

# Socioeconomic and Institutional Dimensions of Dam Removals: The Wisconsin Experience

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**STEPHEN M. BORN\***

**KENNETH D. GENSKOW**

Department of Urban and Regional Planning  
and Environmental Studies

Old Music Hall, 925 Bascom Mall  
University of Wisconsin–Madison  
Madison, Wisconsin 53706, USA

**TIMOTHY L. FILBERT**

**NURIA HERNANDEZ-MORA**

**MATTHEW L. KEEFER**

**KIMBERLY A. WHITE**

Institute for Environmental Studies  
University of Wisconsin–Madison  
Madison, Wisconsin 53706, USA

**ABSTRACT /** There are tens of thousands of small dams in the United States; many of these aging structures are deteriorating. Governments and dam owners face decisions regarding repair or removal of these structures. Along with the many benefits society derives from dams and their impoundments, numerous recent ecological studies are revealing the extensive alteration and degradation of river ecosystems by dams. Dam removal—a principal restoration strategy—is an infrequent event. The major reasons for removal have been

public safety and the high costs associated with repair; the goal of river ecosystem restoration now warrants greater attention. Substantial study is being given to the environmental aspects of dams and dam removals, but very little attention has been given to the socioeconomic and institutional dimensions associated with the removal of dams, although these factors play a significant role in the removal decision-making process. Based on a case study of dam removals in Wisconsin—where more than 30 of the state's 3600 small dams have been removed in the past few decades—legal, financial, and socioeconomic issues associated with dam removal are documented and assessed. Dam removal has been complex and contentious, with limited community-based support for removal and loss of the impounded waters. In cases examined here, the estimated costs of repairing a dam averaged more than three times the cost of removal. The availability of governmental financing has been a key determinant in removal decisions. Watershed-scale ecological considerations are not major factors for most local interests. As watershed management and restoration increasingly include dam removal options as part of an integrated strategy, more attention will need to be focused on socioeconomic factors and stakeholder perspectives—variables that strongly influence the viability of this management alternative.

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Until the past few decades, development and alteration of the nation's waterways for human benefits have been the central water resources management strategy in the United States (White 1971). There are more than 75,000 dams included in the 1992 National Inventory of Dams,<sup>1</sup> and about 2 million smaller dams in the United States (Haberman 1995, Shuman 1995). The many benefits that have accrued to humankind from this dam-building era include power generation, recreation,

flood control, water supply, and community and regional development. New habitat created by the impounded waters behind dams has been favorable for certain aquatic assemblages, including popular sport-fishes and aquatic organisms adapted to lakes, and the impoundments are often cherished by shoreland property owners, businesses, and communities for their property-related, recreational, and aesthetic values.

Not all consequences of dam-building are beneficial. Over time, severe water quality problems can arise in these impoundments, including shallowing due to rapid sedimentation, nutrient enrichment and increased productivity, and accumulation of contaminants. Highly eutrophic conditions can lead to undesirable algal blooms and excessive growth of aquatic vegetation, deteriorating sport fisheries, impaired recreation, and other problems. These problems can result in expensive maintenance and/or rehabilitation costs (Dunst and others 1974, Moore and Thornton 1988). The costs of

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<sup>1</sup>Under the Dam Safety Act of 1972 (P.L. 92-367), the National Inventory data base selection criteria include dams in excess of 6 ft in height with at least 50 acre-feet of water impounding capacity, or at least 25 ft with more than 15 acre-feet maximum storage. The criteria were amended in 1986 to include dams that pose a significant threat to human life or property in the event of failure.

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\*Author to whom correspondence should be addressed.

dam maintenance and repair can also be very high. Many dams, especially nonfederal dams, have deteriorated and need repairs; a significant number pose safety hazards (L. R. Johnson Associates 1989, Shuman 1995). However, the most profound long-term effects of dams, and perhaps the least recognized by the general public, are their ecological impacts on entire river systems.

Only in recent years has ecological research begun to identify the severe ecosystem disruptions caused by dams (Chisholm 1994, Ligon and others 1995, National Research Council 1992, Ward and Stanford 1987). The blockage of anadromous fish migrations, particularly with regard to Atlantic and Pacific salmon, has received the greatest attention (see, for example, National Research Council 1995, Nehlsen and others 1991, Williams 1996). Other adverse impacts of dams include changes in the movement of sediments and carbon-rich organic matter; modifications in stream channel morphology; loss of connectivity among ecological components, including spatial decoupling of rivers and their floodplain wetlands; and fragmentation and loss of habitat suitable for riverine aquatic life. According to one recent state report on biodiversity, dams are among the most significant obstacles to restoring the integrity of riverine systems (Wisconsin Department of Natural Resources 1995). Negative consequences of dams are further described in Doppelt and others (1993) and Naiman and others (1994). Additionally, from a human perspective, recreational and aesthetic values associated with free-flowing rivers are foregone when a river is impounded, including economic values associated with paddle sports and river fishing.

Most of the dams that have been removed to date in the United States—a relatively small number—have been removed because the structures have fallen into disrepair, become safety hazards, and been too costly to rehabilitate. Increasingly, however, as biophysical scientists have begun to document the nature and extent of damage to aquatic ecosystems caused by dams, the policy context has expanded beyond simply questions of public safety. Dam removal is now being more carefully considered as a means for ecosystem restoration by dam owners, local communities, conservation interest groups, and natural resource and regulatory agencies across the country.

While there is increasing study and attention being given to the biophysical consequences and impacts of dams and dam removal alternatives (e.g., Kanehl and others 1997, Pajak 1992), very little systematic attention has been given to the institutional issues associated with the removal of dams. This is particularly true for smaller dam removals—typically nonfederal dams and those not licensed by the Federal Energy Regulatory Commis-

sion (FERC). Yet these factors can play a major role in the dam removal decision-making process. Ultimately they will affect the opportunities for addressing a national environmental priority—the restoration of altered and degraded riverine ecosystems, including vital and vulnerable headwater tributaries (Doppelt and others 1993, Gore 1985).

The objective of this paper is to assess one state's (Wisconsin) experience with the removal of smaller<sup>2</sup> dams and, based on detailed case study analysis, to identify and evaluate the institutional factors—legal, financial, community attitudinal, and other socioeconomic dimensions—that shape decision-making regarding dam removal.

### The Wisconsin Setting

Wisconsin provides a fertile laboratory for such an examination. As a result of its mechanical and hydroelectric energy development history, there are more than 3600 dams in the state. Moreover, a relatively aggressive state agency dam safety program has led to the removal of more than 30 dams in the past few decades. Thus Wisconsin has had more experience with dam removal than most states, albeit on smaller river systems, and that experience may provide transferable insights regarding the issues and key institutional variables affecting dam removal and subsequent river restoration.

With its glacial terrain and northern continental humid climatic setting, Wisconsin has an enormous water resource base. The state is bordered on the west by the Mississippi River and dissected by some 43,000 miles of rivers and streams—about 10,000 miles of which are headwater streams that support valued cold-water fisheries. Wisconsin was among the leading states in developing its rivers for mechanical and hydropower energy (Bogue 1990). Since passage of the Mill Dam Act in 1840, thousands of dams were built on the state's rivers and streams and they have become a central part of the landscape in many Wisconsin communities.

The decision to remove a feature that has been strongly associated with community identity for decades is controversial and difficult. Over time, most of these structures have deteriorated and have required repeated repair or reconstruction. Although the Wisconsin Department of Natural Resources (WDNR) has documented 30 dam removals since 1965, far more have been repaired. For example, of 174 dams ordered

<sup>2</sup>“Smaller dams” as used here is a somewhat arbitrary term applied to dams generally less than 25 ft high and creating impoundments no more than a few hundred surface acres.

Table 1. Case study profiles

Name of dam	Location (river)	County	Site	Hydraulic head (ft)	Impoundment size (acres)	Year built	Year removed	Owner at time of removal	Original use	Last primary use
Fulton	Yahara R.	Rock	Rural	9	49	1849	1993	Rock Co.	Mill	Recreation
Greenwood	Black R.	Clark	Rural	10	N/A	1905	1994	Ownerless	Electricity	Recreation
Hayman Falls	Embarrass R.	Shawano	Rural	12	80	1917	1995	Shawano County	Electricity	Recreation
Huntington	Apple R.	St. Croix	Rural	28	60	1903	1969	Northern States Power	Electricity	Recr/Elect
Lemonweir	Lemonweir R.	Juneau	Rural	7	11	1914	1992	Town of Lemonweir	Mill/Elect.	Recreation
Manitowoc Rapids	Manitowoc R.	Manitowoc	Rural	8	10	1854	1984	Private	Mill/Elect.	Recreation
McClure	Apple R.	St. Croix	Rural	13	22	1913	1968	Northern States Power	Electricity	Recr/Elect
Nelsonville	Tomorrow R.	Portage	Village of Nelsonville	6	31	1860	1988	WDNR <sup>a</sup>	Mill	Recr/Mill
Ontario	Kickapoo R.	Vernon	Village of Ontario	9	N/A	1865	1992	Ownerless	Mill/Elect.	Recreation
Prairie Dells	Prairie R.	Lincoln	Rural	45	83	1904	1991	Lincoln County	Electricity <sup>b</sup>	Recreation
Pulcifer	Oconto R.	Shawano	Town of Pulcifer	2	negligible	1869	1994	Ownerless	Mill	Recreation
Somerset	Apple R.	St. Croix	Rural	17	83	1850s	1965	Village of Somerset	Mill/Elect.	Recreation
Woolen Mills	Milwaukee R.	Washington	City of West Bend	14	70	1870	1988	City of West Bend	Mill	Recreation
Young America	Milwaukee R.	Washington	Village of Young America	10	67	1851	1992	Town of Barton	Mill/Elect.	Recreation

Source: Wisconsin WDNR files and interviews.

<sup>a</sup>WDNR purchased the dam for purposes of removal.

<sup>b</sup>Never used for electrical generation.

for repair or removal since 1990 by the WDNR, only 19 were removed (WDNR Dam Safety Inventory). Several Wisconsin communities are currently debating the future of their local small dams. Three to four hundred dams in Wisconsin will likely face repair costs of at least \$100,000 within the next ten years (Richard Knitter, WDNR, Madison, Wisconsin, personal communication 1995).

### Dam Removal Issues—An Overview

Economic and financial concerns play a key role in most controversies regarding dam removal. Not surprisingly, there are often questions regarding the adequacy and accuracy of benefit–cost analyses prepared in conjunction with decision making. Critics may contend that these studies are too narrow in scope, failing to consider future maintenance and ultimate dam decommissioning costs. Benefits and costs that are not readily monetized and quantified are frequently not included, including key elements of the debate such as the value of the ecological and aesthetic benefits and costs attached to dams and their impoundments versus those associated with free-flowing rivers.

Economic issues associated with dam removal decisions include long-term operation and maintenance costs for the dam and impoundment versus removal (including who pays) and financial liability considerations. Potential liability can be a serious concern because dam owners are liable for dam failure, personal injury to visitors or trespassers, and potential environmental and property damages stemming from dam failure. Dam liability insurance policies are commonly umbrella policies with large deductibles, leaving dam owners exposed to substantial financial risk.

Another economic issue affecting individual riparian

property owners involves potential decreased property values resulting from dam removal. Shoreland owners generally seem to believe that their property is worth more as “lakefront” than as “river-frontage,” although there is little information to support or refute such perceptions. Interestingly, the Michigan Department of Natural Resources has studied property value changes along the AuSable River and reports that “river frontage was at least equal to, if not more valuable than, the original lake or reservoir frontage” (Haberman 1995).

Because most dam removal issues are highly contentious, significant concerns may be raised about the scope of interests represented in the decision-making process, as well as the process itself. Stakeholders include the public/private dam owner, shoreland property owners directly affected by any decision, a more extended community of local interests and governmental units, and state agencies and nonresident recreational and environmental interests. These entities not only may have very different positions on the issue, but varying degrees of salience in the outcome. Because the dam removal decision-making process is commonly triggered by nonlocal interests, concerns about procedural openness, access to information, and fairness can also become controversial issues.

### Study Design and Methods

Research for this paper was conducted during the fall of 1995 and is more fully described in Born and others (1996). Our work focused on the relatively infrequent occurrence of dam removals in an effort to better understand the factors associated with removal decisions, including a systematic review of pertinent Wisconsin statutes and regulatory authorities. Detailed

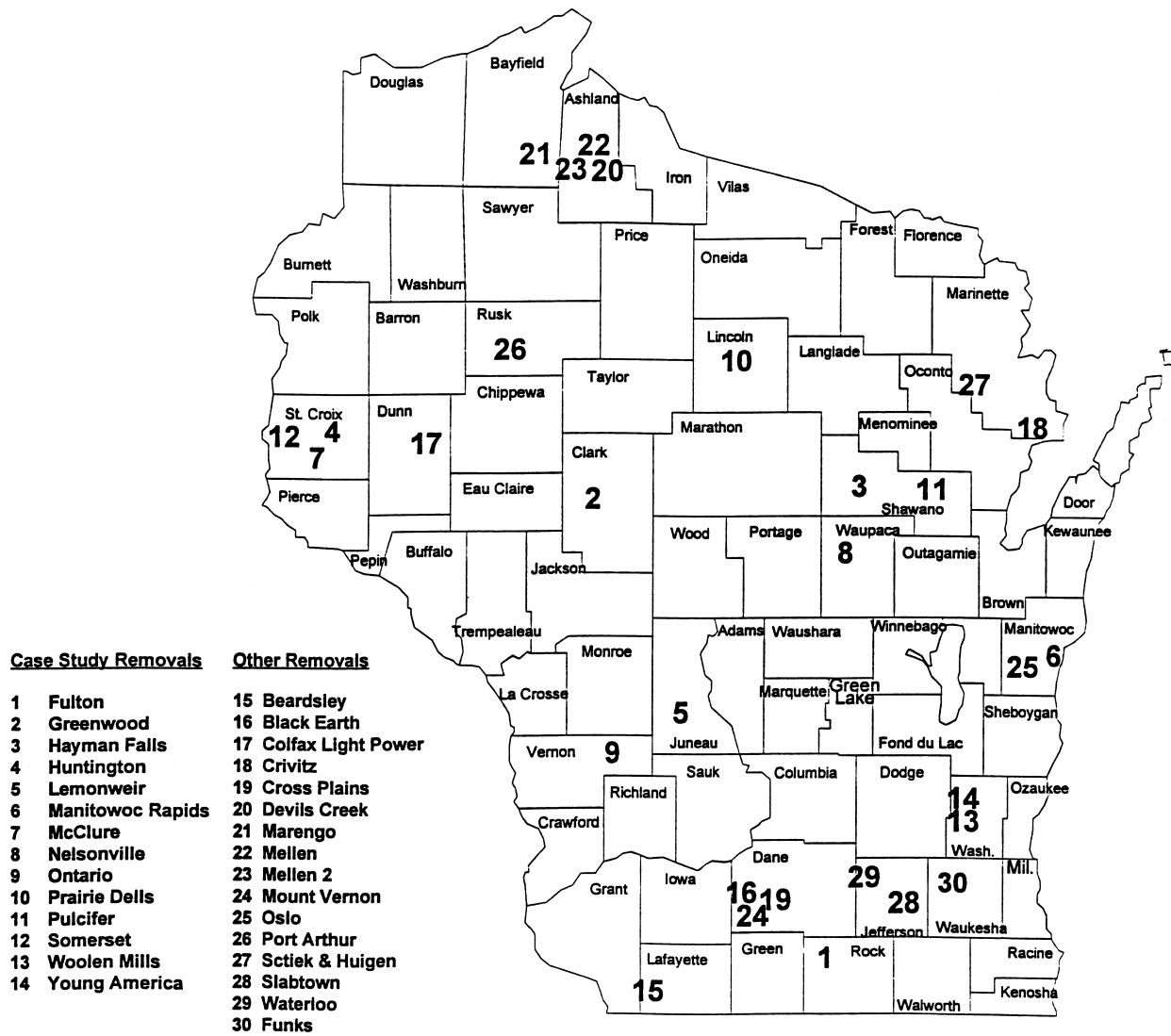


Figure 1. Dam removals in Wisconsin.

case studies (Table 1) were prepared for 14 dam removals selected from the 30 completed removal projects (Figure 1) overseen by the Wisconsin Department of Natural Resources. Cases were selected based on (1) maturity (i.e., where the dams had already been removed, allowing a clearer identification of significant issues that arose during the removal decision process); (2) diversity (i.e., dams of different sizes, ownerships, and issue arrays); and (3) geographic distribution across the state. Data gathering included document reviews of agency files and semistructured interviews with various participants in the removal process. Interviewees included state agency engineers and fishery professionals; local government and community representatives; representatives from conservation, environ-

mental/fishing, and property-owner interest groups; and key stakeholders from nearby communities. Interviews sought to clarify the facts situation, but most importantly to gather the opinions of different stakeholders regarding their perspective on the dam removal experience (see Appendix 1 for the list of open-ended interview questions).

The study addresses only cases where dams were removed. Additional insights would likely have been gained by a parallel study of cases where decisions were made to repair dams. Although an exploratory reconnaissance of 17 recent dam repair cases was conducted, supplemental research was precluded by data limitations and the scope and time constraints for the primary focus of this study.

## Analysis and Findings

### The Legal and Institutional Framework for Dam Removal in Wisconsin

Based upon our review of pertinent laws and regulations, we here present a brief summary of the legal and institutional framework associated with dam removal in Wisconsin. State laws directed at dam operation, safety, and property rights set the context for the stakeholder interactions surrounding dam removal. In addition to state institutions, federal laws and agencies play a role in dam regulation and removal. Federal and state agencies regulate the operation and maintenance of dams, while local governments develop ordinances regulating land uses associated with dams and impounded waters.

*State regulatory role.* All the laws that regulate water in Wisconsin are rooted in the state's strong *public trust doctrine*. Generally, under public trust doctrines, a state holds the beds of navigable waters in custody for all of its citizens and has an obligation to protect public rights in navigable waters. In Wisconsin, the notion of navigable waters is construed very liberally, and thus the public trust doctrine applies to almost all state waters. The public trust doctrine in Wisconsin is supported not only by statute but also by the state constitution as interpreted by the state Supreme Court, beginning with the 1952 benchmark case of *Muench v Public Service Commission* (Quick 1994). Muench successfully challenged the Public Service Commission's approval of a dam on the Namekagon River. Part of the findings in this famous case, which illustrates the broad application of the doctrine in Wisconsin, addressed the question of whether public rights for recreational enjoyment of this scenic river in its natural condition outweighed the benefits to the public that would have resulted from construction of the dam.

While public trust considerations are critical in decisions to approve construction of a dam, there is less certainty about their applicability in dam removal and repair decisions. In some cases, the state has the right to physically remove a nuisance from public waters, a circumstance that might pertain to some dams. An aggressive application of the public trust doctrine in dam removal or repair cases, if upheld, would likely expand the basis for decision making beyond the single issue of public safety.

The legislature, through a series of statutes, has delegated much of the state's authority and responsibilities under the public trust doctrine to WDNR, which is the primary state agency in charge of regulating dams and flowages. A WDNR permit is required for construction, operation, and removal of dams on navigable

waters, as well as for any transfers of dam ownership (Ch.31, Wis. Stats.). WDNR may deny a construction permit if the dam is not in the public interest. This determination is made after comparing the ecological, aesthetic, economic, and recreational values of the river with and without a dam [s.31.06(3), Wis. Stats.]. Wisconsin law requires all dams to be operated in a manner that does not materially obstruct navigation; protects public rights; preserves life, health and property; and maintains the dam in good repair (s.31.185, Wis. Stats.). If an owner is unable to maintain a dam, it can be transferred to a municipality or other party who is able to do so.

A Dam Safety Inspection Program requires WDNR to inspect all dams in the state at least once every ten years (s.31.19 Wis. Stats.). Dams found unsafe according to WDNR safety classification levels (dam hazard ranking and criteria) must be repaired to WDNR standards or removed (NR 333, Wis. Admin. Code). Administrative orders are the enforcement mechanism for safety recommendations deemed necessary.

WDNR permits are required for the abandonment, removal, or alteration of a dam. When a community or other dam owner is either unwilling or unable to pay for essential repair and maintenance, they may choose to have the dam removed. The owner/community must have the financial means to meet the substantial costs that are typically involved in removal, although state aid may be available. WDNR can also remove abandoned ("ownerless") dams or cause their removal. A WDNR cost-sharing program (Municipal Grant Fund) offers municipalities and special purpose districts assistance with dam maintenance, repair, modification, abandonment, and removal (s. 31.385 Wis. Stats.). Program funding varies annually, and projects receive funds according to a priority system that considers the hazard rating of the dam and whether the dam will be removed or repaired. Since 1991–1992, WDNR has also administered an Abandoned Dam Fund to remove dams that pose a hazard to public safety and are unclaimed, although funding for this program ended in 1996. Any state action regarding dam abandonment and removal usually involves public hearings to provide a forum for citizen comment.

WDNR permits for the construction, modification, and abandonment of dams are encompassed under the Wisconsin Environmental Policy Act (WEPA). This act requires the state to consider the environmental and economic effects of policies, plans, and programs on the quality of the human environment. Permits relating to large dams require the preparation of either a formal environmental assessment or a full environmental im-

compact statement. The smaller dams studied here typically do not require such formal reviews, although they could be required if WDNR determines that a proposed action could have a significant impact on the environment.

The Wisconsin Historic Preservation Program requires state and local government agencies to determine if their proposed actions adversely affect any properties of historic significance. The Historic Preservation Program affects all state actions that involve dispensing permits and financial assistance and local government actions involving the demolition or rehabilitation of properties eligible for historic preservation. Given that many dams in Wisconsin were built in the 19th century, the decision to repair or remove can raise historic preservation concerns.

*Pertinent federal and local regulatory authority.* Although the Federal Energy Regulatory Commission currently licenses 81 dams in Wisconsin (Mecozzi and others 1991), and numerous facilities are currently going through the relicensing process, this paper is focused on smaller non-FERC dams. Accordingly, primary federal regulatory authority affecting dams considered here rests with the US Army Corps of Engineers. The Corps' main role in the process is to regulate dredge and fill in waters of the United States under Section 404 of the Clean Water Act.

Local regulatory authority pertinent to dam removal includes zoning requirements and certain land and water rights. In Wisconsin, local authorities are required to enact zoning regulations in shorelands and floodplains (Kent 1994). When a dam is removed and the impoundment drained, previously inundated land becomes exposed and available to new land uses, requiring adjustments to local zoning ordinances.

Under Wisconsin law, riparian landowners own flowed lands to the geographic center of the former stream channel, provided the land was privately owned before a dam was constructed and the flowage rights were not sold. After dam removal, ownership of the newly exposed land reverts to the riparian owner, so that they may gain both acreage and land value.

Riparian landowners can also claim right to maintain the water levels created by a dam. If they can establish that they have had uninterrupted use of the high water for a period of 20 years or more, they may have gained a prescriptive right to continued high water levels—for example homes, resorts, or marinas that were built because of the lake and subsequently relied on the lake levels. While this might provide a means to temporarily prevent a dam owner from intentionally drawing down the impoundment level, it cannot force the owner to

make repairs to the dam or prevent the ultimate abandonment of the structure. Prescriptive rights are determined through litigation.

Finally, Wisconsin Administrative Statutes [section 60.10(2)(g)] state that disposal of property purchased by a municipality must be authorized by the electors of the municipality (city, village, town, or county) at a special public meeting. This would apply to the abandonment of municipally owned dams and thus affects the decision-making process and the outcome in repair/removal decisions.

Dam purchases in Wisconsin are restricted to parties who can provide proof to WDNR of their financial ability to operate and maintain the dam in accordance with WDNR specifications (s. 31.14, Wis. Stats.). Private individuals still own dams in Wisconsin, but the limitations on transferring dam ownership practically limits the pool of current purchasers to the state, municipalities, and public utilities. The primary reason for restricting the transfer of dams from public ownership to private individuals is attributed to liability concerns (s. 31.21, Wis. Stats.), although this statute does not prohibit private individuals from purchasing dams. Owners may lease their dams to private parties for operation and power generation, but leases that extend for more than ten years must be approved by WDNR. In all cases, dam owners, not operators, are liable for environmental and property damages resulting from dam failure, as well as personal injuries that occur on the dam property.

#### Case Study Synthesis

Fourteen cases were selected for analysis of the institutional and socioeconomic dimensions of dam removal (Table 1). All cases involved dam removal under WDNR oversight, and each incorporated a broad range of issues. All dams were built between 1849 and 1920, all were built by private owners predominantly for hydroelectric power or mill operation, all but two dams were less than 20 ft high, and all impounded less than 100 acres. Many of the dams were acquired by local governments in the 1960s after they became obsolete for their original purposes but continued to provide recreation and aesthetic benefits that were highly valued by local residents. Half of the 14 dams were owned by local units of government at the time of removal. In three cases, WDNR failed to locate a viable owner and declared the dams abandoned, thereby assuming responsibility. One dam was purchased by the WDNR from the last owner. Only three were still in private hands at the time of removal.

*Dam removal decision.* In most cases, removal was originally proposed as an alternative to repair following a WDNR or Corps of Engineers safety inspection. Given

Table 2. Reasons for dam removal

Name of dam (year removed)	Initial triggering event(s) in the dam removal process					Ultimate decision-maker
	WDNR safety inspection	Dam failure	WDNR administrative order <sup>a</sup>	Perceived safety risk <sup>b</sup>	WDNR purchase	
Fulton (1993)	✓		✓			County Board
Greenwood (1994)	✓					WDNR (abandoned dam)
Hayman Falls (1995)	✓		✓			County Board
Huntington (1969)		✓				Private Owner
Lemonweir (1992)	✓		✓			Town Board
Manitowoc Rapids (1984)	✓		✓			Administrative Judge
McClure (1968)		✓				Private Owner
Nelsonville (1988)					✓	Village Board
Ontario (1992)	✓			✓		WDNR (abandoned dam)
Prairie Dells (1991)	✓		✓			County Board
Pulcifer (1994)				✓		WDNR (abandoned dam)
Somerset (1965)				✓		Village Board
Woolen Mills (1988)	✓					City Council
Young America (1992)	✓		✓			Town referendum

<sup>a</sup>A safety inspection always precedes a WDNR Administrative Order.

<sup>b</sup>Not associated with WDNR action.

that recommendations are not enforceable, in some cases the removal process did not actually begin until an enforceable administrative order was issued requiring dam owners to take action on WDNR’s safety recommendations (Table 2). This reflects a reluctance on the part of the owners to act, perhaps because dam owners perceive dam safety hazards differently than responsible agencies, and certainly because of an unwillingness to incur expenses. Exceptions to the safety inspections include the three dams removed in the 1960s by the owners because they were no longer economical to operate. Another exception is the dam at Nelsonville, which was purchased by WDNR specifically for removal with the purpose of river ecosystem restoration.

Not all the alternatives to dam removal—repairing the existing dam, replacing the dam with a new structure, or building a new dam in a different location—received the same degree of consideration. In some cases, only the removal option was seriously considered. Table 3 illustrates that the estimated cost to repair a dam was often prohibitive, generally exceeding three times the cost of removal. The analysis of the cases and a reconnaissance review of repair cases indicates that when the decision was up to private owners or local units of government, and the dam had no economic use, removal was chosen because it was the least-cost alternative, even though other alternatives might have been preferred. Other potential benefits such as safety improvements or river restoration were relevant only in those cases where WDNR was responsible for the ultimate decision.

The availability of WDNR cost-sharing programs eased the financial burden of removal in most cases.

Table 3. Comparison of estimated repair and final removal costs

Name of dam (year removed)	Total removal costs <sup>a</sup>	Repair estimates <sup>b</sup>	Cost differential (repair: removal)
Fulton (1993)	\$375,000	\$900,000–1 million	2.5
Greenwood (1994)	\$80,000	\$500,000	6.25
Hayman Falls (1995)	\$180,000	\$455,000–\$800,000	3.5
Huntington (1969)	\$35,000	not evaluated	n/a
Lemonweir (1992)	\$190,000	\$700,000	3.7
Manitowoc (1984)	\$45,000	\$30,000–\$250,000	3
McClure (1968)	\$50,000	not evaluated	n/a
Nelsonville (1988)	\$62,000	not evaluated	n/a
Ontario (1992)	\$47,000	\$100,000–\$200,000	3.2
Prairie Dells (1991)	\$200,000	\$725,000	3.6
Pulcifer (1994)	\$40,000	not evaluated	n/a
Somerset (1965)	\$75,000	\$30,000	0.4
Woolen Mills (1988)	\$80,000	\$3.3 million <sup>c</sup>	n/a
Young America (1992)	\$74,300	\$313,000	4.0
Average	\$109,500		

<sup>a</sup>Dollar value at time (year) of removal; taken from engineering reports, WDNR files, news reports and interviews.

<sup>b</sup>Information availability varied for each case; taken from engineering reports, WDNR files, news reports and interviews.

<sup>c</sup>Estimates for removal were not developed independently of other infrastructure work.

Often there was a belief that if the removal option were chosen, the likelihood of receiving WDNR financial assistance would be greater. Table 4 illustrates that in five removals, WDNR matching funds from the Municipi-

Table 4. Funding sources for dam removal

Name of dam	Local government (%)	WDNR municipal dam fund (%) <sup>a</sup>	WDNR abandoned dam fund (%) <sup>b</sup>	Federal Wallop-Breaux (%) <sup>c</sup>	Other funds <sup>d</sup>
Fulton	50	50			
Greenwood			100		
Hayman Falls	50	50			
Huntington					owner
Lemonweir	50	50			
Manitowoc					WDNR budget and owner
McClure					owner
Nelsonville				partial	WDNR-owned
Ontario			100 (for removal)		additional WDNR funds for postremoval improvements
Prairie Dells	50	50			Trout Unlimited and WDNR funds for postremoval improvements
Pulcifer			100		
Somerset	partial				owner contributions
Woolen Mills	100			partial	additional WDNR funds for postremoval improvements
Young America	50	50			

<sup>a</sup>WDNR's Municipal Dam Repair and Removal fund provides 50% matching grants up to \$200,000 for dam maintenance, repair modification and abandonment.

<sup>b</sup>WDNR finances 100% of removal costs for ownerless dams.

<sup>c</sup>The Wallop-Breaux Fund (Federal Aid in Sport Fish Restoration Act) was previously called the Dingell-Johnson Fund and provides federal cost-sharing money administered by WDNR.

<sup>d</sup>Additional funds available for removal and restoration but not used in these cases include the federal Land and Water Conservation Fund (LAWCON), the federal Small Cities Block Grant Program, federal Clean Lakes funds, and numerous Wisconsin state funds (see Born and others 1996, p 14).

pal Grant Fund covered 50% of the removal costs. Public funds covered the balance of costs. WDNR Abandoned Dam Safety funds were used to remove the three dams that had no owner, and the agency also financed the removal of the dam it had purchased. Other state and federal funding sources such as Wallop-Breaux and WDNR Priority Watershed funds were used for removal purposes or postremoval stream restoration efforts (Table 4).

In almost every case, local communities were involved in the decision-making process through public meetings. Without exception, some citizens voiced opposition to dam removal at these meetings. These forums provided local governments and WDNR opportunities to disseminate information and solicit citizen input. However, efforts to involve citizens in the decision-making process met with varying degrees of success. In half the cases, some stakeholders asserted that citizens' opinions were not fully taken into consideration or that information presented at the meetings (by WDNR or town boards) was intentionally biased toward removal. Some removal permits were appealed at the state level, where they were ultimately upheld. Local governments did not intervene in the removal decision in those cases that involved privately owned or WDNR controlled

dams. In cases where the final decision was up to the WDNR, agency representatives held informational public meetings but ultimately made removal decisions.

*Stakeholders.* A major focus of this study examined how stakeholders perceived decisions leading to dam removals. Given the complexity and the long duration of dam removal processes, in most cases it is difficult to clearly delineate a sustained group of stakeholders for or against removal throughout the entire process. Different groups of people participated in the process at different times, and their positions sometimes shifted as new information became available or as new relevant issues emerged. For example, in the case of Lemonweir, local farmers and business owners who were located along the Lemonweir River originally opposed the dam removal option. However, over time they reversed their stance when they realized that reservoir drawdown would provide them with more acreage for agriculture and development. Several other community interests became more accepting of the removal option after better understanding the costs involved in repairing and maintaining the dam.

Table 5 summarizes the set of perceived gains and losses associated with dam removal. The majority of the cases listed the loss of recreational activities and aesthet-



Table 5. Postremoval stakeholder perceptions of dam removal gains and losses

Name of dam	Hydroelectricity potential	Recreation	Point of interest	Aesthetics	Property values	Wildlife habitat	Safety	End of maintenance costs	End of liability risk
Fulton									
Gain							●	●	●
Loss	●	○		●		●			
Greenwood									
Gain		○					●		
Loss		●	○			●			
Hayman Falls									
Gain			○				●	○	○
Loss	●	●	○	●		○			
Huntington									
Gain		●		○		○	●	●	●
Loss	○	●		○		○			
Lemonweir									
Gain						○	●	●	●
Loss		○		○	○	●			
Manitowoc Rapids									
Gain				○		●	●		●
Loss		●	○	○	○	●			
McClure									
Gain		●		○		○	●	●	●
Loss	○	●		○		○			
Nelsonville									
Gain						●	○	●	
Loss		●	○	●	○				
Ontario									
Gain		●		○		○	●		
Loss		○	○	○		○			
Prairie Dells									
Gain				●		●	●	●	●
Loss	●	●	●	●	○	●			
Pulcifer									
Gain							●		
Loss	○	●				○			
Somerset									
Gain		●				○	●		
Loss		●		●					
Woolen Mills									
Gain		●				●			
Loss		●		●					
Young America									
Gain						○	●		
Loss		●		●		○			

●, major issue; ●, significant issue; ○, mentioned but not significant.

ics associated with the impoundment as the leading concerns among those opposed to removal; significantly, these were also perceived as gains by removal supporters. Over half the cases reflected the loss of a nostalgic location and loss of fish and wildlife habitat

associated with the impoundment. Stakeholders also expressed concern over the loss of potential hydro-power generation, even if the dam had not been actively generating electricity for decades and major retrofits would have been necessary. Surprisingly, reduced prop-

Table 6. Postremoval issues

Name of dam	Restoration efforts	Water quality	Current uses
Fulton	Enlarged park	Fish habitat affected by sediment	Park site
Greenwood	Very little needed	Not an issue	Scenic/aesthetic fishing
Hayman Falls	Revegetated embankments	Not studied because of dams up- and downstream	Scenic area, fishing
Huntington	None known	Not studied	Fishing, canoeing
Lemonweir	Riprap to stabilize embankment		Reduced fishing, reduced waterfowl hunting
Manitowoc		Not studied	Salmon and trout fishing
McClure	None known	Not studied	Fishing, canoeing
Nelsonville	Riprap and tree-planting to stabilize impoundment and channel	Improved to class 1 coldwater status; trout spawning occurring	Trout fishing
Ontario	Streambank stabilized Canoe launch built	Not studied	Trout fishing, canoeing
Prairie Dells	Landscaping, revegetation	Sediment trap installed to control initial turbidity	Trout fishing, scenic area
Pulcifer	Erosion control	Not studied	Limited canoeing, park planned
Somerset	None known	No apparent improvement or degradation	Extensive recreational use, tubing popular
Woolen Mills	\$1.4 Million spent on restoring wetlands and prairie; park facilities and trails built	Improved habitat, fishing potential and biotic integrity	Popular park, fishing
Young America	Bank stabilization downstream of dam	Sediment not a problem	Improved trout fishing, enhanced wildlife habitat

erty value of lakefront development was noted in only four studies as a significant issue in dam removal, although almost all cases had shoreland owners.

The most vocal opponents to dam removal were typically riparian landowners—those living adjacent to the impoundment. These landowners were usually a small group within the larger community, often representing less than a dozen properties (unlike the cases in our reconnaissance of dam repairs, where the number of riparian owners was significantly larger, often involving dams located in the midst of a community as opposed to in a largely rural setting). This lack of substantial opposition may have facilitated the decision to remove the dam. Local communities at or near the dams also frequently opposed removal, as did recreation interests who supported pond fisheries and boating.

Stakeholders in 12 of the 14 cases noted safety improvements as gains, and stakeholders in over half the cases listed improved fish and wildlife habitat as a result of a free-flowing river. The elimination of ongoing financial burdens (through maintenance or potential liability) was seen as a positive result of removal for eight dams. Improved recreational activities associated with a free-flowing river were significantly valued in only three of the cases; stakeholders in three cases also listed improved aesthetics of a free-flowing river. Owners with financial and safety liability for the dams supported removal in all cases. WDNR nearly always supported

removal, particularly with those dams removed since the Dam Safety Inspection Program was established in 1983. Other supporters for removal (in four cases) were river conservation or recreation interests.

*Postremoval issues.* As illustrated in Table 6, slightly more than half the cases included on-site environmental restoration efforts following dam removal. Most restoration efforts were undertaken to stabilize streambanks, the channel or former impoundment; activities included the placement of riprap to reduce erosion and channel scouring of the stream bottom, bank seeding, and tree planting. The degree of restoration was influenced by the size of the dam structure and impoundment, as well as the funds available for restoration efforts. At one location, postremoval activities included extensive wetland and prairie restoration, as well as the creation of park facilities. At other sites, however, minimal restoration attempts were undertaken. For some of the dams removed decades ago, there is no clear historical record of stream restoration.

Changes in water quality were not vigorously investigated following many of the dam removals; this lack of rigorous stream restoration project evaluation is, unfortunately, commonplace (Kondolf and Micheli 1995). When quality was considered, primarily at sites that involved trout fisheries, improved conditions typically followed removal. Some downstream habitats were ini-

tially adversely affected by sediment loads, but subsequent indications suggest that degradation was temporary.

River fishing is apparently the most common postremoval use, although other recreational uses, including canoeing and “tubing,” were common. At least three of the case study sites have developed, or are planning to develop, parks at the old impoundment location.

## Conclusions

There are thousands of small dams across the nation, many of which are deteriorating. Dam owners, communities, and states face decisions regarding repair, replacement, or removal of these structures. While many benefits are derived from dams and their impoundments, advances in ecological sciences are revealing the extensive alteration of river ecosystems by dams. Although concerns regarding safety currently drive decision making about dam removal, the opportunities for river ecosystem restoration warrant greater attention. All but one of the Wisconsin dam removals were catalyzed by safety concerns. The exception involved a WDNR-led river ecosystem restoration as a major goal of dam removal.

In Wisconsin, the decision to remove a dam has generally been based on the prohibitive costs of repair and lack of recognized economic use. In cases examined here, the final decision was based on the least-cost option in terms of costs incurred by dam owners, be they municipalities or private individuals. Considerations of the benefits and costs associated with dam removal and aquatic ecosystem restoration and the future costs of decommissioning the dam were not included. For the cases studied, the estimated costs of repairing dams were more than 300% greater than the costs of removal. The availability of partial governmental financing has been a key determinant in removal decisions.

The dam removal decision-making process is lengthy, complex, and contentious. For the most part, local stakeholders and communities have become strongly attached to their pond or impoundment, valuing it for recreation and aesthetic benefits as well as community identity. The list of dam removal advocates is generally short and includes state agency resource professionals and some conservation/fishing organizations; fishery advocates have been the most active nongovernmental dam removal proponents. Residual hostility and nostalgia exists in many communities following dam removal. However, some communities have capitalized on their “new” free-flowing river with expanded recreational and economic opportunities and riverway parks. For example, the 1965 removal of Somerset dam restored a

segment of the Apple River and enabled development of a thriving “tubing” industry with significant local economic and recreational benefits. This is consistent with community experiences involving other pre-1970 Wisconsin dam removals, such as those on Black Earth Creek and Mt. Vernon Creek, where coldwater fisheries have become valuable community and regional assets.

Numerous policy prescriptions applicable to Wisconsin and other states are suggested by this study. States should consider expanding the criteria and analyses associated with dam removal decisions. A formal policy and supportive funding for selected dam removals for the purpose of river ecosystem restoration, in addition to the long-standing concern of dam safety, could be instituted. Given the lack of citizen and community information and understanding about the value of free-flowing rivers and river restoration, information and education programs about dams, dam removal/repair, and riverine ecosystems and restoration should be initiated or expanded. Without careful attention to the socioeconomic and institutional aspects of dam removal and river restoration, in conjunction with the biophysical dimensions, the potential for restoring and rehabilitating degraded aquatic ecosystems will not be realized.

## Appendix 1. Interview questions for stakeholders in dam removal cases

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1. What were the most significant issues for you in the dam removal debate?
  2. What issues do you think were at stake in the debate? (values to the community)
- OR
3. What do you think the community gained or lost with the dam removal?
  4. Who were the key players in the debate and what were their positions? What were the main events that characterized the debate?
  5. How were you involved in the decision-making process? Did you feel you were given the opportunity to actively participate and influence the outcome of the decision?  
If not, what were the impediments to your participation?
  6. How (if at all) have your opinions on dam removal changed from the time the issue was debated in your community to today?
  7. If the issue were to come up again in your community, what would you have done differently?  
How would you have changed the decision-making process?
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