The Nature Conservancy

Protecting nature. Preserving life.™

The Nature Conservancy and Environmental Flows

Background

Founded in 1951, The Nature Conservancy (TNC) has grown into a leading conservation organization with more than one million members. Its more than 3,500 staff work around the world to protect ecologically important lands and waters for nature and people.

Worldwide, we have protected more than 47 million hectares of land and 10,000 kilometers of rivers, and we operate more than 100 marine conservation projects. Our work in more than 30 countries spans five continents across a variety of habitats from grasslands to coral reefs. Our conservation efforts focus particularly on climate change, fire, freshwater, forests, grasslands, invasive species, and marine ecosystems.

We owe our success to a science-based approach that is non-confrontational and offers pragmatic, science-based solutions to conservation challenges. Our philosophy is to work together with every group affected by a conservation decision. We recognize that we all share the Earth and that for solutions to succeed they must be inclusive, embracing the concerns of indigenous communities, businesses, governments, international financial institutions, community-based organizations, and non-profits alike.

This is a critical moment in the state of the world's environment, and the Conservancy is using its knowledge, networks, and 57 years of experience to stem the tide of our most pressing conservation threats and challenges.

The Nature Conservancy has worked for decades on freshwater conservation and invested heavily in more than 500 freshwater sites around the world. Today, as a result of our capacity, expertise, and real-world field experience, the Conservancy has emerged as a leading global freshwater conservation organization. One of the areas where our leadership is particularly significant is in the arena of environmental flows.

This document was developed at the request of The World Bank to document the Conservancy's experience in environmental flows specifically. To help others implement this cutting-edge work on environmental flows science and policy, Conservancy scientists and policy specialists provide tools, training, guidance, and information (as described below), and they continue to develop and refine new methods for protecting freshwater habitats.

Conservancy staff work with water planners and governments to determine the water flows and fluctuations needed to sustain river and lake ecosystems so that appropriate environmental flow standards can be implemented in water allocation programs. Conservancy scientists are continually advancing scientific methods for determining environmental water needs in

individual river basins, as well as developing guidelines for water allocation when detailed studies cannot be conducted immediately. Conservancy policy specialists engage with governmental agencies and others to mainstream environmental flow policies into the water sector.

The Conservancy strives to demonstrate that human needs and prosperity can be fully realized while maintaining the health of freshwater ecosystems. To achieve this balance, ecosystem water needs must be fully integrated into water planning and management and this integration can only occur if water managers understand and are a part of the process to define environmental flow needs. Partnering with the water management community is one of the Conservancy's greatest strengths. Through our projects, we collaborate directly with water managers – including urban water suppliers, irrigators, and dam operators – to help them meet their commitments while also providing the river flows and lake levels necessary to support functioning ecosystems. The Conservancy's partnerships are critical to the success of this global effort and include alliances with the U.S. Army Corps of Engineers, U.S. Geological Survey, numerous state and national governmental agencies in the United States, the national electric energy utility of Honduras, the World Bank, World Wildlife Fund, the Global Water Partnership and many other entities.

Environmental Flows and Dams – Demonstration Projects

Working with partners and stakeholders, Conservancy staff in our 50 state and 30 country programs have defined, protected, and restored environmental flows at hundreds of project sites. Applying the lessons learned from our demonstration projects, collectively we have accumulated extensive experience in developing and implementing environmental flow prescriptions in a vast range of ecological, hydrological, social, and political settings. These applications, in turn, inform and refine the methodologies we develop, demonstrate, and disseminate.

United States—Sustainable Rivers Project

One of the paramount conservation challenges we face is to manage dams to maintain the ecological health of our rivers while meeting the needs of a thirsty and growing world. This is a global challenge not of the future, but of today. Moreover, with more than 5,500 large dams and tens of thousands of smaller ones, it is an acute problem in the United States, where only 2% of rivers remain free flowing.

Faced with these circumstances, The Nature Conservancy began working with dam operators to modify how and when water is released in order to restore and protect hundreds of river kilometers and thousands of associated hectares of land and wetlands. The largest such effort is the Sustainable Rivers Project, a collaboration between The Nature Conservancy and the U.S. Army Corps of Engineers. The Project – launched in 2002 – includes demonstration sites, joint training and software development, staff exchanges and meetings, and joint publications and communications. Work at demonstration sites involves defining and implementing environmental flows through adaptive reservoir management that relies on close collaboration between water managers and scientists. These sites currently encompass 26 dams in 13 states

across the U.S. (see map below). Lessons learned are to be exported to the more than 600 dams owned by the U.S. Army Corps of Engineers.

The Nature Conservancy
SAVING THE LAST GREAT PLACES ON EARTH

Sustainable Rivers Project

Current Demonstration Sites

US Army Corps of Engineers®

The Nature Conservancy and U.S. Army Corps of Engineer efforts to answer the question "How much water does a river need?" at the Savannah River site began in April 2003, when the two organizations convened a workshop with more than 50 leading scientists from the Georgia and South Carolina state governments, federal agencies, academic institutions and other non-governmental organizations. Using existing data, the team defined the seasonal water flows needed to support the freshwater, floodplain and estuarine ecosystems. Based on this information, they devised a flow prescription – a plan for executing a series of seasonal controlled releases designed to rejuvenate more than 320 river kilometers, 28,000 hectares of bottomland hardwood forests and 8,000 hectares of estuary. In March 2004, the flow prescription was put to the test with the release of the first controlled flood from the lowermost dam (Thurmond Dam) on the Savannah River. The timing and the duration of the water releases are designed to more closely mimic natural seasonal flows that existed prior to the dams. Several controlled floods have since been orchestrated. Scientists are continuing to measure the ecological responses to the controlled floods, including monitoring benefits to floodplain forest regeneration, assessing floodplain invertebrates and fish, and measuring the impacts on salinity in the estuary.

Several other demonstration sites are already beginning to reap rewards. TNC-Corps collaboration on the Green River Dam in Kentucky led to re-operation of the reservoir. This is a vital step to restoring over 80 kilometers of critical habitat for the system's 60 species of

freshwater mussels and more than 150 species of fish, including 7 that are endemic and 12 that are globally rare. Moreover, the updated dam operations improve flood management and extend recreational benefits of the dam by six weeks each year. In the Roanoke River of North Carolina, similar work will ensure the protection of over 220 river kilometers and over 24,000 hectares of one the best and last remaining stands of bottomland hardwood forest that is in conservation ownership along the eastern seaboard. And on the Bill Williams River in Arizona, controlled floods have resulted in regeneration of riparian willow-cottonwood stands that are critical for maintaining the more than 340 bird species found in the watershed while continuing to provide flood management and water supply services.

By working with the U.S. Army Corps of Engineers, the Conservancy has demonstrated the great potential of collaborating directly with water managers. This partnership has given us the opportunity to work side-by-side with dam operators and water planners and, by doing so, we better understand the priorities, methods, and constraints that shape water management decisions. The experiences gained through these interactions significantly improve the ability of Conservancy scientists to develop innovative solutions that can actually be implemented. Further, the Corps is one of the most widely known and respected water management agencies in the world. Dam operators and planners in other countries look to the Corps for examples, and our partnership with the Corps has greatly enhanced the Conservancy's credibility with these key agencies and individuals. Staff from the Corps and other agencies such as the U.S. Fish and Wildlife Service who have been working on the Sustainable Rivers Project have been directly involved in many of the international collaborations described below.

China/Asia

The Conservancy has been active in developing a comprehensive conservation plan, called a "Conservation Blueprint," for the Upper Yangtze, while collaborating with World Wildlife Fund, which is working on the Lower Yangtze. In September 2006, the Conservancy brought together 40 scientists and water managers to determine the necessary volume and timing of water flows needed to ensure a healthy river ecosystem while still providing adequate flood control and power generation in the Jinsha Jiang, the major tributary to the Upper Yangtze. The meeting resulted in a consensus statement – in English and Mandarin – laying the groundwork for the development of flow recommendations. With the Changjiang Water Resources Commission taking the lead, experts prepared a draft report of current information on ecological flow relationships and requirements which was presented at the 2nd Yangtze River Forum in April 2007.

A second workshop was held in November 2006 in Beijing, sponsored by the National Development and Reform Commission (NDRC) and the Energy Bureau, with coordination from the Chinese Hydropower Engineering Consulting Group Company and the Chinese Society for Hydropower Engineering. Conservancy scientists met with representatives of the Three Gorges Company, the developer of the four large dams on the lower Jinsha Jiang, and the NDRC to discuss opportunities and challenges of integrating environmental flow management into the dam operations. As a result of that meeting, the Conservancy received an invitation to assist the Three Gorges Company in developing environmental flow recommendations.

In April 2007, The Nature Conservancy co-sponsored, organized, and presented a variety of activities at the 2nd Yangtze Forum which brought together scientists and water managers from all over the world to discuss the protection and sustainable development of the Yangtze River. Currently, TNC is finalizing a Memorandum of Understanding with the Changjiang Water Resources Commission (CWRC) on longer term collaboration on environmental flows.

The longer term vision includes using new dams in the Upper Yangtze to produce hydropower, and not to control floods. Instead, floods would be *managed* (not controlled) by allowing them to pass through the dam and onto the floodplain below, where the water would spread out onto the plain, fill wetlands, recharge alluvial aquifers, distribute sediment and nutrients, and shape habitat. As that will require major expenditures for restoring the floodplain, moving infrastructure, perhaps relocating people and businesses, and maybe even providing vaccines and health care to deal with resurging water-borne diseases associated with the standing water that will remain after the flood passes, the Conservancy is working to establish a hydropower ecosystem services compensation fund. The funds would come from the "extra" power that the dam companies would be able to produce and sell by maintaining higher reservoir levels than previously anticipated. The money thus earned would be used for managing floods in the floodplains for the benefit of people and biodiversity.

Central America

The Empresa Nacional de Energía Eléctrica (ENEE) of Honduras requested that TNC conduct an environmental flow assessment for the Patuca River below a proposed hydroelectric project, referred to as Patuca III. The Patuca River is the longest river in Honduras, third longest in Central America, and is currently undammed. The river supports globally important aquatic biodiversity and flows through a reserve for indigenous communities and other protected areas. Communities within these reserves rely heavily on the river for water and transport and as an important source of fish protein. Additionally, the river fertilizes agricultural fields by depositing nutrient-rich sediments on the fields during floods. Due to the Patuca River's important biological and cultural values, ENEE sought information on how the proposed dam may affect the river and its resources and asked TNC for guidance for a managed flow regime that will minimize the impacts of Patuca III on the river's ecological integrity and resources.

An environmental flow assessment was conducted based on a variety of information sources, including field trips along the river, scientific data and expertise derived from similar river systems, analysis of hydrological data, and traditional ecological knowledge. These information sources were synthesized and presented during two workshops in fall 2007. During the workshops, participants from the communities, ENEE, government agencies, non-governmental organizations and academia worked to define collaboratively ecologically and socially important river processes and associated environmental flow recommendations. The environmental flow assessment is being considered by the Honduran government and others in determining how to move forward on the project. Through this process, the Conservancy demonstrated how its tools and approaches could be adapted to data-poor situations and we also gained experience incorporating the priorities and concerns of indigenous communities into the development of environmental flow recommendations.

South America

The Conservancy has helped launch several successful payment for environmental service projects to generate funding for watershed protection in South America. Our first project, the Quito Water Fund (FONAG) in Ecuador, is being used as a model for replication in South America and elsewhere. Environmental flow analyses are an integral part of these projects. To support the Quito project, the Conservancy is assisting FONAG in a four-year effort to collect streamflow and biological data for rivers in the Quito watershed and also in an adjoining watershed (which is in the headwaters of the Amazon basin). The exceptional biodiversity of these rivers is threatened by a very large proposed water diversion project, involving multiple reservoirs and inter-basin transfer of large amounts of water to supply Quito's water demands through 2030. If implemented as planned, the diversion project will significantly alter downstream flows. It is hoped that FONAG funding can be used to incorporate environmental flow management into the diversion project plan. The Conservancy is also assisting with environmental flow analyses for rivers in Colombia and Peru, where new Water Fund projects are following the Quito model.

Africa

Throughout its approximately 2,500 kilometers course, the Zambezi River provides food, economic opportunities and power to millions of people in Africa. Eighty percent of the more than 42 million people residing in the river's basin depend on agriculture for their livelihood. One-third of the population relies on healthy fisheries for food. However, competing demands among agriculture, power generation, tourism and other land-based activities have taken a toll on the river's ecological health—especially aquatic life. With its partner, the African Wildlife Foundation, the Conservancy is working in local communities and with the multi-national public agencies that manage the Zambezi's major dams (including the Zambezi River Authority and the Southern Africa Development Community) to rebuild the river's health by restoring environmental flows. In November 2007, the Conservancy, ZRA, and others conducted the Zambezi Basin Stakeholders Forum, where the Conservancy shared lessons and tools for addressing environmental flow issues. The Conservancy will be working with partners and dam managers, specifically, to plan and implement downstream releases that simulate natural flow patterns, thereby restoring floodplains, fisheries, agriculture and wildlife below the Kariba and Cahorra Bassa dams.

Environmental Flows and Dams – Policy Guidance and Standards

Collaboration with The World Bank

In recent years, the World Bank has begun to address the downstream environmental impacts of major infrastructure projects. As part of its series of Water Resources and Environment Technical Notes, the World Bank contracted with The Nature Conservancy, in collaboration with the Natural Heritage Institute, to prepare a Technical Guidance Note on Integrating Environmental Flows in Hydropower Dam Planning, Design and Operations. The Technical Note has been developed to assist World Bank staff and their clients in identifying ways to better

incorporate the benefits associated with environmental flow protection into hydropower dam projects.

Partnership on IHA Sustainability Guidelines

To carry forward the dialogue established during the UNEP-DDP process and continued at the May 2007 World Congress on Advancing Sustainable Hydropower, several organizations have agreed to investigate credible and practicable standards to assess the environmental and social sustainability of hydropower planning, development and operation. A forum of representatives – the "Hydropower Sustainability Assessment Forum" – will work towards a common understanding of the methodology and scope of the Hydropower Sustainability Guidelines and Assessment Protocol, as developed by the International Hydropower Association (IHA). The Nature Conservancy will focus, in addition to other areas, on ensuring adequate coverage of environmental flow issues to enhance the credibility of the Guidelines and Protocol.

Tools, Approaches and Trainings

Indicators of Hydrologic Alteration

The Indicators of Hydrologic Alteration (IHA) is a software program that provides critical information for those trying to understand the hydrologic impacts of human activities or trying to develop environmental flow recommendations for water managers. Nearly 2,000 water resource managers, hydrologists, ecologists, researchers and policy makers from around the world have used this program to assess how rivers, lakes, and aquifers have been affected by human activities over time, or to evaluate future water management scenarios.

This program was developed by scientists at The Nature Conservancy to facilitate hydrologic analysis in an ecologically meaningful manner. This software program assesses 67 ecologically relevant statistics derived from daily hydrologic data. For instance, the IHA software can calculate the timing and maximum flow of each year's largest flood or lowest flows, then calculate the mean and variance of these values over some period of time. Comparative analysis can then statistically describe how these patterns have changed for a particular river or lake, due to abrupt impacts such as dam construction, or more gradual trends associated with land- and water-use changes. The software, user's manual, tutorial, and training modules are available free of charge through the Conservancy's web site at http://www.nature.org/initiatives/freshwater/conservationtools/. The Conservancy is currently in the process of translating the on-line training into Spanish.

Regime Prescription Tool

The Nature Conservancy and the U.S. Army Corps of Engineers Hydrological Engineering Center (HEC) collaborated on the development of a new software program that supports the definition of environmental flow recommendations within workshop settings. The Regime Prescription Tool (HEC-RPT) is a visualization program that allows the display and documentation of various flow recommendations and alternative scenarios in real-time, participatory settings. HEC-RPT seeks to complement other software packages by facilitating

the creation of flow time series that can be exported for immediate analysis in other software, including reservoir system simulation, river hydraulics, and ecosystem function models. The Regime Prescription Tool – which is the first software jointly developed by the U.S. Army Corps of Engineers and a non-governmental organization – is available to download online free of charge at www.nature.org/initiatives/freshwater/conservationtools/.

Flow Restoration Database

The Conservancy developed and manages the Flow Restoration Database, which catalogues and organizes river flow restoration projects into a searchable tool. Projects within the database include those that modify dam operations, remove dams, manage ground-water pumping, and employ other strategies to restore river flows. Case Studies from around the world are summarized. Presently, the database lists 855 rivers in 53 countries. People are encouraged to submit additional projects to it through www.nature.org/initiatives/freshwater/conservationtools/.

Methods for Quantifying Environmental Flows

The Conservancy has a long history of developing, testing, refining, and updating methodologies for quantifying environmental flow needs. Over a decade ago, TNC developed the Range of Variation Approach (RVA) for setting environmental flow targets based upon a river's natural flow variability. By incorporating RVA into the IHA software, TNC enabled environmental flow recommendations worldwide. However, it was soon recognized that flow data alone provide only minimal scientific basis for flow recommendations. Ideally, hydrologic understanding should be integrated with ecological concepts and data. Thus, in parallel with similar developments in South Africa and Australia, the Conservancy designed, demonstrated, refined, and, through numerous applications, perfected a holistic environmental-flow setting approach involving an iterative sequence of diverse data compilation, expert workshops, implementation, and monitoring.

But initial applications of this approach were hindered by the lack of a common language shared by scientists, water managers, and stakeholders. To facilitate all-important communication between players, TNC helped to develop RPT, described above. TNC also introduced Environmental Flow Components (EFCs), a suite of non-traditional hydrologic statistics designed specifically to communicate ecologically-significant hydrologic events such as floods and low flows in terms that non-hydrologists can understand and hydrologists can analyze using IHA software.

Even as TNC and others perfected the application of scientifically credible holistic methods for quantifying environmental flows, the rate of flow alteration throughout the world drastically outpaces the rate at which site-by-site assessments could be conducted. In response to this dilemma, five Conservancy scientists have joined fourteen other leading environmental flow scientists to develop a new desktop approach called the "Ecological Limits of Hydrologic Alteration" (ELOHA) framework. The purpose of ELOHA is to provide water managers and regulatory agencies with a scientific basis for setting environmental flow targets for multiple rivers over very large regions when time and resources for site-specific investigations are limited. Thus, ELOHA provides the scientific basis for integrating environmental flow

protection into nationwide water resource planning and policies. ELOHA applications are underway in several states in the United States (e.g., Arizona, Colorado, Connecticut, Massachusetts, Michigan, Pennsylvania, Tennessee, Washington,), with efforts planned for application outside of the U.S., as well.

Training

The Conservancy conducts training programs on a regular basis, including twice per year at the U.S. Army Corps' Hydrological Engineering Center's training facility and annually at the National Conservation Training Center. In addition, TNC conducts training programs at global environmental and water conferences to raise awareness of the importance of environmental flows and to build the capacity of partners in environmental flow science and policy. In addition, the Conservancy is working to make training available on-line. The Conservancy's website maintains up-to-date information on the offerings (see www.nature.org/freshwater). Other institutions make use of Conservancy trainings as well. For example, the U.S. Environmental Protection Agency maintains an on-line training on "Protecting Instream Flows: how much water does a river need?" which describes a Conservancy approach for defining and restoring the streamflow conditions that sustain the biological diversity of rivers.

Publications

Conservancy science and policy staff working on environmental flow issues publish regularly in peer-reviewed journals (see www.nature.org/initiatives/freshwater/conservationtools/pubs.html). In addition, the Conservancy has produced practical guides, such as the *Practitioner's Guide to Freshwater Biodiversity Conservation,* to help water managers and others address environmental flow issues. The Conservancy worked with the U.S. Agency for International Development and The Coastal Resource Center at The University of Rhode Island to publish *Managing Freshwater Inflows to Estuaries - A Methods Guide*. This guide addresses the need to better integrate river and catchment (watershed) management with estuary management by combining important features of integrated coastal management (ICM) with integrated water resources management (IWRM).

Blue Water Initiative

As part of its commitment to advance water policies and conservation approaches to meet human needs for water while sustaining healthy freshwater ecosystems, The Nature Conservancy began exploring three years ago ways to serve as a catalyst for a water-related sustainability "certification" or "awards" program, similar to what has been achieved in the forestry and marine fisheries sectors. The basic concept uses sustainability certification as a means to encourage and acknowledge water managers or providers to carry out their operations in a way that is environmentally sustainable and, therefore of minimal impact to freshwater biodiversity. The Nature Conservancy and its partners are currently developing this voluntary program to recognize water utilities, and ultimately cities, that are doing an outstanding job of environmental stewardship. Standards on environmental flows, among others, would help define "best practices" in the water utility community and help raise the bar on ensuring adequate freshwater resources in the face of the world's rapid urbanization.

Global Environmental Flows Conference

The Conservancy, in partnership with the International RiverSymposium, produced the 2nd International Conference on Environmental Flows to explore this burgeoning field from scientific, policy and management perspectives. The Conservancy took the lead planning the conference content and on compiling and condensing a wide array of input from Conference participants into the resulting *Brisbane Declaration: A call for action for the global protection and restoration of the water flows that support people and nature*. (see www.nature.org/initiatives/freshwater/press/press3195.html) The Conservancy is actively looking for potential partners to host future global environmental flow conferences to help continue the dialogue and exchange of experiences in this rapidly developing field.

Global Environmental Flows Network

The Nature Conservancy is a founding member, along with IWMI, IUCN, SIWI, DHI, Centre for Ecology and Hydrology, and Swedish Water House and Delft Hydraulics, of the Global Environmental Flows Network. The Network was formally launched at the Environmental Flows Conference/RiverSymposium in Brisbane in September 2007, with stakeholder input provided at an event at Stockholm Water Week 2007. The Network provides a central reference point for all the knowledge and information on environmental flows that is currently dispersed throughout the world, so that it can be accessed and shared easily by everyone. Future plans for the network include demonstrating the link between environmental flows and achieving Millennium Development Goals and poverty alleviation, contributing to the Global Water Partnership's Toolbox, organising capacity building workshops, and providing information on methods and available experts.

Lessons

1. The Nature Conservancy provides global leadership in environmental flow science and management. To help governments, water planners and water users implement this cutting-edge work, program scientists provide tools, training and information, and they continually develop and refine new methods for protecting freshwater habitats.

2. The specification of environmental flows is a key to sustainable water management. When environmental flows are determined, water managers know how much of the remaining flow is available for human uses, and how much alteration of natural water flow patterns by humans is too much.

3. The Ecological Limits of Hydrologic Alteration (ELOHA) framework provides a timely and scientifically credible means for broadly assessing environmental flow needs when in-depth studies cannot be performed for all rivers. The Conservancy helped to develop ELOHA and is actively working to pilot-test this approach.

4. It is very useful to characterize the naturally varying flow that existed in a river prior to substantial human influence. Comparisons of the natural flow regime with current or projected conditions can shed light on the degree of departure from natural flow conditions.

This can focus flow protection and restoration activities, provide direction for ecological research and monitoring, and identify priority management actions.

5. The Indicators of Hydrologic Alteration (IHA) software program, designed by Conservancy scientists, has proven useful for characterizing unaltered flow regimes and human-induced changes to river flows. Its value increases significantly when it is used as an interactive tool in explorations into flow-ecology relationships.

6. Engaging stakeholders, including scientists representing various agencies and institutions involved, early in the process to develop environmental flow recommendations will help to build a strong and influential constituency and to foster a coordinated and consistent vision for the protection and management of a river.

7. Partnering with water management agencies, such as the U.S. Army Corps of Engineers, provides invaluable exposure to the tools, priorities and constraints that shape real-world water management decisions. This experience improves scientists' abilities to propose innovative, feasible solutions. Further, these partnerships establish the Conservancy's credibility among other water management agencies worldwide.

8. In addition to conducting scientific studies and analysis, it is critical to engage in environmental flow policy development. Although a long-term effort, institutionalizing ecosystem protection within governmental agencies and influencing policy and funding authorization for environmental flow work will ensure long-term results.

9. When carrying out environmental flow assessments, best results are achieved when the relevant water management authority is part of the process from the very beginning. Given the time and effort it takes to develop environmental flow recommendations, it is always advantageous to work with national water management authorities and energy development agencies to influence protection of important aquatic resources at the basin-wide, national, or regional scale.

10. Environmental flow assessments can be conducted with only minimal data about the aquatic biodiversity of a river and how it functions, or the connections between species and specific flows. This requires innovation and creativity in including the indigenous communities adjacent to the river, who are closely tied to the river economically and socially.

11. The Conservancy will continue to work closely with partners, such as members of the Global Environmental Flows Network, to reach new audiences and build capacity for carrying out this work. In addition, the Conservancy will continue to use vehicles such as Interagency Personnel Agreements to build day-to-day working relationships with major water science and management agencies such as the U.S. Geological Survey and the U.S. Army Corps of Engineers.