Conservation Guidance for

Iowa Darter

Etheostoma exile (Girard, 1859)

IL status:
Species in Greatest Conservation Need (SGCN)

US status:
Least concern

Global rank:
IUCN Least Concern

Trend:
Stable

Family:
Percidae

Habitat:
Streams and lakes with cool water over sand or organic substrates. Associated with vegetation.

Similar species:
Bluntnose Darter, Johnny Darter, Least Darter, Mud Darter, Banded Darter

Seasonal cycle:

Jan	Pools
Feb	Pools
Mar	Spawn shallows
Apr	Spawn shallows
May	Spawn shallows
Jun	Spawn shallows
Jul	Mid-depth
Aug	Mid-depth
Sep	Mid-depth
Oct	Mid-depth
Nov	Pools
Dec	Pools

Species information

Characteristics

The Iowa Darter is a small (avg. 1.4 to 1.95 inches Total Length; 2.95 inches maximum Total Length) member of the perch family (Percidae).[1,2,3] The body is fusiform (tapered at both ends) to cylindrical and elongate. The snout is rounded and the upper jaw reaches almost to the anterior margin of the eye. The eye diameter exceeds the snout length. Minute teeth exist on both the upper and lower jaws. A black suborbital bar (tear drop) is evident on both male and female. Two dorsal fins are present, the first with 8-12 spines (usually 9) and the second with 10-12 rays (usually 11). The dorsal fins are distinctly separated. The anal fin has 2 spines and 7-9 rays. An adipose fin is absent. The cheeks, nape, and breast are partly scaled. The Iowa Darter possesses a small spine on the posterior portion of the scaled opercle (gill cover). The lateral line is incomplete but the row has 55 or more scales. The lateral line is convex anteriorly and rarely extends past the first dorsal fin. Additional information and keys to distinguish Iowa Darters from similar darters are available in Page,[1] Lyons,[2] Becker,[3] and Smith.[4]

Male: There is great variability in coloration in the Iowa Darter.[4,5,6] The male is light brown dorsally with faint saddle blotches. There is a distinct boundary between the dorsal and lateral pigmentation.[2] Color fades to light olive brown or yellow on the belly. About 8 saddle marks are found on the dorsal surface with 9-12 distinct vertical bars along the side. The vertical bars can become dark blue during breeding season (Fig. 1). Reddish blotches appear in the interspaces and can have dramatically different shapes depending on the breeding status. The spiny dorsal fin has three color bands and/or it can appear relatively transparent. The basal portion of the fin is blue, a red band appears above that and the upper-most band in the fin is again blue. The soft dorsal fin has speckles arranged in rows; the tail fin likewise has speckles arranged in distinct rows.

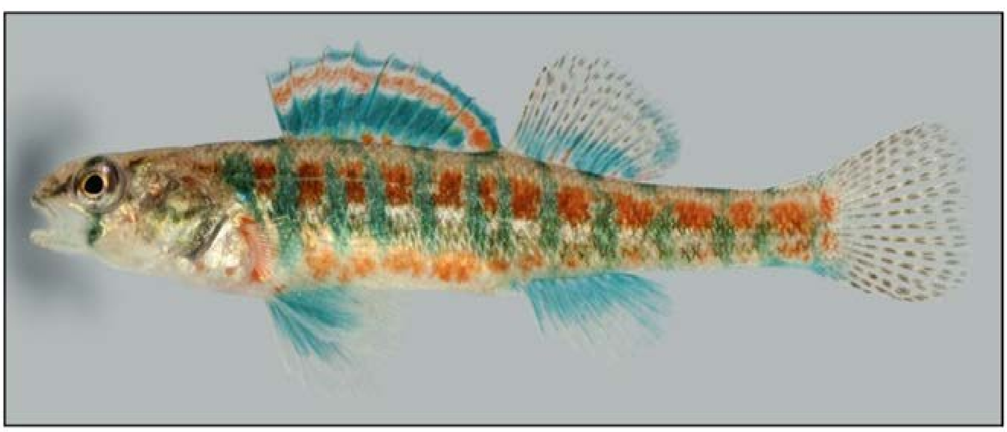

Figure 1. Male Iowa Darter shown in breeding colors. The black bar below the eye exists for both male and female. Photo shopped to emphasize jaws. Photo courtesy of Uland Thomas and North American Native Fish Association.

Figure 2. Female Iowa Darter. Note the minimal coloration in the female dorsal fins. The pigment bar below the eye is present in both the male and the female. Photo from J.K. Bland.

Female: The female is larger than the male and the first dorsal and anal fins are larger.[3] Lateral pigmentation is more mottled in the female (Fig. 2). Pigmentation can range from dark brown spots or chevrons (V-shapes) on a light brown background to very dark brown mottled spots from the snout to the caudal fin. Brown pigment spots on the first and second dorsal and the caudal fin form linear patterns characteristic of darters.

Habitat

The Iowa Darter is found in low gradient creeks, in the pools of moderate size rivers, in deep and shallow lakes and in herbaceous wetlands. Many darter species are closely associated with fast flowing water and riffle habitats. The Iowa Darter is somewhat of an exception and it is one of the few darters that is tolerant of lentic systems. It typically prefers cooler and clearer water, usually with abundant rooted vegetation.[12] Bottom substrate is usually sand, but they are often found over softer substrates as well, like silt, decaying vegetation, etc.

Taxonomy

The taxonomic status of the Iowa Darter as a species is secure even though it has one of the most extensive spatial distributions of any darter. However, its relationship to other darter species and our understanding of its evolutionary history has undergone recent reanalysis by several different researchers using modern genetic techniques as well as traditional morphological analysis.[7,8,9,10] Analysis by Near et.al.[7] contrasted with older phylogenetic analyses of Page [11] and others, *placing Etheostoma exile* into the subgenus *Oligocephalus*. Still other researchers [9,10,11] have argued for variations in the collective phylogeny of the subfamily Etheostomatinae. Evolutionary relationships continue to be contested and remain the subject of conflicting analyses. The variability in color has given rise to the suggestion that perhaps there are subspecies of Iowa Darter, but this has not been validated to date.

Distribution

Iowa Darters are a glacial relict species that can withstand colder water temperatures.[13] It ranges farthest north (Fig. 3) of any darter species. In some studies spawning took place immediately after ice-out and thus cold tolerance characterizes the species.[5]

Iowa Darter is found across the northern third of Illinois, although it is concentrated in the glacial lakes and associated streams of northeastern Illinois (Fig. 4). Additional populations have been found in tributaries of the Rock River, Vermilion (Wabash) River, and along the Illinois River.[14,15,16] A project

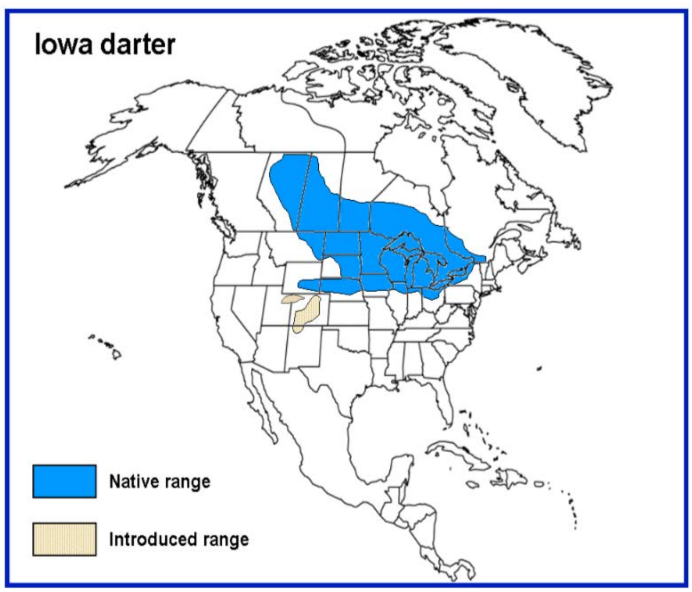

Figure 3. Global distribution map for Iowa Darter. Prepared by USGS. Note introduced range and extensive distribution in far northern Canadian provinces. The Iowa Darter reaches its southern extent in northern Illinois.

at the headwaters of Bulls Brook [17] (Des Plaines Drainage Basin) created a sanctuary for four separate E/T species including Iowa Darters. As a consequence Iowa darter can be found in both the streams and ponds associated with that drainage.

Status

The International Union for Conservation of Nature (IUCN) lists the Iowa Darter as a species of "Least Concern".[18] The basis of this designation is the large number of subpopulations and locations, the overall size of the population and the species is not declining fast enough to qualify for any of the threatened categories. It is declining along the southern perimeter of its range in Ohio [19], Pennsylvania , and New York. In Illinois the Iowa Darter was listed as threatened because it was known from only a few locations and its habitat is susceptible to degradation due to urban development. Iowa Darter populations appear to be increasing in Illinois over the past four decades yet they are rarely found in large numbers.[12,15]
The Iowa Darter became greatly reduced in numbers in many parts of Ohio since 1930, presumably from increased turbidity and habitat modifications.[20] Baker et al.[19] reviewed the status of Iowa Darter in Ohio based on focused surveys of historic stream and lake sites. The surveys were conducted in 2011 and 2012. Forty nine historic sites were visited and comparisons were made between 1980's collections and 2011/2012 collections. Iowa Darters were present in only 12 of the previously sampled sites. The continuing decline was attributed to agricultural land-use practices, nearby urban development, and exotic species.

Natural History

Reproduction

Iowa Darters can be found in home territories in both lakes and streams. They over-winter in pools but spawn in vegetated shallows.[21] Males change color as spawning season proceeds and thus water clarity can be a conservation issue. Nesting territories may range from 30 cm to 60 cm in diameter and are generally in a fixed location on a vegetated shoreline. Males are first to migrate into shallows and they establish a nest against which they fend off other males. Females follow shortly thereafter. Females have genital papillae with which

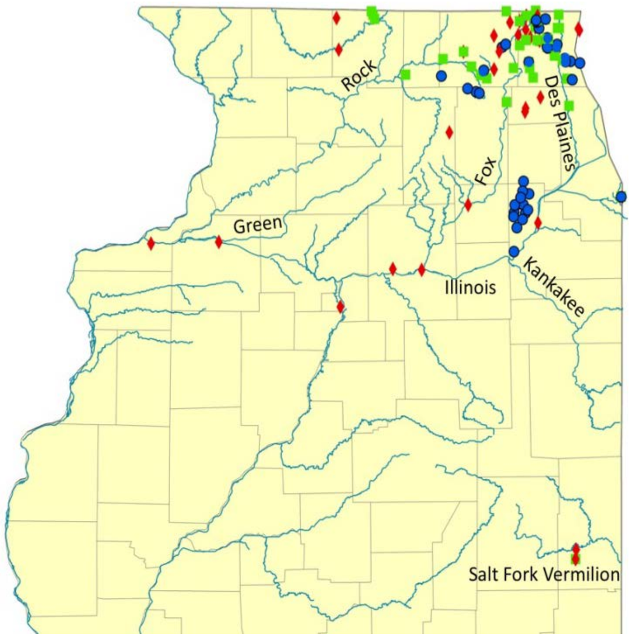

Figure 4. Distribution of Iowa Darter (Etheostoma exile) in Illinois. Red diamonds indicate records up to 1974, green squares 1975-2004, and blue circles 2005 to 2015

they lay adhesive eggs that sink. Lake or stream substrate may vary but vegetation is a critical habitat issue. Small numbers of eggs (3-10) are laid with each spawning episode but 700 to 2000 prespawn eggs exist per individual. Eggs are formed in late summer in prespawn condition to be laid in the spring of the subsequent season.

Spawning is generally from April-May but it may be as early as March or as late as June. Males and females produce mature gametes in the first spring after hatching. Eggs hatch in 18 to 20 days and no parental care is extended to the eggs or fry. Fecundity varies by size and age class for females but averages 1,600 per individual. In one study, spawning was suppressed until water temperatures approached 18°C (64°F) and stopped when water temperatures reached 23°C (73°F).[5]

Population Dynamics

Iowa Darters from Lake Itasca (n=275) and Mississippi headwaters (n=521) were aged as part of a two year study.[5] Notably most darters did not live beyond a second growing season (= Age I). Age II and Age III were extremely rare and mostly female. A single darter out of the two populations made it to Age IV. Egg mortality can be as high as 97%. Limited age categories were true for both lake and riverine populations. Growth was rapid during their first year (Age I) and they achieved 72% of their maximum length during this period. Females reached larger sizes than males whether they were river resident or lake resident.

Migration

Iowa Darters move into shoreline shallows during breeding (March-June) but return to deeper lake depths and in-stream pools to forage during other times of year. Longer movements tend to be localized but migration from lakes into streams occurs probably over distances of no more than several hundred yards.[21] Flood events may distribute fish across longer distances. Low-head dams and some types of highway culverts can restrict upstream fish movement. Iowa Darters in northeastern Illinois appear to be impacted by low-head dams in several localities.

Diet

Based on the analysis of feeding guilds, Iowa Darters should be classed as benthic, grazing, invertivores.[22] FishBase (http://fishbase.org/home.htm) identifies them as carnivores using zoobenthos (bottom dwelling animal life). Diets associated with river residence will vary by comparison with lake habitats but in both habitats they forage within plant communities and in open water. As with many fish species Iowa Darters appear to be opportunistic feeders and have variable diets contingent on what might be seasonally available.[23] Their diet will also vary by life stage thus early stages depend on zooplankton while later life stages forage on larger insect larva as well as zooplankton.[5,13,24,25,26] Food items also vary by volume and thus the percent consumed will not reflect the caloric value of the prey.

Typical prey items for adults include: midge larva, mayfly larva, caddisfly larva, amphipods, blackflies and other aquatic insect larva (Figs. 5-6). Prey items for juveniles and adults include: cladocerans

Figure 5. An amphipod (scud) is a small crustacean that is common in both marine and freshwater environments. Photo by J.K. Bland

Figure 6. Midge larva are another common element of the diet of Iowa Darters. They are quite small and run 2-5 mm in length. Photo by J.K. Bland

(water fleas), copepods (planktonic crustacean), ostracods and fish eggs.

Morphological Adaptations

Darters as a group lack swim bladders and thus they are obligate bottom dwellers. Pectoral fins are also enlarged and adapted for securing the fish against stream flow. The term "darter" is descriptive since they dart from locality to locality and then secure themselves against the water flow.

Members of the *Etheostoma* genera demonstrate a variety of mouth and jaw structures used in slightly different ways by different species. The mouth for Iowa Darters is terminal (at the end of the snout) to subterminal and slightly oblique. The upper jaw of both genders contains a frenum (short piece of tissue) which inhibits protractile movement found in several other species of the genus. The upper jaw is slightly larger than lower jaw (dentary) (Fig. 7). Both jaws contain minute teeth

Shape and function of the jaws of multiple species of darters were examined as part of a physiological study.[26] Iowa Darter best fits the morphological pattern for benthic plant surface forager. They are active in pursuing moving prey. Darters demonstrate wide-spread differences in coloration between sexes. Males typically display intense breeding coloration in reds, blues, and greens; females retain more subdued earth tones. Iowa Darter demonstrates this pattern. Coloration clues reinforced behavioral and sexual isolation in similar darter species.[27] Species recognition was controlled by males who preferentially pursued same species females and directed aggression to other males. Therefore visual recognition is important for ensuring reproductive success.

Morphological Adaptations	Conservation Significance
No swim bladder	Limited spatial range; bottom dwelling; nest building on bottom substrate
Small subterminal mouth	Forages on macroinvertebrates associated with aquatic plant surfaces
Sexual dichromism	Visual clues used in mating ; turbidity will interfere with spawning
Genital adaptations and adhesive eggs	Attachment of eggs to plant surfaces; plant communities are critical habitat

Nipple-like projections from the ventral surface of female darters are used for different types of egg dispersal. Iowa Darters have genital projection which are adaptive to egg laying on organic surfaces like aquatic plants and or roots.[28] As a consequence, aquatic plant communities are important for both stream and lake populations.

Conservation/Management

Threats

Factors responsible for the decline or disappearance of Illinois native fishes include but are not limited to: *"1) soil erosion resulting in high sediment loads, 2) the drainage of natural wetlands, 3) the reduction of the water table and groundwater pollution, 4) interactions between native fishes and non-indigenous species, 5) stream pollution (e.g., sewage runoff, toxic chemicals from industry, pesticide residues, steroid residue from both humans and animals), 6) long-term effects of dams and impoundments, and 7) temperature elevation due to buffer zone reduction and/or stream channelization."* [29] Ohio literature identifies agricultural practices, urbanization, eutrophication episodes and exotic species (e.g., Common Carp) as factors in the disappearance of Iowa Darters from historic habitat sites.[30] Additional potential stresses include fragmentation, parasites/diseases, and climate change.[31]

Even though darters fecundity averages around 1,600, egg mortality for unattended demersal eggs is as high as 97%. Such R-selection populations (high growth rate, many offspring, high mortality) are generally regarded as more resistant to die back and are more adaptive to unstable environments.

Figure 7. Close-up of the head of a female Iowa Darter. Notice that the upper jaw overhangs the lower jaw. Food studies indicate that it is an active forager in aquatic plant communities.

However, the short life span can be non-adaptive in a circumstance where environmental stressors are sustained across multiple growing seasons.

Fish Base graded population resilience/productivity as high for Iowa Darters and made the narrative observation that an individual population would be: *"Vulnerable to extinction if decline in biomass or numbers exceeds threshold over the longer of 10 years or 3 generations."* Projects that create a permanent change in stream or lake habitat have the potential to impact Iowa Darter populations.

Hydrologic Modifications

Hydrologic modifications can include low-head dams, drainage modifications, loss of wetlands, channelization, ground water modifications and impervious cover issues. An important factor associated with urbanization which has a bearing on fish survival is impervious cover. Impervious cover includes streets, roofs, sidewalks, parking lots and any surface which does not allow water to infiltrate the soil. Two hundred separate studies have been done nationwide that demonstrate reductions in fishery and stream quality metrics with increases in catchment/watershed impervious cover.[32] Projects which involve the large scale creation of streets, parking lots, or other forms of impervious cover should be compared to technical literature to assess their potential impact.[32] The Impervious Cover Model (ICM) grades impervious cover approaching 20 –25% as imperiling the aquatic community including the fishery.[33]

Low-head dams have been a common piece of aquatic infrastructure in northeastern Illinois. Recent research on the impact of low-head dams has demonstrated fragmentation of regional fisheries, and degradation of habitat, water quality and macroinvertebrate assemblages.[34] River fragmentation has the potential to alter fish population structure and genetic diversity. There are some forms of highway culverts that can also act as potential barriers to fish passage. Topography and hydrology will influence whether a fish can pass through a culvert. Culvert type and fish body size will also influence possibility.[35] Several reaches of the Des Plaines River currently demonstrate the exclusion of Iowa Darters as a consequence of low-head dams and road culvert design. Projects on the Fox River and along the DuPage River have demonstrated that removal of low-head dams can improve species numbers including darters, macroinvertebrate populations and IBI (Index of Biotic Integrity) indices.

Detention/ retention ponds can modify fish communities, elevate temperature regimes, and suppress spawning and reproduction in Iowa Darters.

Dramatic changes in flow regimes could impact stream populations that rely on more moderate flow profiles.

<u>Turbidity</u>

Turbidity is a measure of the relative clarity of a liquid. Turbidity can be caused by organic particles (generally planktonic algae) or inorganic particles (sediment or silt). Particle size, duration of exposure, concentration, light attenuation, and context within the habitat (i.e., lake or stream) will have a bearing on sediment impacts on fish species. Based on its association with other species (e.g., Blackchin Shiner) and the places that we find it in Illinois we believe the Iowa Darter to be *intolerant to moderately intolerant of sediment exposures.*[36] Projects which can generate increased turbidity include residential development, channelization, bank modifications for highways and bridges, and earth moving of all types.

<u>Dredging</u>

Dredging is intended to remove bottom sediment from designated areas. Dredging can be done for the purpose of increasing depth, reconfiguring stream channels, controlling nuisance aquatic vegetation, removing nutrient rich sediments, and removal of toxic substances. Two basic types of dredge units exist: 1) hydraulic dredges that suck up sediments and deposit them elsewhere for dewatering and 2) excavation equipment that removes sediment in bulk. In some circumstances water bodies have to be drawn down before excavation can take place. Dredging is regulated under Section 404 of the Clean Water Act. As such, a dredging impact assessment, which is evaluated by the US Army Corps of Engineers, has to precede projects. The removal and disruption of aquatic habitats is dramatic with any dredging project and thus the scope of the project will have a bearing on the potential influence on fish populations. Small scale projects which impact limited amounts of shoreline will have less impact than large scale projects which influence large stream reaches or shoreline runs. Side cast sediment increases turbidity and this needs to be controlled for any dredging project where E/T species are present. It is also important to insure that some portion of the aquatic plant community is sustained. Illinois Environmental Protection Agency also has jurisdictional authority over dredging projects and will have screening protocols for the types of sediment being removed and mitigation protocols for reducing turbidity from side-cast sediment.

<u>Aquatic Plant Control</u>

Iowa Darters are associated with regional lakes, and they use the near-shore zone substrate and plant communities. Human lake residents often wish to have a relatively “clean” shoreline for boating, swimming and aesthetics. Due to the importance of these areas lake management methods that look to control rooted aquatic plants and algae have the potential to adversely impact Iowa Darter populations.

Aquatic plant control can be done chemically or mechanically with aquatic weed harvesters. Aquatic weed harvesters come in several different configurations and can be used on a variety of spatial scales (Fig. 8). Large scale harvesters can have a sickle bar of 5 to 7 ft. width, an on-board conveyor belt and storage capacity of several cubic yards. Cutting typically is done up to 5 ft. depths but some units can go deeper. In most cases plant detritus is off loaded and disposed of offsite. As harvesting takes place fish as well as plants are trapped in the conveyor. Harvesting tends to be species specific and larger fish escape more easily than small forage fish. Iowa Darters are somewhat less likely to be trapped in weed harvesters because they are bottom dwellers.

Chemical plant control is one of the most wide-spread management methods for regional lakes. Chemical applications can vary dramatically depending on the specificity of plant control and the magnitude and timing of the application. Currently the Illinois EPA grants chemical Applicators a “general” NPDES permit. IDNR restricts application to non-spawning periods. Chemical control of rooted aquatic plant populations is done with herbicides that are certified for use by USEPA. Certification includes specific label directions on how the herbicide is to be applied, what species are affected, and concentration levels sufficient to protect non-target species. Irrespective of label data there is still considerable latitude on how chemicals can be applied and it is important to know factors controlling herbicide efficacy and side effects. Chemical applications have been done on a number of lakes without the loss of Iowa Darter populations but impact will be contingent on the scale of the application and the specific chemicals used. Ecotoxicology screens exist for some fish species that have been subjected to herbicide/pesticide dosing; generally that data is used to generate the label data for herbicides and pesticides. It is not specific for Iowa Darters however, and thus direct toxicity to various life phases is done by comparison with similar species. Presuming that applications are done according to label specifications, Iowa Darters should be safe from direct acute and chronic toxicity. Population impacts associated with the loss of plant communities due to chemical herbiciding have not been studied. It is reasonable to infer however, that it does have an adverse impact given life history details.

<u>Biological Stressors</u>

Exotic species, competitive species, and stocked predators are examples of biological stressors that can influence Iowa Darter populations. Common Carp can be a minor problem or they can influence sediment dynamics to the detriment of species sensitive to turbidity and sedimentation like Iowa Darters that rely on visual clues for both foraging and spawning. Stocking of upper level predators like Muskies, Channel Catfish, Walleye, and even sunfishes should consider the potential impact on the forage base including the resident E/T species. As a rule, energy pyramids represent 10 fold increases/ annum across each trophic level. Thus a 5 lb. Largemouth Bass will require 50 lbs. of forage /annum to sustain itself. Some authors have implied that Northern Pike populations represent significant predatory pressure but Iowa Darters are frequently found in lakes with resident Northern Pike populations.

Figure 8. Harvesters can come in a variety of sizes. Depending on the duration, depth, and spatial extent of harvesting they can have a substantial impact on aquatic communities.

Other types of exotic species have the potential to influence Iowa Darter populations but we have no scientific documentation of their impact. Zebra Mussels for example are found in over 30 inland lakes in Lake County but Iowa Darters seem to be sustaining their populations in these locations. In lakes the Zebra/Quagga Mussels change energy relationships and can promote hazardous algal blooms. A large number of stream reaches below regional lakes are being colonized by Zebra/Quagga Mussels and are changing the aquatic community structure of these stream reaches. Invasive aquatic plants exist in most of the inland lakes in Lake County. There is no demonstrable impact on Iowa Darters. Round Gobies are an invasive benthic fish that may have adverse impacts on Iowa Darters, but the distributions of the two species have not significantly overlapped to date.

Chemical Pollutants
Traditional pollutants include nutrients, sewage treatment effluents, pesticide residues, toxic chemicals from point and non-point sources, and hormonal and prescription drug influences. Nutrients are an issue for Iowa Darter populations since they were instrumental in the loss of populations in Ohio.

Traditional pollutants have been tracked on the Fox and Des Plaines watersheds in a series of reports prepared by United States Geologic Survey,[33] Illinois EPA,[37] USEPA [38] and the Des Plaines River Watershed Workgroup www.DRWW.org. Additionally point source discharges are scoped through the National Pollutant Discharge Elimination System (NPDES) and each point source will have permit conditions that it must meet. NPDES permits are also required as part of non-point source storm water regulations. These are regulated as part of the Municipal Separate Storm Sewer System (MS4) NPDES permits. Data on NPDES permits should be available through Illinois on-line data bases www.epa.state.il.us/water/permits/npdes/forms/general-npdes. Resource Conservation and Recovery Act (RCRA) permits are given to those facilities that store, use, and move hazardous materials. Facilities of this type are mapped and compliance can be tracked through the USEPA ECHO (Enforcement and Compliance History Online) website.

Increasing Water Temperatures & Climate Change
The Iowa Darter is temperature sensitive in spawning and growth characteristics.[5] It is adapted to cooler temperatures as reflected in its far northern distribution. Development that increases impervious cover, opens up stream canopies, or increases water temperatures (like detention basins) will have the potential to impact Iowa Darter populations.
In regards to climate change, regional predictions by the Union of Concerned Scientists [39] for northeastern Illinois identify episodes of dangerous summer heat, a longer growing season, more flooding due to increased winter and spring rainfall events exceeding 2 inches per day, and increased summer drought. Illinois DNR developed species vulnerability evaluations with the Nature Serve *Climate Change Vulnerability Index*, ver. 2.01. Parameters chosen to grade the Des Plaines watershed include temperature changes, moisture, anthropogenic barriers, and land use changes. The Iowa Darter was rated as *Extremely Vulnerable or Highly Vulnerable* within the Des Plaines watershed.[39]

Increased flooding will result in the distribution of untreated sewage and uncontrolled non-point source effluent. The increased frequency of drought is likely to create a larger number of stream reaches that go to dryness and go to dryness with greater frequency. The loss of the historic flow regimes will also represent the loss of critical habitat. Increased temperatures will promote increased rates of eutrophication in regional lakes and ponds.

Regulations
The Iowa Darter is listed as Threatened in Illinois. "Take" of listed species is defined as "...to harm, hunt, shoot, pursue, lure, wound, kill, destroy, harass, gig, spear, ensnare, trap, capture, collect, or attempt to engage in such conduct", and is prohibited by the Illinois Endangered Species Protection Act:
http://ilga.gov/legislation/ilcs/ilcs3.asp?ActID=1730&ChapterID=43
The IDNR Impact Consultation Section reviews proposed actions to assess potential impacts to listed species, using its online tool Ecocat:
http://dnr.illinois.gov/ecopublic/
IDNR can authorize the taking of listed species that is incidental to otherwise lawful activities. To receive an Incidental Take Authorization (ITA), one must prepare a conservation plan and notify the public of the impact. See
http://www.dnr.illinois.gov/conservation/NaturalHeritage/Pages/ Incidental TakeAuthorization.aspx
Research or handling of listed species may require IDNR permits, including a Scientific Collector Permit and an Endangered and Threatened Species Possession Permit, and additional site permits if research takes place on IDNR land or lands protected by the Illinois Nature Preserves Commission (INPC):
http://www.dnr.illinois.gov/conservation/NaturalHeritage/Pages/ResearchPermits.aspx
Risks and impacts of research methods should be considered and weighed against the benefits.

Conservation efforts

Recovery Plans

While there is no formal recovery plan for the Iowa Darter, there have been efforts to improve Iowa Darter habitat. There are an estimated 64,500 hectares (ha) of wetland in the Northeastern Morainal natural division of Illinois, nearly 18,000 ha of which are under some sort of conservation or recreation ownership.[40] Eleven of the 95 Iowa Darter records in the IDNR Natural Heritage database are under protection by the Illinois Nature Preserve Commission and an additional 31 records are under another type of conservation or recreation ownership. However, aquatic systems are connected to the surrounding watershed and regardless of protection can be degraded.

Habitat Creation Efforts

In 1998 a major fish conservation project was initiated at Prairie Crossing, a residential complex in Grayslake , Illinois.[17] Based on INHS survey data the fish species associated with the Glacial Lakes Fish Community were disappearing from the Des Plaines drainage basin. Four species (Blackchin Shiners, Blacknose Shiners, Banded Killifish, and Iowa Darters) were taken from Cedar Lake and Deep Lake (in the Fox River drainage) and translocated to a 1.3 ha detention pond (Sanctuary Pond) in the Prairie Crossing complex. The detention pond was previously cleared of potential predators and all four species survived well past a ten year window. Populations of these species were subsequently transferred to Lake Leopold (13 ha) at the same complex. Lake Leopold does have a recreational fishery. The four species have survived in Lake Leopold and they have populated the Bulls Brook sub-watershed which empties into the Des Plaines River. Numbers of Iowa Darters which appear in seine based surveys are always relatively low by comparison with other species. While elevated temperatures are a concern for open canopy detention ponds all of the ponds at Prairie Crossing have extensive stands of rooted aquatic vegetation and this is a significant element for the critical habitat of Iowa Darters.

Watershed Planning

Watershed planning groups are active in the range of the Iowa Darter and have the potential to positively impact Iowa Darter habitat through comprehensive planning. These groups include but are not limited to: Des Plaines River Watershed Workgroup (DRWW), DuPage River Salt Creek Workgroup (DRSCW). Fox Waterway Agency (FWA), Lake County Stormwater Management Commission (SMC), Chicago Metropolitan Agency for Planning (CMAP), and Openlands. While E/T considerations make it into some versions of comprehensive planning for villages, cities, and counties they are rarely meaningfully addressed unless and until Environmental Impact Statement (EIS) documents are required or an ITA is invoked for a particular project.

Survey Guidelines

Surveys for Presence /Absence and Distribution

Stream surveys which include seining and/or electroshocking of headwater locations are desirable for validating presence/absence of the Iowa Darter. Lake seining surveys should incorporate multiple habitats around the perimeter of the lake. A minimum of 100 meters of lake shore is reasonable presuming it is split up against suitable habitats. We also suggest the supplemental use of minnow traps set overnight (25 trap nights) along vegetated shorelines. The most effective seine size is typically 3 to 5 meters (10 to 15 ft.) but longer nets can be used , vegetation permitting. Seining is generally undertaken in spring thru early fall in water that is typically waist deep or less; fish retreat to deeper waters as winter temperatures drop. Net size, mesh size (at least 1/8 inch), duration of deployment and/or time of effort can be used to quantify seine hauls. Water discharge profiles, time of effort, and the length of the run can be used to characterize electroshocking.

Electroshocking in streams should be done across at least 100 meters. Metrics associated with the electroshocking unit should be recorded. This includes the type of unit (cf. backpack , electric seine) , voltage, amps, DC vs AC regimen, use of blocking nets and duration of activity of the shocker. Boat electrofishing is not an efficient method for Iowa Darters since boats operate in deeper water and tend to overlook smaller fishes along the bottom, such as darters. Presence/absence surveys are currently what is available to define the existing and historic distribution of the species. Historically resources have been limited and thus distributions may not have been accurately defined. More recent surveys have not expanded Iowa Darter distribution as much as validating their continued presence within historic boundaries.

Surveys to Assess Impacts

Surveys to monitor impacts, such as habitat restoration, translocations, and Incidental Take Authorization, should assess changes in presence and abundance. Monitoring should follow a before-after, control-impact design that includes a comparison site and surveys prior to impacts. Surveys can be undertaken a short time (i.e., month) after completion of a project that involves major disruption of the habitat. Additionally, a survey should be undertaken in the subsequent season to validate the continuous presence of the species. It is desirable that survey work be done on a five year cycle to confirm the long term stability of the population.

Surveys to Profile Trends/Growth Dynamics

Population trend analysis presumes that sufficient data is taken to follow a population across multiple growth seasons. Population dynamics looks to define birth rates, death rates, immigration and emigration. Analysis is done by creating models and measuring total length, weight, gender, fecundity, and spawning condition multiple times across a season, and over a series of years. However this involves substantial handling of the fish and Iowa Darters generally have smaller populations than some other species. It also assumes that populations have been delimited, or at least, defined reasonably. It may be necessary to first determine population 'boundaries' before beginning a population trend analysis. Limited numbers of this type of study have been done with Iowa Darters. This is most reasonably a research study.

Stewardship recommendations

Iowa Darter habitat can largely take care of itself as long as it is not seriously disturbed. The most fundamental element is cool groundwater, so avoid any disruptions to the natural hydrology, such as drain tiles, excessive wells that draw down groundwater levels, etc. The bottom substrate is not as critical. Iowa Darters tend to prefer sandy, firmer substrates, but are also found over mud at times. More critical is native aquatic vegetation, especially submerged macrophytes, which must be preserved. Maintenance of buffer zones around lakes or along streams can help to reduce human impacts.

Preventing the introduction of invasive species, such as Zebra and Quagga Mussels, Round Gobies, etc. is a wise precaution.

Avoidance measures

Avoidance implies cancelling and/or relocating a project to avoid Iowa Darter habitat. Near shore and in-stream reconstruction projects are undertaken for a variety of valid reasons and routinely involve the expenditure of hundreds of thousands of dollars. Chemical applications are generally undertaken to address nuisance growth conditions. It is clear that low head dams are currently limiting Iowa Darter expansion within existing watersheds. Serious consideration of complete avoidance (project cancellation or relocation) is warranted for proposed low head dams and/or culverts which mimic low-head dams.

Minimization measures

Minimization is interpreted here as a method to lessen the impact of a proposed project that is up for review. For example, it would be best to schedule any projects so as to avoid the spring spawning period that usually occurs April to May, but sometimes starts in March and could extend into June.

Hydrologic Modifications

Consider complete avoidance of low-head dam projects, but if avoidance is not possible assure fish passage for dams and culverts. Flows should be low enough to allow those fishes found downstream to be able to move upstream. For projects which increase impervious cover, compare to Impervious Cover Model, and attempt to keep impervious cover below 20%, and ideally well below 10%. Insure increases in infiltrative BMPs and green infrastructure in response to increases in impervious cover. Ponds should be managed to retain native aquatic vegetation.

Turbidity

Earth moving activities of all forms have the potential to generate off-site sediment and turbidity. Consult local ordinances in place for purposes of controlling erosion and regional guidebooks (cf. Natural Resources Conservation Service - National Engineering Handbook [41]) for doing erosion control at project sites. Erosion control enforcement is highly variable depending on the community. Minimization of erosion, and the subsequent sedimentation and increases in turbidity, through use of silt screens and other methods is desirable. Field measure turbidity if warranted.

Dredging

Review Section 404 permits and conditions. The scale of dredging projects can vary widely and the impact of a dredging project on Iowa Darters will be dependent on the scale of the project. Methods to reduce side-cast sediments (e.g., sediment curtains) are desirable. Projects resulting in the loss of near shore substrates and aquatic plant beds represent a loss of critical habitat and will have an impact on Iowa Darter populations. Recovery is theoretically possible if the amount of shoreline being dredged is insignificant when compared to nearby undisturbed habitat. In rivers and creeks, evaluate whether the length of stream being dredged is appropriate and not unnecessarily excessive.

Aquatic Plant Control

Aquatic weed harvesting should be done with a plan that identifies what portion of the shoreline is to be harvested, when it is to be harvested and to what depth. Large scale harvesting equipment generally cannot operate in depths shallower than 3 feet; smaller harvesters exist that can. Small scale hand scythes and cutters are not likely to impact Iowa Darters presuming that cutting is done over a small space. Harvesting close to the bottom should be avoided, since darters are benthic, and this may provide a refuge for them. Harvesting season and spawning season generally coincide but it is desirable to avoid the spawning season if possible. The most reasonable alternative is to leave some portion of the shoreline intact. Where known populations of Iowa Darters exist it is reasonable to check side-cast weed piles for “incidental take”.

For chemical weed control, commercial application of aquatic pesticides requires an NPDES permit; because this species is not the only listed fish, licensed applicators are expected to consult the IDNR when planning applications. Ideally, a plan should be submitted that includes map of target weed beds, plant species being controlled, pesticide used, label of pesticide, control restrictions, and posting safety requirements. IDNR should send Applicators a list of lakes which have E/T species with a request that they coordinate with the Endangered Species Program. Consult US EPA fish toxicity database for each herbicide. Chemical application data should be documented by chemical applicators. Treatment timing should avoid spawning periods.

Biological Stressors

Common Carp can be partially controlled by periodic recreational tournaments, watershed exclusion, and/or commercial fishing. To date there are no completely effective control methods for Zebra/Quagga Mussels. Depending upon circumstances, it may be reasonable to monitor Zebra/Quagga Mussel populations in lakes and downstream environments. If invasive species are absent from the site, then measures should be taken to prevent them from invading the project location, if feasible. Stocking protocols for higher order predators (i.e., Northern Pike, Channel Catfish, Largemouth Bass) should be reviewed by regional fisheries biologists.

Chemical Pollutants

Do regional reviews of point source and non-point source NPDES permits. Be aware of the location of sewage treatment plants and the status of municipal separate stormwater system permits (MS4s), RCRA permits, etc. Review regional enforcement and compliance by using the USEPA ECHO database.

Increasing Water Temperatures & Climate Change

Some forms of minimization are possible through shading of stream corridors and pond perimeters, so it would be beneficial to preserve or enhance riparian vegetation. Disruptions to groundwater (e.g., wells, drain tiles, etc.) are to be avoided. If possible, they should even be removed to restore natural hydrology, since cooler groundwater can in some instances minimize the increasing temperatures of surface waters. Maintain connectivity so species can change distribution in response to changing climate.

Some climate models predict increased frequency of intense storm events as well as extended periods of seasonal low precipitation. Regional stormwater utilities keep maps of flood prone areas and federal flood plain maps are also available. The IDNR Illinois State Water Survey identifies those stream reaches which experience 7 day, 10 year cycles of drought (7Q10 reaches). Information sources of this type need to be consulted for any projects which will impact flow regimes.

Mitigation and Conservation Opportunities
Conservation can be undertaken by creating new habitat on behalf of a species or by preserving existing habitat. Planning efforts are intended to preserve the character of existing aquatic habitat even when stream reaches or lakes have not been specifically set aside as conservation easements. The Prairie Crossing detention ponds described below were not originally intended to serve as a sanctuary for Illinois endangered fish species. The ponds fulfilled a storm water function and their use as a sanctuary came later. Watershed planning is critical to preserving the functional performance characteristics of regional streams and lakes. Iowa Darters are also found in multiple forest preserves and conservation communities where some additional levels of protection are afforded and land use is more conducive to protection.

<u>Sanctuaries</u>
Detention ponds at Prairie Crossing in Grayslake, Illinois were used as a sanctuary for four Illinois E/T species including Iowa Darters.[17]
Environmental elements that were important for sustaining the E/T populations at the complex included:

- Fish were segregated from the downstream drainage and from carp influence
- American Fisheries Society protocols were followed and fish were translocated back into their historic range
- Storm drainage was treated utilizing multiple layers of vegetation
- Native aquatic plants were allowed to grow up to some defined limits
- E/T fish were segregated into one pond without predators (Sanctuary Pond) and allowed to colonize Leopold Lake which has predators
- Genetic screening was done for shiner species
- Cooperation from the community

Similar types of sanctuaries can be constructed using residential detention ponds but physical elements must be available to protect translocated populations. For example, detention ponds should be “wet” basins, since the periodic drying of “dry” basins would exterminate the local Iowa Darter population. There should be a variety of depths, including a “safety shelf” of 36 inches or less around the perimeter where a person can stand upright if they fall in by accident, as well as deeper pools in the middle where water can remain cooler during the summer. The variety of depths allows the Iowa Darters to migrate seasonally to suitable habitats. The variety of depths also allows the detention pond to act as a hemi-marsh with fluctuating water levels. Native plants should ring the basin to minimize erosion, reduce the need for mowing and fertilizer/herbicide application, discourage Canada Geese, and minimize runoff from any nearby impervious surfaces. Inputs should be designed as emergent wetlands that can act as filters. Outputs should ideally draw from deeper, cooler water that would reduce the outflow temperature and minimize the artificial warming of nearby streams. If aeration is installed, avoid fountains and sprays that increase evaporation rates, and incorporate “bubblers” instead. [42]

<u>Restoration</u>
Beneficial habitat restoration can be done on small and large scales within large lakes, small ponds, and along streams. See the preceding section ‘Sanctuaries’ for some guidelines. Restoring native aquatic vegetation is important, but restoring native terrestrial riparian vegetation is beneficial as well. Buffer strips between aquatic habitats and agriculture or urban landscapes help to protect Iowa Darter habitat by reducing erosion (and the subsequent increased turbidity and sedimentation), decreasing nutrient input, etc. Future projects looking to remove low-head dams and connect drainages will aid the species. Restoring the natural hydrology, especially in reference to groundwater inputs, is particularly beneficial to stream populations.

Watershed Planning
Some organizations, notably communities or NGO watershed groups, may have mitigation and conservation opportunities by putting together and implementing a watershed plan. There are many examples of agencies being involved in storm water and regional watershed planning in northeastern Illinois. These include regional planning agencies, stormwater management authorities, forest preserve districts, public utilities, drainage districts, NGOs and villages and municipalities. Northeastern Illinois agencies actively involved in watershed planning that addresses aquatic ecosystems includes but is not limited to: Chicago Metropolitan Agency for Planning (CMAP), Lake County Stormwater Management Agency (SMC), regional Forest Preserve Districts, the DuPage River Salt Creek Workgroup (DRSCW), the Des Plaines River Watershed Workgroup (DRWW), Metropolitan Water Reclamation District and Open Lands. Federal and state agencies also contribute to this type of planning. Individual watershed plans are routinely submitted to Illinois EPA for approval. Planning at this scale directs the spatial extent of urbanization and also identifies various types of aquatic mitigation methods applied to regional watersheds. Recent watershed planning efforts use multivariate statistical methods that focus on faunal restoration.

A subset of watershed planning is focusing on climate change and incorporating management practices that will mitigate future impacts. CMAP has developed two technical reports addressing the impacts of climate change for the northeastern Illinois area and identifying needed changes to regional infrastructure and management.[43,44] Global climate change has the potential to effect dramatic changes in aquatic environments. Local communities and counties will need to adjust engineering specifications for detention and retention ponds that are already in place. Freeboard requirements (the storage space above normal water level) for local ordinances for detention and retention ponds will need to be modified. Sewage treatment plants will have to plan for excessive flooding events. Changes of this type will impact flow regimes and water chemistry and they will potentially impact species like the Iowa Darter.

Research
Another mitigation opportunity is to support research needs that will lead to a better understanding of the Iowa Darter and provide information that will improve conservation plans.

Research needs

Questions which would benefit our understanding of Iowa Darter conservation include:

- Life history studies, especially those comparing lake populations to stream populations
- Genetic profiling of regional populations across the full range of its geographic distribution
- Additional presence/absence surveys to confirm regional distribution
- Profiling of stressors
- Analysis of sportfish diets in lakes with E/T species
- Estimation of population dynamics in lakes and streams
- Estimation of collection efficiency associated with different types of sampling gear; Iowa Darters are rarely found in large numbers
- Importance of Iowa Darter populations for sustaining freshwater mussel species
- Understanding of spatial partitioning in lakes
- Impact of chemical herbiciding and mechanical harvesting on resident populations in lakes
- Cool groundwater is fundamental to Iowa Darters, especially in streams. More information is needed on regional aquifers, human influences on groundwater supply,[45] and how this could impact Iowa Darters.

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