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Distribution and Relative Abundance of the Gilt Darter (*Percina evides*) in Wisconsin

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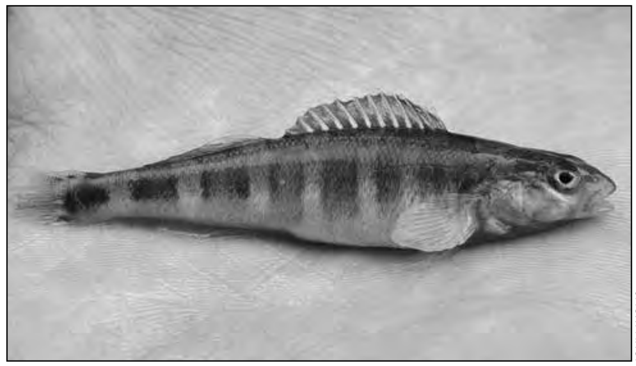
Bureau of Science Services

Abstract

The gilt darter *(Percina evides*) is an intolerant species that is currently recognized as threatened in Wisconsin, but no targeted surveys to provide a comprehensive overview of its status in Wisconsin or monitor trends in its abundance have been conducted previously. We conducted backpack electrofishing index sampling in riffle habitat preferred by gilt darters to evaluate their current status in areas of known occurrence and provide a baseline against which to assess future abundance trends. Index sampling provided repeatable results, consistently ranking sites sampled multiple times within a season. Within the St. Croix River drainage, gilt darters were rare in upstream reaches and more abundant downstream. We also evaluated the outcome of a restoration project that was conducted during 1997 but not thoroughly evaluated. Gilt darters were moved from the St. Croix River to the Namekagon River above the Trego Dam, where they had not been detected since 1982. Sampling during 2009-2010 indicated that gilt darters were not present in the restoration area; therefore, this translocation approach to mitigation is not recommended. Non-wadeable reaches in the St. Croix River were sampled with a bottom trawl, and this sampling confirmed the presence of gilt darters. Gilt darters were present at low abundance in the Chippewa River drainage and the Black River, where habitat fragmentation may restrict distribution. This species appears secure in the St. Croix River where monitoring wadeable reaches with backpack electrofishing will be sufficient to detect large changes in abundance in preferred habitat.



JOHN LYONS

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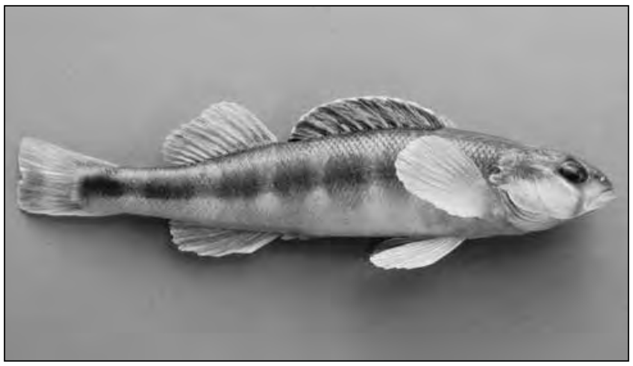

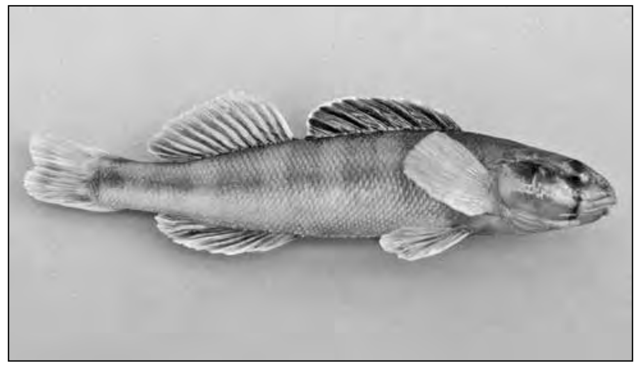

PHOTOS: JOHN LYONS

Gilt darters.

Introduction

The gilt darter (*Percina evides*) is an intolerant species that has become extirpated in several Midwestern rivers (Trautman 1957, Smith 1979, Becker 1983) and is currently recognized as threatened in Wisconsin and as a species of special concern in Minnesota. Eddy and Underhill (1974) referred to the St. Croix River population as a "modern relict population" because of habitat modification that restricted its range. In Wisconsin, the gilt darter's distribution is limited to the Chippewa, Black, and St. Croix river drainages, with the most records from the St. Croix River. Becker (1983) noted the difficulty of sampling the preferred habitat of gilt darters and the scarcity of records with which to assess their status. Despite their known sensitivity to impacts such as siltation (Hatch 1982, 1986), no targeted surveys to provide a comprehensive overview of their status in Wisconsin or monitor trends in abundance have been conducted previously.

Gilt darters occur primarily in medium sized rivers (Becker 1983), where standard river monitoring conducted by the Wisconsin Department of Natural Resources (Wisconsin DNR) consists of boat-mounted electrofishing. This type of sampling is conducted to assess assemblage composition and gamefish abundance but is not efficient for capturing small benthic fishes in shallow water. Records of gilt darter occurrence from river monitoring and incidental sampling for other purposes are useful for documenting their presence, but provide little information to understand differences in local abundance or trends in abundance over time. Understanding the current distribution and detecting future trends are important objectives for management of rare taxa. Given the number of rare species and the limited resources available for surveys, methods need to be efficient and inexpensive (Molloy et al. 2010).

Although additional information on gilt darters is needed throughout their limited range in Wisconsin, an area of particular interest is the Namekagon River above the Trego Dam, where the last record of a gilt darter occurred during 1982. Their decline and possible extirpation above the dam led to an effort by the Wisconsin DNR and the National Park Service to reestablish a reproducing population during 1997. During 1997, more than 800 individuals were translocated from the St. Croix River to a site approximately 28 river kilometers upstream of the impoundment created by the Trego Dam (1997 memorandum from L. Damman to J. Gozdzialski; unreferenced). Although limited sampling was conducted in the restoration project area after the transfer without detecting gilt darters (unpublished Wisconsin DNR file data), no standardized assessment was conducted to determine if the ultimate objective of reestablishing a reproducing population was achieved.

The objectives of our study were to evaluate the outcome of the gilt darter restoration project above the Trego Dam, establish a rapid standardized sampling approach for monitoring trends in gilt darter abundance in preferred habitat in Wisconsin, and determine the current status of gilt darters throughout their Wisconsin range.

Methods

Study Area

Most sampling was conducted in wadeable habitats in the upper St. Croix River drainage, including reaches with historical records of gilt darter presence and areas likely to contain gilt darters based on known habitat preferences described by Hatch (1986): the St. Croix, Moose, Namekagon, Totagatic, Trade, and Wood rivers (Figure 1). The Totagatic River had no records for gilt darters, but it is connected to the Namekagon and has had relatively little sampling conducted because of difficulty with access. Most records from the Namekagon River were from road crossings but little is known regarding distribution throughout that system. The core study area with standardized sampling (described below) included only the upper reaches of the drainage where backpack electrofishing could be deployed. However, gilt darters are known to occur downstream of our study area in the St. Croix River to the Apple River, a distance of approximately 160 river kilometers. The water is generally deeper in these downstream areas, requiring different sampling methods such as a bottom trawl.

We also sampled wadeable reaches of the two additional river drainages with recent reliable records (reports with locality and a museum or photo voucher) of gilt darters in Wisconsin. These included the Chippewa and Jump rivers in the Chippewa River drainage, and the Black River (Figure 1).

Fish Sampling

Gears appropriate for sampling small benthic fishes in wadeable habitats include seines, kick nets, and backpack or towed electrofishing units. Generally, electrofishing is more efficient and is preferred over seining (Poos et al. 2007); furthermore, backpack electrofishing index sampling has been shown to be adequate for detecting spatial and temporal trends in abundance of stream fishes (Bertrand et al. 2006). Much of the study area is part of the St. Croix River National Scenic Riverway, and is managed for aesthetics. Access is restricted to primarily carry-in canoe landings, and much of the Namekagon River is not amenable to motorized boating. Because many of the sampling sites are remote and can only be accessed via canoe, the more portable DC backpack electrofishing unit is more practical than a towed unit.

Sampling was conducted during summer 2009 and 2010. The sampling approach used was to deploy the backpack electrofishing unit in high quality gilt darter habitat (Hatch 1986), which was visually assessed and defined by depth (site predominately 0.2-0.8 m deep with 1.0 m max depth), flow (moderate-fast flow sufficient to keep fines from accumulating) and substrate composition (cobble-boulder over gravel and sand). By sampling only within similar habitats, we minimized variance that results from gear efficiency and fish behavior differences that occur among habitat types (Peterson and Rabeni 1995). Previous work in the St. Croix River system demonstrated

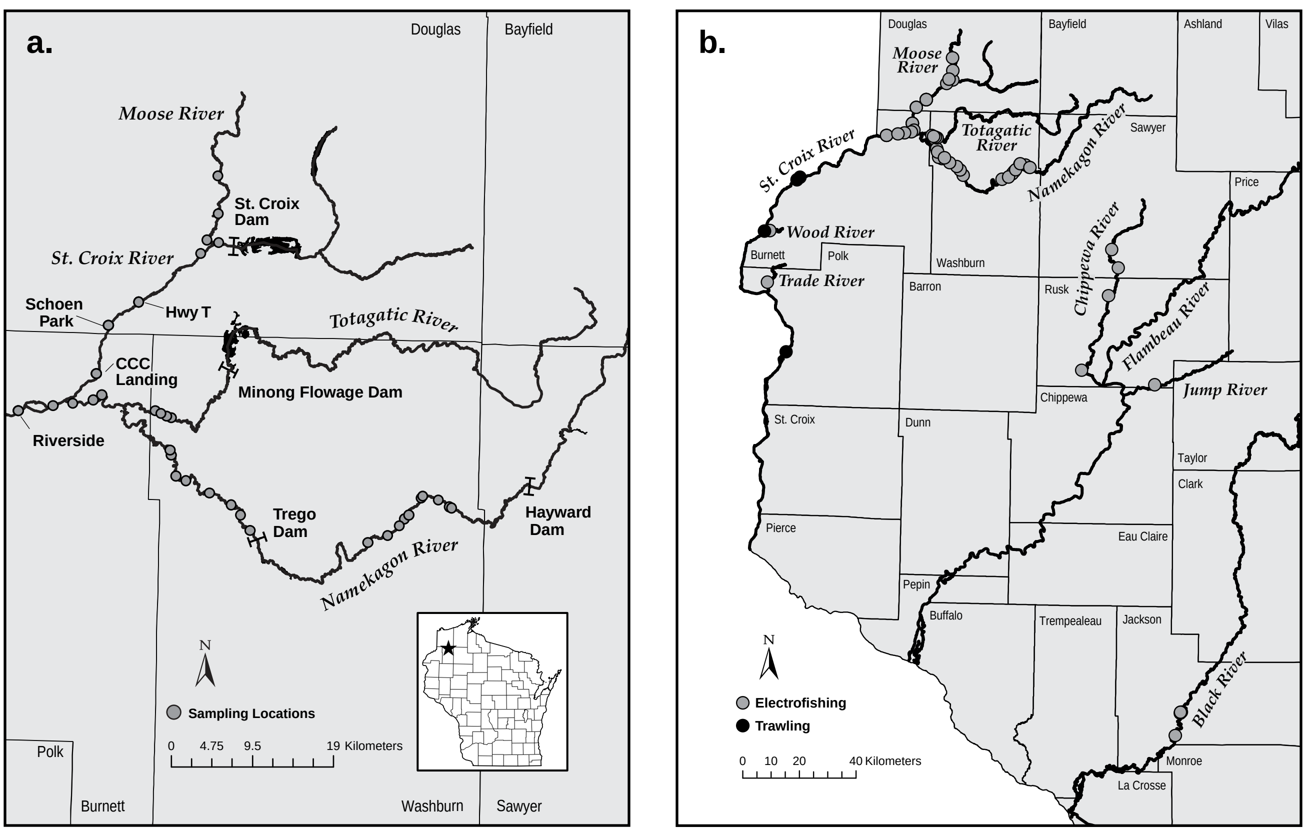

Figure 1. *Sites sampled for gilt darters with DC backpack electrofishing or trawling during 2009 and 2010: a) sampling sites on the upper St. Croix River and its major tributaries, and b) overview of all sampling locations in Wisconsin during the study. The four labeled locations on the St. Croix River represent locations where repeated sampling was conducted to evaluate precision of the methods.*

a significant correlation between catch per effort (CPE) in riffle habitats and Peterson mark-recapture population estimates (Hatch 1986).

To standardize sampling effort we used a time-based approach with two-person crews. This avoided problems with area or distance-based effort estimates that were subject to high variance because of differing spatial distribution of habitat features, specifically the preferred boulder and cobble substrate. The effort deployed at each station (20 minutes) was based on preliminary sampling conducted during 2008. This amount of time stabilized catch rate differences resulting from patchy distribution, was likely to detect gilt darters where they were present, and was appropriate for the size of most riffles sampled.

In addition to gilt darters, all other darters were identified to species and enumerated. All darters were temporarily held in a bucket of water until the 20-minute sampling was completed. Most individuals were identified and released on site, except for voucher specimens collected from the Totagatic and Jump rivers and deposited in the University of Wisconsin Zoological Museum. Darter assemblage composition was documented for similar habitat within each reach in the St Croix River drainage.

Limited standardized backpack electrofishing sampling was conducted in the lower reaches of the Wood and Trade Rivers, which are tributaries of the St. Croix located downstream of the main study area (Figure 1). To confirm the presence of gilt darters in deeper habitats downstream of the study area, we deployed a bottom trawl similar to that described by Ridings (2009). The trawl was towed downstream for 60 seconds at a depth of 2-3 m. The trawl was deployed at four sites on the St. Croix River (Figure 1).

Sampling Variability and Statistical Analyses

We assessed the variability in backpack electrofishing CPE by conducting repeated sampling at four sites on the St. Croix River on three dates during 2009. We used Kendal's coefficient of concordance (Zar 1984) to test the null hypothesis that sampling resulted in random ranking of gilt darter abundance among the sites.

We considered the unit of interest to be a river reach, which was represented by replicate sites within a reach. Reach boundaries were defined by dams and access points, but contained areas of similar stream width and gradient. We chose sites non-randomly based on habitat, therefore, results do not reflect total abundance within the reach, but an index of abundance within high quality gilt darter habitat. Differences in catch per unit effort among reaches were evaluated with ANOVA and Student-Neuman-Keuls multiple comparison tests (α=.05). We conducted our analyses using SAS v. 9.2 statistical computing software (SAS Institute 2009).

Effort and Statistical Power for Monitoring

We considered reaches with high gilt darter CPE to be the priority for a long-term monitoring program. Analyses to develop sampling recommendations within this core area were designed to identify effort required to detect biologically meaningful changes in CPE (Gryska et al 1997). We calculated variance with a pooled sample of all sites in high-CPE reaches. Using this variance estimate, we assessed the statistical power (probability of detecting a true difference) associated with different levels of sample effort (sites), and different levels of difference in mean CPE at sites. The power analysis was conducted using Proc Power in SAS v. 9.2 (SAS Institute 2009) using the statistical test for a two sampled t-test for mean differences. SAS uses the following formula to calculate sample size:

$$N=(\sqrt{2}*\partial/\Delta)^2*(\alpha/_2+z_b)^2$$

Where N=sample size, ∂=the standard deviation of a single observation, Δ=the difference in the two population means, $\alpha/_2$= the probability of the type 1 error, and z_b=probability of a type 2 error.

Results

Gilt Darter Distribution

We sampled 47 sites with standardized backpack electrofishing for 20 minutes per site (CPE). A minimum of 3 sites was used to characterize gilt darter CPE within each river reach in the St. Croix drainage (Table 1, Figure 2). Three reaches (St. Croix River from Riverside to Schoen Park, and the Namekagon River from mile 0 to Namekagon Trails and from Fritz Landing to Whispering Pines) had greater gilt darter CPE than other reaches (ANOVA, $p<0.001$). No gilt darters were encountered in the Namekagon River above the Trego Dam, or in the Moose River. Abundance of gilt darters was greatest in downstream sites of the main study area with wadeable habitat, with abundance decreasing in smaller upstream reaches.

No gilt darters were detected with standardized backpack electrofishing at sites in the lower reaches of two additional tributaries of the St. Croix River, the Wood and Trade rivers. Both of these tributaries are located downstream of the core study area. Trawl sampling in deeper habitats (2-3m depth) of the St. Croix River downstream of the core study area confirmed the presence of gilt darters at all sampling locations (Figure 1). Although useful for documenting presence of gilt darters, the trawl was frequently hung up on submerged wood and boulders, and was not useful for quantitative assessment in complex habitat. Trawl deployment was discontinued after sampling four downstream sites to confirm gilt darter occurrence in areas where they have been previously reported.

Gilt darters were detected with standardized backpack electrofishing in the Chippewa, Jump, and Black rivers. CPE was low in all sampling conducted outside the St. Croix drainage (Table 1).

Sampling Variability

Repeated sampling at four sites on the St. Croix River resulted in similar catches of gilt darters on three different sampling dates, with ranks significantly different from random (Figure 3). Thus, backpack electrofishing CPE provided consistent indices of gilt darter abundance. Furthermore, the results suggested that sampling can be conducted over an extended period during summer and produce similar results.

Table 1. *Mean CPE and standard error (SE) of gilt darters sampled with standard deployment of DC backpack electrofishing unit in river reaches sampled during 2009 and 2010.*

River Reach	Number of Stations	Mean CPE (SE)
St. Croix River, Riverside to Schoen Park	3	16.1 (4.2)
St. Croix River, Hwy T to St. Croix Dam	4	0.7 (1.4)
Namekagon River, Mile 0 to Namekagon Trails	3	11.3 (4.0)
Namekagon River, Fritz Landing to Whispering Pines	4	19.2 (12.1)
Namekagon River, Whispering Pines to Hwy K	4	1.5 (0.6)
Namekagon River, Trego to Hayward	11	0.0 (0)
Totagatic River	4	2.2 (2.1)
Moose River	3	0.0 (0)
Wood River	1	0.0
Trade River	1	0.0
Chippewa River	4	1.0 (2.0)
Jump River	1	1.0
Black River	4	1.8 (1.7)

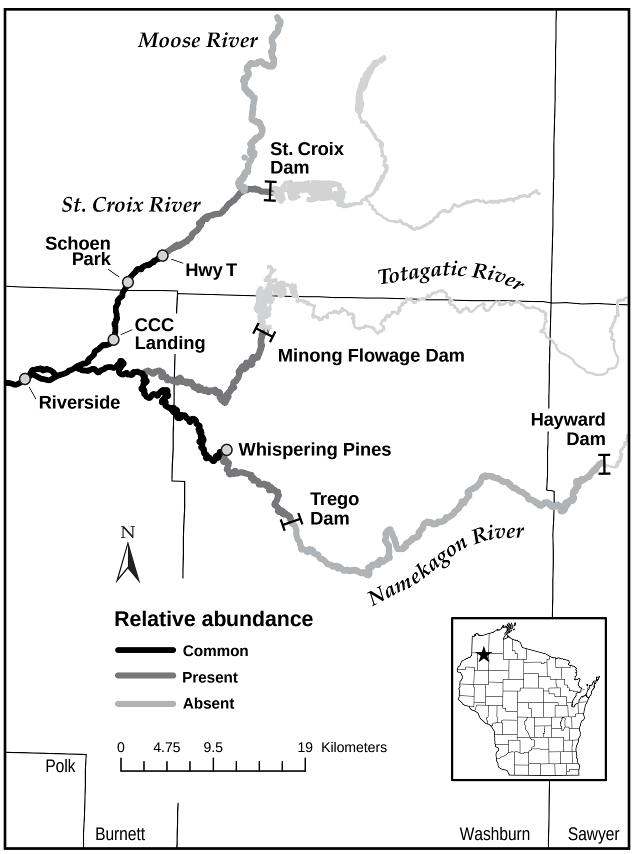

Figure 2. *Relative abundance of gilt darters within river reaches of the upper St. Croix River drainage sampled during 2009. Reaches rated as "common" had significantly greater CPE than reaches rated as "present." General distribution throughout the system indicates decreased abundance in upstream reaches. Waters shown in lightest gray were not sampled.*

Darter Assemblage

Sampling also detected other darter species (Figure 4). Changes in the darter assemblage in the St. Croix drainage occurred concomitantly with decreases in gilt darter abundance (Figure 5). As gilt darter numbers diminished in upstream sites, numbers of blackside darters (*P. maculata*), Johnny darters (*Etheostoma nigrum*), and logperch (*P. caprodes*) increased. Slenderhead darters (*P. phoxocephala*) were detected only at the Riverside Landing station, which was expected based on their preference for larger river habitat.

Effort and Statistical Power for Monitoring

Multiple comparison tests indicated that abundance of gilt darters was not significantly different among the three reaches with greatest abundance. These reaches included the St. Croix River from Riverside to Schoen Park, and the two lower sections of the Namekagon River (Table 1). We consider these reaches with relatively high CPE to be the highest priority areas for future quantitative monitoring. Using results from all samples taken within these reaches (N=16), we computed the mean CPE for 20 minutes of backpack electrofishing sampling and standard deviation (mean=16 ± 7.1). These values were used to conduct a power analysis that assumed similar variance in future samples, and tested power under different scenarios for mean CPE. The power analysis indicated that differences in true CPE of 50% or greater would be detected with >80% probability with sample effort of 15 sites per monitoring period (Figure 6). Given that fish populations are naturally variable, smaller differences are unlikely to be a cause for immediate concern. Sample variability was sufficiently high that smaller differences are less likely to be detected, even with additional effort. An effort level of 15 sites could be accomplished by a 2-person crew in 4 days or less, depending on access to sample sites (road or canoe). Monitoring at low abundance sites (Chippewa and Black rivers, upstream reaches in St. Croix drainage) will be useful for documenting presence/absence, or possibly for detecting increases in abundance.

Discussion

Sampling Approach

The sampling approach was effective for sampling darters in high quality gilt darter habitat within the study area. Repeated sampling at four St. Croix River sites indicated that abundance indices were sufficiently stable during July and August to be useful for characterizing gilt darter CPE. Results were also consistent among sites within reaches, including both high CPE reaches and low CPE reaches such as the Totagatic and the Namekagon immediately below the Trego Dam. Thus, the sampling approach represents a suitable method for detecting gilt darters and providing a repeatable measure of relative abundance in wadeable habitats.

Indices based on single passes with any of a variety of gears (seining, shocking, visual surveys) are limited by mostly unmeasured biases that can be affected by habitat, fish behavior, or limits of the gear. If the questions revolve

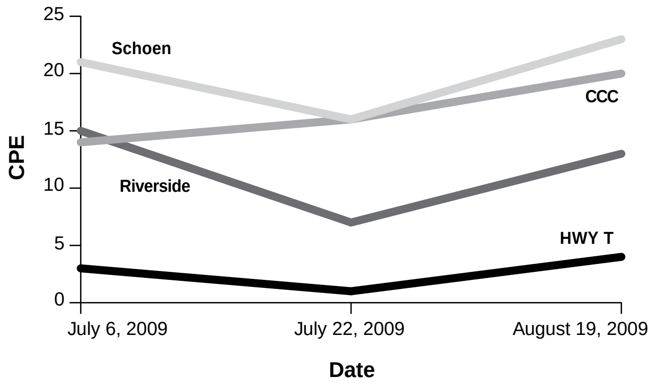

Figure 3. *CPE of gilt darters sampled with DC backpack electrofishing unit in the upper St. Croix River drainage. Four sites were sampled with standardized effort on three separate dates. Site ranks were stable (Kendal's coefficient of concordance, p<0.005).*

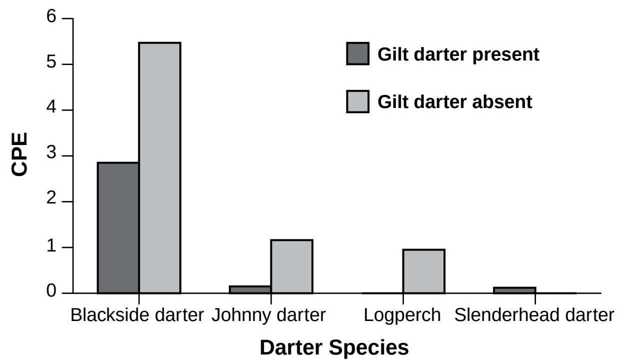

Figure 5. *CPE of darter species comparing sites with and without gilt darters. Data include St. Croix River drainage sites sampled during 2009 (N=36 sites). CPE is based on DC backpack electrofishing at timed (20-minute) stations in riffle habitat.*

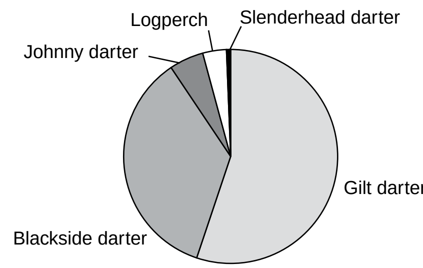

Figure 4. *Relative abundance of darters in the upper St. Croix River drainage (St. Croix, Namekagon, Totagatic, and Moose rivers) sampled during 2009. Sampling was conducted with a DC backpack electrofishing unit in riffle habitat during summer (N=36 sites).*

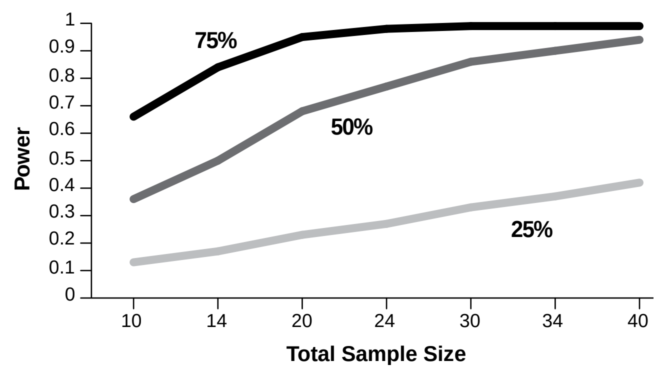

Figure 6. *Approximate statistical power comparing CPE in high-abundance reaches, assuming similar levels of sample variability. Curves represent a hypothetical difference between the 2009 mean CPE at the site level (16) and 25%, 50%, and 75% decreases in CPE for 20 minutes of sampling with DC backpack electrofishing unit. For example, a sample size of 30 (15 sites per sampling period) provides >80% probability of detecting a 50% difference in CPE.*

around detecting population trends (spatial or temporal), however, systematic bias in the methods is not necessarily a problem. CPE abundance indices based on electrofishing have been used successfully to monitor a wide range of fish species, from gamefish in lakes (Serns 1982, 1983) to rare fishes in streams (Quist et al 2006). Given the number of threatened fauna and the resources available to monitor and manage them, methods that provide greater spatial coverage with minimal expense, and which can be deployed quickly and simply are advantageous.

Future sampling of designated riffles in a fixed-site design (Quist et al 2006) will be adequate to detect major changes in CPE. Effort in high abundance reaches should include at least 15 sites. Sampling should also take place in upstream reaches of the St. Croix River drainage (St. Croix River above Hwy T, Totagatic River, and Namekagon River above Whispering Pines) and the Chippewa and Black rivers to track changes in distribution.

When sampling objectives require highly accurate estimates of absolute abundance or biomass, approaches such as mark-recapture population estimates are most appropriate. These methods are far more time consuming and expensive than CPE indices. Such methods also have the disadvantage of extra handling that can induce mortality (problematic for conservation of rare species), and are difficult to employ in large, open systems where model assumptions related to fish movement and mortality can be easily violated. Other sampling approaches such as adaptive cluster sampling require more effort but have clear application for critically imperiled taxa with clustered distribution (Davis and Cook 2011). An important issue is to recognize the limitations of the method and use the information appropriately.

Gilt Darter Distribution

Gilt darters were the most abundant darters in wadeable habitat of the upper St. Croix and lower Namekagon rivers, and appear to be secure in this system. Their relative abundance was reduced in the upper reaches of the study area, consistent with published descriptions of this species as inhabitants of medium sized rivers (Becker 1983). Sampling conducted during 2009 provided the first documentation of gilt darters in the Totagatic River. This newly designated state wild and scenic river has not been sampled extensively in the past, primarily because of difficulty with access. Although records exist for gilt darters collected in other smaller tributaries, including the Moose and Wood rivers, we did not detect them in our sampling. Site localities for museum specimens from smaller tributaries indicate that they were collected near the confluence with the St. Croix. These smaller systems are likely to harbor occasional transient individuals.

No gilt darters were detected above Trego Dam on the Namekagon River. Sampling effort was substantial, with 11 sites in high quality gilt darter habitat evaluated. These results indicate that the 1997 translocation did not lead to any measurable recovery of gilt darters in this reach, where they are likely extirpated. The general trend of decreasing abundance in upstream waters is useful for interpreting this result. Based on the overall distribution within the upper St. Croix drainage (Figure 2), we can speculate that gilt darters were never abundant above the present site of the Trego Dam. This area was likely a population sink dependent on movement from downstream areas. While this reach was used by gilt darters in the past, this habitat is unlikely to support an isolated, self-sustaining population. Without the reestablishment of connectivity to downstream areas, further efforts to reintroduce gilt darters above the dam are not likely to succeed; therefore, we do not recommend this approach to mitigation.

Dams likely affect the distribution of gilt darters in the other Wisconsin rivers where they occur (Figure 7). In the Chippewa River, gilt darters are known to occur only above the Holcombe Flowage, which likely provides a barrier to downstream movement. The suitable area of the Jump River is short and isolated from other gilt darter habitat. Longer stretches of the Chippewa River between the impounded waters of the Holcombe and Chippewa flowages appear to provide suitable habitat, although we found few gilt darters in our samples. In the Black River, dams in the Black River Falls area restrict upstream movement. A limited amount of suitable coarse substrate exists in the vicinity of Hawk Island but this preferred habitat is uncommon downstream. Because of this restricted distribution and scarcity of suitable habitat, gilt darters in the Black River face a more uncertain future than populations in the St. Croix River.

Whereas habitat connectivity is eliminated by dams and restricts movement of gilt darters in upstream reaches of the St. Croix River and its tributaries, different threats occur downstream. The lower St. Croix River is considered impaired based on water quality criteria (MPCA 2012). Management plans to limit nutrients are in place, but existing patterns of land cover and human activity will continue to stress the system. Further downstream in the Mississippi River drainage gilt darters are considered extirpated in Iowa (Harlan et al. 1987) and Illinois (Smith 1979). In Minnesota, gilt darters are restricted to the St. Croix River drainage including the Sunrise, Snake, Kettle and Upper Tamarack rivers (Hatch 1986). Understanding the distribution of sensitive species and establishing a baseline for monitoring future trends is important in systems like the St. Croix River, where expanding urban development and agriculture provide challenges to maintaining water quality required by sensitive fish species.

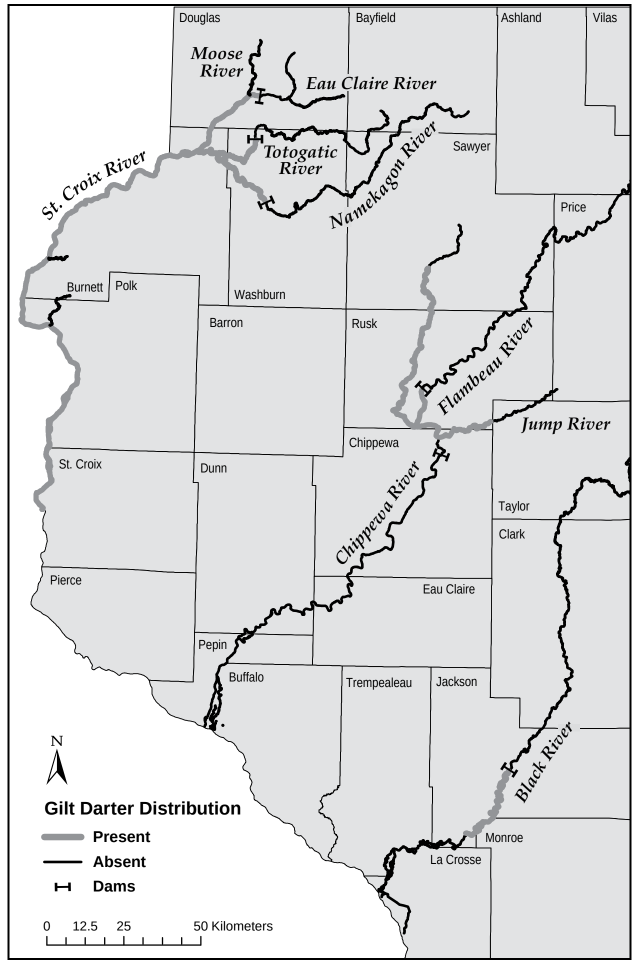

Figure 7. *Statewide distribution of gilt darters including all three drainages with historical records of occurrence in Wisconsin. Dams shown restrict the current distribution of gilt darters.*

DNR FILE

St. Croix River.

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