The influence of aging dams and geography on the distribution of dam removals in the United States

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Abstract

Over 470 dams have been removed in the United States, and a significant increase in dam removals has occurred since the early 1990s. The aging of dams is often cited as the primary factor influencing removals; as dams surpass their functional life span, safety hazards, economic costs, and environmental concerns can increase significantly. However, the removal of dams has physical, economic, social, and political impacts and the distribution of dam removals may be influenced by factors other than age. By analyzing this distribution, this study aims to assess the various factors influencing the removals of dams. Understanding these guiding factors ultimately will assist in the development of policies for future dam removals and promote cooperation between the varied stakeholders in a particular region.

With the help of other researchers, I created a database of dam removals in order to analyze the dam removal distribution in the United States. The database enabled an examination of three research questions pertaining to the distribution of dam removals: 1) whether the age of dams influences distribution; 2) whether political boundaries influence distribution, through the presence of state dam statutes; and 3) whether physical boundaries influence distribution, through the presence of coordinated river restoration projects involving dam removal. The results of this study show a spatially and temporally uneven distribution of dam removals in the United States. A weak trend toward removing older dams is apparent, suggesting factors other than age controlling dam removals. Political, or state, boundaries appear to influence the number of dam removals found within a particular region. These states that include provisions for dam removals within a state statute have the highest number of dam removals, on average. Physical, or river basin, boundaries also appear to influence dam removal distribution, although to a lesser degree. Several basins with the most dam removals have coordinated ecosystem or river restoration efforts that include dam removal. On average, the basins with coordinated restoration efforts have more recent dam removals compared to dam removals nationally, suggesting a trend toward basin-level restoration efforts that include dam removal. Other factors also appear to influence dam removal distribution as well, such as the presence of dam removal organizations and agencies and state-supported funding for dam removal.

Acknowledgements

Molly Pohl of San Diego State University created the original database of dam removals discussed in this paper and she graciously agreed to share her database with me. This research project would not have been possible without her, and I truly appreciate her generosity. The data provided by American Rivers and several other organizations and state agencies also assisted greatly in this research project. In particular, I would like to thank Scott Carney of the Pennsylvania Fish and Wildlife Commission, Brian Fitzgerald of the Vermont Agency of Natural Resources, Laura Hewitt of Trout Unlimited, Stephanie Lindloff of the New Hampshire Dam Removal and River Restoration Program and Serena McClain and Sara Nicholas of American Rivers.

Several faculty members of the Department of Geosciences at Oregon State University helped me complete this project, each in their own unique way. Many thanks to Aaron Wolf, not only for his intense enthusiasm and excellent advising, but for continuously discovering a new source of funding for me in the Terra Cognita Laboratory. Gordon Grant provided me with great insights into the dam removal arena and our many conversations helped to structure this research project. Jon " Dr. K." Kimerling introduced me to the beautiful world of cartography and I will forever be indebted to him. Julia Jones was a wonderful mentor to me as a graduate student and will continue to be as I move forward in life. Finally, Gordon Matzke convinced me to come to Oregon State University in the first place, and I thank him greatly for that excellent advice.

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Finally, I dedicate this paper to anyone who has ever sat a river bank and appreciated the beauty and power of a rushing river. You fight for the protection and restoration of our rivers every day. Thank you.

Introduction

Over 75,000 documented dams can be found along the nation's rivers (USACE 2000), and the estimated number of undocumented dams brings this total to well over two million (NRC 1992). In recent years, however, natural resource agencies and local communities have increasingly considered dam removal as a management option, and this upward trend continues in the early 21st century. As the myriad dams in the landscape surpass their functional life span, they become safety hazards, and the economic and environmental costs of old dams can increase significantly as dams age; therefore, the need for repair or removal of dam increases as the dam ages. However, although dam removals are hydrological in nature, they are often driven by political forces. Occurring within both political and physical boundaries, dam removals have the potential of causing tension and conflict between political regulations and both hydrological and ecological considerations. While age may be a consequential factor in whether a dam is removed, geography, such as political and physical boundaries, may also significantly influence the distribution of dams in the landscape.

The questions examined in this paper are whether this uneven distribution of dam removals is influenced by the increasing age of dams and if the political boundaries of the state and the physical boundaries of the river basin influence this distribution as well. I will analyze the distribution of dam removals by examining the following parameters: 1) the age of dams in relation to dam removals; 2) the influence of political boundaries, through an examination of state statutes pertaining to dam removals; and, 3) the influence of physical boundaries, through an examination of river restoration projects in particular river basins. As dams age, safety, economic and environmental considerations become more acute; therefore, one would expect a relationship between the age of dams and dam removals. Additionally, the presence of dam removal provisions in state statutes can indicate a willingness of the state to consider dam removal as a river management or restoration option, and the degree of detail in explaining the procedures of dam removal within the statute help to describe a state's perspective on the management of its natural resources. Finally, by examining whether removal decisions currently are being made on a basin scale will help to determine the factors influencing these removals in the hopes of better understanding how future dam removals can coincide with ecosystem restoration goals.

Background

Dam development

The history of dam removal is brief, yet it is predated by a long evolution of river basin development and, subsequently, management and restoration. Nearly every river in the United States is dammed. Although the earliest recorded dam in the United States dates back to the late 1600s, the age of river basin development in the United States began during the Great Depression and after World War II, with politics and economics playing the determining role in the direction of river work projects. The idea that large river works projects could bring pecuniary relief to a struggling nation appealed to both the communities affected by the river projects and the government that oversaw them.

Marc Reisner, in his influential book, *Cadillac Desert*, describes the evolution of water resource conflicts in the West as a dichotomy between the desire by the federal government for the expansion of white settlement into the newly-acquired western land and the limitations of the water resources to support that settlement: " while [John Wesley Powell], a Midwesterner, knew that all the private initiative in the world wouldn't make [the West] bloom, Theodore Roosevelt, an easterner, had returned from the West convinced that there were 'vast areas of public land which can be made available for settlement ... by building reservoirs and main-line canals impractical for private enterprise.'" (Reisner 1986:110). Roosevelt promoted the conservation of natural resources, although, in the age of the Progressive Era during the early 20th century, conservation was defined as an efficient use of resources; an efficient conservationist strategy would control the water in the entire river, from the headwaters to the ocean (Schad 1979). In the *Conservation and the Gospel of Efficiency: The Progressive Conservation Movement, 1890–1920*, Samuel P. Hays describes these conservationists:

> "The new realms of science and technology, appearing to open up unlimited opportunities for human achievement, filled conservation leaders with intense optimism ... They displayed that deep sense of hope which pervaded all those at the turn of the century for whom science and technology were revealing visions of an abundant future." (Hays 1959:2)

The construction of dams increased at an incredible pace throughout the first decades of the 20th century and paralleled the westward expansion of european settlement. The National Inventory of Dams (NID), a database that includes only those dams that are over six feet tall, over 100 feet wide or are a high hazard to human safety, lists over 75,000 dams in the United States. The number of smaller dams is unknown, although one source estimates the total number of dams in the United States to be 2.5 million (NRC 1992).

The public's enthusiasm for river basin development withered in the United States during the 1960s. Many of the optimal sites for dams had already been developed, and, subsequently, many sub-optimal sites were also developed, leading to projects whose economic and environmental insults were more flagrant (Reisner 1986). Congress then moved away from "big government" projects, such as large river basin development (Muckleston 1990). Perhaps the most important movement, however, was toward a public reexamination of the past sixty years of uninhibited natural resource degradation and exploitation, including river basin development. In 1962, Rachel Carson published *Silent Spring*, a landmark exploration of the toxic environmental impact of pesticides, initiating the involvement of the American public in the fight against environmental degradation (Carson 1962). A few years later, David Brower, the president of the Sierra Club, placed a full page advertisement in newspapers across the country alerting the public to the Bureau of Reclamation's plan to flood the Grand Canyon by damming the Colorado River: "Should we also flood the Sistine Chapel so tourists can get nearer the ceiling?" (Reisner 1986). The public outcry was immediate and federal legislatures could no longer ignore the sentiment of its citizens. As described by an executive of the Bureau of Reclamation, "Letters were arriving in dump trucks. Ninety-five percent of them said we'd better keep our mitts off of the Grand Canyon ..." (Reisner 1986:286).

The environmental movement also fostered the creation of several federal and state legislative policies in favor of an environmental approach to water resources, including the Wild and Scenic Rivers Act in 1968, the National Environmental Policy Act in 1969 and the Clean Water Acts of the 1970s (Muckleston 1990). The creation of federal entities, such as the Environmental Protection Agency and the proliferate formation of environmental grassroots and non-profit organizations also helped to focus the public's attentions toward the degradation of water resources.

Large river basin development projects virtually ceased in the United States during the last two decades of the 20th century (Gleick 1998). By the 1980s, the severe impacts of dams and other structures on the fluvial system were well known and well researched, garnering the attention of the public (Graf 2000). Water quality, conservation, and planning, therefore, became the focus of water resource management rather than increased development. Large, federal river basin development is largely politically unfeasible as well in the current political climate (Dziegielewski and Baumann 1992). Although the federal government continues to be involved with large river basin projects, these projects tend to be multi-organizational in nature, with equal participation of state agencies and local organizations, and the projects often focus on restoration and planning rather than dam building (Muckleston 1990).

While much of the 20th century focused on construction in rivers, such as damming, rechanneling, and straightening, the trend in the 21st century appears, cautiously, to be one of deconstruction. Over 470 dams have been removed from America's rivers, and a combination of environmental, economic, social, and political issues have contributed to dam removal as a tool for river management (Gleick 2000). For example, the state of Wisconsin has been proactive in removing its dams, especially since the early 1990s, and safety concerns and the prohibitive economic costs of repair have triggered many of the removals (Born et. al 1998). The need to uphold the Endangered Species Act and Clean Water Act, coupled with the physical deterioration of old, obsolete dams and the increased awareness of environmental justice issues, will help to perpetuate this trend of dam removals across the United States in the 21st century:

> "Any grand vision for the future of America's rivers must accommodate the paradox that our twentieth century legacy is one of technological impacts on streams (primarily but not exclusively through the building of dams), while our stated policy (in the Clean Water Act) for the twenty-first century is the restoration of rivers."
> (Graf 2001:2)

Aging of dams

Safety, economic and environmental issues have significantly guided dam removal as a management option (Pohl 2002), leading to a steep increase in removals since the 1990s (Figure 1). The U.S. Army Corps of Engineers has estimated the functional life span of most dams to be around 50 years, and, in 2004, the average age of all U.S. dams in the NID is nearing this age, at 48 years. By 2020, over 85 percent of U.S. dams will have surpassed their functional lives (Doyle *et al.* 2003a), posing a significant safety concern as well as creating a severe economic liability for the owner of the dam. The owner of an aging dam is faced with several options, and, economically, removal is most often significantly less expensive than renovating the dam to alleviate safety concerns (American Rivers *et al.* 1999). Environmental issues, such as fish habitat, water quality, and the benefits of a natural river flow regime, have also influenced the removal of dams, although these benefits are more difficult to quantify (Pohl 2002). The owner of a dam may cite environmental concerns as the reason for removal, when, in fact, economic or safety

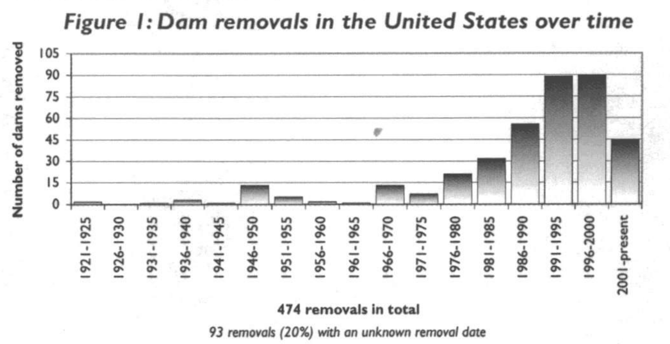


Figure 1: Out of the 474 dam removals in the Dam Removal Database, only 381 entries had both a year built and a year removed date and, therefore, could be plotted on this chart. The first dam removal entry is in 1922 and the last entry is in September 2003.

issues prompted the removal initially. Also, when many dams were built in the early to mid-20th century, engineers, political officials, and scientists rarely considered the environmental impacts; therefore, as these dams age and are reconsidered in the current political and social climate, their environmental impacts may now seem egregious and unacceptable.

Political and regulatory factors affect aging dams as well. For example, as a dam ages, it may be subject to regulation of the Federal Energy Regulatory Commission (FERC), an independent agency that regulates 56 percent of the approximately 2,300 hydroelectric projects in the United States (the remaining projects are regulated by the federal government) (FERC 2004). As part of the FERC's regulatory authority, the agency is responsible for relicensing hydroelectric projects every 30 to 50 years, depending upon the characteristics of the project. Until the mid-1980s, the relicensing process consisted primarily of an examination of economic impacts of the project. However, a 1986 amendment to the Federal Power Act requires the FERC to place equal consideration on the environmental impacts of the hydroelectric projects as well, forcing the commission to examine the impacts on wildlife, water quality, and recreation. The FERC must consult with federal, state, and local natural resource agencies during the relicensing process, providing a unique opportunity for these agencies to alter hydroelectric dam operations in order to achieve river restoration goals or to advocate for the removal of the dam. In 1999, the FERC ordered the owner of the Edwards Dam on Maine's Kennebec River in Maine to remove the dam because of its detrimental impact to the anadromous and endangered fish population in the river (FERC 2004 and American Rivers *et al.* 1999). The Edwards Dam removal is only time that the FERC has exercised its authority to force the removal of a dam, yet many river restoration organizations are using the FERC relicensing process as a legal means to advocate for the removal of hydroelectric dams (American Rivers *et al.* 1999).

Prompted by the relentless aging of dams across the landscape and their safety, economic, and environmental considerations, several research projects and think tanks have addressed how to best manage aging dams in the landscape. American Rivers, founded in 1973, is a national non-profit organization that operates the *Rivers Unplugged* program, which is dedicated to "restoring rivers by removing dams that no longer make sense." (American Rivers *et al.* 1999). In addition to yearly compilations of dams removed across the United States, researchers at the organization have published in-depth case studies of dam removals (American Rivers *et al.* 1999), a summary of ecological benefits of removal (American Rivers 2002), and dam removal decision-making (American Rivers and Trout Unlimited 2002) and removal funding guides (American Rivers 2000) aimed toward natural resource agencies and local organizations. The research conducted by American Rivers was instrumental in this paper and has helped to educate state agencies, watershed organizations and public citizens on the benefits and costs of dam removal.

Two think tanks, the Heinz Center and the Aspen Institute, have recently published reviews and recommendations for future dam removals. Both institutes have panels consisting of experts from various fields, including the academic, federal, state, and private arenas. The Heinz Center report, *Dam Removal: Science and Decision Making* (2002), summarized the known and unknown physical, biological, economic, and social impacts of dam removal. Recommendations resulting from the report include the need for further scientific investigation into the impacts of dam removal on the geomorphology and ecology of river systems as well as the creation of a national database of dam removal information. The Aspen Institute report, *Dam Removal: A New Option for a New Century* (2002), also recommended the establishment of a national clearinghouse for dam removal information as well as expanding the NID database to list all dams, regardless of size.

Finally, the World Commission on Dams (WCD) was established as a response to the detrimental environmental, social, and economic impacts of dams around the world. The WCD published a report in 2000, *Dams and Development: A New Framework for Decision-Making*, that outlined recommendations for enlightened future dam development that would consider the human and biological impacts of dam building. The report also acknowledged the limited life span of dams and the need to provide for decommissioning funds when building new dams as well as the need to consider dam removal as an repair alternative for established aging dams around the world. While the United States is the front-runner in dam removal, other countries, such as France and Japan, are also considering dam removal as an option to alleviate safety risks and economic costs (WCD 2000).

Geographic boundaries of dam removals

The age of the dam is unlikely to be the only factor influencing its removal. Political and ecological factors can influence the decision to remove a dam as well, leading to a need for an examination of the influence of geographic boundaries on the distribution of dam removals. Geographic boundaries can be both political and physical; indeed, many states in the United States have at least one border following a river or basin boundary. John Wesley Powell — western pioneer, runner of the untamed Colorado River, and the second director of the United States Geological Survey — suggested to a late 19^{th} century Congress that the western United States should be organized by hydrological boundaries rather than political ones; he realized early on that governing by watershed boundaries would facilitate more efficient management of scarce water resources (Powell 1879). Congress rejected Powell's vision of the West, and, consequently, the federal and state governments used political boundaries as the organizing unit for the management of water resources. However, an appreciation for the many functions of watersheds has surfaced during the past thirty years, and the definitions of new words and phrases describing this basin approach to water management — restoration ecology, integrated water resource management, ecohydrology and cumulative impact analysis, to name a few — have become commonplace in the vocabularies of many natural resource managers, environmentalists and scientists.

Dam removals are hydrological in nature, yet they are often driven by political forces. Occurring within both political and basin boundaries, dam removals have the potential of causing tension and conflict between political regulations and both hydrological and ecological considerations (not to mention social and economic issues), yet the possibility of harmony exists. Analysis of dam removals at both the political and physical level has the potential of revealing some of the forces guiding dam removal and, ultimately, might assist in the development of policies for future dam removals.

Scientific uncertainty

Finally, it must be noted that despite the factors guiding dam removal, the adoption of dam removal as a management option is hindered by the lack of empirical research on the various impacts of removal. Due to the recent emergence of dam removal and the length of time needed to study the physical, biological and chemical changes to stream networks, the research and literature on the environmental effects of dam removal is sparse (Bednarek 2001, Shuman 1995). Past research has incorporated the use of models (e.g. Rathburn and Wohl 2001), reservoir drawdown experiments (e.g., USGS 1999), controlled floods (Wohl and Cenderelli 2000, Webb *et al.* 1999) and dam failures (e.g. Stock *et al.* 1991) as the basis for study, although studies following actual removal of dams, several of which are cited below, are becoming more common.

Studies on the physical impacts of dam removal have focused on sediment deposition and transport (Rivers Alliance of Wisconsin and University of Wisconsin-Madison 2002, Simons and Simons 1991), geomorphic change (Doyle *et al.* 2003b, Bushnaw-Newton *et al.* 2002, Pizzuto 2002, Anderson 1991) and the change to the characteristics of the ice regime following removal (White and Moore 2002). Quantitative research on the biological impacts of dam removal have focused on the impacts of sedimentation and channel adjustment following removal on spawning areas (Kanehl and Lyons 1997), the pre- and post-removal changes to macroinvertebrate communities (Stanley *et al.* 2002) and other organisms (Bushnaw-

Newton *et al.* 2002). Chemical alternations following dam removal are often connected with suspended sediment concentrations (Bushnaw-Newton *et al.* 2002), although future research will likely focus on the connection between dam removal and agricultural runoff (Doyle *et al.* 2003c).

Economics plays a major role in the dam removal decision-making process and several studies have recently emerged that attempt to estimate these economic impacts, although the literature remains quite sparse. Not all of the outcomes of dam removals are market-based (The Heinz Center 2002), such as the value of a free-flowing river, and several studies have used non-market valuation methods to determine the costs and benefits of dam removal, such as travel cost demand techniques to model the changes in recreational use of a river following a removal (Loomis 2002) and a contingency valuation survey to determine local residents' willingness to pay for a free-flowing river (Loomis 1996). The reduction of property values is often cited as a negative side effect of dam removal, and one recent study has examined the economic costs of fluctuating reservoir water levels on the lake front property prices (Loomis and Feldman 2003).

As empirical studies on dam removal gain momentum and the impacts of removal become less of a mystery, stakeholders will have a better foundation upon which to base their dam removal decisions. However, the impacts of each dam removal is site-specific and can vary tremendously with each removal. Considering that dam removals have typically been conducted only on small dams, the potentially more complicated impacts of large dam removals may remain uncertain for quite some time.

Research questions and objectives

The objective of this paper is to examine three research questions:

1) Does the age of dams influence the distribution of dam removals in the United States?

2) Do the political boundaries of states influence the distribution of dam removals?

3) Do the physical boundaries of river basins influence the distribution of dam removals?

The age of a dam is often cited as a primary reason for removal, and this study assesses the validity of the correlation between aging dams and dam removals. Due to the political nature of dam removals, an examination of political boundaries may prove valuable in determining the guiding factors of dam removals as well. Finally, dam removals are ultimately hydrological in nature; therefore, an examination of coordinated river restoration efforts that include dam removal can help to determine whether the distribution of dam removals is guided by physical boundaries.

Methods: The dam removal database

The analysis of the geographic distribution of dam removals required the collection of all completed dam removals in the United States. American Rivers publishes a list of completed removals and dams slated to be removed on a yearly basis (American Rivers 2004), and several other states publish their own list of dam removals (e.g., WI DNR 2004, California Department of Water Resources 2004). The collection of all known dam removals into a single database facilitated analysis by providing a complete representation of removals in the United States. Additionally, it provided an opportunity the check the accuracy of data collected by other organizations.

Background

Dr. Molly Pohl and other researchers at San Diego State University originally created the Dam Removal Database (DRD). Beginning in 1999, the researchers spent three years gathering dam removal data for removals meeting specific requirements: 1) intentional and complete dam removals; and 2) dams either over six feet high or 100 feet in length (Pohl 2002). Pohl was interested in intentional removals rather than those due to dam failures; the decision-making process to remove a dam that has failed is much different than the process to intentionally remove a dam that is structurally intact (Pohl 2002). Pohl also felt that the decision-making process for breached dams was different than for complete removals, so she limited the DRD to only complete removals. The height and length restrictions were meant to mimic the restrictions on dams included in the U.S. Army Corps of Engineers' NID database.

The researchers began with lists of removals published by several different organizations (such as American Rivers, National Park Service, and state agencies); they then verified each entry with the appropriate agency, organization, or citizen responsible for removal, if such information could be found. Formal requests for information on dam removals were also sent to federal, state and local agencies organizations (Pohl 2002). By only including those removals from lists published by non-profit organizations, such as American Rivers, that could be verified in another manner, Pohl hoped to avoid the possible biases of advocacy organizations (M. Pohl, personal communication). Pohl and her research team then compiled the resulting lists of removals into the DRD.

The original DRD contained 417 dam removals, ranging from the years 1922 through 2000. Latitude and longitude entries were confirmed for 326 dams, although many of the coordinates were not based on exact locations but on general locations within the county or state of the removal (depending on the extent of the data collection). The researchers did not separate the generalized coordinates from the exact coordinates, although entries in the "Comments" field sometimes indicated the method for estimating the dam removal location. Lacking research time and assistance at San Diego State University, Pohl agreed to share her original DRD in order to bring it up to date through 2003.

Updating and reorganizing the Dam Removal Database

Updating and reorganizing the DRD was completed in several steps. I updated the database through September 2003 in the same manner in which the other removal entries were originally compiled. American Rivers published an updated list of dams slated for removal and completed dam removals in the summer of 2003 (American Rivers 2004), and, from this list, I contacted all of the agencies and organizations responsible for removals from 2000-2003. For those removals that I could not verify in this manner, I searched the internet and news outlets for verification of removal, size measurements of the dam, and other information pertaining to the removal. I placed the remaining unverified removals in a separate table in the database for future research. I found other removals, not included on the American Rivers list, by contacting state agencies and organizations responsible for dam removals.

I chose not to use many of the fields in the original DRD[1] due to the lack of time to obtain complete data, and due to the lack of data itself. The fields in the completed DRD are as follows: Removal ID, State, Dam name, River, Latitude, Longitude, Accuracy, Year removed, County, City, Height (ft), Length (ft), USGS quad, Regional basin, Subregional basin, Cataloguing unit basin, NIDID, Year built, and Comments. A unique Removal ID was given to each dam removal; the "State", "Dam name", "River", "Year removed", "County", "City", "Height", "Length" and "Year built" fields all pertain to information collected for each dam removal and not all fields are complete for every dam; the "USGS quad" field lists the United States Geographical Survey (USGS) topographic quadrangle on which the dam was located; and "Comments" lists pertinent information for each removal. The "Regional basin", "Subregional basin" and "Cataloguing unit basin" fields list the watershed region in which the dam was located, as defined by the USGS hydrologic units (Seaber *et al.* 1987). Due to the different levels of accuracy of the dam removal locations, some of the fields may not be complete.

[1] Fields not included in the database: GIS estimate, Section/Township/Range, Primary removal purpose, Additional removal purpose, Total cost of removal, Primary funding source, Contributing funds, Sediment management, Starting removal date, Ending removal date.

The exact locations (the "Latitude" and "Longitude" fields) for every entry in the DRD was extremely difficult to obtain. Many of the dams were removed several decades ago and records of older removals are often either lacking or unobtainable. To accommodate for the several levels of accuracy regarding the locations of dam removals, I created a hierarchy scheme (Table 1) of accuracy for each dam removal entry in the database.

I verified the latitude and longitude coordinates, in decimal degree format, for every entry in the database by studying USGS 7.5 minute quadrangles, either in hard copy form or, more often, in an online geo-referenced form. TopoZone (www.topozone.com , last accessed January 13, 2004) provides a geo-referenced version of most USGS topographic maps in the United States, and the maps are searchable by place name, UTM coordinates, or latitude/longitude coordinates. Exact locations for many of the dam removals were located through a place name search. For dams that I could not locate through place name, I then searched for maps locating the city (if available) of the removal and/or the river (if available) where the original dam was located. For each dam removal entry I entered the level of accuracy of the location in the "Accuracy" field (see Table 1 for a complete description of the accuracy hierarchy).

Collection of other data

Information on state dam removal statutes and permitting processes were collected through the state government agencies responsible for the legislative actions, most often the state Dam Safety Program. The basins are delineated according to the hydrologic units classification defined by the U.S. Geological Survey (Seaber *et al.* 1987). The fourth level of river basin classification, called the cataloguing unit, was selected

Table 1: Hierarchy of the accuracy field in the DRD

Accuracy	*Description*
Exact	Removals for which the exact location was either found through 1) personal communication with or documentation from the agency/organization responsible for removal or 2) a place name search on TopoZone or verification on a hard copy USGS topographic quadrangle.
Approximate	Removals for which the approximate location was known by either personal communication with or documentation from the agency/organization responsible for removal, but was not found on a USGS topographic quadrangle.
City	Removals for which the city/town where the dam was originally located is known, but not an approximate or exact location. The city coordinates were used as the location of the removal.
River confluence	Removals for which the river where the dam was originally located is known, but not the city. The coordinates of where the river flows into a larger water body were used as the location of the removal.
County	Removals for which the county where the dam was originally located is known, but not the city or the river (or if the river could not be located on a map). The county coordinates listed on the U.S. Census Bureau website (www.census.gov) were used as the location of the removal.
State	Removals for which only the state where the dam was originally located is known. The coordinates found by estimating the location of the center of the state on a GIS layer were used as the location of the removal.

for this study because this is the smallest level of basin classification available through the USGS. There are 2,149 basins represented by the cataloguing units; the basins are defined by the USGS as those larger than 700 square kilometers (in most cases) and "representing part or all of a surface drainage basin, a combination of drainage basins, or a distinct hydrological feature." (Seaber *et al.* 1987:3). Very few dams have been removed, as compared to the number of dams currently intact; therefore, I chose to analyze small river basins rather than large ones (such as those listed under regional or subregional basins). Additionally, for political, scientific, and economic reasons, coordinated river restoration efforts often occur within the context of smaller basins rather than larger ones, with the exception of regional coordinated efforts, such as the Chesapeake Bay Program.

Analysis and discussion

Summary of the Dam Removal Database (DRD)

The DRD contains 474 dam removals in the United States, ranging from 1922 through September 2003 and located in 44 states, plus Washington D.C. (see Appendix 1 for a complete listing of dam removal entries). The majority of dam removals have occurred on small dams with heights below 20 feet (Figure 2). Of the 474 dam removal entries, 258 entries have both the height and length measurement, 154 of which (60 percent) have heights less than or equal to 20 feet and lengths less than or equal to 500 feet. The remaining removals without both measurements are most likely smaller dams rather than larger ones, due to the lack of data for smaller dams in general. The average age of dams removed is 69 years old, based on 126 entries that have both a year built and removal date entry (381 removals have a removal date, 162 removals, have a year built date, and 126 entries have both dates). Again, the average age of removals is most likely older than 69 years, based on the assumption that the older the dam, the greater the possibility that data will be lacking. The accuracy of removal locations varies: 51 percent (241 removals) of the dam removal entries have either an exact or approximate accuracy of location; 37 percent (174 removals) have either a city or river confluence level of accuracy; and 12 percent (59 removals) of the entries are at the county or state level, the lowest levels of accuracy in the database. See Figure 3 on the next page for a spatial representation of dam removals in the United States.

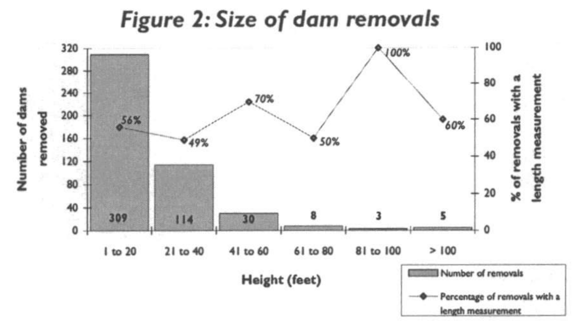
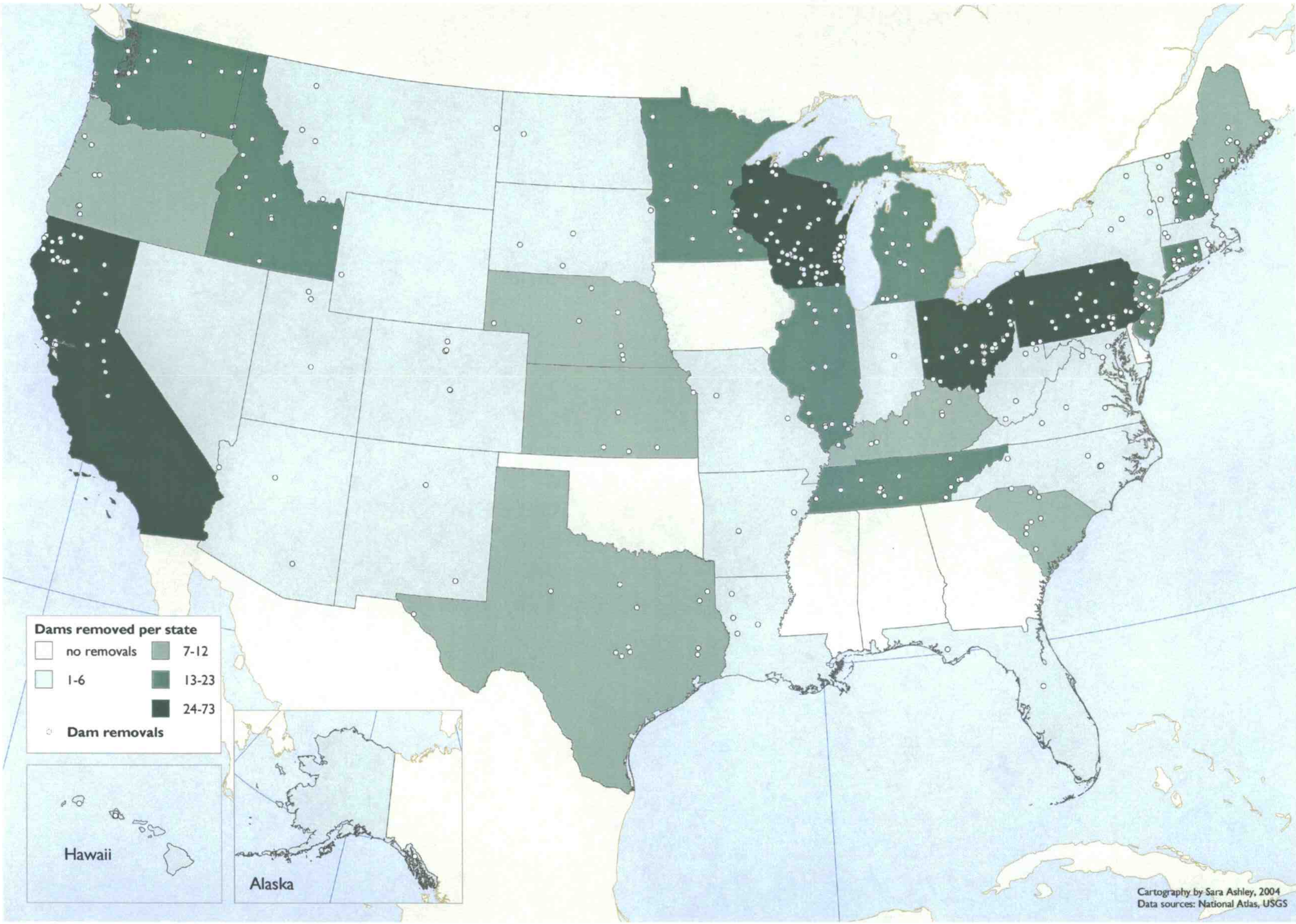


Figure 2: The actual number of dams removed have been small dams with heights below or equal to 20 feet. While most of the dam removals in the DRD have height entries, the entries for length is not as complete.

Forty-six dam removals for which I have detailed information are not included in the DRD either

Figure 3: Distribution of dam removals in the United States



because they do not meet the height or length requirement, or due to a lack of measurement information altogether (see Appendix 2 for a listing of dam removals not included in the DRD). By only including dam removals of a certain size, the analysis of dam removals in the United States is not complete. However, as there are thousands of small dams not included in the NID database, there may be an unknown number of small dam removals for which information is not published or obtainable. This source of error will decrease as more information becomes available for each dam removal.

The aging of dams versus dam removals

The age of a dam is often cited as a key factor in whether the dam is considered for removal (e.g. American Rivers *et al.* 1999, Grant 2001, Doyle *et al.* 2003d). Dams deteriorate as they age and once they surpass their functional life span, which, on average, is 50 years (FEMA 2004), they can become safety hazards and the costs of maintenance and repair accelerate. Therefore, one might expect a positive correlation between the average age of dams in a geographic region and either the number of dams removed or the removal density. The removal density (the number of removals divided by the total number of dams) provides a measure for how many opportunities to remove a dam were taken advantage of in a particular region. For example, comparing the absolute number of removals in California to the number of removals in Rhode Island is not always accurate, because smaller states do not have the same number of opportunities to remove dams as compared to larger states. While the removal density provides a better representation of the proportion of dams being removed, the absolute number of dams removed is also important in determining the region's willingness to consider dam removal as river management tool. Even if large state has many dams, it is still important to consider the reasons why the state removes (or does not remove) its dams.

Analysis and results

For this analysis, I compiled the average age of dams per state using the NID database. Approximately 90 percent of the NID entries (69,450 dams) have a year built date, and the average age for all of the dams in the United States is 48 years. I discuss the inaccuracies of using NID data for this analysis later on in the paper; however, the NID database is the most comprehensive national listing of dams.

The comparison of removals to the absolute number of dams per state reveals that seven out of the top ten states with the highest dam removals have an average age of dams over 50 years: Wisconsin, California, Pennsylvania, New Hampshire, Connecticut, Michigan, and New Jersey. Eight out of the top ten states with the highest removal densities have an average age of dams over 50 years — Wisconsin, Hawaii, Idaho, California, Pennsylvania, New Hampshire, Connecticut and Washington (Table 2).

While absolute numbers of dams removed and removal density per state are generally correlated, a comparison of these two graphs reveals some differences within particular states (Figure 4). Texas, Illinois, California and Pennsylvania, for example, have a high number of removals as compared to their relatively low removal densities, suggesting that these states have a large number of dams that they are not removing. Alternatively, Hawaii has a high removal density, but a low actual number of removals, which implies that this state may be removing a large proportion of its dams despite its relatively low number of removals.

Table 2: Top ten dam removal states

In terms of dams removed				*In terms of dam removal density*			
State	*Removals*	*Avg. age of dams*	*Removal density*	*State*	*Removals*	*Avg. age of dams*	*Removal density*
WI	73	57	0.100	WI	73	57	0.100
CA	40	59	0.026	HI	5	78	0.038
PA	38	60	0.026	ID	13	56	0.031
OH	37	46	0.021	CA	40	59	0.026
IL	23	43	0.018	PA	38	60	0.026
TN	20	40	0.020	NH	17	73	0.026
NH	17	73	0.026	CT	16	95	0.022
CT	16	95	0.022	OH	37	46	0.021
MI	15	64	0.017	WA	14	50	0.020
NJ	15	74	0.020	TN	20	40	0.020
				NJ	15	74	0.020

Eleven states are listed under "Dam removal density" due to ties. States ranking in the top ten in both categories are Wisconsin, California, Pennsylvania, Ohio, Tennessee, New Hampshire, Connecticut, and New Jersey,

Discussion

An analysis of the average age of dams per state versus both the actual number of dams removed and the removal density revealed that a strong positive correlation does not exist; however, a trend toward the increased removal of older dams is apparent (Table 2 and Figure 4). While many of the states with the highest removal

Figure 4: Number of dams removed vs. removal densities

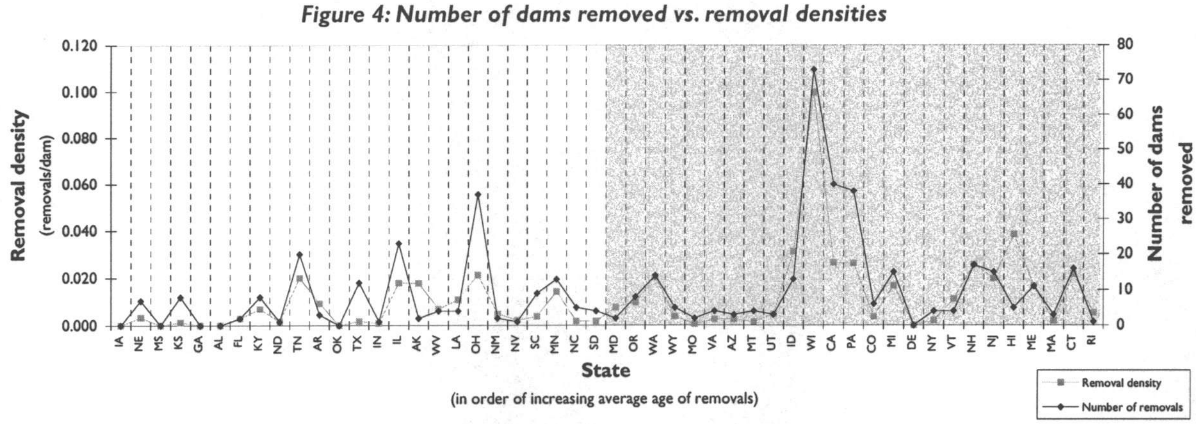


Figure 4: This figure represents both the removal densities (gray line) and the absolute numbers of dams removed (black line) for all of the 50 states. This analysis does not include Washington D.C., due to the lack of data in the NID database. The states that fall within the gray shadow are those whose average age of dams is 50 years or older, indicating an increased possibility that many of the dams within these states have surpassed their functional life span.

densities have average ages of dams exceeding 50 years, several states have high removal densities and lower average ages of dams, such as Ohio, Illinois, and Tennessee. Conversely, several states with the oldest dams in the country have the lowest removal densities as well, such as Rhode Island and Massachusetts (Table 3). The dam densities of these two states are well above the national average of 0.038 dams/sq. mile, which helps to explain their low removal density. However, these two states have only removed four dams between them, and several other states on Table 3 have dam densities that are much lower than the national average. Factors other than age are influencing these states to keep their aging dams intact.

Table 3: States with high average ages of dams and low removal densities

State	*Average age of dams (years)*	*Number of dams*	*Dam density*	*Number of removals*	*Removal density*
RI	111	185	0.177	1	0.005
MA	91	1567	0.1999	3	0.002
DE	68	61	0.0312	0	0.000
NY	68	1970	0.0417	4	0.002
CO	63	1636	0.0158	6	0.004
MT	53	2863	0.0197	4	0.001
UT	53	629	0.0077	3	0.005
AZ	52	1173	0.0103	3	0.003
MO	51	4124	0.0599	2	0.000
VA	51	1570	0.0397	4	0.003
U.S.	*48*	*> 75,000*	*0.038*	*474*	*0.011*

Age cannot be ignored as an factor influencing dam removal, however. While the actual number of dam removals on very old dams (over 120 years) is low, the percentage of those old dams being removed is quite high (Figure 5). In the United States, the majority of the dams were constructed between the 1950s and the 1970s; therefore, although the actual number of dams being removed in this age range is quite high, the proportion being removed is low. This calculation could be deceiving, however, because, the NID only lists dams that are above six feet high or 100 feet long, and older dams tend to be smaller; therefore, the NID may inaccurately represent the population of older dams. Also, older dams are more likely to be unaccounted for than younger dams, especially in the national database.

Figure 5: Average age of dams at removal

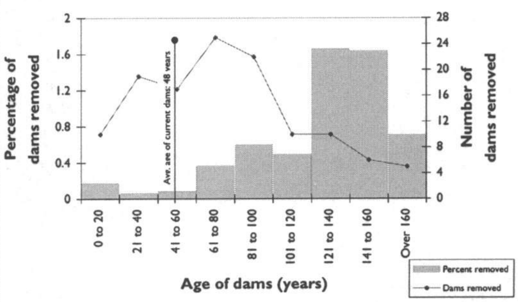


Figure 5: While the actual number of removals is higher in younger dams, the proportion of dams being removed increases as dams increase in age. The age of dams is based on the NID listing.

Age did not prove to be a particularly robust parameter to which to compare dam removals; therefore, I tested whether other general geographic factors have influenced the distribution of dam removals on a broader level. I compared removal densities per state to three relationships — dam density, population density, and state size — in order to determine if further testing was warranted. If a correlation was found between removal density and any of these parameters, it would have provided an insight toward determining

Figure 6a: Removal density vs. state dam density

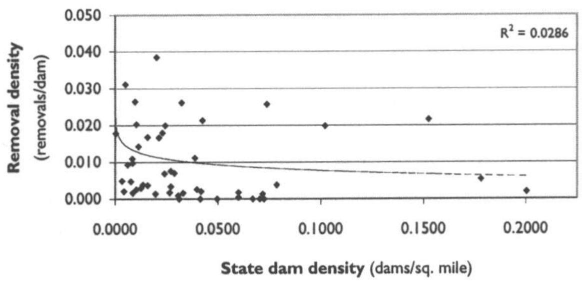


Figure 6: Removal density does appear to be correlated with general geographic measures. The NID database was used to determine dam information and the U.S. 2000 Census was used for the population and land area figures. Washington D.C. was not included in this analysis due to a lack of information included in the NID database.

Figure 6b: Removal density vs. population density

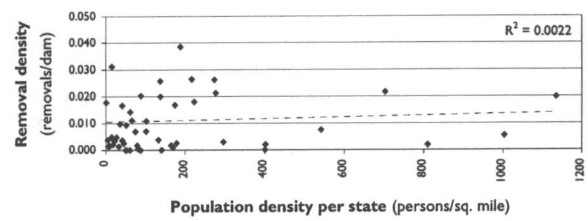
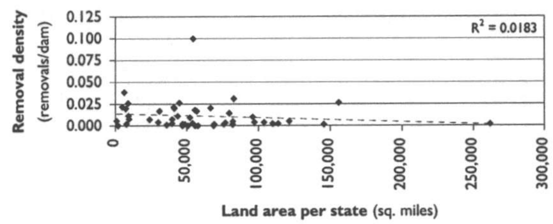


Figure 6c: Removal density vs. state size
(excluding Alaska)



the guiding influences of dam removal. None of the general geographic parameters tested displayed a significant correlation to the number of dams removed in states or basins (Figure 6a-c). These parameters are simple measures, and, due to the complexity of the dam removal issue—physically, socially, politically, and economically—it is not surprising that a strong correlation is lacking. Although it is a simplistic study, the lack of correlation between any of the tested parameters and dam removals indicates the presence of more influential factors guiding removals.

The age of dams does not explain fully the uneven distribution of dam removals across the United States. Indeed, in certain cases, an age analysis presents more complexities, especially when considering why states with old dams have very low removal densities, such as those states listed in Table 3. Considering the many complexities of dam removal, other factors, such as geographic boundaries, may influence the distribution of dam removals across the United States.

Political boundaries of dam removal

The United States government is a federal system consisting of local, state and national levels of control. Each level of government has some degree of autonomy and laws can be enacted at any level of government, although all entities must abide by the federal and relevant state constitution. While the federal government has the largest source of legislative power within the country, the United States is a dual sovereign nation and the federal constitution allows the states a great degree of freedom to enact their own laws, enforced through statutes and rules; the Tenth Amendment states that "the powers not delegated to the United States by the Constitution nor prohibited by it to the State, are reserved to the States respectively, or to the people." (Buck 1996).

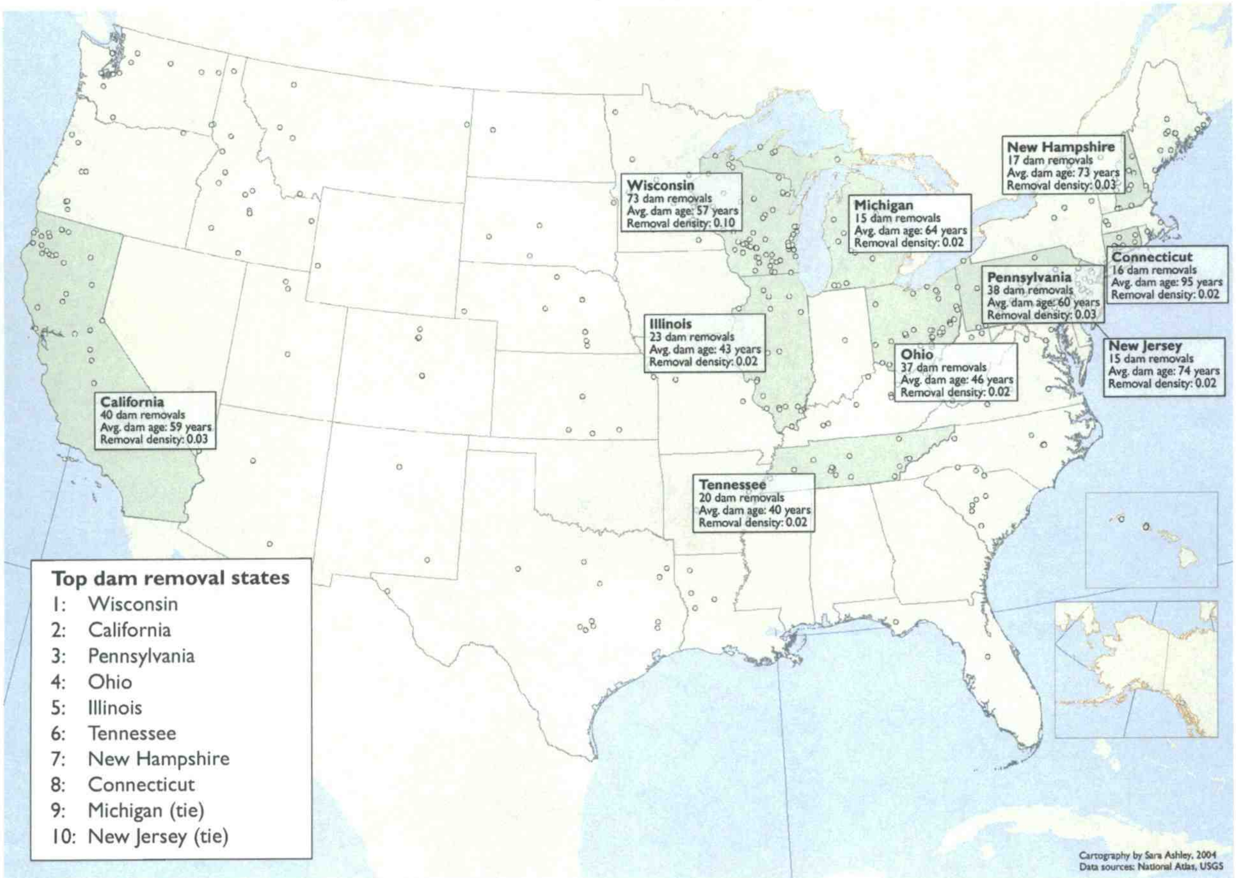
The implementation of environmental conservation programs and regulations typically falls to the state (Buck 1996). The federal government often provides overarching laws concerning the environment (i.e., Clean Water Act, Endangered Species Act), but the states develop their own programs and laws to ensure that they follow these federal regulations. State statutes can be more strict and regulated than the federal statutes, but they cannot be less so; thus, the language of state statutes concerning the environment often outline the attitude of the state toward the value of natural resources, such as water, land and wildlife. Laws regarding dams are found in both federal and state statutes; federally-funded dams are governed by federal law and state-funded and private dams are governed by state law. The majority of dams built and removed in the United States thus far have been dams controlled at the state level (American Rivers *et al.* 1999); therefore, state statutes are important drivers concerning dam removal.

In 1996, the United States federal government passed the National Dam Safety Act, providing federal funds for the purposes of alleviating the risk to human life and property due to old and unsafe dams. In order to receive federal funding, a state must operate its own dam safety program as legislated by a state statute, which, at a minimum, includes timely inspections to identify old and unsafe dams and the authority to "perform necessary maintenance or remedial work, revise operating procedures, or take other actions, including breaching dams when necessary." (Sec 467f (f)(2)(A)(vi) of the National Dam Safety Act). All of the states, with the exception of Alabama, now have a dedicated dam safety program; however, the language of the state statutes dealing with dam safety varies from state to state, especially in terms of dam removal. In its most basic form, the dam safety and construction statute provide regulations for the construction and maintenance of dams within the state and charges a particular department with the responsibility of issuing permits and inspecting dams. Some states, however, provide detailed information on the maintenance of dams and, consequently, dam removal or breaching is oftentimes mentioned in the statute.

Analysis and results

I chose to analyze the dam safety and construction statutes of the top ten states with the highest number of dam removals (Figure 7), accounting for 62 percent of the dams removed. Both the actual number of dams removed and the removal density help to determine a state's dam removal activity, and states with many dams

Figure 7: States with the highest number of dam removals



may have low removal densities, despite a high number of dams removed. Considering that dam removal is a recent river management tool and only a small fraction of dams in the landscape have been removed, the number of dams removed in a particular state is an important factor; therefore, the absolute number of dams removed was the most appropriate parameter for this study. Additionally, all of the top ten states with the highest number of dam removals have removal densities that are above the national average of 0.011 removals/dam.

All of the dam safety and construction statutes in the top dam removal states mention dam removal; however, the statutes vary greatly in terms of provisions for removal, mainly in dam removal procedures, environmental impacts assessment, abandoned dams, and the development of programs and funding opportunities for dam removal (see Table 4 for a summary). The most basic statutes, such as in Tennessee and Ohio, only include the option of removal along with maintenance, repair and modification of the dam in the interest of protecting the safety of humans and property. In contrast, some dam statutes charge the state with the protection of natural resources. For example, Pennsylvania's dam statute includes the right to

Table 4: Summary of dam safety and construction statutes dealing with dam removal								
		Removal can be regulated for the protection of the following:						
State	*Removal provision*	*Human life*	*Property*	*Environment*	*Dam removal procedure*	*Environmental impacts provision*	*Abandoned dams provision*	*Dam removal program*
WI	√	√	√		*		√	√
CA	√	√	√		√			
PA	√	√	√	√	*			
OH	√	√	√					
IL	√	√	√		√	√		
TN	√	√	√					
NH	√	√	√		√*			
CT	√	√	√			√		
MI	√	√	√	√		√		
NJ	√	√	√		√			

* States that have detailed dam removal procedures listed on their website. New Hampshire lists removal procedures in its dam safety and construction statute and the state has also published a more detailed document on its website.

"protect the natural resources, environmental rights and values … and conserve the water quality, natural regime and carrying capacity of watercourses" (PA statute Ch. 25A § 693.2). And Michigan's dam regulation statute states that the government may order the removal of a dam "(w)here significant damage to persons, property, or natural resources or the public trust resources occurs as a result of the condition or existence of a dam" (MI statute Part 315 § 324.31509).

Four of the top dam removal states (California, Illinois, New Hampshire and New Jersey) include dam removal procedures in their dam safety statute, and three other states (New Hampshire, Pennsylvania and Wisconsin) provide detailed accounts of the dam removal process on their dam safety program website. New Hampshire has recently published a document on dam removal that describes, in detail, the procedure for researching and planning the removal project as well as obtaining the necessary permits and applications (NHDES 2003). Three of the state statutes mention the assessment of environmental impacts of dam removal (Connecticut, Illinois, Michigan), although Illinois' statute provides the most direction. Illinois requires that a dam removal permit be accompanied by an analysis of environmental impacts and measures that will be taken to remedy such impacts, such as the control of erosion, an analysis of downstream channel impacts and upstream river restoration procedures (IL statute Title 17, Chapter 1: § 3702.50). Wisconsin's dam statute includes a provision for abandoned dams, giving the state the authority and directive to remove old and abandoned dams. Michigan's statute requires a permit for the removal of an abandoned dam, but there is nothing specific regarding the fate of abandoned dams.

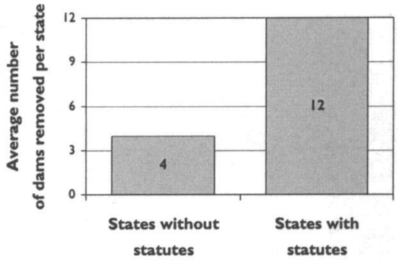
Wisconsin is the only top dam removal state to have created a dam removal program as a direct result of a statute. Section 31.385 of the Wisconsin dam regulations statute requires that the state create a dam safety program in order to provide funding for private owners for the removal of small dams (less than 15 high and an impoundment of 100 acres or less) and for funding the removal of abandoned dams, regardless of size. The resulting *Small and Abandoned Dam Removal Grant Program* (NR 336), created in 1991, provides funding for up to 50 percent of the cost of a small dam removal project (not to exceed $50,000) and for 100 percent of the cost of the removal of an abandoned dam.

Discussion

The conclusions of the dam safety and construction statutes are summarized in Table 4. While all of the dam safety and construction statutes for the top dam removal states contain language regulating dam removals in the interest of protecting human life and property, the rest of the language varies greatly between the states. States enacted dam safety and construction statutes long before dam removal became an environmental issue, and many states may be reluctant to amend the statutes due to the scientific uncertainty of dam removal as well as the political and social sensitivity of the issue. Also interesting to note is that Georgia and Mississippi, two of the five states that have not removed any dams (see Figure 3), do, indeed, have dam safety and construction statutes pertaining to dam removal. Moreover, seven out of the twelve states with average ages of dams over 50 years and removal densities below 0.01 removals/dam (Table 3) have state statutes pertaining to dam removal as well (Arizona, Colorado, Massachusetts, New York, Rhode Island, Utah, and Wyoming).

Statutory laws, however, do appear to influence the distribution of dam removals throughout the United States (Figure 8). Those states with statutes including dam removal provisions have significantly higher averages of removals than those states without these statutes. As discussed earlier, state statutes help to define the state's perspective toward natural resources, while providing direction for state agencies regarding the management of the state's rivers, lands, and wildlife; therefore, those states with statutes pertaining to dam removal can identify those states that are more receptive to river restoration in broader terms—and vice-versa. Typically vague and unclear, the language of statutes leave much room for interpretation, and the public, with the help of lawyers, can use this ambiguousness to their advantage by promoting controversial activities, such as dam removals. Statutes

Figure 8: State dam statutes vs. dam removals



can also prompt the organization of procedural processes; hence, the states with the highest number of dam removals — such as Wisconsin, Pennsylvania, and New Hampshire — also have streamlined permitting processes for removals (Doyle *et al.* 2003d and S. Carney, personal communication). Additionally, statutes identifying dam removal as an option to alleviate the safety concerns of a dam provide direction for state agencies and local organizations in the decision-making process for dam reconstruction and river restoration projects. Although it is not possible, nor wise, to conclude that political boundaries guide all dam removals, state laws help to facilitate the removal process.

Physical boundaries of dam removals

Dam removal has many potential benefits, including increased safety from the removal of decrepit dams and economic benefits from forgoing rehabilitation and maintenance costs. Additionally, as ecosystem restoration becomes an increasingly important goal of water resource management, the benefits of using dam removal as a restoration tool are becoming more apparent to and desired by local communities, environmental groups and natural resource agencies (Born *et. al* 1998). The management of rivers at the basin scale, however, is often a complicated task, especially when the multiple functions of a river are considered, such as hydrological, biological, and socio-economic factors (Nakamura 2003), and dam removal has the potential to affect all aspects of river basin function and management. The development of watershed organizations and river basin commissions has helped to organize river and ecosystem restoration within particular basins, however, as opposed to state programs for river management, which often do not manage within a basin perspective.

Dam removal is a relatively recent tool for natural resource managers as well as a new research area for scientists; hence, studies of dam removals have tended to focus on case studies of particular removals (such as Nelson and Pajak 1990, American Rivers *et al.* 1999, Smith *et al.* 2000, Bushnaw-Newton *et al.* 2002) or on individual states (Born et. al 1998, Pejchar and Warner 2001). By examining dam removals on a basin scale, we can begin to understand how a removal might affect the ecosystem of a river basin. Researchers and natural resource managers can also target those dams whose removal both will be the most beneficial to the ecosystem as well as the most economical.

Analysis and results

Due to accuracy discrepancies, only 416 of the 474 dam removals in the DRD were used in the basin analysis. All of the 416 dam removals can be accurately placed within a cataloguing level basin (referred to

Figure 9: Dam removals per basin

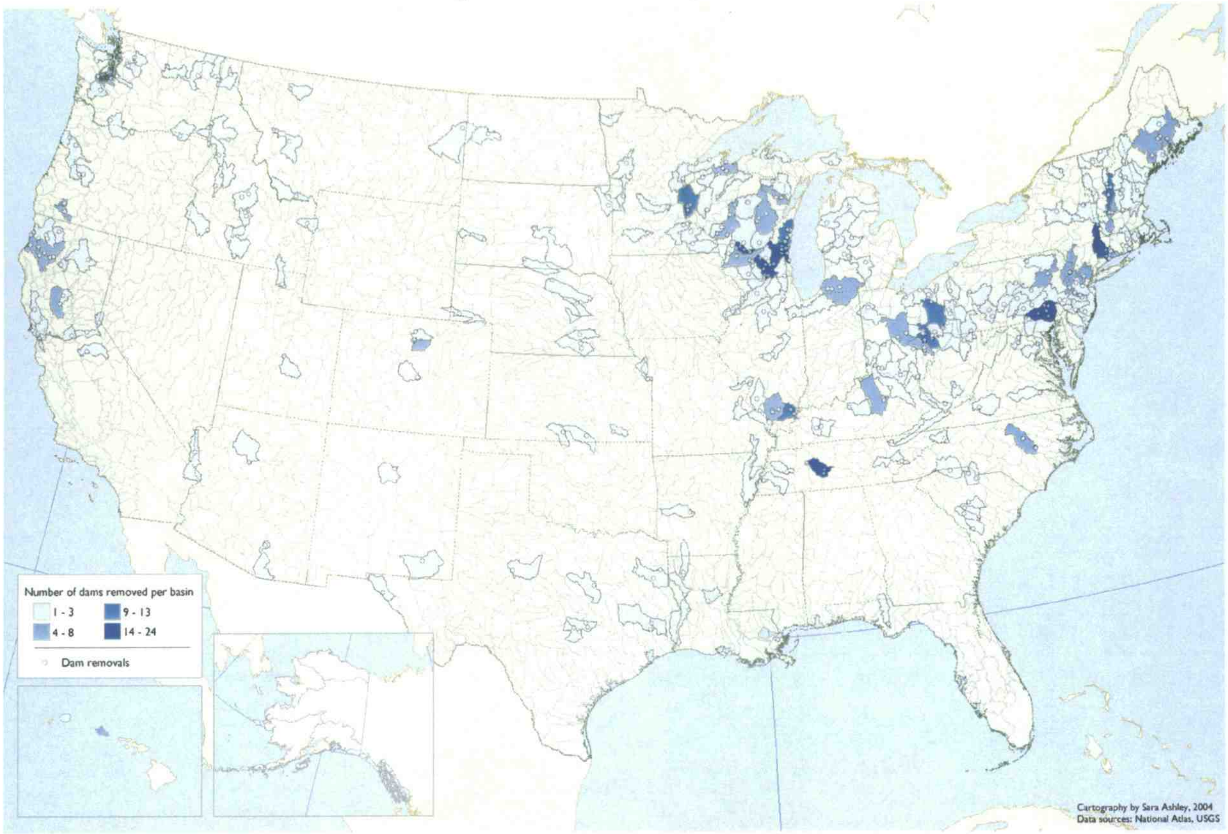


Figure 9: The distribution of dams by basin in the United States. The catologuing unit is the smallest level of basin classification used by the USGS (Seaber et al. 1987) and is depicted in this figure.

hereafter as "basin") and 242 out of 2,149 basins contain at least one dam removal (Figure 9). The majority of the basins contain only one to two dam removals (205 basins, or 84 percent of the basins); 27 basins (11 percent) contain three to four removals; and 12 basins (5 percent) contain five to nine dam removals. I chose the basins with five or more dam removals for analysis (Table 5); only five percent of the basins contained this many removals, but the sample size was large enough for a comparative study. Also, the number of dams removed per basin is quite low (as compared to the number of dams removed per state, for example), and it becomes less likely that any type of coordinated dam removal effort will be found in basins with four or fewer total dams removed.

Table 5: Basins with five or more dam removals

Basin	*Number of removals*	*States boundaries within the basin*
Lower Susquehanna River	9	Maryland, Pennsylvania
Baraboo River	8	Wisconsin
Lower Duck River	8	Tennessee
Milwaukee River	8	Wisconsin
Housatonic River	7	Connecticut, Massachusetts, New York
Upper Rock River	7	Illinois, Wisconsin
Manitowoc-Sheboygan rivers	6	Wisconsin
Upper Connecticut-Mascoma River	6	New Hampshire, Vermont
Lower St. Croix River	5	Minnesota, Wisconsin
Muskingum River	5	Ohio
Saline River	5	Illinois
Tuscarawas River	5	Ohio

Using the information collected for each removal for the DRD, I studied the reasons for the removals within each of the basins. Much of the information was collected from state Department of Natural Resources offices (or equivalent agencies), state Dam Safety Programs, river basin and other non-profit organizations, press releases, environmental impact statements, and American Rivers dam removal case studies (American Rivers *et al.* 1999). Five of the twelve basins studied appear to have coordinated dam removal efforts relating to ecosystem or river restoration: Susquehanna River basin, Baraboo River basin, Milwaukee River basin, Housatonic River basin and the basins of the Manitowoc and Sheboygan rivers.

Within the Lower Susquehanna River basin (Figure 10), there is a coordinated federal, state and local effort to restore the Conestoga River, a major tributary to the Susquehanna River, through the EPA's Chesapeake Bay Program, the Pennsylvania Fish and Boat Commission, other local governments and non-governmental organizations (NGOs) (American Rivers *et al.* 1999 and Scott R. Carney, personal communication). Seven dams were removed in the Conestoga River basin for the expressed purpose of restoration, four of which were large enough to be included in the DRD: Rock Hill, American Paper Products, Mill Port Conservancy, and Maple Grove dams. The EPA selected the Lititz Run (a tributary to the Conestoga River) restoration project, which included the removal of two dams, as one of 12 model stream restoration model projects in the nation (Trout Unlimited 2004). Additionally, eight dams have been removed on Muddy Run, another tributary to the Conestoga River, although these dams are not included in this database due to size restrictions. These removals efforts are coordinated through Trout Unlimited, the National Resources Conservation Service (NRCS) and the Pennsylvania Fish & Boat Commission for stream restoration (Trout Unlimited 2004).

The Baraboo River basin (Figure 11) is a small basin in southwestern Wisconsin. Due to safety concerns, the Wisconsin Department of Natural Resources (DNR) considered either repairing or removing several of the dams along the Baraboo River. The Wisconsin Rivers Alliance, a statewide non-profit organization, then organized the funds and support necessary to remove Baraboo Waterworks, Oak Street and Linen Mill dams with the single purpose of restoring the river (Wisconsin Rivers Alliance 2004). The Sand County Foundation, another non-profit organization in the region, also bought the LaValle Dam on the mainstem of the Baraboo River for these same purposes; the dam was removed in 2001.

The dam removals in the Milwaukee River basin (Figure 12) appear to be independent from one another; for example, the owner of the Schweitzer Dam wanted to remove it in order to drain a stagnant reservoir (WI DNR 2002), while the city of West Bend, Wisconsin, decided to remove Woolen Mills Dam

Figure 10: Dam removals in the Lower Susquehanna River basin

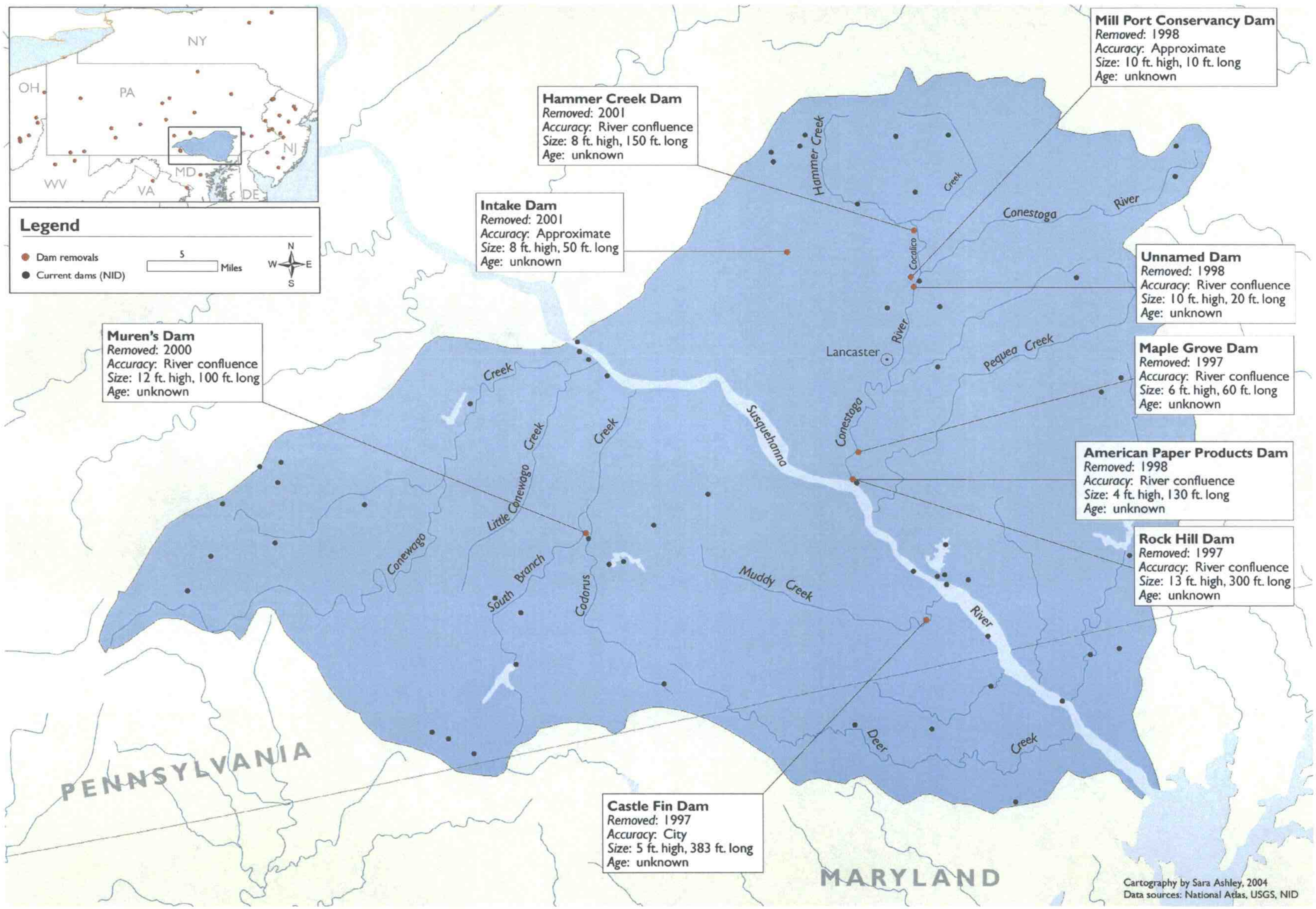


Figure 11: Dam removals in the Baraboo River basin

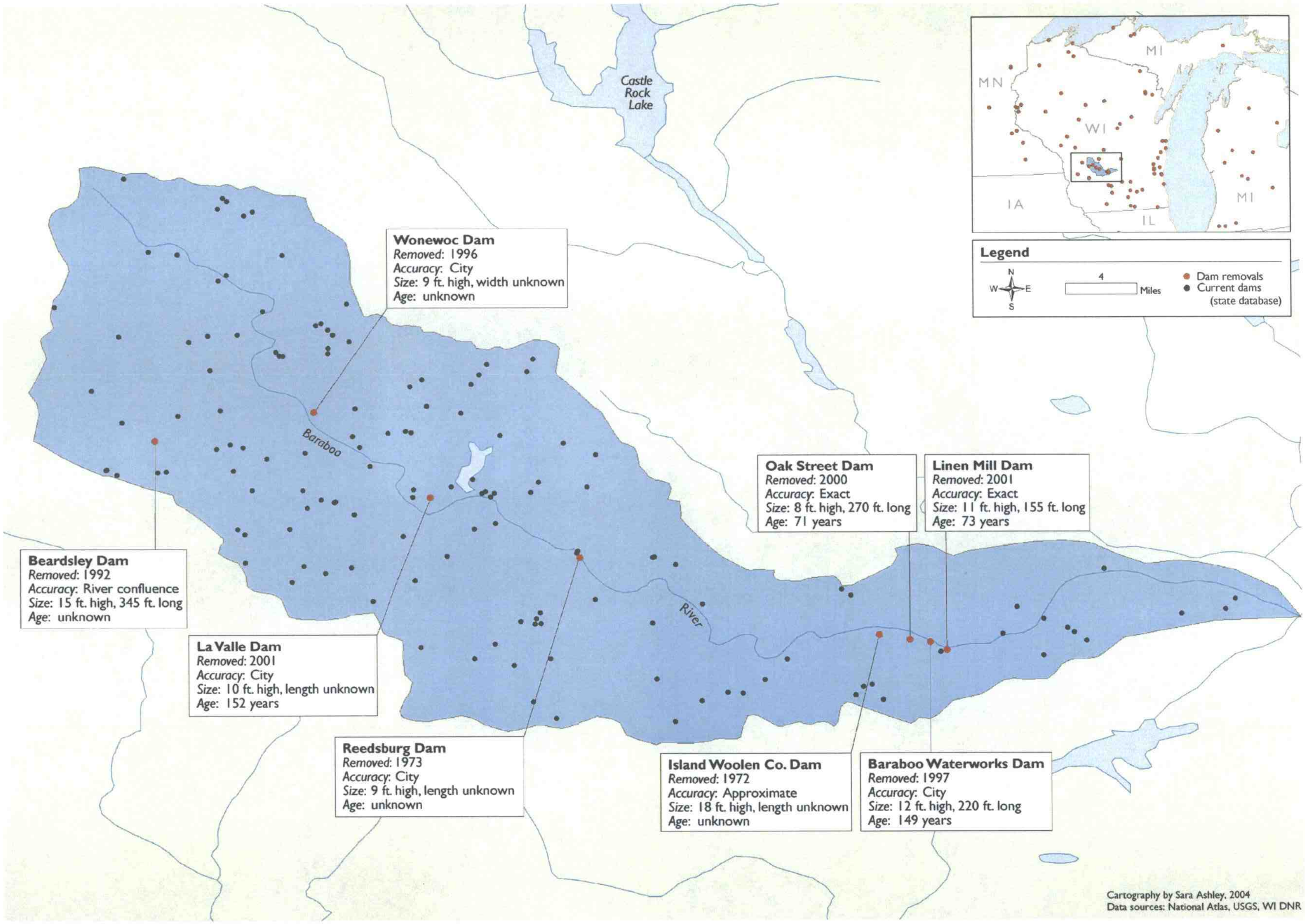
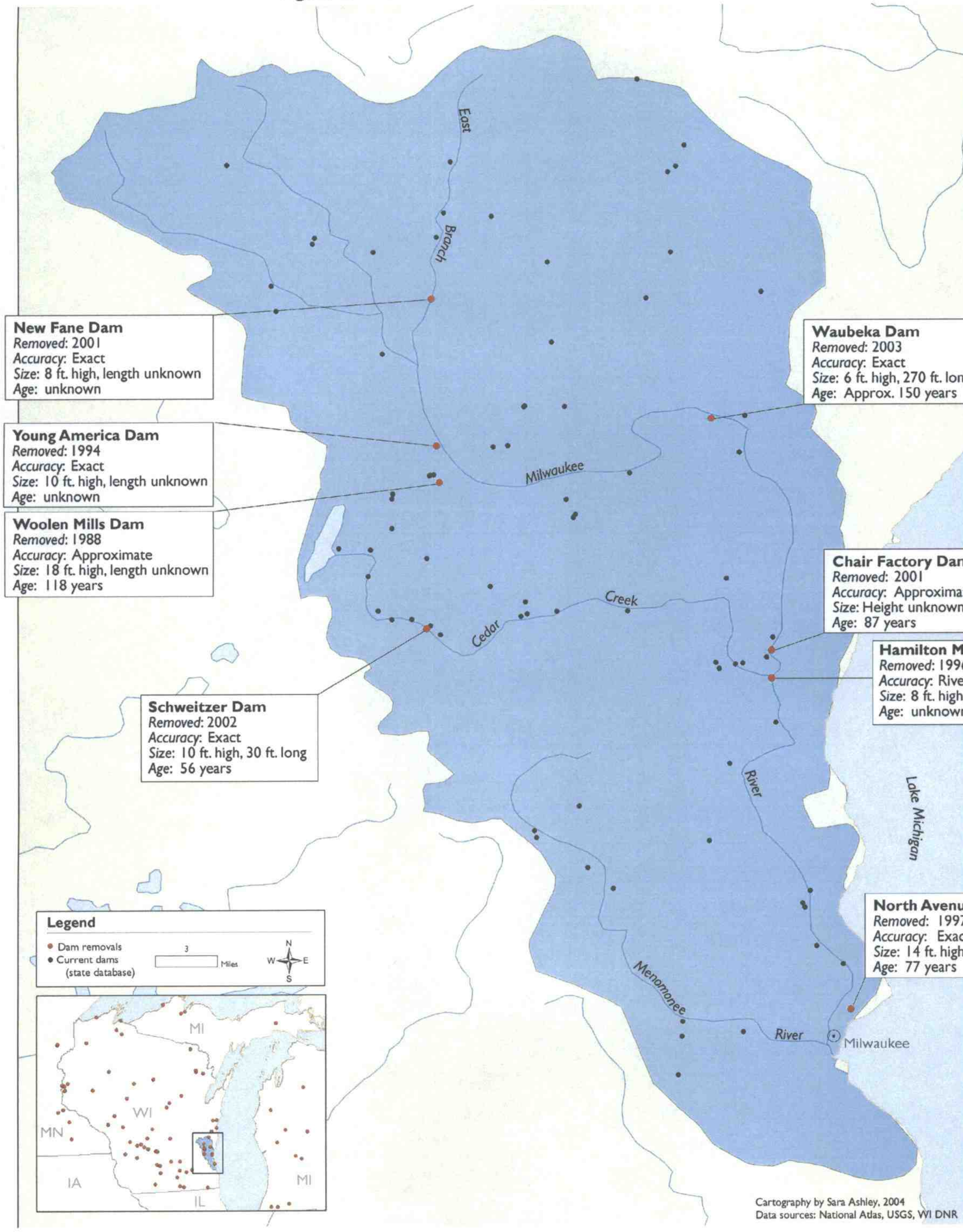


Figure 12: Dam removals in the Milwaukee River basin



due to safety concerns. However, the state of Wisconsin designated the Milwaukee River basin as a "Priority Watershed" in 1985, launching a coordinated effort by the state DNR to restore the basin. Two priorities of the state are to assist in the removal of dams with the purposes of restoring the basin and to restore instream and terrestrial habitat where dams are being removed (WI DNR 2001). The state has an interest and a legislative duty to promote river restoration, which may include removing dams, in the Milwaukee River basin; therefore, when the opportunity arises for removing a dam, the state may be more inclined to consider the restorative possibilities with removal.

The Housatonic River basin (Figure 13) is located in the western portions of Massachusetts and Connecticut. The Naugatuck River Watershed Anadromous Fish Restoration Project, led by Trout Unlimited and Connecticut Department of Environmental Protection (DEP), is a coordinated effort to restore fish passage along the Naugatuck River, a major tributary to the Housatonic River. The goal of the project is to restore fish passage along the entire stretch of the river and it included the removal of seven dams, among other fish passage and water quality improvement projects (Trout Unlimited 2004). Four of the dams removed thus far are the Platts Mill, Anaconda, Freight Street and Union City dams.

Finally, the Manitowoc-Sheboygan River basins (Figure 14) are found along the coast in Lake Michigan in eastern Wisconsin[2]. Trout Unlimited and the Wisconsin DNR are leading a coordinated effort to restore the headwaters of the Onion River, which is located in the Sheboygan River basin. A private entity purchased the land for the specific purpose of restoring trout habitat (Trout Unlimited 2004). Two removals, Kamrath Dam #1 and #2, are in the DRD, but nine others, including all of the removals at the Silver Springs site, are too small to be included in the database. However, the cumulative impact (University of California 2001) of removing so many dams may be great.

The dam removals in the remaining basins (Table 5) appear to be independent events. For example, seven dams have been removed from the Upper Rock River basin between 1992 through 2002 (one removal has an unknown date). The removals are scattered throughout the basin: Afton Dam was removed because the owner did not want to bear the economic cost of repair; the Wisconsin DNR removed the Rockdale Dam in order to reestablish wetland habitat; and the Shopiere Dam was abandoned and removed by the state for economic reasons. Another example is the Upper Connecticut-Mascoma River basin; the six dam

[2] This USGS river basin unit is classified as one unit, when, in fact, it consists of two distinct river basins: The Manitowoc and the Sheboygan River basins. I chose not to separate them into two basins in order to preserve the consistency of the chosen river basin classification, but, in reality, the dams removals in one basin cannot physically affect the river system of the other basin.

Figure 13: Dam removals in the Housatonic River basin

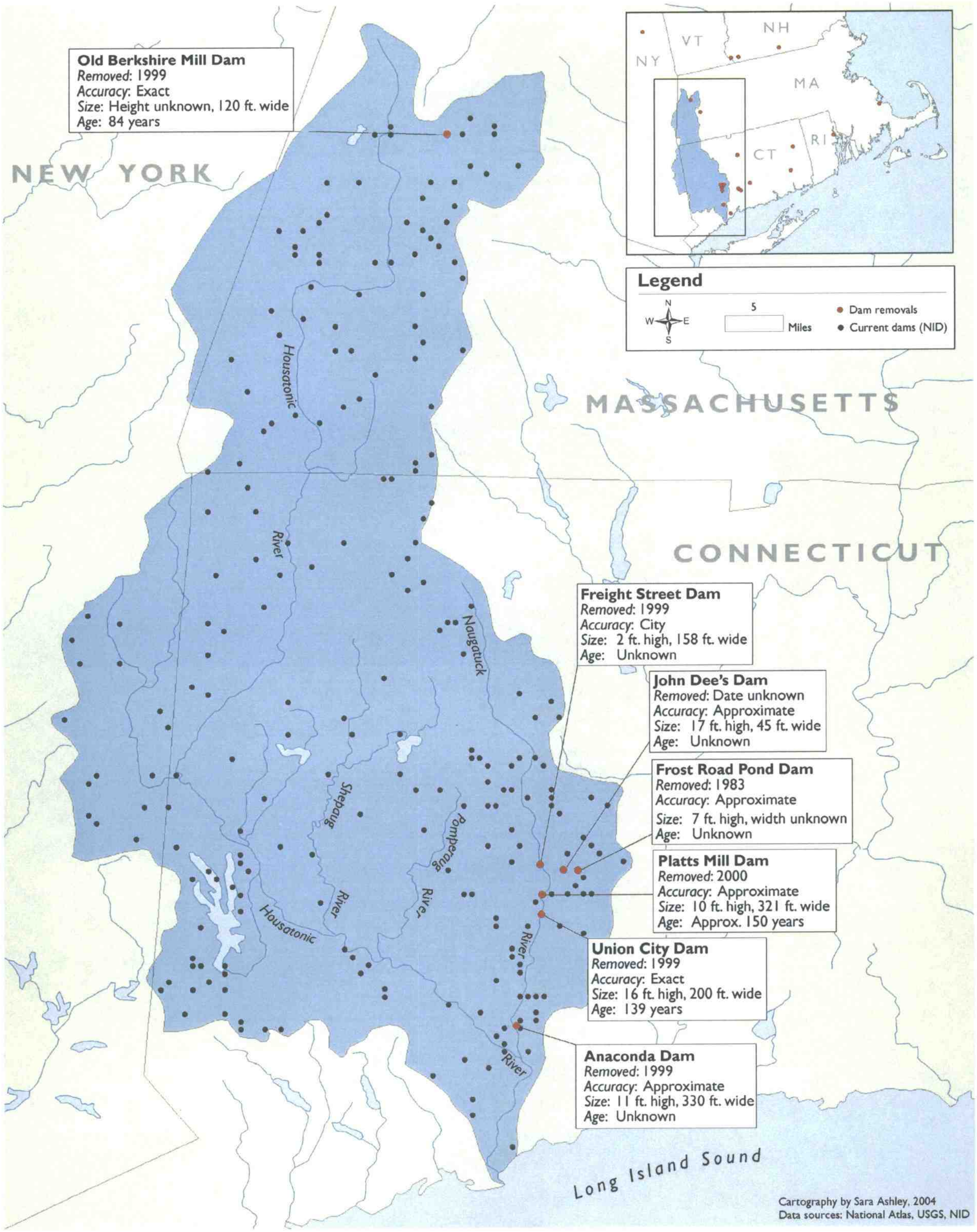
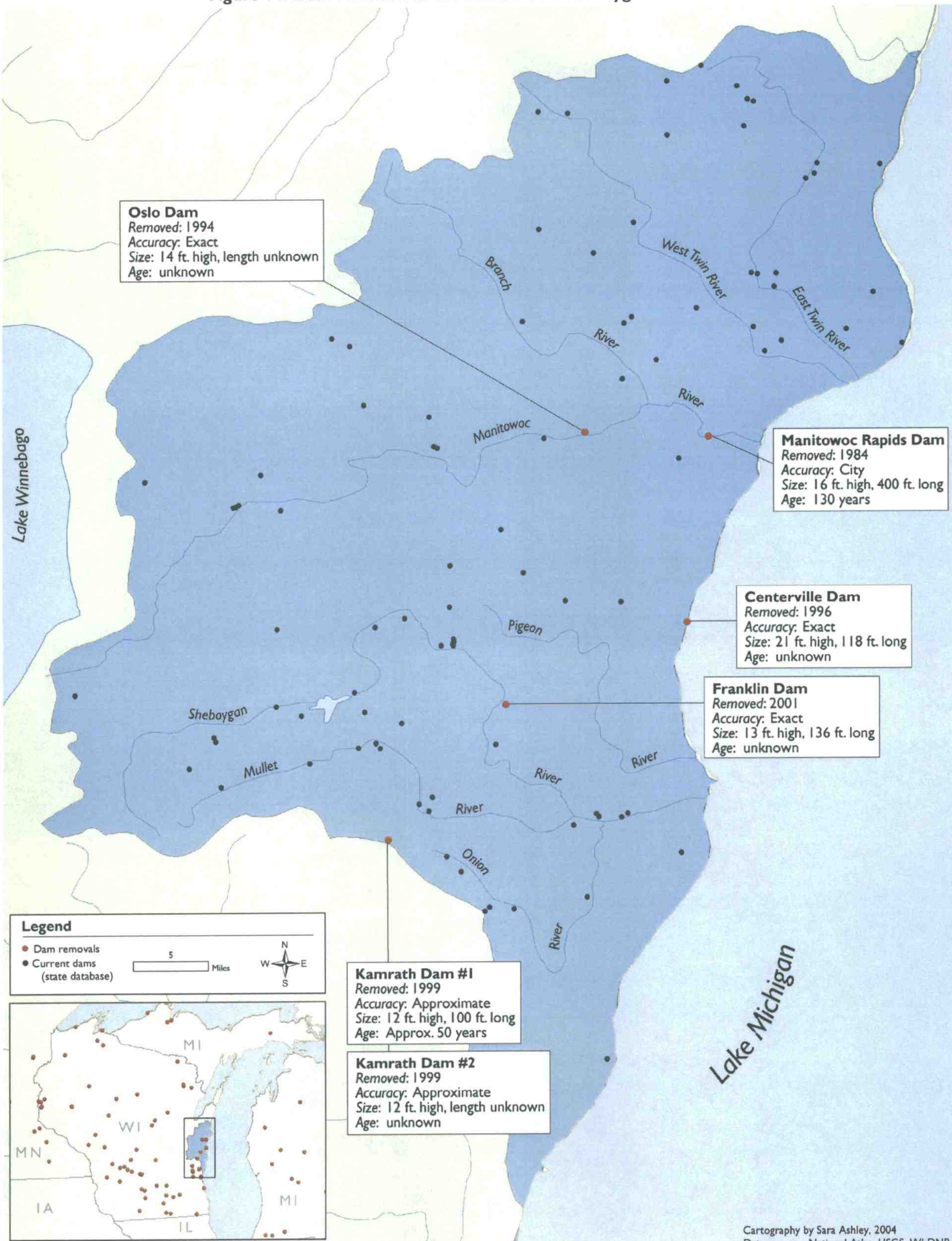


Figure 14: Dam removals in the Manitowoc-Sheboygan River basin



removals in this basin are also scattered, both spatially and temporally (the removal dates range from 1952 through 2002), and no apparent link between the removals was found. Two of the removals in the Lower St. Croix River basin appear to be a coordinated effort at removal, due to their close proximity to one another on the Willow River in the Willow Falls State Park. However, according to American Rivers (1999), the Wisconsin DNR originally intended to repair these dams and only when the costs of repair greatly exceeded the costs of removals did the state decide to remove the dams. Four miles of trout habitat were restored, but the state did not intentionally remove the dams for this reason. In the Lower Duck River basin, eight dams were removed by the Monsanto Corporation when they shut down two phosphate plants (E. Ekwugha, personal communication), but Monsanto did not coordinate the removal for any apparent desire to benefit the ecosystem.

Discussion

At the basin level, the removal of dams affects the entire ecology of an ecosystem through physical, biological and chemical alterations; therefore, basin-wide planning of dam removals would seem to be imperative. But while basin-wide coordination of river restoration may be the most effective and efficient way to organize restorative efforts to ecosystems, it is a difficult process — both scientifically and politically. Scientifically, basin-wide planning depends upon restoration ecology, which is a holistic science focusing not only on one natural feature — such as the river, the wildlife, or the vegetation — but on the interconnections between organisms and their landscape. For several reasons, few studies have employed restoration ecology when studying the affects of dam removals; inadequate pre- and post-removal data, the complexities of the affected ecosystem, scientific uncertainty, and the varying ecological responses due to differences in dams and landscape characteristics all contribute to the lack of ecological study. On the political side, federal, state and local agencies as well as private citizens and organizations may all be stakeholders within a basin and procuring consensus from such a large and diverse group is often an insurmountable task.

However, recent river restoration efforts are gravitating toward basin-wide coordination as natural resource management increasingly depends upon ecological science. With only five out of the top twelve dam removal basins having coordinated dam removal efforts, this research indicates that basin boundaries do not have a significantly strong influence on the distribution of dam removals; however, the trend may be heading in that direction. The average date of removal for all dam removals in the DRD is 1988 (based on 381 dam removal entries that have both a year built and a year removed date) and the median is 1992; however, the five basins with coordinated dam removal efforts analyzed in this paper all have more recent average and median dates of removal (Table 6), indicating a possible trend toward river restoration efforts at the basin level that include dam removal.

Table 6: Summary of removal dates for basins with coordinated dam removal efforts

	Average	Median
All dam removal entries	1988	1992
Susquehanna	1999	1998
Baraboo	1992	1997
Milwaukee	1998	1999
Manitowoc-Sheboygan	1995	1998
Housatonic	1997	1999

Other factors influencing the distribution of dam removals

During the course of this study, I recognized several other guiding factors influencing the distribution of dam removals in the United States in addition to age and geographic boundaries. The process of dam removal has many components that cross scientific, economic, social and political boundaries and a complete understanding of the guiding factors influencing the distribution of removals must consider all of these processes. The discussion below is not an exhaustive study; rather, it identifies areas that an analysis of the Dam Removal Database and subsequent research revealed to be significant.

Institutional factors

Some states, such as New Hampshire, Wisconsin and Pennsylvania, have institutions dedicated to dam removal in the absence of a state statute. The *New Hampshire Dam Removal and River Restoration Program*, for example, was created without the prompting of any specific law or policy; rather, a combination of public and private interests collaborated in the hopes of facilitating selective dam removal within in the state (Lindloff 2003). The state of New Hampshire funds a River Restoration Coordinator to guide private dam owners through the removal process, including helping them to identify public and private sources of funding for dam removal, but the program itself does not have a dedicated source of state-supported funding, such as in Wisconsin. Two dam removals have been facilitated under this program since its inception (McGoldrick Dam in 2001 and Winchester Dam in 2002) , and several other removals are slated for the upcoming year.

The Wisconsin Rivers Alliance is a non-profit group that was created by private citizens, organizations and businesses in order to further the restoration of rivers in Wisconsin; it is not affiliated with any state agency, and, therefore, was created without any regard to a state statute or mandate. Through its *Small Dams Program*, the Alliance promotes the selective removal of small dams throughout Wisconsin by securing funding for removal projects from public and private sources and educating the community on the many facets of dam removal in an effort to improve the decision-making process. Wisconsin has removed over 70 dams since the early 1940s and approximately 25 percent of those removals have occurred since the inception of the *Small Dams Program* in 1999. Although the organizations itself is not a political entity, the Alliance is active in political decisions affecting the state's water resources.

Finally, Pennsylvania has removed almost 40 dams over six feet in height or 100 feet in length (that number reaches almost 70 removals when including smaller dams) and though the state does not have a dedicated dam removal program it does have a system in place orchestrating removals across the state. The Pennsylvania Fish and Boat Commission, along with the national non-profit group, American Rivers, coordinates dam removals in Pennsylvania, and one person from each entity is responsible for assisting in this effort. At the state level, the dam removal coordinator works with the Anadromous Fish Restoration Unit, taking a proactive role in dam removals by contacting owners of private dams in need of repair; other responsibilities of this coordinator include working on efforts to restore American shad and other anadromous fishes to the Susquehanna and Delaware River basins as well as monitoring the populations of migratory alosids and habitat restoration projects across the state (S. Carney, personal communication). Dam safety and construction statutes can help to initiate the process of removal, but the state has created a streamlined permitting process for private dam owners and extensive project coordination; a dam owner only need to sign a form to permit removal of a dam and the state agency will coordinate the rest of the removal, including finding a source of funding (S. Carney, personal communication). Finally, the political climate in Pennsylvania is such that regulatory agencies generally agree to accept short-term negative effects of dam removal in the hopes of gaining long-term benefits. Pennsylvania's Growing Greener Program, signed into law in 1999 and recently extended through 2012, distributes millions of dollars from state funds across several natural resource agencies with the goal of protecting the natural resources of Pennsylvania. The most recent round of grants allocated over one million dollars toward 30 dam removals across the state (PA DEP 2004).

Influence and bias of the data collection method

Influencing the collection of data in this study includes the subjectivity of both the collector and the collecting agency or organization. The collection of dam removal data for inclusion in the database was divided between several different researchers and two separate institutions over a three year study period; although original guidelines for collection were established initially, the opportunity presents itself for uneven gathering of data.

Figure 15: Temporal distribution of removals in the top dam removal states

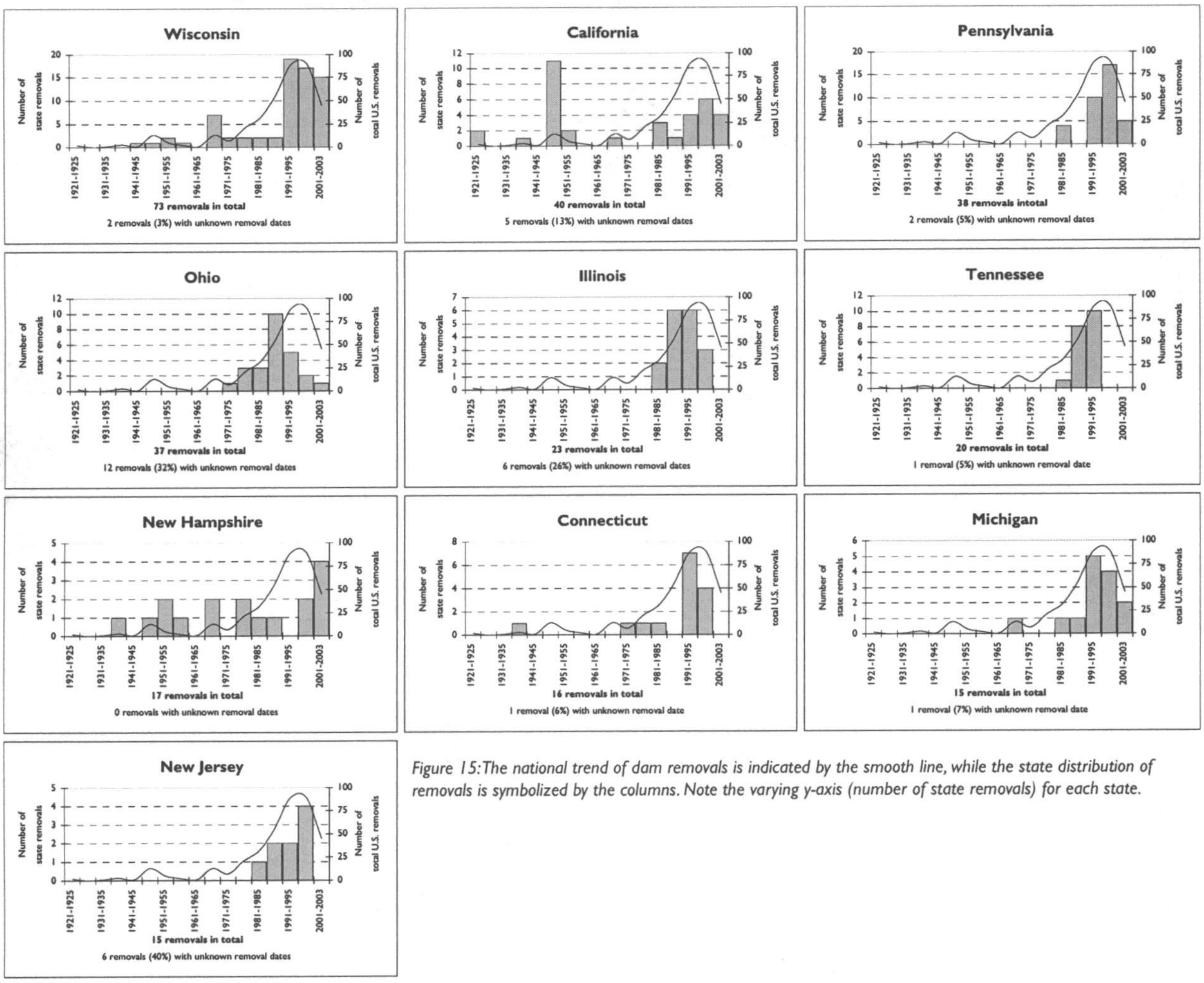


Figure 15: The national trend of dam removals is indicated by the smooth line, while the state distribution of removals is symbolized by the columns. Note the varying y-axis (number of state removals) for each state.

More significant, perhaps, is the influence of state, regional, and local agencies and non-profit organizations on the gathering of dam removal data. For example, the temporal distribution of dam removals in those states with the most dam removals varies significantly (Figure 15). The national trend of dam removals (indicated by the smooth line on Figure 15) reveals a sharp increase in removals starting in the late 1970s, with a peak during the mid 1990s. Dam removals in some states tend to follow the national trend, while others do not. In those states with dam removals distributed over time — Wisconsin, California, and New Hampshire — historical records of dam removals have been published or specific people are charged with the collection of dam removal information. For example, American Rivers lists two dams removed in New Hampshire (and four more slated for removal); however, the coordinator for the dam removal program in New Hampshire, after being prompted to study historical files by my inquiry, added 12 removals to the American Rivers data. The removal dates in New Hampshire now go back as far as 1937, and dam removals are distributed throughout the past seven decades. In this instance, New Hampshire now has a coordinator whose responsibility includes the collection of historical dam removal data. Another example of historical data collection is California, which has published a list of documented dam removals through its Fish Passage Program in the state Department of Water Resources. The Program readily admits that a centralized database of dam removal information does not exist in California, and, therefore, the data collected may be inaccurate. However, similar to New Hampshire, the dam removals for California span from the early 20th century to the present. Very few states have documented historical dam removals; therefore, the apparent lack of dam removals in a certain geographic area may be influenced by simply the lack of data collection. Also influencing the process is the possibility that the researchers collecting the data did not contact the "right" person. Additionally, the subjectivity of the person contacted influences the data, such as their personal feelings toward dam removals and river restoration in general.

The NID is also a possible significant source of error and bias as used in this study. As stated earlier, the NID includes only those dams of a certain size (over six feet tall or 100 feet wide) or those that pose a significant threat to human safety. State databases of dams are often more complete and may include structures less than six feet in height or 100 feet in length (Poff and Hart 2002). For example the NID database lists 675 dams for the state of Wisconsin, ranging from five feet to 97 feet high. In comparison, the Wisconsin Department of Natural Resources maintains a state database of dams and lists 4,742 dams in the state, ranging in heights from less than one foot to 122 feet[3]. Many states either do not publicly list their database of dams (for security reasons, presumably) or they have not systematically collected information on dams in the state altogether. And even when a state database does exist, the types of dams listed varies greatly from state to state. For example, California only lists those dams over 25 feet in height or 50 acre-feet in impoundment capacity; they also explicitly exclude any dam under six feet in height, regardless of impoundment capacity. California's state dam database, therefore, is similar to the NID database; the state dam database lists 1395 dams under jurisdictional control, while the NID lists 1372 dams for the state of California. Ohio, on the other extreme, states that over 50,000 dams exist in the state, 2,694 of which are under jurisdictional control; the NID lists 1294 dams for Ohio. Another example is the state dam database of New Hampshire, which lists all dams that are at least four feet in height, have an impounding capacity of

[3] Not only do the two databases differ on the number of dams listed, but the information for the dams differs as well. For example, the tallest dam in the state database—Eau Galle Dam in Pierce County—is listed at 122 feet high. The same dam in the NID database lists a height of 29 feet. Similarly, the tallest dam in the NID database for Wisconsin—the Hatfield Dam is Jackson County—is listed at 97 feet high; the state database lists a height of 58 feet for the same dam. It would be interesting and useful to conduct a study of the differences in information between state dam databases and the NID database.

at least two acre-feet, or are created for industrial, commercial, or municipal waste, regardless of size. Over 4,400 dams are listed in the New Hampshire dam database, as compared to 617 in the NID database.

Due to the extreme variations in state dam data, this research paper uses the dams listed in the NID database as the basis for comparison to dam removals; therefore, the dam removals listed in the database are based on the same size restrictions as the NID database. State dam databases would be a more accurate tool for comparison, especially considering the fact that many dam removals occur on small dams less than six feet in height, and an area for future research includes the examination of state dam data and smaller dam removals.

Conclusions

In the analyses of dam removals thus far, there has been a tendency to focus on site-specific case studies of removal; while case studies are significant in understanding localized effects of dam removal, they fail to provide a larger perspective of the guiding influences of dam removal. By compiling all known dam removals in the United States into a single database, this study provides a missing link toward the analysis of dam removals on a regional scale.

This study examined three possible factors influencing dam removals in the United States: age, political boundaries, and physical boundaries. The results suggest a trend toward the removal of older dams in the United States, yet the correlation is weak. While most of the states with the highest number of dam removals and highest removal densities also have average ages of dams over 50 years, many states with old dams are keeping them intact rather than removing them. State political boundaries appear to influence the distribution of dam removals, although several states do not follow a typical pattern. On average, states that have enacted laws governing dams and their removal have a higher number of dam removals. The language of the statutes pertaining to dam removal varies with each state, and the language tends to be more detailed in those states with the highest numbers of dam removals. However, some states with few or no dam removals also have statutes that include provisions for dam removals. Physical boundaries of river basins may influence dam removal distribution as well, although, again, the results are inconclusive. Of the basins with the highest number of dam removals, several have coordinated river restoration efforts that include the removal of dams, suggesting that physical boundaries may influence the distribution of dam removals. However, many basins with high numbers of dam removals do not have coordinated river restoration activities; therefore, other factors may be influencing dam removals as well.

The conclusions of this research study suggest the presence of other factors, in addition to age and geographic boundaries, influencing the distribution of dam removals. Those states that have institutionally-organized dam removal permitting and procedural processes and state-supported sources of dam removal funding, such as Wisconsin, Pennsylvania, and New Hampshire, also have the highest number of dam removals in the country. Institutional capacity for removing dams, therefore, is a likely factor guiding removals, and future research could include an examination of state, regional, and federal institutional influences. The amount of seasonal precipitation a region receives and the region's dependence on irrigation are also likely factors influencing dam removal. Many reservoirs serve as water storage facilities for drinking water and irrigation, especially in seasonally-arid areas; although these dams tend to be larger than the ones currently being removed, communities may feel that dam removal in general sets a precedent. Demographically, the political leanings of a state or region may also influence dam removals. States that are typically more conservative may find it politically unfeasible to promote dam removal and, conversely, states that have a liberal tendency may be more likely to support the increased governmental regulations of dam removal. Finally, other factors such as dam utility, the presence of endangered species, and the need to consider historic preservation of dams (Lenhart 2003) may also be guiding factors influencing the distribution of dam removals in the United States.

The Dam Removal Database provides the foundation for future research of dam removals on a larger scale, and it is my hope that others will build upon this database. As the number of dam removals increases in the United States and around the world, it is imperative that a central clearinghouse of data be maintained in order to facilitate analysis and to share information with others. The construction of dams is well researched and documented, and it is only logical that the deconstruction of dams follow this same path. To restore rivers to their free-flowing nature is a grand achievement, but it must be conducted with careful forethought and research. Analyzing the removal of dams on a larger scale leads to a better understanding of the many factors influencing removals, thus, ultimately, promoting effective dam removal policies for the future.

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Appendix 1: Output of the Dam Removal Database

State	Dam Name	River	Latitude	Longitude	Accuracy	Removed	Year built	Height (ft)	Length (ft)	City	County	Cat_basin	Comments
ALASKA													
AK	SWITZER ONE DAM	SWITZER CREEK	58.3564	-134.5149	River confluence	1988		15			JUNEAU	Lynn Canal. Alaska.	
AK	SWITZER TWO DAM	SWITZER CREEK	58.3564	-134.5149	River confluence	1988		15			JUNEAU	Lynn Canal. Alaska.	
ARKANSAS													
AR	LAKE ST. FRANCES DAM	CROW CREEK	35.0686	-90.7513	Exact	1989	1960	45	1150	MADISON	ST. FRANCIS	Lower St. Francis. Arkansas, Missouri.	
AR	SLEEPY VALLEY LOWER DAM NO 2	GULPHA CREEK	34.5320	-93.0286	Approximate	1998	1960	12	140	GULPHA GORGE CAMPGROUND	GARLAND	Ouachita Headwaters. Arkansas.	
AR	SLEEPY VALLEY UPPER DAM	GULPHA CREEK	34.5368	-93.0298	Approximate	1998	1960	10	81	GULPHA GORGE CAMPGROUND	GARLAND	Ouachita Headwaters. Arkansas.	Dam failed and remaining structure was removed.
ARIZONA													
AZ	CONCRETE DAM	WALSH CANYON	35.2383	-112.1883	Exact	1982		39		WILLIAMS	COCONINO	Havasu Canyon. Arizona.	
AZ	GOLDER DAM	CANADA DEL ORO	32.5000	-110.9206	City	1980	1964	111	2900	CATALINA	PINAL	Upper Santa Cruz. Arizona.	
AZ	PERRIN DAM	WALSH CANYON	35.2420	-112.1880	Exact	1980		32		WILLIAMS	COCONINO	Havasu Canyon. Arizona.	
CALIFORNIA													
CA	ALTOONA DAM	KIDDER CREEK	41.5986	-122.8554	River confluence	1947		60	12	FORT JONES	SISKIYOU	Scott. California.	
CA	ANDERLINE DAM	RUSH CREEK	37.5000	-120.0000	State	1936		20				Undetermined	
CA	ARCO POND DAM	LOST MAN CREEK	41.3317	-124.0306	River confluence			10			HUMBOLDT	Mad-Redwood. California.	Removed to improve fish passage. NPS Redwoods NP former owner, near Redwood Creek.
CA	BARTON DAM	SCOTT RIVER	41.6112	-122.8680	Approximate	1950		12	25	FORT JONES	SISKIYOU	Scott. California.	
CA	BEAR VALLEY DAM	BEAR CREEK	37.5000	-120.0000	State	1982	1911	80	360			Undetermined	
CA	BENNET-SMITH DAM	SALMON RIVER	41.3753	-123.4186	Approximate	1950		10			SISKIYOU	Salmon. California.	
CA	BIG CREEK MFG. DAM	BIG CREEK	36.7539	-119.6479	County			14			FRESNO	Undetermined	
CA	BIG NUGGET MINE DAM	HORSE CREEK	40.9331	-121.2156	Approximate	1949		12	40		LASSEN	Lower Pit. California.	
CA	BONALLY MINING CO. DAM	SALMON RIVER	41.2561	-123.3264	Approximate	1946		11	177	FORKS OF SALMON	SISKIYOU	Salmon. California.	
CA	C LINE DAM #1	MCDONALD CREEK-TR	41.2296	-124.0917	River confluence	1993		56			HUMBOLDT	Mad-Redwood. California.	
CA	CLARISSA V. MINING DAM	READING CREEK	40.6435	-122.9524	River confluence	1950		20		COLLINS (1882 MAP)	TRINITY	Trinity. California.	
CA	CROCKER CREEK DAM	CROCKER CREEK	38.7689	-122.9722	River confluence	2003	1904	30	100	ASTI	SONOMA	Russian. California.	
CA	D.B. FIELDS / JOHNSON DAM	INDIAN CREEK	37.5000	-120.0000	State	1947		6				Undetermined	
CA	EAST PANTHER CREEK DAM	EAST PANTHER CREEK	38.4861	-120.4006	River confluence	2003		10			AMADOR	Upper Mokelumne. California.	Removed by PG&E as part of the settlement for a new 30-year operating license for the Mokelumne River Project. Dam removed. Need measurements.
CA	HESSELLWOOD DAM	HAYFORK CREEK	40.6142	-123.4506	River confluence	1925		10			TRINITY	South Fork Trinity. California.	
CA	LAKE CHRISTOPHER DAM	COLD CREEK	38.9114	-119.9667	Exact	1994		10	400	S. LAKE TAHOE	EL DORADO	Lake Tahoe. California, Nevada.	Breached in 1989, removed in 1994. Tributary to Trout Creek, the second largest tributary to Lake Tahoe.
CA	LONE JACK DAM	TRINITY RIVER	41.1859	-123.7064	River confluence			24			HUMBOLDT	Lower Klamath. California, Oregon.	
CA	MCCORMICK-SAELTZER DAM	CLEAR CREEK	40.5056	-122.3667	River confluence	2000	1907	18	60		SHASTA	Sacramento-Lower Cow-Lower Clear. California.	
CA	MCGOWAN DAM	BUTTE CREEK	39.1947	-121.9353	River confluence	1998		6			SUTTER	Sacramento-Stone Corral. California.	Part of a larger restoration effort that includes the removal of four dams and 12 unscreened water diversions on Butte Creek.

Appendix 1: Output of the Dam Removal Database

State	Dam Name	River	Latitude	Longitude	Accuracy	Removed	Year built	Height (ft)	Length (ft)	City	County	Cat_basin	Comments
CA	MCPHERRIN DAM	BUTTE CREEK	39.1947	-121.9353	River confluence	1998		12			SUTTER	Sacramento-Stone Corral. California.	Part of a larger restoration effort that includes the removal of four dams and 12 unscreened water diversions on Butte Creek.
CA	MINNIE REEVES DAM	INDIAN CREEK	41.5892	-122.5330	County			20			SISKIYOU	Undetermined	
CA	NORTH FORK PLACERS DAM	TRINITY RIVER	40.8922	-123.5839	City	1950		15		SALYER	TRINITY	South Fork Trinity. California.	
CA	POINT FOUR DAM	BUTTE CREEK	39.1947	-121.9353	River confluence	1998		6			SUTTER	Sacramento-Stone Corral. California.	Part of a larger restoration effort that includes the removal of four dams and 12 unscreened water diversions on Butte Creek.
CA	QUINN DAM	TRINITY RIVER	40.7505	-123.2780	Approximate	1951		14		BIG BAR	TRINITY	Trinity. California.	
CA	RED HILL MINING CO. DAM	CANYON CREEK	40.6572	-123.1182	County	1951		30			TRINITY	Undetermined	
CA	ROCK CREEK DAM	ROCK CREEK	40.0107	-120.8341	County	1985		12	63		PLUMAS	Undetermined	
CA	ROGERS DAM	OLEMA CREEK-TR	38.0469	-122.7860	Exact	1983		40		OLEMA	MARIN	Tomales-Drake Bays. California.	
CA	RUSSELL (HINKLEY) DAM	HAYFORK CREEK	40.6142	-123.4506	River confluence	1922		11			TRINITY	South Fork Trinity. California.	
CA	SALT CREEK DAM	SALT CREEK	37.5000	-120.0000	State			10				Undetermined	
CA	SMITH DAM	WHITE'S GULCH	37.8412	-120.1774	Approximate	1949		8	25		TUOLUMNE	Upper Tuolumne. California.	
CA	SWEASEY DAM	MAD RIVER	40.8759	-123.9914	City	1970		17	45	BLUE LAKE	HUMBOLDT	Mad-Redwood. California.	
CA	TODD DAM	TRINITY RIVER	41.1859	-123.7064	River confluence	1949		14			TRINITY	Lower Klamath. California, Oregon.	
CA	TRINITY CTY. WATER & POWER CO. DAM	TRINITY RIVER	40.7061	-122.8080	City	1946		10		LEWISTON	TRINITY	Trinity. California.	
CA	UNNAMED DAM	MURPHY CREEK	38.2272	-121.0289	River confluence	2003		12			SAN JOAQUIN	Lower Consumnes-Lower Mokelumne. California.	
CA	UNNAMED DAM #1	WILDCAT CREEK	37.9533	-122.3875	River confluence	1992		6			CONTRA COSTA	San Pablo Bay. California.	
CA	UNNAMED DAM #2	WILDCAT CREEK	37.9488	-122.3127	City	1992		6		RICHMOND	CONTRA COSTA	San Pablo Bay. California.	
CA	UPPER DAM	LOST MAN CREEK	41.3317	-124.0306	River confluence	1989		7	57		HUMBOLDT	Mad-Redwood. California.	
CA	WEST PANTHER CREEK DAM	WEST PANTHER CREEK	38.4861	-120.4006	River confluence	2003	1933	16		PIONEER	AMADOR	Upper Mokelumne. California.	Removed by PG&E as part of the settlement for a new 30-year operating license for the Mokelumne River Project.
CA	WESTERN CANAL EAST CHANNEL DAM	BUTTE CREEK	39.4890	-121.8716	Approximate	1998		10			GLENN	Lower Butte. California.	Part of a larger restoration effort that includes the removal of four dams and 12 unscreened water diversions on Butte Creek. Creek defines the boundary between Glenn and Butte Cty in this area.
CA	WESTERN CANAL MAIN DAM	BUTTE CREEK	39.1947	-121.9353	River confluence	1998		10			SUTTER	Sacramento-Stone Corral. California.	Part of a larger restoration effort that includes the removal of four dams and 12 unscreened water diversions on Butte Creek.
COLORADO													
CO	BLUEBIRD DAM	OUZEL CREEK	40.1914	-105.6544	Exact	1990	1904	56	200		BOULDER	St.Vrain. Colorado.	Located in Rocky Mountain National Park. Removal cost includes $1.9 million to purchase water rights and easements (American Rivers).
CO	GLACIER #1 DAM	BIG THOMPSON RIVER	40.5065	-105.5943	Approximate	1985		11			LARIMER	Big Thompson. Colorado.	Located in Rocky Mountain National Park.

Appendix 1: Output of the Dam Removal Database

State	Dam Name	River	Latitude	Longitude	Accuracy	Removed	Year built	Height (ft)	Length (ft)	City	County	Cat_basin	Comments
CO	NO NAME #22 DAM	GRAPE RIVER-TR	38.9078	-105.2795	Approximate			15			TELLER	South Platte Headwater. Colorado.	Located in the Florissant Fossil Beds National Monument.
CO	NO NAME #8 DAM	GRAPE RIVER-TR	38.9177	-105.2916	Approximate	1990		12			TELLER	South Platte Headwater. Colorado.	Located in the Florissant Fossil Beds National Monument.
CO	PEAR DAM	CONY CREEK	40.1767	-105.6233	Exact	1988		28			BOULDER	St.Vrain. Colorado.	Located in Rocky Mountain National Park.
CO	SAND BEACH DAM	SAND BEACH CREEK	40.2183	-105.6017	Exact	1988		25			BOULDER	St.Vrain. Colorado.	Located in Rocky Mountain National Park.
CONNECTICUT													
CT	ANACONDA DAM	NAUGATUCK RIVER	41.3533	-73.0850	Approximate	1999		11	330	ANSONIA	NEW HAVEN	Housatonic. Connecticut, Massachusetts, New York.	Naugatuck River Watershed Anadromous Fish Restoration Project: Part of a larger project to restore the Naugatuck River basin (American Rivers).
CT	BALTIC MILLS DAM	SHETUCKET RIVER	41.5222	-72.0783	River confluence	1938		26			NEW LONDON	Thames. Connecticut.	
CT	FREIGHT STREET DAM	NAUGATUCK RIVER	41.5566	-73.0545	City	1999		2	158	WATERBURY	NEW HAVEN	Housatonic. Connecticut, Massachusetts, New York.	Naugatuck River Watershed Anadromous Fish Restoration Project: Part of a larger project to restore the Naugatuck River basin (American Rivers)..
CT	FROST ROAD POND DAM	MAD RIVER	41.5494	-73.0068	Approximate	1983		7		WATERBURY	NEW HAVEN	Housatonic. Connecticut, Massachusetts, New York.	
CT	INDIAN LAKE DAM	INDIAN RIVER	41.2483	-73.0150	Exact	1994	1900	11	100	MILFORD	NEW HAVEN	Quinnipiac. Connecticut.	
CT	JOHN DEE'S DAM	MAD RIVER	41.5500	-73.0250	Approximate			17	45	WATERBURY	NEW HAVEN	Housatonic. Connecticut, Massachusetts, New York.	
CT	LITTLE POND DAM	BIGELOW CREEK	41.5000	-72.6600	State	1994		10				Undetermined	
CT	LOWER POND DAM	CEDAR SWAMP BROOK	41.5000	-72.6600	State	1991		12				Undetermined	
CT	MUDDY POND DAM	MUDDY BROOK	41.5000	-72.6600	State	1992		8				Undetermined	
CT	PARADISE LAKE DAM	BLACKWELL BROOK	41.7500	-71.9683	Exact	1994		20	390		WINDHAM	Quinebaug. Connecticut, Massachusetts, Rhode Island.	
CT	PLATTS MILL DAM	NAUGATUCK RIVER	41.5194	-73.0518	Approximate	2000	1800s	10	231	PLATTS MILL	NEW HAVEN	Housatonic. Connecticut, Massachusetts, New York.	Naugatuck River Watershed Anadromous Fish Restoration Project.
CT	SIMPSON POND DAM	WHARTON BROOK	41.4514	-72.8077	Exact	1995	1880	22	300	WALLINGFORD	NEW HAVEN	Quinnipiac. Connecticut.	
CT	SPRUCEDALE WATER DAM	MILL BROOK	41.5000	-72.6600	State	1980		10				Undetermined	
CT	UNION CITY DAM	NAUGATUCK RIVER	41.4946	-73.0530	Exact	1999	1860	16	200	NAUGATUCK	NEW HAVEN	Housatonic. Connecticut, Massachusetts, New York.	Naugatuck River Watshed Anadromous Fish Restoration Project: Part of a larger project to restore the Naugatuck River basin (American Rivers).
CT	UNNAMED DAM	BRADLEY BROOK	41.8071	-72.7349	County	1993		11			HARTFORD	Undetermined	
CT	WOODINGS POND DAM	QUINNIPIAC RIVER-TR	41.4750	-72.8355	Approximate	1971		15		WALLINGFORD	NEW HAVEN	Quinnipiac. Connecticut.	
DISTRICT OF COLUMBIA													
DC	FORD DAM #3	ROCK CREEK	38.8995	-77.0578	River confluence	1991		56	440		DISTRICT OF COLUMBIA	Middle Potomac-Anacostia-Occoquan. DC, MD, VA.	
DC	MILLRACE DAM	ROCK CREEK	38.8995	-77.0578	River confluence	1969		18		WASHINGTON D.C.	DISTRICT OF COLUMBIA	Middle Potomac-Anacostia-Occoquan. DC, MD, VA.	

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State	Dam Name	River	Latitude	Longitude	Accuracy	Removed	Year built	Height (ft)	Length (ft)	City	County	Cat_basin	Comments
FLORIDA													
FL	DEAD LAKES DAM	CHIPOLA RIVER	30.1193	-85.1738	Approximate	1987	1960	22	820	WEWAHITCHKA	GULF	Chipola. Alabama, Florida.	
FL	WHIDDEN DAM	WHIDDEN CREEK	28.5000	-81.7600	State	1999	1965	25				Undetermined	
HAWAII													
HI	KU TREE RESERVIOR DAM	KAUKONAHUA RIVE, SOUTH FORK-TR	21.5000	-157.9800	Approximate		1925	97	550		HONOLULU	Oahu. Hawaii.	
HI	MANUHONUHONU RESERVOIR	SMITH DITCH	21.8978	-159.4828	Exact		1954	32	400	KUKUILA	KAUAI	Kauai. Hawaii.	
HI	RESERVIOR 510	PANAKAUAHI GULCH	21.3973	-157.9811	City		1935	43	940	PEARL CITY	HONOLULU	Oahu. Hawaii.	
HI	RESERVOIR 530	IRRIGATION DITCH	21.3897	-158.0041	City		1935	32	310	WAIPAHU	HONOLULU	Oahu. Hawaii.	
HI	RESERVOIR 545A	PANAKAUAHI GULCH	21.4114	-158.0020	City		1920	47	375	CRESTVIEW	HONOLULU	Oahu. Hawaii.	
IDAHO													
ID	BUSTER LAKE DAM	GARDEN CREEK	44.4400	-114.4150	Exact	1984	1935	26			CUSTER	Upper Salmon. Idaho.	
ID	COLBURN MILL POND DAM	COLBURN CREEK	48.4069	-116.5274	Approximate	2000	1940s	12	35	COLBURN	BONNER	Pend Oreille Lake. Idaho, Washington.	
ID	DIP CREEK DAM	DIP CREEK	43.7533	-114.3817	Approximate	1978	1947	18			BLAINE	Big Wood. Idaho.	
ID	GRANGEVILLE DAM	CLEARWATER RIVER, S. FORK	46.1458	-115.9814	River confluence	1963	1903	56	440	KOOKSIA	NEZ PERCE	Clearwater. Idaho, Washington.	
ID	KASHMITTER DAM	JOHN DAY CREEK-TR	45.5667	-116.2500	Approximate	1988	1988	40			IDAHO	Lower Salmon. Idaho.	Built and removed in the same year. Unauthorized dam.
ID	KUNKEL DAM	SOLDIER CREEK	42.2267	-114.5233	Approximate	1994	1994	19			TWIN FALLS	Upper Snake-Rock. Idaho.	Built and removed in the same year. Unauthorized dam.
ID	LANE DAM	ELKHORN GULCH	43.6633	-114.3417	Approximate	1989	1949	14		KETCHUM	BLAINE	Big Wood. Idaho.	
ID	LEWISTON DAM	CLEARWATER RIVER	46.4333	-116.9533	Exact	1973	1938	45	1060	LEWISTON	NEZ PERCE	Clearwater. Idaho, Washington.	
ID	MALONY CREEK DAM	LAKE FORK CREEK, S. FORK	44.8750	-115.9017	Exact	1986	1924	12			VALLEY	South Fork Salmon. Idaho.	
ID	PACKSADDLE DAM	PACKSADDLE CREEK, N. FORK	43.7716	-111.3383	Exact	1975	1900	15			TETON	Teton. Idaho, Wyoming.	
ID	SILVER SAGE RANCH DAM	SNAKE RIVER-TR	42.9139	-116.0140	Exact	1999	1972	19			OWYHEE	Middle Snake-Succor. Idaho, Oregon.	
ID	SKEIN LAKE DAM	PAYETTE RIVER, N. FORK-TR	44.4778	-116.1103	Exact	1980	1924	11			VALLEY	North Fork Payette. Idaho.	
ID	SUNBEAM DAM	SALMON RIVER	44.2700	-114.7350	Exact	1934	1912	29		SUNBEAM	CUSTER	Upper Salmon. Idaho.	USFS removed dam with dynamite in order to facilitate fish passage.
ILLINOIS													
IL	AMAX DELTA BASIN 31 DAM	BRUSH CREEK	37.8840	-88.3792	River confluence			11			SALINE	Saline. Illinois.	
IL	AMAX/DELTA/BASIN	BRUSH CREEK-TR	37.8840	-88.3792	River confluence	1991		11	1600		SALINE	Saline. Illinois.	
IL	CONSOL/BURNING STAR 5/20 DAM	LITTLE MUDDY RIVER	37.9000	-89.2100	City			18		ELKVILLE	JACKSON	Big Muddy. Illinois.	
IL	CONSOL/BURNING STAR DAM	LITTLE MUDDY RIVER-TR	37.8300	-89.1900	Approximate	1990		18	3000	DESOTO	JACKSON	Big Muddy. Illinois.	
IL	COOK COAL TERMINAL DREDGE DISPOSAL DAM	OHIO RIVER-TR	37.2193	-88.7096	County	2000		15	5000		MASSAC	Undetermined	
IL	FAIRIES PARK DREDGE DISPOSAL DAM	LAKE DECATUR-TR	39.8334	-89.0082	City	1992		19		DECATUR	MACON	Upper Sangamon. Illinois.	
IL	HIDDEN LAKE DAM	HILLS CREEK-TR	41.4070	-90.7320	Exact	2000	1960	25	360	ANDALUSIA	ROCK ISLAND	Copperas-Duck. Illinois, Iowa.	
IL	KUNKEL DAM	SOLDIER CREEK	41.1217	-87.8764	River confluence	1994		19			KANKAKEE	Kankakee. Illionois, Indiana, Michigan.	

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State	Dam Name	River	Latitude	Longitude	Accuracy	Removed	Year built	Height (ft)	Length (ft)	City	County	Cat_basin	Comments
IL	LAKE ADELPHA DAM	NEGRO CREEK	41.3211	-89.2719	River confluence	1988		15			BUREAU	Lower Illinois-Senachwine Lake. Illinois.	
IL	LOCK AND DAM 26	MISSISSIPPI RIVER	38.8516	-90.1245	City			64	4000	WOOD RIVER	ST. CHARLES	Peruque-Piasa. Illinois, Missouri.	
IL	OLD BEN DAM	EWING CREEK	37.9203	-88.9225	River confluence			29			FRANKLIN	Big Muddy. Illinois.	
IL	OLSENS LAKE DAM	SEVENMILE BRANCH, EAST BRANCH	41.9711	-89.5320	Exact	1982	1966	17	490	POLO	OGLE	Lower Rock. Illinois, Wisconsin.	
IL	PARADISE LAKE DAM	WOOD RIVER	38.9183	-90.0917	Exact	1991	1966	6		FOREST HOMES	MADISON	Peruque-Piasa. Illinois, Missouri.	
IL	PEABODY #1A DAM	CYPRESS DITCH	37.7631	-88.1656	River confluence			24			GALLATIN	Saline. Illinois.	
IL	PEABODY #5 DAM	CYPRESS DITCH	37.7631	-88.1656	River confluence			42			GALLATIN	Saline. Illinois.	
IL	PEABODY/EAGLE2/SLURRY WETLANDS DAM	CYPRESS DITCH-TR	37.7203	-88.2502	City	1994	1969	12	1050	JUNCTION	GALLATIN	Saline. Illinois.	
IL	PEABODY/RIVER KING 1/ SLURRY AREA 2 DAM	SILVER CREEK-TR	38.3378	-89.8750	River confluence	1986	1984	36	5000		ST. CLAIR	Lower Kaskaskia. Illinois.	
IL	PEABODY/RIVER KING1/ SLURRY DAM 1	SILVER CREEK-TR	38.3378	-89.8750	River confluence	1986	1982	32	4100		ST. CLAIR	Lower Kaskaskia. Illinois.	
IL	SPRINGFIELD, CWLP RETENTION PONDS DAM	SUGAR CREEK-TR	39.8111	-89.5425	River confluence	1991		25			SANGAMON	Upper Sangamon. Illinois.	
IL	STONE GATE DAM	WAUBONSIE CREEK	41.6863	-88.3535	River confluence	1999		4	100		KENDALL	Lower Fox. Illinois.	
IL	TURKEY BLUFF DAM	MISSISSIPPI RIVER-TR	37.9064	-89.7580	Approximate	1984		43	625		RANDOLPH	Upper Mississippi-Cape Girardeau. Illinois, Missouri.	
IL	WOODHAVEN NORTH IMPOUNDMENT DAM		41.7399	-89.2997	County	1990		12	2300		LEE	Undetermined	
IL	WOODHAVEN SOUTH IMPOUNDMENT DAM		41.7399	-89.2997	County	1990		11	3100		LEE	Undetermined	
INDIANA													
IN	PINHOOK DAM		40.0000	-86.0000	State			15				Undetermined	
KANSAS													
KS	CHAPMAN LAKE DAM	SILVER CREEK-TR	38.5000	-98.0000	State			38				Undetermined	
KS	CITY OF WELLINGTON DAM	EAST PRAIRIE CREEK	37.2117	-97.5283	Approximate			36		WELLINGTON	SUMNER	Chikaskia. Kansas, Oklahoma.	
KS	EDWIN K. SIMPSON DAM		38.5000	-98.0000	State			25				Undetermined	
KS	LAKE BLUESTEM DAM		38.5000	-98.0000	State			68				Undetermined	
KS	MOLINE, CITY OF, MOLINE MIDDLE CITY LAKE DAM	WILDCAT CREEK-TR	37.3500	-96.3400	Approximate		1937	44	1250	MOLINE	ELK	Elk. Kansas.	
KS	MOTT DAM	ELM CREEK-TR	37.3300	-98.5900	Approximate		1976	21	350	MEDICINE LODGE	BARBER	Medicine Lodge. Kansas, Oklahoma.	
KS	SOLDIER LAKE DAM		38.5000	-98.0000	State			14				Undetermined	
KS	WYANDOTTE COUNTY LAKE DAM	MISSOURI RIVER	39.1700	-94.7700	Exact		1941	98	1790	KANSAS CITY	WYANDOTTE	Independence-Sugar. Kansas, Missouri.	
KENTUCKY													
KY	EBENEZER LAKE DAM	POND CREEK	37.1992	-87.1052	Approximate	1985		15	515	EBENEZER	MUHLENBERG	Middle Green. Kentucky.	
KY	GENERAL BUTLER STATE PARK NO 2	KENTUCKY RIVER-TR	38.6636	-85.1480	Approximate	2000		25	400	CARROLLTON	CARROLL	Lower Kentucky. Kentucky.	
KY	MITCHELL DAM	QUICKS RUN-TR	38.6464	-83.3515	River confluence	1981		52	500		LEWIS	Ohio Brush-Whiteoak. Kentucky, Ohio.	
KY	SHARPSBURGH RESERVOIR DAM	LITTLE FLAT CREEK	38.2589	-83.8781	Approximate	1985		35	365	SHERBURNE	BATH	Licking. Kentucky.	
KY	TOM MURPHY DAM	CLEAR CREEK-TR	37.7470	-85.8018	Approximate	1997		32	325		HARDIN	Rolling Fork. Kentucky.	
KY	WEST FORK POND RIVER #7 DAM	POND RIVER, WEST FORK	37.1569	-87.3339	River confluence	1991		16	1300		CHRISTAIN	Pond. Kentucky.	

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State	Dam Name	River	Latitude	Longitude	Accuracy	Removed	Year built	Height (ft)	Length (ft)	City	County	Cat_basin	Comments
KY	WINCHESTER RESERVOIR LOWER	HOWARD CREEK	37.9474	-84.2303	Approximate	1984		25	315		CLARK	Lower Kentucky. Kentucky.	
KY	WINCHESTER RESERVOIR UPPER	HOWARD CREEK	37.8489	-84.2300	Approximate	1994		30	360		CLARK	Lower Kentucky. Kentucky.	
LOUISIANA													
LA	BAYOU DUPONT #13 DAM	BAYOU DUPONT	31.6672	-93.3583	Approximate			23			SABINE	Bayou Pierre. Louisiana.	
LA	CASTOR LAKE DAM	POND BRANCH	31.1391	-93.2097	Exact		1932	10	25	CASTOR LAKE COMMUNITY	VERNON	Lower Sabine. Louisiana, Texas.	
LA	KISATHIE LAKE DAM	DRY PRONG CREEK	31.4153	-92.4117	City		1955	25	3700	BALL	RAPIDES	Little. Louisiana.	
LA	SHIRLEY WILLIS POND DAM	BAYOU DORCHEAT	32.4584	-93.3859	Exact		1936	10	400	LAKE BISTINEAU STATE PARK	WEBSTER	Loggy Bayou. Arkansas, Louisiana.	
MAINE													
ME	ARCHER'S MILL DAM	STETSON STREAM	44.8873	-69.1383	Approximate	1999		12	50		PENOBSCOT	Lower Kennebec. Maine.	
ME	BROWNVILLE DAM	PLEASANT RIVER	45.3067	-69.0353	City	1999	1900	12	300	BROWNVILLE	PISCATAQUIS	Piscataquis. Maine.	
ME	COLUMBIA FALLS DAM	PLEASANT RIVER	44.6536	-67.7281	City	1998	1983	9	350	COLUMBIA FALLS	WASHINGTON	Maine Coastal. Maine.	
ME	EAST MACHIAS DAM	EAST MACHIAS RIVER	44.7401	-67.3876	City	2000		16	150	EAST MACHIAS	WASHINGTON	Maine Coastal. Maine.	
ME	EDWARDS DAM	KENNEBEC RIVER	44.3250	-69.7700	Exact	1999	1837	42	1044	AUGUSTA	KENNEBEC	Lower Kennebec. Maine.	
ME	GRIST MILL DAM	SOUADABSCOOK STREAM	44.7581	-68.8591	Approximate	1998	late 1700s	14	75	HAMPDEN	PENOBSCOT	Lower Penobscot. Maine.	
ME	GUILFORD DAM	SEBASTICOOK RIVER, E. BRANCH	44.8350	-69.2733	Exact	2002			340	NEWPORT	PENOBSCOT	Lower Kennebec. Maine.	
ME	SENNEBEC POND DAM	SAINT GEORGE RIVER	44.2317	-69.2800	Exact	2002	1908	14	240	UNION	KNOX	St. George-Sheepscot. Maine.	A three-foot dam constructed upstream to allow Sennebec Lake levels to remain the same. This dam has a roughened ramp fish passage.
ME	SMELT HILL	PRESUMPSCOT RIVER	43.7209	-70.2701	City	2002	1898	19	151	FALMOUTH	CUMBERLAND	Presumpscot. Maine.	
ME	SOUADABSCOOK FALLS DAM	SOUADABSCOOK STREAM	44.7483	-68.8333	Exact	1999			150	HAMPDEN	PENOBSCOT	Lower Penobscot. Maine.	
ME	SOUADABSCOOK STREAM DAM	SOUADABSCOOK STREAM	44.7400	-68.8300	Approximate	1998	1920	14	75	HAMPDEN	PENOBSCOT	Lower Penobscot. Maine.	
MARYLAND													
MD	AVALON DAM	PATAPSCO RIVER	39.2288	-76.7290	Approximate	1979	1850	9	165	BALTIMORE	BALTIMORE	Gunpowder-Patapsco. Maryland, Pennsylvania.	Removed after damage from Hurricane Agnes, 1972. Shares a border with Howard County.
MD	PATUXENT NAVAL AIR STATION, POND NO. 3	PINE HILL RUN	38.2685	-76.4324	Approximate		1958	13	197	PATUXENT RIVER AIR TEST CNTR	ST. MARYS	Severn. Maryland.	
MASSACHUSETTS													
MA	BILLINGTON STREET DAM	TOWN BROOK	41.9464	-70.6743	Approximate	2002	late 1790s	6	100	PLYMOUTH	PLYMOUTH	Cape Cod. Massachusetts, Rhode Island.	NOAA Fisheries Community-Based Restoration Program.
MA	OLD BERKSHIRE MILL DAM	HOUSATONIC RIVER, E. BRANCH	42.4703	-73.1695	Exact	1999	1915		120	DALTON	BERKSHIRE	Housatonic. Connecticut, Massachusetts, New York.	
MA	SILK MILL DAM	YOKUM BROOK	42.3282	-73.0847	Exact	2003		15	93	BECKET	BERKSHIRE	Westfield. Connecticut, Massachusetts.	Part of a larger effort to restore Yokum Brook.
MICHIGAN													
MI	BEAR CREEK DAM	BEAR CREEK	44.2300	-83.8500	State	1988		9	336			Undetermined	

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State	Dam Name	River	Latitude	Longitude	Accuracy	Removed	Year built	Height (ft)	Length (ft)	City	County	Cat_basin	Comments
MI	BIG RAPIDS DAM	MUSKEGON RIVER	43.7000	-85.4900	Approximate	2000	1866	17	250	BIG RAPIDS	MECOSTA	Muskegon. Michigan	The crib dam failed in 1912; a concrete dam was built in same location in 1914. A botched attempt at dam removal in 1966 caused major flooding.
MI	GLOVER	KIMMERLEE CREEK/POKAGON CREEK/DOWAGIAC RIVER	41.9181	-86.2094	River confluence	1998		6	0		CASS	St. Joseph. Indiana, Michigan.	
MI	MILL POND DAM	CHIPPEWA RIVER	43.5957	-84.7870	City	2002		15	110	MOUNT PLEASANT	ISABELLA	Pine. Michigan.	
MI	NEWAYGO DAM	MUSKEGON RIVER	43.4229	-85.7992	City	1969	early 1900s	18		NEWAYGO	NEWAYGO	Muskegon. Michigan	
MI	SALLING DAM	AUSABLE RIVER	44.6638	-84.7415	Approximate	1991		17	250	GRAYLING	CRAWFORD	Au Sable. Michigan.	
MI	SIX MILE CREEK DAM	SIXMILE CREEK	46.7174	-88.5848	Exact	1995	1965	17	250		BARAGA	Dead-Kelsey. Michigan.	
MI	SMYRNA DAM	SEELY CREEK	43.0597	-85.2542	River confluence		1908	24	600	SMYRNA	IONIA	Lower Grand. Michigan.	
MI	STRONACH DAM	PINE RIVER	44.2132	-85.8963	Exact	2003	1918	18	350		MANISTEE	Manistee. Michigan.	Removed in increments over several years.
MI	THIRD CREEK TROUT POND DAM	THIRD CREEK	46.2558	-85.3983	Exact	1991		10			LUCE	Tahquamenon. Michigan.	Removed to restore a trout stream.
MI	THREE RIVER CITY DAM	ROCKY RIVER	41.9462	-85.6378	City	1992		16	120	THREE RIVERS	ST. JOSEPH	St. Joseph. Indiana, Michigan.	
MI	VILLAGE OF L'ANSE DAM	FALLS RIVER	46.7497	-88.4514	City	1998		10	200	L'ANSE	BARAGA	Dead-Kelsey. Michigan.	
MI	WAGER DAM	GRAND RIVER	42.9721	-85.0683	City	1985	1896	10	250	IONIA	IONIA	Lower Grand. Michigan.	
MI	WASKIEWICZ DAM	GREY CREEK	41.9000	-86.0100	County	1995		20			CASS	St. Joseph. Indiana, Michigan.	
MI	WILLIAMSTON DAM	RED CEDAR RIVER	42.6900	-84.2844	City	1998		9	268	WILLIAMSTON	INGHAM	Upper Grand. Michigan.	
MINNESOTA													
MN	BERNINGS MILL DAM	CROW RIVER	45.1545	-93.6661	Approximate	1986	1900	10	225		WRIGHT	Crow. Minnesota.	HISTORY OF DROWNINGS, FAILED ONE YEAR PREVIOUS TO REMOVAL
MN	FLANDRAU DAM	COTTONWOOD RIVER	44.2801	-94.6878	Approximate	1995		12		SLEEPY EYE	BROWN	Cottonwood. Minnesota.	
MN	FRAZEE DAM	OTTERTAIL RIVER	46.7215	-95.7077	Approximate	1999	1881	21	60	FRAZEE	BECKER	Otter Tail. Minnesota.	
MN	HANOVER DAM	CROW RIVER	45.1535	-93.6616	Approximate	1984	1900	13	250	HANOVER	WRIGHT	Crow. Minnesota.	PARTIAL FAILURE IN 1983, REMOVED DUE TO HISTORY OF DROWNINGS
MN	KETTLE RIVER DAM	KETTLE RIVER	46.1079	-92.8629	Exact		1908	25	321	SANDSTONE	PINE	Kettle. Minnesota.	
MN	LAKE FLORENCE DAM	DEER RIVER	46.0000	-94.5000	State			12				Undetermined	
MN	LITTLE CANNON RIVER DAM	LITTLE CANNON RIVER	44.5087	-92.9072	Exact	2003	1936	33	150	CANNON FALLS	GOODHUE	Cannon. Minnesota.	
MN	MAZEPPA DAM	ZUMBRO RIVER, N. FORK	44.2730	-92.5483	City	2001	1922	10	150	MAZEPPA	WABASHA	Zumbro. Minnesota.	
MN	OLD MILL STATE PARK	MIDDLE TWO RIVERS	48.3623	-96.5720	Approximate	1997		11	92		MARSHALL	Snake. Minnesota.	
MN	POMME DE TERRE RIVER DAM (APPLETON DAM)	POMME DE TERRE RIVER	45.5701	-95.8824	Exact	1999	1872	10	157	APPLETON	SWIFT	Pomme De Terre. Minnesota.	
MN	SANDSTONE DAM	KETTLE RIVER	46.1330	-92.8566	City	1995	1908	20	150	SANDSTONE	PINE	Kettle. Minnesota.	
MN	STEWARTVILLE DAM	ROOT RIVER, NORTH BRANCH	43.8583	-92.4917	Exact	1995	1857	17	470	STEWARTVILLE	OLMSTED	Root. Iowa, Minnesota.	
MN	WELCH MILL DAM	CANNON RIVER	44.5678	-92.7397	Approximate	1994	1900	9	120	WELCH	GOODHUE	Cannon. Minnesota.	
MISSOURI													
MO	ALKIRE LAKE DAM		39.0592	-93.7840	County	1990		30			LAFAYETTE	Undetermined	
MO	INDIAN ROCK DAM	TYREY CREEK-TR	38.2077	-90.7913	Approximate	1986	1978	57			FRANKLIN	Big. Missouri.	
MONTANA													
MT	PEET CREEK DAM	PEET CREEK	44.6325	-112.1067	River confluence	1994		43	250	LIMA	BEAVERHEAD	Red Rock. Montana.	

Appendix 1: Output of the Dam Removal Database

State	Dam Name	River	Latitude	Longitude	Accuracy	Removed	Year built	Height (ft)	Length (ft)	City	County	Cat_basin	Comments
MT	THREE BEARS LAKE-EAST DAM	BEAR CREEK	48.3247	-113.3631	Exact	1990		10		SUMMIT	GLACIER	Two Medicine. Montana.	Dam removed to protect railroad. Lake spanned the continental divide. There was a second dam on the same lake that was not removed.
MT	VAUX #1 DAM	LONE TREE CREEK	47.7270	-104.2253	Exact	1995	1960	34	150	SIDNEY	RICHLAND	Lower Yellowstone. Montana, North Dakota.	
MT	WALLACE CREEK DAM	WALLACE CREEK	46.7800	-113.6700	Exact	1997		29	720	CLINTON		Upper Clark Fork. Montana.	
NEW HAMPSHIRE													
NH	ASHUELOT RIVER DAM	ASHUELOT RIVER	42.7738	-72.3843	City	1937		10	195	WINCHESTER	CHESHIRE	Middle Connecticut. Massachusetts, New Hampshire, Vermont.	
NH	BEARCAMP RIVER DAM	BEARCAMP RIVER	43.8279	-71.2984	Approximate	2003	1929	20	230	SOUTH TAMWORTH	CARROLL	Saco. Maine, New Hampshire.	Built to power South Tamworth Industries, but became obsolete after a fire destroyed the mill in 1945. Project of the NH River Restoration Task Force.
NH	BOSTON EXCELSIOR DAM	MASCOMA RIVER	43.6477	-72.2461	City	1952	1910	20	115	LEBANON	GRAFTON	Upper Connecticut-Mascoma. New Hampshire, Vermont.	
NH	BROWN CO. SPLIT STONE & TIMBER DAM	ANDROSCOGGIN RIVER	44.3925	-71.1726	City	1951		21	150	GORHAM	COOS	Upper Androscoggin. Maine, New Hampshire.	
NH	BURBANK MILL DAM	BLACKWATER RIVER	43.3294	-71.7318	Approximate	1982	1891	12	216	WEBSTER	MERRIMACK	Contoocook. New Hampshire.	
NH	CAPLAN DUSTING MILL DAM	MASCOMA RIVER	43.6422	-72.1345	City	1970		10		ENFIELD	GRAFTON	Upper Connecticut-Mascoma. New Hampshire, Vermont.	
NH	CLAREMONT FLOCK CORPORATION DAM	SUGAR RIVER	43.3764	-72.3431	City	1969		15		CLAREMONT	SULLIVAN	Upper Connecticut-Mascoma. New Hampshire, Vermont.	
NH	FITCH RESERVOIR DAM	GRANDY BROOK	43.3999	-72.3138	Exact	1996	1888	40		CLAREMONT	SULLIVAN	Upper Connecticut-Mascoma. New Hampshire, Vermont.	
NH	MAD RIVER DAM	MAD RIVER	43.9549	-71.5126	City	1946		27	201	WATERVILLE VALLEY	GRAFTON	Pemigewasset. New Hampshire.	
NH	MAST POINT DAM	SALMON FALLS RIVER	43.2866	-70.8988	Exact	1996	1935	13	220	SOMERSWORTH	STRAFFORD	Piscataqua-Salmon Falls. Maine, New Hampshire, Massachusetts	
NH	MCGOLDRICK DAM	ASHUELOT RIVER	42.7861	-72.4869	City	2001	1828	6	150	HINSDALE	CHESHIRE	Middle Connecticut. Massachusetts, New Hampshire, Vermont.	Project of the NH River Restoration Task Force (NH Department of Environmental Services).
NH	MCQUADE RESERVOIR DAM	GRANDY BROOK	43.3974	-72.3183	Exact	2002	1888	17	210	CLAREMONT	SULLIVAN	Upper Connecticut-Mascoma. New Hampshire, Vermont.	
NH	SILVER BROOK DAM	SILVER BROOK	42.6014	-99.3269	City	1980		6	20	NEWPORT	ROCK	Upper Elkhorn. Nebraska.	
NH	SOUHEGAN RIVER DAM #6	SOUHEGAN RIVER	42.7703	-71.8065	City	1977	1926	27	87	GREENVILLE	HILLSBOROUGH	Merrimack. Massachusetts, New Hampshire.	
NH	TILTON HYDRO DAM	WINNIPESAUKEE RIVER	43.4443	-71.5855	City	1960		11	137	TILTON	BELKNAP	Merrimack. Massachusetts, New Hampshire.	
NH	WHITEWATER BROOK DAM	WHITEWATER BROOK	43.3745	-72.3583	Approximate	1989		13		CLAREMONT	SULLIVAN	Upper Connecticut-Mascoma. New Hampshire, Vermont.	

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State	Dam Name	River	Latitude	Longitude	Accuracy	Removed	Year built	Height (ft)	Length (ft)	City	County	Cat_basin	Comments
NH	WINCHESTER DAM	ASHUELOT RIVER	42.7781	-72.3853	City	2002	1900	3	105	WINCHESTER	CHESHIRE	Middle Connecticut. Massachusetts, New Hampshire, Vermont.	Project of the NH River Restoration Task Force (NH Department of Environmental Services)
NEW JERSEY													
NJ	BATSTO DAM	BATSTO RIVER	39.6433	-74.6508	Exact			12	400	PLEASANT HILLS	BURLINGTON	Mullica-Toms. New Hersey.	
NJ	FIELDSVILLE DAM	RARITAN RIVER	40.5407	-74.5134	Approximate	1990		10	400	SOUTH BOUND BROOK	SOMERSET	Raritan. New Jersey.	
NJ	GLENSIDE DAM	BIG TIMBER CREEK, SOUTH BRANCH	39.7793	-75.0509	Approximate	1997		12	130	TURNERSVILLE	GLOUCESTER	Lower Delaware. New Jersey, Pennsylvania.	
NJ	KNOX HILL DAM	WHIPPANY RIVER	40.8456	-74.3416	River confluence	1996		18	150		MORRIS	Hackensack-Passaic. New Jersey, New York.	
NJ	LAKE SUCCESS DAM	DELAWARE RIVER-TR	41.1083	-74.8900	Approximate	1995		20	300		SUSSEX	Middle Delaware-Mongaup-Brodhead. NJ, NY, PA.	
NJ	LAMBERTVILLE WATER CO. DAM #3	SWAN CREEK	40.3606	-74.9236	City		1877	16	770	LAMBERTVILLE	HUNTERDON	Middle Delaware-Musconetcong. New Jersey, Pennsylvania.	
NJ	MAPLE LAKE DAM	STEPHEN CREEK	39.4053	-74.7778	Exact			13	750		ATLANTIC	Great Egg Harbor. New Jersey.	
NJ	MILFORD DAM	HAKIHOKAKE CREEK	40.5636	-75.0919	City	1997		8	125	MILFORD	HUNTERDON	Middle Delaware-Musconetcong. New Jersey, Pennsylvania.	
NJ	NEW JERSEY NO NAME #53 DAM	WHIPPANY RIVER-TR	40.8456	-74.3419	River confluence			35	350		MORRIS	Hackensack-Passaic. New Jersey, New York.	
NJ	OLD EAGLE MILL DAM	CROSSWICKS CREEK	40.1555	-74.6491	Approximate			10	375		MERCER	Crosswicks-Neshaminy. New Jersey, Pennsylvania.	
NJ	PATEX POND DAM	CROOKED BROOK	40.9172	-74.3833	Approximate	1990		20	340		MORRIS	Hackensack-Passaic. New Jersey, New York.	
NJ	POOL COLONY DAM	VANCAMPENA CREEK	41.0861	-74.9290	Approximate	1999		8			SUSSEX	Middle Delaware-Mongaup-Brodhead. NJ, NY, PA.	
NJ	POTTERSVILLE DAM	COLD BROOK	40.6971	-74.7439	Approximate	1985		20	180		SOMERSET	Raritan. New Jersey.	
NJ	UPPER BLUE MOUNTAIN DAM	VAN CAMPTENS BROOK	41.1054	-74.9209	Approximate	1995		26	210		SUSSEX	Middle Delaware-Mongaup-Brodhead. NJ, NY, PA.	
NJ	WHITEHEAD POND DAM	ASSUNPINK CREEK	40.2478	-74.7272	Exact			9	225		MERCER	Middle Delaware-Musconetcong. New Jersey, Pennsylvania.	
NEW MEXICO													
NM	MCMILLAN DAM	PECOS RIVER	32.5950	-104.3467	Exact	1989		65	900		EDDY	Upper Pecos-Black. New Mexico, Texas.	
NM	TWO MILE DAM	SANTA FE RIVER	35.6871	-105.8945	Exact	1994	1894	85	720	SANTA FE	SANTA FE	Rio Grande-Santa Fe. New Mexico.	
NEW YORK													
NY	BLACK CREEK (GRAY) RESERVOIR DAM	BLACK CREEK	43.2542	-74.9280	Exact	2003	1905	30	385		HERKIMER	Mohawk. New York.	
NY	FORT EDWARD DAM	HUDSON RIVER	43.2677	-73.5949	City	1973		31	586	FORT EDWARD	WASHINGTON	Hudson-Hoosic. New York, Massachusetts, Vermont.	
NY	LAKE FLORENCE DAM	DEER RIVER	44.6138	-74.2648	Approximate		1901	18	225		FRANKLIN	St. Regis. New York.	
NY	LUXTON LAKE DAM		43.0000	-75.5000	State			15				Undetermined	

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State	Dam Name	River	Latitude	Longitude	Accuracy	Removed	Year built	Height (ft)	Length (ft)	City	County	Cat_basin	Comments
NEBRASKA													
NE	BENNETT DAM	LODGEPOLE CREEK	41.2517	-103.6183	Exact	1982		21		KIMBALL	KIMBALL	Lower Lodgepole. Colorado, Nebraska, Wyoming.	
NE	GOLF COURSE DAM #2		41.5000	-99.8300	State	1993		8	67			Undetermined	Funding for dam removal made available, so park decided to restore the natural prarie ecosystem (two dams removed - Golf course #s 1 and 2)
NE	GOLF COURSE DAM		41.5000	-99.8300	State	1993		25	200			Undetermined	
NE	JAGELS DAM	LITTLE BLUE RIVER-TR	40.2550	-97.8267	Exact		1967	19	485	HEBRON	NUCKOLLS	Upper Little Blue. Kansas, Nebraska.	
NE	OBERMEIER DAM	BIG BLUE RIVER, WEST FORK-TR	40.7190	-97.9372	City		1982	14	415	STOCKHAM	HAMILTON	West Fork Big Blue. Nebraska.	
NE	SPIEKER DAM	RAE CREEK-TR	41.8217	-98.0967	Exact		1970	16	325	LORETTO	BOONE	Loup. Nebraska.	
NE	YOST DAM	WEST LITTLE SANDY CREEK	40.4200	-97.8683	Exact		1972	18	407	CARLETON	CLAY	Upper Little Blue. Kansas, Nebraska.	
NEVADA													
NV	KATHERINE BORROW PIT EMBANKMENT	KATHERINE WASH	35.2337	-114.5476	Approximate	1992		15			MOHAVE	Havasu-Mohave Lakes. Arizona, California, Nevada.	
NORTH CAROLINA													
NC	ASH BEAR PEN DAM	COLD PRONG	36.1300	-81.7683	Exact	1990		10	45	JULIAN PRICE MEMORIAL PARK	WATAUGA	Watauga, North Carolina, Tennessee.	
NC	CHERRY HOSPITAL DAM	LITTLE RIVER	35.3939	-78.0268	Approximate	1998	1940s	7	135	GOLDSBOROUGH	WAYNE	Upper Neuse. North Carolina.	
NC	QUAKER NECK LAKE DAM	NEUSE RIVER	35.3731	-78.0758	Exact	1997	1952	12	170	GOLDSBORO	WAYNE	Upper Neuse. North Carolina.	
NC	RAINS DAM	LITTLE RIVER	35.3764	-78.0256	River confluence	1999	1928	10	270		WAYNE	Upper Neuse. North Carolina.	
NC	UNNAMED DAM	MARKS CREEK-TR	35.7875	-78.4808	City	2002		25	400	KNIGHTDALE	WAKE	Upper Neuse. North Carolina.	StanTec Engineering removed approx. 20 ft vertically and 300 feet horizontally. See before and after photographs in files.
NORTH DAKOTA													
ND	KUNICK DAM; BERNARD 1	LITTLE MISSOURI RIVER	47.6106	-102.8728	River confluence		1975	20	450		DUNN	Lower Little Missouri. North Dakota.	
OHIO													
OH	ALTIER POND DAM	BLACK FORK-TR	39.6844	-82.0589	City	1989		32	1212	SAYRE	PERRY	Muskingum. Ohio.	
OH	ARMINGTON DAM #2	SALT RUN	41.2033	-81.5117	Approximate	1991		15			SUMMIT	Cuyahoga. Ohio.	
OH	ASHWORTH LAKE DAM	SEVEN MILE CREEK-TR	39.7145	-84.6399	Approximate			25			PREBLE	Lower Great Miami, Indiana, Ohio.	
OH	BRASHEAR LAKE DAM	SUGARTREE CREEK-TR	38.9790	-84.1300	Approximate	1991		16	200		CLERMONT	Little Miami. Ohio.	
OH	BURT LAKE DAM	LITTLE AUGLAIZE RIVER-TR	41.1075	-84.4190	Exact	1992		18	190	FORT BROWN	PAULDING	Auglaize. Indiana, Ohio.	
OH	CARR LAKE DAM	JOHNNY WOODS RIVER-TR	39.8403	-81.5403	Approximate	1985		10			NOBLE	Little Musringum-Middle Island. Ohio, West Virginia.	
OH	CONSOL POND DAM	STILLWATER CREEK	40.1275	-81.1767	City			29	330	GOLDA	BELMONT	Tuscarawas. Ohio.	
OH	COTTINGHAM LAKE DAM	HOCKING RIVER-TR	39.3689	-82.1325	City	1991		17	175	THE PLAINS	ATHENS	Hocking. Ohio.	
OH	DERBY PETROLEUM LAKE DAM	TIMBER RUN-TR	39.9517	-82.0987	Approximate	1984		30			MUSKINGUM	Licking. Ohio.	
OH	DUTIEL POND DAM	LICKING RIVER-TR	39.9409	-82.0154	River confluence	1986		14			MUSKINGUM	Muskingum. Ohio.	

Appendix 1: Output of the Dam Removal Database

State	Dam Name	River	Latitude	Longitude	Accuracy	Removed	Year built	Height (ft)	Length (ft)	City	County	Cat_basin	Comments
OH	FAIR HAVEN LAKE DAM	LITTLE ICE CREEK-TR	38.5136	-82.5987	Exact	1980		30			LAWRENCE	Little Scioto-Tygarts. Kentucky, Ohio.	
OH	FOXTAIL DAM		41.2800	-81.5800	County			30			SUMMIT	Undetermined	
OH	GEORGETOWN UPPER POND NO. 2 DAM	SHORT CREEK, S. FORK	40.1981	-80.9497	City	1988	1978	13	360	DUNCANWOOD	HARRISON	Upper Ohio-Wheeling. Ohio, Pennsylvania, West Virginia.	
OH	GLEN HELLEN DAM	LITTLE MIAMI RIVER	39.0761	-84.4314	River confluence	1998		8	100		HAMILTON	Ohio Brush-Whiteoak. Kentucky, Ohio.	
OH	JACOBY ROAD DAM	LITTLE MIAMI RIVER	39.7619	-83.9108	City	1997	post-1910	8	100	YELLOW SPRINGS	GREENE	Little Miami. Ohio.	
OH	JONES LAKE DAM	OGG CREEK	39.7212	-82.0526	Approximate			20			PERRY	Muskingum. Ohio.	
OH	KILLIANY LAKE DAM	WILLS CREEK-TR	39.9595	-81.5449	Approximate			8		BYESVILLE	GUERNSEY	Wills. Ohio.	
OH	LAKE HILL DAM #1	ROBINSON RUN-TR	40.0846	-81.1708	River confluence			30			BELMONT	Tuscarawas. Ohio.	
OH	LAKE HILL DAM #2	ROBINSON RUN-TR	40.0846	-81.1708	River confluence			30			BELMONT	Tuscarawas. Ohio.	
OH	LITTLE DARBY DAM	LITTLE DARBY CREEK	39.8957	-83.2240	Approximate	1989		20		GEORGESVILLE	FRANKLIN	Upper Scioto. Ohio.	Part of a larger restoration effort on the Darby Creek system. The only dam on Little Darby Creek. It was located just above the confluence with Big Darby Creek.
OH	MARSHFIELD LAKE DAM	PORTER CREEK	41.4502	-81.9566	Approximate	1973	1940	15	220	WESTLAKE	CUYAHOGA	Black-Rocky. Ohio.	
OH	MASTRINE POND DAM	LITTLE PINE CREEK-TR	39.4773	-82.6442	Approximate	1978		15			HOCKING	Lower Scioto. Ohio.	
OH	MILAN WILDLIFE AREA DAM (COHO DAM)	HURON RIVER	41.2913	-82.6372	Approximate	2002	1969	5	100	MILAN	ERIE	Huron-Vermilion. Ohio.	
OH	MODOC RESERVOIR DAM	MODOC RUN	39.4785	-82.1417	Approximate	1981		24		MODOC	ATHENS	Hocking. Ohio.	
OH	OHIO POWER COMPANY POND DAM	BRANNON FORK	39.7505	-81.6990	Approximate	1987		17			MUSKINGDOM	Wills. Ohio.	
OH	OHIO POWER COMPANY POND DAM	COLLINS FORK	39.8370	-81.6908	Approximate			13			MUSKINGDOM	Muskingum. Ohio.	
OH	OKIE RICE DAM	LITTLE DARBY CREEK	39.8936	-83.2190	Approximate	1990		12	175	GEORGESVILLE	FRANKLIN	Upper Scioto. Ohio.	Only low head dam on the Little Darby Creek State and National Scenic River.
OH	OLD JENKINS LAKE DAM	LITTLE YELLOW CREEK-TR	40.6370	-80.7637	Approximate			22			COLUMBIANA	Upper Ohio. Ohio, Pennsylvania, West Virginia.	
OH	POSTON FRESH WATER POND DAM	HAMLEY RUN-TR	39.3942	-82.1642	River confluence	1988		42			ATHENS	Hocking. Ohio.	
OH	SILVER CREEK DAM	SILVER DITCH	39.9667	-83.2483	Exact		1968	44	1650	GEORGESVILLE	MADISON	Upper Scioto. Ohio.	
OH	SLIPPERY RUN (STAHL) DAM	CUYAHOGA RIVER-TR	41.2700	-81.5700	Approximate	1990		14			SUMMIT	Cuyahoga. Ohio.	
OH	STATE ROUTE 800 DAM	SPENCER CREEK-TR	40.0425	-81.1607	Exact	1989		25	650	HENDRYSBURG	BELMONT	Tuscarawas. Ohio.	
OH	STRIP MINE POND DAM	MCLUNEY CREEK-TR	39.7330	-82.0990	River confluence			25			PERRY	Muskingum. Ohio.	
OH	TORONTO BAND FATHER'S LAKE DAM	TOWN FORK	40.5086	-80.7303	Approximate	1991		15	600		JEFFERSON	Upper Ohio. Ohio, Pennsylvania, West Virginia.	
OH	VILLAGE AT ROCKY FORK LAKE DAM	ROCKY FORK-TR	40.0497	-82.8361	Approximate			7			FRANKLIN	Upper Scioto. Ohio.	
OH	WONDER LAKE DAM	EAST RESERVOIR-TR	40.9845	-81.5117	Exact	1986		15		COTTAGE GROVE	SUMMIT	Tuscarawas. Ohio.	
OH	YANKEE LAKE DAM	YANKEE RUN	41.2659	-80.5609	Exact	1980		26			TRUMBULL	Shenango. Ohio, Pennsylvania.	
OREGON													
OR	ALPHONSO DAM	EVANS CREEK, E. FORK	42.6059	-122.9891	Approximate	1999	1890s	10	56		JACKSON	Middle Rouge. Oregon.	
OR	BERRY CREEK DAM	BERRY CREEK, S. FORK	44.6464	-123.2476	Approximate	2000		8	30	CORVALLIS	BENTON	Upper Willamette. Oregon.	Part of the Berry Creek Experimental Stream (G. Stewart, OSU Geosciences). Near Peavy Arboretum.
OR	CATCHING DAM	WILLAMETTE RIVER, N. FORK M. FORK	43.7573	-122.4997	Approximate	1994	1924	28	190	WESTFIR	LANE	Middle Fork Willamette. Oregon.	

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State	Dam Name	River	Latitude	Longitude	Accuracy	Removed	Year built	Height (ft)	Length (ft)	City	County	Cat_basin	Comments
OR	DINNER CREEK DAM	DINNER CREEK	43.7151	-122.7130	Approximate	2003	1925	10	35	DISSTON	LANE	Coast Fork Willamette. Oregon.	Dam has not been needed for municipal water supply since 1949. The Northwest Forest Plan and the Aquatic Conservation Strategy (1994) prompted the removal.
OR	JACKSON STREET DAM	BEAR CREEK	42.3319	-122.8701	Exact	1998	1960	11	120	MEDFORD	JACKSON	Middle Rouge. Oregon.	
OR	MAPLE GULCH DIVERSION DAM	MAPLE GULCH	42.5798	-123.0370	Approximate	2002	Early 1900s	11	25	WIMER	JACKSON	Middle Rouge. Oregon.	
OR	MARIE DORIAN DAM	WALLA WALLA RIVER	45.8995	-118.3383	Approximate	1997	1880s	8	100	MILTON-FREEWATER	UMATILLA	Walla Walla. Oregon, Washington.	Rebuilt in 1952.
OR	VALSETZ LAKE DAM	SILETZ RIVER, S. FORK	44.8506	-123.6658	Exact	1988	1918	40		VALSETZ	POLK	Siletz-Yaquina. Oregon.	Boise Cascade drained the lake and removed the dam after closing up the company town of Valsetz. Superfund site. 435-acre lake.
PENNSYLVANIA													
PA	AMERICAN PAPER PRODUCTS DAM	CONESTOGA RIVER	39.9250	-76.3844	River confluence	1998		4	130		LANCASTER	Lower Susquehanna. Maryland, Pennsylvania.	Part of a larger project to restore the Conestoga River, including the removal of seven obsolete dams from the Conestoga River and its tributaries.
PA	BLACK DAM	CONODOGUINET CREEK	40.1916	-77.3745	Exact	2002		10	350		CUMBERLAND	Lower Susquehanna-Swatara. Pennsylvania.	
PA	BUTTERFIELD POND DAM		39.8200	-77.2200	County	1992		13			ADAMS	Undetermined	
PA	CASTLE FIN DAM	MUDDY CREEK	39.7693	-76.3265	City	1997		5	383	CASTLE FIN	YORK	Lower Susquehanna. Maryland, Pennsylvania.	
PA	CLEAR SHADE CREEK RESERVOIR DAM	CLEAR SHADE CREEK	40.1483	-78.8178	River confluence	1998		14	190		SOMERSET	Conemaugh. Pennsylvania.	
PA	COAL CREEK DAM #2	COAL CREEK	41.2290	-75.9564	River confluence	1995		23	116		LUZERNE	Upper Susquehanna-Lackawanna. Pennsylvania.	
PA	COAL CREEK DAM #3	COAL CREEK	41.2290	-75.9564	River confluence	1995		24		PLYMOUTH	LUZERNE	Upper Susquehanna-Lackawanna. Pennsylvania.	
PA	COAL CREEK DAM #4	COAL CREEK	41.2290	-75.9564	River confluence	1995		14	356		LUZERNE	Upper Susquehanna-Lackawanna. Pennsylvania.	
PA	COLLEGEVILLE MILL DAM	PERKIOMEN CREEK	40.1843	-75.4482	City	2003	1708	6	250	COLLEGEVILLE	MONTGOMERY	Schuylkill. Pennsylvania.	
PA	DIVERTING DAM	COAL CREEK	41.2290	-75.9564	River confluence			8	55		LUZERNE	Upper Susquehanna-Lackawanna. Pennsylvania.	
PA	FIRE POND DAM AT INCLINE #10		41.0000	-77.6600	State	1984		16				Undetermined	Dam impounded a fire pond. New fire suppression facilities were installed and the dam was no longer needed
PA	GOOD HOPE DAM	CONODOGUINET CREEK	40.2628	-76.9795	Approximate	2001		6	300	GOOD HOPE	CUMBERLAND	Lower Susquehanna-Swatara. Pennsylvania.	
PA	HAMMER CREEK DAM	HAMMER CREEK	40.1617	-76.2327	River confluence	2001		8	150		LANCASTER	Lower Susquehanna. Maryland, Pennsylvania.	Negative impacts on the downstream habitat from dam removal due to improper sediment management.
PA	INTAKE DAM	RIFE RUN	40.1666	-76.4067	Approximate	2001		8	50	MANHEIM	LANCASTER	Lower Susquehanna. Maryland, Pennsylvania.	
PA	LEMON HOUSE POND DAM		41.0000	-77.6600	State	1984		15				Undetermined	Dam impounded a fire pond. New fire suppression facilities were installed and the dam was no longer needed

Appendix I: Output of the Dam Removal Database

State	Dam Name	River	Latitude	Longitude	Accuracy	Removed	Year built	Height (ft)	Length (ft)	City	County	Cat_basin	Comments
PA	LOWER FRIENDSHIP DAM	MONONGAHELA RIVER-TR	39.7778	-79.9268	Approximate	1982		30			FAYETTE	Lower Monongahela. Pennsylvania, West Virginia.	
PA	MANATAWNY CREEK DAM	MANATAWNY CREEK	40.2475	-75.6560	Exact	2000	1850	8	96	POTTSTOWN	CHESTER	Schuylkill. Pennsylvania.	The Academy of National Sciences is conducting a large scale ecological study on dam removals on the creek.
PA	MAPLE GROVE DAM	LITTLE CONESTOGA CREEK	39.9509	-76.3689	River confluence	1997		6	60		LANCASTER	Lower Susquehanna. Maryland, Pennsylvania.	
PA	MAPLE HOLLOW RESERVOIR DAM	GILLIAN'S RUN	41.0000	-77.6600	State	1995		22	192			Undetermined	
PA	MILL PORT CONSERVANCY DAM	LITITZ RUN	40.1160	-76.2500	Approximate	1998		10	10		LANCASTER	Lower Susquehanna. Maryland, Pennsylvania.	Part of a larger project to restore the Conestoga River basin, including the removal of seven obsolete dams.
PA	MUREN'S DAM (SEITZVILLE MILL DAM)	CODORUS CREEK, S. BRANCH	39.9260	-76.7516	River confluence	2000		12	100		YORK	Lower Susquehanna. Maryland, Pennsylvania.	The removal is part of a larger effort to restore the South Branch of Codorus Creek.
PA	MUSSERS DAM	MIDDLE CREEK	40.7667	-76.8733	Exact	1992		31	384		SNYDER	Lower Susquehanna-Penns. Pennsylvania.	
PA	NIEDERRITER FARM POND DAM	MILL CREEK	42.1436	-80.0806	Approximate	1995		21	350	ERIE	ERIE	Chautauqua-Conneaut. New York, Ohio, Pennsylvania.	
PA	POMEROY MEMORIAL DAM	SUGAR CREEK, W. BRANCH	41.7844	-76.7892	River confluence	1996		24	442		BRADFORD	Upper Susquehanna-Tunkhannock. Pennsylvania.	
PA	RED RUN DAM	RED RUN	40.3825	-78.9189	River confluence	1996		7	40		CAMBRIA	Conemaugh. Pennsylvania.	
PA	ROCK HILL DAM	CONESTOGA RIVER	39.9250	-76.3844	River confluence	1997		13	300		LANCASTER	Lower Susquehanna. Maryland, Pennsylvania.	Part of a larger project to restore the Conestoga River, including the removal of seven obsolete dams from the Conestoga River and its tributaries.
PA	ROSE HILL INTAKE DAM	KETTLE CREEK	41.0000	-77.6600	State	1998		12	150			Undetermined	
PA	SNAVELY'S MILL DAM	FISHING CREEK	41.1222	-77.4831	River confluence	1997		3	106	MILL HALL	CLINTON	Bald Eagle. Pennsylvania.	
PA	UNNAMED DAM	KISHACOQUILLAS CREEK	40.5941	-77.5751	River confluence	1998		9	175		MIFFLIN	Lower Juniata. Pennsylvania.	
PA	UNNAMED DAM	LITITZ RUN	40.1053	-76.2490	River confluence	1998		10	20		LANCASTER	Lower Susquehanna. Maryland, Pennsylvania.	Another smaller dam (not included in this database due to size restrictions) was removed in the same vicinity in 1999.
PA	UNNAMED DAM	CLARION RIVER	41.1174	-79.6742	River confluence	1998		9	175		CLARION	Lower Juniata. Pennsylvania.	
PA	UNNAMED DAM	TINICUM CREEK-TR	40.3230	-75.0100	County	1998		6	40		BUCKS	Undetermined	
PA	UNNAMED DAM, PEACE LIGHT INN		39.8308	-77.2314	City	1991		7		GETTYSBURG	ADAMS	Monocacy. Maryland, Pennsylvania.	
PA	UPPER FRIENDSHIP DAM	MONONGAHELA RIVER-TR	39.7738	-79.9243	Approximate	1982		12			FAYETTE	Lower Monongahela. Pennsylvania, West Virginia.	
PA	VAN HORN DAM #1		39.8050	-79.5917	County	1991		8			FAYETTE	Undetermined	
PA	VAN HORN DAM #2		39.8050	-79.5917	County			10			FAYETTE	Undetermined	
PA	VAN HORN DAM #5		39.8050	-79.5917	County	1991		12			FAYETTE	Undetermined	
PA	WILLIAMSBURG STATION DAM	FRANKSTOWN BRANCH	40.4717	-78.2083	Exact	1996	1922	13	260	WILLIAMSBURG	BLAIR	Upper Juniata. Pennsylvania.	
RHODE ISLAND													
RI	JACKSON POND DAM	PAWTUXET RIVER	41.7639	-71.3921	River confluence	1979		20			PROVIDENCE	Narragansett. Massachusetts, Rhode Island.	

Appendix 1: Output of the Dam Removal Database

State	Dam Name	River	Latitude	Longitude	Accuracy	Removed	Year built	Height (ft)	Length (ft)	City	County	Cat_basin	Comments
SOUTH CAROLINA													
SC	GALLAGHER POND DAM	BURGESS CREEK	34.0000	-80.8300	State	1989		42	500			Undetermined	
SC	MILLER TRUST POND DAM	TOOLS FORK	34.9081	-81.0664	River confluence	1993		38	600		YORK	Lower Catawba. North Carolina, South Carolina.	
SC	OLD CITY RESERVOIR DAM	TURKEY QUARTER CREEK	34.7000	-80.7600	Approximate	1988		25	2275	LANCASTER	LANCASTER	Lower Catawba. North Carolina, South Carolina.	
SC	POLE BRANCH DAM	POLE BRANCH RIVER	34.0000	-80.8300	State	1990		26	400			Undetermined	
SC	REYNOLDS POND DAM	SHAW CREEK	33.5664	-81.5022	River confluence	1983		15	1300		AIKEN	South Fork Edisto. South Carolina.	
SC	RONALD DEW DAM	GOOSE PLATTER CREEK	33.7674	-81.4467	Approximate	1996		11	525		AIKEN	North Fork Edisto. South Carolina.	
SC	SAXE-GOTHA MILLPOND DAM	RED BANK CREEK	33.9289	-81.2425	Exact	1994		20	250	RED BANK	LEXINGTON	Congaree. South Carolina.	
SC	TUTENS MILLPOND DAM	JACKSON BRANCH	33.0133	-81.2167	Exact	1980		17	1050		ALLENDALE	Salkehatchie. South Carolina.	
SC	UNNAMED DAM, STATE ROAD 11-58	ZEKIAL CREEK-TR	35.1282	-81.8129	Approximate	1979		7			CHEROKEE	Upper Broad. North Carolina, South Carolina.	
SOUTH DAKOTA													
SD	ARIKARA DAM	DRY RUN CREEK	44.3828	-100.2650	Exact	1978	1937	40	1000		HUGHES	Fort Randall Reservoir. South Dakota.	
SD	FARMINGDALE DAM	DRY DRAW	43.9106	-102.6983	City	1986	1936	25	520	CRESTON	PENNINGTON	Rapid. South Dakota.	
SD	LAKE FARLEY DAM	WHETSTONE RIVER, S. FORK	45.2281	-96.6436	Exact	1980		25		MILBANK	GRANT	Upper Minnesota. Minnesota, South Dakota.	
SD	MISSION DAM	ANTELOPE CREEK	43.2993	-100.6707	Exact	1987		25		MISSION	TODD	Keya Paha. Nebraska, South Dakota.	
TENNESEE													
TN	BALLARD MILL MINE DAM	FORK CREEK	35.4475	-84.2508	County	1992		30			MONROE	Undetermined	
TN	CITIES SERVICE COMPANY DAM	LITTLE RIVER	35.1263	-84.5155	County	1995		30			POLK	Undetermined	
TN	CUMBERLAND SPRINGS DAM	HURRICANE CREEK	35.2842	-86.3574	County	1989		30			MOORE	Undetermined	
TN	EBLEN-POWELL DAM #1	OLLIS CREEK	36.3952	-84.1281	River confluence		1964	50	369	LA FOLLETTE	CAMPBELL	Upper Clinch, Tennessee, Virginia.	
TN	GIN HOUSE LAKE DAM	ADKINSON CREEK	35.4764	-89.8064	Exact	1994		32			TIPTON	Lower Hatchie. Mississippi, Tennessee.	
TN	LAKE DEFOREST DAM	JOHNSON CREEK	35.7125	-88.7627	Approximate	1991		36			MADISON	North Fork Forked Deer. Tennessee.	
TN	LAUREL LAKE DAM	TIPTON BRANCH	35.6711	-83.7942	Approximate	1990		43			BLOUNT	Watts Bar Lake. Tennessee.	
TN	MONSANTO DAM #12	ROCKY BRANCH	35.6767	-87.1406	River confluence	1990		125	870		MAURY	Lower Duck. Tennessee.	
TN	MONSANTO DAM #4	GREENLICK CREEK	35.6722	-87.1183	River confluence	1990		53	463		MAURY	Lower Duck. Tennessee.	
TN	MONSANTO DAM #5A	GREENLICK CREEK	35.6722	-87.1183	River confluence	1990		52	1000		MAURY	Lower Duck. Tennessee.	
TN	MONSANTO DAM #7	DUCK RIVER	35.9905	-87.8968	River confluence	1990		78	4659		HUMPHREYS	Lower Duck. Tennessee.	
TN	MONSANTO DAM #9	HELMS BRANCH	35.6728	-87.1267	River confluence	1990		33	1413		MAURY	Lower Duck. Tennessee.	
TN	OCCIDENTAL CHEM POND D	DUCK CREEK	35.6157	-87.0763	County	1995		160			MAURY	Undetermined	
TN	OCCIDENTAL CHEM POND DAM A	DUCK CREEK	35.6212	-87.0781	County	1995		120			MAURY	Undetermined	
TN	RHONE POULENC DAM #20	QUALITY CREEK	35.5490	-87.1970	River confluence	1995		33			MAURY	Lower Duck. Tennessee.	
TN	RHOUNE POULENC DAM #17	QUALITY CREEK	35.5490	-87.1970	River confluence	1995		34			MAURY	Lower Duck. Tennessee.	
TN	RHOUNE POULENC DAM #19	QUALITY CREEK	35.5490	-87.1970	River confluence	1995		60			MAURY	Lower Duck. Tennessee.	

Appendix 1: Output of the Dam Removal Database

State	Dam Name	River	Latitude	Longitude	Accuracy	Removed	Year built	Height (ft)	Length (ft)	City	County	Cat_basin	Comments
TN	SANDY STAND DAM	FLAT CREEK	35.6511	-83.9090	Approximate	1987		38			BLOUNT	Watts Bar Lake. Tennessee.	
TN	SPENCE FARM POND DAM #5	SNAKE CREEK	36.0000	-86.3300	State	1983		35				Undetermined	
TN	WALKERS DAM	WALKER STREAM	35.4000	-87.0028	County	1992		32			MAURY	Undetermined	
TEXAS													
TX	ALAMO ARROYO DAM WS SCS SITE 3 DAM	ALAMO ARROYO	31.3800	-105.8600	Exact	1979	1960	47	2500		HUDSPETH	Rio Grande-Fort Quitman. Texas.	
TX	BEARFOOT LAKE DAM	MILL CREEK	30.4818	-94.7714	Approximate		1964	27	1610		LIBERTY	Lower Trinity-Kickapoo. Texas.	
TX	BLAND LAKE DAM	MUSTANG CREEK	30.5583	-97.3733	Exact	1989		21		TAYLOR	WILLIAMSON	San Gabriel. Texas.	
TX	BROWN SCHOOLS DAM	TAR BRANCH	30.4106	-97.6920	Approximate			12	300		TRAVIS	Austin-Travis Lakes. Texas.	
TX	H AND H FEEDLOT DAM	COTTONWOOD CREEK	32.4812	-100.5460	Exact	1980		35		ROSCOE	NOLAN	Upper Clear Fork Brazos. Texas.	
TX	HARRIS BACK LAKE DAM	PARKER CREEK-TR	32.5567	-94.3433	Exact		1900	15	810	MARSHALL	HARRISON	Middle Sabine. Louisiana, Texas.	
TX	HILLSBORO LAKE PARK DAM	PECAN CREEK	32.0269	-97.1289	Exact			20	1200	HILLSBORO	HILL	Middle Brazos-Lake Whitney. Texas.	
TX	LAKE DOWNS DAM	BIG SANDY CREEK	30.6942	-94.7399	Approximate			26		LAKE DOWNS	POLK	Village. Texas.	
TX	MILLSAP RESERVOIR DAM	DAVES WHITE BRANCH	32.7779	-97.8058	County			25	1060		PARKER	Undetermined	
TX	NAMELESS VALLEY RANCH DAM NO 2	BIG SANDY CREEK-TR	30.5300	-97.9165	Approximate			24	200	NAMELESS	TRAVIS	Austin-Travis Lakes. Texas.	
TX	NIX LAKE DAM	WASSON BRANCH	32.2500	-94.6534	Exact		1940	23	525		RUSK	Middle Sabine. Louisiana, Texas.	
TX	RAILROAD RESERVOIR DAM	WILLIS CREEK-TR	30.7249	-97.4432	Exact			10	840	GRANGER	WILLIAMSON	San Gabriel. Texas.	
UTAH													
UT	BELL CANYON DAM		41.2956	-111.9174	County	1979		30			WEBER	Undetermined	
UT	BOX ELDER CREEK DAM	BOX ELDER CREEK	41.5261	-112.0642	River confluence	1995		50			BOX ELDER	Lower Bear-Malad. Idaho, Utah.	
UT	BRUSH DAM	MUDDY CREEK, N. FORK-TR	39.0733	-111.4383	Exact	1983		49	435		SANPETE	Muddy. Utah.	
VERMONT													
VT	HILLSIDE FARM DAM	OMPOMPANOOSUC RIVER-TR	43.7838	-72.2800	Approximate	2003	2000	18	100	NORWICH	WINDSOR	Waits. Vermont.	
VT	JOHNSON STATE COLLEGE UPPER DAM	GIHON RIVER-TR	44.6433	-72.6754	Exact	2003	1960	31	255	JOHNSON	LAMOILLE	Lamoille. Vermont.	Dam was removed because the corrugated metal spillway riser failed, partially draining the impoundment.
VT	LOWER EDDY POND DAM	MUSSEY BROOK	43.5930	-72.9865	River confluence		1890	20	250	RUTLAND	RUTLAND	Otter. Vermont.	
VT	NEWPORT NUMBER 11 DAM	CLYDE RIVER	44.9371	-72.1805	Exact	1994	1957	22	250	NEWPORT	ORLEANS	St. Francois. Vermont.	The first time that FERC recommended dam removal as the preferred alternative in an environmental impact document against the wishes of the dam owner (American Rivers).
VIRGINIA													
VA	ADNEY GAP POND DAM		37.1233	-80.1234	Approximate	1984		12		ADNEY GAP	FLOYD	Upper Roanoke. Virginia.	
VA	BERRYVILLE RESERVOIR	SHENANDOAH RIVER-TR	39.0767	-77.9058	Exact	1992		15			CLARKE	Shenandoah. Virginia, West Virginia.	Dam impounded a fire pond. New fire suppression facilities were installed and the dam was no longer needed

Appendix 1: Output of the Dam Removal Database

State	Dam Name	River	Latitude	Longitude	Accuracy	Removed	Year built	Height (ft)	Length (ft)	City	County	Cat_basin	Comments
VA	OSBORNE DAM		37.5000	-79.0000	State	1992		12				Undetermined	Dam impounded a fire pond. New fire suppression facilities were installed and the dam was no longer needed
VA	SYKES DAM	HARRISON CREEK-TR	37.2453	-77.3767	River confluence	1982		22			PRINCE GEORGE	Appomattox.Virginia.	
WASHINGTON													
WA	CITY LAKES DAM	SNOW CREEK-TR	47.9909	-122.8476	Exact		1928	15	165		JEFFERSON	Dungeness-Elwha. Washington.	
WA	COFFEE CREEK DAM	COFFEE CREEK	47.2072	-123.1243	River confluence			10	20	SHELTON	MASON	Puget Sound.Washington.	
WA	DARRINGTON WATER WORKS DAM	SAUK RIVER-TR	48.2333	-121.5933	Approximate			19	150	DARRINGTON	SNOHOMISH	Sauk.Washington.	
WA	DAVIS LAKE DAM	DAVIS CREEK	48.2317	-117.2867	Exact		1983	10	48		PEND OREILLE	Pend Oreille. Idaho, Washington.	
WA	GOLDSBOROUGH CREEK DAM	GOLDSBOROUGH CREEK	47.2095	-123.0944	City	2001	1921	14		SHELTON	MASON	Puget Sound.Washington.	
WA	HUNTERS DAM	HUNTERS CREEK	48.1233	-118.1567	Approximate			65			STEVENS	Franklin D. Roosevelt Lake. Washington.	Source: G. Stewart, Oregon State University.
WA	MILL CREEK SETTLING BASIN DAM	MILL CREEK	47.3839	-122.2207	Approximate			15		KENT	KING	Duwamish.Washington.	Source: G. Stewart, Oregon State University.
WA	NORTH END RESERVOIR	PUYALLUP RIVER	47.2766	-122.5118	Exact		1927	28	2200	TACOMA	PIERCE	Puget Sound.Washington.	Offstream reservoir.
WA	PEO DAM #32A	NORTH HANFORD CREEK	46.7777	-122.8195	Approximate			14		TONC	THURSTON	Upper Chehalis.Washington.	Source: G. Stewart, Oregon State University.
WA	POMEROY GULCH DAM	MAD RIVER-TR	46.3967	-117.0700	Approximate		1907	38		CLARKSTON	ASOTIN	Lower Snake-Asotin. Idaho, Oregon, Washington.	Source: G. Stewart, Oregon State University.
WA	RAT LAKE DAM	WHITESTONE CREEK	48.1767	-119.8067	Exact	1989	1910	32	240		OKANOGAN	Chief Joseph.Washington.	
WA	SULTAN MILL POND DAM	WAGLEYS CREEK	47.8643	-121.7994	Exact			18		SULTAN	SNOHOMISH	Skykomish.Washington.	
WA	WAGNER BROTHERS MILL POND	SQUAW GULCH	46.4950	-112.9400	Approximate		1932	17	1050		LEWIS	Upper Clark Fork. Montana.	Source: G. Stewart, Oregon State University.
WA	WIND RIVER DAM	WIND RIVER	45.8295	-121.9352	Approximate			20			SKAMANIA	Middle Columbia-Hood. Oregon, Washington.	
WEST VIRGINIA													
WV	COAL RUN # 2 DAM	COAL RUN	37.9850	-81.0533	Approximate		1940	65		BROOKLYN	FAYETTE	Lower New.West Virginia.	
WV	FOUR STATES WATER SUPPLY DAM	TEVEBAUGH CREEK-TR	39.4827	-80.3059	Exact		1910	29	230	FOUR STATES	MARION	West Fork.West Virginia.	
WV	MOD BRANCH # 2 DAM	MOD BRANCH	37.4408	-81.6000	River confluence		1970	20	150		MCDOWELL	Tug. Kentucky, Virginia, West Virginia.	
WV	PRESTON COUNTY LIGHT AND POWER LAKE #1 DAM	FALLS RUN	39.5685	-79.8207	Approximate		1934	26	219		PRESTON	Upper Monongahela. Pennsylvania, West Virginia.	
WISCONSIN													
WI	AFTON DAM	BASS CREEK	42.6014	-89.0670	Approximate	2002			215	AFTON	ROCK	Upper Rock. Illinois, Wisconsin.	
WI	ANNA HEMPEL (TERRY PATRICK) DAM	CORRECTION CREEK-TR	45.1114	-90.3437	River confluence	2001		9		MEDFORD	TAYLOR	Black.Wisconsin.	
WI	BARABOO WATERWORKS DAM	BARABOO RIVER	43.4648	-89.7286	City	1997	1848	12	220	BARABOO	SAUK	Baraboo.Wisconsin.	
WI	BEARDSLEY DAM	MADDEN BRANCH-TR	43.6283	-90.3561	River confluence	1992		15	345		LAYFAYETTE	Baraboo.Wisconsin.	
WI	BLACK EARTH DAM	BLACK EARTH CREEK	43.1428	-89.7542	Approximate	1957		9		BLACK EARTH	DANE	Lower Wisconsin.Wisconsin.	
WI	BOWEN MILL DAM	PINE RIVER	43.3465	-90.3863	Approximate	1996		7		RICHLAND CENTER	RICHLAND	Lower Wisconsin.Wisconsin.	
WI	CARTWRIGHT DAM	SHELL CREEK	46.1400	-91.8669	River confluence	1995		7			WASHBURN	Namekagon.Wisconsin.	

Appendix 1: Output of the Dam Removal Database

State	Dam Name	River	Latitude	Longitude	Accuracy	Removed	Year built	Height (ft)	Length (ft)	City	County	Cat_basin	Comments
WI	CENTERVILLE DAM	CENTERVILLE CREEK	43.9161	-87.7256	Exact	1996		21	118	CLEVELAND	MANTIOWOC	Manitowoc-Sheboygan. Wisconsin.	
WI	CHAIR FACTORY	MILWAUKEE RIVER	43.3100	-87.9500	Approximate	2001	1914		110	GRAFTON	OZAUKEE	Milwaukee. Wisconsin.	
WI	CLARK'S MILL DAM	MAGDENTZ CREEK	45.3200	-88.2500	State	2003		7	166			Undetermined	
WI	COLFAX DAM	EIGHTEEN MILE CREEK	45.0009	-91.7269	Approximate	1998	1938	14	350	COLFAX	DUNN	Red Cedar. Wisconsin.	
WI	COLFAX LIGHT AND POWER CO DAM	RED CEDAR RIVER	45.0010	-91.7339	Approximate	1969		21		COLFAX	DUNN	Red Cedar. Wisconsin.	
WI	CRIVITZ DAM	PESHTIGO RIVER	45.2325	-88.0132	City	1993		18		CRIVITZ	MARINETTE	Peshitgo. Wisconsin.	
WI	CROSS PLAINS DAM	BLACK EARTH CREEK	43.1131	-89.6606	City	1955		11		CROSS PLAINS	DANE	Lower Wisconsin. Wisconsin.	
WI	DEERSKIN DAM	DEERSKIN RIVER	46.9456	-89.1819	River confluence	2001	late 1800s	9			VILAS	Keweenaw Peninsula. Michigan.	Lunda Construction agreed to remove the dam in return for a reduced fine for violating the CWA (not related to the dam).
WI	ETTRICK DAM	BEAVER CREEK, N. FORK	44.1683	-91.2689	City	1976		10		ETTRICK	TREMPEALEAU	Black. Wisconsin.	
WI	EVANS POND DAM	RATHBONE CREEK	44.0963	-90.7861	Approximate	1998		9			MONROE	Black. Wisconsin.	
WI	FRANBROOK DAM	DOUGHERTY CREEK	42.6842	-89.8558	River confluence	2003		31			GREEN	Pecatonica. Illinois, Wisconsin.	
WI	FRANKLIN DAM	SHEBOYGAN RIVER	43.8372	-87.9003	Exact	2001		13	136	FRANKLIN	SHEBOYGAN	Manitowoc-Sheboygan. Wisconsin.	
WI	FULTON DAM	YAHARA RIVER	42.8100	-89.1300	Exact	1993	mid 1800s	9		FULTON	ROCK	Upper Rock. Illinois, Wisconsin.	
WI	GRAND RIVER DAM	GRAND RIVER	43.7478	-89.2672	River confluence	2002		11			MARQUETTE	Upper Fox. Wisconsin.	
WI	GREENWOOD DAM	BLACK RIVER	44.7662	-90.6068	City	1994	1905	6	300	GREENWOOD	CLARK	Black. Wisconsin.	
WI	HAMILTON MILL DAM	CEDAR CREEK	43.2906	-87.9500	River confluence	1996		8	100		OZAUKEE	Milwaukee. Wisconsin.	
WI	HAYMAN FALLS DAM	EMBARRASS RIVER	44.7400	-88.8000	Approximate	1995	1918	14	200	PELLA	SHAWANO	Wolf. Wisconsin.	
WI	HEBRON DAM	BARK RIVER	42.9253	-88.8258	City	1996	1933	11	170	HEBRON	JEFFERSON	Upper Rock. Illinois, Wisconsin.	
WI	HUIGEN DAM	HANDSAW CREEK	45.2810	-88.2500	River confluence	1970		9			MARINETTE	Peshitgo. Wisconsin.	
WI	HUNTINGTON DAM	APPLE RIVER	45.1909	-92.5572	City	1968	1910	28		HUNTINGTON	ST. CROIX	Lower St. Croix. Minnesota, Wisconsin.	
WI	ISLAND WOOLEN CO. DAM	BARABOO RIVER	43.4706	-89.7699	Approximate	1972		18		BARABOO	SAUK	Baraboo. Wisconsin.	
WI	KAMRATH DAM #1	ONION RIVER-TR	43.7067	-88.0147	Approximate	1999	1950s	12	100		SHEBOYGAN	Manitowoc-Sheboygan. Wisconsin.	Three dams removed at this site, including a smaller dam (5ft high, 15ft long), as part of a single restoration project for the headwaters of the Onion River (Kamrath restoration, Trout Unlimited)
WI	KAMRATH DAM #2	ONION RIVER-TR	43.7067	-88.0147	Approximate	1999		12			SHEBOYGAN	Manitowoc-Sheboygan. Wisconsin.	Three dams removed at this site, including a smaller dam (5ft high, 15ft long), as part of a single restoration project for the headwaters of the Onion River (Kamrath restoration, Trout Unlimited)
WI	KLONDIKE DAM	OTTER CREEK	45.3200	-88.2500	State	1978		30				Undetermined	
WI	LA VALLE DAM	BARABOO RIVER	43.5818	-90.1314	City	2001	1849	10		LA VALLE	SAUK	Baraboo. Wisconsin.	Sand County Foundation bought the dam for the purpose of removing it.
WI	LEMONWEIR DAM	LEMONWEIR RIVER	43.7875	-90.0160	City	1992	1914	7		LEMONWEIR	JUNEAU	Castle Rock. Wisconsin.	
WI	LINEN MILL DAM	BARABOO RIVER	43.4586	-89.7153	Exact	2001	1928	11	155	BARABOO	SAUK	Baraboo. Wisconsin.	The last of four dams to be removed from Baraboo River. The river now flows freely over its entire length (120 miles of the main stem and over 500 miles of tributaries).
WI	LOWE CREEK 1 DAM	LOWE CREEK	44.3702	-91.0449	River confluence	1994		6			JACKSON	Trempealeau. Wisconsin.	

Appendix 1: Output of the Dam Removal Database

State	Dam Name	River	Latitude	Longitude	Accuracy	Removed	Year built	Height (ft)	Length (ft)	City	County	Cat_basin	Comments
WI	LOWE CREEK 2 DAM	LOWE CREEK	44.3702	-91.0449	River confluence	1994		10			JACKSON	Trempealeau. Wisconsin.	
WI	MANITOWOC RAPIDS DAM	MANITOWOC RIVER	44.0946	-87.7045	City	1984	1854	16	400	MANITOWOC RAPIDS	MANITOWOC	Manitowoc-Sheboygan. Wisconsin.	
WI	MARENGO DAM	MARENGO RIVER	46.4221	-90.8194	City	1993		17		MARENGO	ASHLAND	Bad-Montreal. Michigan, Wisconsin.	
WI	MCCLURE DAM	APPLE RIVER	45.1478	-92.7478	River confluence	1968	1910	13			ST. CROIX	Lower St. Croix. Minnesota, Wisconsin.	
WI	MELLEN DAM	BAD RIVER	46.6381	-90.6522	River confluence	1967		76			ASHLAND	Bad-Montreal. Michigan, Wisconsin.	
WI	MELLEN WATERWORKS DAM	CITY CREEK	46.3147	-90.6489	City	1995		9		MELLEN	ASHLAND	Bad-Montreal. Michigan, Wisconsin.	
WI	MOUNDS DAM	WILLOW RIVER	45.0278	-92.6483	Exact	1998	1926	44	430		ST. CROIX	Lower St. Croix. Minnesota, Wisconsin.	Located in the Willow River State Park.
WI	MOUNT VERNON DAM	SUGAR RIVER	42.9470	-89.6560	City	1950		11		MOUNT VERNON	DANE	Sugar. Illinois, Wisconsin.	
WI	NELSONVILLE DAM	WAUPACA RIVER	44.4942	-89.3117	Exact	1988	1860s	9		NELSONVILLE	WAUPACA	Wolf. Wisconsin.	
WI	NEW FANE DAM	MILWAUKEE RIVER, E. BRANCH	43.5562	-88.1887	Exact	2001		8		NEW FANE	FOND DU LAC	Milwaukee. Wisconsin.	
WI	NORTH AVENUE DAM (MILWAUKEE DAM)	MILWAUKEE RIVER	43.0583	-87.8950	Exact	1997	1920	14	432	MILWAUKEE	MILWAUKEE	Milwaukee. Wisconsin.	
WI	NORTHLAND DAM	FLUME CREEK	44.5950	-89.2078	City	1992		6		NORTHLAND	WAUPACA	Wolf. Wisconsin.	
WI	OAK STREET DAM	BARABOO RIVER	43.4667	-89.7450	Exact	2000	1929	8	270	BARABOO	SAUK	Baraboo. Wisconsin.	
WI	ONTARIO DAM	KICKAPOO RIVER	43.7239	-90.5869	City	1992		9		ONTARIO	VERNON	Kickapoo. Wisconsin.	
WI	ORIENTA DAM	IRON RIVER	46.7466	-91.4845	Exact	2001	1865	44		PORT WING	BAYFIELD	Beartrap-Nemadji. Minnesota, Wisconsin.	A temporary low-sill dam installed to prevent sea lamprey and non-native salmonids from entering native brook trout habitat.
WI	OSLO DAM	MANITOWOC RIVER	44.0989	-87.8231	Exact	1991		14			MANITOWOC	Manitowoc-Sheboygan. Wisconsin.	
WI	PARFREY DAM	PINE RIVER	43.3356	-90.3912	Exact	1996	1934	11	450	RICHLAND CENTER	RICHLAND	Lower Wisconsin. Wisconsin.	
WI	PORT ARTHUR	FLAMBEAU RIVER	45.4291	-91.1601	City	1968		17		PORT ARTHUR	RUSK	Flambeau. Michigan, Wisconsin.	
WI	PRAIRIE DELLS DAM	PRAIRIE RIVER	45.1780	-89.6910	River confluence	1992	1904	45			LINCOLN	Lake Dubay. Wisconsin.	
WI	READSTOWN DAM (FOWELL DAM)	KICKAPOO RIVER	43.4491	-90.7646	City	1985		6		READSTOWN	VERNON	Kickapoo. Wisconsin.	
WI	REEDSBURG DAM	BARABOO RIVER	43.5329	-90.0114	City	1973		9		REEDSBURG	SAUK	Baraboo. Wisconsin.	
WI	ROCKDALE DAM	KOSHKONONG CREEK	42.9728	-89.0322	Exact	2000		8		ROCKDALE	DANE	Upper Rock. Illinois, Wisconsin.	
WI	SCHIEK DAM	HANDSAW CREEK	45.2810	-88.2500	River confluence	1970		7			MARINETTE	Peshitgo. Wisconsin.	
WI	SCHWEITZER DAM (CEDAR CREEK DAM)	CEDAR CREEK	43.3255	-88.1920	Exact	2002	1946	10	30	JACKSON	WASHINGTON	Milwaukee. Wisconsin.	Last remaining dam on Cedar Creek between Little Cedar Lake and the city of Cedarburg.
WI	SHOPIERE DAM	TURTLE CREEK	42.5733	-88.9383	Exact	1999		13	138	SHOPIERE	ROCK	Upper Rock. Illinois, Wisconsin.	
WI	SLABTOWN DAM	BARK RIVER	42.9675	-88.6375	City	1992	1948	7	60	SLABTOWN	JEFFERSON	Upper Rock. Illinois, Wisconsin.	
WI	SOMERSET DAM	APPLE RIVER	45.1255	-92.6734	City	1967	1856	17		SOMERSET	ST. CROIX	Lower St. Croix. Minnesota, Wisconsin.	
WI	TOKEN CREEK DAM	TOKEN CREEK	43.1980	-89.2930	Exact			13		TOKEN CREEK	DANE	Upper Rock. Illinois, Wisconsin.	
WI	UPPER WATERLOO DAM	MAUNESHA RIVER	43.1817	-89.0050	Exact	1995	1915	11	115	WATERLOO	JEFFERSON	Crawfish. Wisconsin.	
WI	WARD PAPER MILL DAM	PRAIRIE RIVER	45.1810	-89.6830	City	1999	1905	13	80	MERRILL	LINCOLN	Lake Dubay. Wisconsin.	
WI	WAUBEKA DAM	MILWAUKEE RIVER	43.4720	-87.9920	Exact	2003	1850s	6	270	WAUBEKA	OZAUKEE	Milwaukee. Wisconsin.	
WI	WILLIAMS DAM	BRUSH CREEK-TR	44.0000	-89.8300	State			40				Undetermined	
WI	WILLOW FALLS DAM	WILLOW RIVER	45.0203	-92.6695	Exact	1992	1870	101	160		ST. CROIX	Lower St. Croix. Minnesota, Wisconsin.	Located in the Willow River State Park.

Appendix 1: Output of the Dam Removal Database

State	Dam Name	River	Latitude	Longitude	Accuracy	Removed	Year built	Height (ft)	Length (ft)	City	County	Cat_basin	Comments
WI	WILMOT DAM	FOX RIVER	42.5158	-88.1780	City	1941		3	200	WILMOT	KENOSHA	Upper Fox. Illinois, Wisconsin.	
WI	WONEWOC DAM	BARABOO RIVER	43.6515	-90.2268	City	1996		9		WONEWOC	JUNEAU	Baraboo. Wisconsin.	
WI	WOODS CREEK DAM	WOODS CREEK	45.8342	-88.3681	River confluence	2002		16	200		FLORENCE	Menominee. Michigan, Wisconsin.	Removed as part of the Wilderness Shores Agreement.
WI	WOOLEN MILLS DAM	MILWAUKEE RIVER	43.4278	-88.1830	Approximate	1988	1870	18		WEST BEND	WASHINGTON	Milwaukee. Wisconsin.	
WI	YOUNG AMERICA DAM	MILWAUKEE RIVER	43.4533	-88.1850	Exact	1994		10		BARTON	WASHINGTON	Milwaukee. Wisconsin.	
WYOMING													
WY	EAST DAM		42.2600	-110.7026	County	1997		7			LINCOLN	Undetermined	
WY	NO NAME DAM #1		42.2600	-110.7026	County			7			LINCOLN	Undetermined	
WY	NORTH DAM		42.2600	-110.7026	County	1998		15			LINCOLN	Undetermined	
WY	SOUTH DAM		42.2600	-110.7026	County			7			LINCOLN	Undetermined	
WY	WEST DAM		42.2600	-110.7026	County	1997		7			LINCOLN	Undetermined	

Appendix 2: Dam removals not included in the Dam Removal Database

State	Dam Name	River	Latitude	Longitude	Accuracy	Removed	Year built	Height (ft)	Length (ft)	City	County	Comments
ALASKA												
AK	DAVIDSON DITCH DIVERSION DAM	CHATANIKA RIVER				2002	1920s	4	75			
CALIFORNIA												
CA	HENRY DANNINBRINK DAM	CANYON CREEK				1927						
CA	JOHN MUIR #1 DAM											
CA	MOSER DAM	SWILLUP CREEK				1949						
CA	THREE C. PICKET DAM	BEAVER CREEK				1949						
CA	TROUT HAVEN DAM	MONKEY CREEK										
MAINE												
ME	BANGOR DAM	PENOBSCOT RIVER				1995						
MINNESOTA												
MN	BUFFALO RIVER DAM					2003					CLAY	Information from D. Gauthier, MN DNR. Need measurements. Located in Buffalo River State Park.
MN	STOCKTON DAM	GARVIN BROOK										
OHIO												
OH	DENNISON DAM	OLENTANGY RIVER				2002						
OREGON												
OR	BYRNE DAM	BEAVER CREEK				2002		3	30			Size measurements are estimates from Jerry Vogt (ODFW).
PENNSYLVANIA												
PA	AMISH DAM #1	MUDDY RUN				2000						
PA	AMISH DAM #2	MUDDY RUN				2000						
PA	AMISH DAM #3	MUDDY RUN				2000						
PA	AMISH DAM #4	MUDDY RUN				2000						
PA	AMISH DAM #5	MUDDY RUN				2001						
PA	AMISH DAM #6	MUDDY RUN				2001						
PA	AMISH DAM #7	MUDDY RUN				2001						
PA	AMISH DAM #8	MUDDY RUN				2001						
PA	BARNITZ MILL DAM	YELLOW BREECHES CREEK				2002						
PA	EAST PETERSBURG AUTHORITY DAM	LITTLE CONESTOGA RIVER				1998		4	20			
PA	HINKLETOWN MILL DAM	CONESTOGA RIVER				2000						
PA	MEISERS MILL DAM	MANANTANGO CREEK				2001		5	75			
PA	UNNAMED DAM	LITITZ RUN				1999		4	15			
PA	UNNAMED DAM	LAUREL RUN				1998		5	50			
PA	UNNAMED DAM	LITITZ RUN				1998		4	10			
PA	YORKETOWN PAPER DAM	MILL CREEK				1997		5	60			
PA	YOUNGS DAM	LITITZ RUN				2002		3				

Appendix 2: Dam removals not included in the Dam Removal Database

State	Dam Name	River	Latitude	Longitude	Accuracy	Removed	Year built	Height (ft)	Length (ft)	City	County	Comments
WASHINGTON												
WA	MAIDEN DAM	TOUCHET RIVER				1998						
WA	UNNAMED DAM (WILLAPA NATIONAL WILDLIFE REFUGE)	HEADQUARTERS CREEK				2000		5				
WISCONSIN												
WI	BOULDER CREEK DAM #1	BOULDER CREEK	43.4767	-89.6425	River confluence	2003					SAUK	
WI	BOULDER CREEK DAM #2	BOULDER CREEK	43.4767	-89.6425	River confluence	2003					SAUK	
WI	CARPENTER CREEK DAM	CARPENTER CREEK				1995		4				
WI	KATHRATH DAM #3	ONION RIVER-TR				2001		5	15		SHEBOYGAN	Three dams removed at this site, including a smaller dam (5ft high, 15ft long), as part of a single restoration project for the headwaters of the Onion River (Kamrath restoration, Trout Unlimited)
WI	PULCIFER DAM	OCONTO RIVER				1994		5				
WI	SILVER SPRINGS #1	ONION RIVER-TR				2002		5				Eight small dams removed in Silver Springs site during the summer of 2002. Height is an estimate.
WI	SILVER SPRINGS #2	ONION RIVER-TR				2002		5				Eight small dams removed in Silver Springs site during the summer of 2002. Height is an estimate.
WI	SILVER SPRINGS #3	ONION RIVER-TR				2002		5				Eight small dams removed in Silver Springs site during the summer of 2002. Height is an estimate.
WI	SILVER SPRINGS #4	ONION RIVER-TR				2002		5				Eight small dams removed in Silver Springs site during the summer of 2002. Height is an estimate.
WI	SILVER SPRINGS #5	ONION RIVER-TR				2002		5				Eight small dams removed in Silver Springs site during the summer of 2002. Height is an estimate.
WI	SILVER SPRINGS #6	ONION RIVER-TR				2002		5				Eight small dams removed in Silver Springs site during the summer of 2002. Height is an estimate.
WI	SILVER SPRINGS #7	ONION RIVER-TR				2002		5				Eight small dams removed in Silver Springs site during the summer of 2002. Height is an estimate.
WI	SILVER SPRINGS #8	ONION RIVER-TR				2002		5				Eight small dams removed in Silver Springs site during the summer of 2002. Height is an estimate.
WI	UNNAMED DAM	BRANCH RIVER	44.1297	-87.7683	River confluence	2003		5	40		MANITOWOC	
WI	UPPER TIGERTON DAM	EMBARRASS RIVER				1997		4				
WI	WHITEHALL DAM	TREMPEALEAU RIVER				1988						