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Foreword to the USEPA's National Wetland Condition Assessment Topical Collection

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Abstract The Environmental Protection Agency's (EPA) National Aquatic Resources Survey (NARS) is a 5-year ongoing cycle of nationwide aquatic resource surveys which provide a report card on the condition of our nation's waters. The surveys are performed using a randomized, statistically valid design and provide statistically robust data which are used to develop the reports. These reports assess how well existing pollution prevention programs are protecting those waters, and how to better target future protection efforts. This presentation will focus on the results and uses of the 2011 National Wetland Condition Assessment (NWCA) outcomes. Some of the outcomes from the NWCA include (1) robust multi-metric indices used to evaluate condition across varying wetland types, streams, and ecoregions and (2) physical, chemical, and biological indicators of stress (risk factors) which identify the factors which contribute most to poor condition. (3) A wealth of quality-assured, statistically valid data which can be mined to pursue other questions within both regulatory and non-regulatory programs by providing a more robust look at wetland and stream condition. There are a variety of ways in which knowledge of condition can be used to better evaluate environmental states and inform decision-making. Knowledge of risk factors, for example, can be used to prioritize restoration efforts to improve the health of streams and wetlands in poor condition, as well as to identify practices to be avoided in reviewing permit applications for work in waters. The use of multi-metric plant condition indices could be useful in better identifying achieved "lift" in wetland mitigation banks, as well as providing a more robust measure of mitigation or restoration success. It is our hope to generate some seeds for future thought and discussion on ways in which the products of these NARS surveys can enhance the protection and restoration of these aquatic resources.

Keywords National Wetland Condition Assessment · USEPA · Wetland Condition Metrics · National Aquatic Resources Survey · Wetland Permit Review Tools

This article is part of the Topical Collection on Monitoring Wetlands on a Continental Scale: The Technical Basis for the National Wetland Condition Assessment

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In 1972, Congress passed amendments to the Federal Water Pollution Control Act, making it possibly the most comprehensive environmental legislation in American history. The goal of this landmark legislation was to "restore and maintain the physical, chemical, and biological integrity" of America's waters. The Clean Water Act (CWA), as it came to be known, established the basic structure for regulating pollutant discharges into the waters of the USA. It specifically gave the US Environmental Protection Agency (USEPA) the authority to implement pollution control programs, such as

setting wastewater standards for the industry, and made it unlawful for any person to discharge any pollutant from a point source into navigable waters without a permit. In addition, it maintained existing requirements to set water quality standards for all surface waters and also established significant programs and incentives to states and tribes to encourage the development and adoption of water quality standards. Section 106 of the Act provides the authority and funding to states and tribes to monitor the condition of their waters, and Section 305(b) of the CWA requires them to report on the condition of their waters and to identify whether those waters meet water quality standards.

In 2000–2002, several studies (Government Accountability Office, 2000; Government Accountability Office, 2002; H. John Heinz III Center for Science, Economics and the Environment, 2002; National Academy of Public Administrators, 2002; National Research Council, 2002) examined the design and analysis of the existing data and the approaches used by USEPA and the states and tribes for monitoring the condition of their waters. Those analyses found that the approaches used by states in determining sample site locations were inconsistent and that the data were not sufficiently robust to infer condition of the population of waters, especially at the statewide scale. The studies concluded that these monitoring efforts did not provide USEPA with adequate data to evaluate the overall quality of the nation's waters for assessing the effectiveness of the CWA programs or for making decisions about the resources.

To address these findings and ensure that the data collected by the monitoring programs were robust and provided a sound basis for decision-making, USEPA developed a different approach to sample the nation's waters. The National Aquatic Resource Surveys use a probability-based approach to select sample points for each survey, as well as thorough, quality-assured sample designs, methodologies, and analytical processes. Five different aquatic resource types are surveyed every 5 years: Coastal Waters, Lakes, Rivers, Streams, and Wetlands.

The first National Wetland Condition Assessment (NWCA) was performed in 2011. The NWCA is designed to promote national consistency in the sampling and evaluation of the nation's wetland resources. It uses a randomized stratified design to sample and report on the condition of each type of resource, both nationally and on a regional basis, with documented confidence. The data, which are collected primarily by state and tribal teams using strict quality assurance protocols, are used to develop indicators of both condition and stress. The data collected may be used to detect patterns in the condition of the resource as well as examine the distribution of stressors at multiple geospatial scales.

In addition to assessing the condition of aquatic resources, the NWCA seeks to help states and tribes build and enhance monitoring and assessment capacity for their wetland programs, as well as advance the science of monitoring and assessment. Participation in the survey can help inform states and tribes on the types, methods, and utility of different sampling approaches that can meet individual state or tribal needs. The outcomes of the surveys can therefore effectively support decisions made about the resources, as well as inform future policy.

A total of 1138 sites were sampled in the lower 48 states during 2011; an additional 41 sites were sampled in Alaska.[1] The 2011 NWCA report (U.S. Environmental Protection Agency, 2016) on wetland condition used the characteristics of wetland vegetation to classify wetland condition as good, fair, or poor. The report also identified physical, chemical, and biological stressors, ranked them based on the strongest association with poor condition, and quantified the risk of a wetland being in poor condition if a given stressor is present. It also identified the likelihood of condition improvement if a stressor is removed. The information is used to meet a national goal to report on the overall effectiveness of CWA programs. It identifies a baseline of the condition against which future assessments may be compared, and the results may then be used to develop program priorities to improve the effectiveness of CWA programs.

The 2011 results on both condition and stressors were produced using a number of tools developed during the NWCA analysis from the data collected (U.S. Environmental Protection Agency, 2016). The primary indicator used to identify plant community condition was the Vegetation Multi-Metric Index (VMMI) (Magee et al., 2019). The VMMI is composed of four metrics, some of which have been used in other contexts at smaller scales. These metrics are the following: the Floristic Quality Assessment Index (FQAI), the relative importance of native species, the relative cover of native

[1] Alaska performed a separate study of tundra wetland condition in the Arctic Coastal plain within the bounds of the National Petroleum Reserve-Alaska. The results of that study are presented in the 2011 NWCA report but are not included as part of the dataset on the lower 48 states.

monocots, and the number of plant species tolerant to disturbance, which is defined as species having coefficients of conservatism (CC's, or *C* values) ≤ 4 (U.S. Environmental Protection Agency, 2016). These measures were not only calibrated from the large NWCA dataset, but also independently validated using a separate portion of the dataset (Magee et al., 2019). As a result, for the first time, the public has been provided with a set of statistically robust tools for evaluating wetland conditions which have been vetted for use nationwide.

The indicators of condition and stress developed from the NWCA and used to report on national and regional condition may have applications beyond the NWCA report. In addition, the *relative* and *attributable* risks which are associated with the stressors and identified in the NWCA report may also provide useful tools for other resource management contexts. Relative risk identifies the likelihood that wetlands will be in poor condition if a specific stressor is present at high levels. Attributable risk identifies what the likelihood is that wetland condition will be improved, given the removal of that stressor. These additional pieces of information could be used to weigh and prioritize different management and/or restoration actions. The process of sampling, indicator development, and risk analysis thus offers a template which could be adapted to assess condition at other scales, given the appropriate dataset. We see at least five broad categories or applications which would lend themselves to the use of the NWCA template:

1. Ecological restoration, either through regulatory requirements or through voluntary efforts. Every restoration effort, regardless of its goals, needs to have an objective means of evaluating the success of its outcome. Within regulatory programs, success is often measured against performance standards, such as percent plant coverage, percent invasive species, or animal use of the restored area. These types of measures are designed to be easily measured on the ground and (more importantly, in the case of a permit requirement) enforceable. These measures, however, do not have a common standard against which to measure improvement—either in terms of ecological function or condition.

   NWCA metrics and/or indicators could be used to evaluate wetland condition both before and after the restoration, as well as at intervals over time following the restoration action. By comparing the post-restoration condition against the baseline pre-restoration condition, we can measure whether the restoration actions improved the condition. This is commonly referred to as the ecological "lift" resulting from restoration efforts. Measures of lift are currently estimated using (largely) functional assessment tools. While the desire in restoration is to improve the functional capacity of target wetlands, current estimates of function are often qualitative and generally do not measure function directly (e.g., Cole 2006). The NWCA condition measures, however, do measure biological condition based on plant community assemblage. They are calibrated regionally using data from a randomly selected subset of the regional resource and thus reflect the range of condition of wetlands within the region. Consequently, wetland restoration sites can be evaluated for change in condition both before and after the treatment, but their condition can also be described against the continuum of wetland condition within the region. Furthermore, by looking at the ecological lift achieved over time at restored sites, it may be possible to identify how much of the target wetland improvement is achieved over time. Within regulatory programs, where wetland restoration is frequently required as compensatory mitigation and is made part of a permit condition, such data can be used to determine whether a goal of "no net loss of wetland function" is likely to be achieved by the regulatory program. It can also be used to provide objective evidence to determine whether mitigation proposals are adequate to compensate for losses due to permitted activities. The tools developed for NWCA, therefore, offer measures to not only track the success of an individual effort, but also evaluate the success and endpoints of wetland mitigation within the program.
2. Impact assessment. These measures provide possible ways of documenting baseline and potential future conditions under different proposed alternatives. This can be useful for planning purposes when investigating options for minimization of wetland impacts associated with large-scale development projects. Post-project monitoring could also use the NWCA tools to determine whether wetlands experienced secondary impacts which changed condition, something that is generally not measurable using most currently existing assessment tools.

3. Development of watershed-wide restoration strategies. Information on the condition of wetlands in a watershed coupled with information on levels of achievable success for wetland restoration (which can be developed from the abovementioned program level of analysis) can be used to help identify targets for watershed-wide restoration, as well as provide baselines against which the success of planned restoration may be evaluated. It would also allow for the assessment of wetland resources over a much larger geographic area and provide a means to characterize the condition of watersheds relative to one another.
4. Prioritizing wetlands for restoration within a chosen watershed. In addition to measurements of condition, the NWCA reports on the extent of physical, chemical, and biological stressors, and identifies which are most likely to be associated with poor condition of a wetland through the concepts of relative and attributable risk (see Herlihy et al., 2019). These tools can therefore be used to identify which stressors are present in a watershed targeted for restoration, and which actions (i.e., removal of a stressor) would be likely to give the greatest level of improvement in wetland health within that watershed. Consequently, decision-making can be better informed as to where the greatest benefits are likely to be obtained from among available restoration options for different watershed planning efforts, such as Total Maximum Daily Load (TMDL) development and implementation. The condition tools and indicators can measure the level of progress for the action, as well as the actual level of improvement in condition.
5. Reporting on the status of water quality standards of wetlands. Section 305(b) of CWA requires States and Tribes to monitor, assess, and report on the quality of their waters relative to designated uses established in accordance with their USEPA approved Water Quality Standards. Section 303(d) of the CWA requires State and Tribes to list waters not meeting water quality standards and to prioritize those waters for TMDL development or other management. Reporting for these waters is submitted to USEPA every 2 years as an integrated water quality monitoring and assessment report. States and Tribes would be able to use the NWCA indicators to meet the requirements to report biennially on the current condition of waters including wetlands in their integrated reporting process. Most states/tribes that include wetlands under their definition of state or tribal "waters" have not been able to include information on the condition of their wetland resources in their biennial reporting to USEPA. The assessment tools developed in the NWCA now make this reporting possible.

In certain water regulatory programs in the lower 48 states—e.g., U.S. Army Corps of Engineers (Chicago District), Ohio EPA—measures of condition such as those discussed above are already used to make regulatory decisions. Ohio EPA developed methods from an ongoing data collection and pioneered the use of indicators similar to those developed for the NWCA to provide their regulatory program with defensible, effective tools to guide decisions (Mack et al., 2000; Mack et al., 2004; Andreas et al., 2004). The Chicago District uses similar measures to evaluate success in compensatory mitigation projects and also to determine the level of improvement achievable in compensatory mitigation (Blackburn personal communication). The development of nationwide and regional measures represents an enormous step toward more robust, testable, evidence-based decision-making. The use of such tools could help reduce the functional gap between impacts and offsets and potentially guide and improve the success of wetland restoration efforts.

The goals of the CWA—to restore and maintain the physical, chemical, and biological integrity of the waters of the USA—can only be furthered by the ability to characterize and measure the condition of those waters. We believe that the NWCA has already produced valuable data, information, and products which are adding to efforts nationwide to achieve the goals of the CWA. The following collection of papers is a strong first step in documenting the technical aspects and applications from the 2011 NWCA. It will be exciting to see what else science develops as we move forward.

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