GREAT LAKES PROTECTION FUND

Report on a meeting of the
Water Resources Roundtable

November 13, 1998

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In November 1998, the Great Lakes Protection Fund convened a group of experts to discuss how to improve the ecological integrity of the basin by restoring the physical dynamics of water resources in the Great Lakes Basin. The discussion focused on five topics: opportunities for further ecological improvement of the Great Lakes ecosystem; using natural flow regime as a central principle in carrying out restoration projects; activities currently underway; the range of further scientific, citizen, and policy activities necessary to achieve ecological objectives; and the funding opportunities. The meeting began with introductions and followed a format of short presentations and open discussion.

This following synopsis is intended to capture the spirit of that discussion, supplemented by summaries of background materials and results of follow-up conversations. It raises a lot of basic questions about the dynamics of water resources—lake-level fluctuations, groundwater flow, surface water runoff, etc.—but primarily uses flow regime as it pertains to tributaries as the forum for discussion. It is not an all-inclusive transcript of the meeting and may not capture all of the views of all of the participants. The Fund did not seek, and does not wish to imply, that the following represents the consensus opinion of the group.

Opportunities for Ecological Improvement

The timing is right for addressing the dynamic physical nature of water resources in the Great Lakes basin. Over the past several decades, water quality management has been largely focused on chemical pollution and clean-up. "The focus on clean-up over the last 30 years has improved the cleanliness of parts of the system, allowing us to broaden our perspective to regional and systemic regimes," said George Francis of the University of Waterloo, in his opening comments.

In addition, Francis noted that, traditionally, Great Lakes water quantity management has attempted to reduce the extreme effects of natural phenomena such as flooding and lake level fluctuations. However, natural systems are dynamic and their healthy functioning depends upon the variability of a wide range of conditions. Land managers and scientists today have an unprecedented opportunity to realize systemic improvements through strategically designed local projects that restore natural flow regimes, such as the flow of water through a system.

Historically, attention has been more focused on restoring the biological and chemical components of aquatic resources than on the physical component. Addressing the physical parameters of a system and allowing it to respond naturally is an economically and ecologically efficient approach to restoring ecological integrity. "We have to think in terms of restoring functionality," noted Scudder Mackey, Coastal Geologist with the Ohio Department of Natural Resources (ODNR), "Geology and hydrology set the stage for everything else."

One of the biggest challenges to address in restoring naturally functioning water systems is that there is no common vision of ecological integrity for the Great Lakes ecosystem. As a result, goals are not clearly defined, making it difficult to prioritize activities and budgets. For example, Joseph Koonce, of Case Western Reserve University, noted that scientific goals for aquatic systems have been largely driven by limnologists with an emphasis on off-shore habitat and sediment. Our understanding of the more dynamic nearshore habitat is extremely limited.

Goal setting is further complicated by the limited understanding that we have of how the system functions as a whole. "Because efforts have been focused more on structure and components, than on function and process, landscape-level goal setting efforts get bogged-down quickly when you start to think in terms of the bigger system," said Koonce, "it reveals how little we understand the underlying problems."

However, participants felt strongly that the incomplete data and understanding of aquatic ecosystem functions is not an excuse for not acting. Adaptive management—where new questions are asked, innovative approaches are tested and ecosystem goals are articulated—will lead to both a healthier and better understood Great Lakes ecosystem.

Framework for Ecosystem Restoration

Terrestrial resource management and planning that preserves and restores ecosystem processes and functions (biological, chemical and physical) at the landscape level is an excellent model for aquatic systems. The flow-regime paradigm provides a framework for integrating the biological and chemical aspects of water resources with a dynamic physical aspect. Participants were encouraged that aquatic ecologists are beginning to borrow from their counterparts working in terrestrial landscapes and viewing all connectivity—water, biota and materials—in a natural flow regime paradigm.

Flow Regimes Organize and Define Aquatic Systems

Physical processes organize and define aquatic systems and significantly influence the biological and chemical elements of a system. In rivers and coastal environments water drives the movement of materials and biota and is the primary factor in how they interact. Rivers and coastal environments, in turn, are the biological "engines" of the Great Lakes. The flow regimes—the natural dynamic character of flowing water systems—of the basin's tributaries can be thought of as "master variables" that control their ecological integrity.

The magnitude, timing, duration, frequency and rates of change of water movements within a watershed make up its flow regime. These factors, in turn, control how materials, energy and biota interact in stream, river and lake environments. In the Great Lakes basin, these fundamental master variables have been altered by physical modifications such as dams and levies and by changes in land use. Water, biota and materials enter and move through the waterways at different times, at different rates, and in different amounts than they have historically because of the significant changes in the watershed they drain. The discussion focused primarily on three facets of a system's flow regime—magnitude, duration, and rates of change.

The magnitude of flow is the amount of water moving past a point, per unit of time. Magnitude is a significant factor in determining the depth and width of a tributary and the amount of material entrained in the water. All moving water carries material—and the amount of material that can be carried varies with magnitude. When the magnitude increases, so does erosion. As magnitude decreases, materials begin to settle out and sedimentation occurs.

The duration of flow is the time period associated with specific flow conditions. Alteration of natural flow regimes generally results in higher flood frequencies and shorter flood duration. Duration of is a significant factor in determining the stability of a system. Flow events maintained for short periods result in highly dynamic systems while flow events maintained for longer periods result in relatively stable conditions.

The rate of change in flow events is a measure of how quickly flow magnitude changes in a system. A system with a high rate of change is considered flashy, meaning that it moves from a low magnitude to a high magnitude of flow (or vice versa) in a short period of time. Flashy streams also exhibit high peak discharges and short flood durations. Such systems are subject to scouring, flooding, and other extreme disturbances.

Flow Regimes in Great Lakes Systems Have Been Altered

In the Great Lakes basin, the natural flow regime has been significantly altered by changes in land use, water withdrawals, and structures such as dams and levies. Agricultural conversion and urban development have caused higher peak flows, increasing the amount of sediment movement in the stream, and ultimately disrupting the geomorphology of the channel and flood plain. "Land use in 'plain old America' has had a significant effect on the magnitude and flashiness of flow," said Brian Richter, Director of the Nature Conservancy's Freshwater Initiative. Nearly every use of water—residential, industrial and agricultural withdrawals from surface and ground waters—has the potential to alter the flow and material regimes of basin waters.

Dams with the primary function of flood control have the effect of locally reducing the overall variability in flow while those built for power tend to locally increase the variability of flow over short time frames. In both cases, dams create barriers that stop the flow of sediments and other materials required for healthy aquatic systems. Additionally, dams can fragment aquatic habitat, separating sections of tributaries from one another and from the open water of the lakes. Such fragmentation eliminates the longitudinal movement (or flow) of biota and can bury valuable fish spawning habitat.

In the 1997 State of the Great Lakes Annual Report, the Director of Michigan's Department of Natural Resources made the point that, "Much of the habitat needed to support reproduction of Great Lakes fish is buried behind dams…for example…it is estimated that removing or providing fish passage around the lowermost dams on the Muskegon River would result in enough salmon reproduction to support most of Lake Michigan's Chinook salmon fishery."

The Natural Flow Regime Paradigm is a Powerful Concept

Natural flow regime is an excellent concept for understanding how a river system operates in space and time, and is likely to help frame new solutions to old problems. It requires managers and scientists to acknowledge that the river is connected laterally to surface runoff from the surrounding watershed, vertically to the aquifers and other groundwater resources, and longitudinally to its upper and lower watersheds (and eventually the Great Lakes). Any physical changes in these spatial features, say an increase in impervious surfaces in the surrounding watershed, will cause changes in the temporal aspects of the river's flow regime—in this example, an increase in the rate of water entering the river after a precipitation event. Understanding that land use changes in a watershed disrupt critical aspects of flow regime may lead to new actions to improve the ecological health of the system.

Understanding how changes in the temporal aspects of a system's flow regime cause structural changes to the system may be even more powerful. Increases in sediment load due to alteration of the flow regime are not due to the simple addition of man-made substances into the system but rather are due to fundamental changes in the energy of the system. Certain forms of non-point source pollution such as sedimentation may be better understood as an artifact of altered flow regime. Pollution control programs are designed to control what enters the system, not to control or alter the energy of the system. Solutions to some non-point source pollution problems may actually be simple plumbing fixes, not expensive or intrusive pollution control programs.

The group also discussed how to view the differences between the flows of water, the flows of materials and the flows of biota. While some participants thought that biological connectivity was a separate topic, others believed that when biological, hydrological and material connectivity are thought of in terms of flow, the flow-regime paradigm becomes much more powerful because it makes one think about how different aspects of a system are connected.

Participants cautioned the Fund to seek incremental gains rather than to expect a return to pre-settlement conditions. While, in theory, it might be useful to frame management goals in the context of recreating an unaltered, natural flow regime, practically implementing such conditions may be impossible. "The reality is that there are a lot of human interactions," said Richter, "so the question is really, how to approach a *naturalized* flow regime". It is important not to jump to the conclusion that the desired goal is to restore pristine conditions, warned Mark Bain of Cornell University, "we *can* make incremental ecological gains". Such gains may be more than additive—incremental progress in several key places could be truly synergistic, collectively yielding results greater than the sum of the individual actions.

Current Restoration Activities

Participants noted that they are beginning to see changes in traditional approaches to water resources management. In the past we have sought "hard" engineering solutions such as dams, levees and rip rap. The new field of ecological engineering seeks more "natural" solutions such as wetland creation and restoration. "What we are seeing emerge is soft engineering on hard substrates," said John Gannon of the U.S. Geological Survey's Great Lakes Science Center. Participants also noted that newly re-issued operating licenses for basin hydro-electric facilities are addressing the restoration of biological and hydrological flows. The flow regime paradigm could help to reframe the issues and lead to innovative solutions.

Aquatic Conservation Sites

The Nature Conservancy has identified over 500 sites for the conservation of representative aquatic habitats in the Great Lakes basin. "To ensure that we protect ecological and evolutionary processes and interactions," said Jonathon Higgins, of The Nature Conservancy's Great Lakes Program, "it's essential to characterize and map distinctive portions of tributaries including representative assemblages of species, hydrology and land use."

The sites have been ranked qualitatively based on characteristics such as land use/buffer analysis, water quality, shoreline modifications and the health of native aquatic populations. "Generally we found that the northwest portion of the basin has large, intact areas while the southeast portion of the basin is fragmented," said Higgins, "What we see as a result is preservation activities in the northwest and restoration efforts in the more developed and populated southeast portions of the basin".

"The map identifies a constellation of representative sites for protection," noted Higgins, "coastal wetlands, sandy shorelines, lake plain systems and large river systems". While the level of degradation varies among sites, there are few, if any, systems that have not been degraded to some degree. In fact, there are no intact examples of lake plain systems and all the large river systems have been highly altered by dams and levies.

The 1998 State of the Lakes Ecosystem Conference (SOLEC) identified a number of candidate aquatic biodiversity investment areas (BIA) in the Great Lakes Basin. The candidate sites support critical habitat for a number of species, are important to lake-wide biodiversity, and regulate structure and productivity of the lake ecosystems. As a point of entry, Francis urged participants to think about the "flip side" of the Areas of Concern. "Think about biodiversity investment areas as an entree and run up the watershed," he said.

Freshwater Initiative

The Nature Conservancy's Freshwater Initiative is a five-year, national effort to link water and land conservation efforts in key watersheds. The Initiative was founded on the principles of education, partnership, and catalytic success. "It is important to integrate land and water efforts for the greatest benefit," said Helen Taylor, Director of the Nature Conservancy's Great Lakes Program. The idea behind the Initiative is to create place-based learning networks at critical habitat sites. Thirty-eight watershed projects, 19 focusing on hydrologic alteration and 19 focusing on non-point source pollution, have been selected across the country.

The project's adaptive management approach will test new hypotheses about aquatic function and restoration. In monitoring and evaluating the success of the projects, it will be important to identify representative assemblages of species and to identify "signature" species, such as brook trout, that serve as indicators of functioning systems.

Dam Removal and Sediment Management

Sara Johnson of Trout Unlimited reported that the River Alliance's dam removal demonstration project in Wisconsin revealed the strong social attachments that people have to dam structures, and identified a huge gap in understanding and in information relating to the real costs and benefits of dam removal. "People have deep, deep emotional attachments to the pond or to the structure," Johnson emphasized, "they grew up boating, fishing and swimming there." Because of the attachment that individuals have to the structures—and to the status quo—it is critical to work at the local level to build public understanding and support for a project.

"Economics and aesthetics rank highly with the public but the health of the river is a low priority," she said, "people don't understand the ecological and economic value of a functioning river system." In addition, people don't realize that dam removal is often less expensive than repair. In fact, repair costs are generally three to five times higher than removal costs.

Beyond the social challenges, Johnson identified cost effective sediment management and reclamation of riparian areas as significant challenges. She cited several projects where sediment management alone would cost over $1.5 million, with approximately half of that earmarked for baseline monitoring and evaluation. A cost-effective alternative to the traditional approach of mechanically removing sediment may be to allow the sediments to disperse naturally by gradually notching the dam over a number of years. This incremental approach also allows those sediments that don't disburse to compact and stabilize. Cost estimates for dam removal, including sediment management are typically less than $100,000 for small structures.

In addition to the economic advantages of notching dams, Mackey cited benefits such as reduced hazard potential, lower regulatory thresholds, and incremental riparian habitat restoration that allows for more effective exotic species control. Notching a dam can lessen the hazard potential by relieving stress on the structure and reducing the amount of water held behind the structure. Lowering the retention capacity of the structure will also often cause it to be reclassified by the agencies, meaning fewer regulations and requirements.

However, Mackey warned that in many cases, large loads of sediment are released due to dam removal operations. "It is important to protect spawning and other habitat downstream," he said.

Other basin dam removal activities involve state agencies, and national and local environmental organizations. Sharon Hanshue, of the Michigan Department of Natural Resources, announced that her agency is looking for dam removal projects that make sense from environmental and social perspectives. The National Fish and Wildlife Foundation's Dams and Rivers project is supporting Trout Unlimited and municipalities in dam removal projects in the basin.

Margaret Bowman of American Rivers, reported that they are working collaboratively with the Hydropower Reform Coalition, the hydropower industry and other interested parties to improve operations at 70 active hydropower dams throughout the Great Lakes basin to rehabilitate the health and sustainability of the system. The Coalition's efforts are helping to bridge the scientific and institutional gap between river and lake conservation in the Great Lakes region. Through the cooperative relicensing process, the Coalition is helping to ensure that both river protection and hydropower production needs will be met in the future.

Needs and Information Gaps

Participants noted that the current activities discussed above reflect an issues approach in practice. There is not over-arching agenda linking them as a unified body of work and no framework in place to disseminate the results and share the lessons learned. Participants also identified further information, tools, and permitting needs necessary to effect change in the way Great Lakes waters are managed. At the same time, participants emphasized the need for adaptive management so that the principles of flow dynamics are being implemented and tested as more data is gathered and analyzed and as models are developed.

Scientific Information and Research

It is important to build strong scientific baselines and models and to make the data accessible to policy makers and managers. "We need to document the linkages between the physical and biological," said Mackey. Paul Seelbach, of the University of Michigan, agreed that there is a lot of basic science and inventory work that is needed. He noted that much of what is assumed about basin hydrology is, in fact, based on models and not on actual data.

Take for example USGS stream gauge data. A lot of information has been collected from the gauges that has not been utilized. "We haven't even begun to mine that information," said Seelbach "and many of the gauges are being closed down." In fact, he said, additional groundwater monitoring may be needed as we begin to view groundwater and surface water as a single resource. In another example highlighting the need for more scientific research and baseline development, the Great Lakes Fishery Commission's management goal setting was hindered when they discovered that basic inventory data just didn't exist. As a result, they were forced to set management goals based on very limited information.

Tools for Practitioners

However, said Tim Eder of the National Wildlife Federation, "it's not enough to access data--we need real tools." For example, he emphasized that sediment routing models of downstream impacts are needed as well as resource benefit models, and process models. Johnson agreed, adding that both economic cost/benefits models for various strategies and resource benefits models for dam removal would be extremely useful.

Participants agreed that a technical clearing house for information, a "how to guide" for local communities, and training workshops for managers and decision makers would be helpful in supporting local land use decision makers that don't have the tools and background to incorporate ecological objectives into their decision-making processes. Most local drainage decisions are made by county soil and water districts whose mandates are not focused on restoration of natural flow regimes.

Permitting

Current permitting and management strategies largely focus on reducing variability in the quantity and timing of water movements—in effect attempting to manage the resource into a more static state—when, in fact, healthy natural systems are dynamic and depend on variability for their long-term survival.

The current regulatory framework issues permits that allow for changes in land use and loss of habitat—essentially permitting the destruction of habitat. "We need to rethink the way permits are issued," said Koonce, "The problem is, that decision makers do not have a larger system concept to *deny* permits." Ultimately, what is needed is a different decision making structure that sets a new standard of ecosystem improvement. The current permitting system of approving small individual projects without considering their cumulative effect or their systemic impact can not result in anything other than environmental degradation.

Financing Dam Removal

Ecological restoration was not envisioned by the regulatory process—making financing the removal of dams for ecological restoration a particularly important issue. Reclassifying or exploring creative uses for existing funds may be the most efficient route for securing financial resources for dam removal. There may be opportunities for new partnerships and alliances. For example, "some people look refuges and diked wetlands as villains," said Bain, "there's got to be a way that what's good for ducks can be better for other things." In addition, there may be strategic ways to tap into flood recovery funds, Farm Bill funds, hydropower mitigation funds and other government and philanthropic sources of support.

The Role of the Great Lakes Protection Fund

Participants were asked to help define programming opportunities for the Fund in soliciting innovative demonstration projects that improve the ecological health of the aquatic resources of the Great Lakes by restoring the physical hydrology of the environment. Participants not only offered input on specific types of projects that the Fund should consider and guidance on how the Fund could handle the award process, but also identified a suite of funding opportunities that others could support as well.

Project Strategies

There are numerous restoration opportunities associated with creating more natural flow regimes in the Great Lakes basin. In fact, because of the connectivity of the basin's aquatic systems, a few smart actions in key locations could yield tremendous ecological return. In addition, the highly altered nature of the basin's aquatic ecosystems provide numerous opportunities for restoration.

Using a flow-regime framework to organize thinking about water resources and restoration projects in the Great Lakes leads to real solutions. Management responses in the past have often been to the symptoms of alteration not to the alterations themselves. For example, the management solution to the decline and collapse of native fisheries has been to raise (native and non-native) fish in hatcheries for release into the waterways. A flow-regime framework leads one to the solution of repairing spawning habitat—its physical habitat qualities and its connectivity to the system—so that ecosystem function, not simply fish populations, is restored.

Non-point source pollution control efforts have largely focused on sediment input as a pollutant. In fact, when viewed in a flow regime framework, sedimentation—both erosion and deposition—can be thought of as a water problem, not as a sediment problem. Changes in historical sedimentation loads reflect an altered system that is no longer capable of transporting sediments appropriately because water is moving through the system at different rates and at different times. Although some changes in sedimentation can be attributed to land use practices, most sedimentation is from in-stream erosion.

Programs presently in place for addressing increased sedimentation are invested in highly erodable lands and focus on created wetlands, filter strips and minimizing impervious areas as solutions to the problem. However, solutions targeted at land-use practices that accelerate stream flashiness and impact aquifer recharge have systemic effects and have an impact beyond the local project area.

There may also be opportunities to link these concepts to shortfalls in the current regulatory framework. For example, there may be a real opportunity for states to use water quantity in the Clean Water Act total maximum daily load (TMDL) efforts.

Participants identified several types of projects where Fund support would be key in helping to demonstrate the concepts discussed. Dam and structure removal or modifications were high on the list as were creative projects that address drainage issues and groundwater recharge on agricultural lands and in suburban developments.

Strategies for Award

The discussion on the Great Lakes Protection Fund supplemental request for proposals had, as its starting point, the question between the difference of "what you ask for" and "what you fund." Participants did agree that it is important to support projects in a way that enhances our ability to inform larger ecosystem issues. However, there was much discussion as to whether that meant requesting a closely related group of projects that would give a tight data set or a wide range of projects that would better cover the range of possibilities.

Allegra Cangelosi, of the Northeast Midwest Institute, suggested that the Fund strategically select a number of small projects that "tack down the big picture of flow regime" so that people can begin to see what the principles look like in practice. Richter agreed that investing in site-specific projects is the "absolute best thing to do" and offered suggestions for gaining the most benefit from that approach. He suggested looking for efficiencies such as funding a hydrologist to assist several projects. In order to link the lessons learned to research, technical information and policy, it will be important to have someone synthesize the whole of the information learned from the projects.

It is important to get results to a level where people can make informed decisions. Participants suggested that the Fund look for projects with opportunities to link substrate to biota, that focus on connectivity issues, that will serve to educate the community, that employ strategic thinking, that work from a watershed basis, that deal appropriately with exotics, and that will build capacity.

Other participants noted that the process of ecosystem restoration will take a number of years and that it is important to make provisions for long-term monitoring and evaluation in the grants. All agreed that it would be extremely useful for the Fund to facilitate another forum for continued discourse on the topic.

Conclusions

A flow-regime paradigm for aquatic ecosystem restoration in the Great Lakes forces one to confront tough issues, to formulate and articulate ecosystem goals and to think about *why* certain actions are being undertaken. It raises questions—How do we restore the physical environment so that it supports the biology? And what about the biology? What species do we consider naturalized? What species do we consider nuisance? At what cost (ecologically) do we control them? How do we address the unequal benefit of public subsidies?—that are not answerable from a scientific position, and not solvable from a social values position.

In employing a flow-regime framework for aquatic restoration, uncomfortable choices have to be considered and difficult decisions have to be made—but they are choices and decisions that are essential to making any real progress in ecosystem restoration. We can't afford to wait for unified field theory or consensus because we will never, as a society, reach agreement on these issues.

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