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The Science Behind Instream Flow Laws

The amount of flowing water in streams and rivers and water levels in lakes are some of the most important issues affecting life on planet Earth. The timing, quantity, and quality of water flowing in streams are some of the most critical environmental factors that affect where we and most other organisms live as well as how well we live. Likewise, the way water is used is among the most contentious issues we deal with. A variety of tools and strategies have evolved over time to address the controversy, and indeed significant strides have been made and are occurring to help quantify some of the trade-offs associated with water allocation decisions. But scientific advances in the field of instream flow needs quantification are far from eliminating controversy. Indeed, as demands for water grow, so too will the number and passion of arguments increase in the future, as will the need for even better quantification tools. This paper looks at the basic nature of instream flow issues, the evolution of flow quantification needs assessments, and the importance of effective laws to better address disagreements in the future.

The Setting

Throughout the course of civilization, people have typically looked at water as a simple, extractable resource like coal, oil, or timber. However, the fact is that flowing water affects our lives in ways that are much more complex than your garden-variety single-use resource. No other natural resource is as essential for our survival or provides so many important functions for society. Allowing water to be used solely for one purpose to the exclusion of others happens all too often, but in reality it is this practice and mind-set that has led to many of the conflicts today.

The notion that water is an extractive, single-use resource of limitless proportions was typical of historical perspectives about many natural resources to early settlers. However it was this belief that, among other things, led to the demise of many wildlife species like the passenger pigeon, degradation of water quality, and loss of nearly 60% of the wetlands in the U.S. (www.epa.gov/owow/wetlands/vital/toc.html).

In the early years of settlement when our numbers were fewer than today, there seemed to be plenty of water to go around for both in-channel and out-of-channel uses. Controversies arose when water was taken out of the channel and consequently led to the development of laws to regulate its allocation among the various consumptive users. It wasn't until most of the water was allocated to these uses that in-channel users realized they'd been unwittingly left out of the equation. Arguably, the "evolving" desire to use water for in-channel purposes is not some new, Johnny-come-lately interest: the public has always had much interest in the values of flowing rivers, though that interest wasn't expressed until the resources of their interest were compromised. Efforts today are a move to remedy this oversight. Unfortunately, with most of the water legally given away, rectification is very difficult, as it usually means an existing water user has to do something different.

In the United States, the legal authority for allocating water within the boundaries of each state rests with state governments. Each state has subsequently devised its own strategies for administering water among the various interests competing for its use. While the precise mechanisms vary according to the needs and culture of each state, most states rely on their fish and wildlife agency or equivalent to help quantify the amount of water needed to protect the public interest in fishery and wildlife resources of flowing waters and lakes. Predictably, not all states developed their instream flow programs at the same pace. In fact, many states still do not have a formal instream flow / water management program for fisheries (Annear et al. 2009).

Tools to estimate flow regime needs for streams have existed for some time, but the formal science of quantifying instream flow needs for streams and lakes did not take shape until the early 1970's when a proliferation of instream flow methods were developed. Many of these strategies were showcased at a conference held in Boise, Idaho (Orsborn and Allman 1976). In the 30 years since this historic conference, there has been tremendous growth in the number and type of strategies used to quantify flow needs. Almost all of these new methods were effective at some level, but the variety of available techniques also generated its own controversy. This has been especially true when the results and recommendations of any one particular method differed from another method's findings or provided a flow level that didn't match the expectations of one or more stakeholders.

State fish and wildlife agencies often found themselves in the middle of these controversies over methods and data interpretation. As a consequence, they felt a need for some standard strategy to credibly quantify flow needs. Within this environment, the fishery and wildlife agencies of U.S. states and Canadian provinces formed the Instream Flow Council (IFC) in 1998. Membership on the IFC is provided to each state or provincial fish and wildlife agency, whose interests on the Council are represented by their lead instream flow or water management coordinator.

One of the purposes of the IFC was to develop a network whereby those charged with the responsibility of protecting public fishery and wildlife interests within their political jurisdictions could share ideas and strategies. Careers are simply too short, and the issues too serious, for each state and provincial agency to make the same mistakes as their counterparts in other states and provinces. In the years since its formation, the IFC's facilitation of networking and sharing both successful and unsuccessful strategies has proven highly valuable.

The IFC also sought to develop a standardized protocol or approach consisting of what they considered were accepted concepts and practices for quantifying instream flow needs for public trust fishery resources in rivers and lakes of North America. To address this need, 16 IFC members from throughout the U.S. and Canada authored a book that defines the science, law and role of the public in setting instream flow needs (Annear et al. 2004). The book provides 46 policies the authors felt were important when making instream flow decisions. In addition, the authors provided critical opinions of 34 of the most commonly used instream flow methods in the U.S. and Canada. This assessment is uniquely different from other instream flow method summaries in that the authors went beyond mere descriptions of methods and offered their specific critiques of the shortcomings, strengths and applications for each method. With over 600 references and the insights of so many front-line instream flow experts, the book has become a primary reference source for instream flow practitioners in the U.S. and Canada. The book is also an important tool for helping IFC members and others better understand the complexities of the instream flow arena by addressing legal, institutional, and social issues as well as science. The concepts presented in this paper are drawn largely from the IFC book.

Where to Start?

Quantifying the instream flow needs of a river is not a simple matter and must begin first with an understanding of some of the terms and concepts associated with the process. Primary among these is the concept of instream flow itself. In fact much of the conflict associated with the term can be reduced by acknowledging that instream flow is more accurately termed instream use, which puts this use on equal footing with other uses. At its most basic level, "instream flow" simply means water flowing in a stream or river. Streams in flood stage as well as streams where the only water in the channel is flowing through shallow sands just beneath the surface both have instream flow. The amount flowing (or used) at any particular time may or may not be adequate for creating, maintaining, or improving ecological functions. Instream flow can refer to a single flow or it can be a range of seasonally adjusted flows. Usually when people talk about this kind of "water-in-the-creek" instream flow, there's little if any consideration for whether or not the water is legally protected from diversion for other uses. In most cases, these discussions are just an issue of water.

In other situations, when people talk about an "instream flow," they're actually talking about a piece of paper such as a water right, permit or operating agreement. In many of these situations, just because you have an instream flow right, permit, or agreement there's no guarantee you'll actually have the amount of water identified on the certificate. That's especially true of unregulated, free-flowing systems where natural precipitation and runoff patterns cause widely variable flows. An instream flow water right or permit doesn't necessarily put water in the channel, but it can protect it from diversion for other uses when it is available in the stream. Many disagreements about instream flow can be avoided at the outset by making clear whether we're talking about water in the creek but no legal protection, legal protection but no guaranteed flow, or wet water in the creek with legal protection to go with it.

The majority of instream flow prescriptions are often made to create, maintain, or restore a fishery. But the discipline of instream flow isn't just about fish. As a consequence, the term "fishery" must be defined at the outset of a study too. Although fish are definitely a part of a fishery, the latter term actually relates more broadly to the community of organisms (including forage fish species and macroinvertebrates), aquatic habitat (including water quality, channel form and function, and riparian habitat), and human users. When state and provincial agencies manage fisheries, they typically address all three of these components via stocking, managing in-channel habitat and surrounding lands, and setting regulations for utilization of fish (harvest). Instream flow studies designed to create, maintain or restore a fishery should be much broader than setting a single minimum flow to protect a single species of fish – even if that's the target species for the study.

One aspect of achieving a successful outcome in an instream flow study is the importance of recognizing the importance and inter-related nature of science, legal/institutional, and public involvement components of water management. All too often scientists wonder why their most compelling research doesn't stimulate action. The public often has strong opinions – sometimes based on fact, sometimes not – but also often feels ignored when their requests or demands are not recognized or accepted. When not properly addressed, public opinion can stop a project just as surely as the lack of credible data.

At other times the existence, or lack, of laws and policies can prevent the best science and public support from playing out. Many western states now have instream flow laws, which leads people to think that the legal component is no longer an issue. However, a close look at most instream flow laws reveals at least as many limitations as there are opportunities provided by the law (Annear et al. 2009). Further, even though some states have seemingly good laws, the interpretation of them can and does limit their usefulness for protecting water in-channel.

Although laws and policies are often the trump card, in reality each of these components is equally important. Stakeholders who are intent on working effectively need to recognize the legitimacy of each of these components, identify potential bottlenecks, and then work cooperatively with other stakeholders to address potential stumbling blocks that are within their ability to control. While that's easier to say than do, the fact is that ignoring or failing to address the need for appropriate scientific studies, the role of the public, and legal and institutional limitations up front and on equal bases simply sets the stage for a potentially major confrontation or frustration at some point in the future.

Where you are on the landscape can also make a difference in how instream flow problems are addressed. If the focus of the study is on public lands, it's often likely that unallocated water is available to protect everything from base flows to flushing flows to flood flows. Securing needed flows can still be a significant challenge requiring detailed scientific justification, development of public support and the ability to legally protect needed flows, but the opportunity to do good things often does exist. Situations such as this where adequate water is available are sometimes described as "top-down" strategies where the focus is on identifying how much water can be depleted from existing flows without affecting the existing aquatic community.

If the focus of the study is on private lands, much of the natural flow is often already allocated to out-of-channel uses. In these situations, it may be a considerable challenge to find enough water (either by reallocation of existing rights, water conservation, or construction of new dams) to restore a fishery. Legal issues and public involvement will often be significant factors here. These types of efforts are described as "bottom-up" strategies in terms of trying to put enough water back in the stream to accomplish a desired effect.

Sometimes we even need to step back and make sure we acknowledge the most basic philosophical question: "what is the instream flow for?" The public perception can be that protecting sufficient quantities of water for instream flow is a matter of providing water for fish at the expense of people. Though emotionally compelling, this is wrong thinking. Water in the United States and Canada is typically held in trust and managed by the state or province, which means it is the property of all citizens. Determining the amount of water to dedicate to instream use is almost always the product of a public process that reflects public choice to use water for maintaining fisheries. Thus, it is not the fish that hold an instream flow water right or permit. Rather, instream flow protections are owned and shared by all the citizens of the state or province. By virtue of this public ownership, claims by water right or permit holders that they are being discriminated against by fish or wildlife have a certain emotional appeal, but no basis in law. The bottom line is that using water for instream flow is matter of people choosing to use water for that purpose. Many disagreements can be headed off by agreeing up front that instream flow is a legitimate use of water – for people – that just happens to grow fish.

The State of the Science

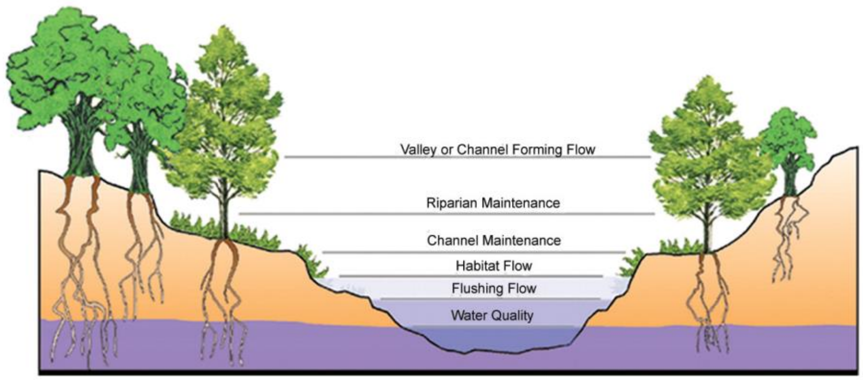
Though fisheries scientists need to address legal/institutional issues and should spend much of their time dealing with the public, the truth is that most of them spend more time and are much more comfortable dealing with the science of instream flow. Still, "just" doing the science is no simple matter as river managers today need a level of ecosystem understanding that is unprecedented. As noted previously, they are no longer afforded the luxury of focusing solely on fish. Today's issues require knowledge of the life history requirements of organisms living in and adjacent to streams, habitat and the processes that form habitat, the effect of land alterations in the watershed on hydrology, the inter-relationship of organisms in the system, and much more.

Through the early part of the last century, natural resource managers were aware that some level of flow was needed to sustain the natural functions of streams; however, they lacked defensible methods to quantify those needs. The earliest tools to fill this need were relatively simple ones that identified single-level base, or minimum, flows. Unfortunately, for many folks who are not fisheries scientists this "minimum flow mentality" became established as an acceptable strategy and in too many cases this view persists today. A wide range of other methods followed this first suite (Morhardt 1986 and Reiser et al. 1989). Most were designed to address the habitat needs of single species of fish.

Increased access to computers in the 1970s and 1980s coupled with increased knowledge of aquatic systems and organisms resulted in the ability to do more sophisticated, incremental studies that could evaluate the trade-offs between flow and physical habitat over a range of flows. However, even when approaches such as the widely used Instream Flow Incremental Methodology (IFIM) were employed, the tendency was to focus on only one or a few species (usually sport fish), life stages, or habitat needs (Stalnaker 1993).

Scientific advances have also occurred in areas other than fisheries, such as understanding how the timing, frequency and duration of flows affect the character of rivers and some of the organisms that live there. Studies today take more of a holistic approach that reflects this growing body of knowledge. Based on these advances, the IFC endorses the philosophy that rivers are defined by the interaction of five primary riverine elements that include hydrology, biology, geomorphology, connectivity and water quality (Annear et al. 2004).

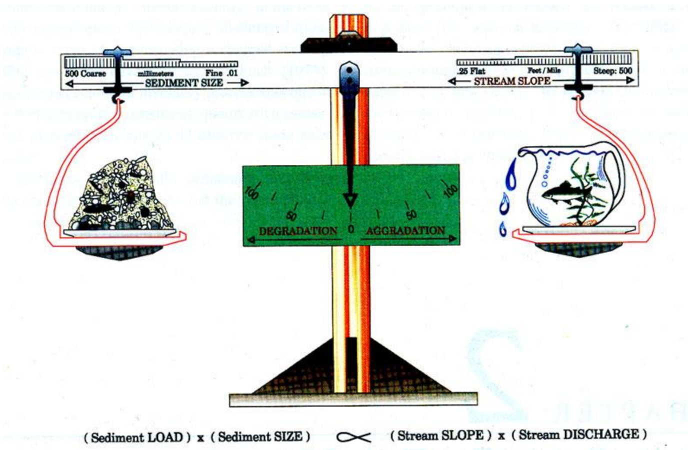
Each of these disciplines entails its own level of complexity and each is intricately related to the other four in even more complex ways that we only partially understand. Hydrology is the driving force and central variable for all rivers. In short, river systems are defined by the timing, duration and magnitude of flows that pass through their channels over long periods of time. Addressing the hydrologic component of an instream flow involves more than keeping a minimum amount of water in the stream to maintain fish survival. A range of river flows is needed to provide specific, important ecological functions, which are associated with the other four riverine components. Natural droughts can be as important as natural floods – though neither should be prescribed on a permanent basis. Management of intra- and inter-annual flow variability, properly timed, is essential to protect, restore, enhance and manage riverine structure and function.



A range of river flows provides specific, important ecological functions that can be related generally to the five riverine components. Preservation of river flow variability—properly timed—is essential to sustaining river structure and function and ecosystem health. Providing a single, minimum amount of water in the stream to maintain fish survival will not maintain long-term habitat features to perpetuate an existing fishery.

Biology relates to all of the organisms that are associated with and help define a river (fish, aquatic insects, and vegetation along the banks). Traditionally biologists considered only the dominant sport fish or endangered species. However, when we talk about how much water is needed for the biology component of an instream flow we also need to talk about the entire community of organisms that live in the stream as well as the vegetation in the stream and the riparian community through which it flows. The fish we are often focused on are just one part of the energy web that is intimately tied to and affected by the structure and function of the entire riverine community. Looking at just fish is a gross oversimplification of what's going on in most rivers.

Fluvial geomorphology pertains to the way water affects sediment and bed particle conveyance capacity and patterns and the subsequent effect on stream channel shape. Typically an overall goal is to maintain a stable stream channel by keeping the stream in a condition of dynamic sediment equilibrium where sediment import equals export over time (years). The timing, duration and magnitude of flow, as well as the amount of sediment entering the system, determine whether down-cutting, deposition, or channel migration will occur. Managing both flow and sediment is important in terms of maintaining the number of pools, the cleanliness of riffles and the overall width and depth of the river. Changing any of these elements or protecting only a single minimum flow can and often will change the kind and number of organisms that live in the river.

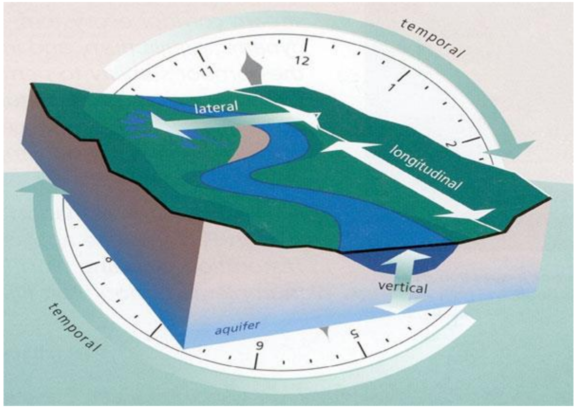


Lane's Balance Equation has been used to show the concept of "stable channel balance," depicting the relationship of sediment load and sediment size to slope and discharge graphically. A change in any one of the parameters will set up a series of adjustments in companion variables and ultimately result in changing the river channel and the organisms that live there. Water quality is affected by water availability and flow patterns too and in turn elicits a biological response. In some situations, managing this riverine element is as simple as dilution being the solution to pollution. But sometimes dilution isn't a good thing – especially for organisms that prefer turbid or warm water. Adding water with less sediment than occurs naturally, such as sediment-free waters coming from a dam to a formerly warm-water river, can have drastic ecological effects on organisms that are adapted to an environment with different natural water quality characteristics. One element related to water quality that is rarely considered is the effect of a project on icing processes (as a function of water temperature) and winter habitat. This is an area of science that has yet to receive much attention, but studies done to date suggest that the effect of altered icing processes on populations of fish and their habitat can be among the most significant of all factors affecting a fishery in ice-prone regions (Prowse 2001a, 2001b; Annear et al. 2004).

Connectivity consists of four dimensions, each with its own range of considerations related to hydrology, biology, geomorphology, water quality and energy. Understanding the importance and function of these four dimensions can be critically important for crafting effective flow regimes. The four dimensions of connectivity include:

- <u>Longitudinal connectivity</u> pertains not only to the presence of physical, chemical, or hydrological (e.g. lack of water) barriers on the main stem of the river. It also relates to connectivity of the main stem to its tributaries and a downstream terminus (e.g. a lake or ocean).
- <u>Lateral connectivity</u> references the ability of the river to spill onto the associated flood plain as well as for nutrients and woody materials on the floodplain to reach the river. Many fish species spawn during floods in flood plains or juveniles rear in seasonally connected wetlands. Construction of dikes and berms typically are designed to disconnect these components of a river and often have significant unintended consequences to the energy flow, habitat use, productivity, and persistence of aquatic organisms found in the river.
- <u>Vertical connectivity</u> relates to the connection of surface flow in the river to shallow groundwater. Wells located in riparian areas that draw from shallow groundwater can influence flow in the river just as directly as a diversion taking the water right off the top. Vertical connectivity patterns can be highly variable over both time and space as a function of changing geologic patterns and other factors, making it necessary to do site specific studies to define the relationship between and potential effects associated with the use of shallow groundwater adjacent to flowing rivers.

- Temporal connectivity pertains to the pattern in which flow passes through a channel over time. In many situations, riverine organisms are dependent on continuous, adequate flow in a section of river at all times of year. However in other situations, healthy community assemblages have evolved and are defined by some manner of disconnectivity. Many stream segments cease flowing but still have isolated pools that provide refugia for native fishes to the exclusion or disfavor of non-native organisms. Though we sometimes call these "dry streams," there's a big difference between when a stream goes dry and when it simply ceases flowing for some organisms. These natural flow patterns can be essential for excluding non-native fishes. Increasing year round flows may look good to people, but can have drastic unintended consequences to assemblages of fish and other aquatic organisms.



Rivers are connected in four dimensions—from headwaters to their mouth, from channel to floodplain and valley, vertically from their bed to the groundwater, and through time. Rivers are shaped and characterized by movements of water through the longitudinal, lateral, and vertical dimensions, which transfer materials, energy, and organisms. The time dimension (duration and rate of change) is also a critically important consideration in establishing instream flow prescriptions because of the dynamic nature of the riverine components (From Ward 1989).

In consideration of the five riverine components and sub-parts, it's more important than ever that we ask the question "instream flow for what purpose" early in the project planning process.

Regardless of how fast or far scientific advances occur or the level of sophistication contained in an ecological model, it seems more knowledge is always expected. But it's important to recognize some of the basic tenets of riverine modeling. Among the more important of these are the following:

- There is not a straight-line relationship between water and habitat. More water does not always mean more habitat.
- There is no best method or approach for quantifying flow needs.
- The ecological processes in every stream are unique and different from other streams, though there may be some similarities in some characteristics and functions.
- The ecological characteristics of streams change longitudinally and temporally – every stream segment is different. A flow that maximizes habitat in one part of the stream may not provide the same benefit in another part.
- A flow or flow regime that is beneficial to one life stage or species may be detrimental to other life stages or species.
- No single flow is best for an ecosystem or a full suite of organisms. Managers typically must manage for flow regimes.
- Modeling output must be evaluated to determine if there are any inconsistent or alarming results. Professional judgment is an essential part of all instream flow prescriptions.

Dealing With Uncertainty

Although there are many cases where the relationship between flow and an ecological response have been documented, some effects are not readily or immediately apparent. Ecological systems are complex and their short and long-term interrelations are not completely understood. Dasman (1973) noted, "Today natural diversity still baffles us. Even the simplest natural communities escape our comprehension. We abstract and simplify them intellectually with energy flow charts or system diagrams. When we understand the pictures and formulae, we delude ourselves into believing we understand reality." This realization is as true today as it was when Dasman pointed this out, and it remains one of the most important things to keep in mind when analyzing data. The illusion of technique is a dangerous lure of all models, and stakeholders must be vigilant to not blindly follow outputs. In many cases, the professional judgment of experienced scientists or strategies as simple as taking a series of photos at a range of flows can be at least as influential as the output from some models.

This situation is at least in part associated with the difficulty of defining "nature" or the objectives for which laws are intended to apply. Simply put, instream flow protection means different things to different people or interests. This general situation is broadly described by Kull (1998) in a paper where he proposes there are at least four different faces or definitions of "nature." Borrowing (or adapting) Kull's framework, we can describe the first facet as True Nature, in and of itself, which exists in an unaltered state in places like wilderness areas. Then there is Observed Nature, which is nature as humans perceive it, which people (especially scientists) describe in great detail but which nevertheless includes elements and processes we do not see or comprehend. Next is Modeled Nature, which is the nature that scientists describe with mathematical models – and is generally even more removed from True Nature. And the last form of nature is Human Nature, which is the very simplified form of nature that people enjoy. Think in terms of back yards, golf courses, and even art. The IFC contends there is yet another form of nature – Legal Nature. This is the nature that's recognized and protected by laws and policies. With the exception of laws that fully protect areas like wilderness areas, Legal Nature often covers an even narrower slice than Observed, Modeled, or even Human Nature. Legal Nature is almost always at least a decade behind the understanding of ecosystem processes provided by science.

One attribute of all models is that they require users to accept some level of uncertainty. The statistician George Box summed this characteristic up succinctly in his oft-used quote "all models are wrong, but some models are useful" (Box 1979). Managing uncertainty is one of the most important parts of the assessment process, which of course is what science is designed to address. Regardless, uncertainty associated with instream flow quantification can be, and often is, used by all stakeholders to delay a project and, if great enough, can just as easily kill a project or compromise a valuable aquatic resource.

For their part, fishery scientists are often all too willing to agree to come up with precise answers. Unfortunately, this is often a formula for failure because of the likelihood that their prediction will be unacceptably high or low and lead to the claim that the answer is "wrong." In some cases where the measured response does not match up with the predicted one, "failing" to show a strong relationship between flow and fish is used to discredit both the science and the scientist.

Accuracy versus Precision

In science there is a very clear, and often significant, difference between providing an accurate answer and a precise one. Environmental responses based on trends or patterns measured over time (years) can be determined with a relatively high degree of accuracy. The science has evolved sufficiently that it is quite feasible to determine if the fishery (including habitat) will be better, worse, or about the same under one flow regime compared to another. In many situations, these kinds of accurate, though imprecise, predictions of trends are acceptable.

However the same cannot be said of the ability of methodological tools to predict a precise number of fish at any given place or point in time – especially with highly mobile populations. Fish populations are naturally dynamic from year to year, season to season, and segment to segment as a function of many variables of which water is only one, albeit an important one. The fact is there are very few studies to date that document a strong, consistent relationship between a particular flow level or regime and a precise fishery response.

In brief, scientific tools today are quite capable of providing relatively accurate answers (e.g. more fish) but they will most certainly always have difficulty providing precise determinations of fish numbers. Thus, it is often important that stakeholders consciously note whether the standard for studies is one of precision or accuracy.

Linking Science and Law

A nationwide survey of every state and provincial fish and wildlife management agency revealed that the lack of effective laws and policies was the number one factor preventing them from more effectively managing rivers and lakes for fish and wildlife (Annear et al. 2009). Indeed, though some states have better, more comprehensive legal authorities than others, the study found that no state or province afforded instream flow the same legal process and protection as water rights and permits for other uses.

The majority of instream flow studies today still rely largely on one-dimensional or two-dimensional physical habitat assessments that are designed to predict habitat suitability and trade-offs for sport fish. The level of accuracy of most of those studies is reasonably good as long as practitioners restrict their interpretations to the limits of the model they're using. Still, when we consider that these models usually address only one of the five riverine elements that define rivers (e.g. biology) and provide little information about the other four (hydrologic processes, fluvial geomorphology, water quality and spatial/temporal connectivity), there is much uncertainty associated with recommendations from these studies. Instream flow laws need to be flexible enough to allow, if not mandate, inclusion of these other considerations that are not accounted for in models in the business of protecting and restoring environmental benefits as well.

To achieve effective or meaningful ecosystem protection, the great challenge facing society is to recognize that instream uses are on equal footing with out-of-stream uses and afford instream uses the same opportunities for legal protection as traditional, out-of-channel uses.

No Silver Bullet

Though not widespread, it is increasingly common to see studies include more of the five riverine elements in their assessments than in the past, though few if any include the entire suite. It isn't always necessary to quantify outcomes based on all five elements, but it is very important that studies at least acknowledge that they have considered things like geomorphology and water quality in their study design and document why they chose not to include those elements, if indeed they are left out. In practice, the design of each instream flow study should be based on the unique set of issues and questions for that situation.

Almost all people have the common tendency to want to boil things down to a simple level. It seems we always want to know things like "what's the one thing I need to know." Or with fisheries "what's the minimum flow to protect this fishery?" Unfortunately for all of us, the world we live in is not simple to understand. Instream flow and water management decisions will always be imprecise regardless of the sophistication of models we develop. They may be accurate in the sense that we are capable of detecting and modeling some cause and effect relationships or trends. But the complexity of natural processes, whether quantifying instream flow needs or forecasting the weather, is so great that precise predictions are simply beyond our ability to fully comprehend let alone describe in detail with mathematical models.

As much as some of us would like to think that a single, highly sophisticated model to quantify instream flow needs would make the decision-making process easier, the fact is there is no silver bullet. Science serves a useful purpose in helping reduce uncertainty and will continue to evolve. But the controversy associated with water is based more on personal values than on an understanding of ecological principles. Einstein commented that "Science can ascertain what is, but not what should be, and outside of its domain value judgments of all kinds remain." Thus, instream flow decisions will always be a combination of science, public involvement, and the laws and policies under which we function as a society.

Tom Annear is the Water Management Coordinator for the Wyoming Game and Fish Department, co-founder of the Instream Flow Council and the senior author of the book Instream Flows for Riverine Resource Stewardship. Copies of the book can be purchased at www.instreamflowcouncil.org.

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