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A Template for Conducting Ecosystem-Based Instream Flow Studies

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Abstract

Since the development of the first quantitative instream flow techniques in the 1970s and 1980s much has been learned about ecological processes of rivers. Though much remains to be learned, many technical tools or methods have been developed to incorporate that understanding into developing and applying instream flow prescriptions. However, most studies to date have focused on only one or a few of the several elements that affect biological processes and ecosystem needs of rivers. In a recent project by the Instream Flow Council, a template was developed for conducting instream flow studies and improving strategies for riverine management. That construct draws on existing facts and knowledge to emphasize that effective instream flow management should integrate 5 riverine components (hydrology, geomorphology, biology, water quality and connectivity), public education and involvement, and legal/institutional elements. This report will illustrate the general characteristics of these various components, explain why it is important to integrate them all, and provide an example of how they might be addressed to improve the quantification of instream flow needs and protection of riverine resources.

Introduction

The following is the Executive Summary from the recent publication (Annear *et al.*, 2004), *Instream Flows for Riverine Resource Stewardship, Revised Edition*, published by the Instream Flow Council. The book was a collaborative effort with sixteen contributing authors: Peter Aarrestad, Connecticut Department of Environmental Protection; Tom Annear, Wyoming Game and Fish Department; Hal Beecher, Washington Department of Fish and Wildlife; Ian Chisholm, Minnesota Department of Natural Resources; Chuck Coomer, Georgia Department of Natural Resources; Christopher Estes, Alaska Department of Fish and Game; Joel Hunt, Manitoba Water Stewardship; Rick Jacobson, Connecticut Department of Environmental Protection; Gerrit Jobsis, South Carolina Department of Natural Resources; John Kauffman, Virginia Department of Game and Inland Fisheries; Allan Locke, Alberta Department of Sustainable Resource Development; John Marshall, Ohio Department of Natural Resources; Kevin Mayes, Texas Parks and Wildlife Department; Gary Smith, California Department of Fish and Game; Clair Stalnaker, and Rod Wentworth, Vermont Department of Fish and Wildlife.

Executive Summary
Instream Flows for Riverine Resource Stewardship, Revised Edition

Federal, state, provincial, tribal, and local governments are charged with stewardship responsibilities to wisely manage the quantity and quality of waters within their jurisdictions for current and future generations. Fundamental to that charge is ensuring that sufficient water is retained in rivers and lake systems at all times of year to sustain fishery and aquatic wildlife resources and ecological processes.

In the United States, the authority of state fishery and wildlife agency stewardship is derived, in part, from the Public Trust Doctrine. The basic tenets of the doctrine, as described in this book, intertwine principles of common and statutory law, including property law. When combined with other laws, the doctrine can be a very powerful tool for protecting and restoring instream flows in some situations. At present, the Public Trust Doctrine forms no recognized basis of law in Canada. Instead, Canadian stewardship responsibilities are broadly based on the provinces's need to act in the

public interest. Although the Public Trust Doctrine is not formally incorporated in statute, we argue that the principles of the doctrine may be included in current Canadian law.

Instream Flows for Riverine Resource Stewardship presents the collective views and recommendations of the Instream Flow Council's (IFC) state and provincial fishery and wildlife agency members regarding appropriate instream flow strategies for managing, maintaining, or restoring riverine fishery and aquatic wildlife resources and processes. We also identify eight components that should serve as guidelines in establishing or improving existing agency instream flow programs and in developing prescriptions to be addressed in each instream flow assessment. These components include hydrology, biology, geomorphology, water quality, and connectivity as well as legal, institutional, and public involvement.

Although our work is similar to that of other works published on instream flow methods, it extends beyond a mere listing of methods and a description of their strengths and weaknesses; it incorporates ideas, policies, and recommendations that the IFC believes should, at a minimum, be addressed in all instream flow assessments.

In overseeing the management of game, fishery, and wildlife programs, resource managers routinely set goals and objectives, monitor progress, and evaluate performance. The IFC recommends that this approach be expanded to include the management of instream flow programs and that program development and evaluation encompass the concepts recommended herein. When developing goals and objectives for riverine management, it is important that resource managers seek strategies that explicitly address public demands and help them fulfill their legal responsibilities to maintain and restore healthy aquatic ecosystems.

The IFC promotes the goal of maintaining the ecological integrity of unregulated rivers and restoring regulated rivers to the ecological conditions that more nearly approximate their natural form and function. To move toward this goal in any increment, instream flow practitioners should address the eight ecosystem components in developing an instream flow program and incorporate them as appropriate.

Prior to the 1980s, many of the instream flows that were provided for water projects were limited to a flat-line "minimum" flow because water developers and managers had little or no appreciation for the importance of natural flow variability. In most of these cases, water managers ignored the recommendations of the early instream flow practitioners who noted the potential shortcomings and negative riverine effects that could result from a flat-line minimum instream flow versus maintaining or restoring variable flows that more nearly resemble the seasonal flow patterns and processes that sustain natural ecological functions.

Since the 1980s, laws and regulations have been developed in many states and some provinces to begin addressing these water management needs. These statutory and regulatory changes, combined with better understanding of riverine processes and enlightened attitudes, have improved the opportunity for instream flow practitioners to quantify and establish variable flow regimes for sustaining viable fisheries and riverine processes. Although opportunities now exist for protecting instream flows in most jurisdictions, the legal and institutional opportunities for reserving water for riverine purposes in most states and provinces are still more restrictive than those that exist for out-of-channel users and uses.

We provide guidelines for quantifying flow regimes and developing recommendations for replacing formerly assigned minimum flows and insufficient flow caps with more appropriate variable flows. Before initiating plans that will modify the flow of streams and rivers, water developers and managers should ask what the maximum amount of water is that can be removed at any given time without adversely altering the river system and its natural functions and processes rather than the minimum flow needed to sustain the resource.

The natural flow paradigm (preservation of the natural flow variability and ecological function of river systems) is axiomatic to ecological integrity of river systems. Managers establishing instream flows must recognize the importance of inter- and intra-annual flow variability in riverine systems because different flow levels enable critical ecological processes that cannot occur otherwise. For example, it was formerly accepted, and in some cases is still believed, that higher flows

represent "excess" water in rivers and that flood water can be removed without harm and, perhaps, even benefit the ecological function of the river. However, as initially recognized by instream flow practitioners as early as the 1970s, seasonal high flows are critical components of river ecology. This is especially true at the terrestrial/aquatic interface where high flows deposit sediment, shape channels, rejuvenate and maintain riparian vegetation and habitats, improve water quality, expand and enrich food webs, maintain the valley, and provide access to spawning and rearing sites in the floodplain. The same can be said about the importance of natural periods of low flow (drought). Likewise, there is a growing body of evidence that supports the maintenance of natural processes of ice formation and breakup.

Most traditional state and provincial fishery and wildlife instream flow programs have limited, if any, staff primarily trained as fishery biologists. Although many agencies provide some training in instream flow assessment methods, trained staff often spends limited time on instream flow issues. Effective instream flow programs entail more than an occasional instream flow study or periodic mitigation negotiation with water development interests or consultants for a planned water project. Such programs require well-trained specialists who are capable of integrating the five riverine components into complex legal and institutional procedures while also ensuring effective public involvement. This is a daunting challenge for state and provincial fishery managers and one that makes their responsibilities uniquely different from those of instream flow practitioners whose assignment is less broad.

In developing an instream flow prescription to enhance or restore a degraded stream, it is prudent to involve all stakeholders, formally identify the problems to be addressed, solicit technical expertise, and devote attention to study design. Perhaps the most critical aspect of developing an instream flow prescription is to routinely and formally document the rationale used to decide a particular course of action. The strategy should address the riverine components individually and collectively, whether or not inclusion of a particular component in the study design is warranted. This approach drives the practitioner to consider all factors in developing prescriptions, documents the considerations for the record, and provides the basis for adjusting recommendations as new information or opportunities become available.

There is no universally accepted method, or combination of methods, that is appropriate for establishing instream flows on all rivers or streams. Selection of a method or adaptation of methods is dependent on the water body and potential modification under consideration. Moreover, selected methods should only be applied in accordance with the guidelines recommended in this document to ensure a solid scientific basis for establishing an instream flow prescription. Only when used in conjunction with other techniques can a specific tool afford adequate instream flow protection for all of a river's needs.

In some situations, scientifically sound demonstrations of tangible harm and benefit resulting from a range of experimentally controlled instream flow levels over extended periods of time may be required. Adaptive management may be a useful tool in some, but not all, of these situations. It is most appropriate when financial investment is significant, values for riverine resources are high, risk to all parties is considerable, and the time frame for the project allows prolonged monitoring. Further, binding commitments among stakeholders must be established at the start of studies to ensure that adequate resources (water and money) are available to fulfill testing needs for the full range of potential mitigation strategies, and that safeguards are provided to avoid irrecoverable impacts to riverine resources. As we emphasize throughout this work, studies that focus on only a limited number of components, such as the response of fish populations, should be avoided because they are often confounded by interrelations with riverine components other than streamflow. Consequently, managers must be critical of efforts to ascribe perceived short-term changes, or lack thereof, to a single factor such as streamflow alone. Measurable targets or conditions and defined decision points are essential.

Of the many instream flow quantification methods and variations developed over the last 30 years, we assess 34 of those most commonly used. In some cases, a broad class of methods is addressed collectively within a single review (e.g., flushing flow methods and biological response

correlations). Although not exhaustive, tool evaluation is sufficiently broad to allow practitioners to identify an appropriate methodology for most study designs that may be encountered. Evaluation addresses 14 categories, ranging from the method's purpose to the IFC's critical opinion.

Understanding the underlying mechanism(s) responsible for the biological, physical, and chemical outcomes evident in river systems must underpin the instream flow prescriptions if they are to succeed. However, much remains to be learned about the role and interrelations of factors governing riverine resources and processes. We do not presume to imply that this document is the definitive resource for all instream flow study needs. The science of instream flow management is a relatively young and evolving discipline and much additional research is needed. Although we do not provide a summary of additional research needs, we note that research is being conducted in many settings throughout the United States, Canada, and elsewhere. Clearly, there is a need for research that better identifies how to build a flow prescription that addresses the eight ecosystem components in concert. We urge instream flow practitioners and water managers to remain open to the application of new assessment tools as they continue to be developed and accepted by the instream flow community.

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