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 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).

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

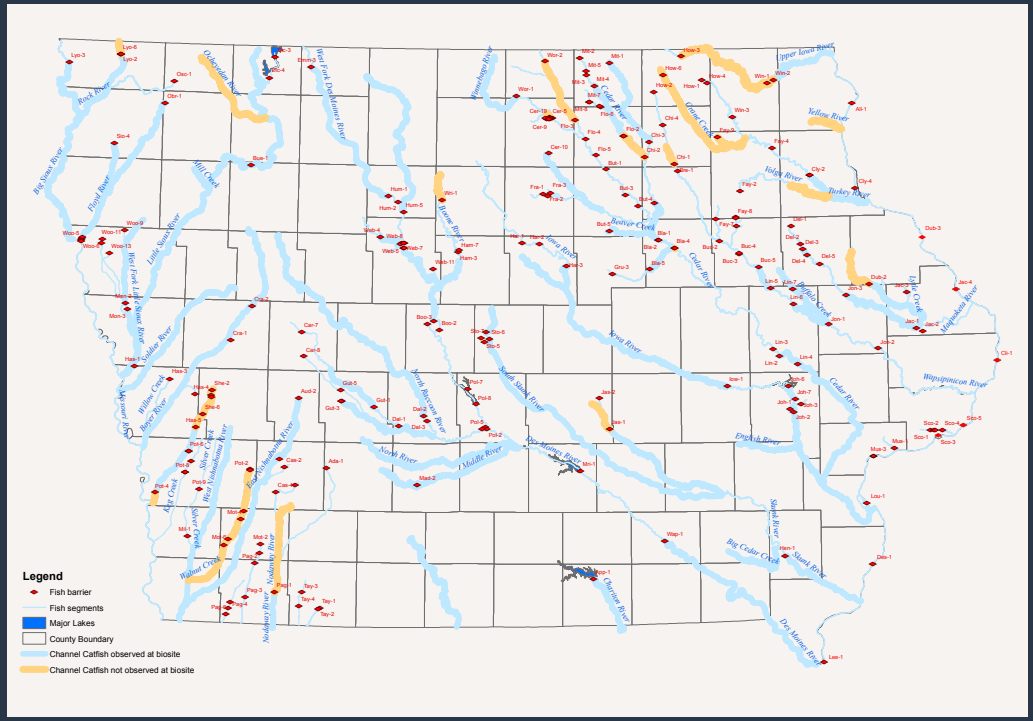
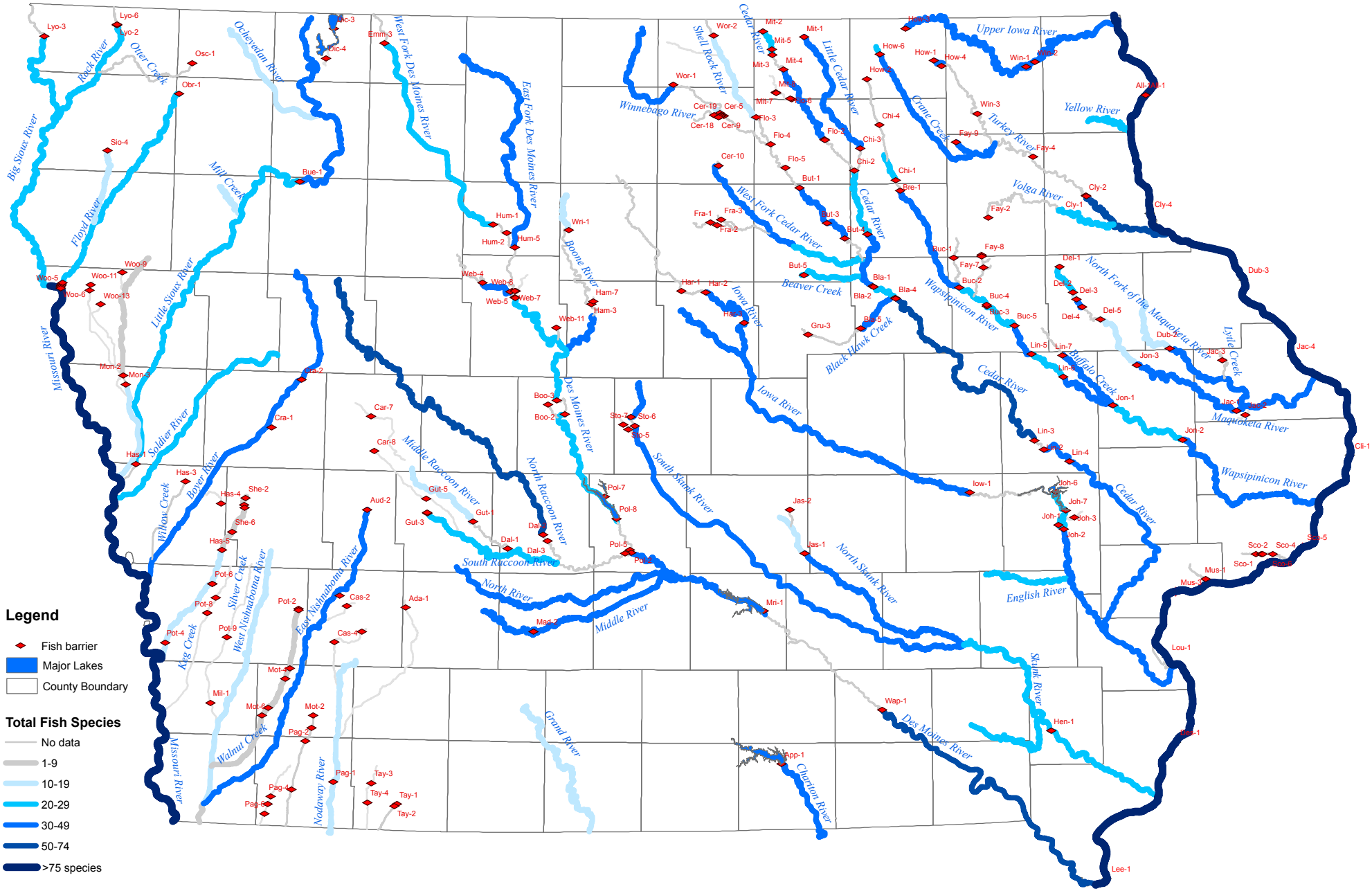


Figure 3-b. Presence and absence of fish species analysis from combined datasets.



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 pocketbook 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:

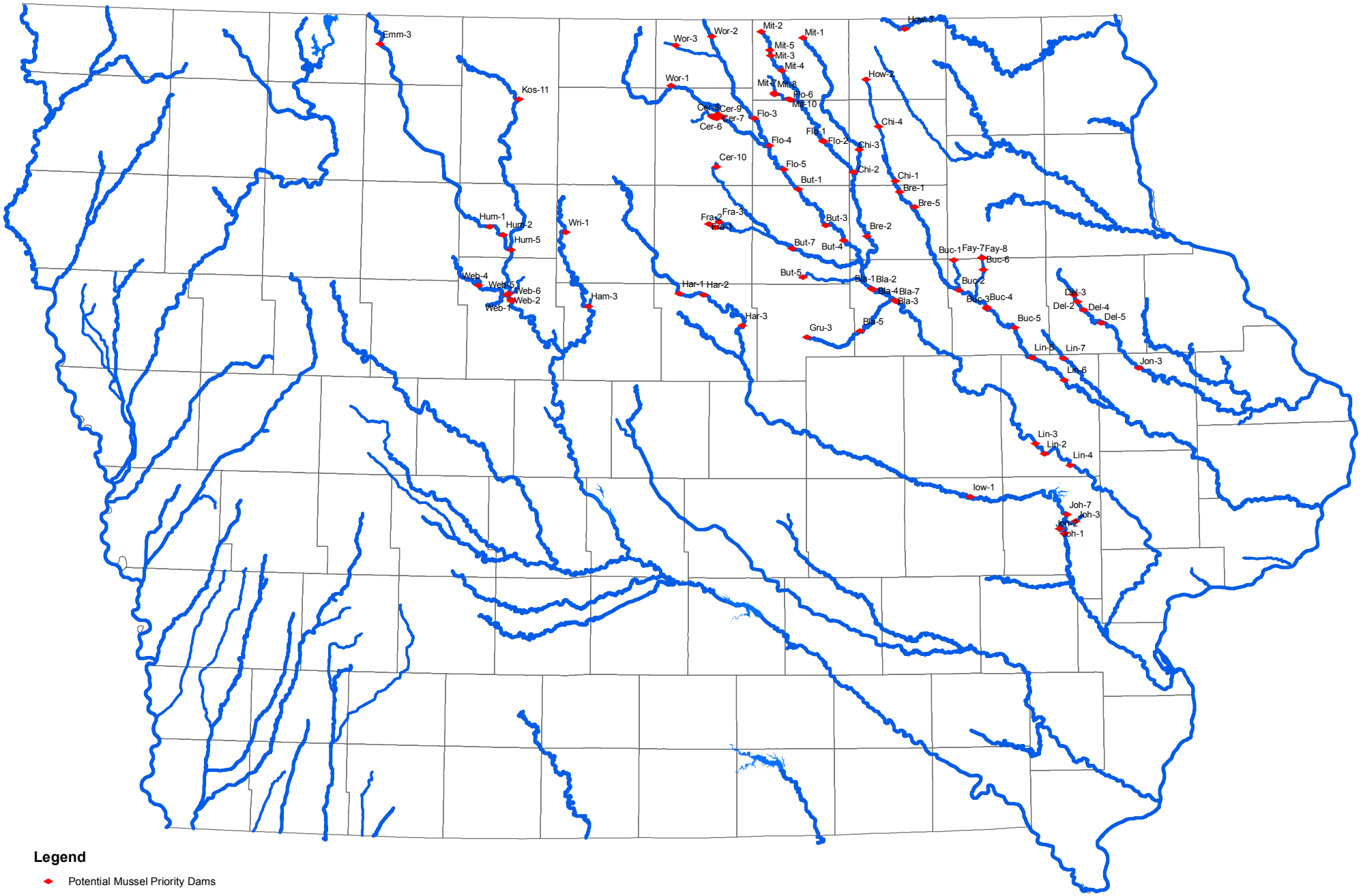
Common Name	Scientific Name	Iowa Abun.	Iowa Trend
Elktoe	*Alasmidonta marginata*	U	D
Slippershell	*Alasmidonta viridis*	R	D
Flat floater	*Anodonta suborbiculata*	R	D
Cylinder	*Anodontoides ferussacianus*	R	D
Rock pocketbook	*Arcidens confragosus*	U	D
Spectacle case	*Cumberlandia monodonta*	R	D
Purple 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.

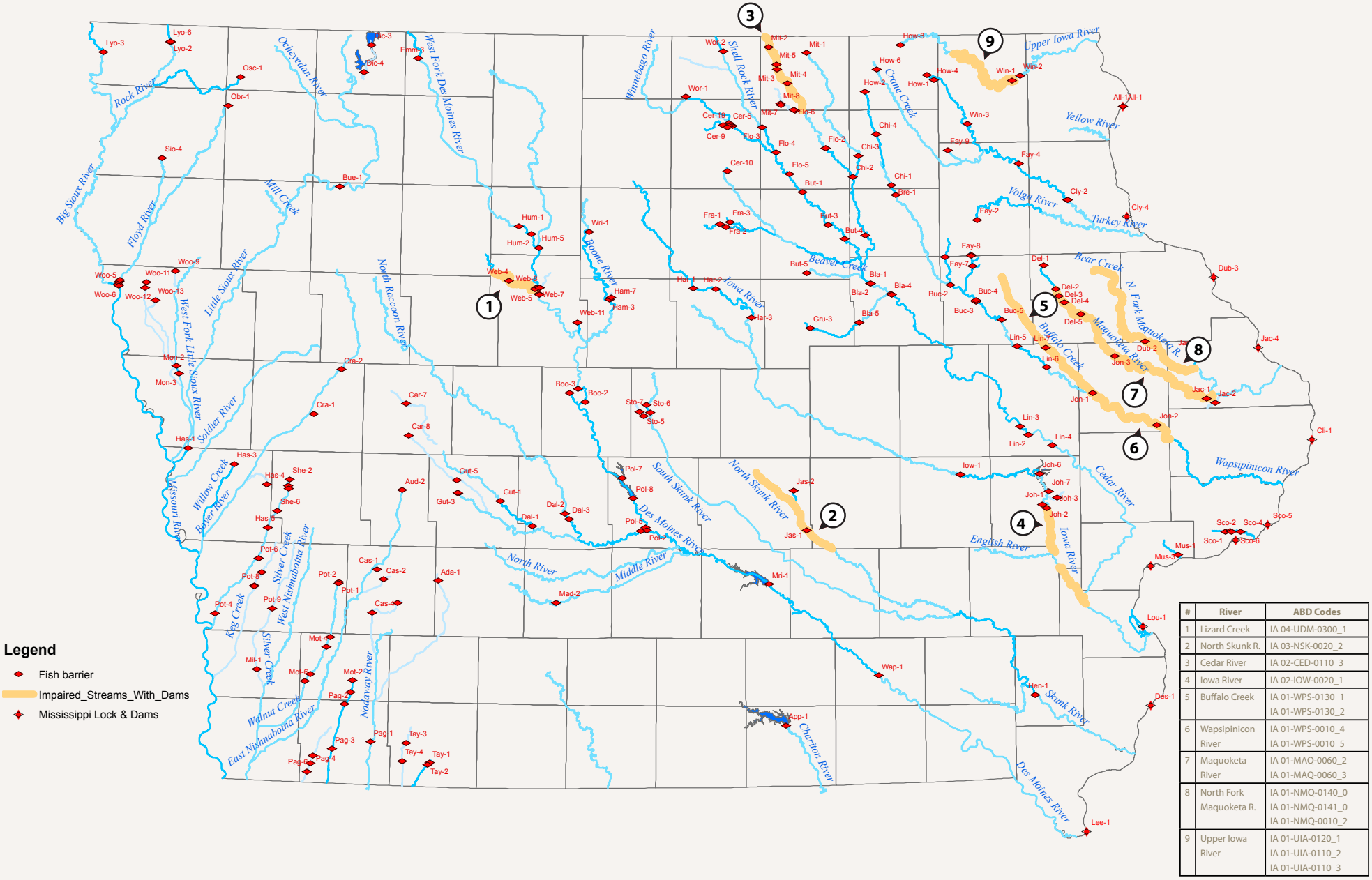
Invasive species priorities

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.



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

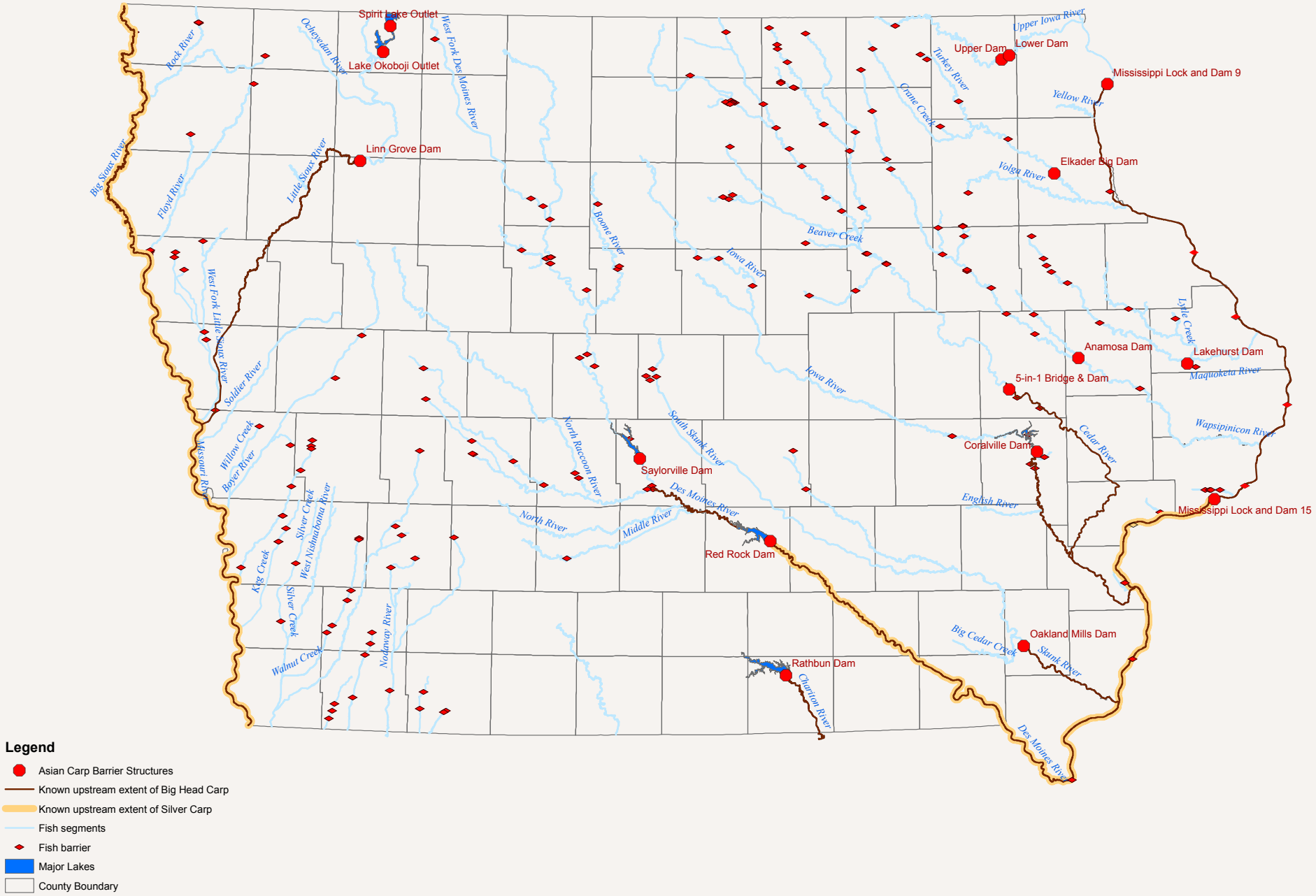
The zebra mussel (*Dreissena polymorpha*) is another invasive species which can cause both harm to native ecosystems and economic damage. Issues related to dams are very different, however, due to a different type of life cycle. In lakes or impoundments, zebra mussels rapidly spread over any hard surface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

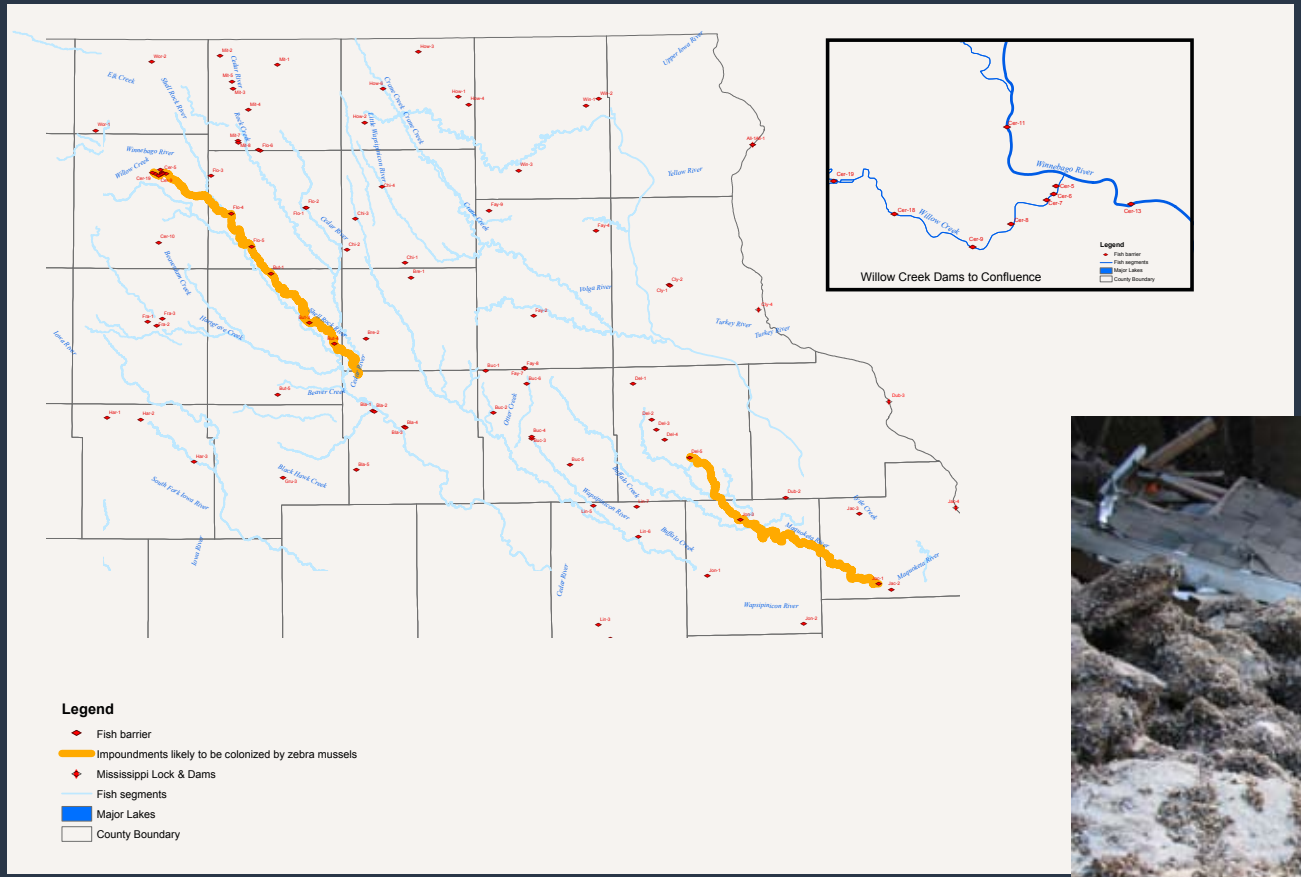


Excessive zebra mussel colonization of native mussels can lead to mortality among native mussels. However, unlike native mussels which colonize upriver by using fish hosts, exotic zebra mussels produce immense quantities of young, waterbourne zebra mussels called "veligers" that can quickly spread throughout 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 downstream, 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 invansive species program, and Iowa DNR 319 program will be sought in support of such projects.

3) Where dams are failing, ensure the public is presented 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.