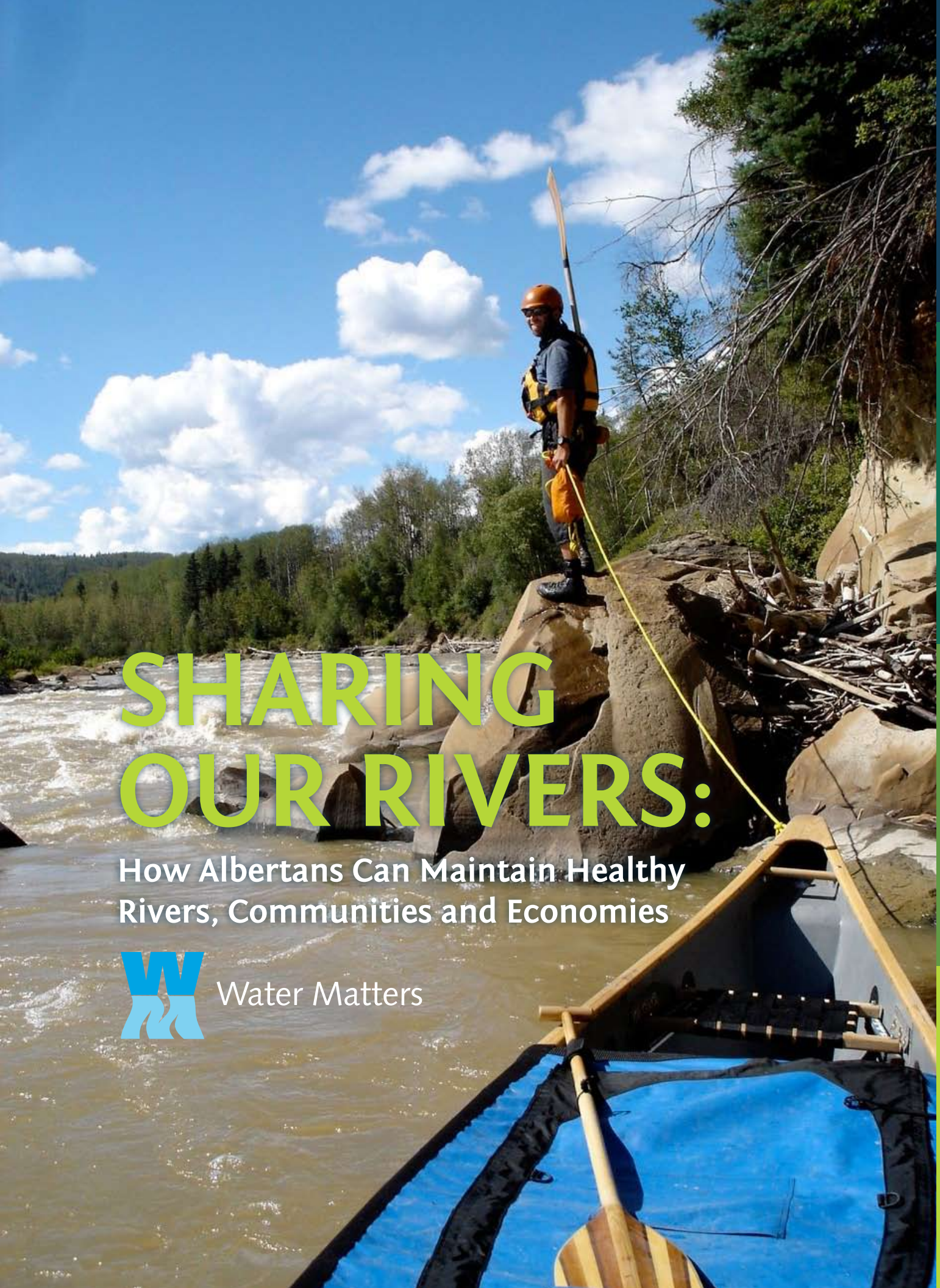

SHARING OUR RIVERS:

How Albertans Can Maintain Healthy Rivers, Communities and Economies

Water Matters

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SHARING OUR RIVERS: HOW ALBERTANS CAN MAINTAIN HEALTHY RIVERS, COMMUNITIES AND ECONOMIES

April 2012

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Introduction

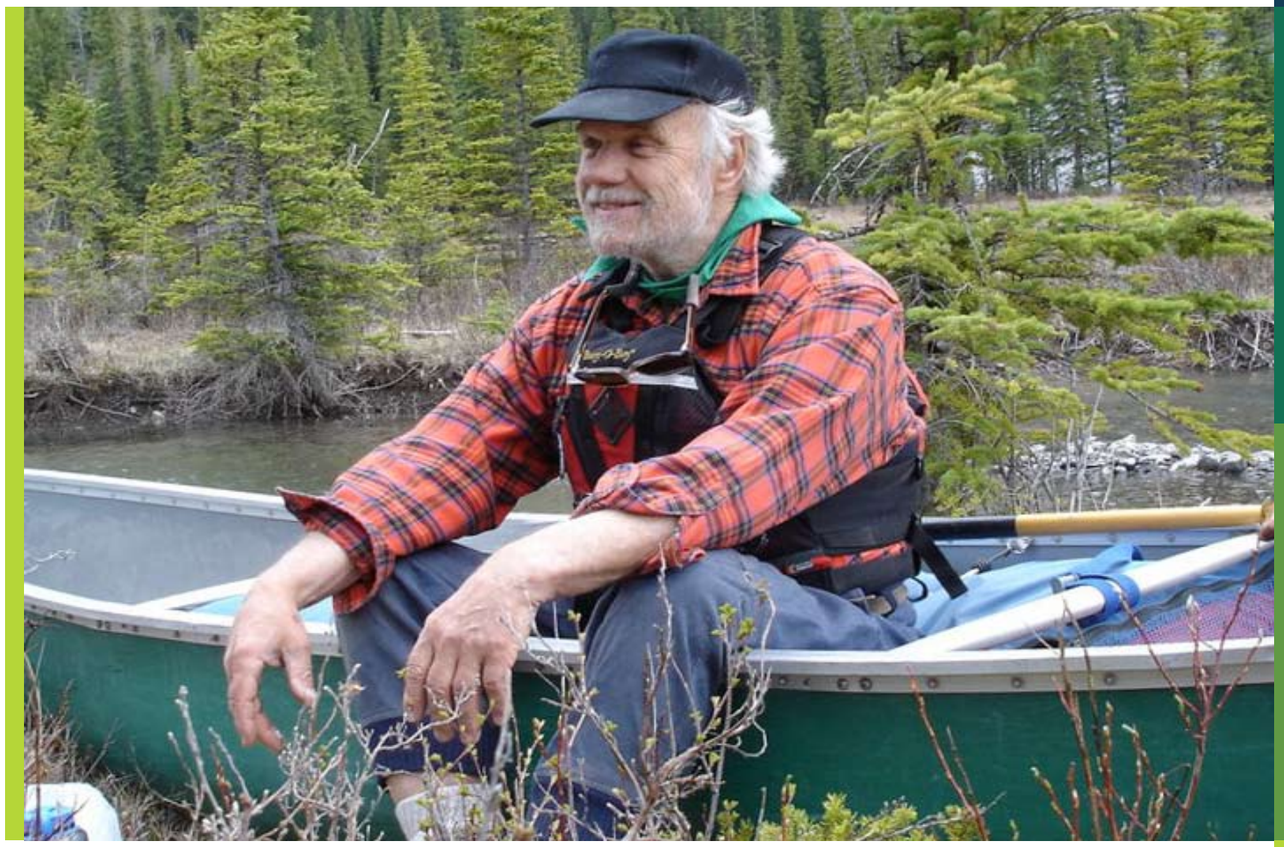
Healthy aquatic ecosystems are a public interest because they provide ecosystem services upon which we all rely for our environmental, social, and economic well-being, now and in the future. These services can be characterized as provisioning services (*e.g.* of safe food and water), regulating services (*e.g.* flood and disease control), providing cultural services (*e.g.* spiritual, recreational, and cultural benefits) and supporting services (*e.g.* nutrient cycling that maintains the conditions for life on Earth).[1] Healthy rivers provide us with high-quality drinking water and healthy and sustainable fish populations, and sustain riparian wetlands and forests along their borders. Freshwater systems are the foundation of our social, cultural and economic well-being, which is why Alberta has prioritized the protection of healthy aquatic ecosystems in the *Water for Life Strategy*.

Unfortunately, climate change and growing demand for water have already reduced water availability in Alberta, and many rivers in Alberta are impaired and continue to be degraded.[2] This means that Albertans have to use less water much more efficiently, and develop more effective, flexible, and adaptive management and policy approaches than are now used. So far, Albertans have not been engaged meaningfully in discussions about the changes needed to better manage water in Alberta, and we are collectively unprepared to live in a future with less water. Although there is disagreement on how Albertans may reach a sustainable future, it is exceptionally important that water be secured to ensure that aquatic ecosystems remain healthy and basic human needs are satisfied. Ultimately, we must maintain healthy aquatic ecosystems in ways that satisfy basic human needs and enable us to achieve our economic and social goals.[3] Based on our discussions with senior water users representing a variety of sectors, including irrigation, oil and gas, municipalities, hydropower, and water utilities, it is clear that policy and operational solutions are needed in Alberta that address water shortages and ensure that our rivers are managed and maintained according to a sound scientific understanding of ecosystem health.

What is a Healthy River?

A healthy river is one that balances a complex combination of chemical, physical, biological and hydrologic interactions that maintain a healthy aquatic ecosystem. Flow in creeks and rivers in Alberta normally vary with seasonal changes in precipitation and runoff, with spring rains and the melting of snow causing floods, and periods of less precipitation and less runoff causing low flows in late summer and winter. Periodic floods restore riparian forests that line creeks and rivers, shape riverbeds, and create and maintain habitat for fish and other aquatic life. From year to year, the amount of water in a river is affected by the amount of precipitation, including the amount of winter snow that is available for spring melting, and high temperatures and wind that cause high evaporation: flows are high in cool, wet years, and low in hot, windy, dry years. Over the long term, there is great variability in flow in creeks and rivers, but that variability is necessary for the maintenance of ecological health.

The changes we make to land in a watershed, dams, and withdrawals of water from rivers, lakes, and wells all contribute to changes in river flow, on top of the natural variation in flow. However, despite naturally variable river flows, and water supply, we rely on stable water supplies for drinking water, and to meet the needs of farmers, oil and gas producers, and hydro-electric power generators. In Alberta, we also rely on rivers to carry away our municipal wastes. Put simply, ecologically healthy river and surrounding lands provide us a suite of ecological services that satisfy many of our basic needs and provide support for our economy. But when ecological health is impaired, the loss of those services can be disastrous.



Threats to River Health and Ecological Thresholds

In Alberta, five threats degrade rivers and lakes because of their effects on river flows and flooding regimes: over-exploitation, pollution, fragmentation, destruction or degradation of habitat, and invasion by non-native species.[4] Rivers provide important ecosystem services — healthy and sustainable fisheries, high quality freshwater, and water for irrigated agriculture and industrial use — that are subject to these threats.[5]. When too many pressures upset the delicate balance in a healthy river, it can shift everything to a new state that causes a decline in these important ecosystem services (Figure 1). If we hope to return degraded rivers to a healthy state and regain the full suite of ecosystem services they provides us, then the pressures we have imposed need to be reduced.

We are surrounded by environmental problems caused by exceeding ecological thresholds, including toxic algal blooms, high fish contaminant levels, boil water or swimming advisories, and collapsed fisheries, to name a few. Even where it is possible to reverse or reduce the harm we have caused, it is almost always far more expensive than simply avoiding the problem in the first place. Similarly, when we choose not to reduce or reverse environmental harm, costs can increase substantially. For example, as water quality in a river declines because of high pollution levels, the expenses associated with treating drinking water increase significantly. In worst-case scenarios, contamination of drinking water sources with human or animal waste can cause critical health emergencies, such as occurred in Walkerton, Ontario, in 2000. Avoiding ecological disasters, and the accompanying costs of lost ecological services and necessary reclamation and rehabilitation, provides a common-sense rationale for managing rivers sustainably.

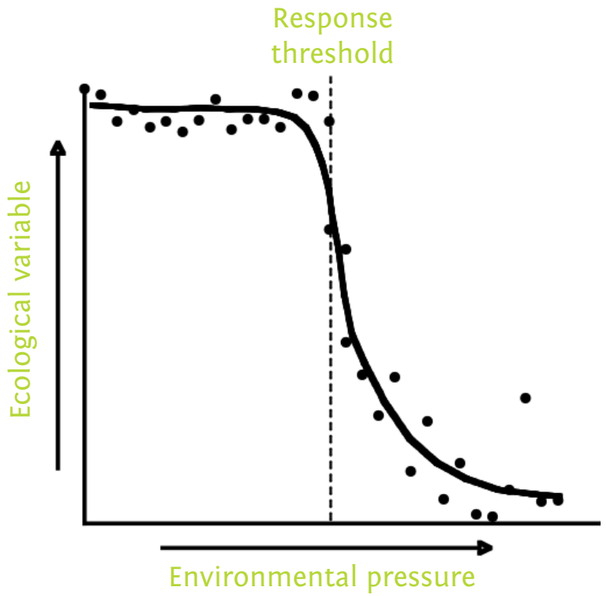


Figure 1. When environmental pressure increases, an ecological variable or service will usually continue for a while, then drop off suddenly once it hits its ecological "threshold". Sustainable development and effective environmental management limits development pressures to those below levels that cause major harm (illustrated by the dotted line) and prevents environmental collapse. Environmental variables that respond this way to environmental pressure are almost unlimited, and include such things as animal or fish populations, natural removal of nutrients from water, and binding of heavy metals in soil.

Ecosystem Management and Instream Flow Needs

The concept of "instream flow needs" (IFNs) has become the focus in river management[6] because it captures the quantity, timing and quality of water flows required to maintain the health and resilience of aquatic ecosystems and the human livelihoods and well-being that depend upon them.[7] If our goal is to continue to enjoy the benefits that healthy rivers provide us, establishing the point at which flow rates, water levels, and water quality changes start to impair the most sensitive aspects of river health and ecosystem services is critical to determining IFNs and understanding the point beyond which development pressures should not extend.

In Alberta, risks for rivers usually are characterized according to expert judgment or even stakeholder consensus, rather than according to rigourous scientific studies and the assessment of real data.[8] While consensus-based judgment is valuable in designing adaptive management or monitoring programs,[9] it is a very risky way to identify IFNs because it is not quantitative. For instance, relationships between changes in river flow and ecological indicators developed for one river may not be appropriate for use elsewhere, or for development of regional environmental flow standards.[10] Because of this, management decisions that rely on consensus-based, regional standards rather than science-based IFNs are less likely to protect river health.[11] It also increases the likelihood of being unable to determine what is causing environmental collapse when it occurs.[12] For these reasons, it is critical to assess IFNs scientifically, and to do so for all of Alberta's rivers.

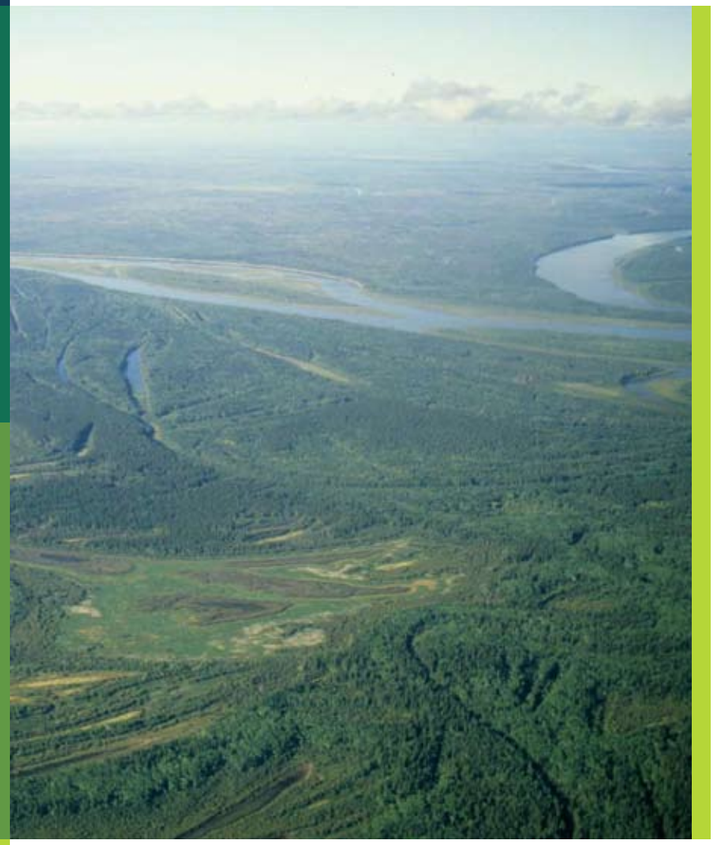
Management of Alberta Rivers Should Be Based on IFNs

IFNs and the importance of the protection and preservation of aquatic ecosystem health are recognized in Alberta's water laws and policies, but they have not been adopted as the basis upon which management decisions are made. For example, one of the explicit purposes of the *Water Act* is "to support and promote the conservation and management of water, including the wise allocation and use of water, while recognizing the need to manage and conserve water resources to sustain our environment and to ensure a healthy environment and high quality of life in the present and the future." [13] Under the *Act*, the management, planning, and taking part in decision making for water also is recognized as a shared responsibility of all Albertans, and the *Water for Life Strategy* affirms the public interest in healthy aquatic ecosystems.

The need for understanding IFNs permeates every aspect of integrated water resource management, and determining them scientifically is therefore recognized as the foundation of strong public policy, planning and management.[14] Understanding IFNs better ensures that water management decisions, and investments in water resource infrastructure that are seen as essential for economic development, are sustainable, such as for hydropower, urban water supply, food security and irrigation, flood, drought mitigation, and maintenance of healthy sport fisheries.[15]

In Alberta, there has been insufficient environmental assessment and monitoring to provide the information needed to understand IFNs. Because of this, the Alberta government has adopted what it calls the "Alberta Desktop Method" to determine minimum flows in most rivers, in hopes of providing fish with sufficient habitat and sustaining ecosystem services.[16] Unfortunately, this approach has been recognized as inadequate for protecting ecosystem services.[17] While various technical methods may be employed to determine ecological thresholds and IFNs, they have not been applied to most of Alberta's rivers. Local and regional assessments and monitoring must be performed to enable informed environmental flow management, if we want to sustainably manage rivers like the Athabasca that are not yet substantially impacted, or hope to reduce harm on rivers, like those in the South Saskatchewan River Basin (SSRB).[18] To do this, it is critical that gaps in scientific capacity in the Alberta government be filled to enable adequate monitoring, environmental impact assessment, modeling, and adaptive management planning and implementation.

Science-Based Decision Making is Critical for Water Management



The development of science-based IFNs and water management frameworks could happen more quickly by engaging expert scientists in the development of scientific environmental assessment and monitoring programs. Public and stakeholder consultation should identify the ecosystem services that are important to Albertans, as well as the best options and trade-offs to be pursued in implementing more sustainable water management strategies. Ultimately, Albertans may choose to sacrifice aquatic ecosystem health in return for increased short-term economic benefits. However, it is critical that Albertans and decision makers are fully informed about the risks, costs, and benefits associated with either protecting or sacrificing IFNs and healthy aquatic ecosystems.

Rather than developing specific frameworks for managing each river in Alberta, the Government of Alberta should develop and adopt a science-based, province-wide framework for decision making. As has been done elsewhere, this should include:

1. Classify Alberta's rivers and streams according to hydrological regime, based on land-use and environmental variables describing or contributing to ecologically relevant characteristics of a river's natural flow patterns.[19]

2. Develop and adopt new scientific frameworks for determining IFNs, so ecological and management standards for IFNs can be established, adopted, and enforced for all rivers at broad geographic scales, without having to "reinvent the wheel" for each river.[20]

3. Assess primary ecosystem process and function responses to changes in flow, such as riparian production and nutrient retention rates, rather than using periodic monitoring to provide a site- and time-specific snapshot of the quality and structure of aquatic communities, in hopes of tracking ecological change and inferring flow-dependence of many ecological processes.[21]

4. Determine ecological thresholds by pursuing original scientific studies and prescribed monitoring programs that identify relationships between individual ecological components and changes in flow or water quality throughout the full range of natural or disturbed river conditions. Ideally these studies would include ecosystem-scale experiments and monitoring, as well as studies that assess relationships between ecological components and changes in flow or water quality before, after and in the absence of various impacts. [22]

5. Design sampling programs that target sites across ranges of stream and river sizes, condition types, flow and water quality changes, and undisturbed to highly disturbed sites and systems, in order to test specific hypotheses on impacts of ecosystem change and identification of ecological thresholds.[23]

If our desire is to actually manage our rivers sustainably, then we have to support, develop, and implement substantial scientific monitoring and assessment programs that underpin effective water management frameworks. We also must combine water and land-use planning and decision making, and tie them to science-based assessments and management frameworks, to avoid arbitrary decisions that compromise ecological sustainability for short-term local political or economic advantage. This will demand a fundamental shift in Alberta, to a system that bases water and land management on long-term planning and scientific understanding and assessment of sustainability. It also would demand fundamental changes in provincial water management regimes toward those based on prescribed responses to documented changes in aquatic ecosystem health.

Operational Options to Enhance IFN-based Water Management

In rivers that are over-allocated, such as those within the SSRB, increases in river flows to more natural levels can be achieved via changes to operational water management that do not demand changes in existing laws and policies. Because unusually high or low flows introduce unique challenges to water management in Alberta, managers should develop and implement adaptive water management regimes that allow them flexibility in responding to those challenges. A variety of operational options are available to minimize harm caused by changes in water availability and enhance the ecosystem services that rivers provide us.

Permitting seasonal flexibility in the release or storage of water in reservoirs, and allowing operators to utilize full reservoir capacities, can lead to major environmental gains with little or no losses in hydropower or agriculture production.[24] For example, one unintended result of dams, which tend to even out seasonal flow patterns, has been the reduction in riverside cottonwood forests lining southern Alberta rivers. These forests not only provide habitat for rich communities in regions that otherwise would not have them, but also stabilize river banks and intercept and delay runoff, thereby reducing flood intensities and associated erosion. In 2011, high spring flows from heavy winter snowpacks in southern Alberta permitted water managers to pass more water through agricultural reservoirs in the region, so that high spring flood conditions could replenish cottonwoods along river edges. Such flexible river management approaches provide a hedge against the risk of serious and irreversible damage to aquatic ecosystems and the services they provide us.

Similarly, more flexible off-stream dam operations could be used to reduce withdrawals from southern rivers during critical low-flow periods in summer. This would result in proportional increases in dilution of pollution in rivers during late summer, and increase other ecological services that are dependent on increased flow. Further, this approach would be especially beneficial during hot years with low late-summer flows, when water temperatures rise and decreased cool-water habitat for fish can negatively impact fish populations.

As with off-stream reservoirs, the timing and speed of filling of instream hydropower reservoirs is generally subject to regulatory or operational limits and conditions that do not necessarily reflect changes in river flow. If hydro operators filled reservoirs earlier in the year, then downstream river flows in late July and August also would increase. If this technique were employed wherever safely possible, and hydro operators were compensated for the proportion of total power that is not generated because of rapid reservoir filling, it would dispel economic resistance to such changes. Such compensation could be considered the trade-off cost for increasing low summer flows in the downstream reaches of rivers. Given the value of ecological services in rivers — especially in the over-allocated SSRB — it is likely that this could be one of the cheapest ways to substantially increase summer river flows.

A third option for increasing flows in southern Alberta rivers involves improving irrigation canal efficiency and decreasing the minimum flow levels needed in the canals, thus allowing irrigation districts to reduce river water withdrawal rates. The potential for this approach is already being pursued with the installation of a single weir that may allow the Bow River Irrigation District to reduce its withdrawal rates from the Bow River in July and August by 5% of river flows in average summers and 13% in dry summers.

Recommendations to Enhance IFN-based Water Management

The absence of a policy in Alberta to protect rivers with science-based IFNs erodes river health that collectively benefits all Albertans. Without changing the way Alberta manages rivers, the Government of Alberta will likely be unable to achieve the goals of the *Water for Life Strategy* or satisfy the purpose of the *Water Act*, at least as they relate to managing the use, allocation, and conservation of water in ways that sustain and ensure a healthy environment for future generations.[25]

Identifying and implementing science-based IFNs are critical for long-term, sustainable economic development in Alberta, and ensuring wise, efficient, and effective water use and the provision of ecological services upon which we all rely. For this reason, we recommend the Alberta government implement the following recommendations:

Policy Recommendation

1. Develop and adopt a science-based Instream Flow Needs Policy that provides for rigourous scientific assessment of IFNs and dictates that river-specific IFNs shall be applied without exception in a "one-window" approval regime that encompasses all water allocation and water and land-use management approval decisions falling under the authority of the *Water Act, Environmental Protection and Enhancement Act*, and *Alberta Land and Stewardship Act* (*i.e.* IFNs become a critical aspect of all watershed frameworks and regional watershed and land-use plans).

Science Recommendations

1. Initiate determination of river health throughout Alberta, including connected groundwater sources and riparian zones that require peak flows, based upon a scientific assessment of ecosystem services and ecological thresholds.[26]

2. Identify IFNs for unclosed basins on the basis of ecosystem services and ecological threshold analysis, including connected groundwater sources and riparian zones that require peak flows. For the over-allocated SSRB, identify specific long-term goals for sub-basins to eventually achieve flows equivalent to scientific IFNs.

3. Outside the SSRB, apply interim precautionary IFNs determined according the Alberta Desktop Method.[27] Using a coherent scientific plan, develop a phased approach to define and implement science-based IFNs throughout Alberta, including connected groundwater sources and riparian zones that require peak flows. Establish a clear timeline for development and adoption of IFNs, and an adaptive management approach to continually assess the appropriateness of IFNs.[28]

Endnotes

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[9] Failing, L., G. Horn and P. S. Higgins, "Using Expert Judgment and Stakeholder Values to Evaluate Adaptive Management Options," *Ecology and Society* 9 (2004): Article 13.

[10] Poff, N. L. and J. K. Zimmerman, "Ecological Responses to Altered Flow Regimes: A Literature Review to Inform the Science and Management of Environmental Flows. *Freshwater Biology* 55 (2010): 194-205.

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[12] Bernhardt et al., "Synthesizing U.S. River Restoration Efforts," *Science* 308 (2005): 636-637.

[13] S. 2, *Water Act*, R.S.A. 2000, c. W-3 ("the *Act*").

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[16] Locke, A. and A. Paul, *A Desk-top Method for Establishing Environmental Flows in Alberta Rivers and Streams,* (Edmonton, AB: Alberta Environment and Alberta Sustainable Resource Development, 2011).

[17] Renöfält et al., "Effects of Hydropower Generation and Opportunities for Environmental Flow Management in Swedish Riverine Ecosystems," *Freshwater Biology* 55 (2010): 49–67; Arthington et al., *supra* note 34; McEachern, P. and B. Makowecki, *Water Management Framework: Instream Flow Needs and Water Management System for the Lower Athabasca River* (Edmonton, AB: Alberta Environment/ Fisheries and Oceans Canada, 2007).

[18] Poff, N. L. and J. K. Zimmerman, *supra* note 10, 194-205.

[19] Kennard et al., "Classification of Natural Flow Regimes in Australia to Support Environmental Flow Management," *Freshwater Biology* 55 (2010): 171-193.

[20] This would also initially involve classifying all rivers according to ecological integrity using a simple decision tree or key (*i.e.* as bad, poor, moderate, good, or high), and managing them according to standards to be applied to each class. See: Acreman, M. C. and A. J. D. Ferguson, *supra* note 7.

[21] Poff, N. L. and J. K. Zimmerman, *supra* note 10, 194-205.

[22] Ibid. Such studies should also include assessments of experimental flow releases in ecosystems that are substantially disturbed by damming and water withdrawal, because of the exceptional opportunity available in these systems to learn about the interactions between flow variation and environmental condition.

[23] Ibid.

[24] Bow River Project Research Consortium, *Bow River Project Final Report* (Alberta Water Research Institute, 2010), **http://www.albertawater.com/reports/BowRiverProject-FullReport-March2011.pdf** (accessed 9 March 2012). See also: Renöfält et al., *supra* note 17; Hughes, F. M. R. and S. B. Rood, "Allocation of River Flows for Restoration of Floodplain Forest Ecosystems: A Review of Approaches and Their Applicability in Europe," *Environmental Management* 32.1 (2003): 12-33; Kalischuk, A. R., S. B. Rood, and J. M. Mahoney, "Environmental Influences on Seedling Growth of Cottonwood Species Following a Major Flood," *Forest Ecology and Management* 144 (2011): 75-89.

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[27] Locke and Paul, 2011, *supra* note 16.

[28] *Supra* note 26.

Water Matters

As Alberta continues to chart its water management path, strong leadership from an independent non-governmental organization with expertise and resources dedicated to province-wide watershed protection is vital. Established in October 2007, Water Matters is a champion for watershed protection in Alberta.

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