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APPLIED RESEARCH

# An Overview of Research Supporting Wetland and Ordinary High Water Mark Delineation

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Over the past 25 years, researchers at the U.S. Army Corps of Engineers (USACE) Engineer Research and Development Center (ERDC) have addressed a wide range of technical issues pertaining to identification and delineation of aquatic resources under §404 of the Clean Water Act (CWA) (US Congress 1977). Research focuses on topics related to wetland and stream delineation, such as identifying ecological relationships between hydrophytic vegetation, hydric soil, and wetland hydrologic conditions, developing and maintaining an accurate and robust National Wetland Plant List (NWPL), and developing ordinary high water mark (OHWM) delineation methods and technical guidance for rivers and streams. NWPL wetland indicator status ratings of plant species, along with soil and hydrologic conditions, are used to define federal jurisdictional limits in wetlands (33 U.S.C. 1344), while the OHWM defines the lateral extent of federal jurisdiction in non-tidal Water of the U.S., in the absence of adjacent wetlands. This work is led by a research group at the USACE-ERDC Cold Regions Research and Engineering Laboratory (CRREL) and performed in collaboration with the National Technical Committee for Wetland Vegetation (NTCWV), whose members represent six federal agencies and four universities, and with the National Technical Committee for the OHWM (NTCOHWM), which has representation from USACE, the U.S. Environmental Protection Agency (EPA), and academia. Both of these technical committees provide scientific insight, guidance, peer-review, and a diversity of perspectives from different agencies, regions, and fields of expertise. Research is primarily funded through the USACE Wetlands Regulatory Assistance Program in a continual effort to provide scientific and technical support for the USACE Regulatory Program. Here we present an overview of ongoing research efforts in these topic areas.

Our wetland delineation research supports the wetland regulatory program by enhancing technical procedures consistent with advances in wetland ecology. We evaluate wetland delineation methods to provide accurate field indicators by examining vegetation formulas (e.g., Lichvar et al. 2011; Wakeley and Lichvar 1997; Gillrich et al. 2011; Lichvar and Gillrich 2014a; Lichvar and Gillrich 2014b) and evaluating groups of plants as wetland vegetation indi-

**TABLE 1**
Summary table of recent studies that support NWPL and Wetland Regulatory Programs

| Research Area | Project | Significant findings | Specific support for NWPL and Regulatory |
|---|---|---|---|
| NWPL | Indicator Status Challenges | Indicator status ratings for Colorado blue spruce (Picea pungens) and eastern hemlock (Tsuga canadensis) varies at landscape scales. | Provides methodology for future NWPL indicator status challenges |
| NWPL | NWPL ratings trends across the US | Appalachian Mountains and Arid West have low wetland densities yet high wetland plant species richness. | Regional and National Panels in these regions can reevaluate ratings and revise mitigation efforts |
| Wetland delineation | Remote Sensing (RS) Boundaries | Preliminary results suggest high variability in boundaries for different vegetation types. | Creates guidelines for assessment of RS tools for determining wetland boundaries |

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cators (e.g., Lichvar et al. 2009; Lichvar and Fertig 2011; Gillrich and Lichvar 2010; Gillrich and Bowman 2010; Lichvar and Gillrich in prep-a) (Table 1). Additionally, through collaborations with remote sensing and geographic information systems (RS/GIS) experts at CRREL we compare RS/GIS models of wetland boundaries to field delineations across the U.S (e.g., Gillrich and Lichvar 2014; Lichvar et al. 2008; Lichvar et al. 2006a) (Table 1).

Our research group manages the NWPL through applied research on wetland indicator status ratings, overseeing periodic updates to the NWPL, and administration of the NWPL website (http://wetland_plants.usace.army.mil). The NWPL is a multi-agency effort involving the U.S. EPA, U.S. Fish and Wildlife Service, and the U.S. Department of Agriculture Natural Resources Conservation Service. Our research improves the NWPL by examining the accuracy of wetland indicator status ratings for individual and groups of species using spatial data and field studies. For example, by analyzing GIS data of wetland density for the conterminous U.S. (Dahl & Griffin, submitted for publication) and county level species presence/absence data (Kartesz 2013; Lichvar et al. 2014) we've identified areas where NWPL wetland species richness is unexpectedly high or low relative to available wetland habitat across the U.S. (Figure 1; Table 1). Additionally, through our collaborations with the NTCWV and Colorado State University, we have completed two of the first studies that use statistically sound methods of collecting and analyzing frequency data to determine wetland frequency for individual NWPL species challenges (Lichvar and Gillrich in prep-b; Gage et al. in press; Table 1). Our research uses empirical field data to investigate how groups of species respond to abiotic factors other than hydrologic gradients, such as saline soils (halophytes) or a deep water table (phreatophytes) that may influence wetland plant occurrence and distribution patterns at various landscape scales. Our ongoing research helps to clarify the wetland fidelity of groups of problematic plant species, in particular halophytes, phreatophytes, and three problematic Alaskan birch taxa. We've developed guidelines for challenge studies, reevaluation of NWPL indicator status ratings by regional panels, and updating NWPL ratings and descriptions of rating categories (e.g., Lichvar and Minkin 2008; Lichvar and Gillrich 2011; Lichvar et al. 2012).

Additionally our research group addresses challenges related to OHWM delineation in fluvial systems and develops OHWM delineation technical guidance aimed at increasing the accuracy and consistency of OHWM delineations across the country. Our research focuses on identifying robust physical and biological OHWM indicators (e.g., Lichvar and Wakeley 2004; Mersel et al. 2014) by assessing relationships between streamflow recurrence and field indicators (e.g., Lichvar et al. 2006b; Curtis et al. 2011; Mersel et al. in prep), identifying variability in OHWM indicators and hydrologic conditions across the U.S. (e.g., Wohl et al. in prep), and exploring the use of additional tools and data such as remote sensing, hydraulic modeling, and stream gage data to assist with field delineations (e.g., Gartner et al. 2016a, 2016b, and 2016c in press). This work has supported our development of OHWM delineation manuals for the Arid West (Lichvar and McColley 2008) and Western Mountains, Valleys, and Coast (Mersel and Lichvar 2014) USACE regions, and we are currently developing additional regional and national technical resources to support and improve OHWM delineation practices across the entire U.S.

Further information on the NWPL and OHWM delineation, including technical reports, manuals, and other resources, can be found online at http://wetland_plants.usace.army.mil and http://www.erdc.usace.army.mil/OHWM. ■


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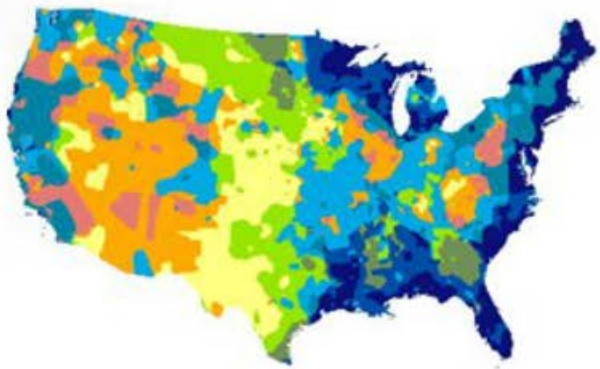
**FIGURE 1**

Relationship between relative wetland density and wetland plant species richness in the continental United States. Initial analysis shows patterns of low wetland density and high wetland plant species richness in the Appalachian Mountains and Arid West. Relative Wetland Density (WD) Categories: Low: 0.0002 - 0.02, Med: 0.02 - 0.1, High: 0.1 - 1.0. Wetland density is the ratio of wetland area to upland area. Plant Richness (Count of all NWPL species/County) Categories: Low: 29 - 395, Med: 395 - 675, High: 675 – 1259. Data for relative wetland density obtained from Griffin & Dahl, submitted for publication. Data for plant species count per county from Kartesz 2013.



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