SPECIFYING WATER FLOW REQUIREMENTS TO SUPPORT RIVER HEALTH

Brian D. Richter[1], Judy L. Meyer[2], Kim Lutz[3] and Andrew Warner[2]

AUTHORS: [1]Freshwater Initiative, The Nature Conservancy, 490 Westfield Road, Charlottesville VA 22901; [2]Research Professor, Institute of Ecology and River Basin Science and Policy Center, University of Georgia, Athens GA 30602-2602; [3]South Atlantic Conservation Manager, The Nature Conservancy, P.O. Box 9391, Savannah GA 31412.

REFERENCE: Proceedings of the 2003 Georgia Water Resources Conference, held April 23-24, 2003, at the University of Georgia. Kathryn J. Hatcher, editor, Institute of Ecology, The University of Georgia, Athens, Georgia

Abstract. Water managers, scientists and conservationists around the world are now exploring ways to meet human needs for water while keeping river ecosystems healthy. This requires identifying the amount and timing of water flows that must remain in rivers to sustain their ecological health. This is a challenging scientific endeavor, because river flow influences a large variety of plants and animals living in the river and in floodplain or estuarine areas. River flows shape their habitats both directly and indirectly, because water flows influence water quality and temperature, the physical character of a river and its floodplain, and interactions among species. Thus, the process of developing flow recommendations requires input from scientists of many disciplines. This paper provides an overview of a consensus-building process designed to produce an inter-disciplinary recommendation for river flow management that is being applied on the Savannah River below Thurmond Dam as a test case.

INTRODUCTION

Water is in short supply in many parts of our planet. As the human population has increased, human demand for fresh water has grown. The human demand is often met with little regard to the degradation of aquatic ecosystems. As more people have recognized the valuable services provided by healthy freshwater ecosystems, new approaches are being explored to meet human needs with less damage to aquatic ecosystems (Baron et al. 2002).

In South Africa, scientists are working with water managers to define how much water is needed by a healthy river ecosystem using an approach termed the "Building Block Methodology" (King et al. 2000). The river's natural hydrograph is characterized and data are assembled on how species and ecological communities require or are impacted by different flows. In a workshop setting, this information is used to determine water needs for low flow periods and frequency, duration, and timing of flood events. These building blocks are assembled as a set of flow targets that can be used by managers.

A modification of this approach is being explored in Australia, where "Benchmarking Methodology" is being developed (Brizga et al. In Press). In this approach, scientists are asked to identify the extent of flow alteration at which significant ecological change can be detected. This involves rating the condition of a suite of variables (e.g. vegetation, fish populations) at several sites along the river using a scale from "near natural" to "very major modifications from natural." The ratings are compiled and used to determine the level of hydrologic alteration at which ecological alterations become significant.

In this paper we outline a process that is being used in Georgia and elsewhere in the US to establish ecosystem flow requirements. Dams have been constructed to satisfy human demands for electricity, flood control, navigation, and water storage capacity. One mechanism for reducing the impact of dams on downstream ecosystems is to modify the schedule on which water is released to meet the flow requirements of essential components of the ecosystem and to more closely mimic the natural hydrologic regime (Poff et al. 1997). The first step in this process is to identify the hydrologic regime that will sustain a healthy ecosystem, what we are calling "ecosystem flows."

OUTLINE OF AN APPROACH FOR DETERMINING ECOSYSTEM FLOWS

The process of determining ecosystem flows requires quantifying ecosystem requirements based on best available scientific information and best professional judgement of a group of scientists and managers familiar with the river of interest. The following approach is one that is being applied by the Nature Conservancy in several rivers including the Green River in Kentucky and the Savannah River (below Thurmond Dam) in Georgia and South Carolina, which is discussed in greater detail in the next section. The first three phases of this process are described below.

The first phase consists of preparing for and conducting a meeting of a diverse group of key stakeholders and experts with local knowledge of the river. These individuals can come from agencies (e.g. involved in river management), institutions (e.g. academicians doing research on the river) and organizations (e.g. conservation organizations and consulting firms) associated with the river. The purpose of the meeting is to engage this group in the process of determining ecosystem flow requirements and to identify relevant data sources. An analysis of the manner in which flows have been altered in the river provides useful background information for this meeting. This information should include output from Indicators of Hydrologic Alteration (IHA) (Richter et al. 1996) that shows which flow parameters have been most altered as well as daily hydrographs representing typical wet, average, and dry years for pre- and post-impact periods. Meeting discussions should focus on the state of scientific knowledge about the river ecosystem and determination of the process and timeline for determining ecosystem flow requirements.

The second phase includes preparation of a report that summarizes current understanding of the system's biota as it relates to the natural flow regime. This is followed by a workshop in which this information is used to develop flow requirements that meet ecosystem needs, taking into account requirements and tolerances of the biota and ecosystem processes related to flow, such as channel dynamics, riparian succession, and nutrient transport. The report should identify species of concern, critical life history stages, and how they are related to flow. It should also characterize the natural flow regime for wet and dry years by showing baseflow averages by month as well as duration, timing and frequency of extreme low flows, 2-10 year floods, and rarer floods. Another component of the report is a conceptual diagram illustrating the linkage between critical ecological processes (e.g. spawning, channel formation) and flow. Workshop participants are expected to be familiar with the report and are asked to refine the conceptual model, develop an initial set of ecosystem flow requirements, and prioritize a list of research needed to improve the flow requirements.

The third phase consists of further technical assessments to refine the flow recommendations and fill in the information gaps noted in the previous phase. An important aspect of this phase is development of a monitoring plan and initiating monitoring before dam re-operation begins.

DETERMINING ECOSYSTEM FLOWS IN THE SAVANNAH RIVER BELOW THURMOND DAM

A Savannah River Basin Ecological Flow Workshop was held in May 2002, beginning the first phase of the process described above. In attendance at this workshop were 50 individuals from state agencies (Georgia and South Carolina Departments of Natural Resources), federal agencies (Fish and Wildlife Service, Geological Survey, National Marine Fisheries Service, Army Corps of Engineers), academia (University of Georgia, Georgia Southern University), consulting firms, and conservation organizations (The Nature Conservancy).

After introductory presentations outlining the need for ecosystem flow requirements and the process described above, the group divided into four subgroups: diadromous fish, floodplain systems, riverine fishes and mussel species, and hydrology and water policy. During breakout sessions, each subgroup: identified the relevant research that has been conducted and data gaps; discussed the relationship between flow and important life stages of species within the ecosystem; and discussed which contributors were needed to make this process successful on the Savannah and what steps are needed. The product of this workshop was a summary document listing potential sources of information, individuals to contact, and suggestions for steps that needed to be taken.

We are currently in Phase 2 of the process. A group of faculty and students at the University of Georgia has investigated the data sources identified in the workshop as well as others and prepared an annotated bibliography of over 375 references. These include papers, reports, and on-line data on hydrology and water quality, floodplain processes, aquatic biota, and estuarine processes. The subsequent presentations in this session present some of the findings from this research. These findings have been incorporated into a summary report that will provide the background for a second workshop being held in early April 2003. The proposed ecosystem flow requirements for the Savannah River below Thurmond Dam that were developed at that workshop will be presented in the final paper in this session.

ACKNOWLEDGEMENTS

We thank the Army Corps of Engineers for providing funding for the Savannah River ecosystem flow project.

LITERATURE CITED

Baron, J.S., N.L. Poff, P.L. Angermeier, C.N. Dahm, P.H. Gleick, N.G. Hairston Jr., R.B. Jackson, C.A. Johnston, B.D. Richter and A.D. Steinman. 2002. Meeting ecological and societal needs for freshwater. *Ecological Applications* 12: 1247-1260.

Brizga, S.O., A.H. Arthington, B.J. Pusey, M.J. Kennard, S.J. Mackay, G.L. Werren, N.M. Craigie and S.J. Choy. In Press. Benchmarking, a top-down methodology for assessing environmental flows in Australian rivers. *River Research and Applications*.

King, J.M., R.E. Tharme, and M.DeVilliers (editors). 2000. *Environmental Flow Assessments for Rivers: Manual for the Building Block Methodology*. Pretoria, South Africa: Water Research Commission.

Poff, N.L., J.D. Allan, M.B. Bain, J.R. Karr, K.L. Prestegaard, B.D. Richter, R.E. Sparks and J.C. Stromberg. 1997. The natural flow regime: a paradigm for river conservation and restoration. *BioScience* 47: 769-784.

Richter, B.D., J.V. Baumgartner, J. Powell and D.P. Braun. 1996. A method for assessing hydrologic alteration within ecosystems. *Conservation Biology* 10: 1163-1174.