mental outcomes noted above. Although such identification and quantification can lead to important and useful data, full participation in the benefit–cost analysis process is granted only to those outcomes that can be described in monetary terms. Although a variety of methods exist for attaching monetary value to environmental resource services, they are relatively costly, require great skill to apply, are applicable only to certain services or under certain conditions, and are characterized by substantial uncertainty.

CONCLUSION AND RECOMMENDATION

Formal economic analyses can be very helpful in supporting the decision-making process for dam removal, in setting priorities, and in considering the interests of stakeholders and agencies. Nevertheless, significant challenges remain for those who would use methods such as benefit–cost analysis for this purpose. Dam removal has various environmental outcomes, including some that are highly uncertain and difficult or impossible to value monetarily. It may be tempting to ignore these issues, as often was done in the earlier building of dams. However, these nonquantified environmental effects are major issues when dealing with removal and need to be taken into account. Rather, it is necessary to confront these dam removal impacts and the challenge of accounting for them, and to focus on developing credible projects and improved methods with which to evaluate them.

- **Conclusion:** The science of economics does not offer decision makers considering dam removal a sufficient array of analytical tools and supporting data to assess adequately the economic outcomes of a decision in quantitative terms.
- **Recommendation**: The panel recommends that the community of economics researchers provide (1) improved economics evaluation tools for dam removals to enable the assignment of monetary valuations for outcomes of dam removal and (2) empirical research on changes in property values associated with dam removals already accomplished.

7

Social Aspects of Dam Removal

Dam removal decisions involve social and cultural issues, which frequently can be contentious. Some of these issues relate to visual aesthetics, recreation, and cultural and historical preservation and/or restoration. Restoration most often is thought of in dam removal processes as an environmental concept, but it also has human social dimensions. The historical restoration that may be a result of dam removal can be a desirable outcome from a community standpoint because of commonly shared social values that revere the area's human history. Social and historical values are important considerations in decisions to remove dams because society in general pays the costs, not only in monetary terms when public funds are involved, but also in terms of the lifestyles experienced by residents of the area. The general appearance of the river after a dam is removed may be important to local residents for purely aesthetic reasons, and the ambience of the river may have far-reaching commercial implications. This chapter reviews some general ideas about social values and aesthetics related to rivers and dams. It also reviews the values of tribal nations in the United States and the use of social impact assessments.

AESTHETICS AND SOCIAL VALUES

Like all natural resources, rivers have use and non-use values (Hanna and Jentoft, 1996). Use values include direct use, indirect use, and option values (see Chapter 6). The predominant U.S. perspective on environmental resources, including rivers and water, has been one of exploitation for economic development. Throughout most of this nation's history, the dominant perspective (anthropocentric) has been to see nature as existing to serve humankind, and a guiding principle in the use of natural resources has been the alteration of natural environments to enhance the wealth and comfort of people. An important ancillary concept is that of private property rights, which is firmly enshrined in the policy and laws of the nation and is a mainstay of the orderly use of resources, including rivers.

Social values for the natural environment, including rivers, have undergone considerable change during the history of the United States. When Europeans came to the North American continent, they considered it a wilderness, something wild, savage, and untamed that demanded the imprint of "civilized" activity to bring it into conformance with a world made for people. Alexis de Tocqueville recognized this dominant perspective while traveling in the new nation in 1831, observing that Americans were not interested in the beauty of the wild forests and rivers, but rather that "their eyes are fixed upon another sight, the march across these wilds, draining swamps, turning the course of rivers, peopling solitudes, and subduing nature" (de Tocqueville, 1953, p. 47). In 1903 Mark Twain quoted someone else who in 1837 stated that the Mississippi River was "a river of desolation, and instead of reminding you, like others, of an angel which has descended for the benefit of man, you imagine it a devil" (Twain, 1903, p. 295).

Throughout the early history of the country, this perspective of society overcoming the resistance of nature and turning natural resources to human good was virtually the only public policy ethic for rivers. Through the very earliest times, rivers powered gristmills and embryonic industries, and diversions and water control structures often supplied agriculture during the colonial period. During the first half of the 1800s, the construction of canals added artificial components to the natural channel systems, and from midcentury onward, the alteration of rivers to obtain water for mining and lumbering was common. By the end of the 1800s, the installation of dams for major irrigation projects on the Plains and in the far West became major features of environmental, economic, and social landscapes. It was not until the dawn of the twentieth century that the conservation of resources, including water, reached the national agenda as the growing population and economic development associated with it put increased strains on natural resources (Huth, 1957).

The emphasis in the early twentieth century was still on use of environmental resources to meet human-centered needs; the question was not so much preservation versus development as it was how to develop

the resources. The emphasis was on wise, forward-looking use, with the conservation of resources such as water and rivers viewed as sound business practice (Hays, 1959). This civic-minded approach to resource development shared the public stage with engineering, which enjoyed great recognition and esteem. Engineering accomplishments in transportation, such as railroads, and in industries ranging from steel making to textiles, brought a new prominence to the engineering profession (Barry, 1997). Public confidence in engineering extended to hydrologic and civil engineers who were designing and building river works. Engineers became national heroes. John S. Eastwood, for example, was viewed as a savior in the West, where he perfected the design and construction of multiple concrete arch dams that served rural and urban interests alike (Jackson, 1995). Herbert Hoover, the nation's leading engineer, became president.

This emphasis on taming lands and rivers as part of America's destiny continued largely unabated until the late 1960s, when national policymakers became more concerned with environmental quality (Harper, 2001). Previously, the installation of dams had been resisted by some local populations, largely because of the drowning of agricultural lands by reservoirs or loss of personal property, as on rivers of the Tennessee system when the Tennessee Valley Authority began its dam construction program in the 1930s (Cutler, 1985). In the 1960s, however, rivers were pivotal in the adjustment of American social values, especially those related to water quality. Urbanization, industrialization, and overuse had degraded water quality by the 1960s to a degree noticeable by ordinary citizens, and widely publicized events such as the Cuyahoga River catching fire in Cleveland, Ohio, began to highlight the costs of using water and rivers as resources without regard for the consequences. Although there was little understanding of the downstream outcomes of dams at the time, the 1960s and 1970s saw the emergence of national policies to restrict dam construction (e.g., the Wild and Scenic Rivers Act of 1968) and to improve water quality in rivers (e.g., the Clean Water Act of 1972 and later amendments).

The 1970s and later decades witnessed the emergence of a broadly defined set of social values in the United States that placed emphasis on the preservation and restoration of environmental quality in general (Harper, 2001), and the quality of river environments in particular. The desire for aesthetically pleasing environments along streams, the use of rivers in historical restoration efforts, and the central position of rivers in the maintenance of endangered species all fit into a perspective that sought an improved balance between economic development and environmental quality. Today, however, amid increasingly diverse opinions, consensus social values for rivers and their dams are difficult to define; the nearly monolithic opinions of a century ago are gone. As a result, a decision about whether or not to remove a dam depends not only on the forecasted outcomes for the physical, biological, and economic systems, but also on public perceptions of the future aesthetics and use of the resulting landscape.

In one of the few windows on public opinion about dam removal, Born et al. (1998) conducted surveys showing the trade-offs people make when a dam is removed (Box 7.1). Investigations of 14 cases of dam removal show that the public perceived important losses when dams were removed, including the loss of hydropower and recreational activities associated with reservoirs. The public also perceived important gains such as improved safety and savings related to discontinued maintenance. The survey showed not only that there was a variety of opinions, but also that in half the cases the public perceived an important gain to improved fish and wildlife habitat offered by a free-flowing river. The valuation by public opinion of a free-flowing river is relatively new on the river manage-

Box 7.1 Perceived Gains and Losses Resulting from the Dam Removals in Wisconsin

Research in Wisconsin shows the range of social and cultural values associated with recent dam removals. Born et al. (1998) summarized the perceived gains and losses associated with 14 dam removals in the state as follows. For the majority of cases, members of the public mentioned as a social value the loss of recreational activities and aesthetics associated with the impoundment. Over half mentioned the loss of a nostalgic location and loss of fish and wildlife habitat associated with the impoundment. Other concerns were the loss of potential hydropower generation, even if the dam had not generated electricity for decades and major retrofits would have been necessary. Reduced property value of lakefront development was noted in four cases as a significant issue in dam removal. Stakeholders in 12 of the 14 cases listed safety improvements as a gain, and half listed improved fish and wildlife habitat as a result of a free-flowing river. The elimination of maintenance and potential liability for owners was seen as a positive result of removal at many sites. Improved recreational activities associated with a free-flowing river were valued in only three of the cases; three also valued the improved aesthetics of a free-flowing river.

Box 7.1 continued

	Dam Removals													
Perceived Gains and Losses	Fulton	Greenwood	Hayman Falls	Huntington	Lemonweir	Manitowoc Rapids	McClure	Nelsonville	Ontario	Prairie Dells	Pulcifer	Somerset	Woolen Mills	Young America
Perceived losses														
Recreational activities associated with the impoundment	x	x		x	x	x	x	x	x	x	x	x	x	x
Aesthetics of the impoundment	x		x	x		x	x	x	x	x		x	x	x
Fish and/or wildlife habitat associated with the impoundment	x	x		x	x	x	x		x	x	x			x
Nostalgic location	x			x	x		x	x	x	x			x	
Potential to generate "clean" hydroelectric power	x		x	x			x			x	x			
Historical structure, point of interest		x	x			x		x	x	x				
Lakefront property values						x		x		x				
Perceived gains														
Safety improvements	x	x	x	x	x	x	x	x	x	x	x	x		
Improved fish and wildlife habitat of a free-flowing river					x	x		x	x	x		x	x	x
Perpetual maintenance costs eliminated	x		x	x	x		x	x		x				
Liability risks eliminated	x		x	x	x	x	x			x				
Improved recreational activities assocaited with a free-flowing river									x			x	x	
Improved aesthetics of a free-flowing river						x			x	x				
Fulfilled legal obligation of administrative order									x					x
Prevention of shoreline erosion	x													

Source: Adapted from Born et al., 1998.

ment and decision making landscape, and it represents a very different perspective than emphasis on water resource development that prevailed unchallenged just a century ago. Nonetheless, the results of the surveys with their wide range of opinions and perspectives show why dam removal decisions are rarely straightforward and unambiguous.

There are few reliable measures for social values, but public opinion about maintaining or removing a dam can be ascertained through surveys. One potential route to assessing public opinions is a method used by the late Professor Marie Morisawa, a geologist at the State University of New York at Binghamton. She provided respondents with pictures of various river landscapes and asked them to rate the scenes according to their desirability as recreation sites. A similar approach can be informative in making dam removal decisions. In considering the removal of a dam, an inevitable question arises among local residents about what the river landscape will look like after the dam is removed. The digital alteration of photographs of the exact sites, or photographs of similar sites without dams, can provide comparisons with existing conditions with the dam in place. Standard survey techniques, such as the assurance of a broadly representative sample of the affected population, can ensure a reading of existing social values in the locale of the potential dam removal.

DAMS AND TRIBAL CULTURE IN THE UNITED STATES

Tribal culture and religion are attentive to the human place within nature. Perhaps nowhere are the differences in tribal and nontribal ways of relating to nature more evident than in the treatment of water. Many traditional Native Americans had, and continue to have, a perspective on nature that is very different from the Jewish and Christian ethic common in the early decades of the nation's history. Many Native American religions view nature not as something to be overcome, but as something to be blended with and respected. In this view, people are part of a matrix or society of natural objects and places that puts humans on an equal footing with nature rather than in a superior position (Callicott, 1982). The emphasis on the importance of natural objects and places does not mean that tribes have been averse to changing or manipulating their environment, because when and where possible they effected significant changes (Martin, 1981). As traditional values enjoy resurgent positions in many

tribes, there is a renewed awareness of the importance of nature, and new efforts are under way to reduce damaging impacts of human activities.

Dams play an important role in affecting rivers and the natural objects associated with them from a Native American and perspective. For example, coastal tribes in the Pacific Northwest for economic as well as cultural reasons revere many fish species, such as migrating salmon and sea lamprey. Many tribes in the region once subsisted on salmon as a primary food source, so the installation of dams that disrupted the migration had serious dietary consequences.

Because of the value of nature in traditional Native American culture, there are certain places in the geographical landscape that have special importance. These areas are sacred spaces, revered for their particular connection to the spiritual world. Native Americans are not alone in this definition of sacred spaces, because many cultures set aside special areas or sites for religious or spiritual reasons (Graber, 1976). Riverine environments often play a special role for Native Americans, just as was the case elsewhere in the ancient world (Tuan, 1974). Dams affect such sacred spaces by drowning them under reservoir waters, or by otherwise altering them through changes in downstream flows.

Historically, small dams were likely to be constructed on significant Native American sites. Small modern structures have the same purposes as did dams built prior to European settlement: to divert flow from sites where the river morphology constricted flow, or to raise water levels at sites that previously were logical choices for fish weirs. Therefore, the sites of the dams themselves may be significant for the Native American population. At present, there are insufficient data on the locations of dam sites on Native American land to evaluate their significance; such data will need to be collected on a case-by-case basis.

Many traditional Native American religions ascribe sacred values to water features in the general landscape. For example, among the Native Americans at Taos Pueblo in New Mexico, many lakes, springs, and streams in the vicinity of the pueblo are places to which individuals must go to perform rituals at particular times of the year (Bodine, 1979). Any interference with these sites, either through dam construction or because of dam removal, is of concern to the pueblo residents.

Dams and their reservoirs may exert strong influences on specific cultural sites. Three examples are two large dams, Glen Canyon and Fort Peck dams, and the medium-sized Elwha Dam. Glen Canyon Dam created Lake Powell, which inundates hundreds of archeological sites important to the Navajo tribe and influences downstream conditions near salt mines in the Grand Canyon held sacred by a number of tribes, including the Navajo, Hopi, and Zuni. Fort Peck Dam inundates sacred lands of the Sioux tribe in the Dakotas, and Elwha Dam creates an artificial lake over the place of origin for the Elwha Indians. Numerous dams across the entire nation are entangled in one way or another with tribal sacred space (Waldman, 1985). If nothing else, any dam removal that resurrects land that previously was inundated by reservoir waters needs to take into account potential Native American land claims, an important subject to tribes and a defining political issue for them.

Defining sacred space for protection by members outside individual tribes is problematic. Native Americans are reluctant to reveal the exact location of many sacred sites, fearing the interference of curiosity seekers or the removal of temporary shrines constructed close by. The dominant Anglo-American population, although increasingly sensitive to Native Americans' point of view, does not have a track record of protecting Native American interests, especially in cases in which resource development would result in economic gain for the majority. Therefore, Native American input into decision making about dam removal may be less forthcoming or precise than some other inputs.

Sources of information about Native American concerns regarding sacred space also may be difficult to assess. Tribal representatives may simply designate large areas rather than specific sites as being of religious interest so as not to reveal too much detail about the sites. Oral histories, written historical accounts and observations, and consultation with tribal representatives are all sources of information that may be useful in alerting decision makers to potential conflicts between Anglo-American and Native American values. Native American societies are just as complex as Anglo-American society, and there are likely to be differences of opinion within tribal communities about the outcomes of dam removal, particularly if the benefits are perceived as largely related to religious concepts rather than to economic gain for tribal members.

SOCIAL IMPACT ASSESSMENTS OF DAM REMOVAL PROJECTS

Social impact assessments in the United States developed out of a need to apply the knowledge of sociology and other social sciences to predict the

social outcomes of development projects subject to the National Environmental Policy Act (NEPA) legislation of 1969 (Burdge 1994). A goal of social impact assessments (SIAs) is to identify and understand the consequences of change for human populations and communities. Unfortunately, the use of social impact assessments has not been consistent (Burdge 1994). The objective in the SIA process is to anticipate and predict social impacts in advance, so that findings and recommendations can become part of the planning and decision-making process.

Burdge (1994) developed a list of 26 social variables that may be useful in conducting a social impact assessment (Box 7.2). These variables represent the types of outcomes arising from planned change in local communities. Burdge used the following criteria in the selection of the 26 SIA variables:

1. An SIA variable is operative when a community may be altered by project development and policy change.
2. An SIA variable will tell the decision maker or planner a specific consequence of the proposed action.
3. An SIA variable always has a discrete, nominal, or continuous empirical indicator that can be measured, collected, and interpreted within the context of a specific social impact setting.
4. All SIA variables are based upon data that can be collected or made available during the planning and decision stage as well as other stages in the development of the project or policy.
5. An SIA variable does not require, but may utilize, information from questionnaires of the general population.
6. An SIA variable is not to be confused with sociological labels such as middle class, ethnicity, or other small groups.

To provide an illustration of how the SIA variables might help to inform a decision about whether or not to remove a dam, the Heinz Center panel adapted a table from Burdge (1994) (Table 7.1).

Sometimes the social process of reaching a decision to remove a dam can be a catalyst for bringing diverse interests together rather than sharpening their differences. Citizen's groups such as watershed councils often are formed to address a single issue (such as dam removal) and later evolve to address wider-scale issues (National Research Council, 1999). An example is the broadly defined effort by local citizens to organize and raise money for the removal of Stoever's Dam in Pennsylvania (Box 7.3).

Box 7.2 Social Impact Assessment Variables

Population Impacts
- Population change
- Influx or outflux of temporary workers
- Presence of seasonal (leisure) residents
- Relocation of individuals and families
- Dissimilarity in age, gender, racial, or ethnic composition

Community/Institutional Arrangements
- Formation of attitudes toward the project
- Interest group activity
- Alteration in size and structure of local government
- Presence of planning and zoning activity
- Industrial diversification
- Enhanced economic inequities
- Change in employment equity of minority groups
- Change in occupational opportunities

Conflicts between Local Residents and Newcomers
- Presence of an outside agency
- Introduction of new social classes
- Change in the commercial/industrial focus of the community
- Presence of weekend residents (recreational)

Individual and Family-Level Impacts
- Disruption in daily living movement patterns
- Dissimilarity in religious practices
- Alteration in family structure
- Disruption in social networks
- Perceptions of public health and safety
- Change in leisure opportunities

Community Infrastructure Needs
- Change in community infrastructure
- Land acquisition and disposal
- Effects on known cultural, historical, sacred, and archaeological resources

Source: Burdge (1994) p. 37.

In this instance, the dam was rebuilt and its reservoir made into a public park. A similarly satisfactory, if opposite, outcome resulted in the town of West Bend, Wisconsin, where the Woolen Mills Dam was removed through the cooperative efforts of the state Department of Natural Resources, the dam owner, local citizens, and businesses. The reservoir

Table 7.1 Social Impact Assessment Variables by Dam Removal Project Stage

Project Stage	Variables
Problem Identification	Small or medium-sized dams
Planning/Policy	Safety issues, environmental issues, public attitudes toward the project
Implementation	Relocation of families, influx of workers, change in recreation, change in wildlife habitat
Maintenance	Safety problems, insurance liabilities, flood protection, fish passage issues, native versus non-native values, sediment removal
Removal	Changes in employment, potential change in property value, restoration of natural environment, hydropower replacement, native fish return, introduced fish species leave, flood protection needed for houses near river, sediment flows to beaches, sediment quality and removal issues

Adapted from Burdge, 1994.

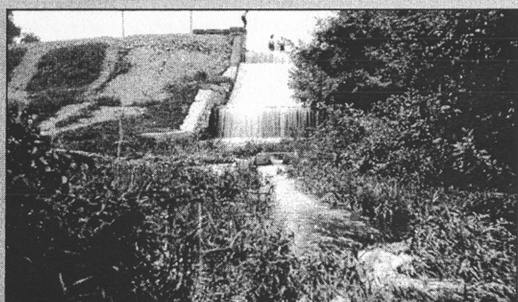
became the site of an extensive public park and recreation facility that includes a reconstructed trout stream.

CONCLUSION AND RECOMMENDATIONS

There is little research on social science aspects related to dam removal. This is a serious shortcoming because the social context of dam removal decisions is often as important as the environmental and economic contexts. The lack of relevant social science research is a serious shortcoming in the knowledge base for dam removal decisions because these decisions are made by people and affect them as much as they do the environment. This significant gap could be filled in many ways. For instance, research in sociology, geography, history, and planning could investigate the connections among communities, rivers, and dams. There is also more to learn more about the cultural significance of dams. Some dams or structures directly associated with them may have substantial historical signifi-

Box 7.3 Saving Stoever's Dam in Pennsylvania

The case of Stoever's Dam illustrates how a dam removal decision-making process can bring a community together. In the 1920s, the Union Canal Company needed a steady supply of water in its canal and built Stoever's Dam across a tributary to Brandywine Creek in Lebanon County. More than 150 years later, in 1978, the dam was identified as a high hazard facility after an investigation required by The Dam Inspection Act (P.L. 92-367) discovered that the dam' storage and spillway capacity was capable of passing only 11 percent of the probable maximum flood load. The investigation also found the dam and its appurtenant structures in poor condition and concluded that a failure would affect several inhabited structures located downstream.



Stoever's Dam in 1915.

Courtesy of Pennsylvania Department of Environmental Resources

In 1981, the Pennsylvania Department of Environmental Resources, Division of Dam Safety, requested that the dam's current owner (the city of Lebanon) either drain the reservoir or present a proposal for the dam's rehabilitation. Although the local government and citizens favored saving the dam and creating a focal point around the reservoir for a new park, the city did not budget the money necessary to rebuild the dam. The city, along with local citizens, organized the Save Stoever's Dam Committee to garner political and monetary support to rebuild the dam. In addition to applying for state and federal money, the committee sponsored various fundraisers. Several local sportsmen and youth groups also held fundraisers.

The rebuilding project began in April 1982 and was completed in January 1983. The final project costs, including design and construction, totaled more than $605,000. Funding was provided by $500,000 in grants from the Pennsylvania Department of Community Affairs and the U.S. Department of Housing and Urban Development. The Save Stoever's Dam Committee raised the remaining money, more than $100,000, needed to complete the project.

cance, so there may be reasons to remove only part of a dam or to preserve or restore the associated mill works or power house. A particularly important line of investigation that could be undertaken by nongovernmental organizations with the cooperation of state agencies would be to investigate the social and economics outcomes after dam removal. These after-project studies are at least as important as environmental and social impact studies undertaken before the dam removal.

Although the social outcomes of dam removal decisions are not yet well known, standard survey-based research outlines changes in individual and community behavior related to such decisions. Adaptive management for environmental systems could be extended to social systems, so that river managers could make informed adjustments to their plans. In this way, an active role would be reserved in the decision-making process for people and communities as well as natural organisms and ecosystems.

- **Conclusion:** Social science perspectives on dam removal suffer from a lack of research on the subject, so that decision makers wishing to include social perspectives in the process are faced with many unknowns and little guidance.
- **Recommendation:** The panel recommends that agencies and organizations that fund social science research support investigations into the social and cultural dimensions cases in which dams have been removed as a way of improving the predictability of outcomes.
- **Recommendation:** The panel also recommends that decision makers in dam removal cases should undertake social impact studies modeled on the environmental impact studies that are a common feature of such decision-making processes. These social impact studies should address the cultural significance of the dam site (e.g., as a tribal sacred site), reservoir area, and river areas likely to be changed by the proposed removal.

The Future

The familiar wisdom is that times change, and that time waits for no one. During the deliberations that led to this report, a number of changes occurred on the national science and policy landscape that are relevant to the future of dam removal. Severe electrical power shortages in California and elsewhere prompted new interest in power sources, including dams. Terrorist attacks on the nation's civilian populations and concern for the water control infrastructure, especially dams, became front-page news. A new administration assumed the presidency and the executive branch of the government, bringing with it changes in perspective and opinion. Control of the U.S. Senate switched from one political party to another. At the same time, new advances occurred on the scientific front. Biologists discovered fishes (the robust redhorse) thought to be extinct but apparently surviving in southeastern rivers with dams. Physical and biological scientists were cooperating in research focusing on the effects of dam removal in locales as diverse as Pennsylvania and California, and their reports were beginning to work their way through to publication in the refereed journal literature. New knowledge was beginning to surface to deal with old problems. Thus, managers, scientists, and decision makers were gaining a larger experience base for dam removals.

This report is a primer for researchers, decision makers, and the public, providing information on background, science, and decision concepts. If funding is provided for a second phase of the project, the Heinz Center will conduct a scientific conference on research related to the outcomes of dam removal. The conference will feature invited speakers from the major scientific disciplines engaged in research related to dam removal and provide them with the opportunity to interact with each other in

accomplishing three tasks: (1) outlining the present state of knowledge in their individual fields, (2) identifying those topics in one field that are in need of supporting research from other fields, and (3) specifying gaps in scientific knowledge that require additional research to support decision making. The proceedings of the conference will include written papers and conclusions. In addition, if funding is provided, the Heinz Center may experiment with the decision-making processes outlined in this report in two or more localities dealing with dam removal.

The present report is a summary of current understanding of the decision-making process regarding dam removals that are scientifically informed and serve the best interests of the largest number of stakeholders. It represents the state of the knowledge about these decisions at one point in time. The possible futures for the nation's rivers turn on the wise use of knowledge about them, and the wise use of them as resources. Because experience is an important part of that wisdom, subsequent advances will augment and change some of the concepts in this report. The greatest chance for success in making good decisions about dam removal lies in the use of this report as merely a starting point, and in the subsequent growth and change of the ideas it presents.

Appendix A

Useful Sources of Information on the World Wide Web for Dam Removal Decision Makers

EXISTING DAMS

National Inventory of Dams (U.S. Army Corps of Engineers and Federal Emergency Management Agency)

http://crunch.tec.army.mil/nid/webpages/nid.cfm. This web site (as of Oct. 15, 2001) is offline as a security precaution in light of the Sept. 11, 2001, terrorist attacks on the United States. The site may be restored after further evaluation.

- The online interactive map and downloadable database contains information about approximately 76,000 dams. Includes those structures whose collapse might be a threat to life and property downstream, those greater than 6 ft (2 m) high with more than 50 acre-ft (61,000 cu m) of storage, and those that are 25 ft (8 m) high with more than 15 ac ft (18,500 cu m) of storage.

National Atlas (U.S. Geological Survey)

http://www.nationalatlas.gov/damsm.html

- This online interactive map and downloadable database contains information about approximately 7,700 major dams. A subset of the National Inventory of Dams, the dataset includes dams that are 50 feet or more in height, have a normal storage capacity of 5,000 acre-feet or more, or have a maximum storage capacity of 25,000 acre-feet or more.

DAM REMOVALS

Dam Removal Success Stories (American Rivers, Friends of the Earth, and Trout Unlimited)

http://www.americanrivers.org/damremovaltoolkit/successstoriesreport.htm

- In December 1999, these three organizations issued a cooperative report outlining the experiences of specific dam removal projects. American Rivers also has a resource center of material regarding dam removals at http://damremoval.americanrivers.org.

Wisconsin Rivers (Wisconsin River Alliance)
http://www.wisconsinrivers.org/
- This organization provides examples of changes brought about by dam removal and useful information on dam removal decision-making processes.

MAPS

National Atlas (U.S. Geological Survey)
http://nationalatlas.gov
- The atlas contains a variety of high-quality, small-scale maps for the entire United States, including authoritative national geospatial and geostatistical data sets. Examples of digital geospatial data include soils, county boundaries, volcanoes, rivers, streams, and watersheds.

Topographic maps

U.S. Geological Survey
http://www.usgs.gov
- Paper maps can be ordered online.

MapTech
http://www.maptech.com/mapserver.

Microsoft's Terraserver
http://terraserver.microsoft.com
- This web site includes aerial photography for many parts of the nation.

TopoZone
http://www.topozone.com
- This web site provides digital topographic maps at a variety of scales.

Maps showing census data related to social and economic data

Bureau of the Census
http://tiger.census.gov and http://factfinder.census.gov/servlet/BasicFactsServlet

Maps showing environmental data

Environmental Protection Agency
http://maps.epa.gov/enviromapper
http://www.epa.gov/surf/

Department of Housing and Urban Development, Healthy Communities
http://www.hud.gov/emaps

U.S. Geological Survey and U.S. Environmental Protection Agency, National Hydrography Dataset
http://nhd.usgs.gov/

Maps showing earth science data

U.S. Geological Survey
http://geode.usgs.gov

Base maps for use with geographical information systems

Environmental Systems Research Institute, ArcView
http://www.esri.com/software/arcview/index.html

Map Info Professional
http://dynamo.mapinfo.com/products/web/Overview.cfm?productid=44

Hydrological Information and Maps

Federal Emergency Management Agency
http://www.fema.gov/maps
- This web site contains surveys and highly detailed topographic maps (including cross sections) of many streams and rivers used to determine the extent of the active channel and the 100-year floodplain.

National Hydrography Dataset (U.S. Geological Survey and U.S. Environmental Protection Agency)
http://nhd.usgs.gov/
- The dataset is a basic source for stream and river geography.

U.S. Geological Survey
http://www.usgs.gov/water
- A variety of water data based on the 6,600 stream gages USGS operates. Data are available for each day of record, as well as in an abbreviated form showing only annual peak flows; information on each gaging station includes its dates of operation and a map showing its precise location. Users can retrieve the data either in tabular form for numerical analysis, or in easily read graphs.

OTHER DATA SOURCES

Sediment

U.S. Geological Survey

http://water.usgs.gov/owq.html

- The USGS keeps data on the quantity of sediment discharged passing through approximately 1,600 gaging stations.

Water Quality

National Water Quality Assessment Program (U.S. Geological Survey)

http://water.usgs.gov/owq/data.html

- Near real-time and historical data for many of the nation's rivers are available from the web site. The data can be downloaded in the form of tables for analysis from much, but not all, of the country.

APPENDIX B

GLOSSARY

Acre-foot the amount of water required to cover one acre to a depth of one foot. An acre-foot equals 326,851 gallons or 43,560 cubic feet.

Adaptive management a systematic process for continually improving management policies and practices by learning from the outcomes of operational programs. Its most effective form — "active" adaptive management — uses management programs that are designed to experimentally compare selected policies or practices, by evaluating alternative hypotheses about the system being managed.

Aggradation the raising of a riverbed due to sediment deposit

Allochthonous characteristic of or referring to events originating from outside the organism or the self.

Anadromous fish that hatch in freshwater, migrate to the ocean to mature, and return to freshwater to spawn.

Anchoring The practice, by some survey respondents, of basing stated willingness to pay for a non-market good on the known value of a market good that is considered similar or related in some way.

Arch dam a dam construction type used at sites that are narrowly constricted (e.g., valley or canyon containing the stream) and that spans the valley opening as one single structure, anchored in the sidewalls by thrust blocks.

Autotrophic needing only carbon dioxide or carbonates as a source of carbon and a simple inorganic nitrogen compound for metabolic synthesis

Bequest value a willingness to pay to preserve the environment for the benefit of one's descendants.

Breach a break or opening in a dam

Buttress dam a dam construction type made of flat decking sloping from crest to the base, typically comprised of reinforced masonry or stonework built against concrete.

Channelization the modification of a natural river channel, including deepening, widening, or straightening

Crib dam a dam construction type that is constructed of a timber outer box typically filled with rocks for stability, sometimes further stabilized with wire or brush blankets

Dam any barrier that impounds or diverts water

Decommissioning is a term used mostly for dams that are or have been generating hydropower and are shutting down power operations after losing relicensing from the Federal Energy Regulatory Commission (FERC). This may or may not include removing diversions for power generation, shutting down operations entirely, safe maintenance of dams after turbines are shut down and restoring sites to their normal, pre-project conditions.

Dam removal removal of the entire structure on a river or stream. This can also include restoration of the site to pre-project conditions.

Diversion the taking of water from a body of water into a pipe or other conduit

Earth fill dam a dam construction type that is constructed from local earth materials that are shaped and rolled into a sill across the watercourse to be dammed.

Existence value In the case of a unique and essentially irreplaceable resource, the value experienced by some due to the simple knowledge that the resource exists, irrespective of any current or expected future use.

Erosion wearing away of the land surface by detachment and movement of soil and rock fragments during a flood or storm or over a period of years through the action of wind, water, or other geologic process.

Fish ladder a series of ascending pools of running water constructed to enable fish to swim upstream around or over a dam.

Fish passage any feature of a dam that allows fish to move around, through, or over a dam without harm.

Free-flowing Undammed and unchannelized watercourses, as defined by the federal Wild and Scenic Rivers Act.

Gravity dam a dam construction type usually made of concrete, the weight of which is capable of providing the major resistance to the water forces exerted on it.

Hydroelectric power electric power generated by a flow of water.

Hypothetical bias Random error in survey results which is attributable to the hypothetical nature of the valuation task. Hypothetical bias is not actually a bias, since it is defined to have a zero mean.

Implied value cues Information communicated, explicitly or implicitly, in the course of an interview or in the body of a survey instrument that serves to suggest a value or range of values that may be appropriate for the non-market good in question.

Impoundment a body of water (such as a pond or reservoir) confined by a dam, dike, floodgate or other barrier used to collect and store water for future use.

Levee a raised embankment of a river, showing a gentle slope away from the channel, usually built to protect land from flooding.

Nonresponse bias A systematic error in valuation which results from incorrect assumptions about respondents who do not answer some or all questions; for example, assuming that these respondents hold values similar to those who do answer the questions.

Option value often categorized as a nonuse or passive use value and refers to the fact that an individual places a certain current value on the option to use a resource in the future.

Reservoir a large natural or artificial lake used as a source of water supply.

Restoration return of an ecosystem to a close approximation of its condition before a disturbance. The goal is to emulate a natural, functioning, self-regulating system that is integrated with the ecological landscape in which it occurs.

Riparian pertaining to a river.

Riparian habitat the habitat found on the bank of a natural watercourse (as a river) or sometimes a lake or tidewater.

River a natural stream of water of considerable volume.

Rock fill dam a dam construction type that uses rocks for weight and stability with a cover or membrane to provide watertightness.

Run-of-the-river dam A structure built by humans across a river or stream for impounding water, such that the impoundment at normal flow levels is completely within the banks and all flow passes directly over the entire dam structure within banks, excluding abutments, to a natural channel downstream. Some dams with storage reservoirs create a run-of-river condition through operating rules, whereby the dam releases water at approximately the same rate as the reservoir receives it.

Sample bias A systematic error in valuation which results from the way in which the sample of respondents was selected from the population.

Spillway a channel on a dam over which excess or flood flows are discharged designed to prevent impounded water from escaping over the top of the dam.

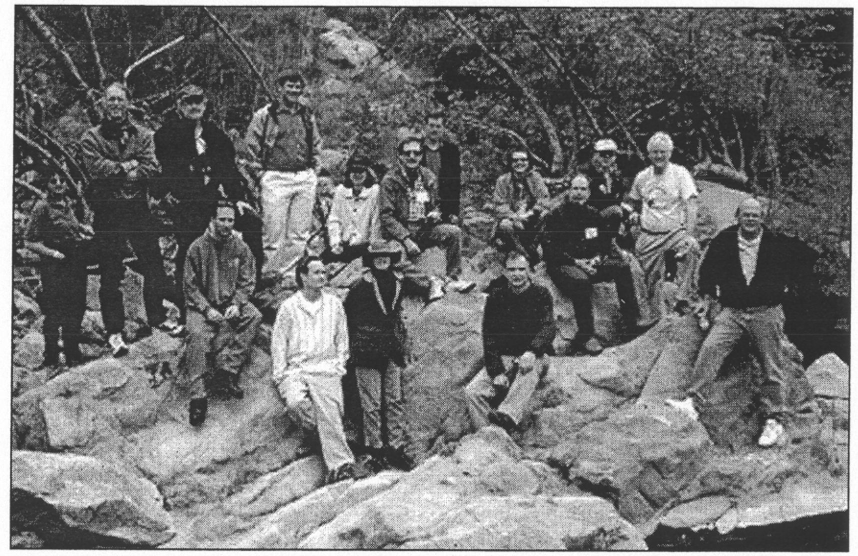
Strategic bias A systematic error in valuation which results from attempts by respondents to answer questions in a way that will benefit them in the future; for example, by understating values so as to cause lower user fees.

Stream Order The numbering of streams in a network. There are many different methods; the most widely used is a classification which labels all unbranched streams as first-order streams. When two first order streams meet, the resulting channel is a second-order stream. Where two second-order streams meet, a third-order stream results, and so on. Any tributary of an order lower than the main channel is ignored.

Watershed a region or area bounded peripherally by a divide and draining ultimately to a particular watercourse or body of water.

Appendix C

About the Contributors and the Project Staff



The Heinz Center panel met with federal and state officials during a field visit to the site of Rindge Dam on Malibu Creek in California. Back row, left to right: Syd Brown (California Department of Parks and Recreation), David Wegner (panel member), David Freyberg (Stanford University), Reinard Knur, Sheila David (Heinz Center Fellow and project manager), Will Graf (panel chair), Tom Downs, Mary Lou Soscia (panel member), William J. Bennett (California Department of Water Resources), Jack Kraeuter (panel member), Phil Williams (panel member), Doug Dixon (panel member). Front row: Jason Shea (U.S. Army Corps of Engineers), Chris Peregrin (California Department of Parks and Recreation), Suzanne Goode (California Department of Parks and Recreation), and Robert Hamilton (U.S. Bureau of Reclamation). Photograph courtesy of Sarah Baish.

THE CONTRIBUTORS

William L. Graf, *Chair*, is Educational Foundation Endowed University Professor and professor of geography at the University of South Carolina. His specialties include fluvial geomorphology and policy for public land and water. His research and teaching have focused on river-channel change, human impacts on river processes, morphology, and ecology, as well as contaminant transport and storage in river sediments. In the arena of public policy, he has emphasized the interaction of science and decision making, and the resolution of conflicts among economic development, historical preservation, and environmental restoration for rivers. He has published several books and more than 100 scientific papers and is past president of the Association of American Geographers. Previously, he was Regents Professor of Geography at Arizona State University. He has served on the National Research Council (NRC) as a member of the Water Science and Technology Board and is a member of the Board on Earth Sciences and Resources. His NRC committee experience includes a 10-year membership on the Committee to Review the Glen Canyon Environmental Studies and chairing the Committee on Innovative Watershed Management and the Committee on Research Priorities in Geography at the U.S. Geographical Survey. He was appointed by President Clinton to the Presidential Commission on American Heritage Rivers. He is also a National Associate of the National Academy of Science.

John J. Boland is a professor of geography and environmental engineering at Johns Hopkins University. He is a registered professional engineer. His background includes management positions in water and wastewater utilities, teaching, research, and consulting activities at all levels of government and private industry. Dr. Boland has published widely on economic aspects of water and resource policy. He is an associate editor of *The Annals of Regional Science* and a member of the Risk Management Technical Advisory Workgroup of the American Water Works Association. He has served on a number of committees and panels of the National Research Council and served as chair of the Water Science and Technology Board (1985–1988). He holds a B.E.E. in electrical engineering from Gannon College, an M.S. in governmental administration from George Washington University, and a Ph.D. in environmental economics from Johns Hopkins University.

Douglas A. Dixon manages the aquatic protection, water quality and fishery research initiatives at the Electric Power Research Institute (EPRI). Dr. Dixon has more than 25 years of wide-ranging experience in environmental science and engineering research, including 10 years assessing the impacts of hydroelectric projects on aquatic resources. He is experienced in the regulatory and procedural requirements of the Clean Water Act, National Environmental Policy Act, Federal Power Act, Endangered Species Act (ESA), and numerous other environmental acts as they apply to the Federal Energy Regulatory Commission's licensing and re-licensing authority and state permitting of steam-electric facilities. Areas of expertise include ecological risk assessment, environmental impact analysis, ecological modeling, fish passage, impingement/entrainment monitoring, ESA assessments, instream flow assessment, fisheries management plan review, and current and historical aquatic resource assessment. He holds a B.A. in biology from the State University of New York at Geneseo and a Ph.D. in marine fisheries science from the College of William & Mary.

Thomas C. Downs is a member of Patton Boggs's administrative and regulatory practice and concentrates on environmental law and general public policy. Mr. Downs has extensive experience in federal environmental law and policy, including the Comprehensive Environmental Response, Cleanup, and Liability Act (CERCLA, or Superfund); brownfields; Clean Water Act; and solid waste issues. Mr. Downs assists clients in briefing congressional offices, drafting legislation and congressional briefing papers, and developing legislative strategy. He also works closely with federal agency staff on executive branch initiatives. Mr. Downs handled environmental and natural resources legislation and other matters on Capitol Hill for more than 10 years before joining Patton Boggs. He served as legislative director and chief of staff to Representative George J. Hochbrueckner (NY-01) from 1987 to 1995 and as legislative assistant to Representative Martin O. Sabo (MN-05) from 1985 to 1987. He received a B.A. from Brown University in 1983 and J.D. from The American University, Washington College of Law in 1994.

John J. Kraeuter is an aquatic biologist with the Pennsylvania Department of Environmental Protection, Bureau of Waterways Engineering. His responsibilities include evaluating the environmental impacts of the proposed construction, modification, and removal of dams across the Commonwealth. Previously, he worked for a consulting firm specializing in the collection of biological data, including fishery, benthic macroinvertebrate, plankton, and freshwater mussel surveys, in streams, rivers, and lakes. He holds a bachelor's degree in biology from the University of Delaware.

Mary Lou Soscia serves as the Columbia River coordinator for the U.S. Environmental Protection Agency (EPA), Region 10-Seattle. In this role, she represents the EPA in discussions of the role of the Clean Water Act in future federal decisions on the Columbia River power system. Ms. Soscia has more than 20 years of experience with state, federal, and tribal government, specializing in watershed and river management issues. While on an assignment from the EPA in 1993–1997, Ms. Soscia served as coordinator of the Tribal Watershed Program for the Columbia River Inter-Tribal Fish Commission and as program manager for the Oregon Watershed Health Program. While working for the EPA in Washington, D.C., Ms. Soscia served on the team that developed and established the National Estuary Program, a collaborative effort to restore the nation's estuaries. Ms. Soscia also has worked for the states of Maryland and Wyoming. Ms. Soscia has a bachelor's of science degree in geography from Virginia Polytechnic Institute and State University and a M.S. in geography from the University of Maryland.

David L. Wegner has been involved in the design, coordination, and implementation of innovative scientific and river rehabilitation programs in the western United States and internationally since the late 1970s. Recently he established a company, Ecosystem Management International, Inc., that applies the scientific expertise developed in the Grand Canyon to river and terrestrial rehabilitation work focusing on endangered species and river process studies. From 1982 through 1996, Mr. Wegner coordinated the most extensive series of ecosystem studies and rehabilitation work ever attempted in the Colorado River basin. His expertise is in the areas of aquatic ecology, river engineering, and the application of science to risk assessment and adaptive management. His professional career includes work with the states of Minnesota and Utah and the U.S. Department of the Interior (DOI), and consulting with numerous Native American and environmental groups. He has received numerous commendations for public service, including recognition from the National Research Council, and is a recipient of the DOI's Bureau of Reclamation's Resource Management Award.

Philip B. Williams is president of Philip Williams & Associates LTD, an engineering and environmental planning firm he formed in 1979 that has offices in California, Oregon, and Washington. A professional civil engineer, he founded the San Francisco–based International Rivers Network in 1985. Dr. Williams has been engaged in a wide range of national and international hydrologic and engineering hydraulics work, primarily assessing the environmental effects of hydrologic change caused by dams and diversions and preparing feasibility studies, management plans, and environmental impact studies, related to river and wetlands restoration. He has directed more than 250 such studies, including projects on flood control, wetland restoration, river management, national park plans, water resources development, and estuarine management plans. He has authored or co-authored numerous papers on river management. He holds a Ph.D. in Hydraulics from the University of London's University College Civil and Municipal Engineering Department.

Craig S. Wingo is the national director for both the earthquake and dam safety programs within the Federal Emergency Management Agency (FEMA). He is responsible for the coordination of earthquake and dam safety activities at

the federal level in partnership with the states and private sector. Previously, Mr. Wingo served as the deputy associate director of the Mitigation Directorate (1996 to 1999), where he had oversight responsibilities for special projects covering a broad spectrum of FEMA's mitigation programs. Prior to that, he directed the Infrastructure Support Division in FEMA's Response and Recovery Directorate, served as the assistant associate director of the Office of Technological Hazards, and held several positions in the National Flood Insurance Program. Prior to his federal service, Mr. Wingo worked in a private civil engineering firm in Maryland. He is a licensed professional engineer in the Commonwealth of Virginia and received numerous awards and citations during his federal career, including the Senior Executive Service's Meritorious Executive Award and two FEMA Meritorious Service Awards.

Eugene P. Zeizel has more than 22 years of service with the Federal Emergency Management Agency (FEMA) and Federal Insurance Administration (FIA). Initially, he worked for more than three years as a project officer for flood insurance studies in Region VI. From 1981 through 1997, Dr. Zeizel managed FEMA's hurricane evacuation studies, conducted jointly with the U.S. Army Corps of Engineers and National Weather Service. He later was the project engineer for Regions VII and X, managing and resolving appeals and protests to the FIA's flood insurance rate maps. Dr. Zeizel has been working in the National Dam Safety Program Office since January 1999 and is responsible for dam safety research and training projects. He is a member of the subcommittees on research and training of the Interagency Committee on Dam Safety. Dr. Zeizel holds a B.S. in geology, M.S. in hydrology, and Ph.D. in civil engineering specializing in water resources and planning.

HEINZ CENTER STAFF

Sheila D. David is a fellow and project manager at The Heinz Center, where she is managing studies for the Sustainable Oceans, Coasts, and Waterways Program. At The Heinz Center, she has helped produce two reports: *The Hidden Costs of Coastal Hazards* and *Evaluation of Erosion Hazards*. Before joining The Heinz Center in 1997, she was a senior program officer at the National Research Council's Water Science and Technology Board for 21 years, where she was the study director for approximately 30 committees that produced reports on topics such as managing coastal erosion, restoration of aquatic ecosystems, protection of groundwater, wetlands characteristics and boundaries, water quality and water reuse, natural resource protection in the Grand Canyon, and sustainable water supplies in the Middle East. Ms. David has served as an advisor and board member of the Association for Women in Science (AWIS) and as editor of *AWIS* magazine. She is also a founder of the National Academy of Sciences' annual program honoring women in science.

Sarah K. Baish, now working towards a master's degree in urban and environmental planning at the University of Virginia, was a research associate for The Heinz Center's Sustainable Oceans, Coasts, and Waterways program through January 15, 2002. Before joining the Center, she worked in a national park in Slovakia as an environmental management consultant with the Peace Corps. Her primary responsibilities included grant writing, organizing educational events, promoting interpretive visitor services, and developing international collaborations. Before that, she had interned with the National Oceanic and Atmospheric Administration, and her work contributed to the establishment of a humpback whale sanctuary in Hawaii. Ms. Baish holds a B.A. in environmental science from the University of Virginia.

Judy Goss is a research assistant for The Heinz Center's Sustainable Oceans, Coasts, and Waterways program. She graduated cum laude with a degree in political science from Mary Washington College in May of 2001. She also works for Mary Washington as a part-time assistant debate coach. She is particularly interested in the intersection of gender and political communication, and she plans to pursue a graduate degree in communication studies.

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