Spatial and Functional Characterization of Isolated Wetlands

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Science Questions

Our research addresses multi-scale questions relating to the location, function, condition, and ecological services provided by isolated wetlands: How can we classify the landscape and identify isolated wetlands for the development of bioassessment indicators? What are the relationships between stressors and the biological response of isolated wetland ecosystems and the resulting services such systems provide? How can classification schemes, bioassessment methods, and biological response relationships be applied across U.S. isolated wetlands to set criteria for identifying/restoring impaired waters and maintaining designated uses?



Research Questions

1. What remotely sensed spectral signature patterns of fundamental wetland components (e.g., soil, hydrologic, and vegetation/phenological) can be used to identify isolated wetland resources heretofore unmapped?
2. What are the broad-scale relationships between landscape condition and wetland quality?
3. What bioassessment protocols can be developed for both on-site and landscape-scale rapid assessment that will be useful to states and tribes in assessing condition and determining causes of impairments in isolated wetlands?
4. What are the relationships between physical and chemical parameters and soil nutrient (phosphorous) sorption capacity in isolated wetland soils?
5. How effective is visual and near infrared spectroscopy for the rapid, non-destructive and cost-effective assessment and characterization of isolated wetland soils?



Research Objectives that Address WQ MYP Goals

There are multiple, concurrent components to ORDs isolated wetland research addressing program office and MYP needs in EPA Regions I, IV, V, and VI.

The first research component explores using remote sensing platforms to identify and classify isolated wetlands in the landscape. This critical component provides needed data on isolated wetland extent based on spectral signatures and concurrence between edaphic, hydrologic, and vegetation datasets. Developing approaches and methods to determine resource location provides crucial data for understanding the function, condition, and ecological services of isolated wetland resources.

The second component addresses the ability of isolated wetlands to assimilate and process excess phosphorus on the landscape, thereby preventing its mobilization to downstream waters. An additional objective is to identify if the assimilation function for isolated wetlands is constrained by stressors, such as location in agricultural landscape, or by classification schema (e.g., emergent marsh or forested swamp).

The third component concurrently focuses on developing on-site biological assessment methods and rapid assessment protocols. Calculating baseline soil and water physical/chemical parameters, as well as sampling the biota, will provide data for the development of quantitative and causal relationships between wetland condition and stressors. Visual and near infrared spectroscopy for the efficient and accurate quantification of isolated wetland soil parameters will provide the means to rapidly assess soil constituents (including sorption capacity) and classify isolated wetlands.

Research Methods

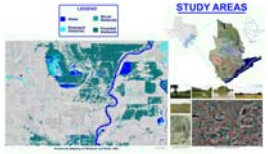
Remotely sensed imagery, geographic information system (GIS) data, existing field data, and *a priori* knowledge of depressional wetlands are being integrated to estimate the extent, connectivity to other waterbodies and ecosystems, and ecological/hydrologic functions of isolated wetlands in 5 Texas coastal counties and the entire Texas Coastal Plain. Multi-date, multi-season satellite data are being used to map the presence of water, saturated soils, and hydrophytic vegetation. Additional broad (i.e., landscape) scale assessments are currently being conducted in the Texas study area. National Wetlands Inventory data, National Land Cover Data, and Gap Analysis Program Vegetation Associations are being used to develop a contemporary mapping and assessment of wetlands based on these components.

Wetland soil was sampled from 180 small, isolated depressional herbaceous and forested wetlands of NE Ohio and north-central Florida in various land uses in summer 2005 for analyses of nutrients, metals, and physical/chemical parameters. Phosphate sorption isotherms are currently being developed to measure the ability of wetlands to sorb phosphate. Spectroscopic analyses are ongoing to develop models correlating spectra to constituent concentration. Baseline water nutrient samples (n = 80) were collected for analyses from Florida wetlands. On-site biological assessment metrics are being developed and tested from macroinvertebrates and diatoms sampled from isolated wetland along a disturbance gradient in Florida. The Ohio Rapid Assessment Method (ORAM) was completed at all sites; relationships between wetland condition, soil and water parameters, and spectral signatures are being developed.

A model to aid in landscape-scale assessment and mapping of isolated wetlands in New England is currently under development. The model uses available digital orthophotography along with USGS hydrology and state wetlands, soils, and elevation data-layers in a GIS to identify potential isolated wetlands. Additionally, rapid assessment protocols are being developed for field investigations of New England isolated wetlands. The protocols will include descriptions of land use in adjacent upland buffers, stressor and disturbance identification, on-site plant cover, soil characteristics, and hydrology. Potential assessment metrics under consideration include open basin depth, within-pond vegetation structure, and landscape setting.

Research Results

Interim results in Region VI suggest concordance between spectrally-derived wetland maps and existing data. The use of these new data sets, including recent satellite and aerial imagery, may improve the cost-effective and accurate mapping and ecological assessment of wetland condition over large areas of the landscape.



Baseline soil and water chemistry are undergoing analyses and phosphate sorption isotherms are being developed for sites sampled in Regions IV and V. Diatoms and macroinvertebrate are being identified for metric development.

Sites, landscape-scale assessments (Tier 1), and potential rapid (Tier 2) and biological (Tier 3) metrics are being identified for isolated wetlands in New England.

Research Conclusions & Future Directions

The on-going and proposed research will provide baseline information on the location, function, and condition of isolated wetlands in 4 EPA regions. Spectroscopic analyses of soils for additional constituents, such as metals and pesticides will provide information on ecological services performed by isolated wetlands. Condition assessments and causal analyses in isolated wetlands will be improved by using additional assemblages, such as amphibians, macrophytes, diatoms, and macroinvertebrates.

Rapid assessment protocols will provide sound, quantitative information on the condition of New England isolated wetlands with a relatively small investment of time and effort. Future work will include supporting research and intensive site assessments to help develop and validate rapid assessment metrics. These studies may also help in defining management and conservation strategies: for example, recent studies have demonstrated that protecting a diversity of ponds with varying hydroperiods may be an effective strategy to maintain the long-term stability of amphibian populations.

Interactions with Customers

The development of scientifically sound, cost-effective wetland assessment protocols are being carried out in collaboration and communication with state and tribal resource managers, academicians, EPA Regional wetlands scientists, and other state and federal entities throughout Regions I, IV, V, and VI. Results identifying the ecological importance of isolated wetlands, as well as the location and extent, are being communicated to program offices, state, tribe, and federal resource managers through guidance materials, presentations, and journal articles.

How Research Contributes to Outcomes

Advanced methods for the identification of previously unmapped isolated wetland abundance and extent is being transferred to state and tribe resource managers providing critical data for nutrient and hydrological modeling of landscape processes and ecological services of isolated wetlands. The techniques developed in Region VI may also be applied to other areas of high isolated wetland density to identify systems not previously mapped.

Functional measures of nutrient assimilation by isolated wetlands in different ecoregions will provide accurate baseline data on isolated wetland nutrient and physical/chemical condition, as well as a cost-effective means to assess total phosphorus and other soil properties using spectral signatures. This information will allow the development of improved models of landscape processes in isolated wetlands that can inform decisions regarding the management, protection, and restoration of these vulnerable water bodies.

Bioassessment methods, rapid assessment protocols, and the application of landscape ecology techniques will enable states and tribes to monitor the condition of their isolated wetland resources for Clean Water Act 305(b) reporting requirements, and for stressor identification and disturbance mitigation.

Collaborators: USEPA Office of Water, Office of Wetlands, Oceans, and Watersheds; Kenyon College; Ohio EPA; Univ. of Florida Soil & Water Science Department; EPA Region VI; Texas Parks and Wildlife