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 restoration, management, and conservation of salmon populations, resident fish and their habitats throughout Washington, this paper could not 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., 2018) 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

The Pacific Northwest has experienced major declines in the population of various native salmon species native. The States of Oregon, Washington and California all regulate commercial and recreational salmon harvests to address concerns, so they are heavily invested in assessing salmon population numbers and trends. These states have also made major investments in restoring salmon habitat.

Outputs

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

- Numbers of salmon returning to Washington's rivers and streams, and numbers of young salmon returning to the ocean
- Salmon spawning and rearing habitat available and suitable
- Native fish populations maintained or enhanced
- Communities and landowners are involved and engaged in restoring or protecting rivers, streams, aquatic habitats and salmon

Outcome statements

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

- Listed salmon populations recovered sufficiently to allow for removal from the ESA list
- Unlisted salmon populations stabilized to avoid potential listing
- Salmon harvest available to meet tribal, recreational and commercial needs
- Salmon reproduction rates are consistent with long-term sustainability of populations
- Existing populations of salmon are resilient to potential human population and climate change pressures
- Future generations of Washingtonians enjoy native fish biodiversity

Funding agencies, including the Salmon Recovery Funding Board, NOAA, the Pacific Coast Salmon Recovery Fund (PCSRF) administered through NOAA, and WDFW require watershed groups or grantees to report on project success, and to monitor restoration for a number of years. As a result, a broad range of indicators are used to document the condition of salmon habitat. While indicators commonly represent outputs or effort, rather than the outcomes in terms of salmon numbers, they provide a practical approach to documenting change. Further, they address another goal of the legislation that created these funding mechanisms, which is to involve local communities in the process of restoring and providing stewardship for their local rivers and streams.

Literature

Restoring Pacific salmon populations has been a major focus of state and federal agencies in the U.S. for over 20 years. NOAA Fisheries, Washington Department of Fish and Wildlife (WDFW), other federal agencies and Tribal governmental agencies collect large amounts of information about the number of salmon that return to Washington's rivers from the ocean. They also collect information to judge salmon reproductive success, including numbers of redds, fry and smolts. There are many peer-reviewed papers describing the biology, movement, survival and mortality factors of the different life-stages of salmon in the Pacific Northwest. Because assessing salmon returns and reproductive success has been mainstream business for so many years, there is not much recent literature about methodology or indicators. However, traditional salmon population indicators may be just fine for looking at the outcomes of the state's efforts. However, it may be particularly difficult to link these indicators to habitat conservation and restoration activities due to the influence of unrelated factors, such as survival rates in the ocean or time lags between restoration actions and salmon population responses.

For salmon habitat indicators, the best source of information may come from an ongoing project undertaken by the Pacific Northwest Aquatic Monitoring Partnership (PNAMP) to identify these. The project, which includes staff from WDFW, NOAA Fisheries, ODFW, IFG, USGS, and others, resulted from a high-level indicators for salmon and ecosystem health [report](#) PNAMP prepared in 2008. The group is evaluating indicators based on overall relationship to important outputs and measurement feasibility given available or attainable monitoring data.

Efforts to protect non-game freshwater fish and their habitat are less common, and the indicators, methods and best practices to understand whether species or important populations are being conserved are much less studied. The Heinz Center (2008) identified At-Risk Native Freshwater Species and Established Non-native Freshwater Species as the best indicators, but decided that the data was insufficient to report on changes in the percentage of fish or aquatic species that were at risk, or on their populations. The data for the percentage of species at risk in Washington may be sufficient, although aside from salmon, population trend data is probably lacking. A more recent report (Costanzo et al., 2015) identified native fish diversity, non-native fish, and juvenile Chinook salmon as their key indicators for fish in Oregon's Willamette basin; and for habitat they identified channel complexity as the best measure of in-stream habitat and area of floodplain forest as the best indicator of healthy riparian areas.

In practice

Many state departments of Fish and Wildlife include the status and trends of monitored salmon and steelhead populations as their primary indicators of program success. These often include measures that accurately reflect the status and trends in the sampled areas. However, these measures may not reflect overall state status in cases where the ongoing monitoring is established to assess the trends of a watershed or particular population or species group. Conversely, monitoring across large spatial scales may provide information about ESA-listed population groupings (Evolutionarily Significant Units) but with poorer resolution at the scale of individual populations or watersheds. The states of Washington and Oregon currently do an excellent job monitoring salmon trends, especially in their priority watersheds.

Few states have developed statewide monitoring programs to comprehensively assess status and trends for both game and non-game fish species. California has developed one of the few statewide assessments of all native fish, through their native fish-based stream classification system, although it would be difficult to emulate this elsewhere. The University of Missouri has developed a statewide assessment called their Aquatic Gap Analysis (Annis et al., 2010) in which they assessed the distribution and status of the approximately 130 fish species that are native to Missouri, as well as all of the native fish that occur in the Missouri River Basin. This included an evaluation of how well these species are protected and how the diversity of streams that support native fish. The Missouri Department of Conservation, which includes their Fisheries agency has taken this distribution data, and used it to monitor the status and trends of all at-risk fish species in the state, as well as to inform the state's water quality regulatory program through their 303(d) and 305(b) regulations (Matthew Combes, personal communication). Because the system covers all of the streams in the state, reporting on over status and trends statewide is possible.

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 focus on their need to understand the effectiveness of their actions to restore habitats or to address threats to species and habitats on property they manage – both important issues for agencies wanting to understand the priorities for their work. However, understanding priorities for action or the effectiveness of actions may not inform if the overall 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 – which helps to assure the development and measurement of the indicators are not focused on plans or projects.

To understand if acquisition, restoration and regulatory programs are effective at protecting fish species and their habitats in Washington, it is critical to have a reasonable understanding of what fish species are in the state, where they are, and approximately how abundant they are. For salmon, this information (where they are distributed and how abundant they are, is better than almost any of the other key program elements evaluated in this study. However, because salmon are so mobile and factors such as ocean conditions or harvest can be major drivers of their populations, it can be especially difficult to evaluate the importance or effectiveness of the habitat restoration and protection measures funded by the state. Additionally, so many different types of restoration and protection activities are underway within salmon habitat, the desire to understand the effectiveness of various treatments can become more important than analyzing the overall changes in salmon populations compared to the overall amount of acquisitions or restoration occurring.

Because salmon are so important to the people of Washington, recovering their populations remains the priority of most agencies, and little information is available on the status, trends or distribution of many of the native resident fish in the state. Without this information, it is impossible to understand if acquisitions or restoration activities are making a difference. Until recently, it has been difficult to assess the distribution and relative abundance of native resident fish species and their habitats across a state, especially using traditional field-based methods. New methodologies, such as eDNA, may make it easier to collect and analyze this information, potentially reducing the cost and allowing resident fish to be evaluated while continuing the Washington's focus on salmon restoration.

Table 1. Indicators and metrics for coastal system outcomes identified in the literature or effective practices

Measure Categories	Indicators and Metrics (Units of Measurement)	Source(s)
Salmon Population Recovery	• Number of returning salmon • Number of out-migrating salmon	Crawford and Rumsey, 2011; O'Neill et al., 2008
Native Fish Species Abundance and Diversity	• Native fish species diversity across the state • Relative abundance of native versus invasive fish (with a focus on harmful introduced fish, rather than all of them within watersheds or stream reaches • Number or status of at-risk fish.	Annis et al., 2010; Wagner et al., 2013; Stalberg et al. 2009
Status of Important Fish-supporting Habitat	• Extent of floodplain forests • Channel complexity (length of channel per 100 meters) or suitable fish habitat • Inundation frequency of high quality chinook habitat	Castanzo et al., 2015; Hulse, 2017, personal comm.
Access to Rivers and Streams for Spawning	• Barriers (dams without passage and culverts needing repair) blocking fish passage, and the potential amount and quality of the habitat above the barrier.	Independent Multidisciplinary Science Team, 2007

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