Environmental Flows: The Savannah Process

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Abstract

Because The Nature Conservancy's approach to site-specific environmental flow assessment and implementation was first described for the Savannah River in Georgia, USA, it has acquired the nickname "the Savannah Process." Like the DRIFT method and the Building Block Methodology (BBM), the Savannah Process addresses the linkages between diverse flow characteristics and ecosystem components. This holistic method relies on facilitated expert consensus to prescribe environmental flows. The process consists of five steps. Step 1 is a one-day orientation meeting to inform and engage interested scientists, water managers, government agencies, and other stakeholders and provide a forum to express their values and concerns for the river. Step 2 is the preparation of a literature review and summary report describing existing data and knowledge of the river-floodplain-estuary system, species, and their flow dependencies to describe the annual and inter-annual flow or inundation patterns needed to support ecosystem health. Step 3 is a facilitated expert workshop, typically about two days, with participants representing expertise in all riverine ecosystem components. During this step, scientists are tasked with developing a set of environmental flow components (EFCs), which can be discussed by workshop

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participants in breakout groups. The whole group then reconvenes for a final review and agreement upon a unified environmental flow prescription. Step 4 is the initial implementation of the flow prescription. Following the flow workshop, scientists continue a dialogue with water managers to identify opportunities for implementing portions of the recommendations. Step 5 consists of additional data collection and research as needed to refine the environmental flow prescription. To date, the Savannah Process has been applied in a range of contexts around the world, mostly to guide changes in existing reservoir operations.

Keywords
Environmental flows · Savannah Process · Water management · Water allocation · Environmental water need · The Nature Conservancy · Environmental flow components

Introduction

The Nature Conservancy's adaptive, interdisciplinary, and science-based approach to site-specific environmental flow assessment, implementation, and adaptive management has been applied in a range of contexts around the world. Because it was first demonstrated and described for the Savannah River in Georgia, USA (Richter et al. 2006), it has acquired the nickname "the Savannah Process." Similar to the Downstream Response to Imposed Flow Transformation (DRIFT) method (King et al. 2003) and the Building Block Methodology (BBM) (King and Louw 1998), the Savannah Process is considered holistic because it addresses the linkages between a full range of flow characteristics and diverse ecosystem components. All three of these holistic methods rely heavily on facilitated expert consensus to prescribe environmental flows. To date, the Savannah Process has been most applied to helping guide changes in existing reservoir operations, with each of these case studies including consideration of floodplain and/or coastal (estuarine) wetland systems. Figure 1 illustrates the Savannah Process.

The Savannah Process

Step 1 is a one-day orientation meeting. The purpose of the orientation meeting is to inform and engage interested parties – including scientists, water managers, government agencies, and other stakeholders – in the process of prescribing environmental flows and provide a forum for them to express their values and concerns for the river. The meeting begins with an overview of the proposed process. During breakout sessions, participants discuss the details of the process, identify additional scientists who should be involved, and identify sources of information that can inform the process.

Step 2 is the preparation of a literature review and summary report describing existing data and knowledge of the river-floodplain-estuary system, native species, and their flow dependencies. The primary purpose is to quantitatively

Fig. 1 Adaptive Management of Environmental Flow Restoration in the Savannah River, Georgia, USA, and subsequently applied to most of the rivers involved in the Sustainable Rivers Project (Based on Richter et al. 2006; used with permission from John Wiley and Sons)

describe the annual and interannual flow and inundation patterns needed to restore or sustain ecosystem health, as well as to capture additional qualitative flow-ecology relationships. During this step, specific habitat requirements for a diversity of species life stages are articulated, along with their links to specific conditions of flow or inundation. The Indicators of Hydrologic Alteration (IHA) software may be used to analyze unaltered versus altered river hydrology or wetland inundation; for example, the current hydrology of the river compared to the predevelopment hydrology. Typically, this report is contracted to an interdisciplinary team, with members representing a diversity of technical disciplines. Richter et al. (2006) describe the basic structure of the report in detail, noting that it is helpful to organize information about life stages and ecological functions - such as specific timing and frequency - according to specific environmental flow components. Box 1 lists a number of example outcomes of Step 2.

Box 1. Example outcomes of Step 2 of the Savannah Process

- *Supporting the Development of Flow Recommendations for the Stretch of Big Cypress Creek below Lake O' the Pines Dam* is a literature review and summary report prepared by a team from Texas A&M University in support of an environmental flows workshop (Step 3) for Big Cypress Bayou and

(continued)

Caddo Lake, one of the Sustainable Rivers Project (SRP) demonstration sites and a RAMSAR site.

- Summary Report Supporting the Development of Ecosystem Flow Recommendations for the Savannah River below Thurmond Dam is a literature review and summary report prepared by a team from the University of Georgia to inform an environmental flows workshop (Step 3) for the Savannah River, one of the SRP sites.
- Preliminary IHA Analysis for the Middle Fork Willamette River at Jasper OR describes an analysis of hydrologic alteration using the Indicators of Hydrologic Alteration (IHA) software (link to IHA software) to inform an environmental flow workshop (Step 3) for the Willamette River in Oregon, USA, one of the SRP sites.
- Summary Report to Assist Development of Ecosystem Flow Recommendations for the Coast Fork and Middle Fork of the Willamette River, Oregon, is a literature review and summary report prepared by a team from Oregon State to inform an environmental flows workshop (Step 3) for the Coast and Middle Forks of the Willamette River, Oregon, USA, one of the SRP sites.
- Indicators of Hydrologic Alteration Analysis for the Patuca River describes an analysis of hydrologic alteration using the Indicators of Hydrologic Alteration (IHA) software to inform an environmental flows workshop (Step 3) for the Patuca River in Honduras.
- Ecological and Social Impressions of the Middle Patuca River and Potential Consequences of the Patuca 3 Hydropower Project is a literature review and summary report for the Patuca River in Honduras, for which very few data – but considerable local knowledge – were available.

Source: compiled from information available at https://www.conservationgateway.org

Step 3 is a facilitated expert workshop, which typically runs about two days. The workshop participants should be highly interdisciplinary, representing expertise in all riverine ecosystem components. The literature review and summary report is provided to all participants, typically 3–4 weeks prior to the workshop to allow time for review. During this workshop, scientists are tasked with developing a set of flow recommendations, also known as an environmental flow prescription. Scientists are encouraged to articulate these recommendations quantitatively, describing recommended ranges of flows throughout the year in terms of magnitude, duration, frequency, timing, and rate of change. The flow recommendations can be provided in the form of Environmental Flow Components (EFCs), such as low flows, high-flow pulses and floods, and recommendations can vary between dry, average, and wet years. Initial recommendations usually are developed within breakout groups, each focusing on a major portion of the river (e.g., confined river vs. floodplain river) or

major groups of organisms (e.g., fish, riparian vegetation, estuarine wetlands). Each breakout group prepares flow recommendations with ecological justification for its area of emphasis. Next, workshop participants are reorganized into new breakout groups focused on different EFCs (e.g., low flows, high-flow pulses, and floods), during which differences between the previous breakout group recommendations are resolved. The whole group then reconvenes for a final review and agreement upon a unified environmental flow prescription. Significant knowledge gaps are captured throughout the breakout group discussions and are used in a session toward the end of the workshop to discuss and prioritize future research needs. Box 2 presents some example outcomes of Step 3.

Box 2. Flow workshop reports illustrating example outcomes of Step 3, of the Savannah Process

- Defining Ecosystem Flow Requirements for the Bill Williams River, Arizona, summarizes a flow workshop and results for the Bill Williams River, a highly regulated river in an arid climate, as synthesized into the preworkshop literature review and summary report (Step 2 product).
- *Environmental Flows Workshop for the Middle Fork and Coast Fork of the Willamette River, Oregon* summarizes a flow workshop which developed environmental flow prescriptions for a regulated river to inform dam reoperation. This is synthesized into the preworkshop literature review and summary report (Step 2 product) and includes figures generated by Regime Prescription Tool (HEC-RPT) modeling software developed by the US Army Corps of Engineers Hydraulic Engineering Center (HEC; http://www.hec.usace.army.mil/).
- Environmental Flow Assessment for the Patuca River, Honduras: Maintaining ecological health below the proposed Patuca III Hydroelectric Project summarizes recommendations developed during flow workshops for the Patuca River, a pristine river in an extremely data-poor context prior to dam construction.

Source: compiled from information available at https://www.conservationgateway.org

Step 4 is the initial implementation of the flow prescription. Following the flow workshop, scientists continue a dialogue with water managers to identify opportunities for implementing portions of the recommendations. Often, sufficient management flexibility exists to begin implementing some of the recommendations immediately, which can be framed as flow experiments. These provide a valuable opportunity to test the flow-ecology relationships articulated in the environmental flow prescription and to improve scientific understanding of the flow conditions necessary to effect desired ecological changes or processes. Therefore, monitoring of both flow changes and ecological response are critical at this stage (e.g., Higgins

et al. 2011). By carefully tracking the response of an ecosystem to flow management, the flow prescriptions can be further refined, thus helping to ensure that river management accomplishes its objectives. While some recommendations can be implemented or tested relatively quickly, other recommendations may require further modeling or research to reduce physical, economic, or political constraints or uncertainties (Warner et al. 2014). Box 3 presents an example of Step 4 outcomes.

Box 3. Report document with example outcomes of Step 4 in the Savannah Process

- Environmental Assessment and Findings of No Significant Impact: Modification of Regulation and Operation of Green River Lake, Kentucky, is the Environmental Assessment and Finding of No Significant Impact for the re-regulation of Green River Reservoir, Kentucky, USA. The Green River was the first Sustainable Rivers Project site. On the Green River, the Army Corps of Engineers began to reoperate the dam to provide environmental flows. This reoperation was eventually formalized in a revision of the dam's Water Control Plan. This document is part of the environmental review required to make such a revision.

Source: based on information available at https://www.conservationgateway.org

Step 5 is additional data collection and research as needed to refine the environmental flow prescription. Konrad (2010) examined monitoring data collected for this purpose at five different sites where the Savannah process is being applied.

Additional information and resources are available at: https://www.conservationgateway.org/ConservationPractices/Freshwater/EnvironmentalFlows/Pages/environmental-flows.aspx

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