Coasts & Shorelines

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, acquisition or restoration of species populations, habitats, water quality or quantity in coastal and shoreline areas of Washington, this section is not 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

Coastal conservation in the State of Washington is driven by three, key programs. Two of the programs: the Puget Sound Acquisition and Restoration Fund (PSAR) and Puget Sound Estuary and Salmon Restoration Program (ESRP) are state-led programs run in partnership with federal agencies, private nonprofit organizations, universities and tribes. Together, the programs aim to protect and restore critical habitat for salmon populations, as well as the natural processes that create and sustain the Puget Sound nearshore ecosystem. Their heavy focus on salmon habitat has benefitted these programs by providing a strategic, goal-oriented focus. The strategic monitoring framework developed by the State Recreation and Conservation Office (RCO) for the PSAR and ESRP programs compares favorably to other states, in terms of use of conceptual models, public engagement, goal development, and selection of metrics that link back to measuring progress towards those goals. An Action Agenda includes a list of targeted activities for PSAR, for ESRP, and for the Puget Sound Nearshore Ecosystem Restoration Project (PSNERP, Brandon et al. 2013); and all projects funded must fall within the scope of these plans.

The programs' most significant challenges with respect to monitoring outcomes appear to be the cost of implementing the entire monitoring program as envisioned. Since the inception of the program, most of the monitoring and evaluation effort has focused in the upper watersheds of salmon spawning areas. In 2016 the Salmon Recovery Funding Board, in its annual review of the monitoring program, recommended eliminating additional tasks within the monitoring program that could be eliminated or deferred, in light of reduced funding (Gross et al., 2016; Tyler et al., 2016). The SRF Board Monitoring Panel and others recommended that the effectiveness monitoring program, now in its 10th year, evaluate existing information and adaptively manage the monitoring program. This effectiveness monitoring is similar to that recommended by the Association of Fish and Wildlife Agencies (AFWA) for the national review of state wildlife grant funding, but does not attempt to address overall status and trends.

Reflecting the relative effort invested in monitoring output indicators, the State's online reporting systems related to the PSAR and ESRP programs (PRISM, State of Salmon and the Washington Results Dashboard) focus almost exclusively on the output indicators (referred to as "primary indicators" in the monitoring framework), rather than outcomes (referred to as "tertiary indicators" in the monitoring framework), or on salmon population data. A possible alternative source of information is the Puget Sound Vital Signs Report (Hamel et al., 2015), containing a

Outputs

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

- PSAR: stream bank improvements; fish passage; nearshore protection; shoreline armoring removal; and floodplain function
- ESRP: size and quality of restored beaches and bluffs (metrics are specific to project and landform); acres planted or protected; miles of dike removed or shoreline improved
- ESRP: The natural processes that create and sustain the Puget Sound nearshore ecosystem are protected
- Standard outputs reported for PSAR and ESRP include funding allocated, river shoreline restored, watershed habitat protected and fish passage restored
- CZM: number of coastal communities engaged; number of public access sites; acres of coastal habitat protected or restored; pounds of marine debris removed; and number of communities that developed or updated policies and plans

Outcome statements

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

- PSAR: Salmon health, abundance and diversity
- ESRP: The natural processes that create and sustain the Puget Sound nearshore ecosystem are protected
- CZM: Healthy and productive coastal ecosystems; environmentally, economically, and socially vibrant and resilient coastal communities

comprehensive set of indicators that could inform the outcomes of multiple programs.

The third program that influences coasts and shorelines falls under the Coastal Zone Management Act (CZMA), administered by NOAA in cooperation with the states. This is the only program that applies to all coastlines in the state as opposed to just the Puget Sound shoreline.

The Washington Coastal Management Program was the first state program approved by NOAA under the CZMA in 1976, and it is administered by the Department of Ecology. The program's progress is evaluated using a formal CZMA Performance Management System. NOAA compiles data provided by the states on output metrics annually, and compiles national data to provide "contextual indicators," identified collaboratively by NOAA's Office of Ocean and Coastal Resource Management (OCRM) and representatives of state coastal management programs. The contextual indicators would be outcome measures if they were tied to goals and targets, but they are not. Thus, they serve to illustrate long-term trends. Reporting of results has been sparse, with the most recent set of regional reports published in 2012, covering the period of 1996-2010. In an effort to streamline the CZM monitoring program, NOAA worked with states in 2014 to identify a subset of the original measures to reduce the reporting burden. The State's last CZM evaluation was in 2010.

Literature

Coastal habitats are widely acknowledged to play a vital role in both human and ecological well-being. More than half of the U.S. population lives within 50 miles of the coast, and this area constitutes one of the most important zones of economic activity in terms of both jobs and dollars. Moreover, much of that economy is directly dependent on coastal habitats (e.g., fishing), or indirectly dependent (e.g., desire of people to live near recreational opportunities). Yet these habitats are very dynamic – constantly evolving in response to influences from the land, the deep sea, and storms in the atmosphere. The literature provides few comprehensive discussions on how to monitor these zones. Three sources stand out as providing the best examples of different approaches.

The Heinz Center's State of the Nation's Ecosystems (2008) remains the single most comprehensive take on coastal and ocean indicators. Recommendations were based on a series of workshops and working groups, drawing on hundreds of experts. The strength of this approach is that it takes a high-level view, addressing many of the key values derived from coastal habitats within a relatively small number of indicators. Its primary weakness is that it does not link directly to specific goals, so there are no targets or benchmarks by which to determine performance. As a result, these indicators function more like vital signs for the coasts, rather than outcome measures. Their recommended indicators are:

Extent and Pattern

- Acres of coastal living habitats
- Extent of shoreline habitat types
- Development pattern in coastal areas

Chemical and Physical Characteristics

- Areas with depleted oxygen
- Contamination in bottom sediments
- Coastal erosion
- Sea surface temperature

Biological Components

- At-risk native marine species
- Established non-native species in major estuaries
- Unusual marine mortalities reported annually
- Harmful algal events
- Condition of bottom-dwelling animals (% of communities in degraded condition)
- Chlorophyll concentrations

Goods and Services

- Commercial fish and shellfish landings
- Status of commercially important fish stocks (% of stocks decreasing, stable and increasing)
- Concentrations of mercury, DDT, PCB above thresholds in fish and shellfish.
- Recreational water quality (% of beach-mile-days affected by Enterococcus).

Lederhouse and Link (2016) tackled the challenge of developing habitat metrics to support ecosystem- based fishery management. They state that while there has been some success in setting habitat metrics at smaller scales (e.g., a specific estuary), these have not scaled-up very well to broader regional scales. Ecosystem-based fisheries management (EBFM) is supposed to account for changes in the overall ecosystem when determining appropriate fishery management or conservation measures. Most work

has been focused on developing indicators of ecosystem function (e.g., predator-prey relationships) and socioeconomic factors when setting targets. Yet there is a lack of information that quantitatively links habitat quality and availability to fishery productivity. They propose a set of indicators based on priority habitat types or conservation areas. They place a particular emphasis on fish habitats used during early life history stages, because they assert that these tend to have stronger habitat linkages and serve as bottlenecks for productivity. Also, they are often located in nearshore or coastal areas vulnerable to human disturbances. Their four proposed indicators are:

- % of priority species found within a given habitat area with a strong habitat dependence at early life history stages.
- % of species above for which habitat information is included in fishery or ecosystem assessments.
- % of key habitat types or areas protected.
- % of priority habitat-dependent species using protected key habitats.

The approach has similarities to a standard gap analysis (e.g., determining the extent of protection afforded to habitat for priority species). By monitoring these indicators and evaluating them in combination with fish catch data (or other abundance and population data), fishery managers can, over time, draw quantitative inferences between fish stock productivity and habitat quality.

Schlacher (2014) examined 36 potential indicators to assess ecological condition, change, and impacts for sandy beaches. Each indicator was evaluated to determine its ability to consistently reflect changes and impacts to the system by erosion, recreation, fishing, habitat loss, conservation, and pollution. Composite scores were used to rank each potential metric for its overall usefulness. The potential indicators were then ranked by overall sensitivity, practicability, cost, and communications/public appeal, for a final usefulness score. Most of the purely physical metrics scored relatively poorly overall because they represented just a single physical attribute. The four types of metrics that performed best across all six categories were:

1. bird populations habitat use, abundance, diversity, and distributions
2. breeding/reproductive performance of a variety of species (especially relevant for birds and turtles nesting on beaches and in dunes, but equally applicable to invertebrates and plants)
3. population parameters and distributions of vertebrates associated primarily with dunes and the beach splash-zone (traditionally focused on birds and turtles, but expandable to mammals)
4. compound measurements of the abundance, cover, and biomass of vertebrates, invertebrates, and plants at the population and assemblage level.

These species-oriented metrics did the best because they were most sensitive to a range of disturbances of interest. The tables in the paper can further help with index selection by illuminating which metrics are best for tracking specific impacts (e.g., erosion vs. pollution), as well as composite measures of overall condition.

In practice

Conservation goals for coastal habitats, and the resulting performance metrics used by states, are strongly influenced by the physical characteristics of the coast (e.g., shallow wetlands in the Gulf of Mexico, sandy beaches and barrier islands along the Atlantic Coasts, and bluffs/gravel shorelines in the West). This can make detailed comparisons among regions challenging.

Innovative Practice: Oregon Plan for Salmon and Watersheds. The Environmental Indicators for the Oregon Plan for Salmon and Watersheds (Dent et al., 2005) provide a thorough example of a rigorous process for setting outcome measures relevant to Washington. The document lays out a comprehensive and compelling case for a suite of environmental indicators that can track the impact of Oregon's collective restoration efforts, for biennial reporting to the Governor and Legislature. The categories of indicators were aquatic, riparian, terrestrial and estuarine ecosystems, along with ecosystem biodiversity.

The metrics were selected based on clear, conceptual frameworks that link them to changes in pressures, condition, impact and policy response, making them as important as the indicators. Each indicator was also evaluated using usefulness criteria as to whether they were quantifiable, relevant, responsive (e.g., sensitive to changes), understandable, reliable, and accessible (e.g., useful for communication with the public). The authors sought to use indicators common to other monitoring efforts such as the Oregon State of the Environment Report (2000), The Heinz Center's State of the Nation's Ecosystems Report, EPA's digital Report on the Environment's website, and several others, including monitoring as part of species

recovery plans – which has the potential to foster streamlined data collection among programs.

Promising Practice: Vision for the California Delta. Several performance evaluation efforts in the California Bay-Delta region can also provide useful guidance. A handy summary document by Healy (2008) lays out the Vision for the California Delta. Example indicators are cross-walked with goals from the Bay Delta Conservation Plan (2013), and the CALFED Bay-Delta Program/Ecosystem Restoration Plan (State of California, 2007). The indicators are organized using three categories: administrative indicators, driver indicators, and outcome indicators (similar to the policy, pressure and benefit indicators mentioned above). Healy also stresses the importance of setting benchmarks against which to evaluate the indicators –which may be based on historic values, or may be set based on conceptual models of system dynamics for highly altered systems. No actual indices are proposed but examples are used to illustrate the framework concepts.

For coastal systems, the most relevant indicators found in the literature or identified practices are included in Table 1 (below).

Common Practice: Maine and New Hampshire Dashboards. A few states currently report coastal metrics in their online, environmental dashboards. Two examples of states often cited as leading best practices in online dashboards are:

Maine Environmental Trends Dashboard (Maine Department of Environmental Protection, 2016)

- Combined sewer overflows – millions of gallons discharged per inch of precipitation.
- Healthy beach days - % of days with no health advisory, based on bacteria monitoring.

New Hampshire Environmental Dashboard (NH Department of Environmental Services, 2014)

- Eelgrass – acres
- Shellfish harvesting - % acre-days open –
- Total nitrogen concentration – nitrogen/ liter

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, helping to assure the development and measurement of the indicators are not focused on plans or projects.

To understand if the coasts and shorelines of Washington are effectively protected, and providing the expected benefits to citizens of the state, it is critical to have a reasonable understanding of the baseline conditions in all coasts and shorelines in the state, specific to the key outcomes. Because there are so many diverse outcomes, deciding what are the most important ones to measure and report on is a critical step. Much of the habitat work is focused on fish habitat, and for these, the outcome measures identified for fish, tidal wetlands and estuaries should be sufficient. For many of the other outcomes, such as coastal wildlife or upland ecosystem protection, identifying key outcomes will likely need to come from the legislature.

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)
Terrestrial Ecosystems	• Water supply reliability index (e.g., % time flow meeting user requirements • Extreme low flow duration • Fish supported at measured flows	Paulson et al., 2008; Willis et al., 2016
Biodiversity	• Surface water health (or the rate of impairment vs. non-impairment statewide and by watershed) • Lake and Stream Water Quality (changes in time of key WQ parameters for lakes and streams, which include: temperature, pH, conductivity, dissolved oxygen, phosphorus or nitrogen and physical properties including turbidity, sedimentation, disturbance, intact hydrology • Median concentrations of pesticides of concern in surface water statewide. • Trends of mercury in fish and statewide mercury emissions (MN). Other states replace mercury with toxins as a more general indicator. • Balance between groundwater use and recharge or groundwater levels.	James et al., 2012; Paulson et al., 2008; Bernhardt et al., 2005; Davies and Jackson, 2006

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