation Mapping wetlands data (see Sharpe et al. 2016) was not attempted with this data, however, the information contained within this report could be integrated into a similar multi-park analysis should the park express an interest.

The spatial data and data files for this inventory are stored in multiple locations in an effort to minimize the risk of data loss. The NPS – Northeast Regional hydrologist maintains copies of all of the original data and analysis files. The GIS data generated for this project was made Federal Geographic Data Committee (FGDC) compliant and stored at the park (HOFU), the northeast regional cartography office, and with the participating NPS Inventory and Monitoring Network data manager, and in NPS Datastore. Wetland delineation data sheets were generated electronically using an NERO developed wetland delineation field application (McElroy and Sharpe 2015) and stored at the aforementioned locations.

Results

A total of 31 unique palustrine wetland habitats totaling 77.53 ac (31.38 ha) and encompassing 6 unique Cowardin et al. (1979) subclasses were observed over the course of this inventory. Table 1 provides a summary of the wetland habitats, their size, and Cowardin et al. (1979) class/description. The most frequent wetland classes encountered within the HOFU study area were palustrine forested and emergent wetland systems (PEM n=21) (Figure 4). In contrast to these findings, NWI and VegMap data identified a total of 2 and 5 unique palustrine wetlands within the same boundary respectively (USFWS Interactive Wetlands MapperV2, Online: <https://www.fws.gov/wetlands/data/mapper.HTML> accessed 9 January 2017, and Podniesinski et al. 2005).

Table 1. Summary table of identified and mapped wetland habitats from HOFU. Sampling point identification codes correspond to the data points shown on park mapping and the data sheets found in Appendices A and C.

Wetland ID (Sampling Point ID)	Cowardin et al. 1979 classification code	Cowardin et al. 1979 code description	Size	
			Acres	Hectares
Wetland-2 (WTP-2)	PFO1B	palustrine forested broad-leaved deciduous seasonally saturated	1.33	0.54
Wetland-3 (WTP-3)	PFO1B	palustrine forested broad-leaved deciduous seasonally saturated	0.13	0.05
Wetland-4 (WTP-4)	PEM2E	palustrine emergent nonpersistent seasonally flooded/saturated	0.18	0.07
Wetland-5 (WTP-5)	PEM1E	palustrine emergent persistent seasonally flooded/saturated	0.04	0.02
Wetland-6 (WTP-6)	PFO1J	palustrine forested broad-leaved deciduous Intermittently Flooded	0.01	0.005
Wetland-7 (WTP-7)	PSS6E	palustrine scrub-shrub deciduous seasonally flooded/saturated	0.13	0.05
Wetland-8 (WTP-8)	PEM2D	palustrine emergent nonpersistent continuously saturated	0.42	0.17
Wetland-9 (WTP-9)	PEM2D	palustrine emergent nonpersistent continuously saturated	0.15	0.06
Wetland-10 (WTP-10)	PEM2E	palustrine emergent nonpersistent seasonally flooded/saturated	0.01	0.006
Wetland-12 (WTP-11)	PFO1D	palustrine forested broad-leaved deciduous continuously saturated	0.76	0.31
Wetland-15 (WTP-15)	PEM2D	palustrine emergent nonpersistent continuously saturated	0.01	0.004
Wetland-16 (WTP-16)	PEM2Cf	palustrine emergent nonpersistent seasonally flooded farmed	0.07	0.03
Wetland-17 (WTP-17)	PEM2D	palustrine emergent nonpersistent continuously saturated	0.03	0.01

Table 2 (continued). Summary table of identified and mapped wetland habitats from HOFU. Sampling point identification codes correspond to the data points shown on park mapping and the data sheets found in Appendices A and C.

Wetland ID (Sampling Point ID)	Cowardin et al. 1979 classification code	Cowardin et al. 1979 code description	Size	
			Acres	Hectares
Wetland–19 (WTP–19)	PEM1D	palustrine emergent persistent continuously saturated	0.36	0.14
Wetland–20 (WTP–20)	PEM2Ef	palustrine emergent nonpersistent seasonally flooded/saturated farmed	0.69	0.28
Wetland–22 (WTP–22)	PEM2Bm	palustrine emergent nonpersistent seasonally saturated managed	0.07	0.03
Wetland–23A (WTP–23)	PUB4C	palustrine unconsolidated bottom organic seasonally flooded	0.02	0.01
Wetland–23B (WTP–23)	PUB4C	palustrine unconsolidated bottom organic seasonally flooded	0.001	0.0005
Wetland–24 (WTP–24)	PUB4C	palustrine unconsolidated bottom organic seasonally flooded	0.05	0.02
Wetland–25 (WTP–25)	PSS1E	palustrine scrub-shrub broad-leaved deciduous seasonally flooded/saturated	0.25	0.10
Wetland–27A (WTP–27A)	PEM1Ef	palustrine emergent persistent seasonally flooded/saturated farmed	5.52	2.23
Wetland–27B (WTP–27B)	PEM1Ef	palustrine emergent persistent seasonally flooded/saturated farmed	1.51	0.61
Wetland–27C (WTP–27C)	PFO1Ef	palustrine forested broad-leaved deciduous seasonally flooded/saturated farmed	1.42	0.58
Wetland–27D (WTP–27D)	PFO1D	palustrine forested broad-leaved deciduous continuously saturated	6.50	2.63
Wetland–27E (WTP–27E)	PFO1E	palustrine forested broad-leaved deciduous seasonally flooded/saturated	44.76	18.11
Wetland–28 (WTP–28)	PSS1Ef	palustrine scrub-shrub broad-leaved deciduous seasonally flooded/saturated farmed	1.61	0.65
Wetland–29 (WTP–29)	PFO1D	palustrine forested broad-leaved deciduous continuously saturated	0.69	0.28
Wetland–30 (WTP–30)	PEM2Ef	palustrine emergent nonpersistent seasonally flooded/saturated farmed	0.32	0.13
Wetland–31 (WTP–31)	PEM2E	palustrine emergent nonpersistent seasonally flooded/saturated	0.14	0.06
Wetland–33 (WTP–33)	PEM2E	palustrine emergent nonpersistent seasonally flooded/saturated	0.09	0.04
Wetland–34 (WTP–34)	PFO1D	palustrine forested broad-leaved deciduous continuously saturated	10.26	4.15

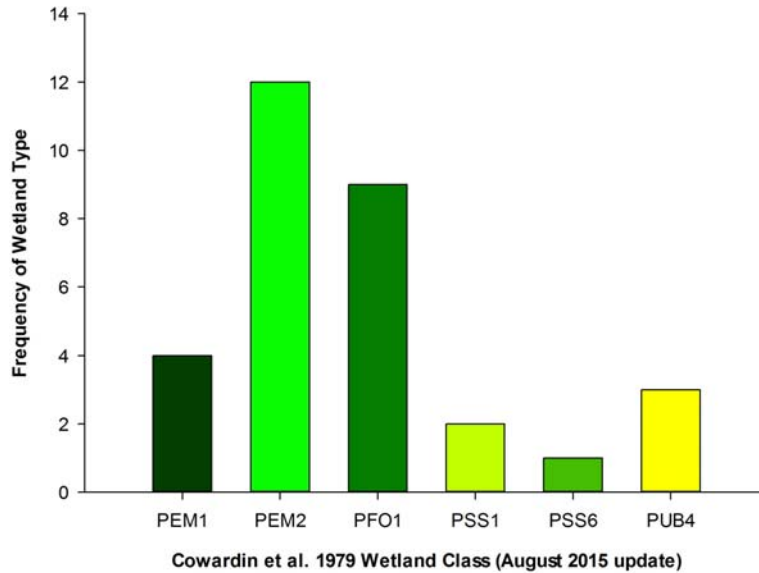


Figure 3. Frequency histogram showing the various Cowardin et al. (1979) wetland habitats (sorted by subclass) identified during the HOFU wetland field investigations.

Wetland size at HOFU ranged from a maximum of 44.76 ac / 18.11 ha (Wetland 27E) to a minimum of 0.001 ac / 0.0005 ha (Wetland 23B). Mean and median wetland sizes at HOFU were 2.50 ac / 1.01 ha and 0.18 ac / 0.07 ha respectively. The bulk of the total wetland area within the park fell within a small number (n=4) of Size Class 5 large wetlands (Figure 5). This section will not describe in detail all 31 unique wetland features identified and mapped over the course of this inventory, however, for more detailed information about a particular site, readers are encouraged to examine the wetland data sheets (Appendix A), representative photographs (Appendix B), and mapping exhibits (Appendix C).

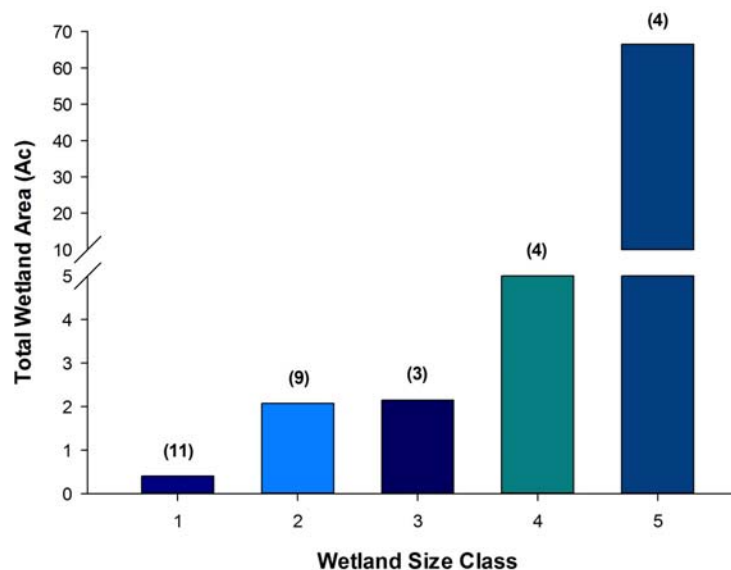


Figure 4. Total wetland area by size class for HOFU. Size Classes organized from smallest to largest. Values in parentheses represent the number of wetlands within each size class.

Wetlands of interest within the HOFU study area were subjectively determined based on uniqueness of habitat and relative size. The first of these ecosystems and by the far the largest was Wetland-27E, located west and east of S.R. 345 which bisects the park (Figure 6 and Appendix C, Map Grids E6, E7, F7, F6, F5, G5, and G6). This site is a palustrine, forested, broad-leaved deciduous, seasonally flooded/saturated wetland site. As can be seen from the Mapping exhibits and the photograph in Figure 6, this system is situated low on the landscape and appears to receive groundwater, as well as surface water inputs via floodwaters from French and Baptism Creeks. The wetland possesses a mature overstory dominated by red maple (*Acer rubrum* L.) with a sparse understory composed primarily of common winterberry (*Ilex verticillata* (L.) A. Gray) with an herbaceous layer dominated by Japanese stilt-grass (*Microstegium vimineum* (Trin.) A. Camus). While this brief summary adequately captures the majority of the wetland community there are two areas within the Wetland-27E located west and east of S.R. 345 where groundwater upwellings have promoted the survival and growth of emergent marsh habitat comprised of species indicative of less disturbed habitat. This site represents the largest wetland polygon found within our study area (44.76 ac/ 18.11 ha) and appears to extend beyond the park boundary – to the south where it likely would connect with Wetland-34.



Figure 5. Representative photograph of Wetland-27E taken 19 June 2014; view is southwest (Taken by P. Sharpe).

Though smaller in size compared with the aforementioned Wetland-27E, Wetland-34 is another palustrine forested, broad-leaved deciduous wetland system located near the southern limit of the park boundary (Figure 7 and Appendix C, Map Grids H7 and I7).



Figure 6. Representative photograph of a portion of Wetland-34 which appeared to be saturated year-round (September 2014 taken by P. Sharpe).

Wetland-34 was primarily categorized as a forested wetland ecosystem (Table 1), however, as evidenced in Figure 7, the site receives groundwater inputs from three distinct seeps located along the western edge of the wetland which have promoted highly saturated soil conditions that appear to exist year round.

The remaining wetland ecosystems within the HOFU study area that deserve special mention are the palustrine, unconsolidated bottom habitats located along the right floodplain of French Creek west of the village area of HOFU (Wetlands-23A, B, and 24). These habitats exhibited characteristics of seasonal pools and as such may be of some conservation interest to the park staff (Figure 8). These pools were also observed within the vicinity of ACS Site 1 (an identified seasonal pool area) from the 2003 herpetofauna inventory (Tiebout 2003). This work compliments the 2003 herpetofaunal inventory as the exact limits and extent of those seasonal pools was not previously known or

recorded. These wetlands are important breeding areas for wood frogs, spotted salamanders and other amphibians specifically identified in the Tiebout (2003) inventory.



Figure 7. View is of Wetland – 23A located just downstream of Hopewell Lake dam (Wetland 23B is located behind the dead snag in the photo background). Photograph taken 19 June 2014, by P. Sharpe.

An additional benefit of this inventory was the identification of additional sites within the park that contained populations of invasive exotic plant species targeted for control specifically - *Microstegium vimineum* (Trin.) A. Camus (Japanese stilt grass). Japanese stilt grass in particular is a common herbaceous species found within and adjacent to wetland habitats and as such is not always detected via the inventory and monitoring network long-term forest vegetation monitoring (Comiskey et al. 2009) or invasive exotic early detection protocols. The methodology employed for the wetland inventory involved a near total land traverse of the study area by foot, and as such required daily coordination with park staff for safety reasons. This daily communication subsequently involved a briefing of identified invasive plant populations and their locations (often times flagged in the field and located using GPS) which provides park staff an opportunity to either control those populations themselves or coordinate with the regional exotic plant management team (EPMT) for their removal.

Discussion

A wetlands boundary determination following the U.S Army Corps of Engineers (USACE) Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Eastern Mountains and Piedmont Region and the National Park Service D.O. #77.1 was performed at HOFU during the summer and fall of 2014 and 2015. All of the lands within the legislative boundary of the park were surveyed with the exception of any active inholdings (see mapping exhibits Appendix C). A total of 31 unique palustrine wetlands were identified, delineated, and mapped over the course of this inventory. No new (unmapped) waterways (riverine habitats) were delineated due to funding and time constraints.

From the results of this work it is our opinion that all of the wetland habitats possess sufficient vegetation, hydrologic, and soil characteristics to classify them as regulated wetland sites based on the U.S. Army Corps and National Park Service criteria. All of the mapped wetland systems of HOFU possessed either a direct surface water connection to French Creek or were situated within the floodplain of a water of the U.S. making each of these systems subject to Section 404 of the federal Clean Water Act (1977) and D.O. #77.1 of the National Park Service compliance obligations.

The results of this work have not only provided the park with NPS/USACE compliant wetland boundary data but the study also assisted the park with the identification of previously unknown source populations of invasive exotic plant communities within the HOFU study area, and complimented previous herpetofaunal investigations. The wetland data collected at HOFU may also be used as part of a regional effort to help inform wetland remote sensing practices for broad scale wetland tracking and planning efforts service wide (Sharpe et al. 2016). Wetland data collected in support of the mapping products utilized a new wetland delineation application for the ipad mini developed in-house and is now available to NPS parks (and the general public) nationwide (McElroy and Sharpe, 2015).

This report has been prepared in accordance with generally accepted wetland investigation practices outlined by the U.S. Environmental Protection Agency and the U.S. Army Corps of Engineers and the National Park Service. The vegetation zone delineations are based upon our identification of plant species present at the time of our field examination, therefore, seasonal variation in the type and composition of plant species, in particular non-persistent herbaceous plants, is to be expected. Hydrology observations portray conditions present at the time of the field study and depend upon the time of year and amount of prior precipitation when obtained. We have provided representative photographs of each wetland identified in the report (Appendix B) in an effort to provide a reader with a better idea of the prevailing site conditions present at the time of this investigation.

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Appendix A: Wetland Data Sheets

(Provided under separate cover to Amy Ruhe (VAFO/HOFU Natural Resource Specialist) and Jim Comiskey (MIDN Coordinator))

WETLAND DETERMINATION DATA FORM – Eastern Mountains and Piedmont			
Project/Site: <u>HOFU</u>		City/County: <u>Chester</u>	Sampling Date: <u>9/9/2014</u>
Applicant/Owner: <u>NPS</u>		State: <u>PA</u>	Sampling Point: <u>WTP-22</u>
Investigator(s): <u>Dr. Peter J. Sharpe,</u>		Section, Township, Range: <u>West Nantmeal</u>	
Landform (hillslope, terrace, etc.): <u>Floodplain</u>		Local relief (concave, convex, none): <u>Convex</u>	Slope (%): <u>20-30%</u>
Subregion (LRR or MLRA): <u>LRR S</u>		Lat: <u>40.205201</u>	Long: <u>-75.774231</u> Datum: <u>NAD83</u>
Soil Map Unit Name: <u>LfA - Lamington silt loam</u>		NWI Classification: <u>PEM2</u>	
Are climatic / hydrologic conditions on the site typical for this time of year? ☒ Yes ☐ No (If no, explain in Remarks.)			
Are ☐ Vegetation ☐ Soil ☐ Hydrology significantly disturbed?		Are "Normal Circumstances" present? ☒ Yes ☐ No	
Are ☐ Vegetation ☐ Soil ☐ Hydrology naturally problematic?		(If needed, explain any answers in Remarks.)	
SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.			
Hydrophytic Vegetation Present? ☒ Yes ☐ No Hydric Soil Present? ☒ Yes ☐ No Wetland Hydrology Present? ☒ Yes ☐ No		Is the Sampled Area within a Wetland? ☒ Yes ☐ No	
Remarks:			
HYDROLOGY			
Wetland Hydrology Indicators: Primary Indicators (minimum of one is required; check all that apply) ☐ Surface Water (A1) ☐ True Aquatic Plants (B14) ☐ High Water Table (A2) ☐ Hydrogen Sulfide Odor (C1) ☐ Saturation (A3) ☐ Oxidized Rhizospheres on Living Roots (C3) ☐ Water Marks (B1) ☐ Presence of Reduced Iron (C4) ☒ Sediment Deposits (B2) ☐ Recent Iron Reduction in Tilled Soils (C6) ☐ Drift Deposits (B3) ☐ Thin Muck Surface (C7) ☐ Algal Mat or Crust (B4) ☐ Other (Explain in Remarks) ☐ Iron Deposits (B5) ☐ Inundation Visible on Aerial Imagery (B7) ☒ Water Stained Leaves (B9) ☐ Aquatic Fauna (B13)		Secondary Indicators (minimum of two required) ☐ Surface Soil Cracks (B6) ☐ Sparsely Vegetated Concave Surface (B8) ☒ Drainage Patterns (B10) ☐ Moss Trim Lines (B16) ☐ Dry Season Water Table (C2) ☐ Crayfish Burrows (C8) ☐ Saturation Visible on Aerial Imagery (C9) ☐ Stunted or Stressed Plants (D1) ☒ Geomorphic Position (D2) ☐ Shallow Aquitard (D3) ☐ Microtopographic Relief (D4) ☐ FAC-Neutral Test (D5)	
Field Observations: Surface Water Present? ☐ Yes ☒ No Depth (inches): _____ Water Table Present? ☐ Yes ☒ No Depth (inches): _____ Saturation Present? ☐ Yes ☒ No Depth (inches): _____ (includes capillary fringe)		Wetland Hydrology Present? ☒ Yes ☐ No	
Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:			
Remarks:			

US Army Corps of Engineers

Eastern Mountains and Piedmont

Figure A-1. An example of page 1 of a Wetland Determination Data Form.

VEGETATION (Four Strata) – Use scientific names of plants.

Sampling Point: WTP-22

Tree Stratum	(Plot size: _____ square ft)	Absolute % Cover	Dominant Species?	Indicator Status	
1. <i>Platanus occidentalis</i>		67.5	☒ Yes ☐ No	FACW	Dominance Test worksheet: Number of Dominant Species That Are OBL, FACW, or FAC: <u>5</u> (A) Total Number of Dominant Species Across All Strata: <u>5</u> (B) Percent of Dominant Species That Are OBL, FACW, or FAC: <u>100.000</u> % (A/B)
2. <i>Acer rubrum</i>		17.5	☒ Yes ☐ No	FAC	
3. _____			☐ Yes ☐ No		
4. _____					
5. _____					
6. _____					
7. _____					
8. _____					
<u>85</u> = Total Cover 50% of total cover: <u>42.5</u> 20% of total cover: <u>17</u>					Prevalence Index worksheet: Total % Cover of: _____ Multiply by: _____ OBL species <u>0</u> x 1 = <u>0</u> FACW species <u>116.5</u> x 2 = <u>233</u> FAC species <u>160</u> x 3 = <u>480</u> FACU species <u>8.5</u> x 4 = <u>34</u> UPL species <u>0</u> x 5 = <u>0</u> Column Totals: <u>285</u> (A) <u>747</u> (B) Prevalence Index = B/A = <u>2.621</u>
Sapling/Shrub Stratum (Plot size: _____ square ft)					
1. <i>Lindera benzoin</i>		37.5	☒ Yes ☐ No	FAC	
2. <i>Rosa multiflora</i>		3.5	☐ Yes ☒ No	FACU	
3. _____			☐ Yes ☐ No		
4. _____					
5. _____					
6. _____					
<u>41</u> = Total Cover 50% of total cover: <u>20.5</u> 20% of total cover: <u>8.2</u>					Hydrophytic Vegetation Indicators: ☐ 1 - Rapid Test for Hydrophytic Vegetation ☒ 2 - Dominance Test is >50% ☒ 3 - Prevalence Index is ≤3.0* ☐ 4 - Morphological Adaptations* ☐ Problematic Hydrophytic Vegetation* (Explain) *Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.
Herb Stratum (Plot size: _____ square ft)					
1. <i>Microstegium vimineum</i>		67.5	☒ Yes ☐ No	FAC	
2. <i>Pilea pumila</i>		17.5	☐ Yes ☒ No	FACW	
3. <i>Impatiens capensis</i>		17.5	☐ Yes ☒ No	FACW	
4. <i>Onoclea sensibilis</i>		7.5	☐ Yes ☒ No	FACW	
5. <i>Persicaria pensylvanica</i>		3.5	☐ Yes ☒ No	FACW	
6. <i>Boehmeria cylindrica</i>		1.5	☐ Yes ☒ No	FACW	
7. <i>Arisaema triphyllum</i>		1.5	☐ Yes ☒ No	FACW	Definitions of Four Vegetation Strata: Tree – Woody plants, excluding vines, 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height. Sapling/Shrub – Woody plants, excluding vines, less than 3 in. DBH and greater than 3.28 ft (1 m) tall. Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall. Woody vine – All woody vines greater than 3.28 ft in height.
8. _____			☐ Yes ☐ No		
9. _____					
10. _____					
11. _____					
12. _____					
<u>116.5</u> = Total Cover 50% of total cover: <u>58.25</u> 20% of total cover: <u>23.3</u>					
Woody Vine Stratum (Plot size: _____ square ft)					
1. <i>Toxicodendron radicans</i>		37.5	☒ Yes ☐ No	FAC	
2. <i>Celastrus orbiculatus</i>		3.5	☐ Yes ☒ No	FACU	
3. <i>Parthenocissus quinquefolia</i>		1.5	☐ Yes ☒ No	FACU	
4. _____			☐ Yes ☐ No		
5. _____					
<u>42.5</u> = Total Cover 50% of total cover: <u>21.25</u> 20% of total cover: <u>8.5</u>					
Remarks: (If observed, list morphological adaptations below).					Hydrophytic Vegetation Present? ☒ Yes ☐ No

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Figure A-2. An example of page 2 of a Wetland Determination Data Form.

SOIL

 Sampling Point: WTP-22

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)																																
Depth (inches)	Matrix		Redox		Type ₁	Loc ₂	Texture	Remarks																								
	Color (moist)	%	Color (moist)	%																												
0-7	10YR 2/1	95	2.5YR 4/8	5	C	M	cl. lo																									
7-15	5YR 4/6	100					sandy	waste soil																								
1Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. 2Location: PL=Pore Lining, M=Matrix.																																
Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)																																
<table border="0"> <tr> <td>☐ Histosol (A1)</td> <td>☐ Dark Surface (S7)</td> </tr> <tr> <td>☐ Histic Epipedon (A2)</td> <td>☐ Polyvalue Below Surface (S8) (MLRA 147, 148)</td> </tr> <tr> <td>☐ Black Histic (A3)</td> <td>☐ Thin Dark Surface (S9) (MLRA 147, 148)</td> </tr> <tr> <td>☐ Hydrogen Sulfide (A4)</td> <td>☐ Loamy Gleyed Matrix (F2)</td> </tr> <tr> <td>☐ Stratified Layers (A5)</td> <td>☐ Depleted Matrix (F3)</td> </tr> <tr> <td>☐ 2 cm Muck (A10) (LRR N)</td> <td>☐ Redox Dark Surface (F6)</td> </tr> <tr> <td>☐ Depleted Below Dark Surface (A11)</td> <td>☐ Depleted Dark Surface (F7)</td> </tr> <tr> <td>☐ Thick Dark Surface (A12)</td> <td>☐ Redox Depressions (F8)</td> </tr> <tr> <td>☐ Sandy Mucky Mineral (S1) (LRR N, MLRA 147, 148)</td> <td>☐ Iron-Manganese Masses (F12) (LRR N, MLRA 136)</td> </tr> <tr> <td>☐ Sandy Gleyed Matrix (S4)</td> <td>☐ Umbric Surface (F13) (MLRA 136, 122)</td> </tr> <tr> <td>☐ Sandy Redox (S5)</td> <td>☐ Piedmont Floodplain Soils (F19) (MLRA 148)</td> </tr> <tr> <td>☐ Stripped Matrix (S6)</td> <td></td> </tr> </table>									☐ Histosol (A1)	☐ Dark Surface (S7)	☐ Histic Epipedon (A2)	☐ Polyvalue Below Surface (S8) (MLRA 147, 148)	☐ Black Histic (A3)	☐ Thin Dark Surface (S9) (MLRA 147, 148)	☐ Hydrogen Sulfide (A4)	☐ Loamy Gleyed Matrix (F2)	☐ Stratified Layers (A5)	☐ Depleted Matrix (F3)	☐ 2 cm Muck (A10) (LRR N)	☐ Redox Dark Surface (F6)	☐ Depleted Below Dark Surface (A11)	☐ Depleted Dark Surface (F7)	☐ Thick Dark Surface (A12)	☐ Redox Depressions (F8)	☐ Sandy Mucky Mineral (S1) (LRR N, MLRA 147, 148)	☐ Iron-Manganese Masses (F12) (LRR N, MLRA 136)	☐ Sandy Gleyed Matrix (S4)	☐ Umbric Surface (F13) (MLRA 136, 122)	☐ Sandy Redox (S5)	☐ Piedmont Floodplain Soils (F19) (MLRA 148)	☐ Stripped Matrix (S6)	
☐ Histosol (A1)	☐ Dark Surface (S7)																															
☐ Histic Epipedon (A2)	☐ Polyvalue Below Surface (S8) (MLRA 147, 148)																															
☐ Black Histic (A3)	☐ Thin Dark Surface (S9) (MLRA 147, 148)																															
☐ Hydrogen Sulfide (A4)	☐ Loamy Gleyed Matrix (F2)																															
☐ Stratified Layers (A5)	☐ Depleted Matrix (F3)																															
☐ 2 cm Muck (A10) (LRR N)	☐ Redox Dark Surface (F6)																															
☐ Depleted Below Dark Surface (A11)	☐ Depleted Dark Surface (F7)																															
☐ Thick Dark Surface (A12)	☐ Redox Depressions (F8)																															
☐ Sandy Mucky Mineral (S1) (LRR N, MLRA 147, 148)	☐ Iron-Manganese Masses (F12) (LRR N, MLRA 136)																															
☐ Sandy Gleyed Matrix (S4)	☐ Umbric Surface (F13) (MLRA 136, 122)																															
☐ Sandy Redox (S5)	☐ Piedmont Floodplain Soils (F19) (MLRA 148)																															
☐ Stripped Matrix (S6)																																
Indicators for Problematic Hydric Soils:																																
<table border="0"> <tr> <td>☐ 2 cm Muck (A10) (MLRA 147)</td> <td></td> </tr> <tr> <td>☐ Coast Prairie Redox (A16) (MLRA 147, 148)</td> <td></td> </tr> <tr> <td>☐ Piedmont Floodplain Soils (F19) (MLRA 136, 147)</td> <td></td> </tr> <tr> <td>☐ Red Parent Material (TF2)</td> <td></td> </tr> <tr> <td>☐ Very Shallow Dark Surface (TF12)</td> <td>3Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.</td> </tr> <tr> <td>☐ Other (Explain in Remarks)</td> <td></td> </tr> </table>									☐ 2 cm Muck (A10) (MLRA 147)		☐ Coast Prairie Redox (A16) (MLRA 147, 148)		☐ Piedmont Floodplain Soils (F19) (MLRA 136, 147)		☐ Red Parent Material (TF2)		☐ Very Shallow Dark Surface (TF12)	3Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.	☐ Other (Explain in Remarks)													
☐ 2 cm Muck (A10) (MLRA 147)																																
☐ Coast Prairie Redox (A16) (MLRA 147, 148)																																
☐ Piedmont Floodplain Soils (F19) (MLRA 136, 147)																																
☐ Red Parent Material (TF2)																																
☐ Very Shallow Dark Surface (TF12)	3Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.																															
☐ Other (Explain in Remarks)																																
Restrictive Layer (if observed): Type: _____ Depth (inches): _____						Hydric Soil Present? ☒ Yes ☐ No																										
Remarks:																																

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Figure A-3. An example of page 3 of a Wetland Determination Data Form.

Appendix B: Representative Photographs



Figure B-1. Photograph of Wetland 2 taken 18 June 2014, view is southwest (Taken by P. Sharpe). See Wetlands Map Grid B6.



Figure B-2. Photograph of Wetland 3 taken 18 August, 2014, view is south (Taken by P. Sharpe). See Wetlands Map Grid C6.



Figure B-3. Photograph of Wetland 4 taken 18 June 2014, view is southwest (Taken by P. Sharpe). See Wetlands Map Grid C7.



Figure B-4. Photograph of Wetland 5 taken 18 June 2014, view is southwest (Taken by P. Sharpe). See Wetlands Map Grid C7.



Figure B-5. Photograph of Wetland 6 taken 18 August 2014, view is southwest (Taken by P. Sharpe). See Wetlands Map Grid C7.



Figure B-6. Photograph of Wetland 7 taken 18 June 2014, view is east (Taken by P. Sharpe). See Wetlands Map Grid C8.



Figure B-7. Photograph of Wetland 8 taken 25 August 2014, view is south (Taken by P. Sharpe). See Wetlands Map Grid D8.



Figure B-8. Photograph of Wetland 9 taken 18 June 2014, view is northwest (Taken by P. Sharpe). See Wetlands Map Grid D7.



Figure B-9. Photograph of Wetland 10 taken 18 June 2014, view is southwest (Taken by P. Sharpe). See Wetlands Map Grid D6.



Figure B-10. Photograph of Wetland 12 taken 18 June 2014, view is southeast (Taken by P. Sharpe). See Wetlands Map Grid D7.



Figure B-11. Photograph of Wetland 15 taken 15 October 2015, view is northwest (Taken by P. Sharpe). See Wetlands Map Grid C4.



Figure B-12. Photograph of Wetland 16 taken 19 June 2014, view is northeast (Taken by P. Sharpe). See Wetlands Map Grid D3.



Figure B-13. Photograph of Wetland 17 taken 19 June 2014, view is southeast (Taken by P. Sharpe). See Wetlands Map Grid D4.



Figure B-14. Photograph of Wetland 19 taken 19 June 2014, view is southeast (Taken by P. Sharpe). See Wetlands Map Grid E5.



Figure B-15. Photograph of Wetland 20 taken 19 June 2014, view is south (Taken by P. Sharpe). See Wetlands Map Grid E5.



Figure B-16. Photograph of Wetland 22 taken 19 June 2014, view is west (Taken by P. Sharpe). See Wetlands Map Grid F3.



Figure B-17. Photograph of Wetland 23A taken 19 June 2014, view is west (Taken by P. Sharpe). See Wetlands Map Grid F3.



Figure B-18. Photograph of Wetland 24 taken 19 June 2014, view is west (Taken by P. Sharpe). See Wetlands Map Grid F3.



Figure B-19. Photograph of Wetland 25 taken 19 June 2014, view is east (Taken by P. Sharpe). See Wetlands Map Grid F3.



Figure B-20. Photograph of Wetland 27A taken 19 June 2014, view is north (Taken by P. Sharpe). See Wetlands Map Grid F4.



Figure B-21. Photograph of Wetland 27B taken 6 October 2014, view is east (Taken by P. Sharpe). See Wetlands Map Grid F4.



Figure B-22. Photograph of Wetland 27C taken 19 June 2014, view is east (Taken by P. Sharpe). See Wetlands Map Grid F4.



Figure B-23. Photograph of Wetland 27D taken 7 October 2014, view is east (Taken by P. Sharpe). See Wetlands Map Grid F4.



Figure B-24. Photograph of Wetland 27E taken 19 June 2014, view is southwest (Taken by P. Sharpe). See Wetlands Map Grids E6, E7, F7, F5, F6, G5, and G6.



Figure B-25. Photograph of Wetland 28 taken 7 October 2014, view is west (Taken by P. Sharpe). See Wetlands Map Grid E4.



Figure B-26. Photograph of Wetland 29 taken 19 August 2014, view is southwest (Taken by P. Sharpe). See Wetlands Map Grid C7.



Figure B-27. Photograph of Wetland 30 taken 20 June 2014, view is northeast (Taken by P. Sharpe). See Wetlands Map Grid F9.



Figure B-28. Photograph of Wetland 31 taken 2 September 2014, view is east (Taken by P. Sharpe). See Wetlands Map Grid I5.

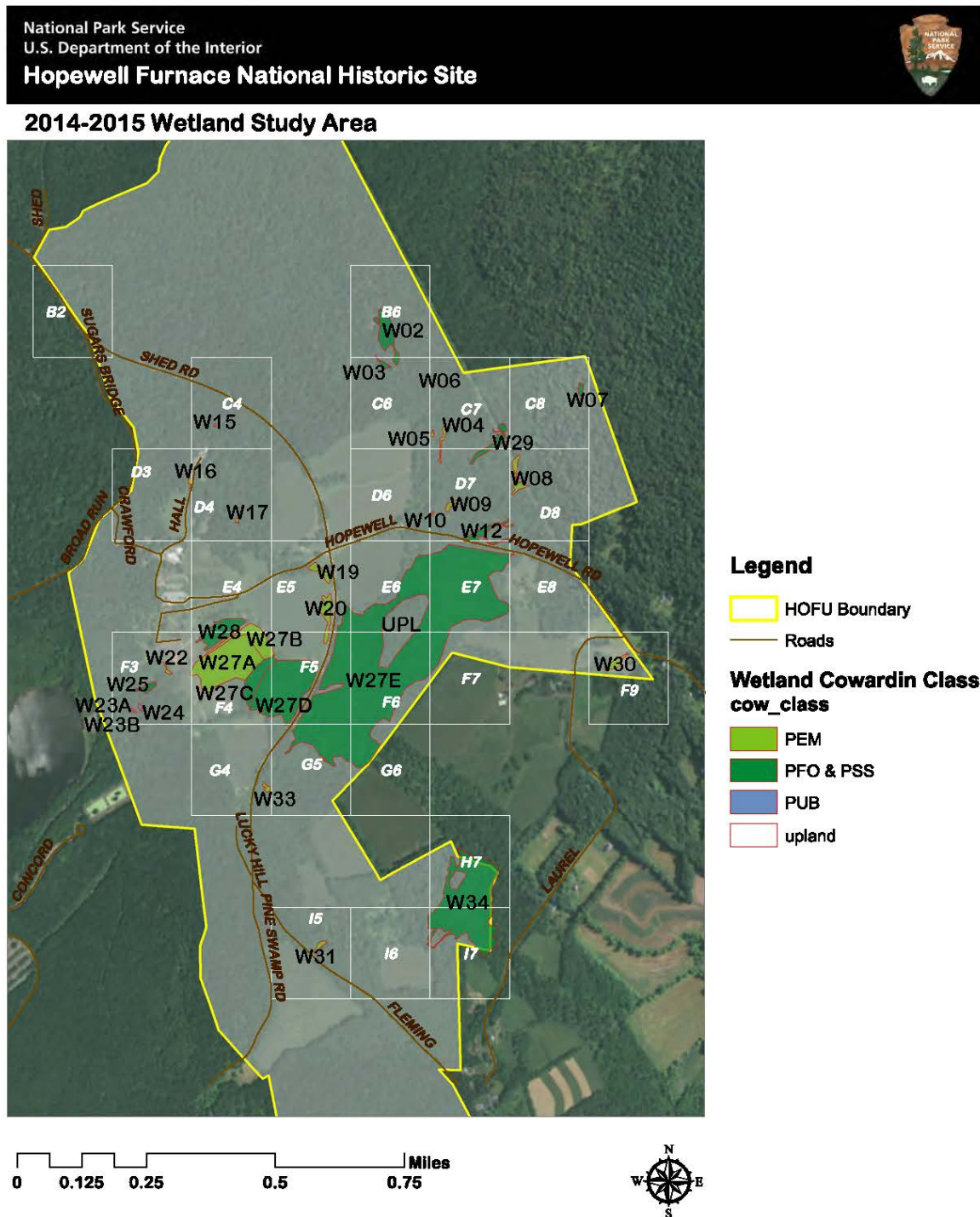


Figure B-29. Photograph of Wetland 33 taken 20 June 2014, view is east (Taken by P. Sharpe). See Wetlands Map Grid G4.



Figure B-30. Photograph of Wetland 34 taken 4 September 2014, view is northwest (Taken by P. Sharpe). See Wetlands Map Grid H7 and I7. Appendix C: Mapping Exhibits

Appendix C: Mapping Exhibits



Date: 5/3/2016

Northeast Region Natural Resource Science - P. Sharpe, J. Farrell

Figure C-1. Hopewell Furnace National Historic Site (HOFU) wetland inventory grid index map.



2014-2015 Wetland Study

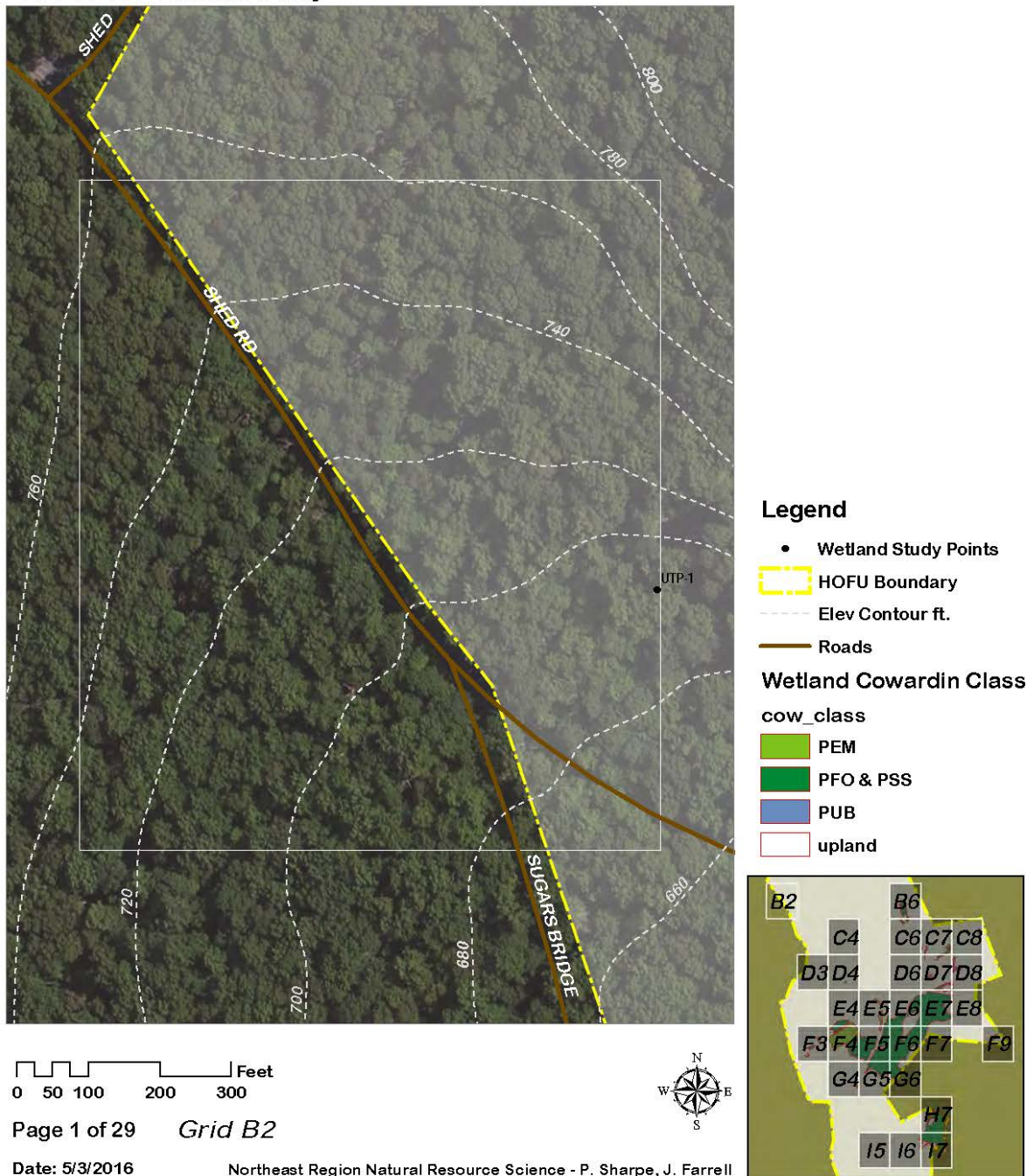


Figure C-2. Hopewell Furnace National Historic Site (HOFU) wetland inventory Grid Map B2.



2014-2015 Wetland Study

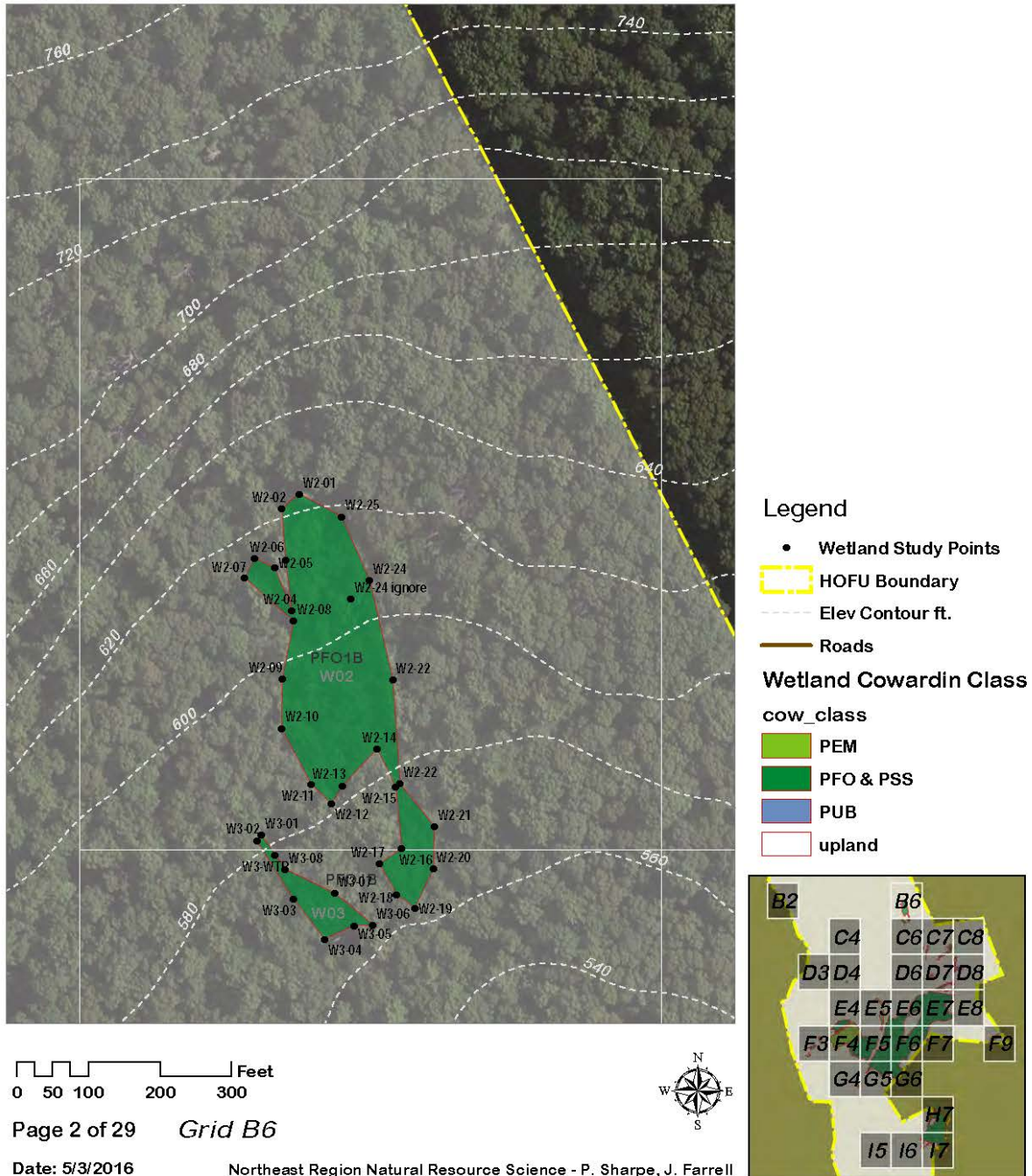


Figure C-3. Hopewell Furnace National Historic Site (HOFU) wetland inventory Grid Map B6.



2014-2015 Wetland Study

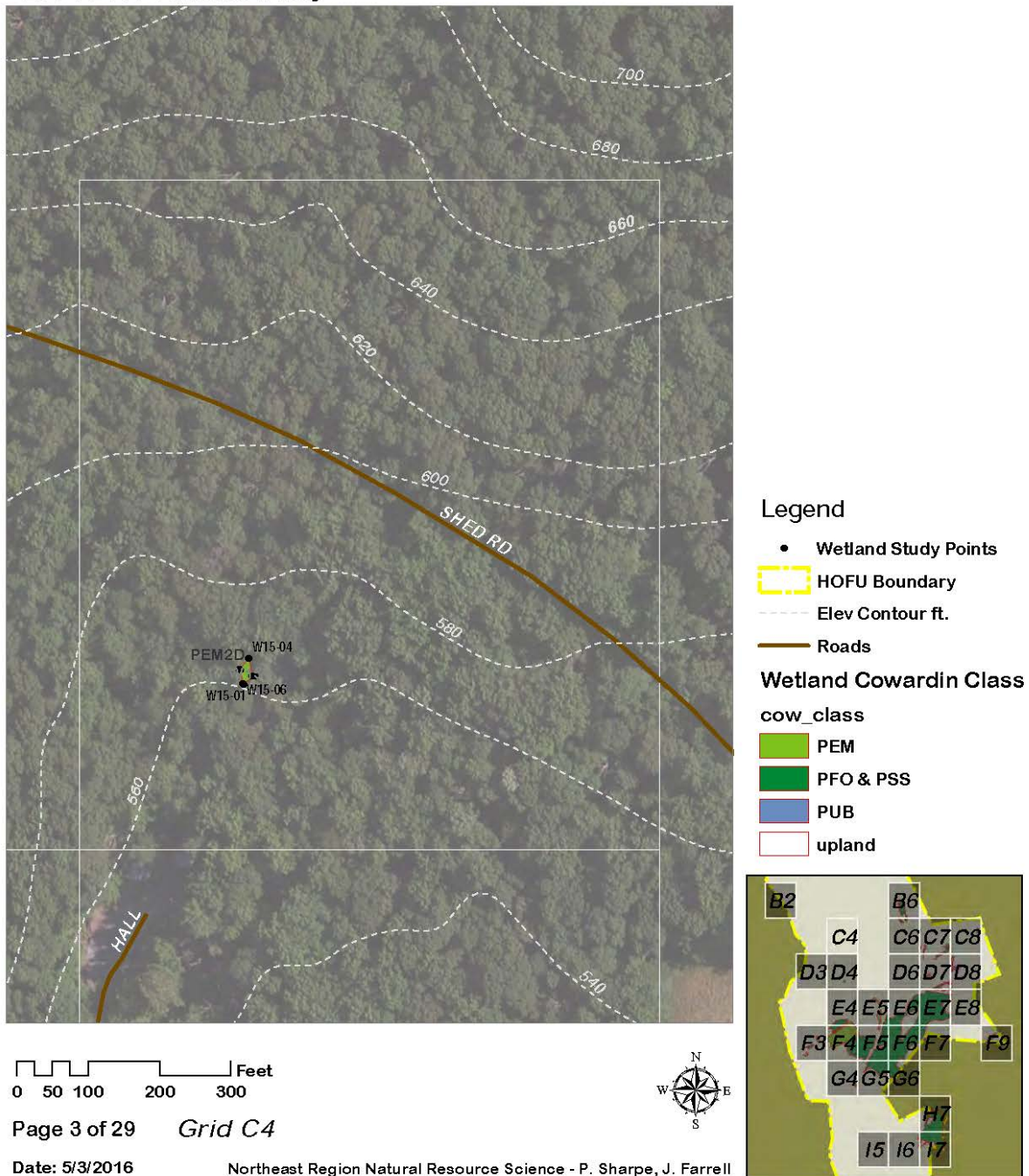


Figure C-4. Hopewell Furnace National Historic Site (HOFU) wetland inventory Grid Map C4.



2014-2015 Wetland Study

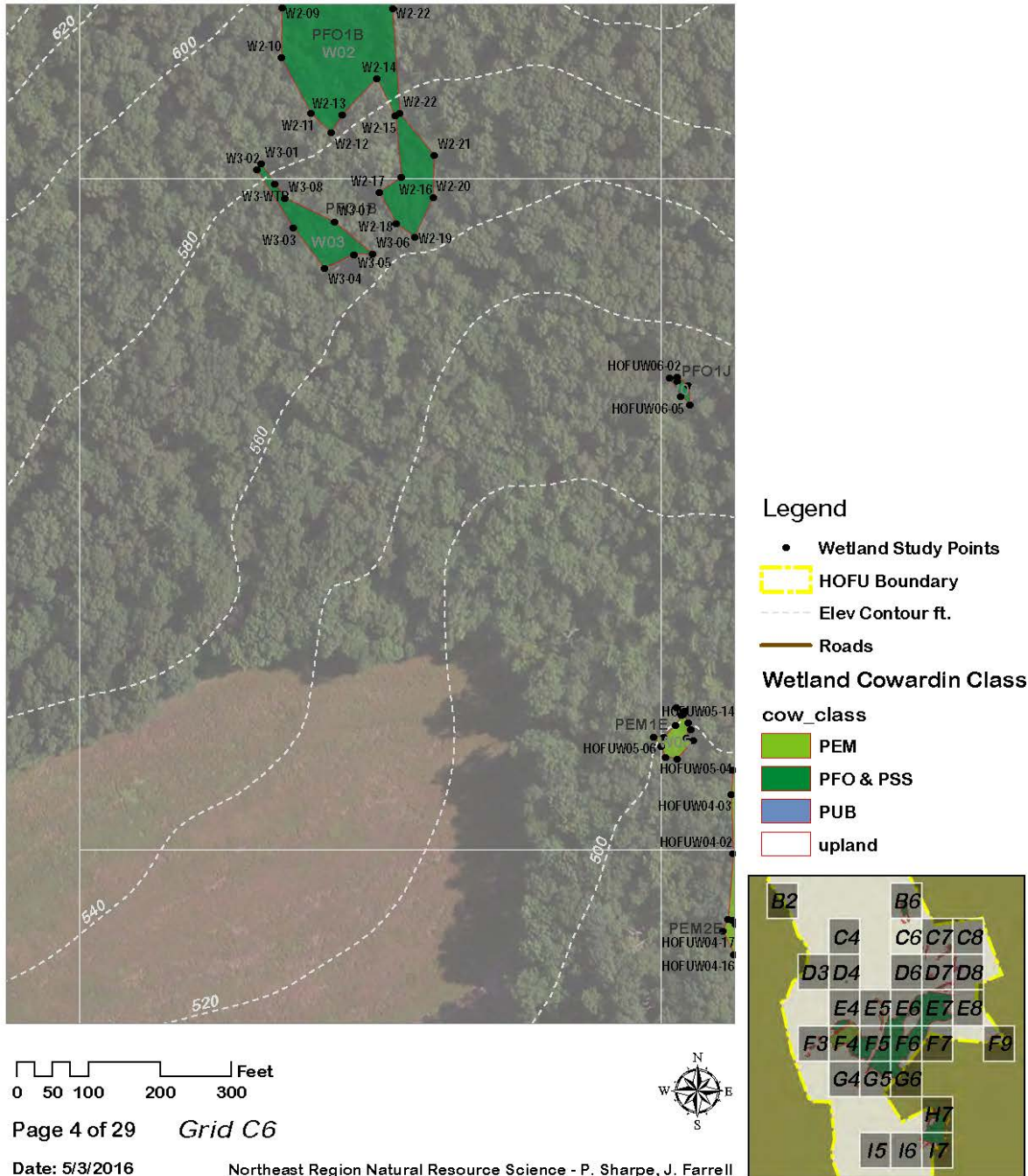


Figure C-5. Hopewell Furnace National Historic Site (HOFU) wetland inventory Grid Map C6.

Figure C-6. Hopewell Furnace National Historic Site (HOFU) wetland inventory Grid Map C7.



2014-2015 Wetland Study

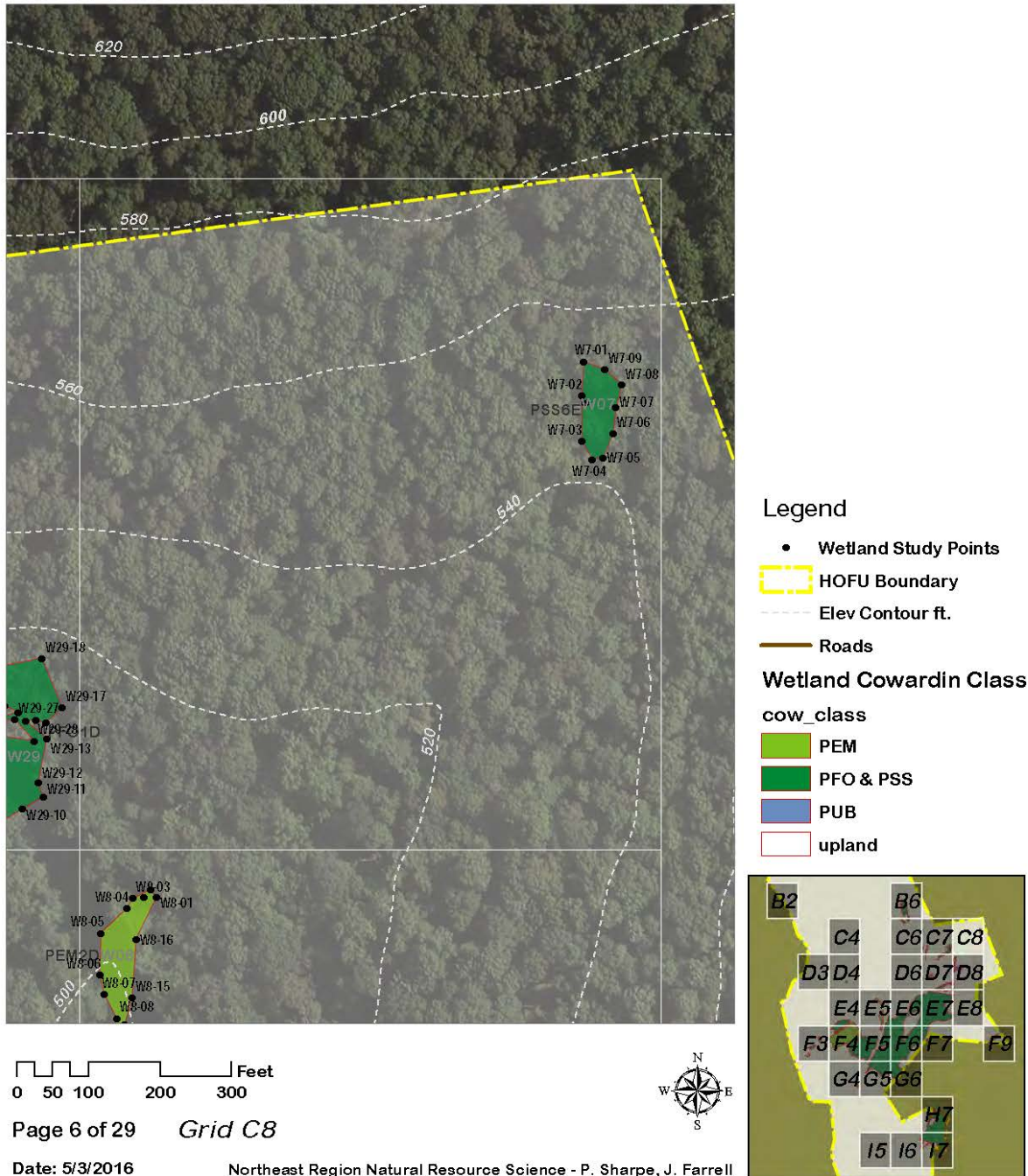


Figure C-7. Hopewell Furnace National Historic Site (HOFU) wetland inventory Grid Map C8.



2014-2015 Wetland Study

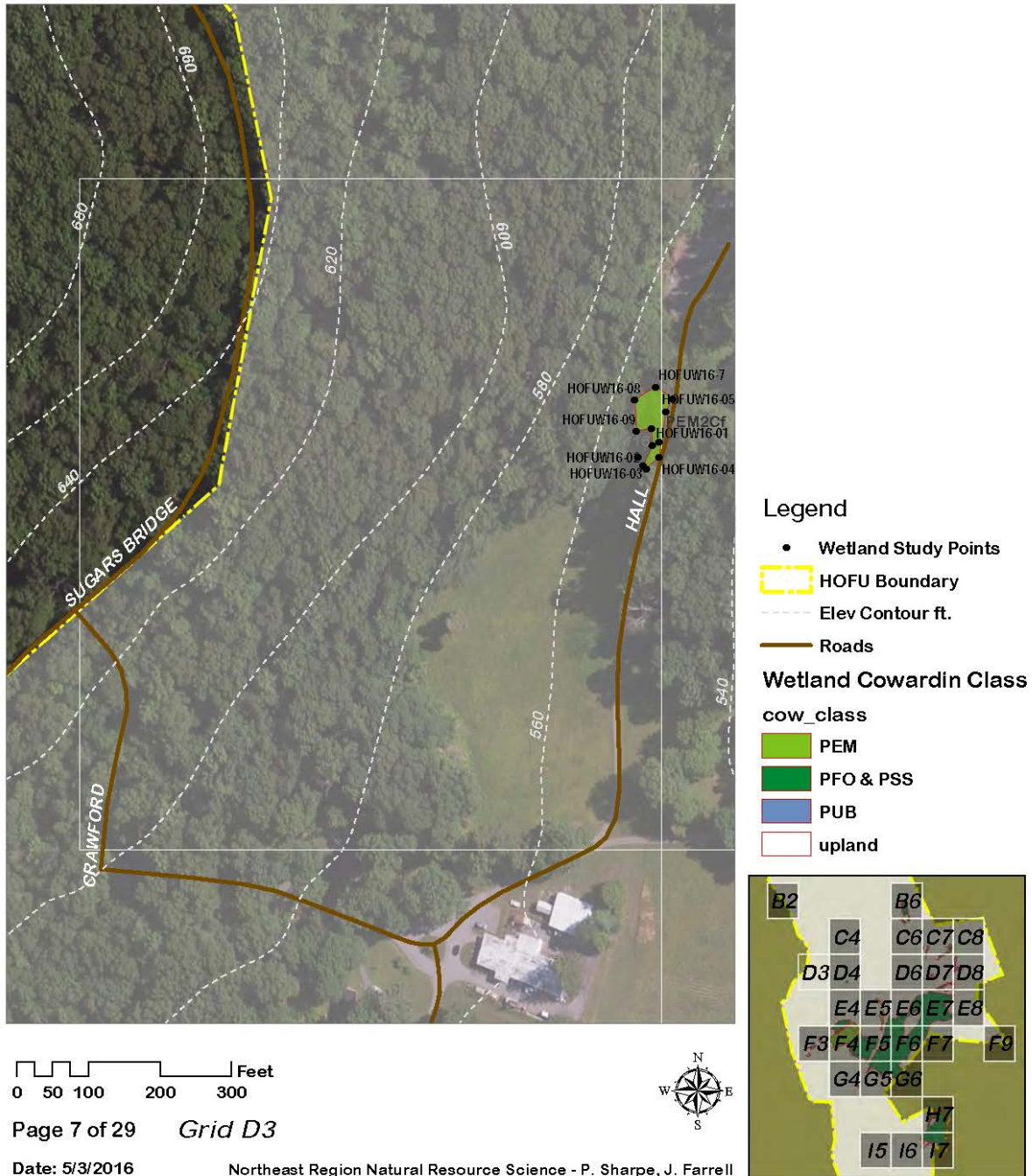


Figure C-8. Hopewell Furnace National Historic Site (HOFU) wetland inventory Grid Map D3.



2014-2015 Wetland Study

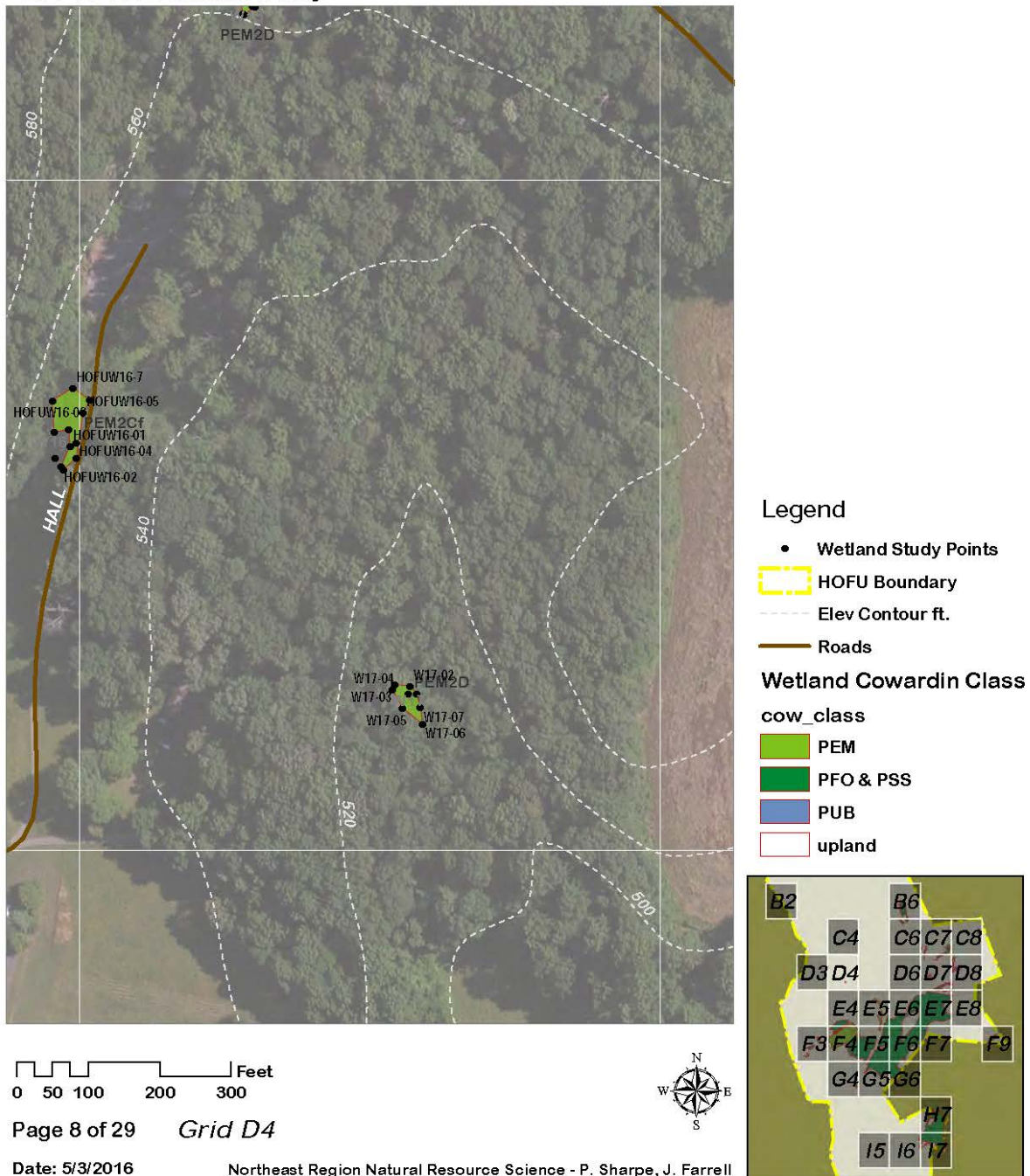


Figure C-9. Hopewell Furnace National Historic Site (HOFU) wetland inventory Grid Map D4.



2014-2015 Wetland Study

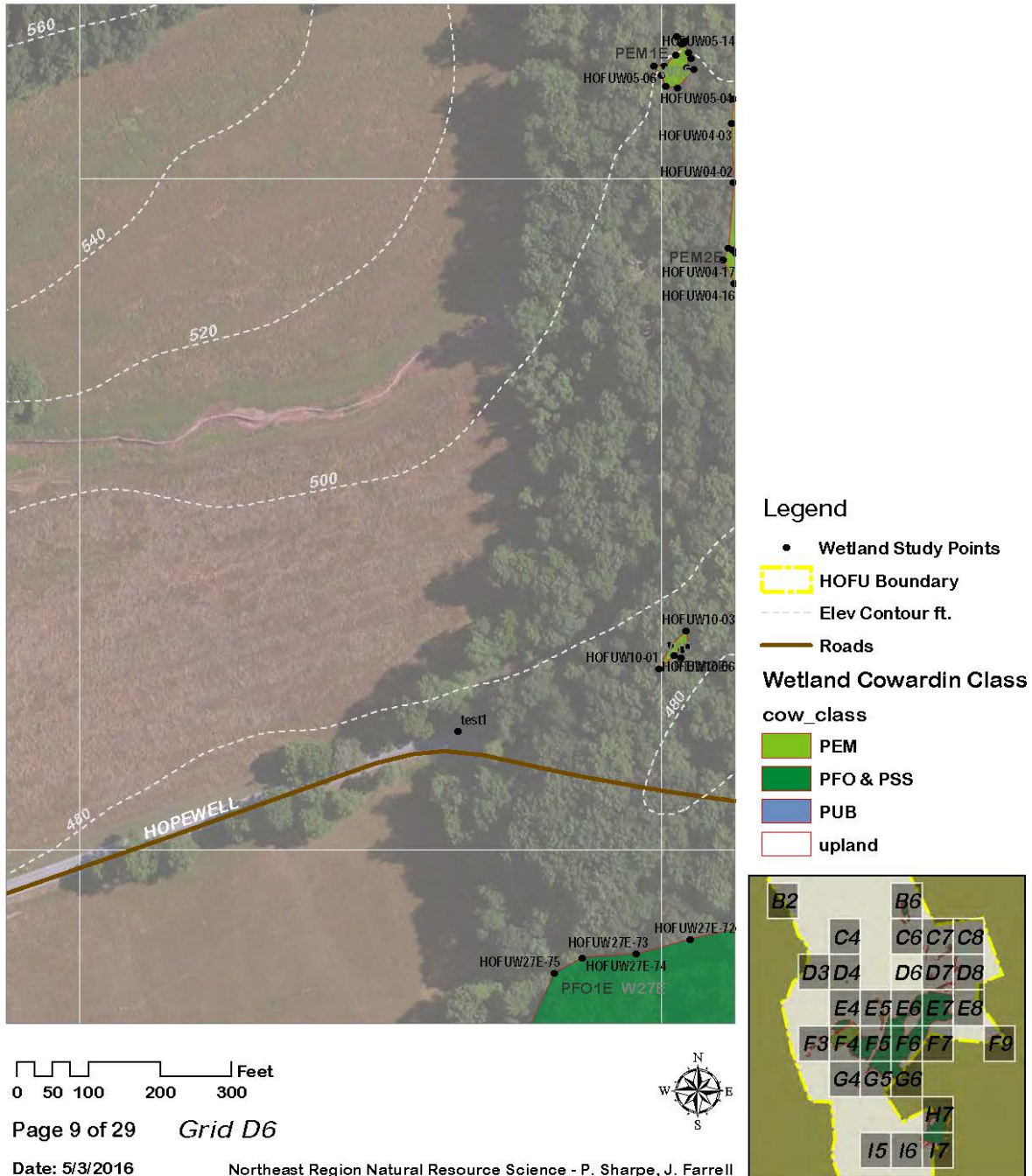


Figure C-10. Hopewell Furnace National Historic Site (HOFU) wetland inventory Grid Map D6.



2014-2015 Wetland Study

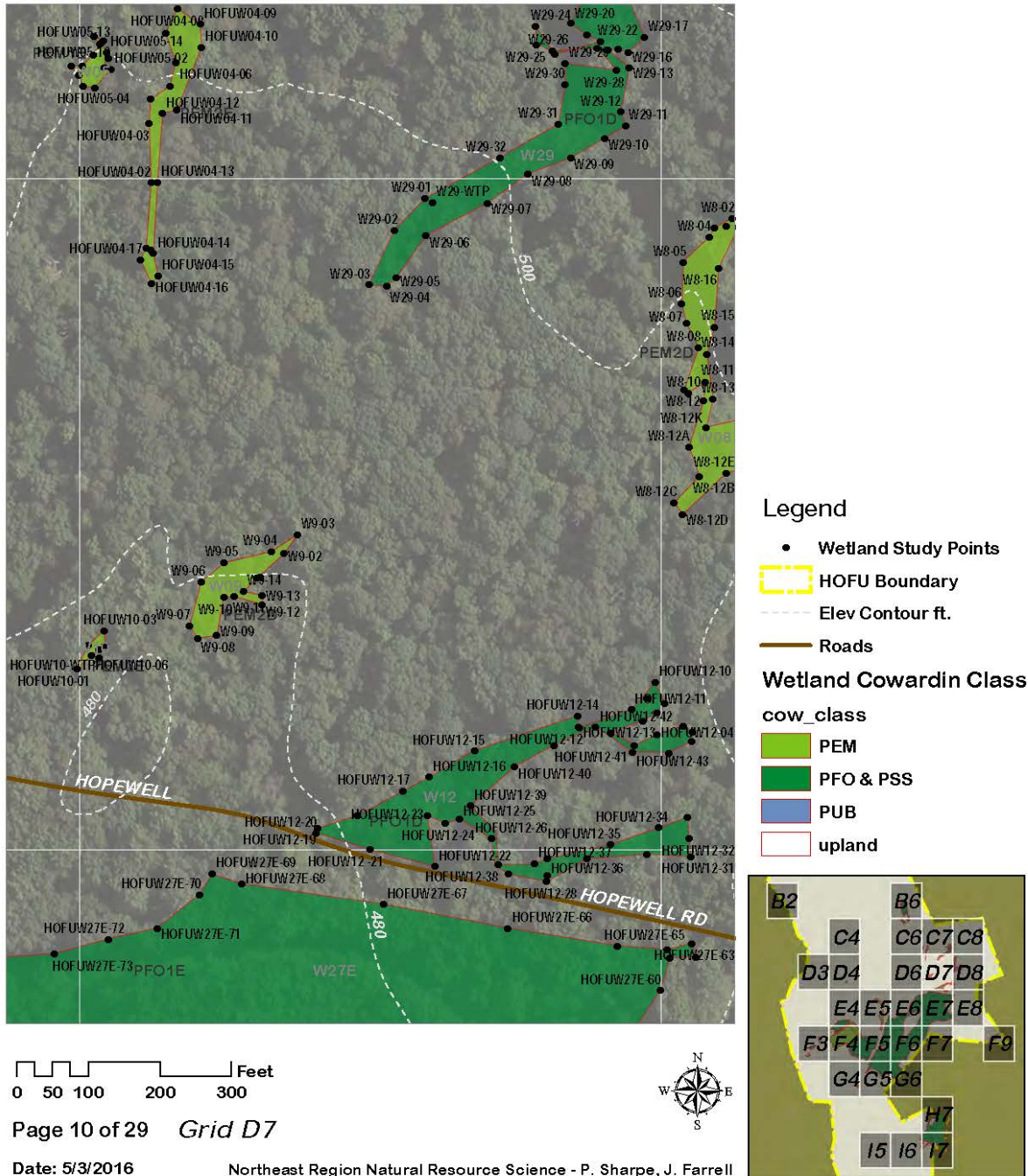


Figure C-11. Hopewell Furnace National Historic Site (HOFU) wetland inventory Grid Map D7.



2014-2015 Wetland Study

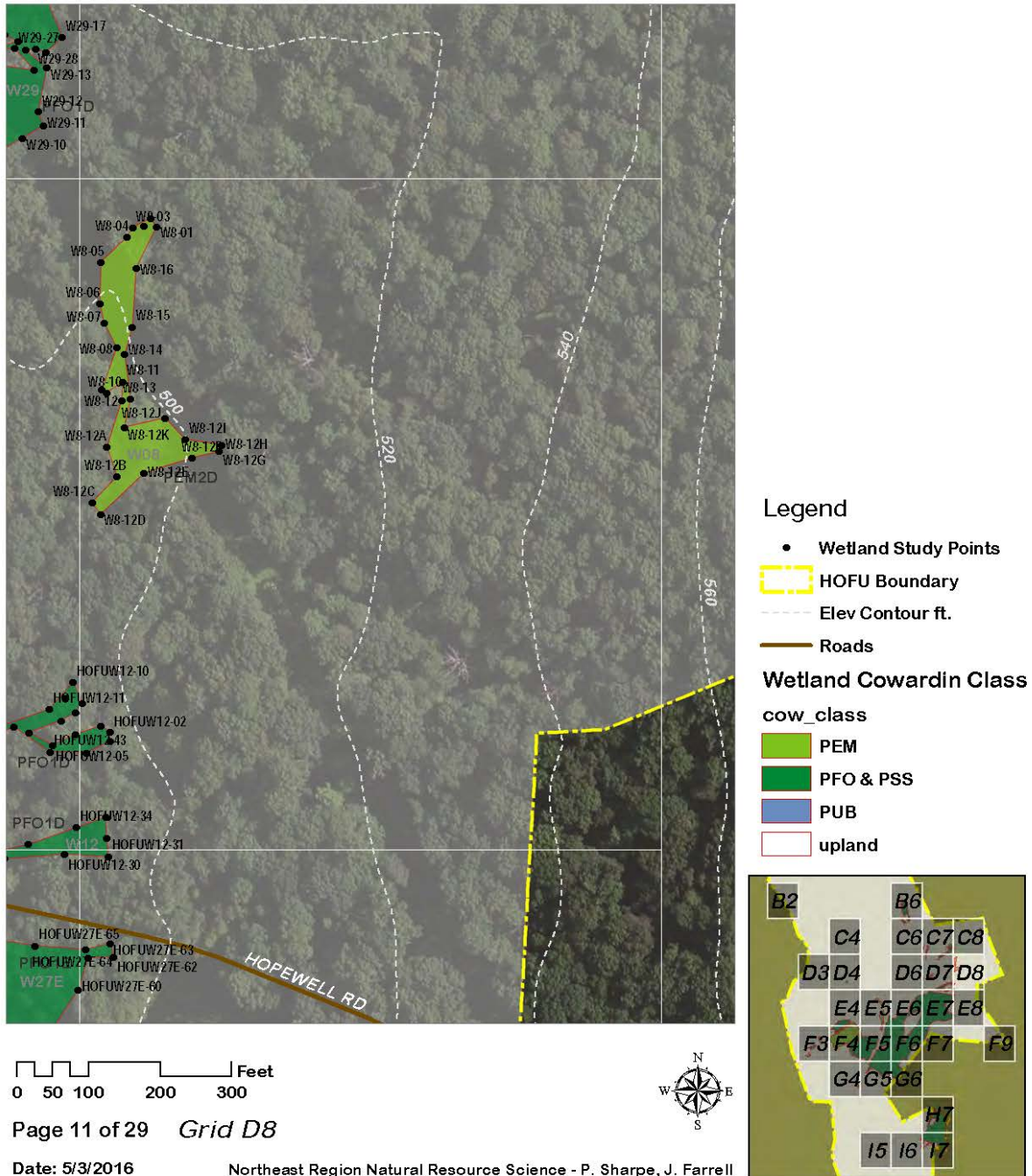


Figure C-12. Hopewell Furnace National Historic Site (HOFU) wetland inventory Grid Map D8.



2014-2015 Wetland Study

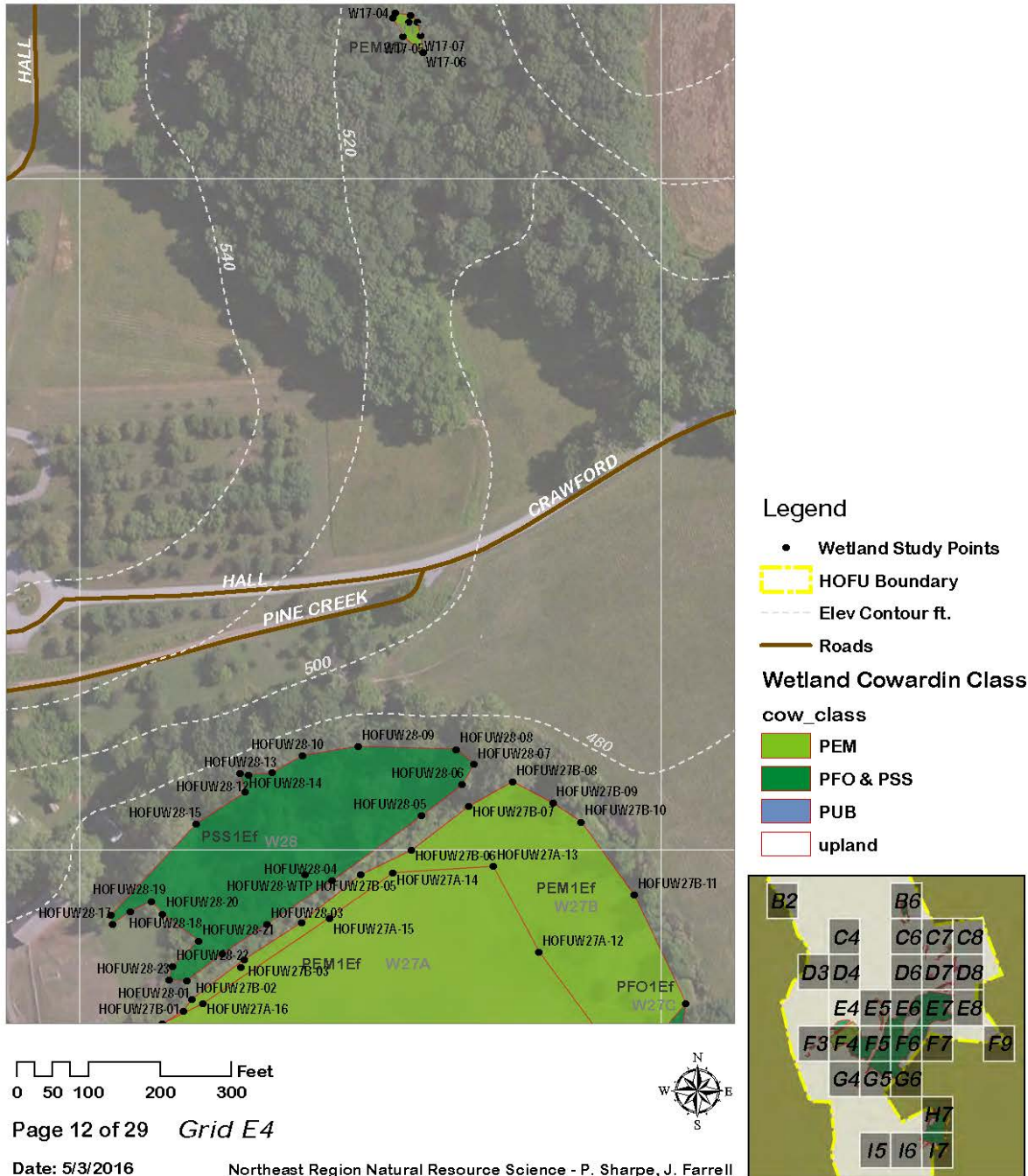


Figure C-13. Hopewell Furnace National Historic Site (HOFU) wetland inventory Grid Map E4.



2014-2015 Wetland Study

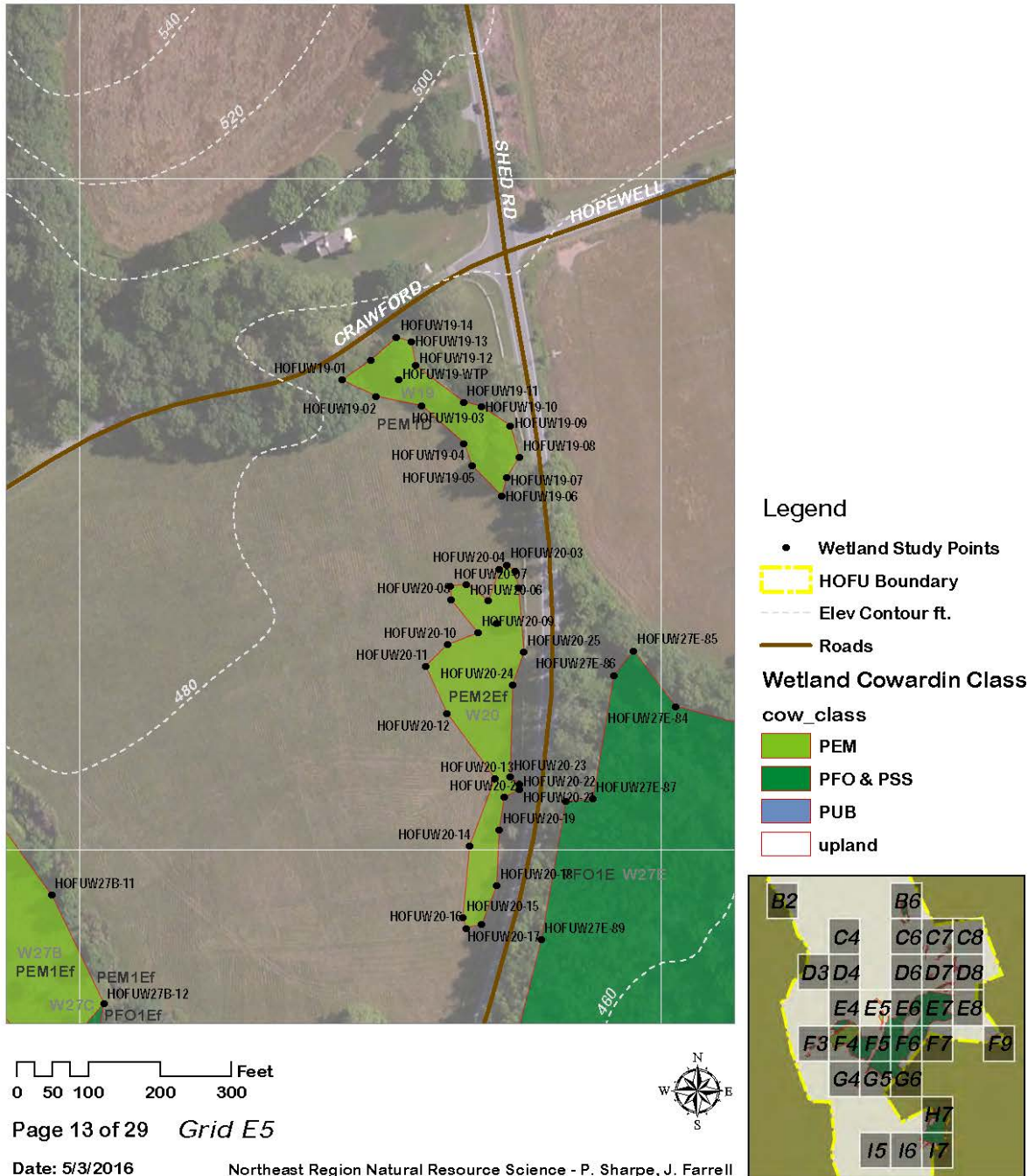


Figure C-14. Hopewell Furnace National Historic Site (HOFU) wetland inventory Grid Map E5.



2014-2015 Wetland Study

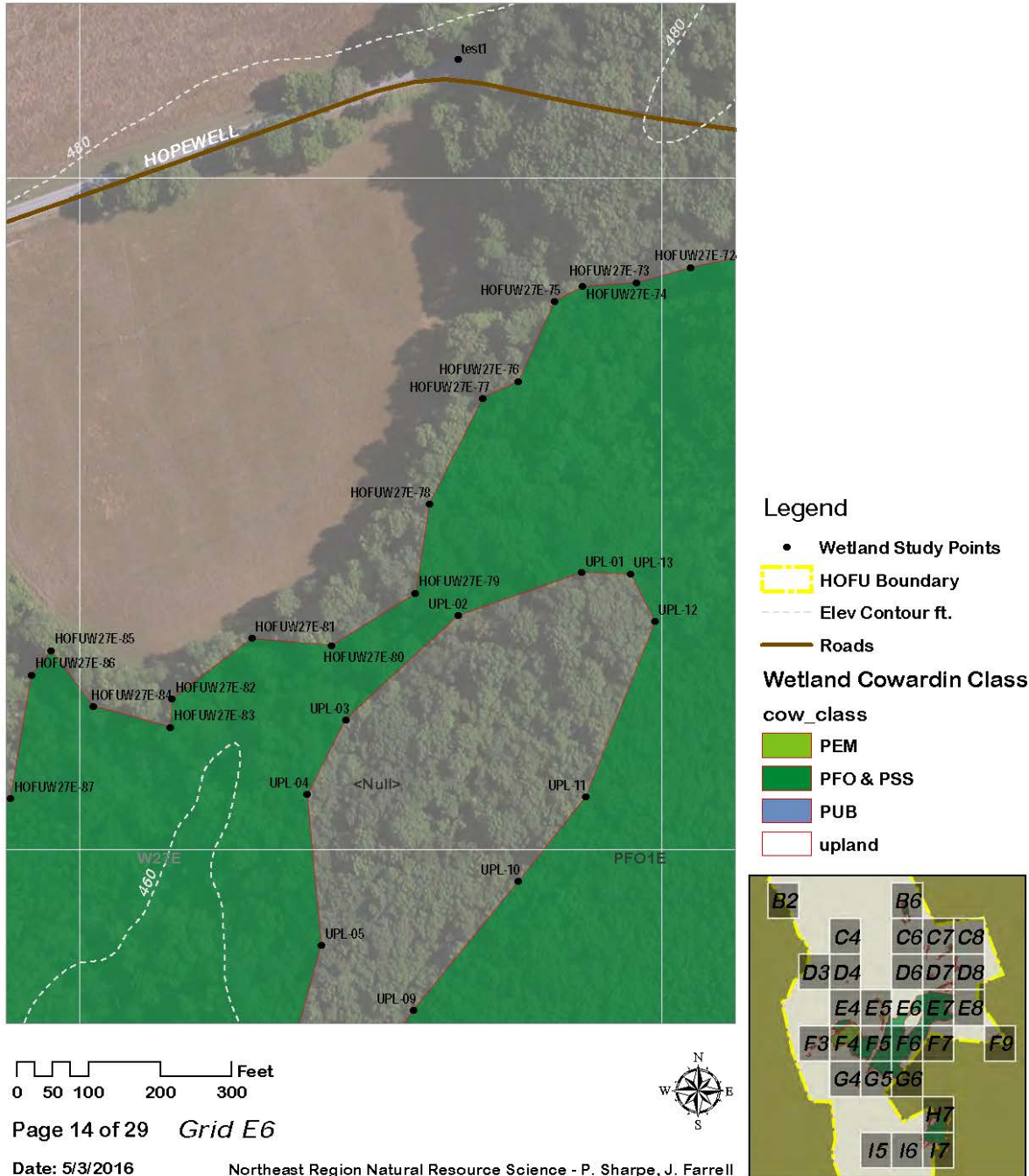


Figure C-15. Hopewell Furnace National Historic Site (HOFU) wetland inventory Grid Map E6.



2014-2015 Wetland Study

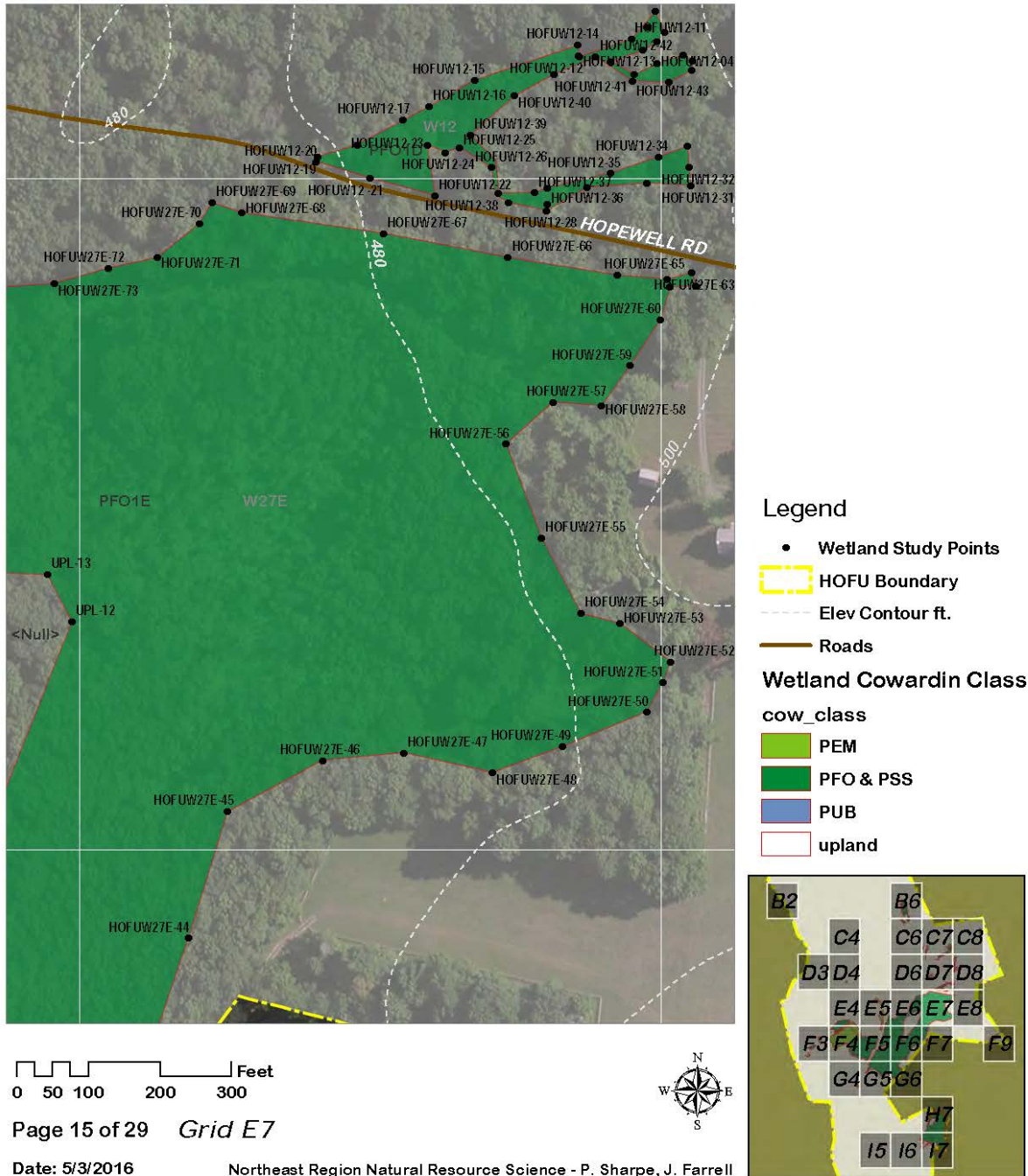


Figure C-16. Hopewell Furnace National Historic Site (HOFU) wetland inventory Grid Map E7.



2014-2015 Wetland Study

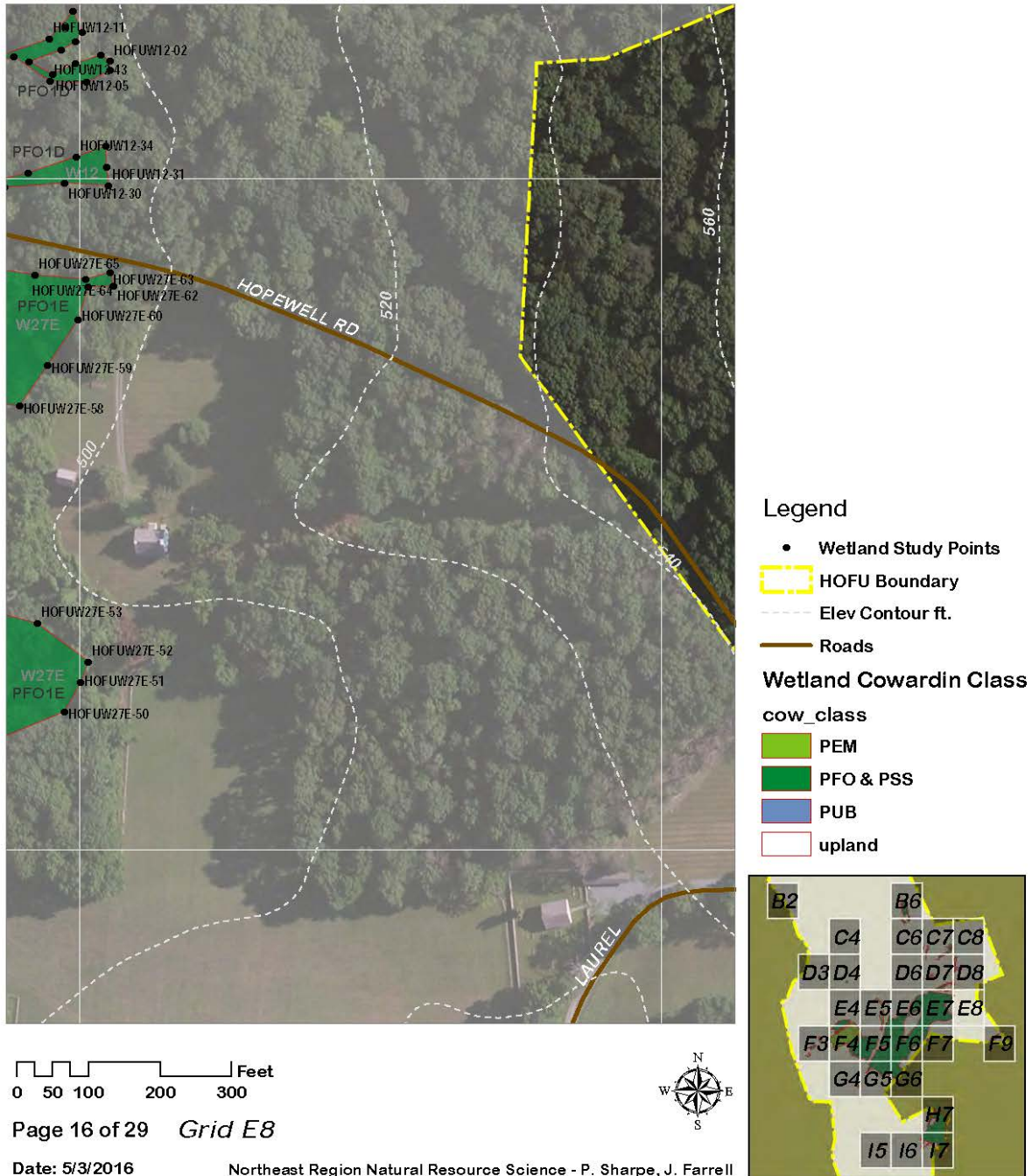


Figure C-17. Hopewell Furnace National Historic Site (HOFU) wetland inventory Grid Map E8.



2014-2015 Wetland Study

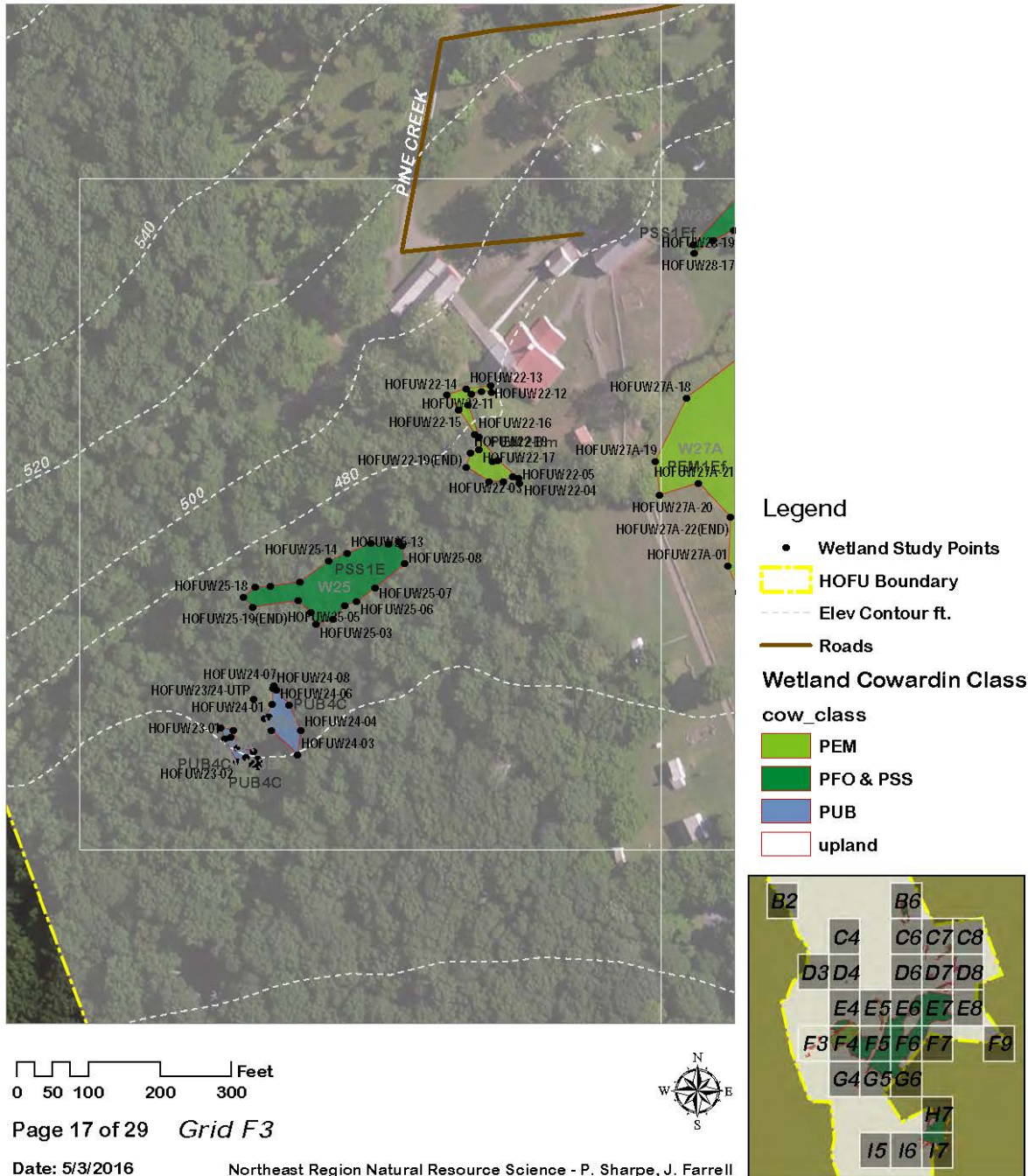


Figure C-18. Hopewell Furnace National Historic Site (HOFU) wetland inventory Grid Map F3.



2014-2015 Wetland Study

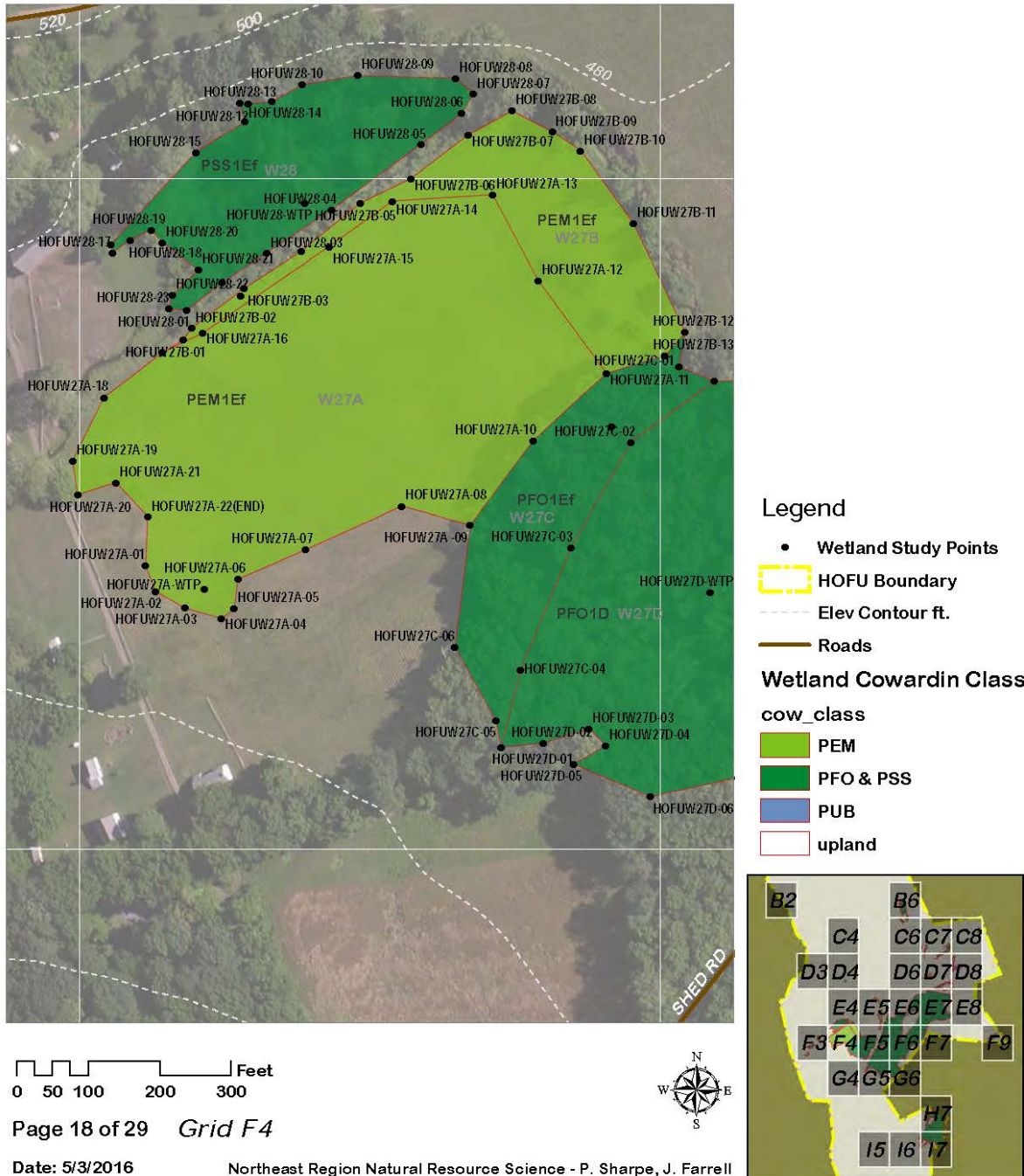


Figure C-19. Hopewell Furnace National Historic Site (HOFU) wetland inventory Grid Map F4.



2014-2015 Wetland Study

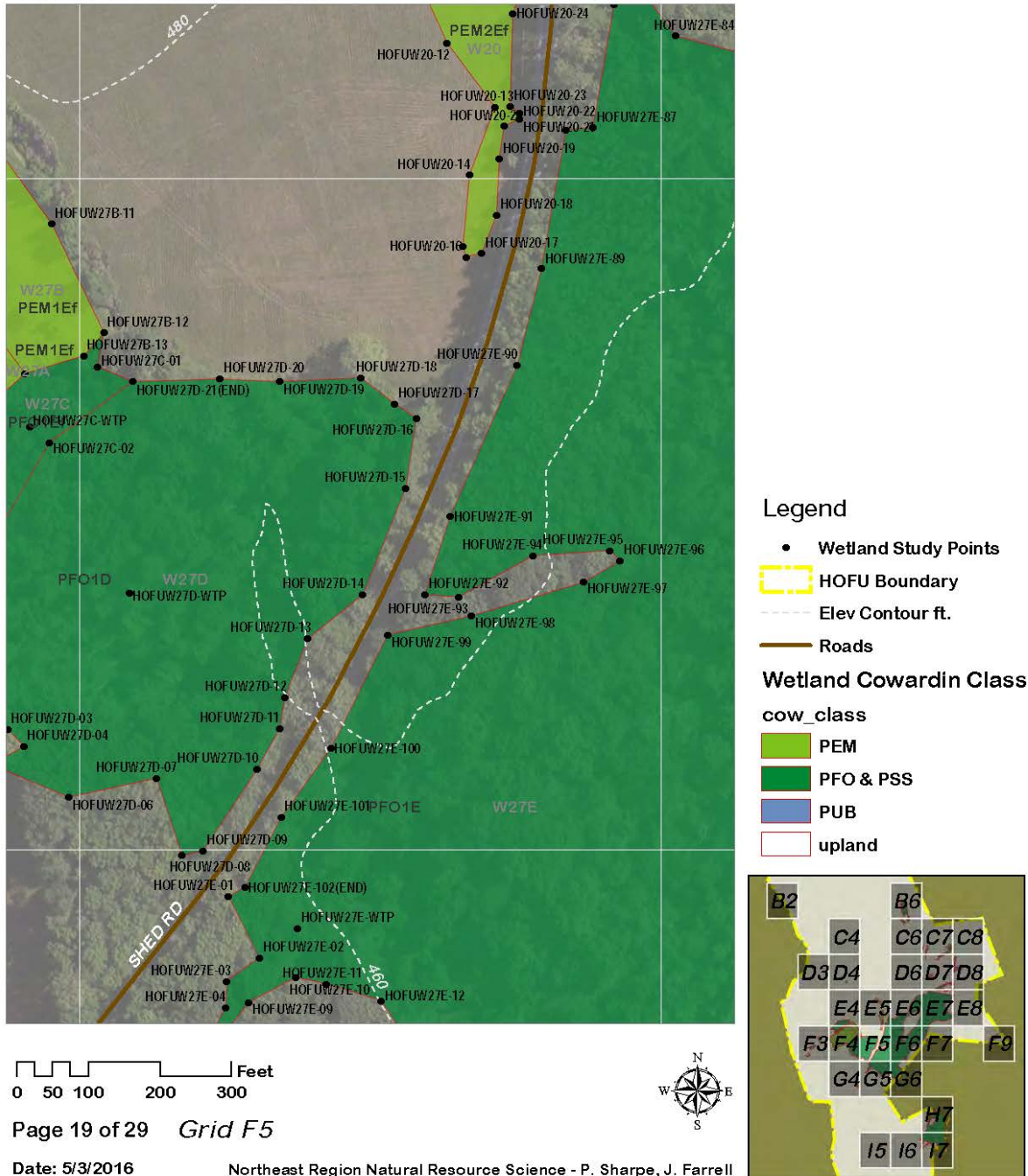


Figure C-20. Hopewell Furnace National Historic Site (HOFU) wetland inventory Grid Map F5.



2014-2015 Wetland Study

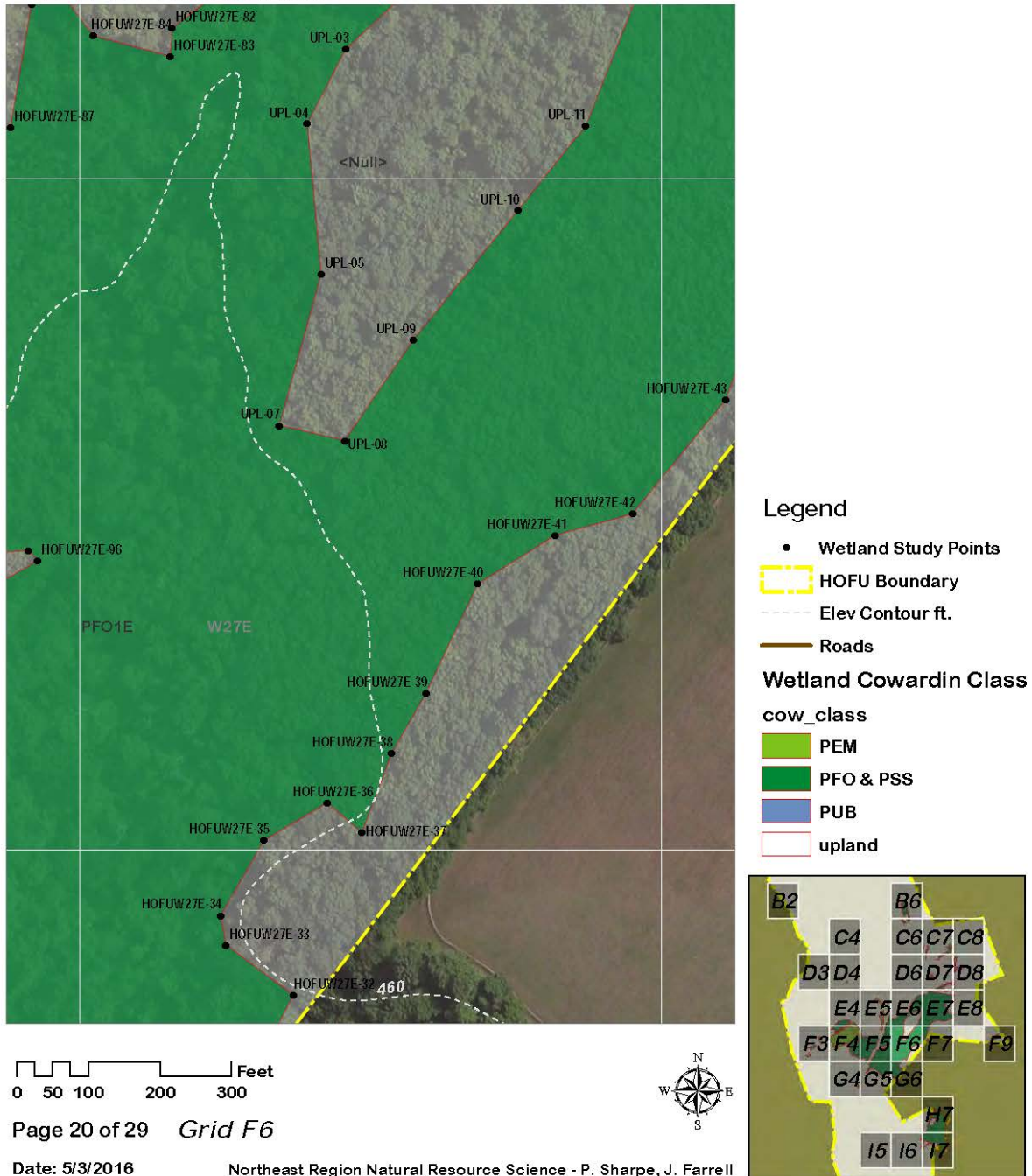


Figure C-21. Hopewell Furnace National Historic Site (HOFU) wetland inventory Grid Map F6.



2014-2015 Wetland Study

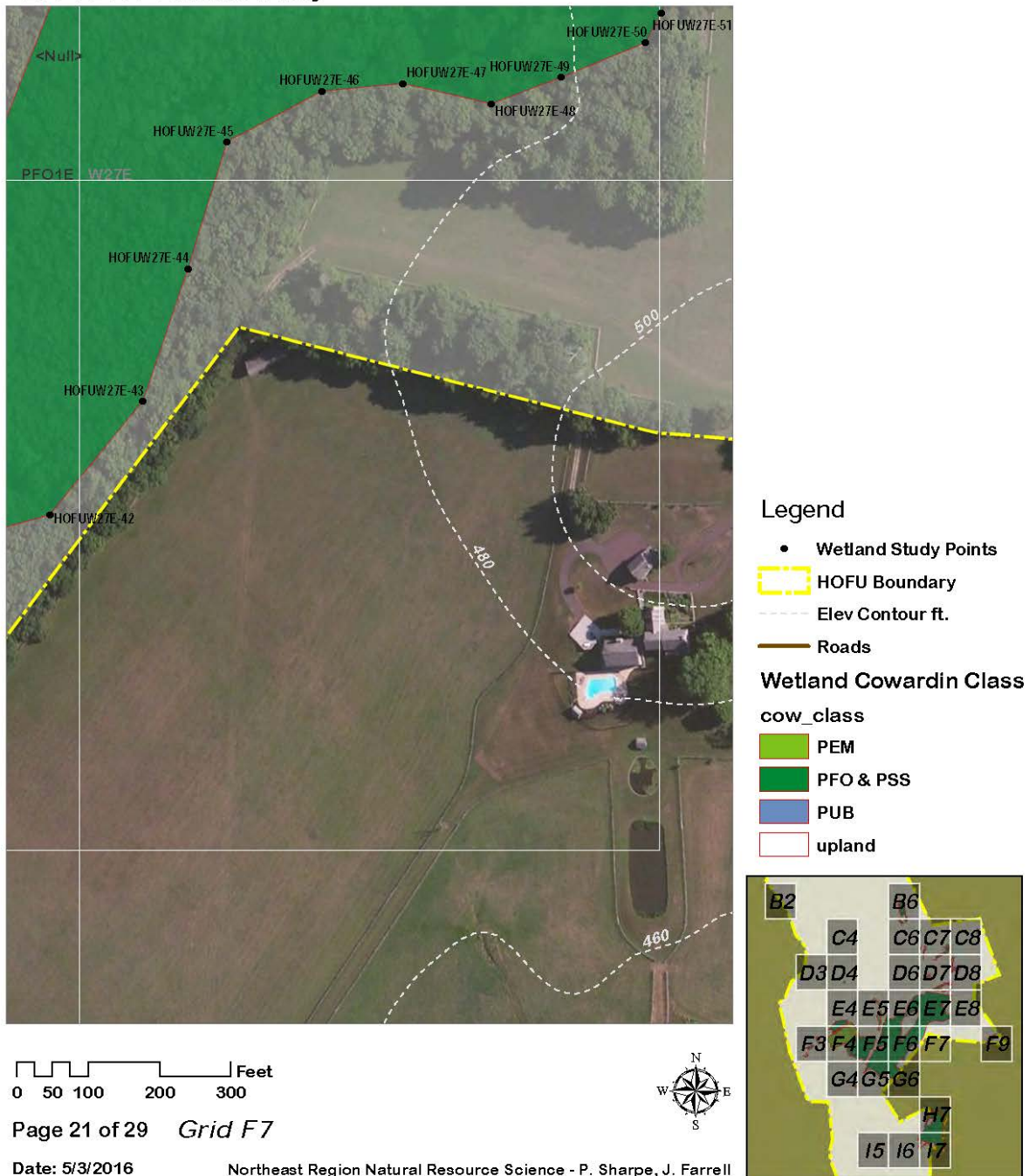


Figure C-22. Hopewell Furnace National Historic Site (HOFU) wetland inventory Grid Map F7.



2014-2015 Wetland Study

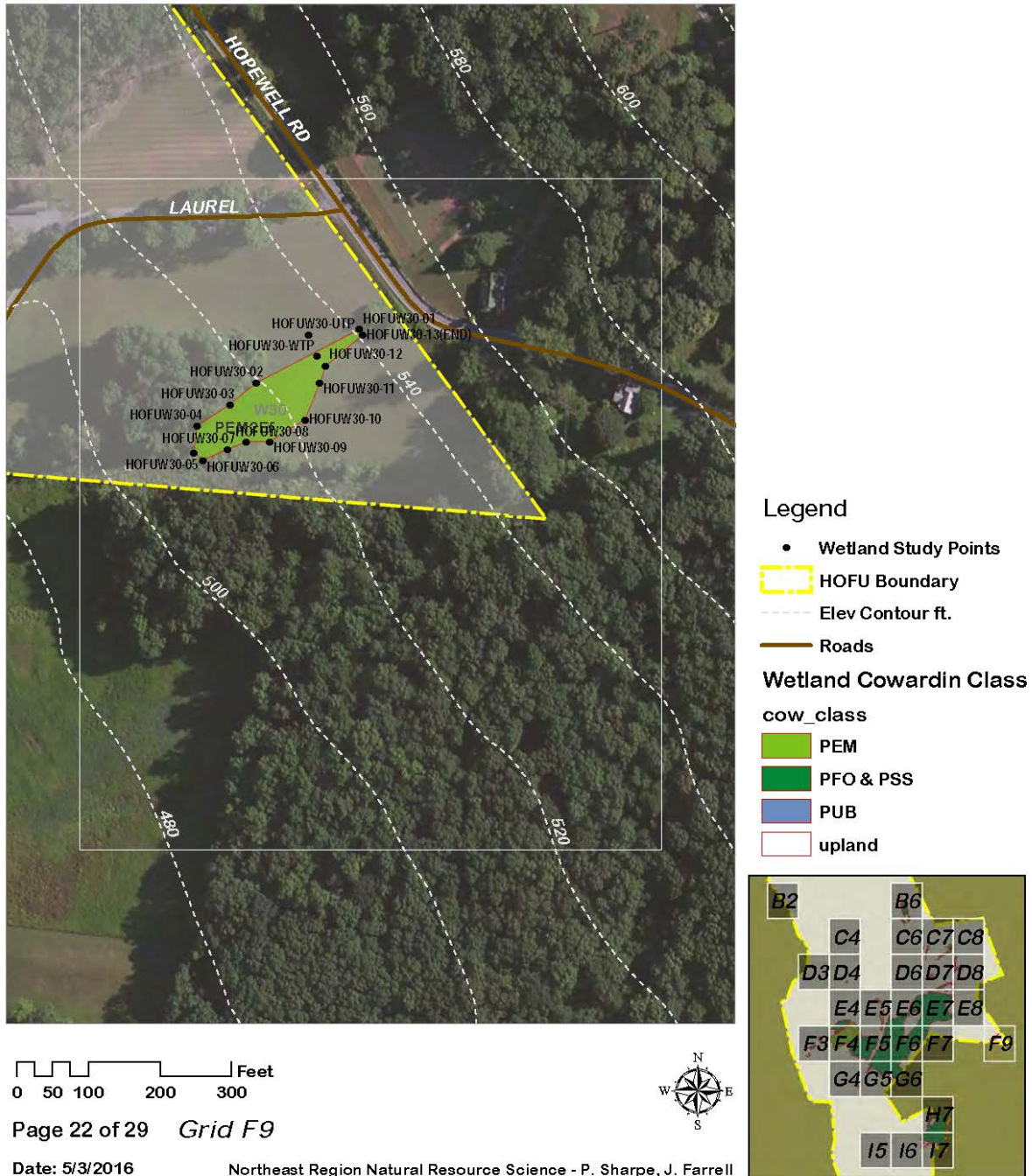


Figure C-23. Hopewell Furnace National Historic Site (HOFU) wetland inventory Grid Map F9.



2014-2015 Wetland Study

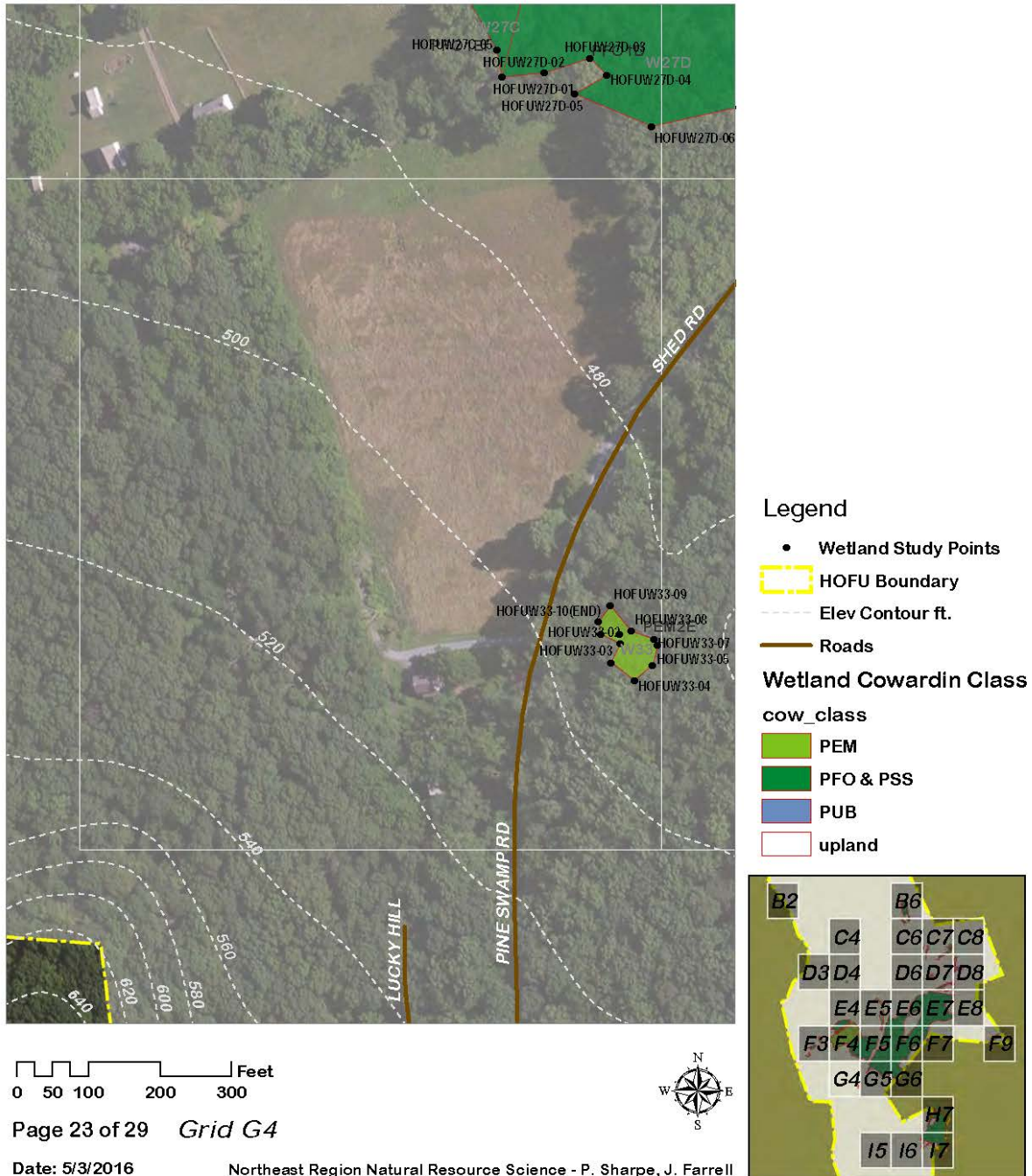


Figure C-24. Hopewell Furnace National Historic Site (HOFU) wetland inventory Grid Map G4.



2014-2015 Wetland Study

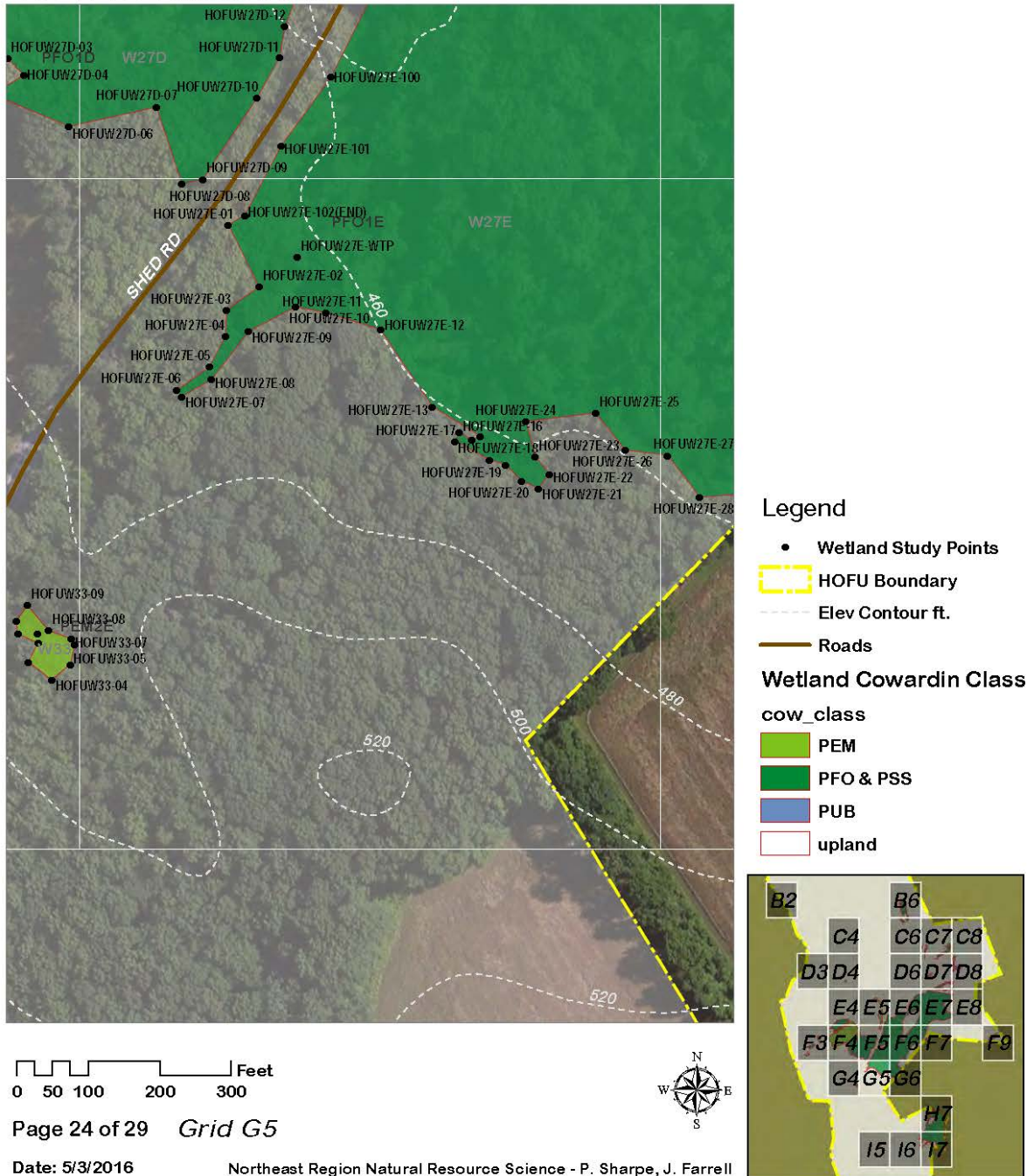


Figure C-25. Hopewell Furnace National Historic Site (HOFU) wetland inventory Grid Map G5.



2014-2015 Wetland Study

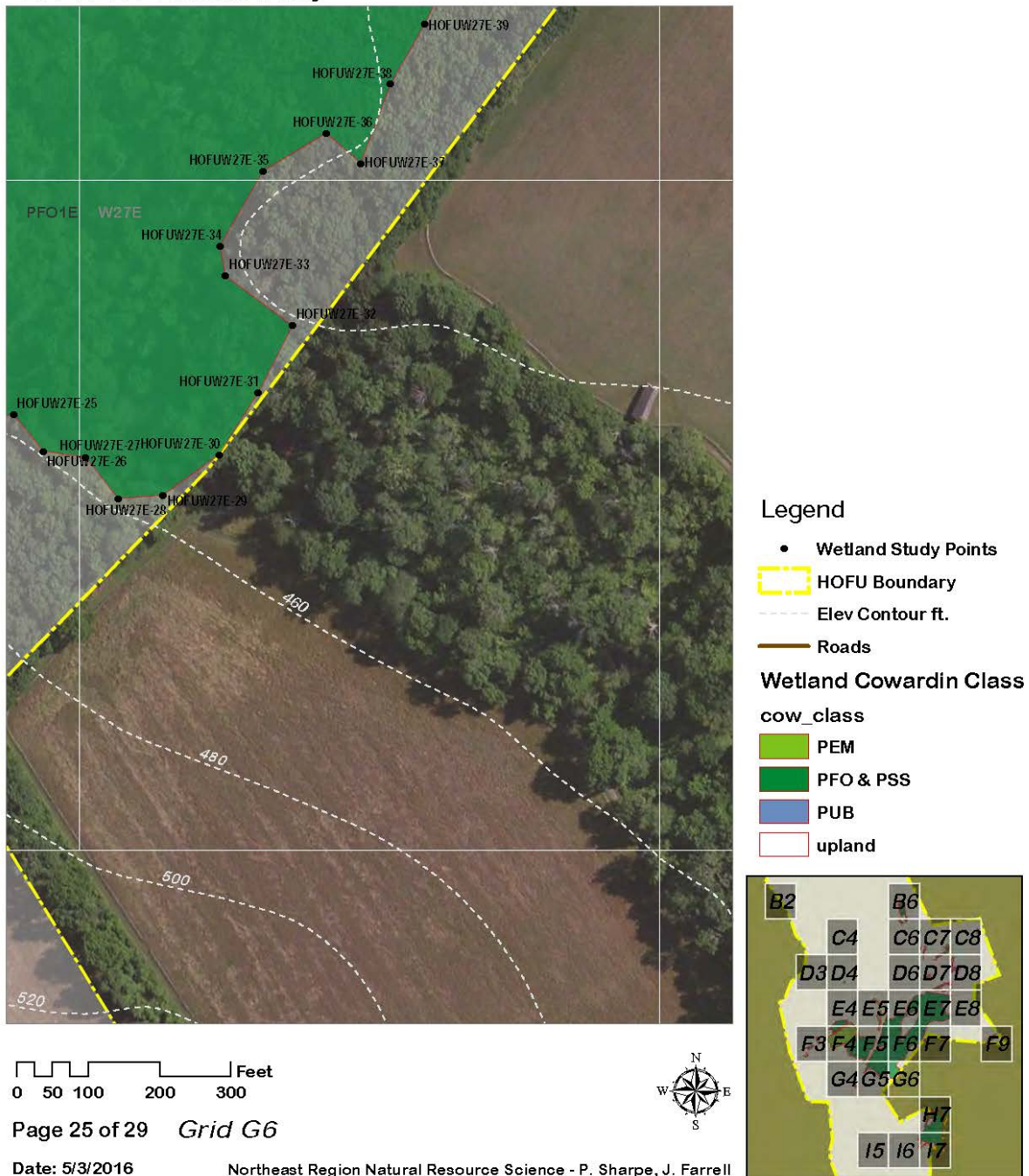


Figure C-26. Hopewell Furnace National Historic Site (HOFU) wetland inventory Grid Map G6.



2014-2015 Wetland Study

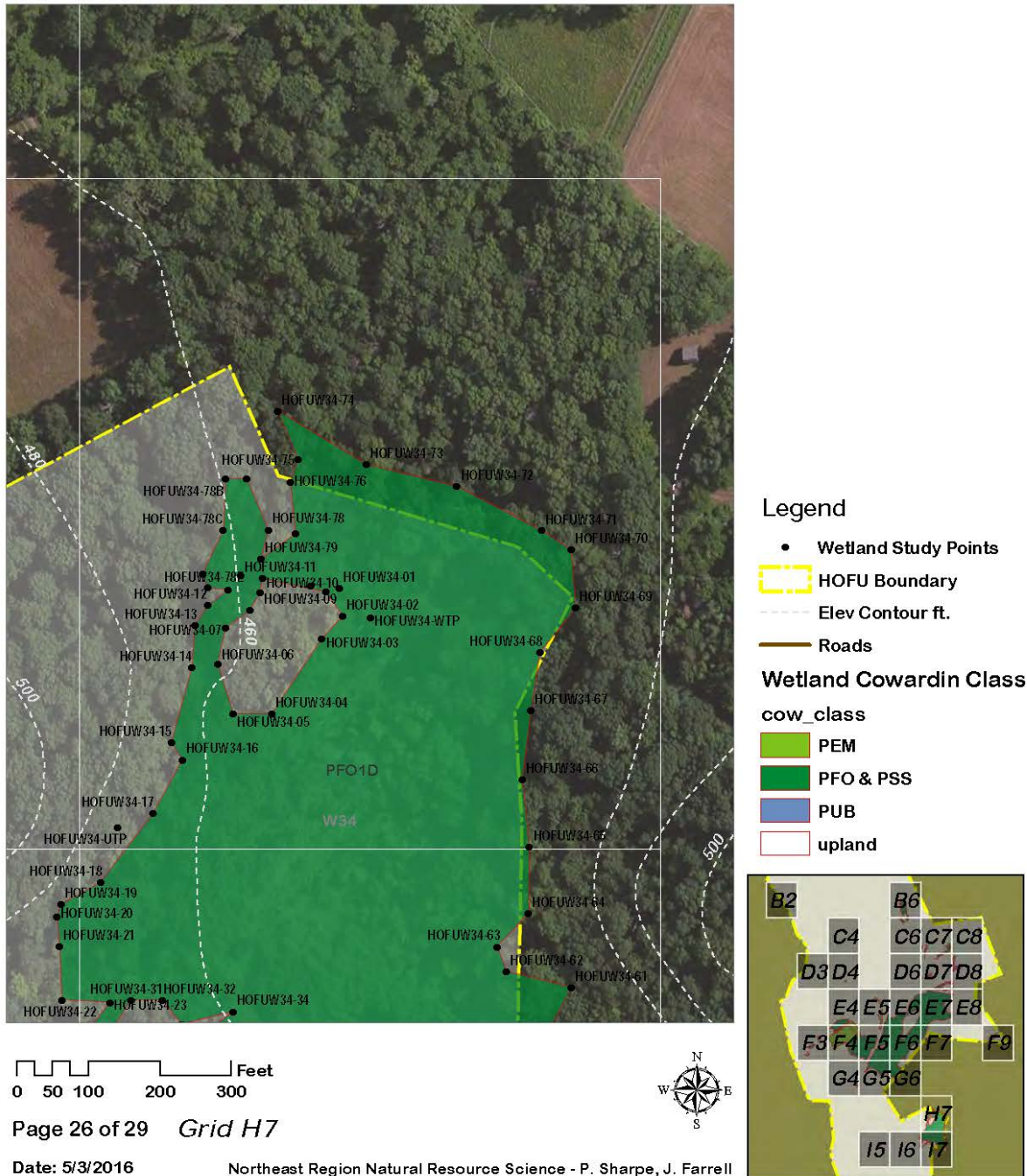


Figure C-27. Hopewell Furnace National Historic Site (HOFU) wetland inventory Grid Map H7.



2014-2015 Wetland Study

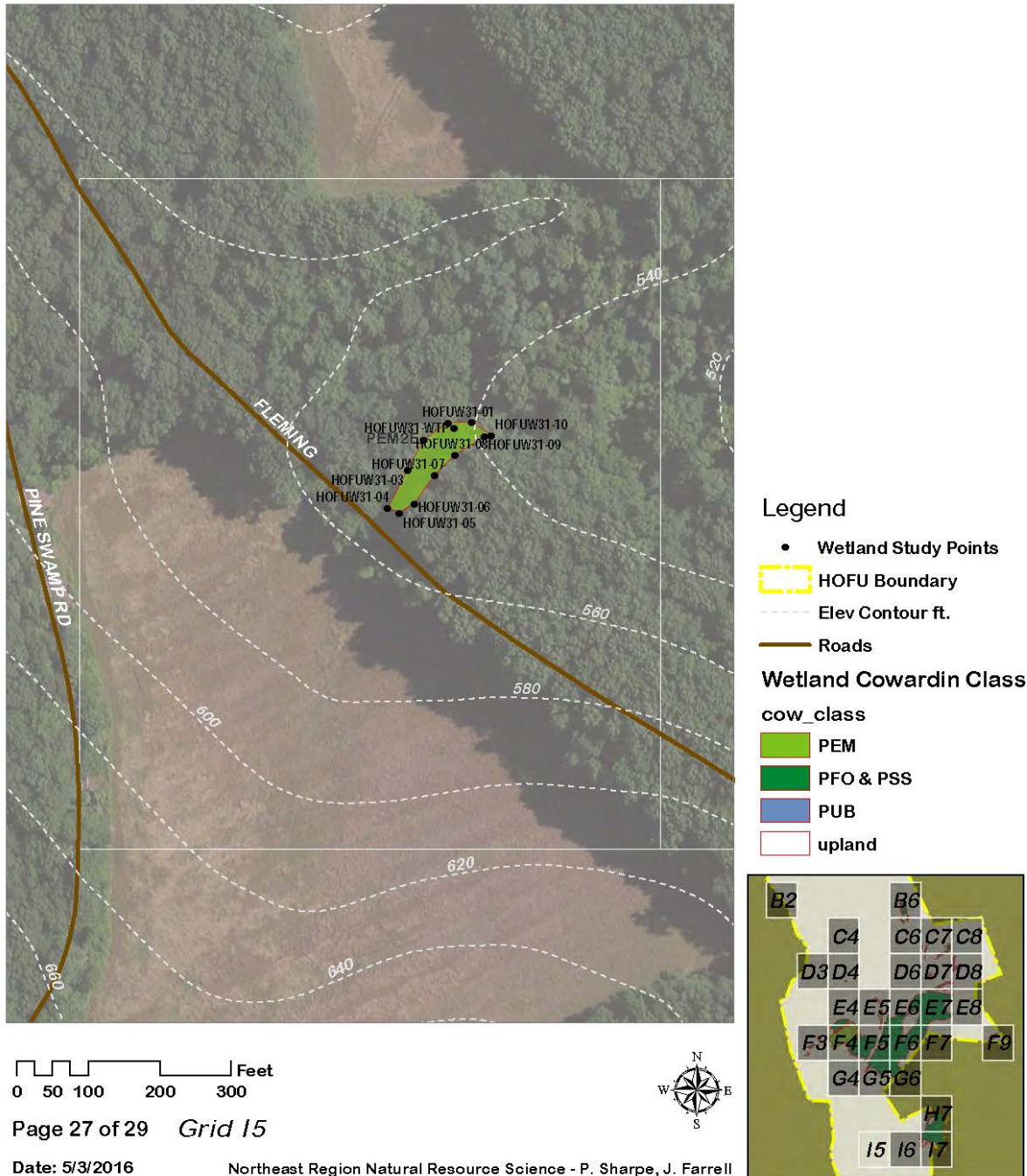


Figure C-28. Hopewell Furnace National Historic Site (HOFU) wetland inventory Grid Map 15.



2014-2015 Wetland Study

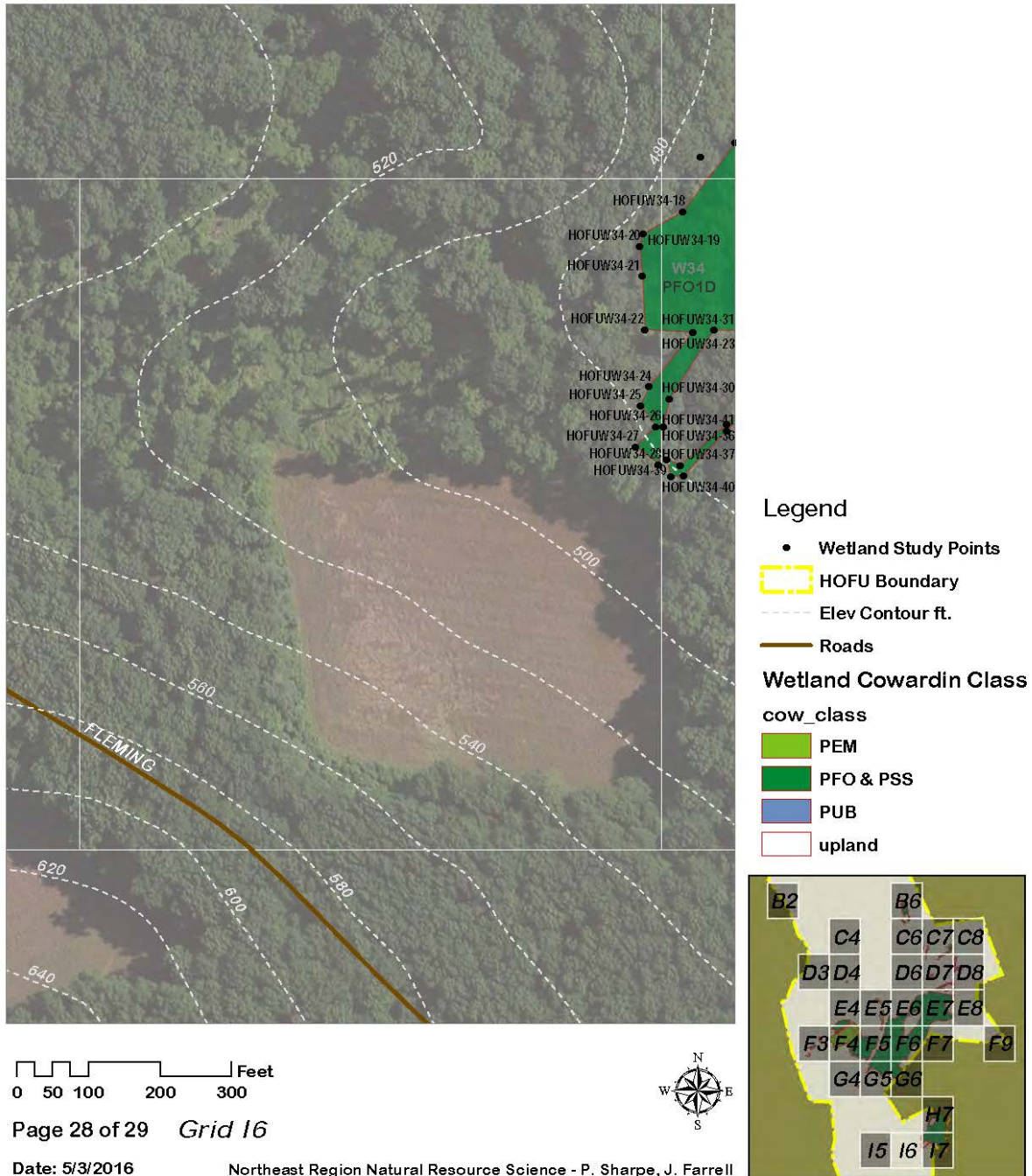


Figure C-29. Hopewell Furnace National Historic Site (HOFU) wetland inventory Grid Map I6.



2014-2015 Wetland Study

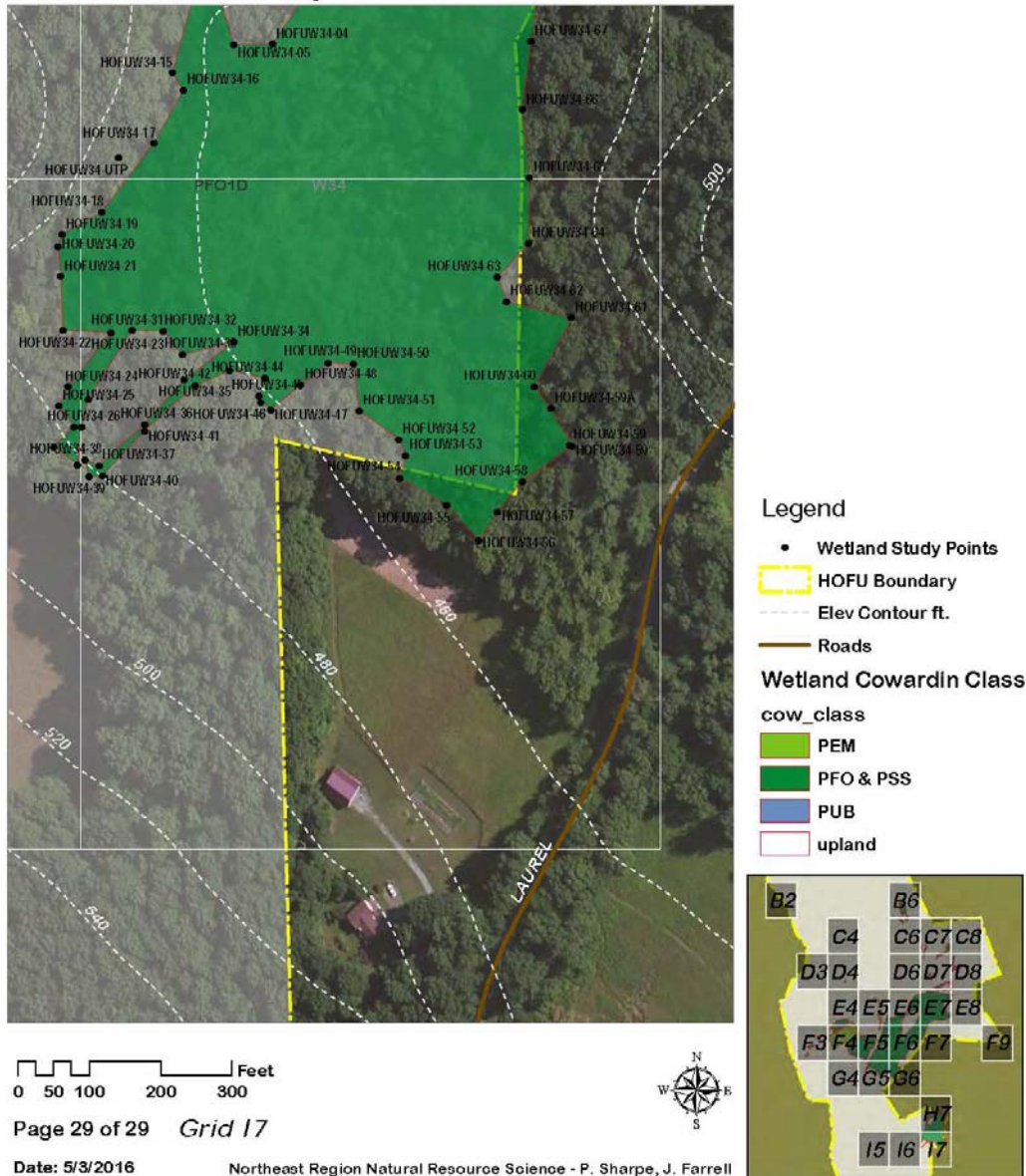


Figure C-30. Hopewell Furnace National Historic Site (HOFU) wetland inventory Grid Map 17.

Appendix D: Palmer Drought Severity Index (PDSI) maps depicting hydrologic conditions prior to and during wetland investigations at HOFU

(The climatic division containing HOFU is circled in red on the maps)

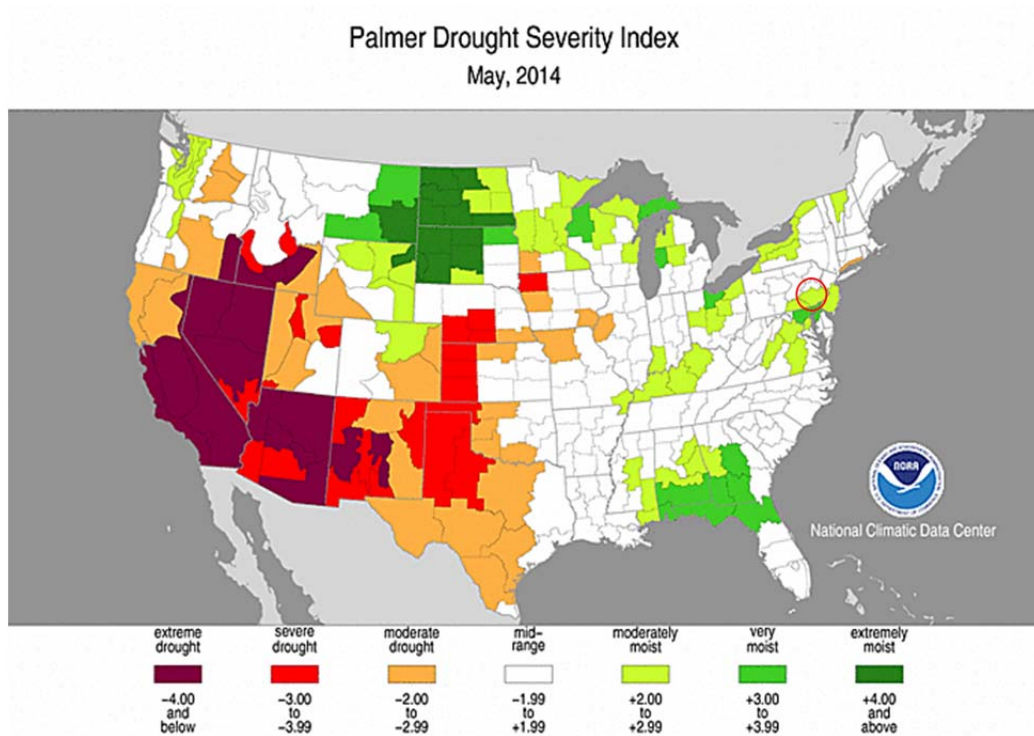


Figure D-1. Palmer Drought Severity Index (PDSI) maps depicting hydrologic conditions at Hopewell Furnace National Historic Site (HOFU) – May 2014. The area circled in red depicts the park's general location.

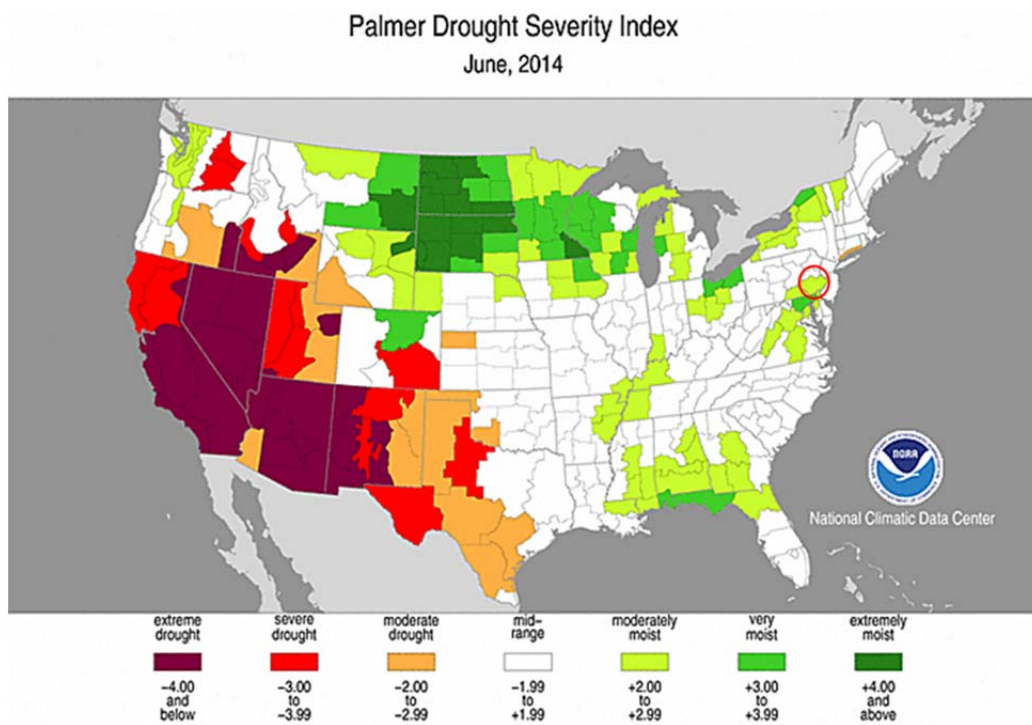


Figure D-2. Palmer Drought Severity Index (PDSI) maps depicting hydrologic conditions at Hopewell Furnace National Historic Site (HOFU) – June 2014. The area circled in red depicts the park's general location.

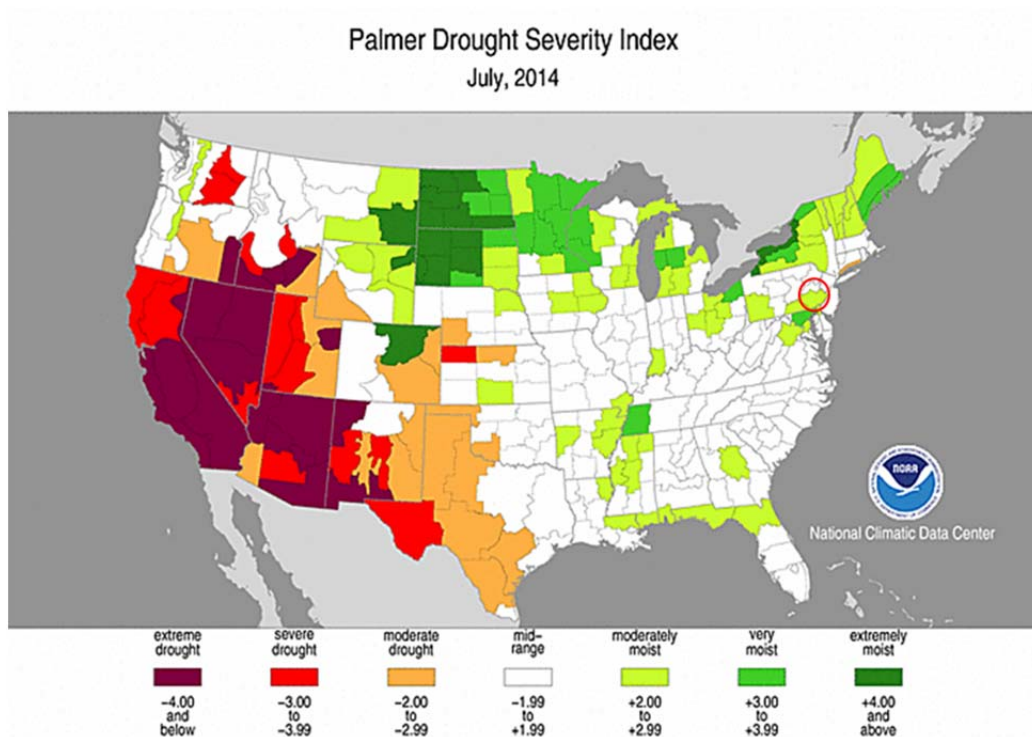


Figure D-3. Palmer Drought Severity Index (PDSI) maps depicting hydrologic conditions at Hopewell Furnace National Historic Site (HOFU) – July 2014. The area circled in red depicts the park's general location.

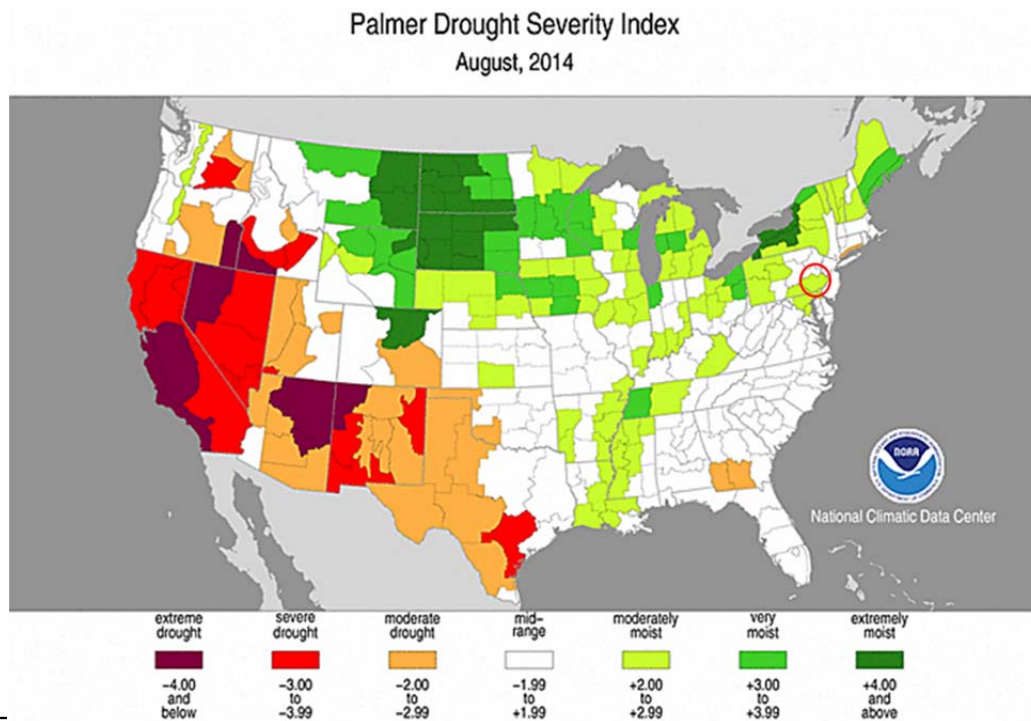


Figure D-4. Palmer Drought Severity Index (PDSI) maps depicting hydrologic conditions at Hopewell Furnace National Historic Site (HOFU) – August 2014. The area circled in red depicts the park's general location.

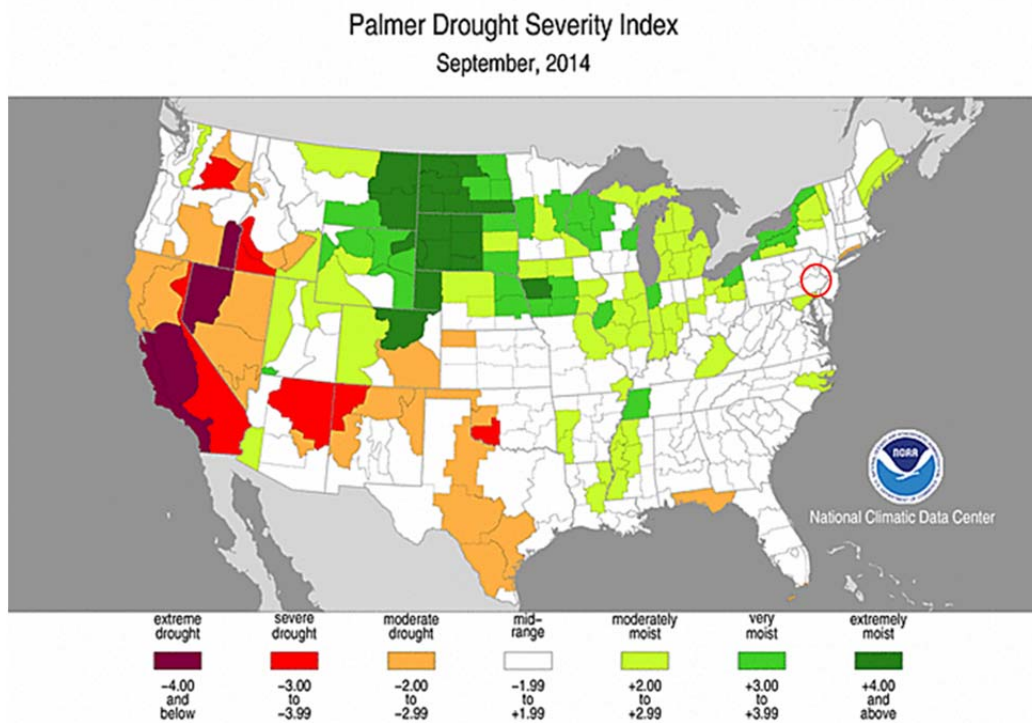


Figure D-5. Palmer Drought Severity Index (PDSI) maps depicting hydrologic conditions at Hopewell Furnace National Historic Site (HOFU) – September 2014. The area circled in red depicts the park's general location.

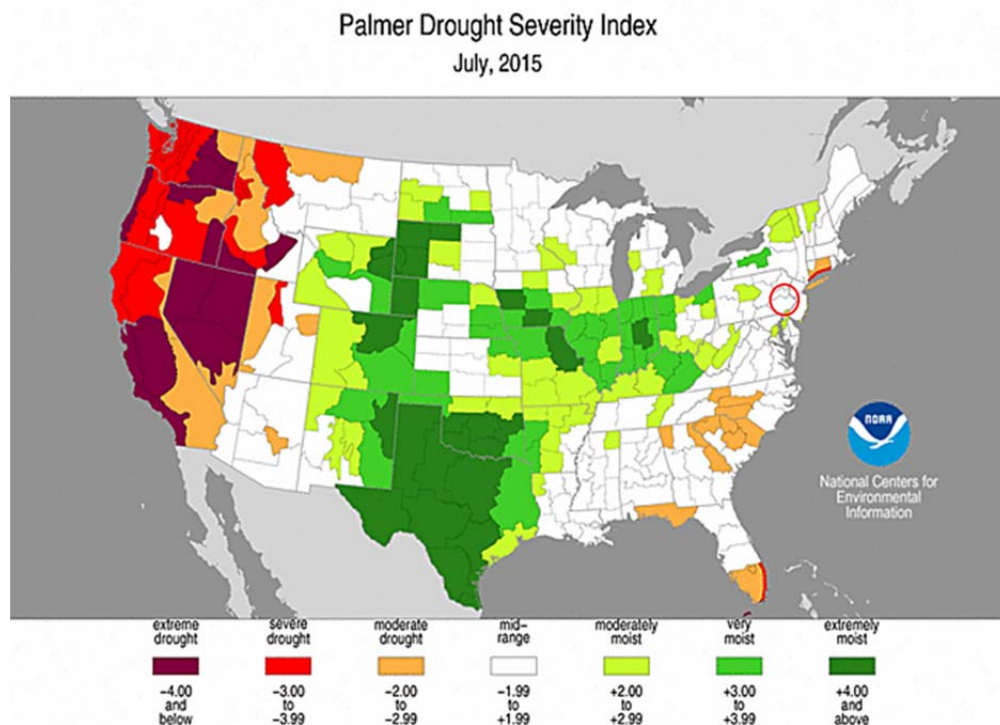


Figure D-6. Palmer Drought Severity Index (PDSI) maps depicting hydrologic conditions at Hopewell Furnace National Historic Site (HOFU) – July 2015. The area circled in red depicts the park's general location.

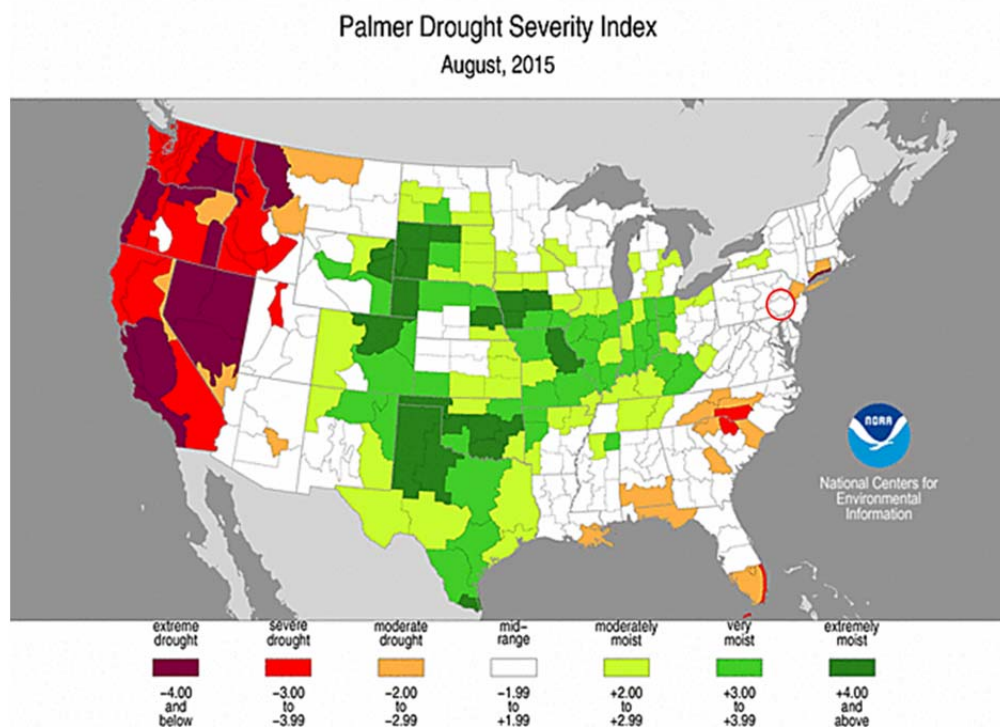


Figure D-7. Palmer Drought Severity Index (PDSI) maps depicting hydrologic conditions at Hopewell Furnace National Historic Site (HOFU) – August 2015. The area circled in red depicts the park's general location.

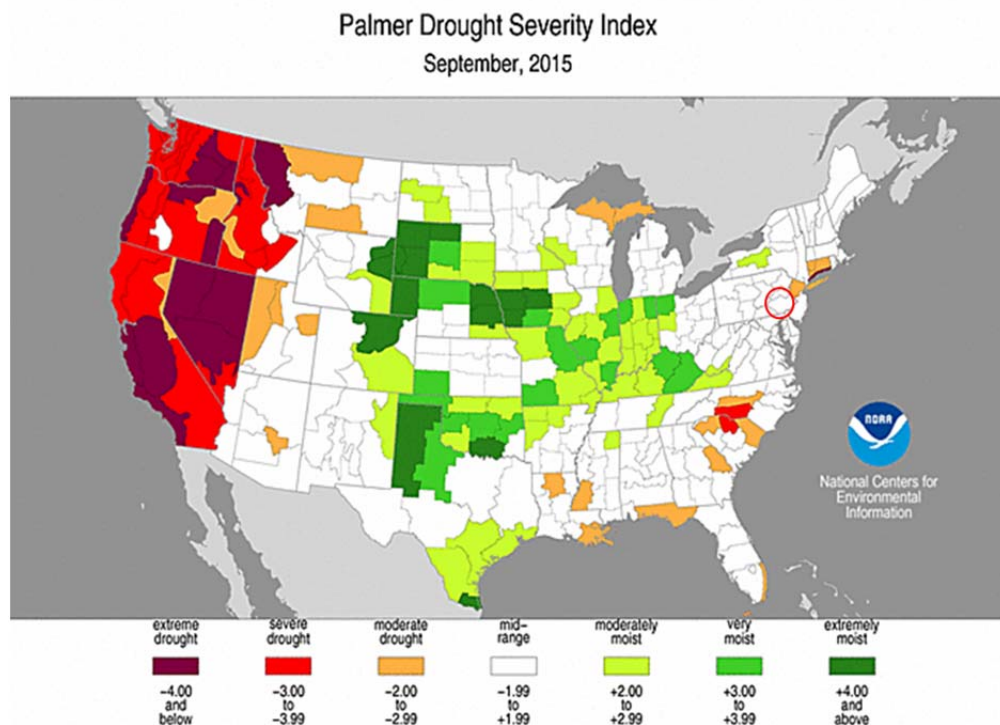


Figure D-8. Palmer Drought Severity Index (PDSI) maps depicting hydrologic conditions at Hopewell Furnace National Historic Site (HOFU) – September 2015. The area circled in red depicts the park's general location.

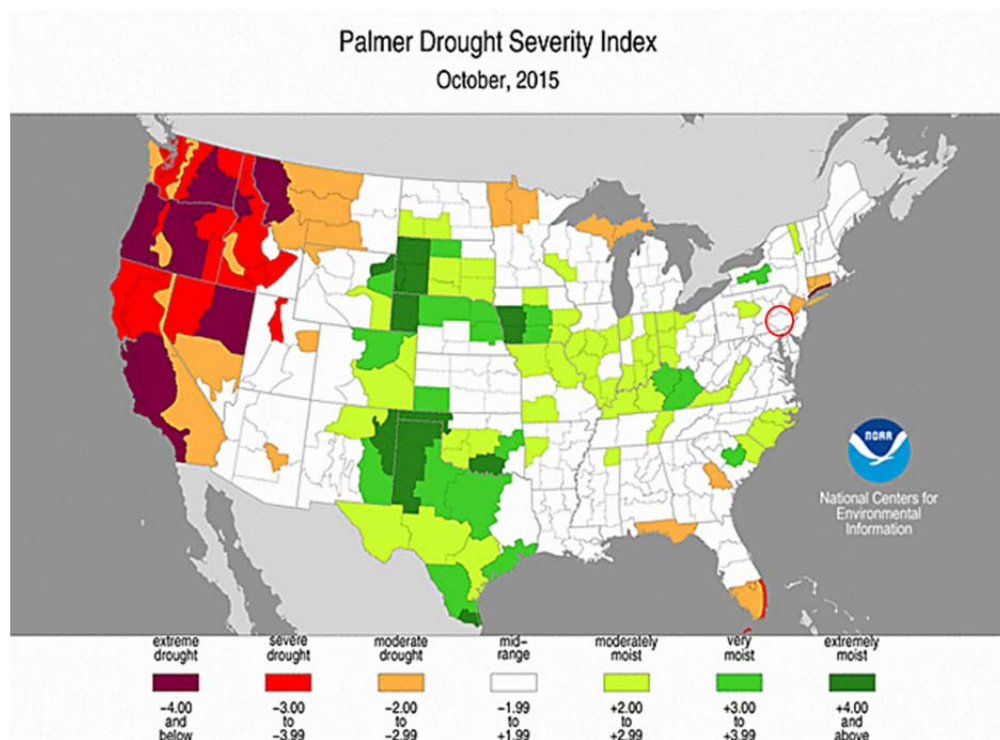


Figure D-9. Palmer Drought Severity Index (PDSI) maps depicting hydrologic conditions at Hopewell Furnace National Historic Site (HOFU) – October 2015. The area circled in red depicts the park's general location.

The Department of the Interior protects and manages the nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its special responsibilities to American Indians, Alaska Natives, and affiliated Island Communities.

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