



SOLVING DAM PROBLEMS:

Iowa's

2010 Plan for

Dam Mitigation

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Iowans have great and oftentimes competing expectations for our river systems. Our rivers must carry away excess waters from our developed places and fields, but without flooding. Rivers must carry away nutrients and industrial pollutants, but without affecting drinking water downstream. They must carry away bacteria, but without harming people drawn to them. Our riverways must be the last vestiges of our state's ecological lifeblood, but must also provide anchors for intense recreational use, from hunting grounds to bike trails, from angling to innertubing. "Systems thinking" provides a way forward that avoids unintended consequences and externalized costs.

Aging, failing dams provide challenges in identifying key needs and technologies, but also opportunities to re-think how local stakeholders and the broader interests of Iowans can be one in the same. Rivers are a shared public resource. Iowa's future dam reconstructions will be expected to solve a broader array of problems than were required in the past. Planning and leadership are needed to guide dam approaches. This results in stable projects that continue serving local needs, but also serve other multiple benefits. Often, this may come at less expense than "building it back." On balance, projects at dams can restore normal ecological and navigational functions to rivers statewide.

Remarkable improvements are unfolding on Iowa's lake systems today, a direct result of visions and plans initiated more than a decade ago. Those efforts would not have been successful without intrepid execution by Iowa DNR lake restoration program staff, and consistent funding by elected officials.

A 2009 survey by Iowa State University's Center for Agriculture and Rural Development found that nearly half of Iowans recreate along rivers. Linked with Iowa "Water Trails: Connecting People with Water and Resources," and the "Developing Water Trails in Iowa," this plan is the last of a new suite of documents providing planning relevant to the times, and to conditions for major river systems. While these three publications by no means comprise a comprehensive river restoration plan, these documents do offer promising early restorative elements. They also address important demands of stakeholders, including improved aquatic ecosystems, improved angling, better and safer navigation, and reduced flood frequency. They provide ways for regular Iowans to connect with their waterways. They provide entrepreneurs new opportunities for nature-based recreation and responsibly enhancing destination activities like innertubing, canoeing, and kayaking.

"Solving Dam Problems: Iowa's 2010 Plan for Dam Mitigation," provides a carefully balanced road map to address local infrastructure needs while avoiding as many of the side-effects of traditional dams as possible. Given a solid implementation over the course of years and decades, lasting improvements will be realized throughout Iowa as a result of the efforts put into developing this plan.

Sincerely,

Pat Boddy
Interim Director of the Iowa Department of Natural Resources

Table of Contents

1 Introduction

Aging dams and intense storms with subsequent floods have led to at least ten structural failures at Iowa dams in the past three years. This presents serious challenges, but also provides a chance to correct a legacy of problems not anticipated three to four generations ago when many small dams were constructed. New frameworks for low-head dam mitigation provide exciting opportunities to usher in a new legacy of enjoyment, respect, and care for the navigable waters of Iowa. *Solving Dam Problems: Iowa's 2010 Plan for Dam Mitigation* provides an updated inventory, new naturalistic approaches to enhance rivers in dam mitigation projects, perspectives on flood reduction, and cost effective methods of reducing deaths at dams.

1a. The Role of Iowa's 2010 Plan for Dam Mitigation

In 2008, the Iowa Department of Natural Resources was instructed to develop statewide plans for the newly formed water trails low-head dam public hazard programs. Elements were to include an inventory of low-head dams, various mitigation design templates and construction guidelines for working in and along rivers and recommendations for volunteers, communities, water trail developers, and dam owners. Experts in engineering, stream restoration, and fisheries were consulted to develop recommendations for alternatives that create fewer life-cycle problems than traditionally designed low-head dams.

In July of 2010, as this plan was being finalized, a catastrophic breach occured at the Lake Delhi Dam. Techniques outlined in this plan were put to use in Maquoketa riverbed stabilization projects necessitated by the failure of that large dam. Lessons learned in that disaster have been incorporated into this plan.

The resulting 2010 dam mitigation plan relates the function and historical importance of dams to today. The plan also inventories Iowa's dams, provides design templates for mitigating hazards and improving fish passage and lays out a general statewide strategy and action steps to improve river connectivity over the next ten years. Two companion documents to this plan were developed:

1. A fully illustrated manual *Developing Water Trails in Iowa* for water trails developers, including planning guidance, standardized signage design, and incorporation of stream restoration and stormwater management concepts in access construction.
2. The state water trails plan *Iowa Water Trails: Connecting People, Water and Resources*, documenting the historic and present day importance of Iowa's navigable waters, with comparisons of relevant data and strategies for adding value to Iowa's system.

The low-head dam public hazard program within the Iowa DNR was established in 2008 to reduce fatalities at traditionally designed dams. The Iowa DNR has a separate dam safety program tasked with assuring Iowa's dams are constructed and maintained per a hazard classification system based on risks downstream of the dam; however, this program does not specifically address the hazard posed by low head dams to recreational users. Reducing what to date have been more numerous Iowa deaths due to traditional "low-head" dam design was a main consideration in creating the newer public hazard program. This plan broadens the set of goals for mitigation to improve river ecology and enhanced recreation.

Taken together, this plan responds to increased demand in Iowa for safer water-based recreation, improving water quality, conserving Iowa's aquatic resources, and developing opportunities to enhance resilience of aquatic life by improving stream connectivity. Together, these factors are expected to contribute to economic vitality and a higher quality of life for Iowans. •

1b. The Vision for Low-Head Dam Mitigation

Iowa's vision was developed using a thoughtful process involving thousands of Iowans.

Social assessment tools developed both through public input meetings and questionnaires show evolving attitudes about dams. Protecting and restoring rivers and watersheds and reducing the number of dam-related drownings were the top priorities identified with various tools, including internet stakeholder surveys, a statewide mail survey, a livery owners mail survey, and a mail survey of the owners of dams.

Nearly 1,000 Iowans participated in an internet-based survey developed by Iowa State University's Department of Landscape Architecture to construct strategies and goals for water trail and dam mitigation programs. Stakeholders included anglers, paddlers, natural resource agency staff, economic development staff, and the general public. This survey helped set early direction when all stakeholder groups clearly articulated that a balanced mix of safe avoidance, warning signage, and modification or dam removal should be considered. Habitat improvements were considered valid impetus for mitigation, and physical mitigation at deteriorating dams was considered most appropriate. Only 10 percent of research participants indicated they were strongly in favor of dam removal as a blanket solution to dam problems.

Mailed surveys and telephone interviews implemented by Iowa State University's Center for Agriculture and Rural Development (CARD) tracked Iowan's river use and preferences from 4,775 participants. CARD estimates that nearly half of all Iowans logged at least one trip to an Iowa river in the past year. Economic effect estimates of river use patterns will be developed in the near future.

Numerous experts in stream restoration, engineering, environmental education, law enforcement, fisheries, aquatic invasive species, water quality, public land management, tourism, and economic development also contributed insights and knowledge. Statewide committee members provided insight into the vision. Iowa's river corridors appear to be both highly valued and well-used according to all sets of studies.

Iowa's vision for the future of major river dam mitigation links multiple benefits and avoids setting up conflicts. It's about the importance of listening to and communicating with Iowans, and putting the spotlight on problem solving. It's about improving recreation, aqatic habitats and water quality, and it's about finding economic opportunities. The vision is also about rekindling the connection between people's interactions with the landscape and their respect and understanding of resource conditions and functions. •

IOWA'S FUTURE FOR DAM MITIGATION WILL …

... respond to aging dam infrastructure

... be grounded in listening to local interests and dam owner concerns

… strive to reduce dam-related deaths through education, warning signage, guidelines for access areas near dams, and structural mitigations such as removal or rapids conversions

… balance ecological benefits of fish passage with the need to block or slow the spread of invasive species at some of the largest dams

… consider recreational benefits from new features created at former dam sites

… blend benefits to aquatic species, angler access, recreational safety, navigation improvements, economic development, and tourism when prioritizing structural dam mitigations

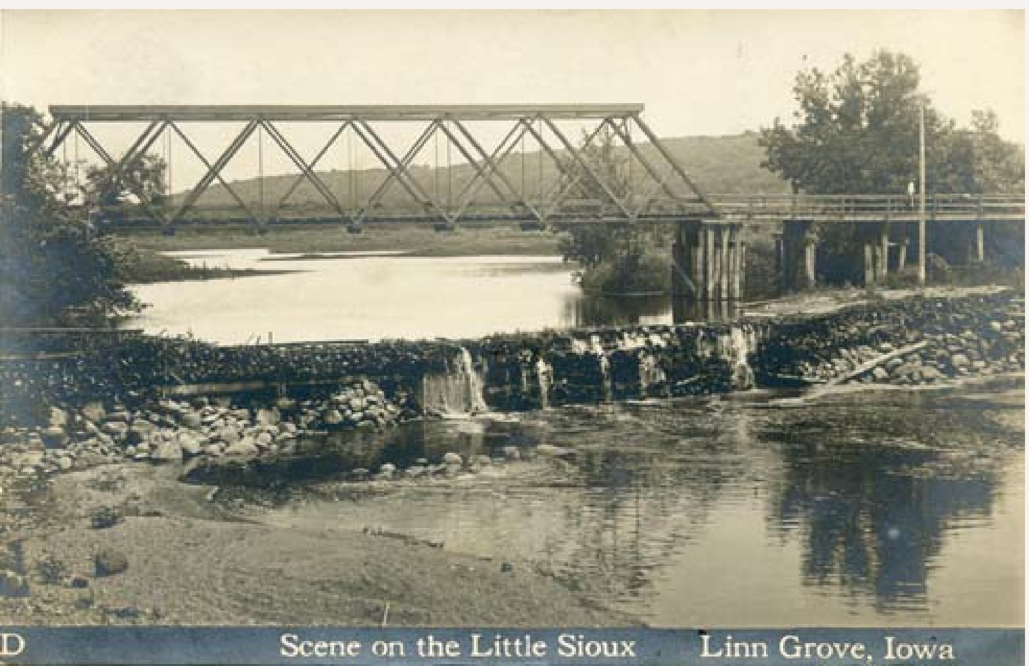
1c. History of Iowa Dams: Why They Are Here

The first recorded dam on an Iowa stream was built on the Yellow River in 1829 to refurbish Fort Crawford with newly sawn lumber for its rotting palisade. For a time, a young lieutenant named Jefferson Davis (who later led the Confederacy during the Civil War) operated the sawmill. Throughout the 1830s and throughout the settlement of Iowa, the milling industry relied primarily on Iowa's rivers. Most of those created a head of water with small rock or crib dams. These dams helped power grist, woolen, or saw mills. According to the first census in 1840, there were 118 mills operating in Iowa employing 154 settlers. "By 1870 the Federal census enumerated 502 flour and gristmills and 545 sawmills — or more than a thousand mills in the Hawkeye State" (Petersen, 1941:20). There were as many as 40 mills alone on the Upper Iowa River (Knudson, 48), and as many as 80 operating along Des Moines River (Swisher, 1940:14) by the 1880s. (Swisher, 1940: 15-16). Mill operation reached its zenith in the 1890s.

Many of Iowa's natural rapids and falls were preferred places to build dams because fewer materials were needed for construction. Cedar Falls, Cedar Rapids, and Iowa Falls are all named after natural river features. Immediate negative effects to upstream fisheries were observed (see Chapter 3).

The first hydropower dams

Water-powered mills declined as the economic base shifted throughout the late 1800s from wheat production to corn, cattle, and hogs. Dams resurged in importance in the early 1900s with the invention of the light bulb and other devices. Some old mill dams were repurposed to hydroelectric generation, while other dams were newly constructed to generate electricity. During the same time, rapids on the Mississippi River at Keokuk and Rock Island were considered navigational problems, and plans were laid for the first locks and dams. The Rock Island rapids was submerged when the Moline Lock opened in 1907, and the Des Moines rapids at Keokuk was submerged 1913 with a dam that also became one of the world's largest hydroelectric facilities of the time. As floods were known to regularly wipeout rock-and-crib style dams, dam owners began slathering concrete caps over older dams, using Portland cement as a primary material for new constructions. Thus, the"low-head" style of dam was born in Iowa. By the 1920s, however, the power generated by smaller hydroelectric dams could not meet demand; coal burning power plants soon took over as the primary source of energy production, and hydroelectricity generation declined (Swisher, 1940).



1930s dams

In the 1930s, about 50 dams were constructed, most of them in the name of conservation (despite earlier observations that fishing declined for upstream communities) and work development. Construction of some dams employed work-hungry men through the Civilian Conservation Corp, the Work Progress Administration, and the state's Civil Works Administration (CWA). Local conservation leagues also built a number of dams in Iowa. These projects provided temporary work for scores of otherwise unemployed Iowans. However, the purpose of the dams themselves was not economic.

Many were called "beauty dams" and others were billed as "recreational improvements" at places that were often already popular angling areas or picnic sites. As new dams were constructed as uniform concrete walls across rivers with abutment walls along the banks, local populations were quickly educated about the forces involved. For example, the Iowa Conservation Commission authorized construction of a CWA dam at Littleton in 1933; the first victims drowned in 1936 and 1937.

The Rivers and Harbors Act of 1930 also led to the construction of present-day locks and dams on the Mississippi River to create a 9-foot navigation channel.

A historical postcard of the dam in Littleton, Iowa, on the Wapsipinicon River. Built in 1933, a young teenage boy drowned here in 1936, and a second drowning occured in 1937.

The Redfield Dam on the Middle Raccoon River.

Fairbank Dam on the Little Wapsipinicon River

The old mill at Fort Dodge.

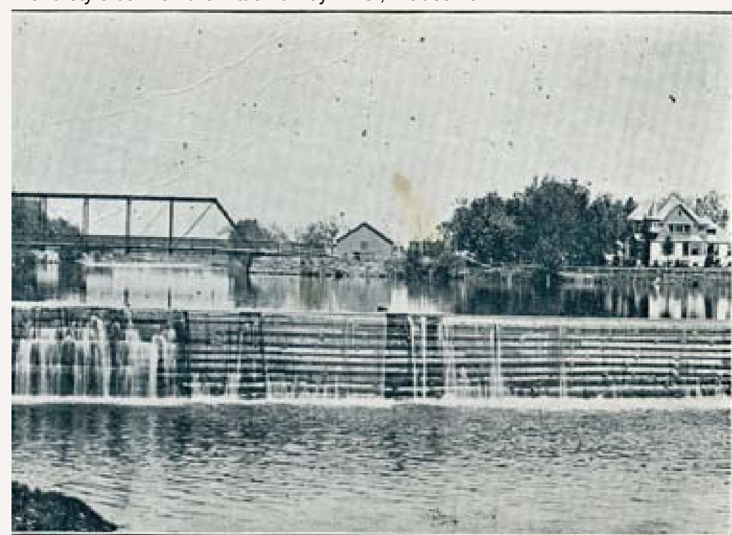
Modern low-head dam era

Additional low-head dams, were constructed from the 1950s to the 1980s for various purposes, including water supply, grade stabilization for down-cutting streams, and for recreation. In this era, many dams were constructed with "roller buckets" or a small curving lip that magnified upward water forces to dissipate energy and reduce downstream scour (Forester, 1949). The U.S. Army Corps of Engineers constructed the first large earthen dams to create large impoundments during the 1960s and 1970s for flood control. These reservoirs (Red Rock, Saylorville, Coralville, and Rathbun) are managed by the USACE. These dams provide a number of recreational opportunities, including trails, campgrounds, shelter houses, and motorboat ramps. Iowa DNR and county conservation boards created a number of smaller recreational lakes on smaller stream systems. In several decades of experience, watershed area to lake surface area ratios for newly constructed lakes have become decidedly lower to avoid rapid sedimentation problems experienced on large main-stem rivers. (Hoyer, McGhee, personal communication)

The latest major cycle of dam building on major streams came as southwestern Iowa rivers and creeks unexpectedly began to rapidly downcut due to downstream channelization of main-stem tributaries of the Missouri River. This had been done to create more productive land and in the name of flood control. Channelization creates high energy gradients, resulting in head-cuts upstream. In highly erodible loess soils, streams that formerly meandered peacefully toward the Missouri began tearing gullies through fields and pastures in an upstream march of head-cuts. Many channels suddenly looked like canyons. More than $1 billion in infrastructure damage to bridges and roads led to mobilization of efforts. After the creation of the Hungry Canyons Alliance, numerous check dams were installed throughout the 1990s and 2000s, with a present-day total of more than 157. The most common type are sheet-pile low-head dams. Some are rock riffles, and some of the low-head dams have had rock ramps installed downstream to aid fish passage.

Social attitudes about dams in the past decade have evolved. In many cases, a broader range of concerns are being incorporated when dams are in need of repair or reconstruction. In 2010, eight projects to mitigate legacy problems with dams were either ongoing or complete. •

A crib-style dam on the Little Turkey River, Waucoma.



1a. Problems associated with dams on major rivers

Dams in Iowa were exceedingly important to the early economic development of the state. Many have important ongoing economic value, such as water supply and hydroelectrical power generation. However, negative factors related to dams on major rivers have not been thoroughly explored until recently.

Problems associated with low-head and other dams on major rivers are numerous. They include:

1) **Dam infrastructure is failing rapidly.** This can cause downstream flooding and excessive sediment releases may elevate downstream turbidty for months or even years.

2) **Periodic fatalities** related to the recirculating hydraulic that forms, particularly at moderately high flows.

3) **Blocked fish passage**, and other interruptions to biological connectivity resulting in streams that are not meeting their biological potential for anglers and diversity of aquatic habitat.

4) **Fine-particle sediment accumulation** upstream of the dam can create poor uniform habitat and poor-quality recreation.

5) Downstream of the dam, **high scour** and sediment disequilibrium create bank erosion and streambed downcutting.

6) Some dwellings and businesses near impoundments are flooded more frequently than necessary because of a dam's high crest **contributes to upstream flooding**, while run of the river dams do nothing to reduce downstream flooding.

7) **Liability issues** related to dam ownership and a greater awareness has led to increased interest in dam removal or divestment.

This section explores various issues confronted dam owners and the public related to dams on major rivers. •

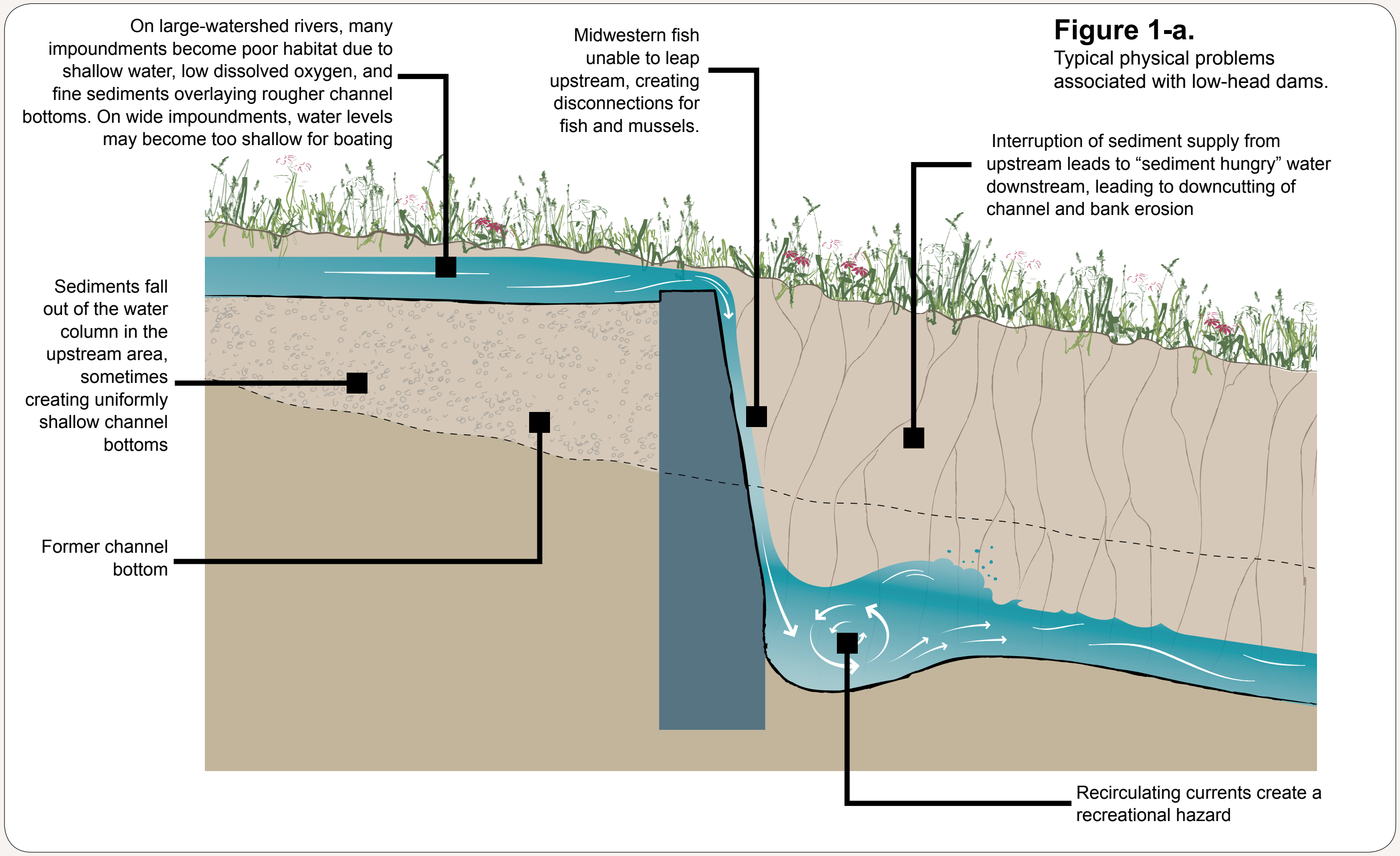


Figure 1-a.
Typical physical problems associated with low-head dams.

Costs to replace damaged or underperforming gates can range from $500,000 to several million dollars. Debris accumulation can also worsen upstream flooding.

River dams with failures or structural problems

A strong majority of Iowa dams on major rivers are well past their deisgn life cycles. Flooding in 2008 exposed a wave of structural problems statewide, and more flooding in 2010 reinforced the point. Visible structural problems were noted at the following dams:

Lower Dam, Upper Iowa River

Charles City, Lower Dam, Cedar River

Yellow River Ford / Dam

Klondike Dam, Big Sioux River

Littleton Dam, Wapsipinicon River

Boone Waterworks Dam, Des Moines River

Nora Springs Dam, Shell Rock River

Rockford Dam, Shell Rock River

Fort Dodge Hydroelectric Dam, Des Moines River

Lake Delhi Dam, Maquoketa River

Quaker Mill Dam, Maquoketa River

Water flowing under the Klondike Dam on the Big Sioux River after undermining. The dam's water supply function will be replaced with a rapids that will create a similar pool upstream.

Fractures in this dam at Charles City would eventually have widened, but the dam was removed and replaced with a recreational feature instead. (See Chapter 4, Alternative D)

Quaker Mill Dam. A dike breached in 2008's Maquoketa River flood, dewatering the mill pond and dam. After repairs were completed, the dike breached again in 2010 flooding.

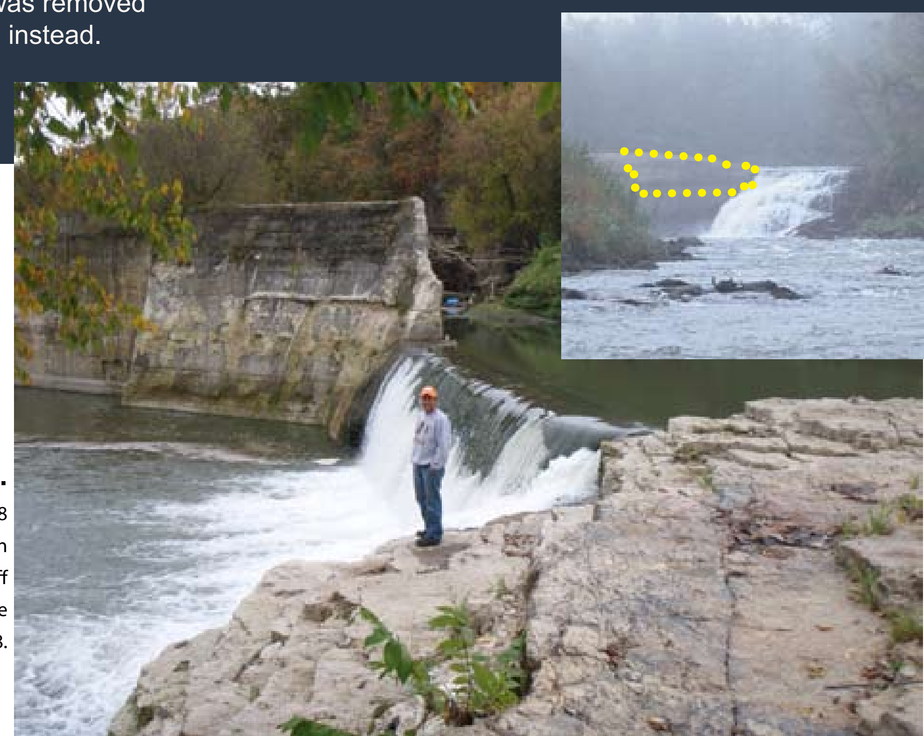


Figure 1-b. Post-flood and pre-2008 photo showing a portion of Lower Dam shorn off during flooding on the Upper Iowa River in 2008.

Head cut after the Delhi Dam breach

Immediate flood damage to downstream commmunities Hopkinton and Monticello after the Lake Delhi Dam breached was widely reported. For several months after the floodwaters subsided, a lesser known ecological emergency continued. Decades of silt trapped by the impoundment gradually built the lakebed higher and higher. Post-breach, water had to fall over silt to reach the lower riverbed. The scouring force undermined the silt as it fell, sending energy upstream. More than 200,000 cubic yards of silt was released as the resuting “head cut” moved up lakebed silts a total of two miles.

Figure 1-c. Headcut progress after the breach.

Stabilizing the channel bed after the breach.

Temporary rock riffles were constructed at two sites to add stability to a shifting channel bed contributing massive silt loads to the Maquoketa River. One riffle at the breach(left) stabilized a remnant of the dam. Another was built near the bridge 2-miles upstream to intercept the head cut.

Public navigational and recreational safety

Memorials at the Reasoner Dam in Humboldt (left) on the Des Moines River and at Alden (above, and top right) on the Iowa River.

Small craft and navigation

A rise in small craft (kayaks, canoes, innertubes, angling float tubes, small motorized kayaks, etc.) recreation has increased navigation of Iowa's rivers in the past decade. Rapid expansion in innertube, canoe, and kayak rental services contributes to the accessibility of these activities, as does a wider commercial availability of various types of craft. Dams are often popular places to fish, oftentimes by wading anglers. Because low-head dams create recirculating hydraulics that may be unrecognizeable at times, drownings and injuries tend to be more concentrated at dam sites than other areas on rivers.

- Dam-related deaths occurrd at a rate of approximately 1.5 per year from 1998 to 2010.

- Not all low-head dam owners are actively implementing warning signage, which can be a critical education point for new river users.
- Dams may not be harmful at all flow levels, leading the public into complacency.
- Business opportunities may be limited when liveries are prevented from expansion by dams (Des Moines River at Boone, Maquoketa River at Monticello, Turkey River at Clermont).
- Low-quality impoundments at some dams are not popular for recreation or navigation.

Angling at dams

Dams are often attractive places to fish. Fish tend to congregate at or near them while trying to move upstream, and scour below dams can create deep water habitat with highly oxygenated water. Wading anglers, however, are vulnerable to drowning after being swept off their feet.

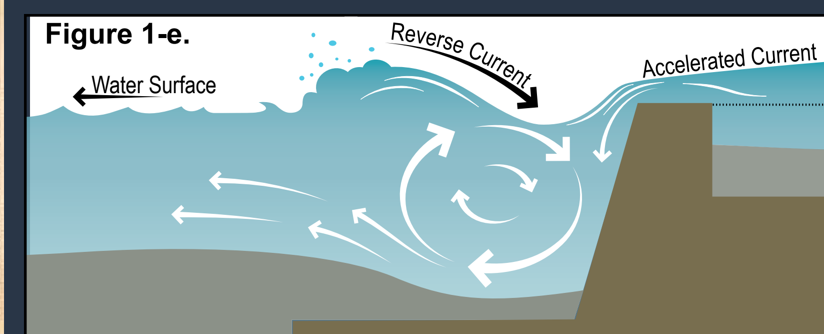
Figure 1-d. The two photos to the right, both of the Mon-Maq Dam on the Maquoketa River near Monticello, illustrate how a dam may not recirculate significantly at low flows. However, at high flows, the river's flow direction is upstream from the boil line (yellow dotted line), holding debris against the dam's face.

Hard to see. Falling a few feet, Little Dam in Fort Dodge can be difficult to see from upstream. From the side, it's danger is readily apparent.

"Drowning machines" are not a new problem

The "drowning machine" effect has been publicized by rescue and safety personnel nationwide since a rash of drownings among rescuers in the 1970s and 1980s. This 1985 Des Moines Register article explains the hazard of the low-head dam, a dam which is like a wall across a river that creates upward force. This results in a mound of water (the boil line), from which water flows upstream toward the dam.

Figure 1-e.



Flooding and flood mitigation

Dams are often thought of for their value in flood control. For a few of Iowa's notable dams, namely U.S. Army Corps of Engineers reservoir dams, this is the case for areas downstream. However, most of Iowa's dams are "run of the river" dams. These dams simply pass over water at the same rate it arrives from upstream. Low-head dams, rock dams, crossings, and even some large impoudnment dams fit this description.

For areas upstream of a run-of -the-river dam, the height of the dam becomes the lowest river bottom throughout the entire impounded reach upstream. Until the dam is submerged by restrictions from downstream, the dam is the main limiting factor in the area. Where a dam is still impounding water while infrastructure is being flooded (see photo, bottom right), flooding could be lessened if the dam's height were reduced to an optimal level, or if the dam were removed entirely.

Some dams are fitted with tainter gates that are opened during floods to reduce problems with upstream flooding. Sometimes, gates are confused as being flood-control features, when in fact they only mitigate problems that occur due to the presence of the dam. When gates are damaged and stuck closed, or filled with debris, they no longer reduce upstream flooding problems.

When a dam has reached its life-cycle end, considering these factors through professional analysis and modeling can help a community reduce flooding by predictable amounts. With what appears to be increasing flood frequency in Iowa, reducing height of dams may be valuable to explore. •

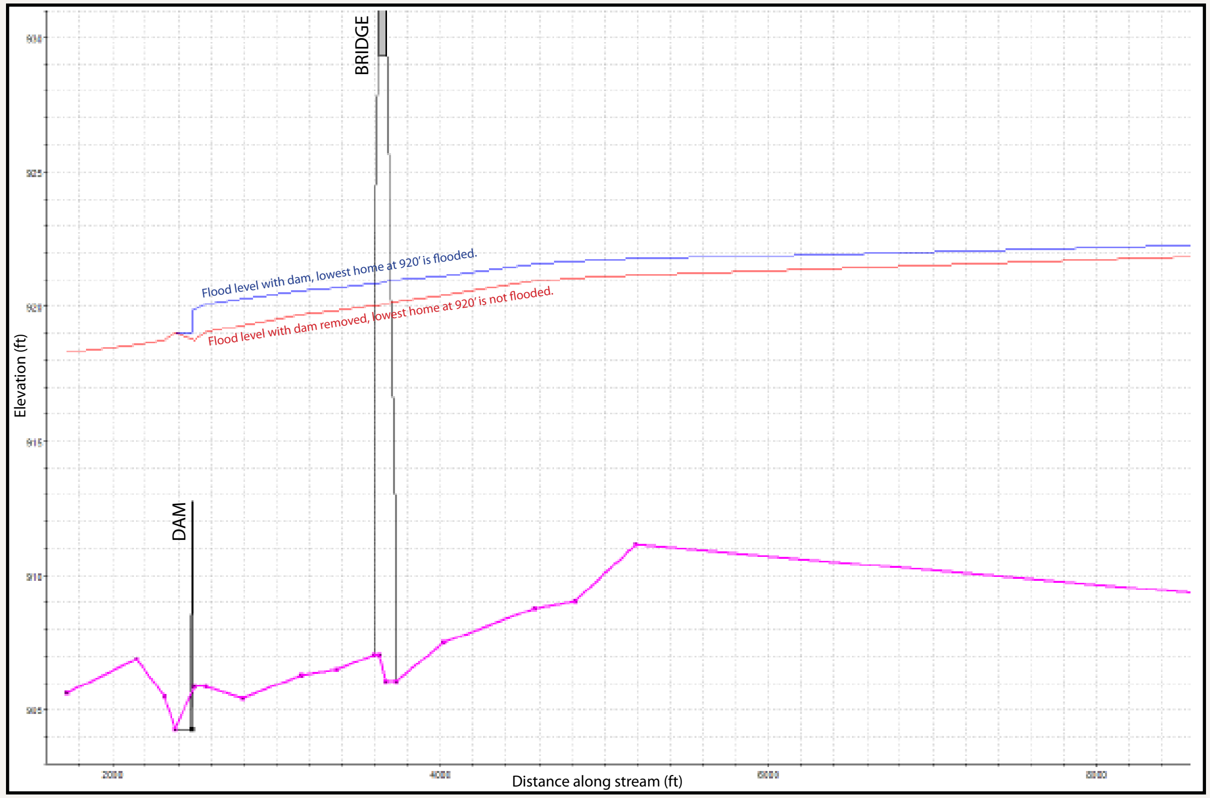


Figure 1-f. A HEC RAS model depicts water surface with a dam and no-dam scenario on the Wapsipinicon River upstream of the Littleton Dam, at a discharge of 10,000 cubic feet per second, or the relatively frequent 5-year flood event. The lowest habitable structures on the impoundment begin to flood when the water surface elevation is 920 feet. (Modeling by Interfluve, Inc.)

Manchester, Flood of 2010. When a dam's influence is clearly visible during a flood, like the dam below the bridge in Manchester, the dam likely contributes to upstream flooding. (Photo from AP video footage.)

2 The 2010 River Dam Inventory

Dams, like the rivers and streams in which they are built, are not a constant. Some are wiped out in floods, never to return. Some are re-constructed with a new design or a new height, while others are patched. Others gradually fall into disrepair. A few remain stable long beyond their original design lifespans. Periodically, major data updates will be needed. The 2010 river dam inventory provides a snapshot of vital information for developing a mitigation plan for major rivers.

2a. Inventory Background

The 2010 inventory of low-head dams in Iowa began with the Iowa Conservation Commission's 1979 *Inland Dams Inventory*. For five years, additional data was added via the water trails program. When this plan was initiated, a review of existing GIS data and aerial photos was conducted in the study area. The list was reviewed against the National Inventory of Dams kept by the Iowa DNR floodplains program.

Study area: Major rivers

The study area was narrowed to streams that are clearly public resources (Code of Iowa, Chapter 462A.2.20; 462A.69). "Major rivers" for the purposes of this plan means:

- any flowing water with a watershed greater than 50 square miles
- in urbanized streams, a more conservative criteria of 25 square miles of watershed was used

Direct staff and volunteer observations, a survey of dam owners, additional calls to public managers, and intensive data entry, review, and updating led to the final inventory.

Categories of dams

To aid policy decision making and generalized priorities for public purposes, dams were categorized into the following:

Low-head dams: A river-wide dam that is normally overtopped by the entire river's flow; gates may or may not be present to reduce upstream flooding effects. Height is less than 30 feet.

Breached low-head dams: A low-head dam with a breached portion at some point across the width. These may be relatively low-hazard at low flows, but may have long portions that re-circulate at higher flows. Fish passage may or may not be consistent.

Large impoundment dams: Earthen dams that create a recreational lake upstream with a concrete chute or piped spillway, usually accompanied by an emergency overflow spillway. Height is 30 feet or greater.

Rock dams: Human-made structures of loose rock.

Minor low-head: Low-head dams with 1-foot or less of head that are known to submerge at relatively low river discharge levels.

Rubble dams: Human-made structures that often include waste concrete, rebar, rocks, bricks, and other waste building materials.

Seasonal wetland low-head: Adjustable height dams that are used seasonally by wildlife management authorities to seasonally flood floodplain wetlands. Not a planning priority.

Lake outflow structure: Outflow structures on natural lakes that manage lake levels; not a planning priority.

While rubble, rock dams, and lake outflow structures were identified as obstructions during the process of evaluating structure types, they were not included in the analysis, as they were considered out of scope of this study.

Table 2-a

Quick statistics: The 246 structures on major rivers

Types (# dams / category)	**Ownership (# dams / category)**
Low-head dams: 177	Private: 28
Breached low-head dams: 6	Cities: 77
Minor low-head dams: 4	State: 47
Large impoundment dams: 18	County conservation: 34
Stream Crossings: 8	Federal: 17
Seasonal wetland dams: 4	Unknown: 15
Rock and rubble dams: 29	

Why is this inventory different from the National Inventory of Dams?

The U.S. Army Corps of Engineers' 2009 National Inventory of Dams was used to document dams from a list of 3,374 dams. The purpose of this listing relates to hazard potential for structural failure, what the consequences of that would be, and inspect to avoid a catastrophe. Out of the total, 210 are listed as "significant" and 101 are listed as "high" hazard if failure would occur.

The highest hazard dams do not relate to the number of actual deaths at the dam, and no deaths have occurred due to dam failure to date. For the purpose of documenting the types of dams where deaths are actually occurring in Iowa, and which create the primary barriers for aquatic species, the National Inventory of Dams provides little overlap, as it does not require reporting for dams under 6 feet in height.

Figure 2-a: Iowa's 2009 National Inventory of Dams.

2b. Social considerations

Stakeholder groups and the public were surveyed or otherwise contacted about their views on dams. This data was used to determine planning direction.

Dam owners

Important among stakeholders in any discussion about dam mitigation are the owners of the dams. Dam owners, including state and county managers, municipal officials, and corporate or individual landowners were surveyed by mail in 2009, and 54 percent responded. Surveys were not sent to rock or rubble dam owners. Tallies of responses to various questions are included in this section and provide insight into views reported by the owners. Their most common reported problem (Figure 2-d) was upstream siltation. Majorities of respondents believed their dam was a barrier to navigation and fish passage, but a majority believed the dam had no role in reducing biodiversity (Figure 2-h). A majority of responses also indicated they would be "very open" or "somewhat open" to a modification on their dam.

Anglers

Dam owners reported fishing as the most common dam use. Anglers are often the most resistent to change at dams. After being listened to, and being educated about benefits, they can become a mitigation project's strongest proponents. About 50 avid stream anglers responded to the internet survey. Of those, 96 percent fished 10 or more days per year, 44 percent reported fishing streams below river dams, and 20 percent reported fishing below lake dams. They spent 43 percent of their angling time wading, 22 percent at the stream edge, and 13.2 percent in non-motorized boats. A majority believed in balance mitigation approaches, whereas as 16 percent thought all dams should be removed.

Table 2-b

Dam Owners' Most Common Responses

Question	Most frequent answer	% of total responses
How open are you to considering a modification?	Very open	34
Current Stream Use	Fishing	71
Benefits Dam Provides at Area of Stream	Fishing	56
Why was the dam originally constructed - What was its purpose?	Mill / business function	24
What problems may exist with your dam?	Upstream siltation	45
How acceptable is the condition of the dam?	Somewhat acceptable	31

Figure 2-b. Reported Openess to Modification, Dam Owners Survey

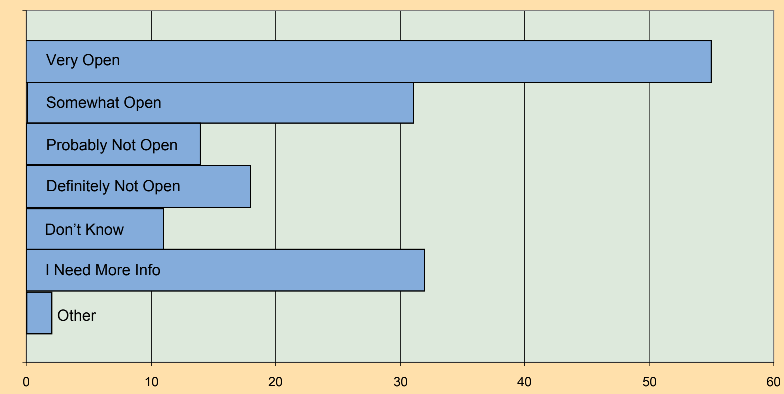


Figure 2-c. Reported Current Stream Uses, Dam Owners Survey

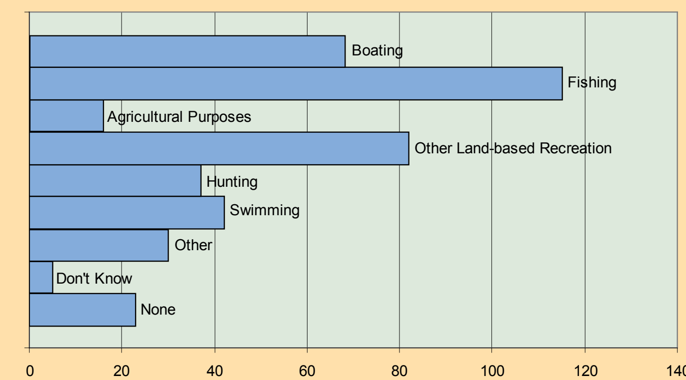


Figure 2-d. Reported Problems, Dam Owners Survey

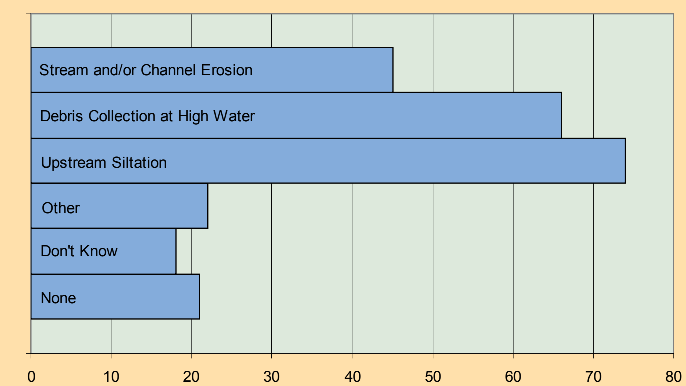


Figure 2-e. **Perceived Benefits, Dam Owners Survey**

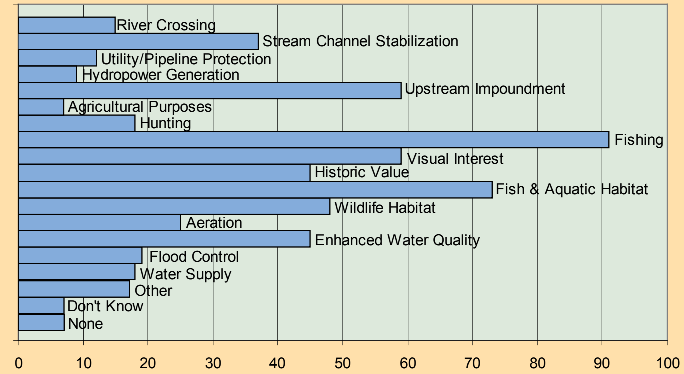
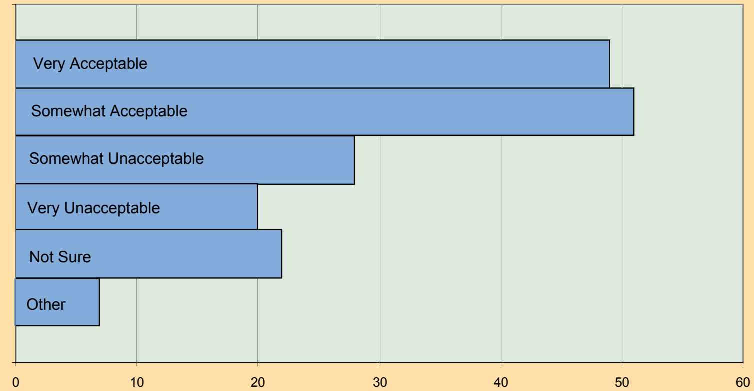


Figure 2-f. **How Accepted is Dam Condition? Dam Owners Survey**



What Iowans told us...

In the Iowa State University's CARD survey, *Iowa Rivers & River Corridors Recreation Survey*, a randomized sampling of Iowans were asked to rank issues ranging from water quality concerns to historic interests, to dam issues based on whether a statement would positively or negatively affect their decision to visit a given stream segment.

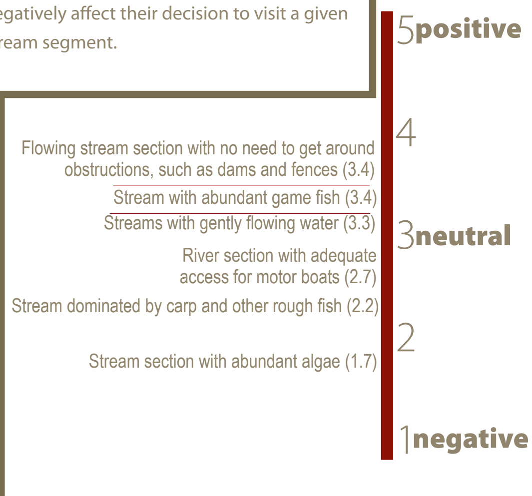


Figure 2-h.

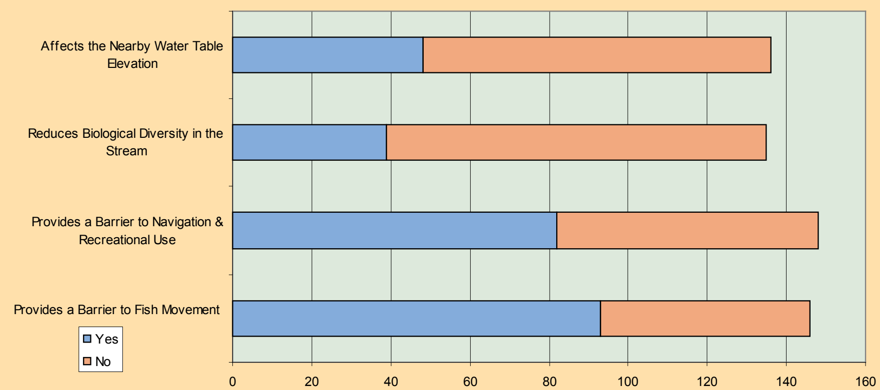
Navigation interests

In the CARD river usage survey (Figure 2-g), a randomized sampling of Iowans responded with general preference toward stream sections where there is no need to get around obstructions. One canoe, kayak, and livery owner mentioned dam safety being of concern in a 2009 survey, and others have mentione the importance of reducing navigation hazards at livery trainings held annually.

Of the 327 paddlers who responded to the internet stakeholder survey, 61 percent favored a balanced approach to mitigation methods, 11 percent believed portages around dams should be emphasized over physical modifications, and 10 percent thought that all dams should be removed.

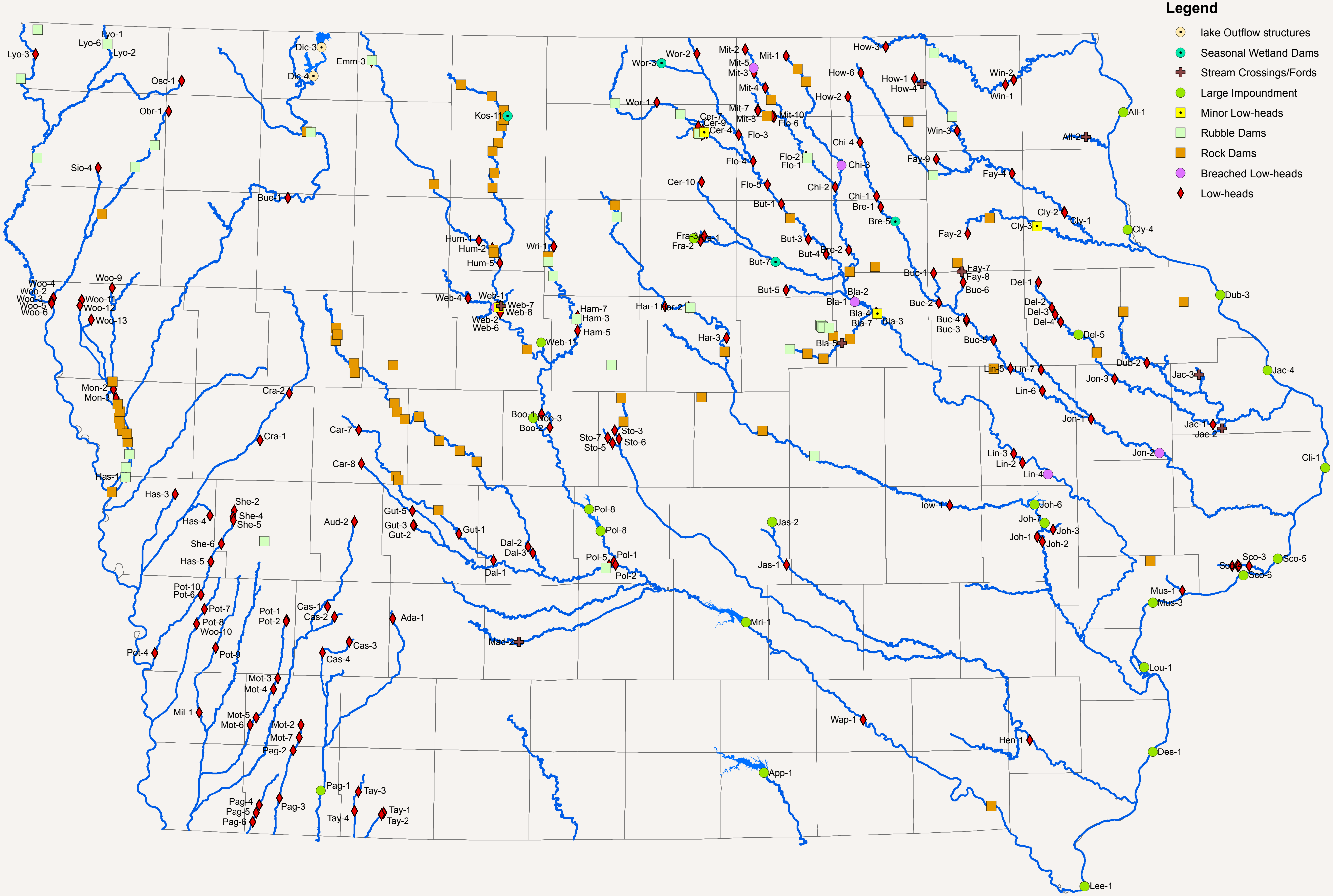
Among these groups, it is clear a plan with a strong bias toward dam removal would face limited support among key stakeholders. •

Figure 2-g. **Reported Beliefs by Topic, Dam Owners Survey**



Inventoried dams on major rivers

Figure 2-i. Map of inventoried dams in various classifications.



Low-head Dams

Established portage around dam · Asian carp barrier · Known fatality # · Hydroelectric

Low-head Dams

Dam Map ID #	County	Stream	Location Description	Dam Name	Special condition	Condition	Height (ft)	Length (ft)	Ownership	Drainage Area	X_UTMS	Y_UTMS
Ada-1	Adair	West Fork Middle Nodaway Rive	Anita - 5.5 mi SE						Adair County Engineer		359064	4581622
Aud-2	Audubon	East Nishnabotna R	Audubon - 2 mi E	Audubon Waterworks Dam		Good	5	120	City of Audubon	83	343658	4620708
Bla-1	Black Hawk	Cedar River	Cedar Falls	Cedar Falls Dam/Center St. Dam	Fatality 1	Good	12	342	City of Cedar Falls	4734	545282	4709820
Bla-3	Black Hawk	Cedar River	Waterloo	Park Avenue Dam	Fatality 6	Good	12	414	City of Waterloo	5146	554377	4705201
Bla-4	Black Hawk	Cedar River	Waterloo	Sixth St. Dam		Poor	2	450	City of Waterloo	5146	554606	4704948
Boo-1	Boone	Des Moines River	Fraser	Fraser Dam	Portage	Good	6	240	City of Fraser	5483	419266	4664217
Boo-2	Boone	Des Moines River	Boone - 2.5 mi NW	Boone Waterworks Dam	Portage, Fatality 4	Good	5	212	City of Boone	5510	422559	4658764
Bre-1	Bremer	Wapsipinicon River	Frederika	Frederika Dam	Portage, Fatality 1	Good	6	60	Bremer County Conservation Board	328	556299	4748008
Bre-2	Bremer	Cedar River	Waverly	Waverly Dam	Hydroelectric, Fatality 1	Good	11	310	City of Waverly	1549	543322	4730581
Buc-1	Buchanan	Little Wapsipinicon R (lower)	Fairbank	Fairbank Dam			12	289	City of Fairbank	125	577701	4721232
Buc-2	Buchanan	Wapsipinicon River	Littleton	Littleton Mill Dam	Portage, Fatality 9	Good	9	280	Coventry with DNR easement	899	579839	4709144
Buc-3	Buchanan	Wapsipinicon River	Independence	Independence Low Dam	Fatality 1	Fair	4	240	City of Independence	1048	590892	4701849
Buc-4	Buchanan	Wapsipinicon River	Independence	Independence Mill Dam		Good	12	270	City of Independence	1048	590870	4702468
Buc-5	Buchanan	Wapsipinicon River	Quasqueton	Quasqueton Dam	Portage	Good	6	210	City of Quasqueton	1142	601874	4694228
Buc-6	Buchanan	Otter Creek	Hazelton - 1 mi S	Fontana Lake Dam		Good	12	80	City of Hazelton	56	589487	4717441
Bue-1	Buena Vista	Little Sioux River	Linn Grove	Linn Grove Dam	Asian carp barrier	Good	10	210	Buena Vista County Conservation Board	1548	316708	4751673
But-1	Butler	Shell Rock River	Greene	Greene Dam	Hydroelectric	Good	10	210	Butler County Conservation Board	1357	516118	4749189
But-3	Butler	Shell Rock River	Clarksville - 1.5 mi SW	Heery Woods Park Dam	Portage	Good	4	150	Butler County Conservation Board / Iowa DNR	1650	527091	4734985
But-4	Butler	Shell Rock River	Shell Rock	Shell Rock Mill Dam		Fair	5	215	Butler County Conservation Board	1746	534215	4728905
But-5	Butler	Beaver Creek	Parkersburg - N edge	Beaver Meadows Dam		Good	4	125	Butler County Conservation Board	264	517937	4714440
Car-7	Carroll	Middle Raccoon River	Carroll						City of Carroll		345259	4657839
Car-8	Carroll	Brushy Creek	Dedham - 2 mi NW	Mikkelsen Low Head Dam					Carroll County Engineer		346422	4644148
Cas-1	Cass	Troublesome Creek	NE corner Atlantic	Atlantic Waterworks Dam		Good	8	28.5	Atlantic Municipal Utilities	131	332736	4586364
Cas-2	Cass	Turkey Creek	Atlantic - 1 mi SE						Cass County Engineer		335536	4582191
Cas-3	Cass	Sevenmile Creek	Cumberland - 1 mi SW						Cass County Engineer		341530	4572096
Cas-4	Cass	Sevenmile Creek	Lewis - 5 mi SE						Cass County Engineer		330635	4567847
Cer-10	Cerro Gordo	Beaver Creek	Rockwell - 1 mi SW	Linn Grove Park Dam		Fair	5	50	Cerro Gordo County Conservation Board	35	483829	4758069
Cer-11	Cerro Gordo	Winnebago River	North part Mason City	12th Street Dam	Fatality 1	Good	3	100	City of Mason City	526	484304	4778855
Cer-13	Cerro Gordo	Winnebago River	Mason City - E side	Illinois Street Dam		Good	2		City of Mason City	632	485982	4777823
Cer-18	Cerro Gordo	Willow Creek	Mason City	Jackson Avenue Dam		Good			City of Mason City	103	482826	4777689
Cer-19	Cerro Gordo	Willow Creek	Mason City - W side	Pierce Avenue Dam		Fair			City of Mason City	103	482012	4778136
Cer-5	Cerro Gordo	Willow Creek	Mason City - East Park	Fourth Street Dam		Good	2	40	City of Mason City	105	484993	4778066
Cer-6	Cerro Gordo	Willow Creek	Mason City - East Park	Lagoon Diversion Dam		Good	2	40	City of Mason City	105	484962	4777950
Cer-7	Cerro Gordo	Willow Creek	Mason City - East Park	East Park Slide Dam		Fair	4	40	City of Mason City	105	484869	4777880
Cer-8	Cerro Gordo	Willow Creek	Mason City	Rock Glen Dam		Fair	6	90	Abandoned	105	484388	4777555
Cer-9	Cerro Gordo	Willow Creek	Mason City	Pennsylvania Avenue Dam		Good	3	104	City of Mason City	105	483875	4777241
Chi-1	Chickasaw	Wapsipinicon River	Williamstown - 5 mi S	Buckley Rock Dam Ford		Excel	7	80	Bob Buckley	325	554510	4752224
Chi-2	Chickasaw	Cedar River	Nashua - above IA-346 bridge	Cedar Lake Dam		Excel	17	407	City of Nashua	1113	537862	4755951
Chi-4	Chickasaw	Little Wapsipinicon R (upper)	North Washington	North Washington Mill Dam		Fair	8	54	Chickasaw County Conservation Board	79	547951	4774072
Cly-1	Clayton	Turkey River	Elkader	Elkader Big Dam	Asian carp barrier	Good	16	205	City of Elkader	891	630347	4746021
Cly-2	Clayton	Turkey River	Elkader	Elkader Little Dam		Good	2	235	City of Elkader	891	630534	4745773
Cra-1	Crawford	East [Branch] Boyer River	Denison - S side	Denison Dam		Poor	3	30	City of Denison	127	305468	4653599
Cra-2	Crawford	Boyer River	Kiron - 5 mi W						Crawford County Engineer		317397	4672613
Dal-1	Dallas	Middle Raccoon River	Redfield - West part	Redfield Dam		Good	9	110	City of Redfield	609	399742	4605029
Dal-2	Dallas	N. Raccoon River	Adel	Adel North Dam	Portage	Poor		142	City of Adel	2250	413797	4610588
Dal-3	Dallas	N. Raccoon River	Adel - NE side (Island Park)	Adel Island Park Dam		Good	12	163	City of Adel	2281	415571	4608109
Del-1	Delaware	Maquoketa River	Dundee - 2 mi N	Backbone Lake Dams		Good		110	State Conservation Commission	118	620037	4717512
Del-2	Delaware	Maquoketa River	Manchester - 1 mi NW	Quaker Mill Dam	Portage	Breached, 2010		196	Willard Hawker	157	625354	4707288
Del-3	Delaware	Maquoketa River	Manchester	Manchester Dam		Excel		154	City of Manchester	268	626704	4704459
Del-4	Delaware	Maquoketa River	Manchester - 2 mi SE	Pin Oak Park Dam		Fair	2	120	Iola Carr / USGS	305	629053	4701431
Dub-2	Dubuque	North Fork Maquoketa R	Cascade	Cascade Falls Dam		Good	1			207	663817	4684925
Emm-3	Emmet	[West Fork] Des Moines R	Estherville	South Riverside Park Dam		Poor	2	70	City of Estherville	1372	350539	4806732
Fay-2	Fayette	South Fork (or Little) Volga R	Maynard	Maynard Dam		Fair	5	40	City of Maynard	26	591421	4737080
Fay-4	Fayette	Turkey River	Clermont	Clermont Dam		Poor	5	110	City of Clermont	745	609362	4761457
Fay-7	Fayette	Otter Creek	Oelwein - S edge	Lake Oelwein Dam		Good	14	200	City of Oelwein	41	588877	4722156
Fay-9	Fayette	Little Turkey Creek	Wacouma	Wacouma Mill Dam			11	224			578689	4767349
Flo-1	Floyd	Cedar River	Charles City	Main Street Dam		Good	11	238	City of Charles City	1054	526029	4768226
Flo-2	Floyd	Cedar River	Charles City	Charles City Beauty Dam		Good	7	260	City of Charles City	1054	526235	4768075
Flo-3	Floyd	Shell Rock River	Nora Springs	Nora Springs Dam		Good	6	70	City of Nora Springs	499	498849	4777169
Flo-4	Floyd	Shell Rock River	Rockford	Rockford Dam		Poor	10	200	F.R. Ayers, Rockford, Co. Cons. Board	529	504685	4766405
Flo-5	Floyd	Shell Rock River	Marble Rock	Marble Rock Dam		Good	10	200	City of Marble Rock	1319	510516	4756982
Flo-6	Floyd	Rock Creek	Osage - 4 mi SSW	Rock Creek Ford		Fair	3			56	513061	4784395
Fra-2	Franklin	Spring Creek	Hampton - N edge	Harriman Park Dam		Fair	6	70	City of Hampton	32	483264	4734161
Fra-3	Franklin	Otter Creek	Hampton - 2 mi NNE	Robinson Park Dam		Poor	3	52	Franklin County Conservation Board	84	484900	4736223
Gru-3	Grundy	Blackhawk Creek	Grundy Center - NE part	Grundy Center Ford		Fair	3			56	519579	4690540
Gut-1	Guthrie	Middle Raccoon River	Panora - SW corner	Lenon Mill Dam		Fair	5	100	Guthrie County Conservation Board	434	385877	4615927
Gut-2	Guthrie	South Raccoon River	Guthrie Center - 5 mi WNW			Good		50	Northern Natural Gas Company	42	367757	4619169

Low-head Dams, cont.

Established portage around dam · Asian carp barrier · Known fatality # · Hydroelectric

Gut-3	Guthrie	South Raccoon River	Guthrie Center - 5 mi WNW			Good			Northern Natural Gas Company	42	367439	4619351
Gut-5	Guthrie	Brushy Creek	Guthrie Center - 7 mi NW					0	Guthrie County Engineer		367115	4625099
Ham-3	Hamilton	Boone River	Webster City	Webster City Dam		Good	3	40	City of Webster City	660	433040	4702708
Ham-7	Hamilton	White Fox Creek	Webster City - 1/2 mi N	Kendall Young Park Ford		Good	2	50	City of Webster City	112	433729	4703812
Har-1	Hardin	Iowa River	Alden	Alden Dam	Portage; Fatality 2	Good	10	208	City of Alden	638	469055	4707737
Har-2	Hardin	Iowa River	Iowa Falls - SE side	Iowa Falls Dam	Hydroelectric	Good	26	200	North American Hydro	667	478713	4707389
Har-3	Hardin	Iowa River	Steamboat Rock	Steamboat Rock Dam	Fatality 1	Good	10	210	Iowa DNR	737	494024	4695118
Has-1	Harrison	Little Sioux River	Little Sioux - 4 mi NE	Sill #4	Fatality 2	Deter	1	100	Corps of Engineers	3538	251265	4638886
Has-3	Harrison	Willow Creek	Woodbine - 5 mi NW	Miles Mann Flume		Excel		15	Harrison County - Road Dept.	69	271191	4631834
Has-4	Harrison	Willow Creek	Magnolia - 3.5 mi NE	Burkholder Flume		Excel	14	20	Harrison County - Road Dept.	108	285258	4623144
Has-5	Harrison	Mosquito Creek	Persia - 1 mi S	Mosquito Creek Flume		Excel		20	Harrison County - Road Dept.	97	285594	4604572
Hen-1	Henry	Skunk River	Mount Pleasant - 4 mi SW	Oakland Mills Dam	Asian carp barrier; Fatality 1	Good		160	Henry County Conservation Board	4001	616555	4532450
How-2	Howard	Little Wapsipinicon R (upper)	Elma - (Lylah's Marsh)	Lylah's Marsh Dam	Fatality 1	Good	10	70	Howard County Conservation Board	19	542999	4792547
How-3	Howard	Upper Iowa River	Lime Springs - 1 mi N	Lidtke Mill Dam		Good	12	120	Howard County Conservation Board	182	558363	4812675
How-6	Howard	Crane Creek	Sarasota - Lubbert Park	Saratoga Dam		Good			Howard County Conservation Board		548196	4802151
Hum-1	Humboldt	[West Fork] Des Moines R	Rutland	Rutland Dam		Good	13	200	Humboldt County Conservation Board	2233	393916	4734446
Hum-2	Humboldt	[West Fork] Des Moines R	Humboldt	Reasoner Dam	Fatality 1	Good	15	300	Humboldt County Conservation Board	2256	399323	4731201
Hum-5	Humboldt	Des Moines River	Dakota City - 3.5 mi S	Corn Belt Power Dam	Fatality 3	Good	5	196	Corn Belt Power Cooperative	3623	402488	4725315
Iow-1	Iowa	Iowa River	South Amana - 1.5 mi NW	Amana Millrace Diversion Dam	Portage; Hydroelectric	Good	9	178	Amana Colony	2829	584147	4627396
Jac-1	Jackson	Maquoketa River	Maquoketa - 1 mi W	Lakehurst Dam	Portage; Asian carp barrier; Hydroelectric	Good	25	150	North American Hydro	1550	690455	4660133
Jas-1	Jasper	North Skunk River	North edge Lynnville	Wagaman Mill Dam	Portage; Fatality 2	Good	10	84	Lynnville Historical Society	282	518105	4603275
Joh-1	Johnson	Iowa River	Coralville	Iowa River Power Company Dam	Fatality 4	Good	10	280	Johnson County Conservation Board	3162	619490	4614591
Joh-2	Johnson	Iowa River	Iowa City	Burlington Street Dam	Fatality 5	Good	11	300	University of Iowa	3271	621482	4612804
Joh-3	Johnson	Rapid Creek	Iowa City - 3.5 mi NE	Rapid Creek Gaging Dam				20	U.S.G.S.	25	625825	4617585
Jon-1	Jones	Wapsipinicon River	Anamosa	Anamosa Dam	Asian carp barrier; Hydroelectric; Fatality 2	Fair	8	160	North American Hydro	1562	641246	4662412
Jon-3	Jones	Maquoketa River	Monticello - 1 mi NE	Mon-Maq Dam		Good	10	441	Jones County Conservation Board	657	650799	4678546
Lin-2	Linn	Cedar River	Cedar Rapids	C Street Roller Dam	Fatality 7	Good		636	Alliant Energy	6510	613535	4644502
Lin-3	Linn	Cedar River	Cedar Rapids	5-in-1 Bridge & Dam	Asian carp barrier; Hydroelectric	Excel		515	City of Cedar Rapids	6510	609967	4648291
Lin-5	Linn	Wapsipinicon River	Troy Mills	Troy Mills Dam		Deter	6	280		1210	608612	4682632
Lin-6	Linn	Wapsipinicon River	Central City	Pinicon Ridge Park Dam		Good		240	Linn County Conservation Board	1263	621475	4673559
Lin-7	Linn	Buffalo Creek	Coggan	Buffalo Creek Park Dam		Good		130	Linn County Conservation Board	142	621022	4682232
Lyo-1	Lyon	Rock River	Rock Rapids - City Park	Rock Rapids Dam		Good	10	162	City of Rock Rapids	789	243699	4814228
Lyo-2	Lyon	Rock River	Rock Rapids - City Park	City Park East Channel Dam		Fair	5	74	City of Rock Rapids	789	243815	4813914
Lyo-3	Lyon	Big Sioux River	Klondike	Klondike Mill Dam	Portage	Good	12	175	S. Dak. Dept of Schls & Land /Iowa DNR		214749	4809726
Lyo-6	Lyon	Rock River	Rock Rapids - City Park	City Park Big Ford		Poor	2		City of Rock Rapids	789	243751	4814225
Mil-1	Mills	Silver Creek	Malvern - .5 mi W						Mills County Engineer		280995	4543575
Mit-1	Mitchell	Little Cedar River	Stacyville	Stacyville Dam			8	80	Town of Stacyville	88	517921	4809106
Mit-10	Mitchell	Rock Creek	Osage - 4 mi SSW	Jersey Avenue Wier		Fair	2			56	512460	4784757
Mit-2	Mitchell	Cedar River	Otranto	Otranto Mill Dam	Fatality 1		7	120	Mitchell County Conservation Board	656	501494	4811636
Mit-3	Mitchell	Cedar River	St. Ansgar - 1/2 mi SW	St. Ansgar Mill Dam		Fair	8	220	Sherwin Klienwart	780	505163	4802092
Mit-4	Mitchell	Cedar River	Mitchell	Mitchell Mill Dam	Hydroelectric	Good	20	120	Mitchell County Conservation Board	826	509624	4796156
Mit-7	Mitchell	Rock Creek	Rock Creek village	Rock Creek Village Ford		Good	3			41	506615	4787245
Mit-8	Mitchell	Rock Creek	Rock Creek village	Rock Creek Village Dam		Poor	6			46	506739	4786816
Mon-2	Monona	West Fork Ditch	Whiting - 5 mi NE #4	Bed Grade Control Structure			6	30	Little Sioux Drainage Dist.	597	246248	4674181
Mon-3	Monona	West Fork Ditch	Whiting - 4.5 mi ENE #3	Bed Grade Control Structure		Good	6	30	Little Sioux Drainage Dist.	600	247272	4670761
Mot-2	Montgomery	Tarkio Creek	Stanton - 1/2 mi. W	Stanton Dam		Good	10	80	Burlington Northern Railroad	49	322059	4538612
Mot-3	Montgomery	Walnut Creek	Elliot - 3 mi W	901 Sherman (HHRTS)					Montgomery County Engineer		312628	4557295
Mot-4	Montgomery	Walnut Creek	Elliot - 5 mi SW	2007 Sherman (Straton Church)					Montgomery County Engineer		310927	4553048
Mot-5	Montgomery	Walnut Creek	6 Miles SW of Red Oak	3307 Garfield (Flying "A")					Montgomery County Engineer		303982	4541539
Mot-6	Montgomery	Walnut Creek	9 Mi SW of Red Oak	805 West (Klookeys)					Montgomery County Engineer		301507	4538522
Mot-7	Montgomery	Tarkio River	4 mi SW city of Stanton	2007 3/4 (Bergulinds)					Montgomery County Engineer		321335	4533528
Mus-1	Muscatine	Pine Creek	Fairport - 3 mi. NE	Pine Creek Grist Mill Dam		Good	8	50	State Conservation Commission	38	678067	4592875
Obr-1	O'Brien	Floyd River	Sheldon - 1/2 mi N	Sheldon Waterworks Dam		Fair	4	40	City Sheldon	64	268563	4786537
Osc-1	Osceola	Otter Creek	Ashton	Ashton Dam		Fair	6	75	Chicago, Northwestern Railway	107	273800	4798888
Pag-2	Page	Tarkio River	Coburg - 6 Miles SE	83/5-20					Page County Engineer		318831	4528327
Pag-3	Page	Tarkio River	Yorktown - 3 mi SW	L-315-10					Page County Engineer		313327	4509051
Pag-4	Page	Middle Tarkio River	Coin - 3.5 mi NW	L-315-03					Page County Engineer		305098	4506188
Pag-5	Page	Middle Tarkio River	Coin - 4 mi W	HCA - 1					Page County Engineer		303919	4502996
Pag-6	Page	Middle Tarkio River	Northboro - 2 mi NW	EWP - IA - 73 - 88					Page County Engineer		302562	4499417
Pol-1	Polk	Des Moines River	Center Street, Des Moines	Center Street Dam (Des Moines)	Fatality 15	Good		364	City of Des Moines	6245	448434	4604628
Pol-2	Polk	Des Moines River	Scott Street, Des Moines	Scott Street Dam	Fatality 3	Good		440	City of Des Moines	9879	449011	4603272
Pol-5	Polk	Raccoon River	Des Moines - E Water Works	Fleur Drive Dam		Fair		205	DSM water works	3626	446449	4603218
Pot-1	Pottawattamie	Walnut Creek	Hancock - 9 mi ESE			Good		45	City of Council Bluffs	37	316270	4581037
Pot-10	Pottawattamie	Mosquito Creek	Neola - S side						Burlington Northern Railroad		281691	4591209
Pot-2	Pottawattamie	Walnut Creek	Hancock - 9 mi ESE			Excel		45	City of Council Bluffs	37	316166	4580464
Pot-4	Pottawattamie	Mosquito Creek	Council Bluffs - E side	Council Bluffs Dam		Good			Lake Manawa St. Park	230	262925	4567688
Pot-6	Pottawattamie	Mosquito Creek	Neola						Iowa D.O.T.		281691	4591209
Pot-7	Pottawattamie	Keg Creek	Neola - 4 mi SSE						Pottawattamie County Engineer		283094	4585449
Pot-8	Pottawattamie	Keg Creek	McClelland - 2.5 mi E						Pottawattamie County Engineer		279806	4579420
Pot-9	Pottawattamie	Silver Creek	Treynor - 3.5 NE						Pottawattamie County Engineer		287601	4569658
Sco-1	Scott	Duck Creek	Davenport	Hickory Grove Rd Dam					City of Davenport		698366	4602844
Sco-2	Scott	Duck Creek	Davenport	Washington St. Dam					City of Davenport		700465	4602897

Low-head Dams, cont.

Established portage around dam — Asian carp barrier — Known fatality # — Hydroelectric

Sco-3	Scott	Duck Creek	Davenport	Marquette Rd Dam					City of Davenport		700986	4602859
Sco-4	Scott	Duck Creek	Davenport	Jersey Ridge Rd Dam					City of Davenport		705030	4602868
She-2	Shelby	Mosquito Creek	Panama - 2 mi. N	North Panama Dam		Good	20	40	Iowa D.O.T.	34	295038	4625270
She-4	Shelby	Mosquito Creek	Panama- NE	Panama High Tress Weir					Shelby County Engineer		294476	4622635
She-5	Shelby	Mosquito Creek	Panama - .5 mi SE	F-32 Weir					Shelby County Engineer		294702	4621317
She-6	Shelby	Mosquito Creek	Porthsmouth - 1 mi S	Bruch Weir					Shelby County Engineer		289764	4611843
Sio-4	Sioux	West Fork Floyd River	Maurice - 1 mi NNE	460th Street Ford		Good				127	240109	4763773
Sto-3	Story	Skunk River	Ames - 1/2 mi N	Sleepy Hollow/Hannum's Mill	Portage, Fatality 1	Fair		50	U.S.G.S.	315	448761	4657551
Sto-5	Story	Squaw Creek	Ames	Lincolnway Gaging Dam		Fair	2	60	Ames Water and Pollution Control	204	447775	4652473
Sto-6	Story	Skunk River	Ames - E side	East River Valley Park / 13th St. Dam	Portage	Good	4		U.S.G.S.	323	450507	4654095
Sto-7	Story	Squaw Creek	Ames	Veenker Golf Course Ford		Fair	3			191	445867	4654584
Tay-1	Taylor	East 102 River	Bedford - E edge	Bedford Waterworks Dam		Good	6	40	City of Bedford	88	355447	4503117
Tay-2	Taylor	East 102 River	Bedford - S edge	Fairgrounds Dam		Excel	16	80	Spencer	90	354499	4502343
Tay-3	Taylor	West Fork 102 River	New Market - 3 mi E	Wind Mill Lake County Park					Taylor County Engineer		345241	4511652
Tay-4	Taylor	West Fork 102 River	New Market - 4.5 mi SE						Taylor County Engineer		343656	4503825
Wap-1	Wapello	Des Moines River	Ottumwa	Market Street Dam	Hydroelectric, Fatality 9	Good	14	700	Ottumwa Water Works	13374	549105	4540671
Web-1	Webster	Des Moines River	Fort Dodge	Ft. Dodge Hydro Dam		Good	16	270	City of Fort Dodge	3753	401397	4707800
Web-2	Webster	Des Moines River	Fort Dodge	Little Dam	Fatality 1	Good	8	366	City of Fort Dodge	4228	402432	4705278
Web-4	Webster	Lizard Creek	Clare - 3 mi S	Clare Gaging Dam		Good	2	60	U.S.G.S.	257	389567	4711101
Web-6	Webster	Des Moines River	Fort Dodge	Trestle Weir		Good	1	80	City of Fort Dodge	4228	402669	4705067
Web-8	Webster	Soldier Creek	Fort Dodge	Williams Drive Dam					City of Fort Dodge	37	402596	4707953
Win-1	Winneshiek	Upper Iowa River	Decorah - 6 mi NE	Upper Dam	Portage, Asian carp barrier	Fair	16	123	DNR	584	606510	4797423
Win-2	Winneshiek	Upper Iowa River	Decorah - 11 mi NE	Lower Dam	Portage, Asian carp barrier	Poor	25	300	DNR	629	610069	4799356
Win-3	Winneshiek	Turkey River	Ft. Atkinson - 1/2 mi. N	Weist Mill Dam	Fatality 1	Deter	2	55	Weist Feed Mill Company	211	587127	4778732
Woo-10	Woodbury	Mud Creek	Moville - 1 mi NW						Woodbury County Engineer		279806	4579420
Woo-11	Woodbury	Big Whiskey Creek	Lawton - 3 mi NW		Fatality 2				Woodbury County Engineer		233337	4710380
Woo-12	Woodbury	Big Whiskey Creek	Lawton - 3 mi W						Woodbury County Engineer		232755	4708088
Woo-13	Woodbury	Elliot Creek	Bronson - 1 mi NE						Woodbury County Engineer		237204	4702442
Woo-2	Woodbury	Floyd River	Sioux City	"6th Street Dam"		Good	3	75	City of Sioux City - Public Works	910	221645	4710627
Woo-3	Woodbury	Floyd River	Sioux City	"4th Street Dam"		Good	2	75	City of Sioux City - Public Works	911	221408	4710183
Woo-4	Woodbury	Floyd River	Sioux City	"11th Street Dam"		Good	3		City of Sioux City - Public Works	909	221983	4711261
Woo-5	Woodbury	Floyd River	Sioux City	"Dace Avenue Dam"		Good	7		City of Sioux City - Public Works	911	221241	4709581
Woo-6	Woodbury	Floyd River	Sioux City	"Dam at the Mouth"			3		City of Sioux City - Public Works	912	221253	4709003
Woo-9	Woodbury	Mud Creek	Moville - 3.5 mi NW						Woodbury County Engineer		245785	4715165
Wor-1	Worth	Winnebago River	Fertile	Fertile Mill Dam	Fatality 1	Good	11	114	Worth County Conservation Board	304	465772	4790195
Wor-2	Worth	Shell Rock River	Northwood	Northwood Dam	Fatality 2	Good	2	35	City of Northwood	277	481901	4809881
Wri-1	Wright	Boone River	Goldfield	Goldfield Dam		Fair	5	50	City of Goldfield	418	424122	4731995

Breached Low-head Dams

Established portage around dam — Asian carp barrier — Known fatality # — Hydroelectric

Dam Map ID #	County	Stream	Location Description	Dam_Name	Special condition	Condition	Height (ft)	Length (ft)	Ownership	Drainage Area	X_UTMS	Y_UTMS
Bla-2	Black Hawk	Cedar River	Cedar Falls	Clay Hole		Deter	3	410	City of Cedar Falls	4734	545776	4709665
Chi-3	Chickasaw	Little Cedar River	Ionia - 2.5 mi W	Chickasaw Mill Dam		Fair	6	100	Chickasaw County Conservation Board	306	540357	4764758
Jon-2	Jones	Wapsipinicon River	Oxford Mills - 1 mi S	Oxford Mills Dam		Deter		290	NA	1788	668918	4648642
Lin-4	Linn	Cedar River	Palisades-Kepler Park	Palisades-Kepler Dam	Portage, Fatality 4	Deter	8	780	Iowa DNR	6955	623836	4639894
Mit-5	Mitchell	Cedar River	St. Ansgar - 1.5 mi NW	Interstate Power Dam/Old power Dam		Deter				680	504979	4804227
Web-5	Webster	Lizard Creek	Fort Dodge	Lizard Creek Mill Dam		Deter	1	30	City of Fort Dodge	437	400717	4707397

Minor Low-head Dams

Established portage around dam — Asian carp barrier — Known fatality # — Hydroelectric

Dam Map ID #	County	Stream	Location Description	Dam_Name	Special condition	Condition	Height (ft)	Length (ft)	Ownership	Drainage Area	X_UTMS	Y_UTMS
Bla-7	Black Hawk	Cedar River	Waterloo	Pioneer Park Structure/Water Line		Fair	1	0	City of Waterloo	5146	554903	4704762
Cer-4	Cerro Gordo	Winnebago River	Mason City - East Park	East Park Dam		Good	1	150	City of Mason City	526	484974	4778252
Cly-3	Clayton	Volga River	Volga City	Volga City Dam		Deter	1		NA	261	619481	4740275
Web-10	Webster	Soldier Creek	Fort Dodge	Armstrong Park Dam		Fair			City of Fort Dodge	37	402142	4707481

Above-grade Fords and Crossings on Major Rivers

Established portage around dam | Asian carp barrier | Known fatality # | Hydroelectric

All-2	Allamakee	Yellow River	Waterville - 5 miles S	Wilson Rd Ford			8		Warner		639082	4776285
Bla-5	Black Hawk	Blackhawk Creek	Hudson - West	Heritage Farm Crossing		Fair		0	Hudson Farms	280	540617	4692910
Fay-8	Fayette	Otter Creek	Oelwein - S edge	Low Flow Bridge		Good	2		City of Oelwein	41	588935	4721828
How-4	Howard	Turkey River	Cresco - 3.5 mi SSE	King's Road Ford		Good	1		Howard County Conservation Board	78	572832	4797650
Jac-2	Jackson	Prairie Creek	Maquoketa - SE corner	Prairie Creek Ford						44	694066	4658490
Jac-3	Jackson	Lytle Creek	Swingle - 5 mi SW	Lytle Creek Ford		Fair	3			67	684940	4680182
Mad-2	Madison	Middle River	Winterset - 3 mi SW	Pammel Park Ford		Good	3	100	Iowa DNR	230	410011	4572112
Web-7	Webster	Soldier Creek	Fort Dodge	Snell-Crawford Park Fords					City of Fort Dodge	37	402933	4708007

Large Impoundment Dams

Established portage around dam | Asian carp barrier | Known fatality # | Hydroelectric

Dam Map ID #	County	Stream	Location Description	Dam_Name	Special condition	Condition	Height (ft)	Length (ft)	Ownership	Drainage Area	X_UTMS	Y_UTMS
Boo-3	Boone	Bluff Creek	Ogden - 4.5 mi N	Don Williams Lake Dam		Good	45	60	Boone County Conservation Board	33	415842	4662648
Del-5	Delaware	Maquoketa River	Delhi - 1.5 mi SSW	Lake Delhi Dam		Breached, July 2010	38	110	Lake Delhi Recreation Assoc.	347	636151	4696412
Fra-1	Franklin	Spring Creek	Hampton - 1.5 mi NW	Beed's Lake Dam		Good	35	240	Iowa DNR	32	480701	4735300
Jas-2	Jasper	Rock Creek	Rock Creek State Park	Rock Creek Lake Dam		Good	33	200	Iowa DNR	41	512328	4620575
Joh-6	Johnson	Mill Creek	Lake MacBride State Park	Lake MacBride Dam		Good	30	150	US Army Corps of Engineers	27	618464	4627705
Pag-1	Page	West Nodaway River	Clarinda	Clarinda Dam		Good	6	130	City of Clarinda	762	329981	4512057
Pol-7	Polk	Big Creek	Polk City - 1 mi WNW	Big Creek Spillway		Excel	97	100	Big Creek St. Park/ACE	80	438434	4625800
Web-11	Webster	Brushy Creek	Lehigh - 4 mi ENE	Brushy Creek Dam		Excel	80	180	Iowa DNR	88	419114	4693170
All-1	Allamakee	Mississippi River	Harpers Ferry	Mississippi Lock and Dam 9		Good			US Army Corps of Engineers		654257	4786194
App-1	Appanoose	Chariton River	Lake Rathbun	Rathbun Dam	[Asian carp barrier]	Good			US Army Corps of Engineers		509022	4519271
Joh-7	Johnson	Iowa River	Coralville	Coralville Dam	[Asian carp barrier]	Good			US Army Corps of Engineers		622380	4620217
Pol-8	Polk	Des Moines River	Des Moines	Saylorville Dam	[Asian carp barrier]	Good	126	7180	US Army Corps of Engineers		443112	4617155
Mri-1	Marion	Des Moines River	Pella - 1.5 Mi SW	Red Rock Reservior Dam	[Asian carp barrier]	Good	118	6200	US Army Corps of Engineers		501821	4580108
Cly-4	Clayton	Mississippi River	Clayton - E	Mississippi River Lock & Dam No. 10		Good			US Army Corps of Engineers		655950	4738784
Dub-3	Dubuque	Mississippi River	Dubuque - NE	Mississippi River Lock & Dam No. 11		Good	43	5130	US Army Corps of Engineers		4712432	4712432
Jac-4	Jackson	Mississippi River	Bellevue - E	Mississippi River Lock & Dam No. 12		Good	44	8577	US Army Corps of Engineers		712583	4681962
Cli-1	Clinton	Mississippi River	Clinton - NE	Mississippi River Lock & Dam No. 13		Good	44	9999	US Army Corps of Engineers		735834	4642417
Sco-5	Scott	Mississippi River	Between Bettendorf / Le Claire	Mississippi River Lock & Dam No. 14		Good			US Army Corps of Engineers		716795	4605779

Lake Outflow Structures & Seasonal Low-head Dams

Established portage around dam | Asian carp barrier | Known fatality # | Hydroelectric

Dam Map ID #	County	Stream	Location Description	Dam_Name	Special condition	Condition	Height (ft)	Length (ft)	Ownership	Drainage Area	X_UTMS	Y_UTMS
Dic-3	Dickinson	Spirit Lake Outlet	Orleans	Spirit Lake Outlet	[Asian carp barrier]	Excel	4		Iowa DNR	76	330372	4812533
Dic-4	Dickinson	Okoboji Lake Outlet	Milford - NE corner	Okoboji Lake Outlet	[Asian carp barrier]	Excel			Iowa DNR	144	327142	4800857

Seasonal Wetland Dams

Dam Map ID #	County	Stream	Location Description	Dam_Name	Special condition	Condition	Height (ft)	Length (ft)	Ownership	Drainage Area	X_UTMS	Y_UTMS
Bre-5	Bremer	East Fork Wapsipinicon R	Tripoli - 1.5 mi NE	Sweet Marsh Dam					Iowa DNR (Sweet Marsh WMA)	148	562245	4742108
But-7	Butler	West Fork Cedar River	Allison - 4 mi SSW	Big Marsh Diversion Dam		Good	5		Iowa DNR (Big Marsh WMA)	708	513740	4725785
Kos-11	Kossuth	Buffalo Creek	Burt - 3 mi ENE	Buffalo Creek Dam		Excel	13	150	Union Slough National Wildlife Refuge	160	405575	4784716
Wor-3	Worth	Elk Creek	Joice - 3.5 mi NE	Elk Creek Game Mgmt Dam 1		Good	18	60	Iowa DNR (Elk Creek Marsh)	32	467620	4806032

Rock Dams & Rubble Dams

(portage) Established portage around dam   Asian carp barrier   Fatality #   Hydroelectric

Dam Map ID #	County	Stream	Location Description	Dam_Name	Special condition	Condition	Height (ft)	Length (ft)	Ownership	Drainage Area	X_UTMS	Y_UTMS
Bla-6	Black Hawk	Blackhawk Creek	Hudson	Hudson Ford		Good	3	0		302	543907	4694687
Bre-3	Bremer	Quarter Section Run	Denver	Denver Dam		Fair	3	50	City of Denver	49	553973	4723679
Bre-6	Bremer	Cedar River	Janesville	Janesville Rock Dams		Fair	3			1661	543790	4721866
Buc-7	Buchanan	Wapsipinicon River	Quasqueton	Quasqueton Rock Beauty Dam		Good	3		City of Quasqueton	1142	601890	4682632
But-2	Butler	Shell Rock River	Greene - 5 mi SE	Camp Comfort Rock Dam		Good	4	200	Butler County Conservation Board	1454	519737	4743346
Cal-1	Calhoun	Lake Creek	Lake City - 2 mi E & 2 mi N	Lake Creek Rock Dam		Fair	2		Walt Trotter	114	359175	4683901
Car-1	Carroll	N. Raccoon River	Lanesboro - 1.5 mi S	Lanesboro Rock Dam		Good	4	104	Carroll County Conservation Board	1256	359816	4668637
Car-2	Carroll	N. Raccoon River	Glidden - 5 mi NNE	Merritt Access Rock Dam		Good	4	100	Carroll County Conservation Board	1259	360880	4665143
Car-3	Carroll	N. Raccoon River	Glidden - 5 mi ENE	Bennett Access Rock Dam		Good	5	150	Carroll County Conservation Board	1344	363924	4662182
Car-4	Carroll	Middle Raccoon River	Coon Rapids - 1/2 mi N	Pasture Rock Dam		Fair	1			222	360298	4638944
Car-5	Carroll	Middle Raccoon River	Coon Rapids - E edge	Riverside Park Rock Dam		Good	3			223	361327	4637571
Cer-2	Cerro Gordo	Winnebago River	Mason City - NE part	Decker Dam		Gone	1	120	City of Mason City	499	484370	4779320
Chi-5	Chickasaw	Little Turkey River	Jerico - 5 mi E	Saude Park Rock Dam		Poor	2	40	Chickasaw County Conservation Board	38	567466	4782377
Cla-1	Clay	Little Sioux River	Spencer - W side	West Spencer Rock Dam		Poor	1	60	Wilson Cornwall	546	324406	4778469
Del-6	Delaware	Maquoketa River	Hopkinton (SW channel)	Hopkinton Dam - Main Channel	(portage)	Good	7	150	Delaware County	506	643547	4688742
Del-7	Delaware	Maquoketa River	Hopkinton (NE channel)	Hopkinton Dam - Side Channel		Good	4			506	643643	4689052
Dub-1	Dubuque	Little Maquoketa River	Sundown Ski Area	Sundown Rock Dam		Good	8			50	678555	4709672
Dub-5	Dubuque	North Fork Maquoketa R	Dyersville - N side	Second Street Rock Dam		Good	3			80	654262	4705688
Fay-3	Fayette	Volga River	Fayette - 1.5 mi E	Langerman's Ford		Fair	2	50		140	600357	4743625
Fay-5	Fayette	Otter Creek	Oelwein - 1/4 mi W	Red Gate Park Rock Dam		Good	3	75	City of Oelwein	33	587233	4725305
Gre-1	Greene	North Raccoon River	Rippey - 5 mi WNW	Squirrel Hollow Rock Dam		Good	4	140	Greene County Conservation Board	2027	392991	4645068
Gre-2	Greene	North Raccoon River	Churdan - 5.5 mi SW	Hyde Park Rock Dam		Good	4		Greene County Conservation Board	1552	369707	4663275
Gre-3	Greene	North Raccoon River	Jefferson - 4 mi W	McMahon Access Rock Dam		Good	3		Greene County Conservation Board or DNR	1596	377893	4653433
Gre-4	Greene	North Raccoon River	Jefferson - 1 mi S	Henderson Park Rock Dam		Good	3		Greene County Conservation Board	1619	386155	4649373
Gru-1	Grundy	Blackhawk Creek	Morrison - 1/2 mi N	Morrison Rock Dam		Poor	1	60	Grundy County Conservation Board	90	526686	4688530
Gru-2	Grundy	Blackhawk Creek	Reinbeck - N edge	Reinbeck Rock Dam		Good	2	75	City of Reinbeck	135	533099	4686651
Gru-5	Grundy	North Fork Blackhawk Creek	Dike - 5 mi SE	Lower North Fork Rock Dams						87	537097	4695776
Gut-4	Guthrie	Middle Raccoon River	Springbrook St Pk - W side	Springbrook Park Rock Dam		Good	2			385	377598	4625437
Har-4	Hardin	Iowa River	Eldora - SE part	Eldora Dam		Deter	2	160	City of Eldora	764	493249	4689522
Har-6	Hardin	Iowa River	Iowa Falls - SE side	Wastewater Plant Rock Dam		Good	3		City of Iowa Falls	677	479228	4707356
Has-2	Harrison	Little Sioux River	At mouth - W of I-29 bridge	Little Sioux Delta Sill Dams		Good	7		Corps of Engineers or DOT	3554	245638	4632737
How-1	Howard	Turkey River	Cresco - (Vernon Springs)	Vernon Springs Dam		Fair	8	150	Howard County Conservation Board	73	569837	4799746
Hum-3	Humboldt	[West Fork] Des Moines R	Humboldt	Water Plant Rock Dam		Good	3	200	City of Humboldt	2256	399836	4730589
Hum-4	Humboldt	[West Fork] Des Moines R	Humboldt	Humboldt Lower Rock Dam		Fair	2	200	City of Humboldt	2256	400034	4729534
Kos-1	Kossuth	E Fork Des Moines R	Algona - 2 mi N	Plum Creek Dam		Good	2	65	Kossuth County	876	401780	4773836
Kos-10	Kossuth	E Fork Des Moines R	Burt - 2 mi E & 2 mi S							641	403171	4780676
Kos-2	Kossuth	E Fork Des Moines R	Seneca - 1.5 mi N	Seneca Access Rock Dam		Poor		35		315	386671	4797301
Kos-4	Kossuth	E Fork Des Moines R	Algona	Algona Rock Dam		Good	2	60	State of Iowa	883	399379	4770331
Kos-5	Kossuth	E Fork Des Moines R	St. Joseph - 6 mi N	Highway 169 Rock Dam		Good	3	60	State of Iowa	937	400173	4761678
Kos-6	Kossuth	E Fork Des Moines R	St. Joseph - 2 mi N	Devine Wildlife Area Rock Dam		Good	2	80	Kossuth County Conservation Board	992	399399	4755750
Kos-7	Kossuth	E Fork Des Moines R	Bancroft - 1.5 mi WSW							350	399097	4792614
Kos-8	Kossuth	E Fork Des Moines R	Burt - 2 mi E & 2 mi N							447	404028	4786901
Kos-9	Kossuth	E Fork Des Moines R	Burt - 2 mi E	Patterson Rec Area Rock Dam		Good	3	60	Kossuth County Conservation Board	636	403989	4783266
2-Mar	Marshall	Iowa River	Marshalltown - NE part	Riverview Park Rock Dam		Good	3			1532	508670	4657431
4-Mar	Marshall	Minerva Creek	St Anthony - 4.5 mi N	Minerva Creek Rock Dam		Good				41	483891	4671013
Mit-11	Mitchell	Little Cedar River	Little Cedar	Little Cedar Rock Dam		Fair	2			110	522697	4803717
Mit-12	Mitchell	Little Cedar River	Brownsville/Pioneer Park	Brownsville Rock Dam		Fair	1			126	526118	4798562
Mit-6	Mitchell	Cedar River	Osage - 1.5 mi SW	Spring Park Beauty Dam		Fair	3			832	512099	4791305
Mit-9	Mitchell	Rock Creek	Osage - 4 mi SW	Quarry Rock Dam		Fair	8			55	510382	4784693
Mon-1	Monona	West Fork Ditch	Whiting - 6 mi. NE #5			Fair	4	20	Little Sioux Drainage Dist.	405	245892	4677424
Mon-10	Monona	Monona-Harrison Ditch	Onawa - 3.5 mi E							743	249943	4657525
Mon-11	Monona	Monona-Harrison Ditch	Onawa - 3.5 mi ENE			Good				741	248851	4660007
Mon-12	Monona	Monona-Harrison Ditch	Onawa - 3.5 mi NE			Good				740	248608	4662750
Mon-4	Monona	West Fork Ditch	Whiting - 5.5 mi ESE #1			Good	6	30	Little Sioux Drainage Dist.	604	248933	4665279
Mon-5	Monona	West Fork Ditch	Whiting - 5 mi E (#2?)			Fair	2			602	248038	4668227
Mon-8	Monona	Monona-Harrison Ditch	Onawa - 4.5 mi SE			Good				746	252073	4652678
Mon-9	Monona	Monona-Harrison Ditch	Onawa - 4 mi ESE			Good				745	251613	4656264
Mus-2	Muscatine	Mud Creek	Wilton - S edge	Wilton Junction Ford						99	665213	4604924
Pal-3		W. Fork Des Moines	West Bend- .35 mi W	Rock Rapids 3							375775	4757204
Ply-1	Plymouth	Floyd River	Le Mars - 1 mi N	Le Mars Rock Dam		Fair				320	241653	4745090
Sac-1	Sac	N. Raccoon River	Sac City - N edge	Sac City Rock Dam		Fair		60	City of Sac City	342	336364	4699021
Sac-2	Sac	N. Raccoon River	Sac City - 2 mi S Hagge Park	Hagge Park Rock Dam		Good		70	Sac County Conservation Board	697	336097	4694014
Sac-3	Sac	N. Raccoon River	Auburn - 1 mi NW Grant Park	Grant Park Rock Dam		Good		90	Sac County Conservation Board	844	343776	4680980
Sac-4	Sac	N. Raccoon River	Sac City - S edge	Sac City Access Rock Dam						355	336887	4696512
Sac-5	Sac	N. Raccoon River	Auburn - 4 mi NW	Whitehorse Access Rock Dam						833	343496	4684817
Sto-1	Story	Skunk River	Story City	Story City Dam	(portage)	Good		100	U.S.G.S.	180	451553	4670615
Sto-8	Story	Skunk River	Ames - 5 mi N & 2 mi E	Soper's Mill Rock Dam		Good	3		U.S.G.S.	260	452426	4661347
Van-1	Van Buren	Des Moines River	Bonaparte	Bonaparte Lock & Dam		Deter	4	390	City of Bonaparte	14118	600942	4505777
Web-3	Webster	Des Moines River	Lehigh	Lehigh Rock Dam		Fair	4	160	City of Lehigh	4335	413419	4690371
Wri-2	Wright	Boone River	Goldfield - 2.5 mi SW	240th Street Rock Dam		Deter	1	40	Abandoned	440	421910	4728149
Wri-8	Wright	West Branch Iowa River	NNW of Belmond	West Branch Rock Dams		Fair/Poor			NA	148	448920	4748619

Rubble Dams

Established portage around dam · Asian carp barrier · Known fatality # · Hydroelectric

Dam Map ID #	County	Stream	Location Description	Dam_Name	Special condition	Condition	Height (ft)	Length (ft)	Ownership	Drainage Area	X_UTMS	Y_UTMS
Cer-12	Cerro Gordo	Winnebago River	Wheelerwood	Wheelerwood Mill Dam	2	Deter	1		NA	436	475394	4785441
Cer-17	Cerro Gordo	Willow Creek	Mason City	Monroe Avenue Rock Dam		Fair			City of Mason City	103	482905	4777686
Cla-3	Clay	Little Sioux River	Spencer	Leach Park Dam		Fair	1		City of Spencer	990	326056	4778191
Emm-2	Emmet	[West Fork] Des Moines R	Estherville	Swinging Bridge Rock Dam		Fair	3	65	City of Estherville	1372	350674	4807334
Fay-6	Fayette	Crane Creek	Alpha	Johnson's Mill Dam		Poor	1			176	577546	4760841
Flo-7	Floyd	Cedar River	Charles City - St Mary's Park	Charles City Gaging Dam		Fair	1			1054	526601	4767758
Ham-4	Hamilton	Boone River	Webster City	Ice Plant Dam/Zubes		Deter	1	120	City of Webster City	790	433354	4702692
Ham-5	Hamilton	Boone River	Webster City - 2.5 mi S	Briggs Woods Gaging Dam		Fair	1	200	U.S.G.S.	844	433681	4698085
Ham-9	Hamilton	West Fork Skunk River	Jewell	Jewell Dam		Deter	1			66	447523	4684136
Har-5	Hardin	Iowa River	Iowa Falls - SE side	Woolen Mill Diversion Dam		Deter	1			677	479433	4707156
Has-6	Harrison	Little Sioux River	Little Sioux - 4 mi NE	Old Little Sioux Dam		Excel	16	220	Corps of Engineers	4441	251260	4638593
Lyo-4	Lyon	Blood Run Creek	Larchwood - 5 mi. NW	Blood Run Dam		Deter	1	50	Ronald Dubbelde	27	215592	4819733
Lyo-5	Lyon	Big Sioux River	Canton, SD	Canton Dam		Fair	4		City of Canton		208853	4799872
Lyo-7	Lyon	Rock River	Rock Rapids - City Park	City Park West Channel Dam		Good	2		City of Rock Rapids	789	243799	4813974
Mon-6	Monona	Monona-Harrison Ditch	Blencoe - 4 mi ESE			Good	4			764	251367	4642842
Mon-7	Monona	Monona-Harrison Ditch	Blencoe - 5 mi E			Good				759	252710	4647992
Pol-6	Polk	Raccoon River	Des Moines	Waterworks Park Rock Dam		Fair	3			3625	445301	4602080
She-1	Shelby	West Nishnabotna River	Harlan - SE edge	Harlan Waterworks Dam		Deter	1	65	City of Harlan	312	307265	4612847
Sio-1	Sioux	Floyd River	Hospers	Hospers Dam		Fair	3	38	City of Hospers	230	263052	4773095
Sio-2	Sioux	Floyd River	Alton	Alton Dam		Good	5	70	City of Alton	265	255083	4764072
Sio-3	Sioux	Big Sioux River	Hawarden	Hawarden Mill Dam		Poor		60	Sioux Co. Cons. Bd./City of Hawarden		215413	4767848
Tam-4	Tama	Iowa River	Meskwaki Settlement	Tama Hydraulic Diversion Dam		Deter	2			1872	529403	4647282
Web-9	Webster	Soldier Creek	Fort Dodge - 7th St	Seventh Street Dam		Fair	4		City of Fort Dodge	37	402081	4707415
Wib-1	Winnebago	Winnebago River	Forest City	Forest City Dam		Fair	4	60	City of Forest City	234	448811	4789872
Win-4	Winneshiek	Upper Iowa River	Kendalville	Kendalville Dam		Deter	2		Winneshiek County Conservation Board	273	577862	4810318
Win-5	Winneshiek	Turkey River	Spillville	Spillville Mill Dam		Deter	1			177	585231	4784441
Wri-3	Wright	Boone River	Eagle Grove - 2 mi SW	Sportsman Area Rock Dam		Fair	3	40	Wright County Conservation Board	499	423961	4720091
Wri-5	Wright	Iowa River	Belmond	Main Street Dam (Belmond)		Deter	3	40	City of Belmond	347	449538	4743917
Wri-7	Wright	Boone River	Eagle Grove - 2 mi NW	Three Rivers Trail Dam						454	421953	4725910

Rock dams. Dams consisting of loose rock have been contructed on various streams around the state to impound water, create stream crossings, or to improve fish habitat. This rock dam is at the Bennett Access on the Raccoon River.

Crossing dams. Various types of crossing structures impound water. Some may recirculate like low-head dams at certain flows. Other navigation hazards can arise, such as these culvert pipes on the Yellow River, where reported incidents of people being sucked through tubes rose after an innertube livery opened.

3 Dams and River Ecology

During the early 20th century, as dams became true fixtures in river systems, they created a series of bookends throughout many of Iowa's rivers, and between them, aquatic ecosystems were re-defined. Complex interactions may have favored some species over others. Like land-based species, aquatic species declined on Iowa's interior streams in short order after settlement. Reasons for declines were many, including overharvest in the clamming industry, massive volumes of topsoil inundating stream channels and valley floors, hydrological modification, and untreated sewage discharge. Dams interrupted long-standing migrations and seasonal movements of biota, and as species disappeared from a river segment, dams prevented recolonization that may otherwise have occurred.

During the Flood of 2008, many species moved up river over the 7-foot-high Scott Street Dam and over the 10-foot high Center Street Dam in Des Moines. Thousands continued partway up an emergency channel below the spillway at the Saylorville Dam where the spillway dam stopped further upstream progress. As waters receded and fish became locked in a pool, oxygen dwindled and most perished. Large catfish such as these were relocateed to the river. by DNR conservation officers.

Fish passage restoration

Some of the earliest dams constructed in Iowa created immediate controversy because the disconnecting effects on fish populations were not only dramatic, but had noticeable impacts on fishing. For example, when the McNutt's Dam was constructed downstream of Decorah, the May 18, 1880 issue of the Decorah Republican reported: "Perhaps 'millions' is an exaggeration, but the numbers were so large that there was no skill whatever necessary to secure a wagon-load in a very short time. One party became so satiated with catching with a hook and line that they threw back into the river anything smaller than two pounds. Big pickerel and three or four pound bass were plentiful." Citizens the same year complained that stocking allocations were not large enough. Black bass were seined from Mississippi River backwaters and transported by rail to Decorah. Similarly during the late 1800s, Des Moines poet and outdoorsman Tacitus Hussey went on an unsuccessful campaign to have a fish ladder installed at the Bonaparte Dam on the lower Des Moines River to improve fishing in Des Moines. Eventually, a flood took out the entire dam, solving the issue. In 1877, State Fish Commissioner B.F. Shaw wrote: " The plan of building mill-dams now in vogue in Iowa makes the structures a barrier to the passage of fish to the sources of the rivers in spawning season." Eventually, new dams were required to install fishways.

While Iowa Code required fishways, the prevailing design worked primarily for salmon and trout. Midwestern native species used them sporadically at best. Understanding the physiology of native fish is important. Salmonids, such as salmon or trout, migrate long distances and up mountain streams. As a result, they evolved with an ability to leap up small waterfalls to access spawing waters. Midwestern species could access hundreds of thousands of miles of streams without such leaping abilities.

Recent research shows virtually all native Midwestern fish species exhibit movement for a variety of reasons, including accessing overwintering habitat, accessing feeding habitat, predator avoidance, avoiding adverse stream conditions and reproduction. Scores of rapids conversions and dam removals in Minnesota and Wisconsin have shown many species, including small, non-game fish, in downstream segments have quickly colonized upstream segments (Katopodis; 2006). The only known Iowa-native species that migrates as a life-cycle requirement is the American eel, which live its adult life in large, mud-bottomed rivers and moves via the big rivers to the Gulf of Mexico and into the Atlantic ocean east of the Bahamas to spawn. Dams likely restrict the eel's range in Iowa, but it is not considered threatened (Mayhew). Native game fish species are known to bunch up at dams around spawning time, providing angling opportunities. Fish attempt to access various feeding zones during different growth stages. Spawning often occurs in Iowa's smallest streams to help their young avoid predators. Cool-water species such as northern pike, smallmouth bass, and trout move into tributary streams, stream headwaters, or near spring sources for thermal refuge during hot summer periods. Access to refuge areas is also important when an unintended chemical or manure spill occurs, or when periods of poor water quality conditions such as low oxygen, exist in a given segment. During high water, some small dams submerge and create temporary connectivity, while some of the tallest dams are always barriers. As dams submerge, large numbers of fish can typically be observed attempting to move up rivers and streams.

Today, 206 dams on Iowa streams with watershed sizes meeting the 2010 dam inventory criteria are classified as dams that block native fish passage. Some of these block fish passage at all times, or nearly always. Figure 3-b shows total observed species for river segments between dams, and this map forms the study area for biological connectivity. It should be noted that the inventory, review, and plan considers only dams on major streams, primarily down to 50 square mile watersheds. Smaller watersheds include thousands of additional dams and culvert crossings that block fish passage, and lack of access to headwater streams may be a serious constraint biological productivity. Others block fish passage for a significant time during a normal growth season. Minor dams that submerge very frequently were not considered fish passage obstructions.

More extensive movements

Extensive movement of Iowa fish documented in Iowa fish, including brook trout, channel catfish, flathead catfish, paddlefish, lake sturgeon, muskellunge, sauger, smallmouth bass, walleye, and white bass. The largest known paddlefish on record was a 198 pound fishspeared in Lake Okoboji in 1916; the paddlefish is now extirpated from the Okoboji lake system, . The lake sturgeon, also know as "rock sturgeon" through tagging studies is known to move more than 1,000 miles and Missouri Department of Conservation has stocked them in species recovery efforts and tagged lake sturgeon moved as far Lock and Dam 19 at Keokuk on the Mississippi River, and the Gavins Point Dam on the Missouri River in South Dakota (St. Pierre, 2004). Dams are considered a major limiting factor in the recovery of this endangered species. Iowa's only remnant lake sturgeon populations exist Iowa border in the Mississippi River, with some likely use of lower segments of major tributaries (Mayhew, 1987). Walleye and channel catfish have been studied extensively on the Turkey, Iowa, and Mississippi rivers in Iowa using radio telemetry on tagged individuals. They exhibit frequent movements, with major movements toward deep water areas for over-wintering (Gelwicks, 2008).

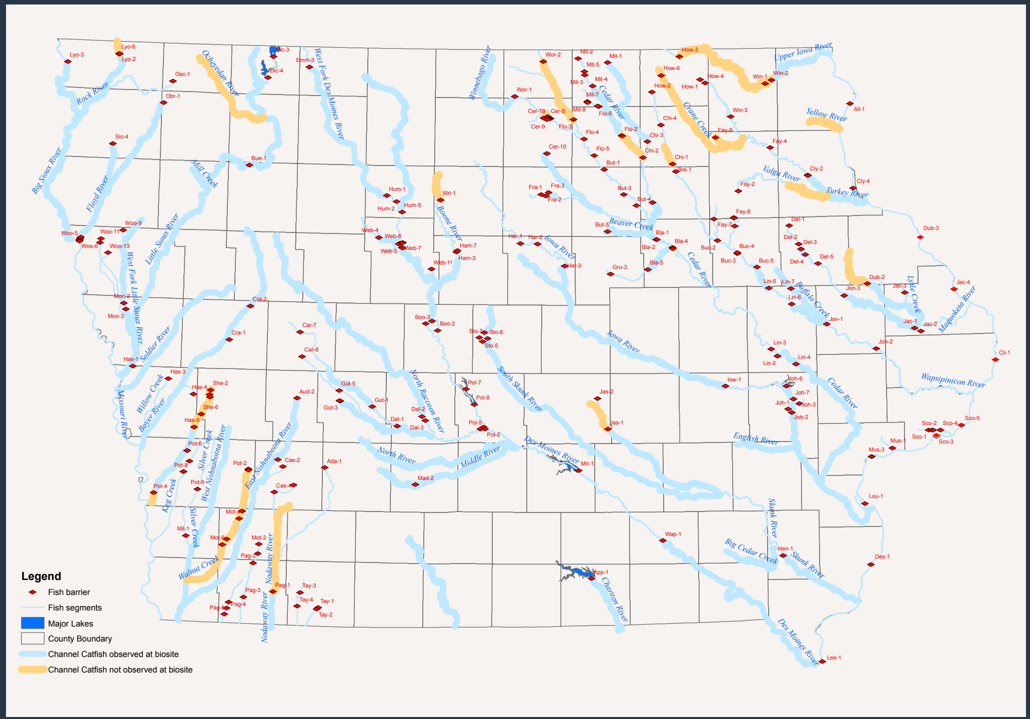
General benefits

Improved connectivity for fish, in general, leads to broader benefits which may include more robust game fish populations, reduced risks for threatened and endangered species, and speedier fish growth (Wisconsin DNR, 2010). Impounded areas upstream of

Potential channel catfish recovery areas

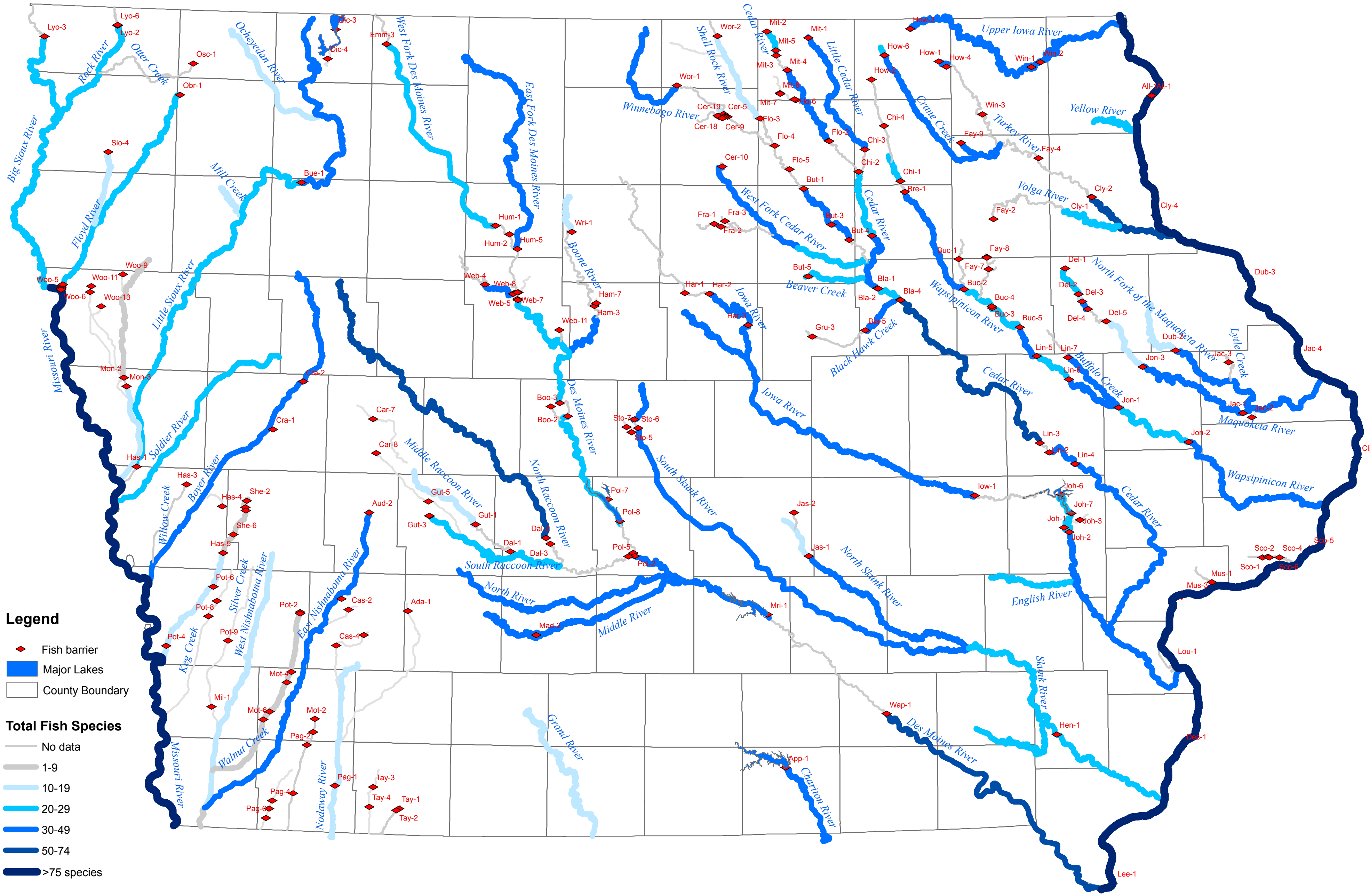
An important gamefish, the channel catfish, is not always found in stream sampling where it otherwise would be expected. In those reaches, they may be under population duress, or may have been extirpated. Channel catfish appear to be highly dependent on deepwater overwintering habitat. They are known to move long distances upriver during warm months when connectivity exists, and tend to move downstream to the nearest deep water (Gelwicks, 2008 Powerpoint presentation). This deep-water seeking habit in the past may have resulted in channel catfish moving downriver over dams, with no ability to return upstream of the dam. Areas with channel catfish downstream, but not upstream, of a dam were identified as segments where angling opportunities for this popular gamefish may be restored.

Figure 3-a: Segments with No Channel Catfish Observed At Monitoring Site



dams tend to favor generalist species such as common carp and green sunfish and replace more specialized species such as smallmouth bass, northern hog suckers, and various darters that are closely associated with coarse substrates and flowing water. Dam removal can restore flow and increase levels of dissolved oxygen in these areas. In cases were the substrate is rocky but overlaid by silt, species such as carp may be replaced by species such as smallmouth bass (Wisconsin DNR). As areas with greater species diversity are connected to segments with less diversity, both segments tend to benefit (Aadland).

Figure 3-b. Presence and absence of fish species analysis from combined datasets.



Mussel restoration efforts

Native mussels are intimately connected with fish and fish migrations. Known to many Iowans as clams – they may be of increasing popular interest to Iowans as they learn more about their habits and life cycle. Mussels reproduce and spread their young, called glochidia, via fish hosts through an astonishing variety of means. Some, such as the pocket-book mussel, have modified mantle tissue that serves as a fish "lure," which attracts fish near. It then sprays glochidia, some of which attach to the fish gills and move to new waters where the fish will spawn. Others wait with shells open in ambush. When a small fish like the logperch that forages by dislodging pebbles gets too near, the mussel clamps down and holds the small fish, injecting it with glochidia. (Barnhart, 2008)

Iowa's mussels filter feed on tiny organisms such as phytoplankton and bacteria. (Heidebrink, 2002). A typical mussel can filter several gallons of water a day, and some can filter up to 10 gallons per day. If they are not overwhelmed with sediments, healthy mussel beds can clarify water and filter bacteria (Machtinger, 2007).

About 12 species of mussel supported a post-settlement button industry beginning in 1891. By 1910 there were 70 factories centered in Muscatine, employing 3,376 Iowans for a total product value of $4 million in 1910, equating to about $90 million today. However, the economic boon for eastern Iowans rapidly decimated mussel populations. As early as 1898, mussels had to be imported from Missouri and Illinois because of "overfishing, made worse by pollution, depleting the supply of oxygen in the rivers" (Annals).

In recent years, the story of mussels has been one of declining populations and potential extirpation of a number of species from Iowa. Unfortunately, they fall victim to a variety of today's stresses on streams. Stressors may include excessive and overly frequent channel scour events that re-locate the animals to inopportune places or bury them under sediments, exessive nutrients or low dissolved oxygen, and an inability to re-polulate after events such as chemical spills. Mussels of greatest conservation need are identified in the Iowa Wildlife Comprehensive Plan.

GIS modeling was used to compare fish host and mussel presence datasets to indicate study areas for recovery (Figure 3-c) and potential re-colonization of mussels identified as species of greatest conservation need (SGCN). An attempt was made to examine segments upstream of dams where both mussels and known fish hosts (Kurth, 2009) had not been sampled, but had been sampled in a segment downstream of the dam. Data was insufficient to find examples. In lieu of this, for calculating scores for biological priority (see Appendix C), proximity of SGCN mussels sampled near dams was used for prioritization. Sample sites for mussels are not as extensive or geographically balanced as they are for fish, but the map does outline areas worthy of consideration. If a dam is being considered for a fish passage project, additional mussel sampling should be conducted within the project scope. In the future, study is needed to verify that fish hosts and their glochidia take advantage of access to upstream reaches. In addition, the immediate project area should be surveyed for mussels by a qualified professional to ensure that various species under population decline are not disturbed in the project area.

Aquatic threatened and endangered species and river connectivity

In addition to mussels, a number of fish species are also imperiled, and have been determined by state and federal authorities to warrant listing as a threatened and endangered species. Iowa administrative code (571—Chapter 77.2) defines animal species to be endangered, threatened or of special concern.

State threatened and endangered species include:

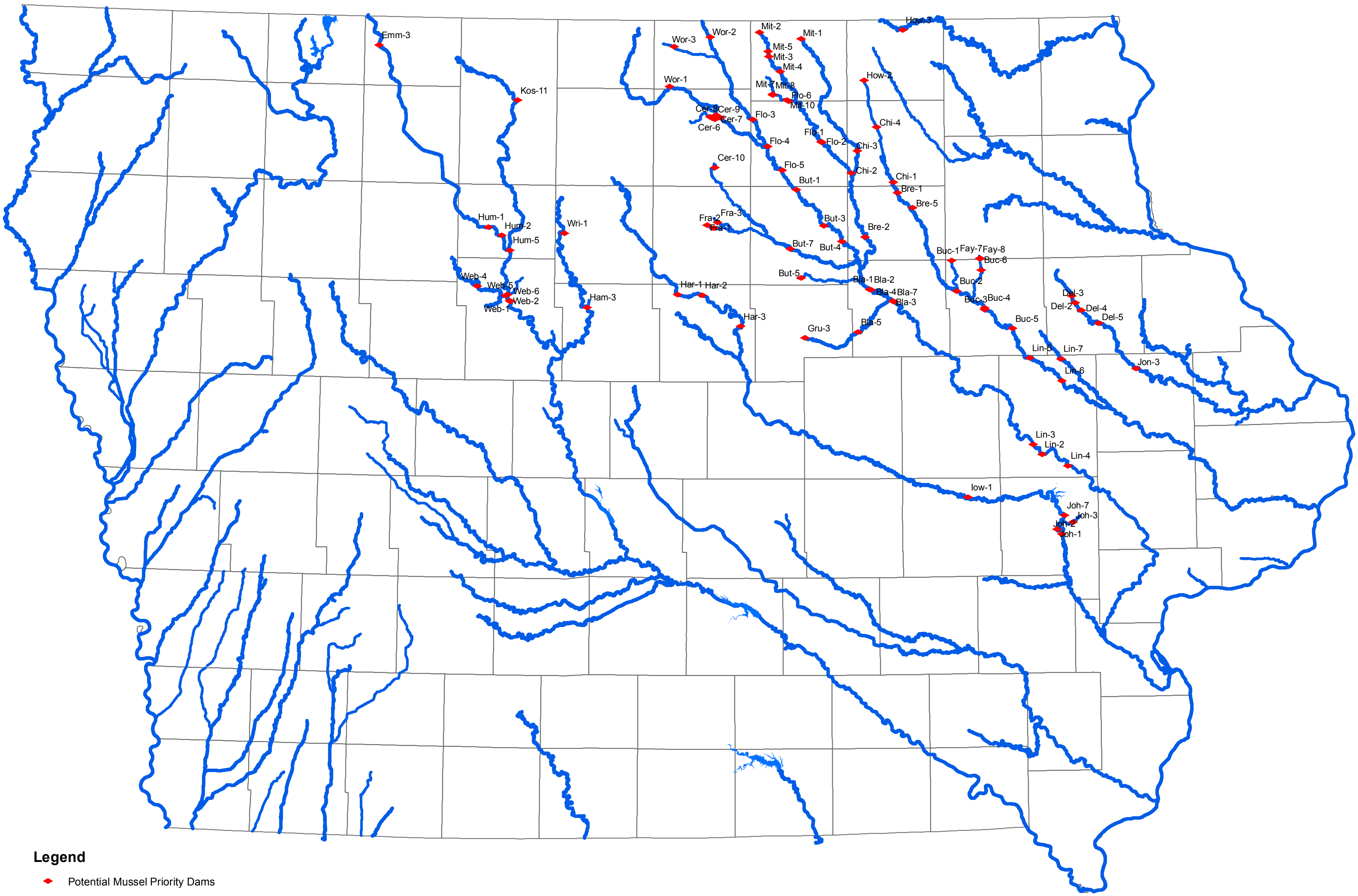
Common Name	Scientific Name	Iowa Abun.	Iowa Trend
Elktoe	*Alasmidonta marginata*	U	D
Slippershell	*Alasmidonta viridis*	R	D
Flat floater	*Anodonta suborbiculata*	R	D
Cylinder	*Anodontoides ferussacianus*	R	D
Rock pocketbook	*Arcidens confragosus*	U	D
Spectacle case	*Cumberlandia monodonta*	R	D
Purple pimpleback	*Cyclonaias tuberculata*	R/X	D
Butterfly	*Ellipsaria lineolata*	U	K
Spike	*Elliptio dilatata*	U	D
Ebonyshell	*Fusconaia ebena*	R	D
Ozark pigtoe	*Fusconaia ozarkensis*	X	X
Higgins' eye pearlymussel	*Lampsilis higginsi*	R	D
Yellow sandshell	*Lampsilis teres anodontoides*	R	D
Slough sandshell	*Lampsilis teres teres*	R	D
Creek heelsplitter	*Lasmigona compressa*	R	D
Fluted shell	*Lasmigona costata*	R	D
Pondmussel	*Ligumia subrostrata*	X	NA
Hickorynut	*Obovaria olivaria*	U	D
Bullhead (Sheepnose)	*Plethobasus cyphus*	R	D
Round pigtoe	*Pleurobema sintoxia*	R	D
Monkeyface	*Quadrula metanerva*	U	D
Wartyback	*Quadrula nodulata*	U	D
Strange floater (Squawfoot)	*Strophitus undulatus*	R	D
Lilliput	*Toxolasma parvus*	R	D
Pistolgrip	*Tritogonia verrucosa*	R	D
Fawnsfoot	*Truncilla donaciformis*	R	D
Pondhorn	*Uniomerus tetralasmus*	R	K
Paper pondshell	*Utterbackia imbecillis*	R	D
Ellipse	*Venustaconcha ellipsiformis*	R	D

Iowa Abundance: A = abundant, C = common, U = uncommon, R = rare, K = unknown, X = possibly extirpated.

Iowa Trend: K = unknown, I = increasing, S = stable, D = decreasing.

Table 3-a: Mussel Species of Greatest Conservation Need, status and trend.

Figure 3-c. Dams on river segments with potential for species of greatest conservation need and mussel recolonization.



Legend

Potential Mussel Priority Dams

Iowa endangered fish

Lake Sturgeon (*Acipenser fulvescens*), Pallid Sturgeon (*Scaphirhynchus albus*), Pugnose Shiner (*Notropis anogenus*), Weed Shiner (*Notropis texanu*), Pearl Dace (*Semotilus margarita),* Freckled Madtom (*Noturus nocturnus*), Bluntnose Darter (*Etheostoma chlorosomum*), Least Darter (*Etheostoma microperca*)

Iowa endangered fresh water mussels

Spectacle Case (*Cumberlandia monodonta*), Slippershell *(Alasmidonta viridis),* Buckhorn (Tritogonia verrucosa)

Ozark Pigtoe (Fusconaia ozarkensis), Bullhead *(Plethobasus cyphyus)*, Ohio River Pigtoe *(Pleurobema sintoxia)*, Slough Sandshell,*(Lampsilis teres teres)*, Yellow Sandshell *(Lampsilis teres anodontoides)*, Higgin's-eye Pearly Mussel *(Lampsilis higginsi)*.

Iowa threatened fish:

Chestnut Lamprey *(Ichthyomyzon castaneus),* American Brook Lamprey *(Lampetra appendix),* Redfin (formerly "Grass") Pickerel *(Esox americanus)*, Blacknose Shiner *(Notropis heterolepis)*, Topeka Shiner *(Notropis topeka)*, Western Sand Darter *(Ammocrypta clara)*, Black Redhorse (Moxostoma duquesnei), Burbot *(Lota lota)*, Orangethroat Darter *(Etheostoma spectabile)*.

Iowa Threatened Fresh water mussels:

Cylinder *(Anodontoides ferussacianus)*, Strange Floater *(Strophitus undulatus)*, Creek Heelsplitter *(Lasmigona compressa)*, Purple Pimpleback *(Cyclonaias tuberculata)*, Butterfly *(Ellipsaria lineolata)*, Ellipse *(Venustaconcha ellipsiformis)*.

Iowa fish of special concern:

Pugnose Minnow *(Notropis emiliae), Pirate Perch (Aphredoderus sayanus)*,

In addition, there are three federally endangered aquatic species in Iowa: pallid sturgeon, Topeka shiner, Higgin's eye mussel. As these species are priorities for federal recovery efforts, US Fish and Wildlife Service is likely to collaborate in species recovery involving fish passage targeted to benefit these species. Two additional mussels, the sheepnose (Plethobasus cyphyus) and the spectacle case (Cumberlandia monodonta), are candidates for federal listing.

Special care should be used in dam-related projects not to damage habitat for these listed species as projects are constructed. But overall, improved river connections, longer segments between obstructions, and more diverse habitat than in existing river impoundments are likely to result in benefits for these species.

Aquatic life impairments

A number of reaches of river in Iowa have been monitored to detmermine whether they support heathly populations of aquatic species. These may include specific listed species, they may document a decline in existing species, or they may indicate a segment is less diverse than would be expected of a more natural reference reach. If they do not attain the aquatic life uses they are designated to support, they are added to Iowa's Section 303(d) listing of impaired streams for waters. The U.S. Environmental Protection Agency requires such lists from all states to comply with Section 303(d) of the federal Clean Water Act.

Iowa DNR can remove segments from this listing when credible data can show designated uses are being attained. In some cases, carefully targeted dam mitigations may be able to help achieve this over-arching goal of removing listings. Using GIS coverages, impaired segments were visually compared to areas where a series of dams exists along rivers. A number of segments were identified where (Figure 3-d) dam mitigationpriorities may overlap with de-listing of a section. Where priorities overlap, there is a potential for collaboration with the Iowa DNR's federally funded Section 319 watershed improvement program.

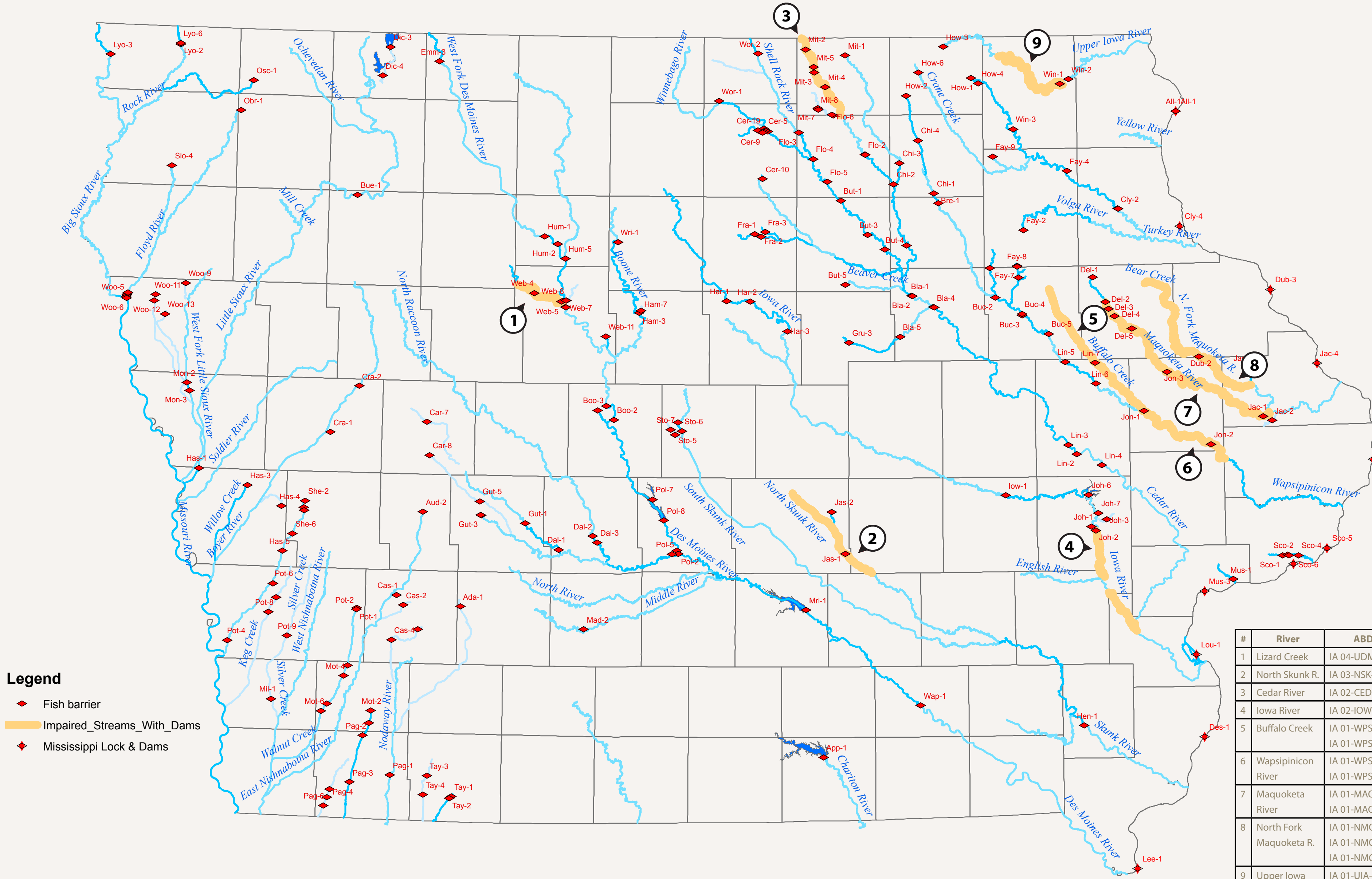
Invasive species priorities

While many factors discussed above favor connectivity, dam mitigation projects should not be assumed to automatically be of general benefit to river ecosystems. Invasive animals in Iowa's streams present a clear and present danger that can quickly displace native species.

Asian carp – preventive dams

A consensus item among U.S. Fish and Wildlife Service staff, Iowa DNR fish management biologists, and IDNR Aquatic Invasive Species (AIS) staff is that certain dams should receive a great deal of scrutiny, research, and planning before a fish-passable connection is re-established to the Mississippi River, the Missouri River, or an Asian-carp- infested interior stream. Generally, these are the tallest dams (generally 10 feet or greater with infrequent submergence) that are farthest downstream on a river. Asian carp, including big head (*Hypophthalmichthys* nobilis) and silver carp (*Hypophthalmichthys molitrix*) are known to inhabit the Mississippi River, Missouri River, and

Figure 3-d. Iowa's section 2009 303(d) listed segments impaired for aquatic life, compared with dams that block biological connectivity.



#	River	ABD Codes
1	Lizard Creek	IA 04-UDM-0300_1
2	North Skunk R.	IA 03-NSK-0020_2
3	Cedar River	IA 02-CED-0110_3
4	Iowa River	IA 02-IOW-0020_1
5	Buffalo Creek	IA 01-WPS-0130_1 IA 01-WPS-0130_2
6	Wapsipinicon River	IA 01-WPS-0010_4 IA 01-WPS-0010_5
7	Maquoketa River	IA 01-MAQ-0060_2 IA 01-MAQ-0060_3
8	North Fork Maquoketa R.	IA 01-NMQ-0140_0 IA 01-NMQ-0141_0 IA 01-NMQ-0010_2
9	Upper Iowa River	IA 01-UIA-0120_1 IA 01-UIA-0110_2 IA 01-UIA-0110_3

lower portions of southeastern and southern Iowa rivers. Grass carp are widespread in many Iowa rivers, and while hardly desirable are currently not viewed as having the destructive effects of bighead and silver carp. This exotic species may put additional strain on native species as its filter-feeding habits may interrupt the food chain. This can, in turn, can lead to increased pressure on threatened and endangered fish and mussel species, and Iowa's species of greatest conservation need. It has also led to economic damage to commercial fishing and sport fishing. In addition, silver carp tend to both school together and leap at disturbances, including noise of motors, splashing of canoe paddles, or hands of innertubers, resulting in fish projectiles sailing through the air. Because silver grow to several feet long, they can collide with people recreating, and can quickly ruin recreation on lakes, impoundments, and slow-moving rivers.

Some dams (Figure 3-e) will be considered low priority for state funds involved in projects leading to fish passage, and may not be recommended for permits during the fish and wildlife review processes. Exceptions will be provided for projects that can improve safety without improving upstream passage for big head or silver carp and projects that have been subjected to rigorous review outlined by the US Fish and Wildlife Service and/or Iowa DNR Fisheries bureau. If both big head and silver carp are determined to be upstream of the barrier, it will no longer be subject to the same level of review.

At certain dams, ecological benefits of fish passage may outweigh the negative expected effect of Asian carp. Connectivity to the Mississippi and Missouri rivers can be highly beneficial to a river's overall diversity of species. If it can be reasonably determined that the upstream area would not provide favorable habitat for Asian carp and that economic damage is likely to be minimal or low, a fish passage project could potentially be considered after rigorous scientific vetting. In any such exception, close coordination among DNR AIS staff, local fisheries management and central office fisheries staff, and US Fish and Wildlife Service staff will be critical. Certain streams may have natural conditions that limit dominance of Asian carp, but factors are not yet well understood and cannot be considered predictive. However, the body of research appears to be growing. In the future biologists may be able to make determinations about which rivers Asian carp would negatively affect the most.

Actions

1) Iowa DNR River Programs staff will coordinate with Iowa DNR AIS staff to keep a current coverage of infested segments and dams that appear to block upstream progress of Asian carp.
2) As dam mitigation projects are developed by communities, sovereign lands permit applications will be routed to fisheries, AIS, and river programs staff for review.
3) Hazard retrofits (see Alternative H in Chapter 4) provide a method of retrofitting dams deemed hazardous that are not wise to mitigate for fish passage due to the dam's ability to block the spread of Asian carp. The project should be approved by AIS staff before proceeding.

Zebra mussels

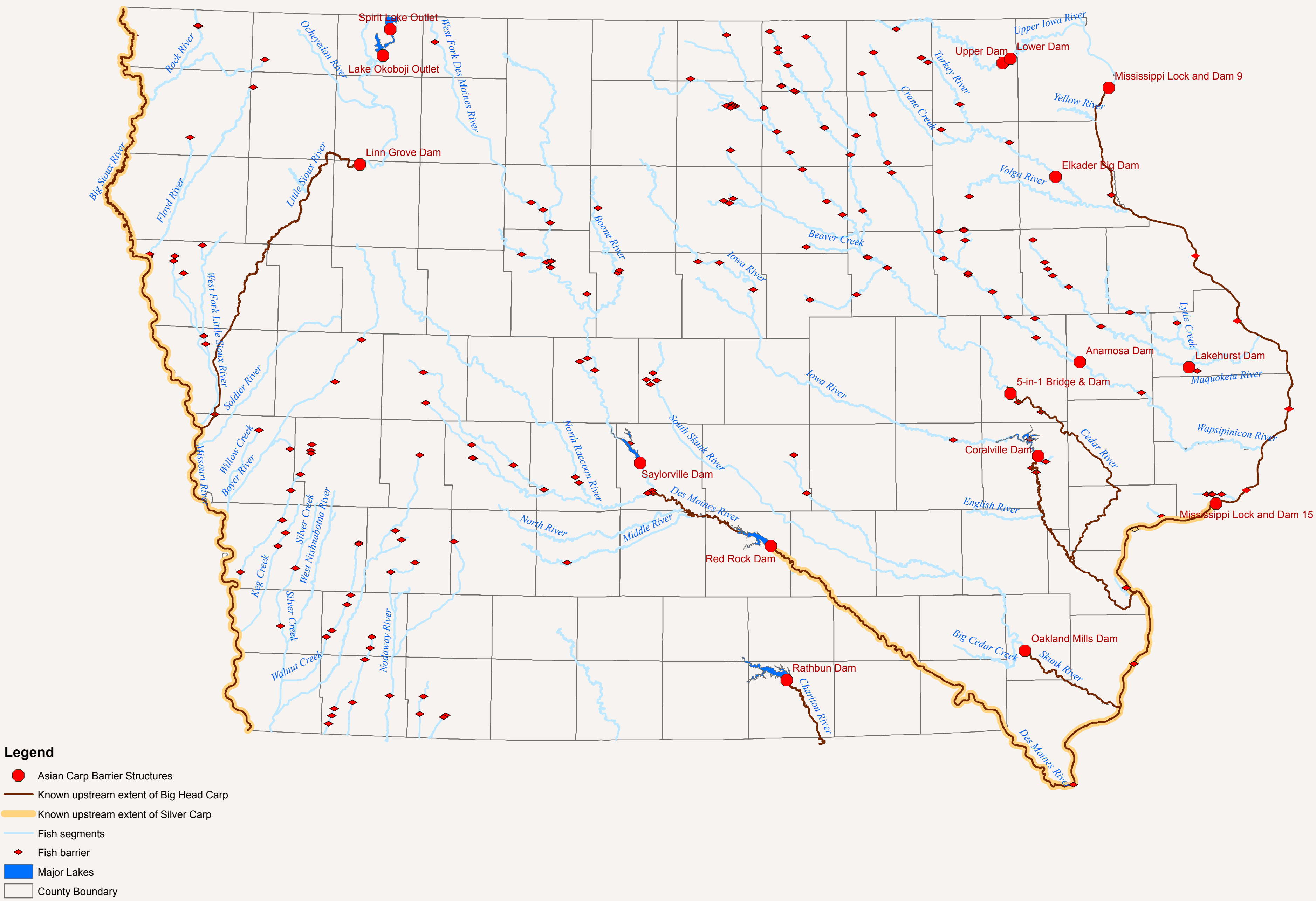
The zebra mussel (*Dreissena polymorpha*) is another invasive species which can cause both harm to native ecosystems and economic damage. Issues related to dams are very different, however, due to a different type of life cycle. In lakes or impoundments, zebra mussels rapidly spread over any hard surface available, including native mussels.

Asian carp barrier dams

Dams in Figure 3-e are considered sufficiently tall to slow progress of Asian carp where they have not yet spread upstream to date. The image to the right illustrates how prolific and damaging silver carp can be to an impoundment.

Most dams listed in this chapter are not effective barriers to persistent Asian carp, especially in light of apparent increases in frequency and severity of floods in recent years. Any dam that becomes submerged will begin passing fish, and the chance of temporary or permanent damage increases during severe floods. Asian carp – especially silver carp with their ability to leap – may be better equipped to quickly take advantage of such conditions than native fish. In the case that established populations of silver and bighead carp are observed upstream of a dam, input from DNR biologists may remove a dam from the list and add a new dam to the list that is further upstream. If technologies, such as introduced parasites, introduction of sterile fish to the gene pool, or other ways to effectively limit Asian carp dominance become available in Iowa, many of the issues may be rendered moot.

Figure 3-e. Dams likely to slow upstream infestation of silver and big head carp.

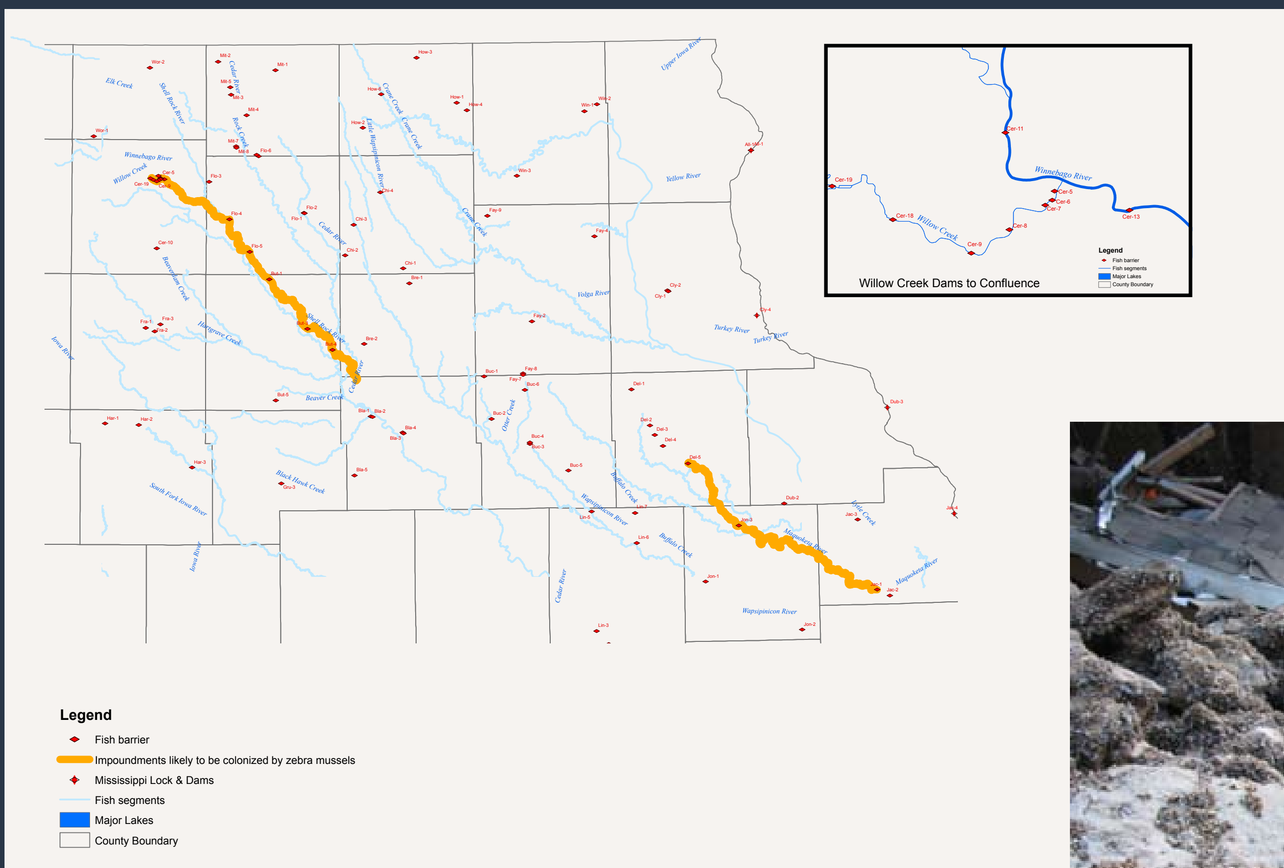


Excessive zebra mussel colonization of native mussels can lead to mortality among native mussels. However, unlike native mussels which colonize upriver by using fish hosts, exotic zebra mussels produce immense quantities of young, waterbourne zebra mussels called “veligers” that can quickly spread throughout lakes and impoundments. These veligers can also drift down rivers. Swifter water may help destroy the veligers as they move downstream, while impoundments provide locations where it is more likely veligers may drop out of the water column and begin colonies.

Currently in the interior of Iowa, zebra mussels are known to infest one natural lake, Clear Lake, and one river impoundment, Lake Delhi. Water from Clear Lake feeds Willow Creek, which flows into the Winnebago River, which flows into the Shell Rock River, which flows into the Cedar River and eventually the Iowa. Because Willow Creek and the Winnebago River are naturally rapids streams, it may be that removal of several unused dams, if there is little social value to the dams, could have positive benefits on slowing the downriver spread of zebra mussels.

Lake Delhi was an impoundment on the Maquoketa River that was heavily infested with zebra mussels prior to its breach in 2010 (see image below). A dam directly down-stream, Mon-Maq Dam, is currently undergoing alternative analysis in a community effort, due to flooding problems that may in part be caused by the dam and an associated dike. While it is unlikely the zebra mussel issue will become a primary local driver to drive outcomes such as thes dams, considering ways to slow the speared of zebra mussels should be considered.

Figure 3-f examines impoundments downstream of the two zebra-mussel infested waters in Iowa’s interior, for potential overlapping priorities. Where dam projects otherwise have movements, removal will be encouraged as a preferred option to potentially reduce downstream spread of zebra mussels.



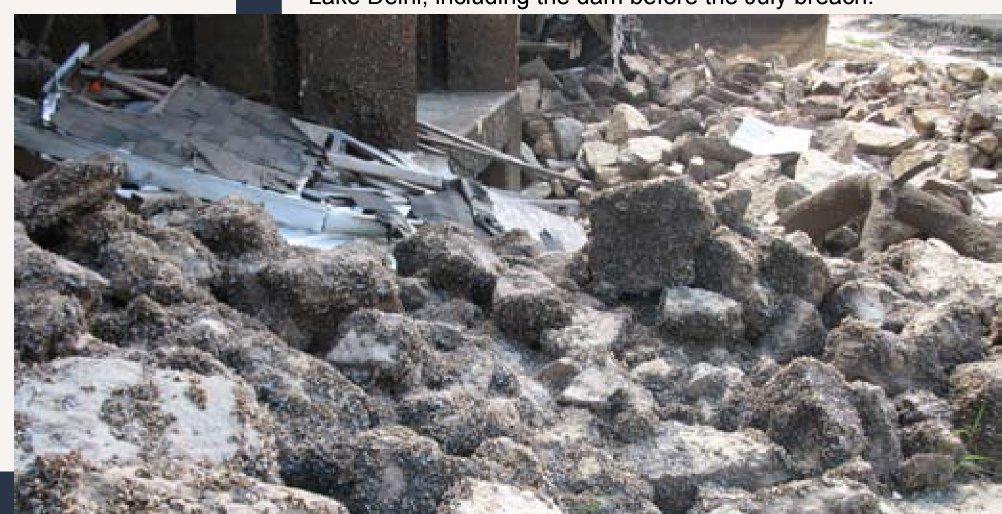
Actions

1) Where dams with little remaining social value coincide with zebra mussel priorities, high biological priority shall be given to removal of structures and restoration of free-flowing water.

2) Collaborations among USFWS, DNR aquatic invan-sive species program, and Iowa DNR 319 program will be sought in support of such projects.

3) Where dams are failing, ensure the public is pre-sented with a full range of alternatives that include biological connectivity.

Zebra mussels blanketed all hard surfaces beneath Lake Delhi, including the dam before the July breach.



4 Mitigation Alternatives

Some dams have remaining purposes. Others do not. Some were built as mills, utility protection, or for water supply functions. Some were constructed for softer purposes, such as "beauty" dams to create what at the time were considered aesthetically pleasing flat pools of water. As dam infrastructure deteriorates, large investments may be required to create stable structures. Many communities are evaluating which needs their dams still serve, and how that relates to the cost of reconstruction. This chapter presents several alternatives being employed in various situations across Iowa and the Midwest.

Choices in dam mitigation are often presented in black and white: dams are “removed” or “saved.”

A personal watercraft rider(above) inspects a new rapids (right) that shored up the Vernon Springs Dam on the Turkey River near Cresco. This allowed fish to pass into the impoundment, created new habitat, and elminated the dam’s “drowning machine” effect.

Evaluating shifting demands, reconstruction and maintenance costs, original functions, current functions, and a host of available mitigation techniques yields a more honest set of choices that can be tailored to given conditions. Given the remaining key functions required in a community, perhaps the most useful questions to ask include: Can the needs be accomplished with inherently safer structures and flood reduction? Can the cost be reduced? What benefits to aquatic species may be reaped?

Stream restoration concepts in dam mitigation

Stream restoration professionals were consulted in the development of this plan, and a training that applied restoration concepts to dam problems included DNR and Iowa State University engineering, river programs, watershed improvement, and landscape archtiture staff. A salient take-away message tools was that a primary focus on dam removal as an approach to dam mitigation sets up a false choice. In fact, in some cases, dam removal may not be desirable unless issues in the former impoundment are addressed in tandem. Naturalistic structures that improve safety and reclaim stream functions can replace many locally desired functions of dams with fewer negatives. An example common to several completed or ongoing functions is the “rock arch rapids” approach replacing water supply, grade stabilization, or impoudment functions of a dam. The project results in public safety improvements and reconnects the fishery.

Removal of dams accompanied with appropriate bed stabilization and stream restoration in the former impoundment can prove beneficial for communities needing major changes. In areas where homes or businesses are flooding near the impoundment, reducing the height of the dam can reduce flood frequency. Where a formerly recreational lake-type impoundment has filled with silt, and can be predicted to do so again in the future, a community’s eyesore and biologically unproductive impoundment can become a floodplain rich with trails, scenic native vegetation, and angling opportunities in a restored river. These types of shifts in recreational amenties can initially seem jarring for a community, but appear to provide a high benefit-cost ratio.

Engineered mitigation approaches

A number of engineering solutions exist to solve specifc problems, and many of them were considered in literature review for this plan. Alternatives G, H, and I include retrofits that may be useful in some very specific applicatons such as flood protection constraints, the need to maintain Asian carp barriers or hydro-electric facilities, or where dams are very wide or very tall. Other engineered approaches, in consideration of State of Iowa priorities in technical assistance and funding, tend not to solve as many public problems.

For example, a style of hinged gate controlled by air bladders can be installed after the height of a dam is reduced or to replace existing gates. If the mechanism fails, it hinges downward into the position that reduces flooding. While certainly useful, other problems outlined in Chapter 1 remain. Some communities with a vested interest in impoundments can certainly benefit from knowing more about engineered solution. However, state funding for these types of approaches is discouraged, as they tend to focus on local problems (sediment flushing, flood reduction, etc.) with un-studied success rates, while ignoring challenges common to the state’s navigable streams, including public hazard reduction, fishery success, overall stream health, and navigational connections. While conventional engineering approaches can solve specific problems, they do not address most of the issues outlined in Chapter 1d, and require long-term maintenance.

Focusing on a single problem on waterbodies used by the public can present more serious problems. For example, during the 1960s, the “roller bucket” style of dam grew in prominence in engineering plans because of its ability to dissipate energy (Christodoulou, 1993). An unfortunate side effect was that dams became more effective drowning machines.

Alternatives A through F are more holistic approaches that mitigate the dam across the entire width of the river. Typically, those approaches will be considered the preferred solutions, unless other factors make them unreasonable. •

Additional resource

More information on project approaches and processes using natural channel design principles can be found in the 2010 book “Reconnecting Rivers: Natural Channel Design in Dam Removals and Fish Passage,” written by Minnesota DNR stream restoration specialist Luther Aadland. It can be accessed online at this Web site:

http://www.dnr.state.mn.us/eco/streamhab/reconnecting_rivers.html

Alternative A: Dam removal with river restoration, profile view

Creating aquatic habitats, floodplains, and recreational / fitness zones

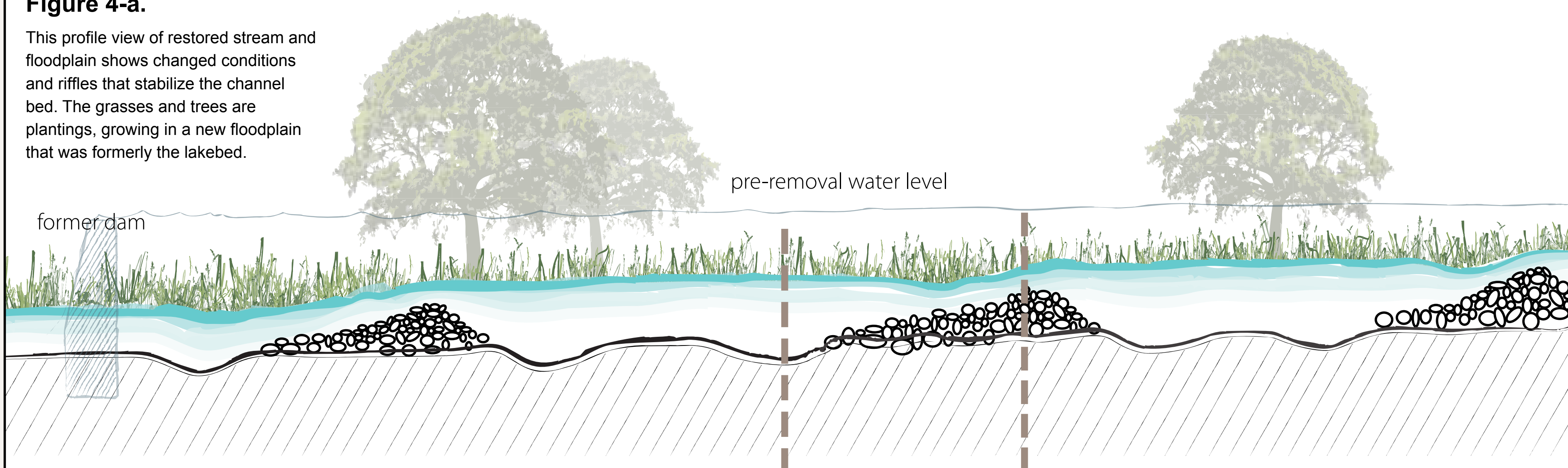
If a community tires of maintaining an aging dam for an impoundment which has decreased in quality over the years, a promising alternative can be to consider stream and floodplain restoration after the impoundment de-watered. A restored floodplain can become a park or natural area restored with native grasses, trees, and wildflowers, and provide a convenient area to develop new pedestrain or biking trails.

River impoundments often have significant community identity associated with them. Restoring a former impoundment bottom into community green space can be viable only when a community can agree it is a necessary next step. A common scenario may lead a community toward this option. Many dams are nearing their life cycle end. Damaged gates, which can be costly to replace, often precipitate local discussions about the sense of investing in a dam that may soon fail in other ways.

Certain impoundments on major rivers—especially wide, lake-like impoundments—have a frustrating tendency to fill regularly with layers of silt or sand. Some Iowa streams transport large loads of sediments even during minor floods. With a current understanding of stream systems and Iowa watersheds, lakes with ground watershed to lake surface ratios of less than 50:1 are considered restorable with watershed treatments and dredging by the Iowa DNR lake restoration and watersheds program. Lakes with greater than a 100:1 watershed to lake surface areas are considered infeasible for restoration due to sediment loads from uplands and stream channels that are impossible to control. This plan focuses on dams on streams with watersheds larger than 50 square miles with lakes in varying states of sedimentation. Wide impoundments tend to accumulate uniform silt or sand botoms, and slow velocities can provide nutrient rich water a favorable environment for algae. Periodic algael blooms may reduce dissolve oxygen. Combined, these factors tend to reduce macro invertebrate and mussel populations, which may in. Some impoundment environments favor a few "generalist" species such as carp capable of living in such an environment. All these factors can limit water quality.

Figure 4-a.

This profile view of restored stream and floodplain shows changed conditions and riffles that stabilize the channel bed. The grasses and trees are plantings, growing in a new floodplain that was formerly the lakebed.



Alternative A (continued): Dam removal with river restoration, plan view

Restoring a former impoundment to a community asset

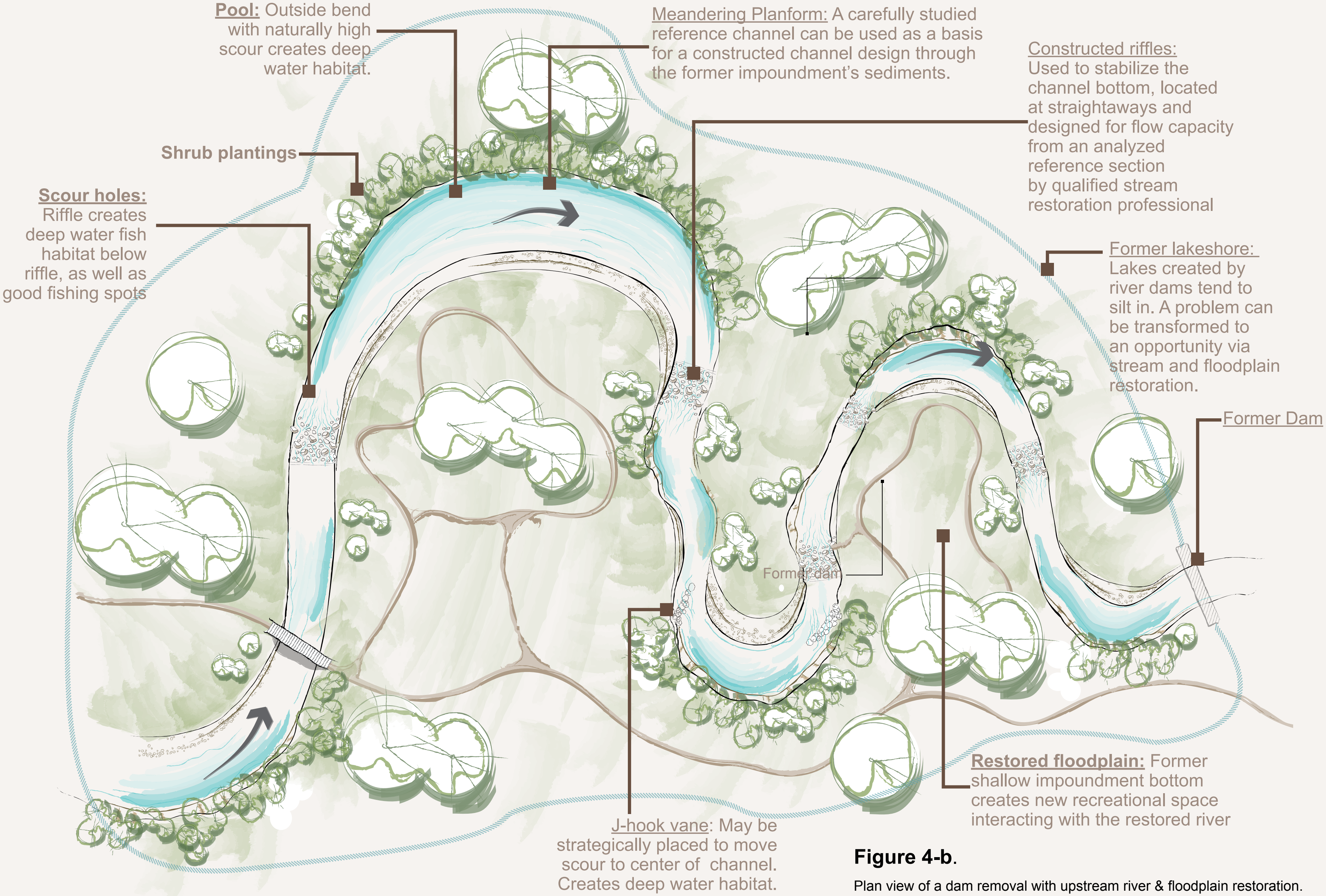


Figure 4-b.

Plan view of a dam removal with upstream river & floodplain restoration.

Alternative A (continued): Dam removal with river restoration, cross section view

Restoring a former impoundment to a community asset

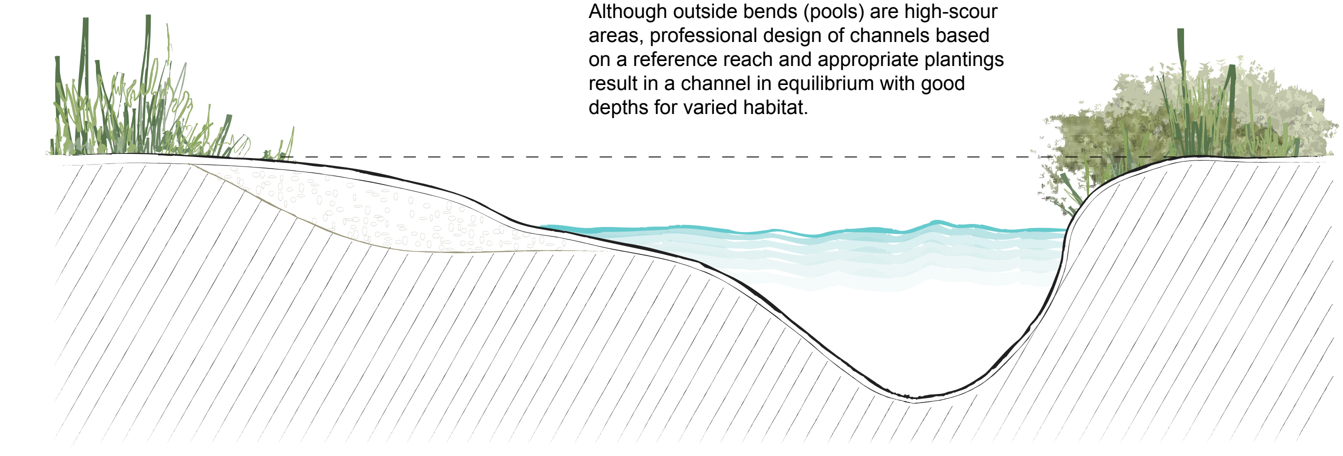


Figure 4-c.
Although outside bends (pools) are high-scour areas, professional design of channels based on a reference reach and appropriate plantings result in a channel in equilibrium with good depths for varied habitat.

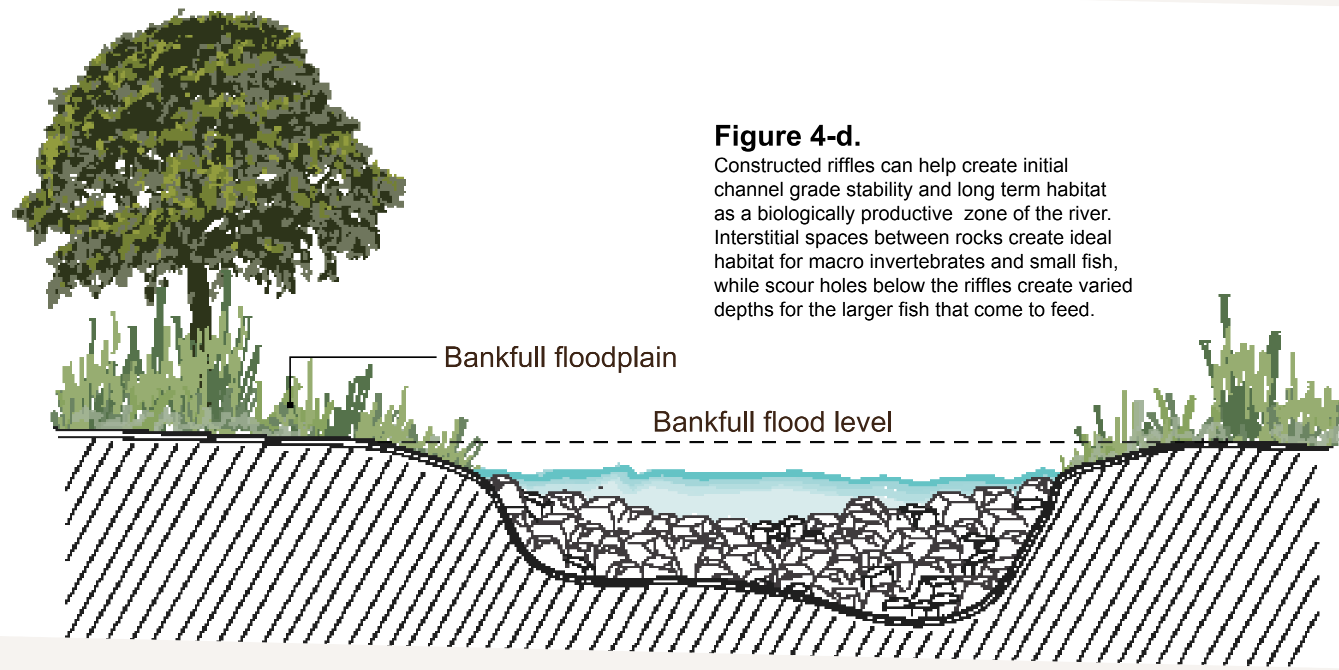


Figure 4-d.
Constructed riffles can help create initial channel grade stability and long term habitat as a biologically productive zone of the river. Interstitial spaces between rocks create ideal habitat for macro invertebrates and small fish, while scour holes below the riffles create varied depths for the larger fish that come to feed.

Removed. A dam removal project with limited river restoration needs began in late 2010 on the Yellow River in Allamakee County.

Alternative B: Rock ramps

Rock ramps create a sloping mass of loose stone downstream of a dam, and are sometimes used as an alternative to removing dams. They offer benefits of breaking up recirculating currents, eliminating the "drowning machine" effect, and can also provide an aestheically pleasing replacement feature in a community. Stability and maintenance can be a problem when this type of structure is not designed by a stream restoration professional.

Rock arch rapids

Appropriately designed rock arch rapids have proven to be remarkably resilient structures on various streams across the Midwest after monitoring through major floods. It has more recently been employed in several Eastern rivers. This style of design was originally developed by Luther Aadland, a Minnesota DNR stream restoration specialist. The rock arch rapids places careful emphasis on material quality, channel capacity, sizing, quantity, slope, and placement. It also incorporates arching buttresses of large boulders that create a riffle-pool sequence. Long-term monitoring data available documenting its permformance makes this the preferred method when a rock ramp is determined to be the most suitable project. This structure can also replace a dam's function, if needed.

Grouted rock rapids

Due to poor availabilty of adequate size and hardness of stone in portions of Iowa, grouting -- injecting masonry mix into gaps between stones -- may be considered in some cases. Design parameters of the rock arch rapids should still be considered in design. This type of design will require future maintenance, as grout may crack over time, allowing undersized materials to separate and move.

Figure 4-e.
Rock arch rapids, plan view.

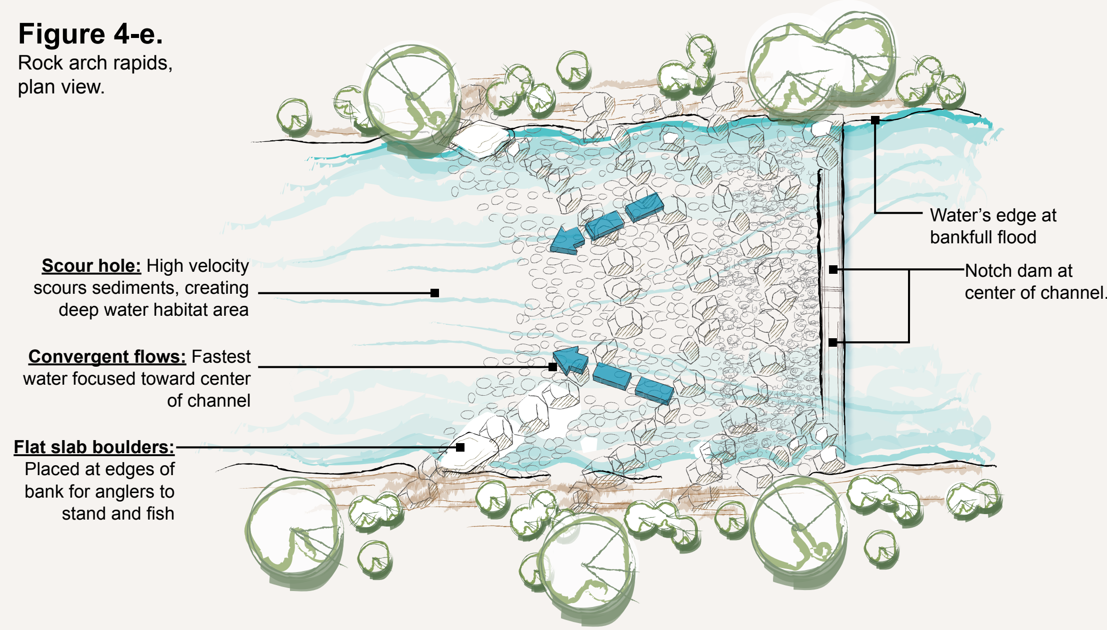
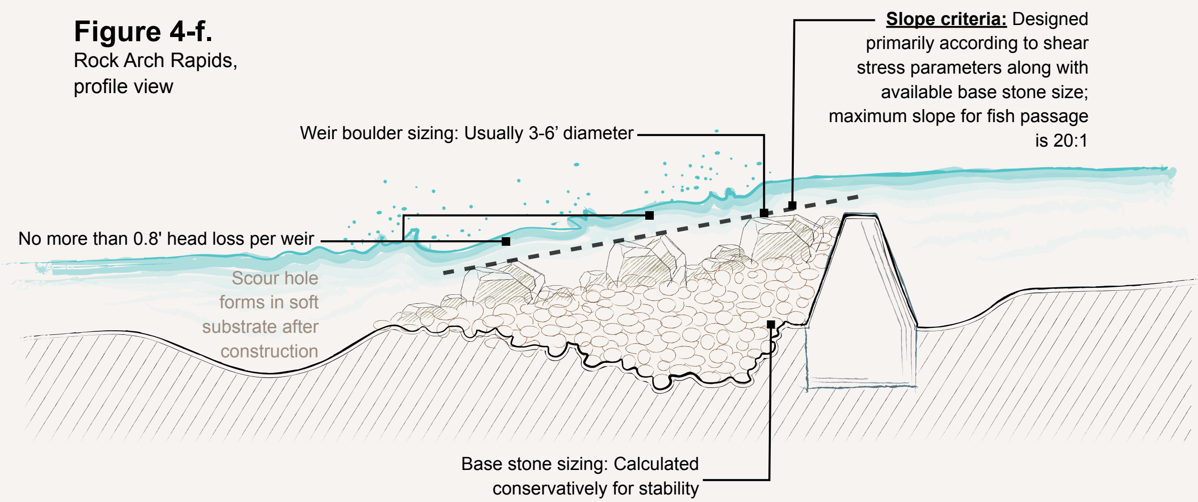


Figure 4-f.
Rock Arch Rapids, profile view

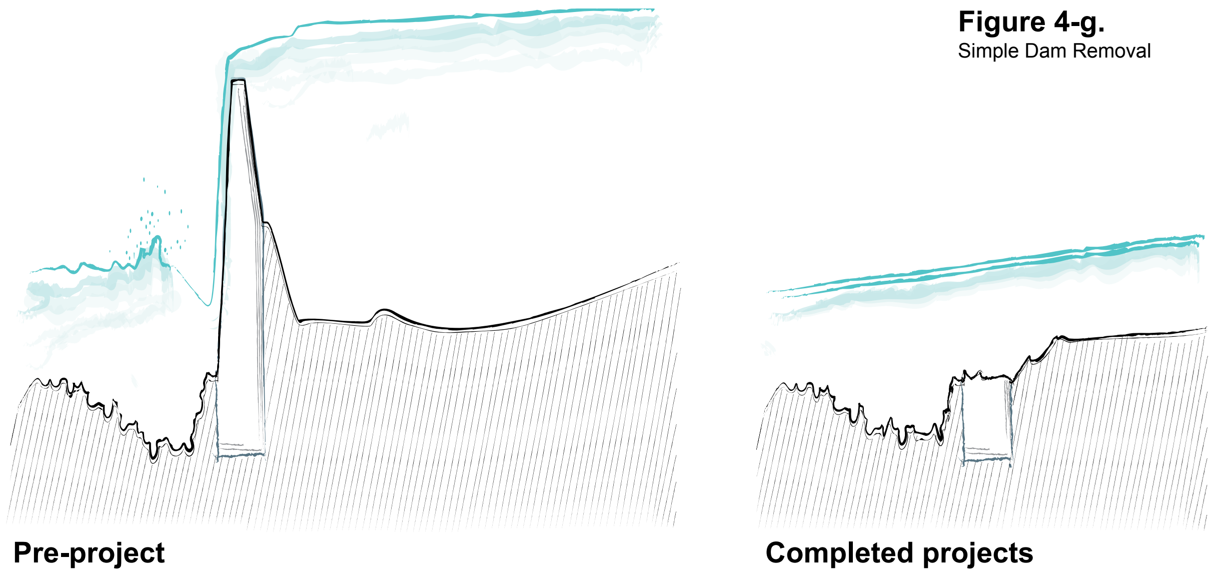


Alternative C: Simple dam removal or staged dam removal

Certain dams can be physically removed without additional restoration. Low dams with narrow impoundments or dams that have been breached for several years are the best candidates. In all cases, the impoudment needs to be carefully studied for potential release of sediments and compared to the river's annual sediment transport rate.

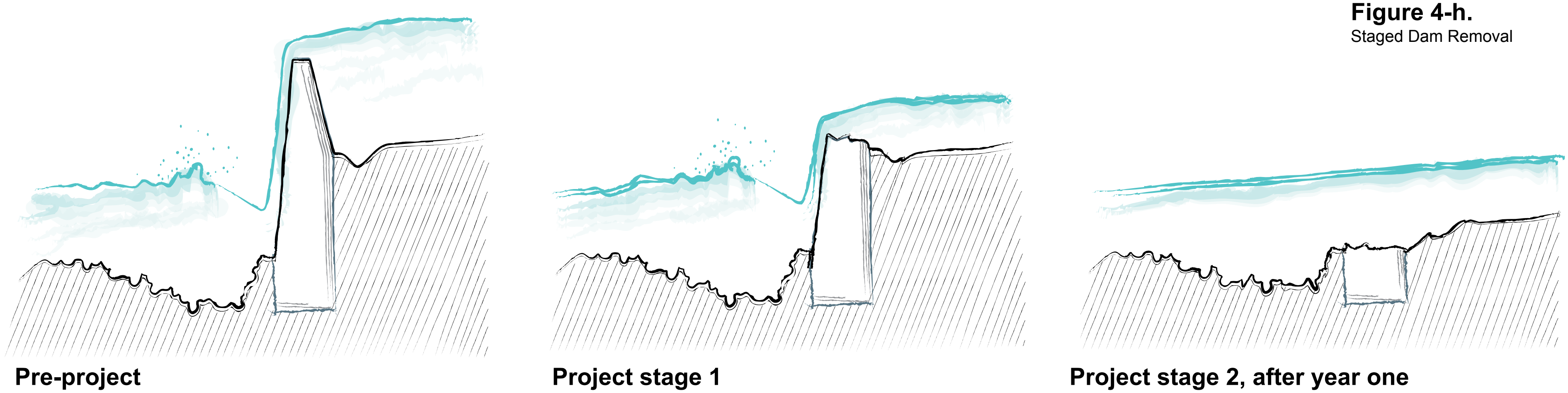
If volumes are significant, analysis of sediment for toxic contaminants may also be required in permits to assess potential harm to aquatic life downriver if sediments were released.

Figure 4-g.
Simple Dam Removal



Simple dam removal: As is implied, the dam is removed to the natural river bed level in one step. This is only an option at where survey and analyis shows limited sediment release not expected to harm aquatic life downstream

Figure 4-h.
Staged Dam Removal



Staged dam removal: The top section of a dam is lowered by a prescribed number of feet over a lenght of time, usually years, in order to control volumes of sediment released in a single event (Morris & Fan). Similar effects can be created by breaching the dam, or leaving existing gates open for a long period of time to gradually release sediments.

Alternative D: Recreational attractions

Several national engineering firms design highly recreational structures that can transform an old dam into an amenity for both locals and tourists, and add to an overall attractive setting. These can range from a mildly adventurous section of water friendly to children on innertubes (right) to a highly technical Olympic whiteater course, such as one constructed in Wausau, Wisconsin.

Construction of the first Iowa example began in Charles City in the fall of 2010 funded by local hotel / motel taxes, Iowa DNR's low-head dam public hazard program, and Iowa Great Places funding. Note in the photograph (FIGURE 4-j) that a portion of the channel is smooth and steep-sloped. That portion of the channel will provide a recreational wave for surfing by kayaks or river surf boards.

Recreational Makeover. Recreational chutes, pools, and boulders replaced a low-head dam, as hazard for innertubers in San Marcos, Texas. The area reamains popular for innertubing, with added swimming and kayaking opportunities.

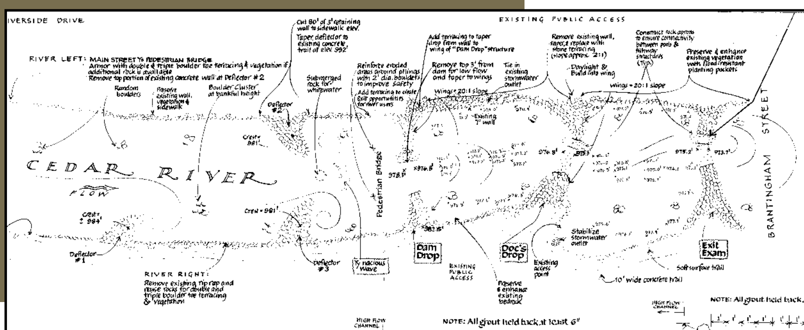


Figure 4-i. The design (Recreational Engineering and Planning) for the Charles City whitewater park uses large natural quarry boulders with grouting injected betwen them in a series of freestanding weirs. The project will result in similar features to the San Marcos park (photos, above).

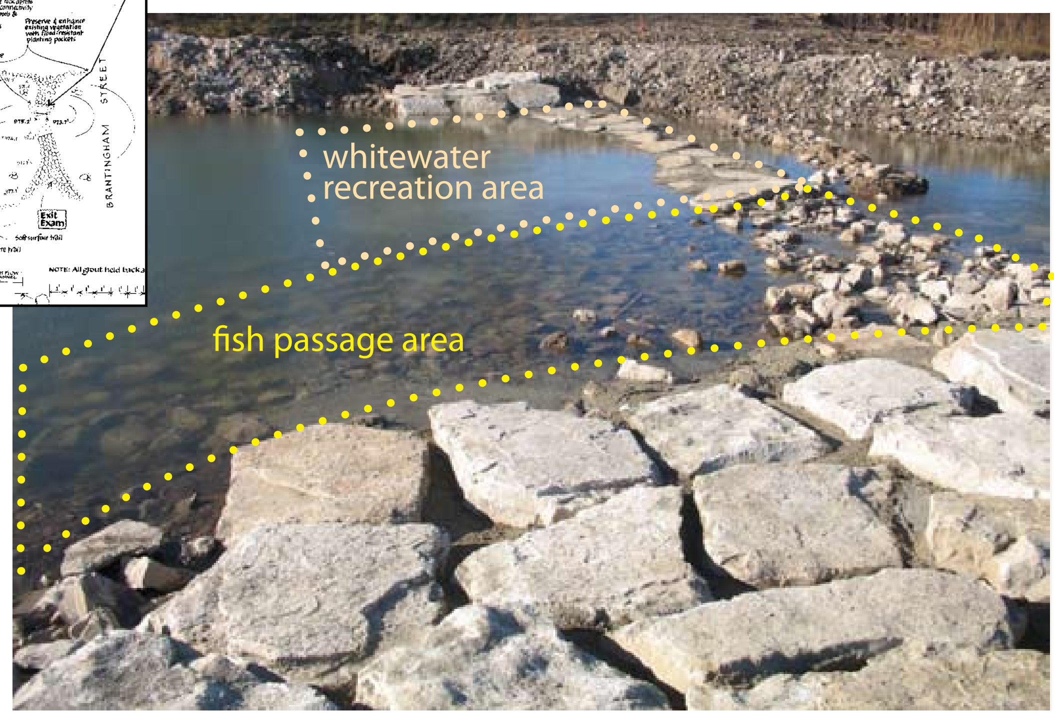


Figure 4-j. Iowa Code 481A.14 requires new in-channel stuctures to provide fish passage. Fish passage is a key for both mussels and fish to access various portions of streams. The roughened, gently sloping portion of the channel at the Charles City whiteater park is designed to maintain velocities and flow patterns fish can use to work up the rapids.

Alternative E: Height reduction with rock ramp

Fully removing a dam is oftentimes neither necessary or desirable. Too much sediment may be released, or the dam owner may not be in control of the upstream area for restoration to occur. At the same time, applying the rock arch rapids design to tall structures can be cost prohibitive or technically infeasible. Lastly, rock arch rapids do not address impoundment problems such as low dissovled oxygen, fine sediment accumulation, and sediment transport interruptions.

Some advantages of stream restoration can be realized in this balanced approach. Reducing the height of a dam can begin to normalize sediment transport while reducing project cost. The bulk of sediments can become a bankfull floodplain across much of the former impoundment bed. However, the channel will likely be wide and shallow until vegetation becomes well established on its own. This may take years or even decades.

Height reduced. The height of the Hopkinton Dam was reduced, with a riffle installed downstream, similar to the Figure 4-l.

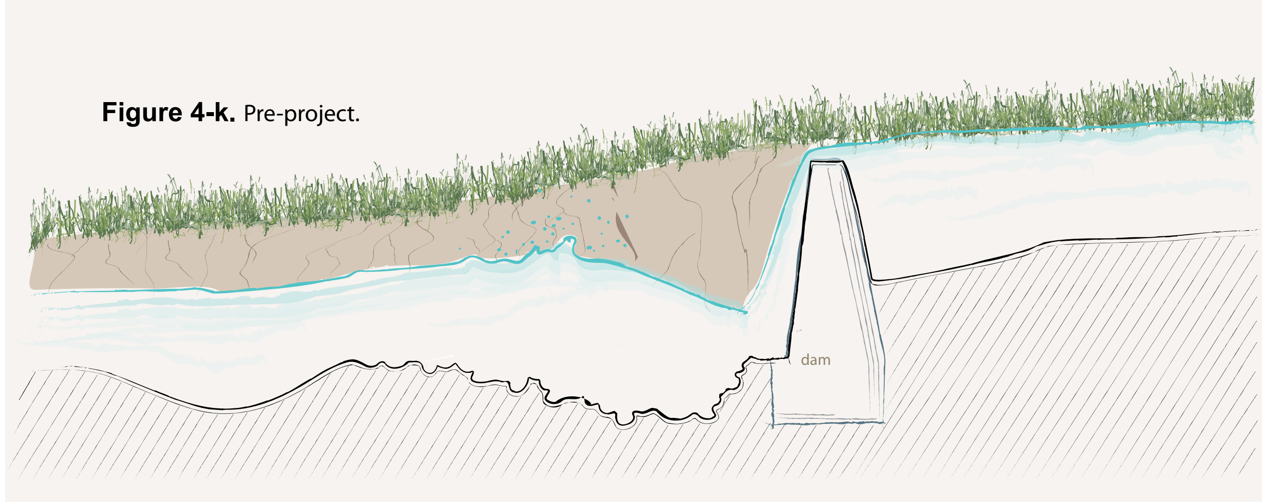


Figure 4-k. Pre-project.

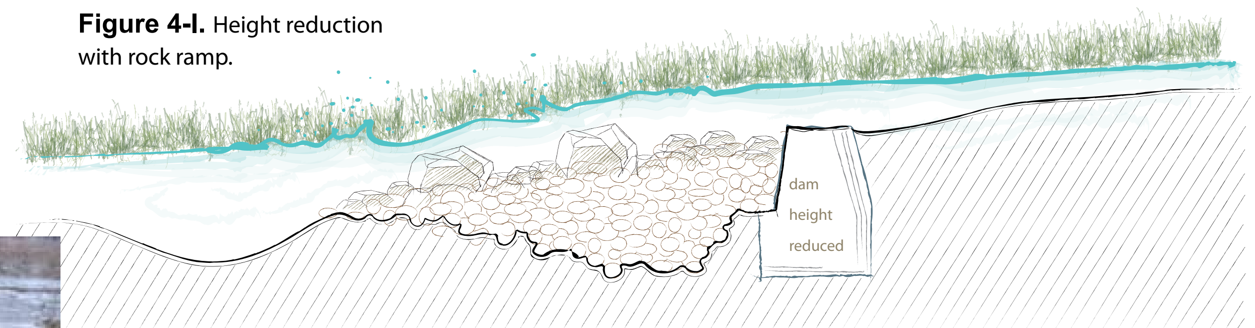


Figure 4-l. Height reduction with rock ramp.

Alternative F: Replacing a dam with a rock-arch rapids

When a pool needs to be maintained for infrastructure reasons, but the dam is not in the optimal position for rock sizing and slope considerations, a dam's impounding function can be replaced by a free-standing rock arch rapids. A 4:1 backslope becomes necessary.

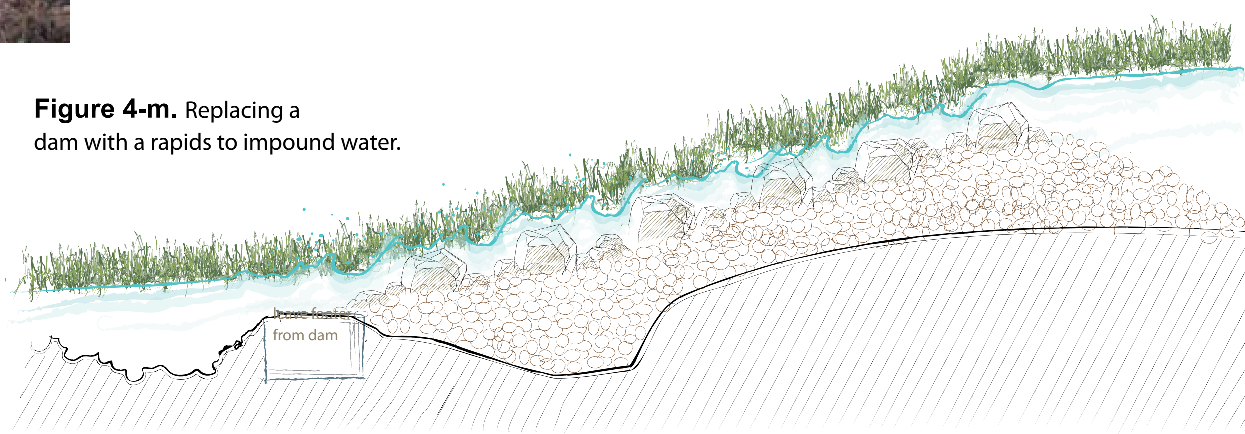


Figure 4-m. Replacing a dam with a rapids to impound water.

Alternative G: Hazard retrofits

Structures that do not enhance fish passage, but are likely to reduce fatalities by breaking up recirculating hydraulics, may play a role in several situations. Figure 3-d in chapter 3 shows dams where fish passage is biologically undesireable because these dams play a role in preventing invasive Asian carp from moving upriver. In other cases, where rivers are wide and dams will be retained, safety-only treatments may be considered for part of the channel width alongside fish and boat passage chutes and side channels.

Step dams

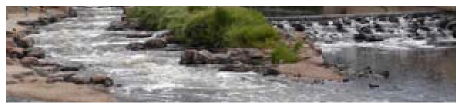
Step dams (Figure 4-n) have been used across North America as a way to reduce recirculating hydraulics. They have probably reduced drownings, but may not be 100 percent effective. Rock structures that disrupt uniform flow patterns may be more successful at dissipating hydraulics than uniform concrete construction. Installing step dams can be fairly costly, and don't offer additional benefits.

Trailing vanes and floating slides

Recently developed engineering techniques can reduce the "roller hydraulic" effect of dams and leave a dam intact by installing adjustable or self-adjusting slides and vanes (Figures 4-o, 3-p). These may be more cost effective than step dams in some situations. However, these new technologies have not been broadly applied and field tested.

Alternative H: Partial channel chutes

A chute uses a portion of the width of a dam to convert it into either a fish passage, boat chute, or both. It requires a wall be constructed to divide the chute from the main channel. Unlike preceding mitigation approaches desribed, it does not reduce hazard across the entire width of a dam. Because it also draws recreation close to the dam, it should be paired with a hazard retrofit from Alternative G. Expense of the combined approaches mean this alternative will likely be deployed at wide dams in urban settings.



Chute with step dam. Denver's Confluence Park has an example of partial channel chute (boating). The remainder dam of the dam was retrofitted into a step dam for safety reasons.

Alternative I: Side passages

Side channel passages, also known as diversions, require excavation of a small channel around the dam. They have been used both for fish passage and boat passages in Europe and North America. Some communities developing whitewater courses prefer this method because flows to the diversion can be controlled. Burried utilities and development near dams can make this approach a challenge, and it tends to be one of the most costly approaches. In addition, it does not remove the hazard. Fish sometimes have a difficult time finding the mouth of the fish passage for migration, because they are attracted to the louder noise of water spilling over the dam.

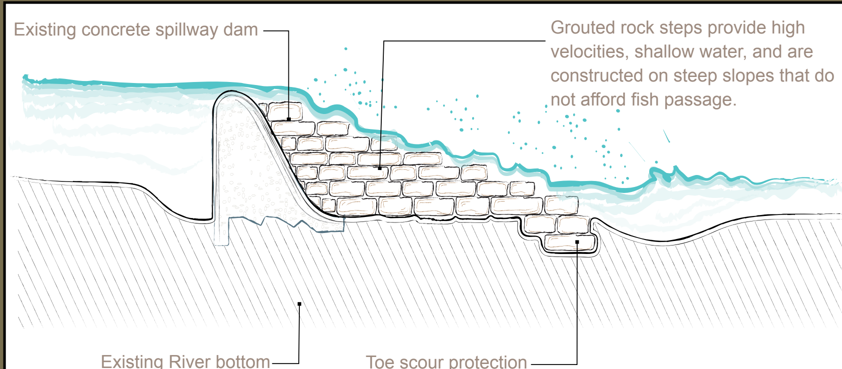


Figure 4-n.
Step dams can reduce recirculating hyraulics by creating a chaotic, rather than uniform, flow pattern.

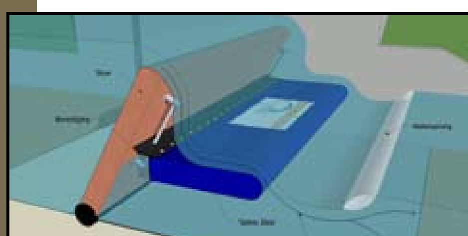


Figure 4-o.
Safety slide, patent pending by Oranjewoud, The Netherlands.

Floating slide. Recirculation eliminated with floating slide in a Dutch canal

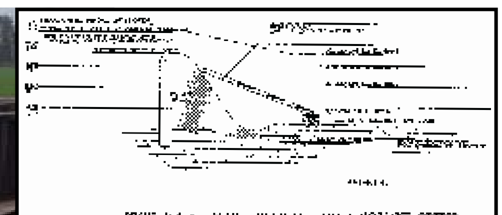


Figure 4-p. Trailing vane proposed for a Fort Dodge dam. Patent by McLaughlin Whitewater Engineering.

5 Strategies and Plan of Action

Iowa's 2010 plan for dam mitigation is a compilation of strategies and action items integrating a series of new approaches as decisions are made about increasingly decrepit infrastructure. These goals address multiple needs mitigation projects will need to meet.

Goal One: Address local and statewide needs by addressing failing dams before they fail

- Avoid potential loss of life from flood or harmful rapid releases of sediment downstream after dam breaches
- Listen carefully to stakeholder concerns and clearly identify problems early in the process
- Coordinate with Iowa DNR dam safety program to identify structural problems
- Focus on solving community problems with cost-effective river restoration techniques using local, federal, state, private, and non-governmental assistance
- Thoroughly vet project designs to mitigate infrastructure, sediment, or ecological problems

Goal Two: Mitigate threats to recreational public and liabilities to dam owners

- Reduce public liability at state-owned low-head dams via warning signage, appropriate launch / landing / portage trail development outlined in Chapter 6 of the 2010 water trails development manual
- Use structural mitigations such as removal or conversion to rapids to further reduce public liability at state-owned low-head dams
- Reduce frequency of Iowa deaths at human-made dams on Iowa's navigable streams through education, warnings, and structural dam mitigation
- Enhance river navigation and diverse recreation including angling, innertubing, or whitewater recreation

Goal Three: Enhance fish and mussel integrity and reduce biological harm

- Enhance effects for river connectivity for overall river species abundance.
- Consider targeted species recovery / recolonization in specific project areas
- Counter spread of aquatic invasive species such as Asian carps and zebra mussels

Goal Four: Maximize public funds by uniting fish passage, safety, and recreational navigation goals and resources in dam mitigation projects

- Require communication and structured listening approaches from first phase forward to ensure project is as responsive as possible to local needs
- Aid public understanding via examples that have solved multiple problems using diverse revenue sources

Table 5-a: Relative factors to determine mitigation function; 1' to 15' high structures*

Mitigation approach	"Drowning machine" reduction	Potential for upstream flood damage reduction	Social / economic function of dam and impoundment retained or stabilized	Aquatic connectivity / fish passage achieved	Sediment transport normalized / pool habitat improved	Economic development enhanced	Avoids potential project site constr. access and control problems	Relative typical design cost	Relative typical constr. costs	Relative 30-year maint.
Removal with stream restoration	●●●●●	●●●●●		●●●●●	●●●●●	●●●●●	●●	$$$	$-$$	none
Simple or staged removal	●●●●●	●●●●		●●●●●	●●●●●	●●●●●	●●●●	$$	$	$
Rock arch rapids	●●●●●	●	●●●●●	●●●●●	●	●●●●●	●●●●	$$	$$	none
Grouted rock arch rapids	●●●●●	●	●●●●●	●●●●●	●	●●●●●	●●●●	$$	$$	$$
Crest reduction with rock arch rapids	●●●●●	●●●●	●●●	●●●●●	●●●●	●●●●●	●●●●●	$	$	none
Whitewater course	●●●●●	●●●●	●●●●●	●●●●	●	●●●●●	●●●●	$$	$$$	$$$
Safety-only structures	●●●●●		●●●●●				●●●●●	$$$	$$$	$$
Side-channel passage (boat or fish)	●	●●	●●●●●	●●●●		●●	●●	$$$	$$$	$ - $$
Partial channel passage (boat or fish)	●	●	●●●●●	●●●●	●●●●●	●●●●●	●●●●	$$$	$$$	$-$$

* Factors for taller structures are more individualized and cost factos may change significantly by site. Site issues and relative importance of each factor will change from project to project.

Figure 5-b: Planning and design phases for mitigating publicly owned dams

1. Exploratory

A. Project application

1. Dam owner files letter of intent with Iowa DNR
2. Acknowledgement
3. Review project versus priorities
4. Project queued or or denied.
5. Develop project agreement

B. Notifications

1. US Fish and Wildlife Service fish passage program
2. DNR Fisheries Management Unit Biologist
3. DNR Dam Safety
4. DNR Engineering survey project request
5. Potential partners

C. Data collection

1. Existing upstream / downstream fishery data
2. Develop aerial base map of project area
3. Calculate stage-discharge recurrence data at nearest gauging station (s)
4. Geological papers related to river or its region

D. Early review

1. Request dam safety inspection reports (DNR Dam Safety)
2. Infrastructure functions review (Local / state engineers)
3. Environmental review (DNR Sovereign Lands)
4. Early public listening via project open house, web survey, or other techniques.
5. Cultural review (SHPO)
6. Floodplains / FEMA flood area review (DNR Floodplains)
7. Identify and collect potentially affected infrastructure data (upstream well logs, bridge pier/ abutment plans, etc.)
8. Identify pricing / quality of stone available

PHASE 1: Exploratory Report

Constraints and opportunities are identified that will guide goal setting, field work, and design parameters.

Report discussed and approved by dam owner before signing and moving to phase 2.

2. Project Determination

E. Field survey

1. Morphological / engineering survey
2. Photograph
3. Engage dam owner or local volunteer to record stage at submergence flow level
4. Note condition of dam
5. Mussel reconnaissance
6. Depth of refusal probing in impoundment and ID bed materials
7. Identify potential downstream erosion areas
8. **Potentially needed:**
   - fish assemblage
   - full aquatic community
   - full mussel survey
   - archaeological review
   - HEC RAS model
   - federal EA or EIS
   - wetland delineation

F. Assessment

1. Quantify potential sediment release at crest elevations and compare to annual sediment load estimate for stream
2. Identify additional needs for stream restoration
3. Process data for stage analysis and shear stress, maximum particle size mobilized, and other parameters

G. Evaluate alternatives

1. **All projects** mitigate for safety hazards, avoid harmful sediment releases, and improve or have little effect on upstream flood conditions
2. **Most projects** require fish passage and improved angling opportunities at the project site
3. **All projects** balance the following needs:
   - respect of local needs
   - stability
   - cost
   - flood reduction
   - infrastructure function
   - invasive species prevention
   - rare species protection
   - recreation
   - navigation
   - habitat improvements
   - stream restoration
   - tourism / economic development

Phase 2: Project Determination

Report with template application or early conceptual drawing(s) and rough costs are reviewed and publicly discussed. Reactions are considered. Partners and dam owners agree on direction before moving to phase 3.

3. Design and Implementation

H. Preliminary design

1. Preliminary design and cost estimate developed by qualified stream restoration professional and/or engineer
2. Approved by dam owner and project partners; funding sought
3. Preliminary design shared on project Web site

I. Permit submission

1. Submit preliminary design to regulators
2. Always includes joint application to DNR Floodplains, Sovereign Lands and USACE for Section 404
3. May be subject to Section 106 environmental / cultural review
4. Local floodplain permit may be required

J. Implementation

1. Adjust toward final construction design throughout permit process.
2. Assemble final funds
3. Structure bid process
4. Construct project

Monitoring Report

Survey and report on stability after bankfull flood.

Dams with strong potential in combined mitigation benefits

Dams with overlap safety / navigational and biological connectivity benefits

Tier 1 Overlap:
Dams meeting 75th percentile or greater for safety and biological categories (See Table 5-2, next page).

Tier 2 Overlap:
Dams meeting 50th percentile or greater for safety and biological categories (See Table 5-3, next page).

Filtering factors
hydroelectric dams, asian carp barrier dams, large impoundment dams, over 15' tall, over 200' wide, already being mitigated, social / practical issues

Not a priority. Dams that may otherwise have met first tier analysis were filtered out. The Lakehurst Dam is both a power-generating dam, and likely protects the Maquoketa River from Asian carp infestation. Therefore, it was filtered out of the listings.

Tier 1

ID	Dam_Name
But-4	Shell Rock Mill Dam
Cer-18	Jackson Avenue Dam
Cer-5	Fourth Street Dam
Cer-7	East Park Slide Dam
Cer-8	Rock Glen Dam
Cer-9	Pennsylvania Avenue Dam
Del-3	Manchester Dam
Dub-2	Cascade Falls Dam
Flo-2	Charles City Beauty Dam
Flo-4	Rockford Dam
Fra-2	Harriman Park Dam
Jac-2	Prairie Creek Ford
Jon-3	Mon-Maq Dam
Lin-4	Palisades-Kepler Dam
Lyo-2	City Park East Channel Dam
Lyo-6	City Park Big Ford
Web-4	Clare Gaging Dam
Web-5	Lizard Creek Mill Dam
Web-6	Trestle Weir
Win-2	Upper Dam
Win-3	Weist Mill Dam
Woo-3	4th Street Dam

Tier 2

ID	Dam_Name
Bla-3	Park Avenue Dam
Bla-4	Sixth St. Dam
Bla-7	Pioneer Park Structure/Water Line
Bre-1	Frederika Dam
Bre-2	Waverly Dam
Buc-2	Littleton Mill Dam
Buc-3	Independence Low Dam
Cer-11	12th Street Dam
Cer-13	Illinois Street Dam
Chi-1	Buckley Rock Dam Ford
Del-2	Quaker Mill Dam
Ham-3	Webster City Dam
Hum-5	Corn Belt Power Dam
Jon-2	Oxford Mills Dam
Lin-5	Troy Mills Dam
Lin-7	Buffalo Creek Park Dam
Lyo-1	Rock Rapids Dam
Sto-6	East River Valley Park / 13th St. Dam
Web-1	Ft. Dodge Hydro Dam
Web-2	Little Dam
Woo-5	Dace Avenue Dam
Wor-2	Northwood Dam

Limitations of GIS-based process

These listings apply broad, statewide datasets for use by agency staff to assist in technical assistance and funding priorities. See Appendix B and Appendix C for details on the process used. A listing indicates of agency support for potential projects, and areas where outreach may be effective for local projects. In no way are the owners of the above dams required to take any immediate actions. More specific information can be incorportated that could reduce priorities for the listed dams, or could help other dams become a higher priority.

Table 5-b: 75th percentile and greater for both safety / navigational and biological categories

ID	Dam_Name
But-4	Shell Rock Mill Dam
Cer-18	Jackson Avenue Dam
Cer-5	Fourth Street Dam
Cer-7	East Park Slide Dam
Cer-8	Rock Glen Dam
Cer-9	Pennsylvania Avenue Dam
Del-3	Manchester Dam
Dub-2	Cascade Falls Dam
Flo-2	Charles City Beauty Dam
Flo-4	Rockford Dam
Jac-1	Lakehurst Dam
Jon-3	Mon-Maq Dam
Lin-4	Palisades-Kepler Dam
Lyo-2	City Park East Channel Dam
Lyo-6	City Park Big Ford
Web-4	Clare Gaging Dam
Web-5	Lizard Creek Mill Dam
Web-6	Trestle Weir
Win-1	Lower Dam
Win-2	Upper Dam

Filtering, and other priorities

Structures filtered out in the process may still offer benefits if a project is pursued. However, factors will need to be examined on a case-by-case basis as projects come forward from communities. Evidence of changed conditions—such as decommissioning of a hydroelectric facility, Asian carp moving up a barrier dam—will be taken into account as projects are presented.

While this plan emphasises combined priorities, there will also be project areas where combined priorities are not sensible. On small, non-navigable streams there are needs for fish passage at small dams and culverts, which will be pursued with appropriate assistance and funding. Conversely, where fish passage is to be discouraged due to invasive species issues, safety-only priorities may be considered. At large dams where river-wide solutions would be impractical, partial channel solutions may be considered. Revenues appropriate to each aspect of the mitigation should be commensurate to the in the solution. For example, in the case of highly recreational projects, local funding or economic development revenues should comprise part of the project.

Table 5-c: 50th Percentile and greater for both safety / navigational and biological categories

ID	Dam_Name
Bla-1	Cedar Falls Dam/Center St. Dam
Bla-2	Clay Hole
Bla-3	Park Avenue Dam
Bla-4	Sixth St. Dam
Bla-7	Pioneer Park Structure/ Water Line
Bre-1	Frederika Dam
Bre-2	Waverly Dam
Buc-2	Littleton Mill Dam
Buc-3	Independence Low Dam
Buc-4	Independence Mill Dam
Buc-5	Quasqueton Dam
But-1	Greene Dam
But-3	Heery Woods Park Dam
But-4	Shell Rock Mill Dam
Cer-11	12th Street Dam
Cer-13	Illinois Street Dam
Cer-18	Jackson Avenue Dam
Cer-5	Fourth Street Dam
Cer-6	Lagoon Diversion Dam
Cer-7	East Park Slide Dam
Cer-8	Rock Glen Dam
Cer-9	Pennsylvania Avenue Dam
Chi-1	Buckley Rock Dam Ford
Chi-2	Cedar Lake Dam
Del-2	Quaker Mill Dam
Del-3	Manchester Dam
Del-4	Pin Oak Park Dam
Del-5	Lake Delhi Dam
Dub-2	Cascade Falls Dam
Flo-1	Main Street Dam
Flo-2	Charles City Beauty Dam
Flo-3	Nora Springs Dam
Flo-4	Rockford Dam
Flo-5	Marble Rock Dam
Ham-3	Webster City Dam
Har-1	Alden Dam
Har-2	Iowa Falls Dam
Har-3	Steamboat Rock Dam
Hen-1	Oakland Mills Dam
Hum-5	Corn Belt Power Dam
Iow-1	Amana Millrace Diversion Dam
Jac-1	Lakehurst Dam
Jas-1	Wagaman Mill Dam
Joh-1	Iowa River Power Company Dam
Joh-2	Burlington Street Dam
Joh-3	Rapid Creek Gaging Dam
Joh-7	Coralville Dam
Jon-1	Anamosa Dam
Jon-2	Oxford Mills Dam
Jon-3	Mon-Maq Dam
Lin-2	C Street Roller Dam
Lin-3	5-in-1 Bridge & Dam
Lin-4	Palisades-Kepler Dam
Lin-5	Troy Mills Dam
Lin-6	Pinicon Ridge Park Dam
Lin-7	Buffalo Creek Park Dam
Lyo-1	Rock Rapids Dam
Lyo-2	City Park East Channel Dam
Lyo-3	Klondike Mill Dam
Lyo-6	City Park Big Ford
Mit-1	Stacyville Dam
Mit-2	Otranto Mill Dam
Mit-3	St. Ansgar Mill Dam
Mit-4	Mitchell Mill Dam
Mit-5	Interstate Power Dam/ Old power Dam
Mit-7	Rock Creek Village Ford
Mit-8	Rock Creek Village Dam
Mon-2	Bed Grade Control Structure
Mon-3	Bed Grade Control Structure
Sto-6	East River Valley Park / 13th St. Dam
Wap-1	Market Street Dam
Web-1	Ft. Dodge Hydro Dam
Web-2	Little Dam
Web-4	Clare Gaging Dam
Web-5	Lizard Creek Mill Dam
Web-6	Trestle Weir
Win-1	Lower Dam
Win-2	Upper Dam
Woo-5	Dace Avenue Dam
Wor-1	Fertile Mill Dam
Wor-2	Northwood Dam
Wri-1	Goldfield Dam

Action Items for Dam Mitigation

This plan addressed goals by achieving the following outcomes:

- Responded to legislation by developing goals, strategies, and template approaches to mitigate public hazard and other problems with dams on major rivers statewide.
- Developed an updated inventory of dams on major rivers in Iowa.
- Formed sensible dam mitigation strategies based on listening closely stakeholders.
- Focused on on developing solutions to problems for both dam owners and the broader public.
- Developed conceptual templates that collectively address numerous situations encountered at small dam sites.

Many goals were met and tasks accomplished in the two-year effort to develop this plan. Important tasks remain, however. The following list prioritizes this work:

Tasks for the Short-Term (by 2014):

- Findings of this plan should be incorporated into mitigation efforts of the DNR and communicated among bureaus (specifically, floodplains, fisheries, wildlife, law enforcement, and parks bureaus) and to other state and federal agencies.
- Priorities and approaches will be adopted in funding guidelines and applicable administrative rules for the low-head public hazard program and communicated with other state and federal funders.
- As existing projects are completed, communicate findings of plan and potential for collaboration with potential priority dam owners.
- Collaborate with DNR floodplains / dam safety and fisheries to require sediment stabilization protocols in case of dam failure at appropriate dams.
- Develop phased planning, technical assistance, and funding assistance approaches from individual projects; develop reports that will help policy makers assess project-by-project benefits and costs in funding decisions.

Long-Term Tasks (3 to 10 years):

- Document and monitor project areas for stability and biological response, and compare effectiveness of techniques over a long term.
- New structures will continue to be needed to address needs such as grade stabilization or stream crossings. Reach out to and provide education for engineers to incorporate stable projects that enhance biological connectivity and the latest ecologically friendly techniques wherever sensible.
- Study Asian carp success to better understand which streams they are likely to severely impact, and potentially weigh against advantages to connectivity to the Missouri and Mississippi rivers for those less likely to have severe impacts.
- Solidify requirements and approaches for fish passage and navigational improvements at larger dams and at barriers on smaller streams.

Conclusions

Solving Dam Problems: The 2010 Plan for Dam Mitigation *carves new directions regarding mitigation of common problems dams can cause on Iowa major waterways. It integrates and visually communicates the ideas and needs of many Iowans, while balancing those with ecological needs. It demonstrates viable alternatives to infrastructure that in many cases is literally falling apart. This plan forms flexible early strategies for mitigation projects resulting in public benefits of statewide importance, using techniques likely to find local acceptance at a range of costs. Taken along with warning signage, education, and portage trail guidelines identified in "Developing Water Trails in Iowa", a comprehensive set of strategies for fatality reduction, ecological connectivity, and other problem mitigation at major river dams now exists.*

Major rivers are challenging places to work. A successful dam mitigation effort will develop through the efforts of many volunteers, as well as local, state and federal agency staff.

Dams often represent strong emotional attachments and sometimes are a major source of community identity. Each mitigation effort needs to respect that by listening carefully to local concerns and needs without pre-supposing exact outcomes.

In all cases related to dams, professional guidance at the project level is advised. Complex projects relating to dam modification or removal, often require both social and hydrologic inquiry and attention. The right experts may be skilled planners or facilitators, stream restoration professionals, and / or engineers. As multiple steps, ongoing project management, and permtis are required, an experienced planner or coordinator can be essential for pulling a vision together into a completed project.

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Appendix A: Raw Responses to Dam Owner's Survey

Question	Response option	Total Responses*
How Acceptable is the Condition of the Dam?	Very Acceptable	49
	Somewhat Acceptable	51
	Somewhat Unacceptable	28
	Very Unacceptable	20
	Not Sure	22
	Other	7
Do You Believe your Dam…	Provides a Barrier to Fish Movement	Yes - 93
		No - 53
	Provides a Barrier to Navigation & Recreational Use	Yes - 82
		No - 66
	Reduces Biological Diversity in the Stream	Yes - 39
		No - 96
	Affects the Nearby Water Table Elevation	Yes - 48
		No - 88
How Open Are You to Considering a Modification?	Very Open	55
	Somewhat Open	31
	Probably Not Open	14
	Definitely Not Open	18
	I Need More Info	32
	Don't Know	11
	Other	2

* of 163 surveys completed

Question	Response option	Total Responses*
Current Stream use	Agricultural Purposes	16
	Fishing	115
	Boating	68
	Swimming	42
	Hunting	37
	Other Land-based Recreation	82
	Don't Know	5
	None	23
	Other	30
Benefits Dam Provides at Area of Stream	River Crossing	15
	Utility/Pipeline Protection	12
	Stream Channel Stabilization	37
	Water Supply	18
	Flood Control	19
	Enhanced Water Quality	45
	Aeration	25
	Wildlife Habitat	48
	Fish & Aquatic Habitat	73
	Historic Value	45
	Visual Interest	59
	Fishing	91
	Hunting	18
	Agricultural Purposes	7
	Upstream Impoundment	59
	Hydropower Generation	9
	None	7
	Don't Know	7
	Other	17
Why Was the Dam Originally Constructed - What Was Its Purpose?	Stream Bed Stabilization	31
	Hydropower Generation	33
	Fishing and Recreation Purposes	27
	Hunting Recreation	6
	Habitat	15
	Agricultural Use	3
	Mill or Business Function	39
	Flood Control	13
	Create Impoundment Upstream	34
	Don't Know	17
	Other	34
What Problems May Possibly Exist With Your Dam?	Upstream Siltation	74
	Debris Collection at High Water	66
	Stream and/or Channel Erosion	45
	None	21
	Don't Know	18
	Other	22

* of 163 surveys completed

Appendix B: Dams ranking high in relative risk analsyis

75th percentile and greater

ID	Dam_Name
Bla-3	Park Avenue Dam
Pol-1	Center Street Dam (Des Moines)
Joh-2	Burlington Street Dam
Joh-1	Iowa River Power Company Dam
Lin-4	Palisades-Kepler Dam
Lin-2	C Street Roller Dam
Bla-1	Cedar Falls Dam/Center St. Dam
Jon-3	Mon-Maq Dam
Iow-1	Amana Millrace Diversion Dam
Jon-1	Anamosa Dam
Buc-5	Quasqueton Dam
Lin-5	Troy Mills Dam
Boo-2	Boone Waterworks Dam
Del-4	Pin Oak Park Dam
Bla-4	Sixth St. Dam
Dal-3	Adel Island Park Dam
Bre-2	Waverly Dam
Wap-1	Market Street Dam
Har-1	Alden Dam
Web-2	Little Dam
Hum-5	Corn Belt Power Dam
Bla-2	Clay Hole
Pol-2	Scott Street Dam
Flo-1	Main Street Dam
Mit-3	St. Ansgar Mill Dam
Mit-2	Otranto Mill Dam
Flo-2	Charles City Beauty Dam
Har-2	Iowa Falls Dam
Web-1	Ft. Dodge Hydro Dam
Buc-4	Independence Mill Dam
Har-3	Steamboat Rock Dam
Flo-3	Nora Springs Dam
Boo-1	Fraser Dam
But-4	Shell Rock Mill Dam
Buc-3	Independence Low Dam
Lin-3	5-in-1 Bridge & Dam
Lin-6	Pinicon Ridge Park Dam
Pol-5	Fleur Drive Dam
Mit-4	Mitchell Mill Dam
Chi-2	Cedar Lake Dam
Buc-2	Littleton Mill Dam
Dal-1	Redfield Dam
Sto-6	East River Valley Park / 13th St. Dam
Del-5	Lake Delhi Dam
Jac-1	Lakehurst Dam
Lyo-3	Klondike Mill Dam
Flo-5	Marble Rock Dam
But-1	Greene Dam
Flo-4	Rockford Dam
But-3	Heery Woods Park Dam
Wor-2	Northwood Dam
Web-6	Trestle Weir
How-3	Lidtke Mill Dam
Woo-5	Dace Avenue Dam

50th to 74th percentile

ID	Dam_Name
Woo-2	6th Street Dam
Woo-4	11th Street Dam
Woo-6	Dam at the Mouth
Sto-7	Veenker Golf Course Ford
Woo-3	4th Street Dam
Sto-5	Lincolnway Gaging Dam
Dal-2	Adel North Dam
Cer-11	12th Street Dam
Cer-13	Illinois Street Dam
Del-2	Quaker Mill Dam
Del-3	Manchester Dam
Joh-7	Coralville Dam
Fay-2	Maynard Dam
Emm-3	South Riverside Park Dam
Win-3	Weist Mill Dam
Sto-3	Sleepy Hollow/Hannum's Mill
Hen-1	Oakland Mills Dam
Mit-5	Interstate Power Dam/Old power Dam
Wor-1	Fertile Mill Dam
Bla-7	Pioneer Park Structure/Water Line
Del-1	Backbone Lake Dams
Jon-2	Oxford Mills Dam
All-1	Mississippi Lock and Dam 9
Win-2	Upper Dam
Win-1	Lower Dam
Hum-2	Reasoner Dam
Hum-1	Rutland Dam
Fay-9	Wacouma Mill Dam
Bue-1	Linn Grove Dam
Jas-1	Wagaman Mill Dam
Lyo-1	Rock Rapids Dam
How-1	Vernon Springs Dam
Mit-1	Stacyville Dam
Chi-1	Buckley Rock Dam Ford
Cer-8	Rock Glen Dam
Osc-1	Ashton Dam
Bre-1	Frederika Dam
Mon-2	Bed Grade Control Structure
Mon-3	Bed Grade Control Structure
Gut-1	Lenon Mill Dam
Fay-4	Clermont Dam
Lyo-2	City Park East Channel Dam
Wri-1	Goldfield Dam
Obr-1	Sheldon Waterworks Dam
Cer-7	East Park Slide Dam
Cer-9	Pennsylvania Avenue Dam
Ham-3	Webster City Dam
Cly-2	Elkader Little Dam
Web-4	Clare Gaging Dam
Cer-6	Lagoon Diversion Dam
Cer-5	Fourth Street Dam
Lyo-6	City Park Big Ford
Lin-7	Buffalo Creek Park Dam
Joh-3	Rapid Creek Gaging Dam

Risk factors were developed after analyzing 1998 to present fatalities at dams and examining other available data. Factors weighted and analyzed using GIS modeling, including relative usage statistics from the 2009 Iowa Rivers and River Corrdiors Recreation survey conducted by Iowa State University's Center for Agriculture and Rural Development. Dams in the low-head, breached, low-head, large impoundment, and ford categories were analyzed (211 total stuctures).The following factors were used:

- Proximity to population centers, (>100,000, 2 pts; >35,000, 1 pt)
- Known fatalities (>5, 3 pts; >3, 2 pts; 1 to 3, 1 pt)
- Height (2' to 15', 2 pts; >15', 1)
- Type (Low-head, 3pts; Breached low-head, 2 pts; Large Impoundment or seasonal low-head, 1)
- Near university / college (50-mile radius, 2 pts; 10-mile radius, 1 pt)
- On designated or in-progress water trail (1 pt)
- River usage survey, total # visits (>1,000 1 pt; >350 .5pt)
- River usage survey, in-water visits including fish/boat/canoe/swim (>700 3 pts; >349, 2pts)

Note that this type of broad-brush statistical analysis does not account for individual site factors, such as hydraulic retention, site design, education, and other factors that may play a role in actual risk. Also, known fatality data may be limited for many dams.

Appendix C: Dams with biological priority potential, unfiltered list

75th percentile and greater

ID	Dam_Name
Jon-3	Mon-Maq Dam
Del-5	Lake Delhi Dam
Mit-4	Mitchell Mill Dam
Cer-13	Illinois Street Dam
Wri-1	Goldfield Dam
Cer-9	Pennsylvania Avenue Dam
Web-5	Lizard Creek Mill Dam
Dub-2	Cascade Falls Dam
Cer-18	Jackson Avenue Dam
Del-4	Pin Oak Park Dam
Mit-3	St. Ansgar Mill Dam
Lin-6	Pinicon Ridge Park Dam
Del-3	Manchester Dam
Cer-11	12th Street Dam
Mit-5	Interstate Power Dam/Old power Dam
Lyo-2	City Park East Channel Dam
Ham-3	Webster City Dam
Web-4	Clare Gaging Dam
Lin-7	Buffalo Creek Park Dam
Cer-4	East Park Dam
Joh-2	Burlington Street Dam*
Mit-2	Otranto Mill Dam
Jac-1	Lakehurst Dam*
But-1	Greene Dam
Flo-4	Rockford Dam
Web-6	Trestle Weir
Flo-5	Marble Rock Dam
How-3	Lidtke Mill Dam
Del-2	Quaker Mill Dam
Bla-7	Pioneer Park Structure/Water Line
Win-1	Lower Dam*
Lyo-1	Rock Rapids Dam
Cer-8	Rock Glen Dam
Cer-7	East Park Slide Dam
Cer-6	Lagoon Diversion Dam
Cer-5	Fourth Street Dam
Lyo-6	City Park Big Ford
Joh-3	Rapid Creek Gaging Dam
Jas-1	Wagaman Mill Dam
Cer-19	Pierce Avenue Dam
Lin-4	Palisades-Kepler Dam
Lin-2	C Street Roller Dam
Wap-1	Market Street Dam
Flo-1	Main Street Dam
Flo-2	Charles City Beauty Dam
Flo-3	Nora Springs Dam
But-4	Shell Rock Mill Dam
Har-3	Steamboat Rock Dam
Chi-2	Cedar Lake Dam
But-3	Heery Woods Park Dam
Wor-2	Northwood Dam
Hen-1	Oakland Mills Dam *
Win-2	Upper Dam
Mit-1	Stacyville Dam

50th to 74th percentile

ID	Dam_Name
Chi-1	Buckley Rock Dam Ford
Bre-1	Frederika Dam
Cer-10	Linn Grove Park Dam*
How-6	Saratoga Dam
Bre-5	Sweet Marsh Dam
Bla-5	Heritage Farm Crossing
Bla-3	Park Avenue Dam
Joh-1	Iowa River Power Company Dam
Iow-1	Amana Millrace Diversion Dam
Buc-5	Quasqueton Dam
Lin-5	Troy Mills Dam
Bla-4	Sixth St. Dam
Jon-1	Anamosa Dam*
Bre-2	Waverly Dam
Web-2	Little Dam
Har-1	Alden Dam
Hum-5	Corn Belt Power Dam
Har-2	Iowa Falls Dam
Web-1	Ft. Dodge Hydro Dam
Buc-4	Independence Mill Dam
Lin-3	5-in-1 Bridge & Dam
Buc-3	Independence Low Dam
Buc-2	Littleton Mill Dam
Lyo-3	Klondike Mill Dam
Joh-7	Coralville Dam
Jon-2	Oxford Mills Dam
Wor-1	Fertile Mill Dam
Fay-7	Lake Oelwein Dam
Buc-1	Fairbank Dam
How-2	Lylah's Marsh Dam
Chi-4	North Washington Mill Dam
Chi-3	Chickasaw Mill Dam
Fra-2	Harriman Park Dam
Mit-8	Rock Creek Village Dam
Fra-3	Robinson Park Dam
Flo-6	Rock Creek Ford
Mit-7	Rock Creek Village Ford
Mit-10	Jersey Avenue Weir
Buc-6	Fontana Lake Dam
She-2	North Panama Dam
Pag-1	Clarinda Dam
But-7	Big Marsh Diversion Dam
Web-8	Williams Drive Dam
Kos-11	Buffalo Creek Dam
She-6	Bruch Weir
She-4	Panama High Tress Weir
She-5	F-32 Weir
Fra-1	Beed's Lake Dam
Wor-3	Elk Creek Game Mgmt Dam 1
Fay-8	Low Flow Bridge
Bla-1	Cedar Falls Dam/Center St. Dam
Bla-2	Clay Hole
Sto-6	East River Valley Park / 13th St. Dam
Woo-5	Dace Avenue Dam

*Asian carp barrier dams to be filtered out during later step.

Factors were weighted and analyzed using GIS modeling. Dams in the low-head, breached, low-head, large impoundment, and ford categories were analyzed (211 total stuctures).The following factors were used:

- Biological impairment, 303 listed segment, (2 pts)
- Within 15 miles of sampled SGGN mussel(s) (2 pts)
- Downstream of zebra mussel investation (2 pts)
- Fish species presence-absence analysis, difference in # present upstream (>15, 3 pts; 10-14, 2 pts; 5-9; 1 pt)
- Segment downstream of dam has >29 species (1 pt)
- Catfish recovery potential (1 pt)
- Use none or unknown (2 pts)

Because this method depends on exisitng data, it heavily favors dams in segments of rivers where signifcant fish and mussel samping has occurred . Additional monitoring could result in other dams becoming higher priorities. In addtion, some deteriorated or breached dams on this listing, with closer inspection, may already be regularly passing fish, elminating their priority status.