

## Current Status and Historic Range of One of Illinois' Rarest Fish

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### ABSTRACT

The Bigeye Chub (*Hybopsis amblops*) was once prevalent in the streams and rivers of Eastern and South Central Illinois. Populations of this species dwindled throughout Illinois in the middle of the 20th century, to the point that the species was thought to be extirpated from the state (Smith 1979; Warren, Burr 1988). Recent sampling within Eastern and South Central Illinois have found reemerging populations of *H. amblops* across multiple basins. An intensive survey of the Vermilion River (Wabash River Drainage) in 2011 showed multiple year classes present and suggests that a healthy population of *H. amblops* is present in this basin. Additionally, a historic species distribution model was created to estimate the possible historic range of this species in Illinois. This model suggests that the possible historic range of *H. amblops* in Illinois included the entirety of the Vermilion, Little Vermilion, and Brouillets Creek basins as well as the northern parts of the Kaskaskia, Embarras, and Little Wabash River basins.

### INTRODUCTION

Alterations to lotic systems throughout Illinois in the 20th Century have led to the decline of several fish species throughout the state (Burr et al. 1996; Page, Retzer 2002). The Bigeye Chub (*Hybopsis amblops*) was once prevalent in the streams of Eastern Illinois but saw one of the most drastic population declines compared to other minnow species (Warren, Burr 1988). Declines were so drastic during the 1970's and 1980's it was thought to be extirpated from the state (Smith 1979). Despite continued sampling, dwindling records of this species led it to be listed as Endangered under the Illinois Endangered Species Act (Illinois Endangered Species Protection Board 2011). Sparse records from prior to the decline of this species only provide marginal information regarding the historic range of this species in Illinois.

Contemporary fish community samples from Eastern Illinois have found an increasing number of *H. amblops* throughout multiple river systems (INHS Fish Collection #105719, 105799, 105867, 106218, 106709). Analyses of these sampling sites are necessary to determine whether stable populations of *H. amblops* are present and if these populations represent displaced populations from elsewhere in this species' range. Furthermore, analysis of the historic range of this species in Illinois is needed to determine if this species is currently occupying those river systems where it was once found.

It is the goal of the authors to 1) Analyze recent samples to determine whether current populations of *H. amblops* are natural-

ly reproducing in Illinois, and 2) Create a historical distribution map of the range of *H. amblops* throughout Illinois.

### METHODS

Contemporary and historical museum records and surveys were examined for *H. amblops* occurrence data in Illinois (IDNR 2013; INHS 2013; Page, Retzer 2002; Tiemann, Retzer & Tiemann 2005; Warren Jr., Burr 1988). These data were divided into 4 distinct time periods that represent records prior to range reduction (prior to 1960), the range reduction as described by Warren and Burr (1988) (1960 – 1988), the status as of 2001 (1989 – 2001) (Page, Retzer 2002), and the range expansion since 2001 (2001 – 2012). Historical localities were georeferenced when possible and those records without accurate locality information were not used.

In order to better estimate the historical range of *H. amblops* in Illinois, a historical species distribution map was created. The objective of this model is to predict the range of *H. amblops* in Illinois prior to the period of range reduction. Historic records were collected by searching the online Fish Net Database ([www.fishnet2.net](http://www.fishnet2.net), accessed 24 Mar 2014) for records of *H. amblops* occurrence. These data were georeferenced as accurately as possible and those without accurate locations were omitted. A phylogeographic analysis of *H. amblops* across its range suggests divergence between populations in the Ohio River drainage (upstream of the Cumberland and Tennessee Rivers, including the Wabash River drainage) and those found in the Columbia River,

throughout Tennessee and areas of Kentucky, and populations from the Ozark Plateau (Berendzen, Gambles & Simons 2008). Populations from the Ohio River clade largely inhabit areas affected by periods of glaciation, where the landscape is different from elsewhere in its range. In order to create a model that best represents the historic range of *H. amblops* in Illinois, only records from the Ohio River drainage upstream of the Cumberland and Tennessee Rivers were used.

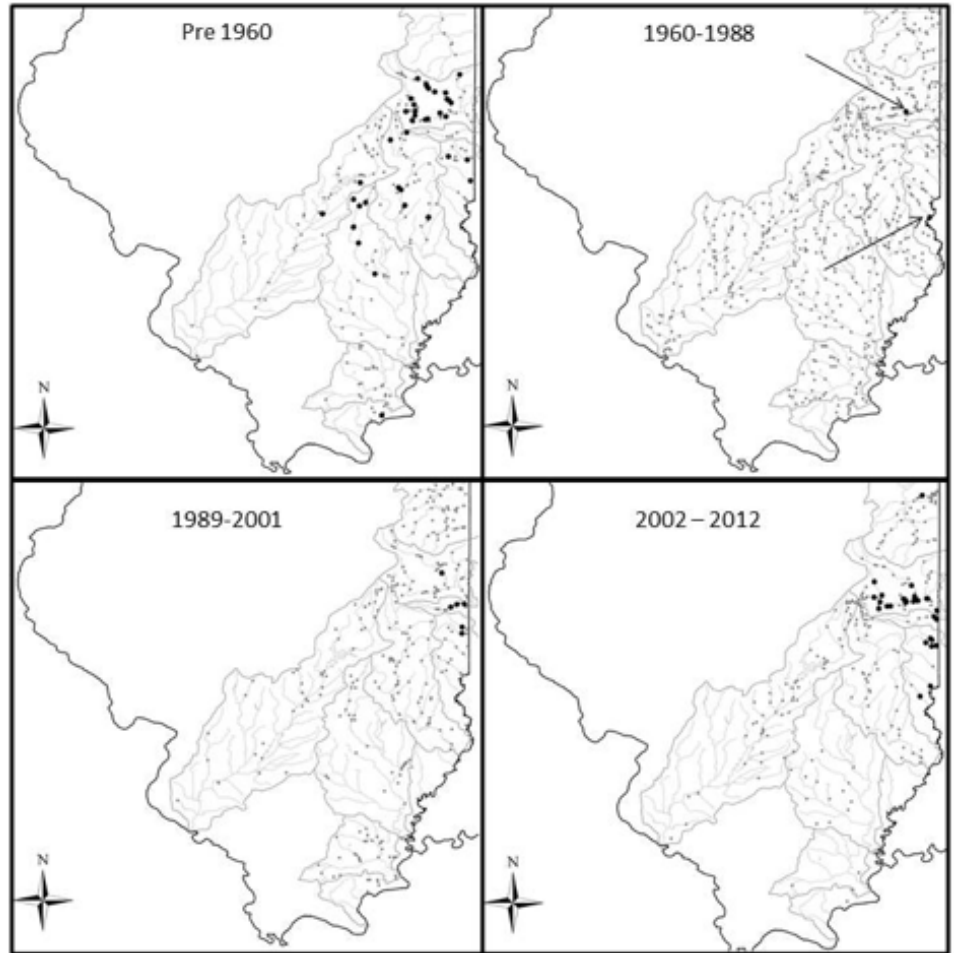
Data layers representing landscape and environmental factors were created using ArcMap 10.1 (ESRI, Redlands, CA). Base layers were downloaded from the National Atlas ([www.nationalatlas.gov](http://www.nationalatlas.gov), accessed 27 March 2014). A total of 9 environmental and landscape layers were used in the creation of the model. Land cover/land use data were not used in the creation of this model. Data layers and Bigeye Chub collection locations were entered into Maxent v3.3.3k (Phillips, Anderson & Schapire 2006). The model was created using data layers and presence locations from the Ohio River basin (excluding Illinois) and the resulting model was then projected to predict the *H. amblops* distribution in Eastern and Southern Illinois. Twenty percent of the Ohio River basin sites were randomly selected by Maxent to be used as test sites for the model while the remaining 80% were used as training sites. No historical records of *H. amblops* were collected from the Illinois River drainage, or other basins from Northern Illinois, so the resulting model was not projected onto these areas of the state. Six models were calculated using different combinations of en-

Environmental and landscape variables across the Ohio River drainage and each model were then projected to Southern and Eastern Illinois drainage basins. The predicted range of each model was then compared to all collection records from Illinois. For each model, the number of collection sites that were correctly predicted, as well as the number of predicted locations from drainage basins where no collection records for *H. amblops* have been recorded (false positives), were calculated. The model in which the number of correct locations predicted was maximized and the number of false positives was minimized was considered the best model.

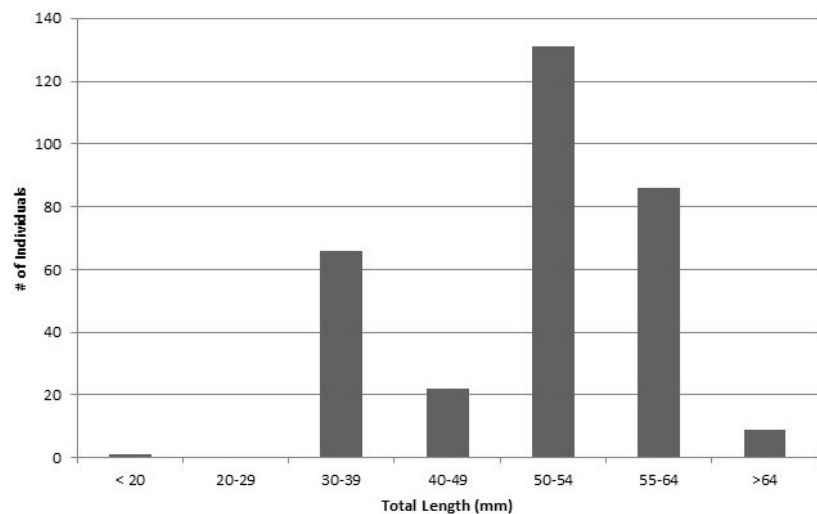
### RESULTS

Historical records indicate that *H. amblops* was found at 40 sites across 6 separate drainages throughout Eastern and South Central Illinois prior to 1960 (Figure 1). One discrepancy noted by Warren and Burr (1988) is that the record from Big Creek in Southern Illinois near the Ohio River is likely not *H. amblops* but a misidentified Pallid Shiner (*Hybopsis amnis*). The 28 years following this period yielded only 2 records of *H. amblops* in Illinois, from Stony Creek in the Vermilion River basin and from the Wabash River along the Illinois - Indiana border adjacent to Clark County, Illinois. Gammon and Riggs (1982) recorded collecting *H. amblops* from the lower 30 km of the Vermilion River in 1979, and one specimen was collected from the Vermilion River in Indiana in 1963 (INHS 73760). Samples performed after Warren and Burr (1988) and prior to Page and Retzer (2002) saw an increase in the number of *H. amblops* records, most of which occurred in the Little Vermilion River basin (9 records total, 6 from the Little Vermilion, 1 from the Middle Fork of the Vermilion, and 2 from the Brouillets Creek basin). Contemporary samples have yielded 35 records across 5 drainages in primarily Eastern Illinois. Tiemann, Retzer, and Tiemann (2005) recorded the first confirmed *H. amblops* from the Kankakee River basin (Illinois River Drainage, INHS 98619) and cited stream capture due to flooding and low topography in the area near the adjacent Kankakee and Tippecanoe River basins as a possible explanation for the range expansion.

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**Figure 1.** Maps of historical *Hybopsis amblops* collection records prior to range reduction (pre 1960), during range reduction (1960-1988), start of reestablishment (1989-2001), and current reestablishment (2002-2012). Black dots indicate locations where *H. amblops* were collected during each time period and grey dots indicate locations where collections were attempted but no *H. amblops* were collected.



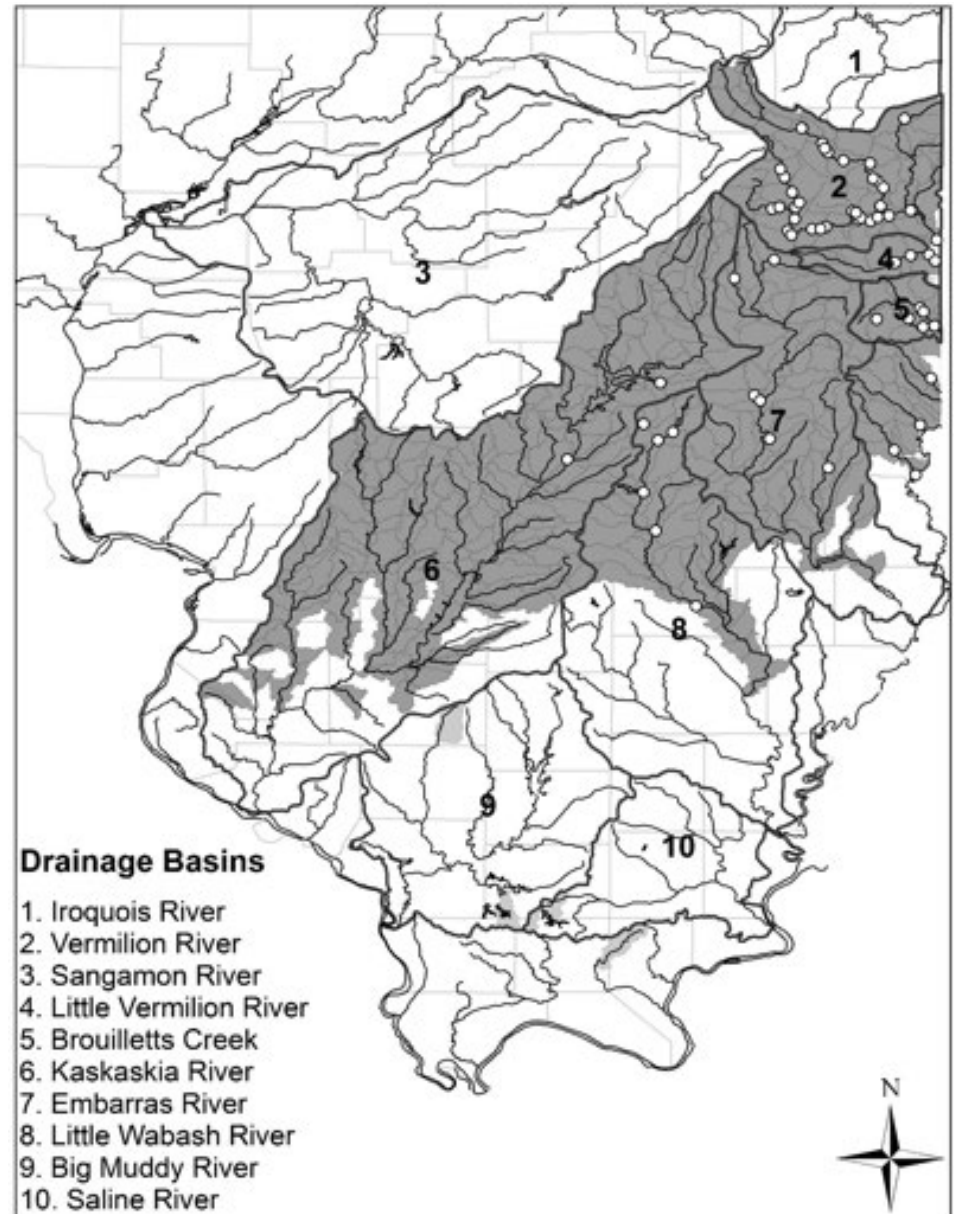
**Figure 2.** Length-frequency histogram of *Hybopsis amblops* collected during IDNR and IEPA 2011 Intensive Basin Survey of the Vermilion River of the Wabash. Pflieger (1997) indicates that this species reaches a length of ~50.8 mm by the end of the first summer and 63.5 - 76.2 mm by the end of the second summer. Etnier and Starnes (1993) states that this species reaches sexual maturity at a length of 55 mm in Tennessee.

sources and Illinois Environmental Protection Agency's 2011 Intensive Basin Survey of the Vermilion River Basin has provided valuable data on contemporary *H. amblops* populations (IDNR 2013). This survey collected 315 individuals from 6 sites in the Vermilion River basin. Length-frequency data from this survey suggests that multiple year classes are present in this basin (Figure 2). Ninety-five individuals were collected that are of a length equal to or greater than the length of sexual maturity (55 cm) (Etner, Starnes 1993). The length group with the most number of individuals sampled (131 individuals) consists of those greater than the size at the end of the first summer (Pflieger 1997), but are likely not sexually mature (50-54 mm) and suggests a strong recruitment from the 2010 year class. These data also indicate that 89 individuals captured were of a length small enough to be considered young of the year for 2011.

The Fish Net Database search yielded 668 *H. amblops* records across the Ohio River drainage. A total of 6 models were created using different combinations of 9 data layers representing basin size (flow accumulation), elevation, slope, ecoregion (Bailey 1980), mean annual precipitation, mean annual precipitation days, mean maximum daily temperature, mean daily temperature, and mean annual days below 0° C. The best model utilized 8 of the 9 data layers and correctly predicted all 84 sites where *H. amblops* was collected in Illinois while only predicting 4 locations in basins where no *H. amblops* have been collected (Figure 3). The model suggests that the historic range of *H. amblops* in Illinois includes the entirety of the Vermilion River (Wabash River Drainage), Little Vermilion, and Brouillets Creek basins. The range also includes all but the southern portions of the Kaskaskia, Embarras, and Little Wabash River basins.

### DISCUSSION

Both Smith (1979) and Warren and Burr (1988) suggested a bleak outlook for the continued occurrence of the *H. amblops* in Illinois. Each hypothesized that all viable populations were extirpated from the state at the time of their respective publications. Populations of *H. amblops* remained in eastern tributaries of the Wabash River throughout Indiana during the period of range reduction in Illinois (Carney, Page



**Figure 3.** Historical range of *Hybopsis amblops* in Illinois as predicted by the best Maxent model. Dark grey areas represent areas where the model predicted *H. amblops* occurrence and are basins where historical records confirm presence in the basin. White dots represent *H. amblops* collection locations in Illinois. Light grey areas represent areas that the model indicates as suitable but where no collection records have been recorded from that basin.

& Keevin 1993; Curry, Spacie 1977; Harrington 1999; Whitaker, Wallace 1972). Additionally, Fisher, Wentz, and Simon (1998) collected *H. amblops* at 11 sites in Tippecanoe County, Indiana in 1994, which increased from only 4 sites from samples performed in 1978, suggesting a concurrent expansion of *H. amblops* populations in Indiana at the same time it was expanding in Illinois.

Collections of *H. amblops* from the Wabash River suggest this species has the ability to survive in larger rivers and indicates that the Wabash River would not act as a barrier to the recolonization of Illinois streams from extant populations in Indiana or from populations within the Wabash River. However, the distance separating recolonized locations indicates that multiple founder events likely occurred from streams east of the Wabash River. Also the continued ab-

sence from the lower Embarras and Little Wabash (tributaries of the Wabash River) suggests that reemerging populations likely are not dispersing from the Wabash River. A dam on the Vermilion River at Danville, IL, downstream of locations where *H. amblops* are now most prevalent, may not be a complete barrier to the dispersal of fish species from the Wabash River to areas upstream, but could hinder the dispersal of *H. amblops* from the Wabash River. It is our opinion that it appears more likely that small populations remained within Illinois basins where it has reappeared.

Whether recolonization occurred through multiple founder events or via small, surviving populations, the occurrence of *H. amblops* in Illinois may still be in jeopardy. In either scenario, it is assumed that the current populations emerged from few individuals. Situations such as these lend to the possibility of reduced genetic variation in current populations through founder effects or through genetic bottlenecks (Meffe 1986). Further research into the genetics of current populations is necessary to determine the genetic health of this species in Illinois and to determine whether it is necessary to increase genetic diversity through supplemental stockings of individuals gathered from elsewhere in the Ohio River Drainage.

The current populations of *H. amblops* in Illinois are found in a rather small geographic area, allowing any adverse climatic events (i.e. droughts, major floods) to effect the majority of the current population. The model of the *H. amblops*'s historic range suggests that it's currently inhabiting a fraction of its historic range within the state. It is likely that this species will still be at risk in Illinois until it is recolonized in more of the basins found within its historic range.

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Illinois Natural History Survey, Sam Noble Oklahoma Museum of Natural History, Academy of Natural Sciences, University of Michigan Museum of Zoology, Texas Natural History Collections, University of Arkansas Collection Facility (Fayetteville, Arkansas), National Museum of Natural History, Ohio State University, University of Kansas, University of Tennessee, Texas A&M, Mississippi Museum of Natural Science, California Academy of Sciences, Florida Museum of Natural History, the Field Museum of Natural History, North Carolina State Museum of Natural Sciences, Harvard Museum of Comparative Zoology, Tulane Museum of Natural History, and the Cornell Museum of Vertebrates.

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