Freshwater Wetlands

The Washington State Joint Legislative Audit and Review Committee (JLARC) conducted a review of the state's efforts to conserve habitat and expand outdoor recreation. This work included a review of existing or potential objective outcome measures that could be used to evaluate the success of 13 land acquisition and regulatory programs intended to protect and conserve habitat and expand outdoor recreation. Based on the effective outcome measures found in the peer-reviewed and gray literature, communications with managers from similar programs in the U.S., and the project team's professional opinion, it was found that there is very little literature that focuses specifically on outcome measures as they relate to land acquisition intended to protect and conserve species, habitats or to expand outdoor recreation; however a number of states and regions have implemented outcome measures for acquisition, and guidance is available from the extensive literature on restoration program and project effectiveness.

Introduction

Developing strategies to effectively measure ecological outcomes linked to specific programs and projects is an essential, but not simple, task that remains generally elusive in practice (Dale and Beyeler, 2001; Sawhill and Williamson, 2003; Niemi and McDonald, 2004; Doren et al., 2009; Margoluis et al., 2013). There are many examples of project-level effectiveness and projects that have laid out clear outcome measures linked to the project goals, such as Hartema et al. (2014). At the programmatic and regional levels, examples of these outcome measures are more difficult to find. For an example of a regional evaluation of the cumulative effectiveness of multiple projects see Diefenderfer et al. (2016). For a model-based evaluation of restoration project impacts at a watershed scale see Roni et al. (2010).

Some researchers note that the increased demand for outcome measurement, particularly ecological outcomes, does not imply that they are useful for decision making or that they are frequently used (Turnhout et al., 2007). Others argue that aligning outcome measures (indicators and metrics) with the mission and goals of an organization, program, or project can change it profoundly.

Margoluis et al. (2013) argue that to measure success in conservation three questions must be answered: (1) are we achieving our desired impact?; (2) have we selected the best interventions to achieve our desired impact?; and (3) are we executing our interventions in the best possible manner? Another question to add to this list is (4) who is the audience and who will care about the effectiveness of our program and our actions?

Outcome measurement processes are based on the selection of indicators and metrics, and the choice of indicators and metrics will directly impact the results of the process (Behan et al., 2017). To understand which indicators and metrics have been shown to effectively measure the performance of land acquisition and regulatory actions, we focused our efforts on peer-reviewed literature, agency publications, and on programs that would help provide information about 'best practices' for outcome measures that were not found in peer-reviewed or agency publications. By best practices we were looking for *outcome measures* (i.e., indicators and metrics) and programs that were effective, innovative, or promising.

Due to the complexity and nuances related to the protection of freshwater wetlands in Washington, this section is not intended to be a comprehensive compendium of the indicators and metrics used to create effective outcome measures. Rather it is a compilation of effective outcome measures and practices based on our literature search, conversations with program managers, and the opinions of the project team within the timeframe of the project. The complete report (Behan et al., 2017) provides many more details concerning the development of outcome-based indicators from the literature, along with information on all of the other related programs and subject areas evaluated in the JLARC study.

Background

Wetland conservation follows from Section 404 of the Clean Water Act, which identifies wetlands as an important resource to the people of the United States because of significant benefits they can provide. These benefits include providing important habitat to many fish and wildlife species, storing water to provide late season irrigation to farmers or municipal drinking water, or to help control downstream flooding, removing nutrients and sediments from water to provide cleaner water, assisting in recharging aquifers. Some forested or deep-water wetlands can assist in lowering downstream water temperatures which supports salmon reproduction and survival. Wetlands also provide aesthetic value and have been shown to increase property values since home near wetlands have higher market value, all else equal (Boyer and Polasky, 2004).

Outcome measures for freshwater wetland goals will ideally reflect the characteristics of wetlands that generate benefits, whether wetland are being protected, enhanced or restored. The Washington Department of Ecology has a wetlands program to promote no net loss of benefits for any wetlands that must be filled for development.

Among other things, during permit review, the wetlands program identifies wetland functions lost through land conversion and recovered in the proposed mitigation to offset those losses. Ecology promotes replacing lost wetlands and their functions using a watershed based approach (Hruby et al., 2009). This approach is designed to assure lost ecological functions are replaced through well-sited and implemented wetland mitigation.

Literature

There is extensive literature documenting the successes and failures of wetland protection and compensatory mitigation restoration activities. Traditionally, success has been measured by the total number of wetland acres protected, restored or lost, which does not directly measure the outcomes outlined in the Clean Water Act. Progressive state wetland conservation programs, including that at the Washington Department of Ecology, have focused on identifying "wetland functions" to address the fact that all wetlands are not equal and that some wetland acres provide more functions than others, depending on local and regional needs. Wetland functions have been enumerated in many places and they include protecting and improving water quality, providing fish and wildlife habitats, storing floodwaters and maintaining surface water flows during dry periods. Wetland functional indicators usually target ecological attributes of wetlands that can be measured or identified in the field, often as compared to a high functioning wetland. In 2016, the Association of State

Outputs

A short list of outputs identified in agency materials, or provided by JLARC, about the programs relevant to freshwater wetlands:

- Amount of wetland acres protected
- Wetland acres lost and authorized through regulatory processes
- Wetland acres lost through unauthorized activities
- Amount and functions of wetland acres restored through mitigation
- Amount and functions of wetland acres restored through voluntary actions
- Total wetland acreage or acres adjusted by wetland rankings

Outcome statements

The primary outcomes the project team identified from the objectives in the enabling legislation of the program:

- Places for wetland dependent wildlife species and ecosystems
- Support for fish species and their habitat
- Recharge aquifers
- Water stored to provide late season agricultural, industrial or municipal drinking uses, or to prevent flooding
- Remove nutrients and sediments (which can be pollutants) from water
- Carbon stored
- Opportunities to view birds and other wildlife
- Provide open space, improve aesthetics, and boost property values

Wetland Managers (ASWM) published a report online updating the definitions of wetland functions, and providing a list of potential value or outcome based indicators.

A few publications, particularly Palmer et al. 2011, have identified indicators of wetland outcomes, including those related to the hydrologic regime, sediment removal, support for fish and wildlife, and water quality. In addition, Olander et al. (in press), have identified a few different outcomes, such as flood amelioration and temperature support, which may be particularly relevant in Washington. Both studies focus on the idea of benefit relevant indicators, which tie the program outcomes with specific communities of beneficiaries.

In practice

Common Practices – Wetland Dashboards. States across the country use a variety of metrics that span simple acreage measures to detailed evaluation of likely benefits. The U.S. Fish and Wildlife Service publishes an area-based assessment of wetland acreage changes across the U.S. using their National Wetlands Inventory's spatial data every 5 years, last completed in 2009. However, most wetland scientists in the western states believe this data, developed largely through air photograph interpretation, is both incomplete and not updated frequently enough to meaningfully represent change. A number of states, particularly Massachusetts, Minnesota, as well as the Chesapeake Bay, have moved to a report card or dashboard concept to communicate program effectiveness. The limitation of these dashboards is that the grading systems tend to be very generalized and may fail to capture important trends in habitat loss or thresholds of ecological function relevant to flood or erosion control. Nonetheless, they inform the public as to conditions and overall trends.

Currently, there are two very different methodologies used or proposed for assessing the status and trends of wetlands in the U.S. The first is a sample-based protocol, which is the basis of EPA's National Wetland Condition Assessment, which is widely referred to in the literature (Paulsen et al. 2008, Ode et al. 2008, Yuan et al 2008). The assessment assumes that wetland condition is a direct indicator of the important outcomes wetlands can provide. A random selection of wetland sites are measured using field visits, typically on a cycle of every five years (last reported on in 2011, and sampled in 2016). Individual states have the option of expanding the number of sites selected using the same probability based network that is used by EPA.

Promising Practices – Modeling Wetland Services. The second methodology used is to map all the wetlands in a jurisdiction, and, using desktop GIS methods, model their ecosystem services outputs based on the combination of services they have the potential to provide and the presence of beneficiaries (Olander et al., 2015, FNAI 2016). This approach has the potential to represent meaningful outcomes of wetland changes, but is more experimental, built on a spatial modeling representation of rapid assessment protocols (Hruby 2009, Stein et al., 2009), but modified. It has been used in a number of academic studies, but is not in practice widely, although some states incorporate some elements of looking at location context to compare likely wetland function. Further, work to date has aimed to prioritize areas for mitigation or restoration based on the overall, relative benefits rather than using the method to generate an absolute indicator of benefits.

The indicators found in the literature or identified practices are listed in Table 1 (below).

Conclusions

Methods for developing meaningful outcome-based indicators are clearly identified in the literature. They are being put into practice successfully in a few states, but generally very sparsely across the country, and rarely for species and habitat focused land acquisition programs. When evaluating program success, most agencies tend to focus on gathering information they need for adaptive management – either data needed to determine if their actions are achieving their goals, or the information needed to develop plans or strategies. These often focus on their need to understand the effectiveness of their actions to restore wetlands, to address threats to wetland functions, or to evaluate if mitigation is effective, all important issues for agencies wanting to understand the priorities for their work. However, understanding priorities or the effectiveness of actions may not inform if the program is achieving the desired outcomes.

The most effective programs for evaluating program success in land acquisition, water quality protection, and restoration had a few commonalities. First, the legislation that created these programs was relatively specific in describing the types of outcomes desired, so designing an outcome based set of indicators was more straightforward

for agencies. Second, the legislation required that indicators of program success be developed and reported on some regular schedule, and at a minimum funded the development of the indicators and their implementation, often requiring interagency cooperation, which is essential as many agencies and local or regional governments may be involved in program implementation. And lastly, they required statewide (or jurisdiction wide for regional governments such as Tahoe) evaluation of outcomes to assure the development and measurement of the indicators were not focused on plans or projects.

To understand if wetland regulatory, restoration and acquisition programs are effective at protecting the important ecosystem services that wetlands provide to people in Washington, it is critical to have a reasonable understanding of the baseline conditions of in all areas in the state. Without this information, it is impossible to understand if any existing programs are making a difference. Statewide assessments are necessary to understand statewide outcomes. A plan or strategy to restore a watershed or improve wetland conditions, is an important way to understand and fix a problem. But the strategy is not necessarily the information needed to describe the status and trends of the benefits wetlands in Washington provide.

Getting statewide information on not only the wetlands in the state, but the services they provide may not be the information agencies need to decide what the priorities for their work should be. If understanding statewide outcomes is important, the legislature must require it be done. As exemplified through the Florida Forever Program, Minnesota's Clean Water Fund, Missouri's Aquatic Gap, and Washington's Puget Sound Partnership, methods have been identified and outcome-based indicators have been used in other states. The large numbers of wetlands in Washington, their diversity, and the multiple benefits they provide makes this a daunting task that requires an investment of time and money. Funds are being spent on wetlands, and it is certainly possible, given a multi-biennium period, to develop this information without major new investments.

Table 1. Indicators and metrics for freshwater wetlands outcomes identified in the literature or effective practices

Measures Category	Indicators and Metrics	Source(s)
Function or Condition Indicators	• Degree of correspondence to reference biological components including benthic macroinvertebrates, amphibians, birds, fish, or phytoplankton • % native species or plant species diversity (relative to characteristic levels), often called Floristic Quality Index (FQI) • Chemical properties, including acidification, conductivity, dissolved oxygen, phosphorus or nitrogen (relative to reference) • Physical properties including erosion or sedimentation, disturbance, intact hydrology (relative to reference), vegetated structure, presence of habitat structures, etc.	Hruby, 2009; Hruby et al., 2009; Faber-Langendoen et al., 2006; Fennessy et al., 2008
Ecosystem Service Indicators *(include the capacity of existing or restored wetlands to provide benefits to communities)*	• The amount of damaging flood water stored by individual wetlands, based on their size, depressional area, soils, hydrology, and downstream development • Amount of carbon stored • Amount of late season water provided to downstream users based on wetland size, soils, hydrology and late-season downstream water needs • Support species and habitats based on the numbers of at-risk, species of concern, or species likely to use wetlands • Amount of pollutants removed, including a) Amount of sediments, based on sediment inputs, wetland physical properties, and presence of sediment concerns in receiving waters (e.g., salmon spawning areas) b) Amount of phosphorus based on phosphorus inputs, wetland physical and chemical properties, and vulnerability of receiving waters (e.g. algal bloom risk) • Amount of cooling provided, based on shading, size and depth, and temperature sensitive species use in receiving water body.	Boyer and Polasky, 2004; Olander et al., 2015; Wang et al., 2010

Citations

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