Conservation Assessment for Bluehead Shiner (*Pteronotropis hubbsi*)

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The goal of this report is to provide information for the U.S. Forest Service regarding the life history, status, and distribution of *Pteronotropis hubbsi*, the bluehead shiner, as well as addressing current research, conservation, and management practices on this species. Only a handful of studies have been published regarding the biology of *P. hubbsi* (e.g., Burr and Warren, 1986; Taylor and Norris, 1992; Fletcher and Burr, 1992), and a few more discuss taxonomy and distribution, but this information has not yet been compiled into one comprehensive document. Indeed, there remains a paucity of information on the biology and distribution of *P. hubbsi*, and its taxonomic status is in a constant state of flux. The present document compiles much of the information on *P. hubbsi*, and also addresses potential threats to existing populations, documents current land use where this species occurs, and suggests future research priorities aimed at management and conservation of this species.

Background

The genus *Pteronotropis*, commonly referred to as the "sailfin shiners," is composed of five species* distributed throughout the Gulf and Atlantic Coastal Plain of the southern United States (Page and Burr, 1991). Males develop a flag-like dorsal fin and spectacular coloration during the breeding season, making them highly coveted by many aquarium fish hobbyists. These fishes are typically found in swamps and small streams, but also occur in backwaters of rivers and lakes (Bailey and Robison, 1978; Page and Burr, 1991). *Pteronotropis hubbsi* was originally discovered by G. E. Gunning in southern Illinois in 1954. It was not described until over 20 years later, after B. M. Burr and L. M. Page found 12 adults and 187 young-of-the-year in Wolf Lake, Illinois. The adult specimens found by Burr and Page were designated as paratypes in the original description of *Notropis hubbsi* by Bailey and Robison (1978). Populations of *P. hubbsi* exist in Arkansas, Louisiana, Texas, and Oklahoma, and historically in southern Illinois, although the Illinois population is believed to be extirpated.

Taxonomy

Pteronotropis hubbsi belongs to the order Cypriniformes, family Cyprinidae. Some discord has surrounded the generic status with various scientists proposing different taxonomic assignments. Bailey and Robison (1978) originally assigned the bluehead shiner to the genus *Notropis*, and concluded it was closely related to the bluenose shiner, *P. welaka* (previously in *Notropis*), based on four synapomorphic characters. They

This Conservation Assessment (dated 15 June 2002) was prepared to compile the published and unpublished information on the subject taxon or community; or this document was prepared by another organization and provides information to serve as a Conservation Assessment for the Eastern Region of the USDA Forest Service. It does not represent a management decision by the Forest Service. Though the best scientific information available was used and subject experts were consulted in preparation of this document, it is expected that new information will arise. In the spirit of continuous learning and adaptive management, if you have information that will assist in conserving the subject taxon, please contact the Eastern Region of the Forest Service, Threatened and Endangered Species Program, 310 Wisconsin Ave., Suite 580, Milwaukee, WS 53203.

* Ed. note: Suttkus and Mettee (2001) described a new species of *Pteronotropis* and elevated one from synonymy, bringing the number of valid species in the genus to seven. Reference: Suttkus, R. D., and M. F. Mettee. 2001. Analysis of four species of *Notropis* included in the subgenus *Pteronotropis* Fowler, with comments on relationships, origin, and dispersion. Geological Survey of Alabama Bulletin 170: 1-50.

Fig. 1. Initial male bluehead shiner (*Pteronotropis hubbsi*). Photograph © William Roston.

also suggested that these species were monophyletic and may be allied to members in the genus *Cyprinella*. Several studies have since revisited the taxonomic relationships of these two species using morphological, biochemical, and molecular methods. Dimmick (1987), using allozymic comparisons, refuted the claims of Bailey and Robison (1978), suggesting that *P. welaka* and *P. hubbsi* did not constitute a monophyletic group, and that *P. hubbsi* was not closely related to members of the genus *Cyprinella*. Mayden (1989) first elevated *Pteronotropis* to generic level, including *P. welaka*, but leaving *P. hubbsi* in *Notropis*. Amemiya and Gold (1990), in documenting chromosomal nucleolus organizer region (NOR) phenotypes in several species of *Notropis* and *Pteronotropis*, united *P. hubbsi* and *P. welaka*, as well as *P. signipinnis*, into a monophyletic group in the genus *Pteronotropis*. Simons et al. (2000) assessed the monophyly of the five species of *Pteronotropis* using DNA sequences of the mitochondrial cytochrome *b* gene and found that while the genus was not monophyletic, the monophyly of *P. hubbsi* and *P. welaka* was strongly supported.

Description

The following description is taken from Bailey and Robison (1978). (See also Robison and Buchanan, 1988.) *Pteronotropis hubbsi* is described as a distinctive slab-sided species having usually 9 or 10 principle dorsal and anal rays and a broad dark lateral axial stripe extending from chin to just beyond caudal fin base where it ends abruptly. Mouth is terminal, sharply upturned; pharyngeal teeth in a single row, 4-4; snout projecting slightly beyond upper lip. Dorsal fin origin behind pelvic insertion, its distance from snout tip and caudal base subequal. Dorsal fin of males rounded and elongated, with middle rays longest. Eye moderate in size, with a diameter about equal to length of lower jaw. Lateral line incomplete; 2-9 pored scales; these scales not elevated; 34-38 scales in lateral series. Nuptial tubercles well developed but small in breeding males; irregularly distributed over the head, concentrated along mandible, anterodorsal rim of orbit, lower edge of lachrymal; uniformly distributed over dorsal surface. Tubercles also on body scales and fins.

Color Broad, dark lateral stripe crossing the chin without involving upper lip or snout. Stripe terminates at caudal base where it forms a deep, darker basicaudal spot that extends a short distance onto the caudal rays. Body dusky above, lower surface of head and belly light, chin distinctly black. Dorsolateral surface reddish orange extending from ahead of nostril back to caudal base. Rays of the basal half to three-fifths of caudal fin and basal half of dorsal fin also reddish orange. Males with olive yellow on membranes but not rays

of middle of anal fin. Dorsal fin of males dark, larger males with iridescent greenish blue on dorsal membranes from just proximal of the middle almost to its distal margin. Pelvic and anal fins washed with blue green. The top of the head from occiput to between the anterior edges of nostrils is a deep azure blue with green iridescence, hence the species' common name.

Habitat

Pteronotropis hubbsi typically inhabits quiet, backwater areas of sluggish streams and oxbow lakes (Bailey and Robison, 1978). The water is usually tea colored and heavily vegetated with plants such as *Proserpinaca palustris*, *Polygonum hydropiperoides*, *Nelumbo pentapetala*, or *Ceratophyllum demersum* (hornwort), with scattered *Nuphar luteum* (lillies) and *Taxodium distichum* (bald cypress) (Bailey and Robison, 1978; Goldstein et al., 2000). Substrates are generally mud, detritus, or mixed mud and sand (Bailey and Robison, 1978; Burr and Warren, 1986). Individuals school in slackwater areas away from substantial current and remain poised in mid-water just outside vegetation, where they dart for protection if disturbed (Bailey and Robison, 1978).

Distribution and Abundance

Pteronotropis hubbsi occurs in the lowlands of the Red, White, Ouachita, and Atchafalaya River drainages west of the Mississippi River in northeastern Texas, the southern one-third of Arkansas and northern Louisiana (Bailey and Robison, 1978; Fletcher and Burr, 1992). Only two known localities exist in northeastern Texas: Caddo Lake (Hubbs et al., 1991) and Big Cypress Bayou in Harrison County (Burr, 1992). Miller (1984) first documented the occurrence of *P. hubbsi* in southeastern Oklahoma in Crooked Creek, an outlet stream of Forked Lake, and recently Lemmons et al. (1997) found several specimens in bar pits adjacent to the Little River, east of the Crooked Creek site.

Historically, *P. hubbsi* occurred at three locations (Wolf Lake, Pine Hills swamp, and Otter Pond) in southern Illinois (Bailey and Robison, 1978; Burr and Warren, 1986). However, despite intensive sampling efforts by Boyd et al. (1975) and Burr and Warren (1986), no specimens have been collected from these locations since 1974 and it is believed that the southern Illinois population has been extirpated.

Little is known regarding the abundance of *P. hubbsi* in the wild. Populations show high levels of geographic and temporal variability. Also, conventional sampling methods (i.e., seining, electrofishing, minnow traps) are often ineffective in the densely vegetated habitat preferred by this species (Burr and Warren, 1986) which may result in unrealistic population estimates. Fletcher and Burr (1992) found it was the dominant cyprinid at Chemin-a-haut Bayou in northeast Louisiana, collecting approximately 740 individuals over four sample dates during 1986-1988. Douglas (1992) reported drastic population fluctuations in collections from the Ouachita River and nearby backwaters in northeast Louisiana. Collections from these sites during 1967-83 produced only three specimens, but 938 individuals were collected during 1984-1991. From 1992-1995, no specimens were collected, leading researchers to believe that increased *P. hubbsi* abundance during 1984-1991 was due to a biological response to hydrologic factors at this site (Douglas and Jordan, 2002). Burr et al. collected 12 adults and 187 young-of-the-year during 1974 in Wolf Lake, IL (Burr and Warren, 1986). However, after an intensive search for *P. hubbsi* in Wolf Lake during 1981-1985, Burr and Warren (1986) were unable to find any specimens. Robison and Buchanan (1988) suggest that *P. hubbsi* are migratory in Ouachita drainage systems. Individuals are never found in upstream areas, except during the late spring when they are believed to migrate upstream to spawn. However, Taylor and Norris (1992) found no such pattern in the Oklahoma population used in their study.

Biology/Natural History

Surprisingly little is known about the general biology and life histories of individuals in the genus *Pteronotropis*. This is especially true of *P. hubbsi*, with only three studies examining the life histories of this species in Illinois, Louisiana and Oklahoma.

Reproductive Biology *Sexual Dimorphism and Polymorphism* *Pteronotropis hubbsi* males display two phases of development, initially coined "flag males" and "non-flag males" by Robison and Buchanan (1988). Fletcher and Burr (1992) later referred to these different phases as "secondary" and "terminal" males. Fletcher (1999) replaced the term "secondary males" with "initial males" to avoid confusion, as the first term was already used extensively in the literature in a different context. We will use Fletcher's (1999) terminology in describing life history aspects of these two phases. Fletcher and Burr (1992) observed that terminal males were longer than initial males and females, and had greatly expanded dorsal, anal, and pelvic fins. The blue coloration on top of the heads of small (42-45 mm SL) terminal males was faded and

was absent on the largest (=45 mm SL) individuals compared to the iridescent powder blue colored heads of initial males and females. Terminal males were deeper bodied and more "slab-sided" than initial males and females. All but the largest initial males (>38 mm SL) were also distinguished by iridescent blue coloration on pectoral and pelvic fins, while females lacked this coloration on fins. After the peak of the breeding season, both initial males and females lost the blue on their heads.

Initial males, which are one year younger than terminal males, transition into terminal males as length, and possibly age, increases (Fletcher and Burr, 1992). Large initial males placed in aquaria transformed into terminal males within a few months, while smaller initial males did not make the transition until the following year.

Terminal males were the dominant individuals in a school, spending much of their time chasing females and performing aggressive territorial displays. During these displays, terminal males, and sometimes large initial males, developed 10-12 dark vertical bars on their sides, exaggerating their apparent body depth (Unger, 1983). This display may emphasize the importance of heavy somatic mass for successful defense of territories and female acquisition (Fletcher, 1999). In support of this hypothesis, Fletcher and Burr (1992) found that vertical bars never developed on a solitary male held in an aquarium until other *P. hubbsi* (10 initial males and 10 females) were placed in its presence.

Reproductive Allotment—Males Testes and somatic weights of terminal males were significantly larger and heavier than those of initial males. As an initial male begins transforming into a terminal male during its second year of life (about 41 mm SL), an energy tradeoff occurs. More energy is allocated to increase somatic tissue, fin development, and agonistic behavior than gonadal tissue, resulting in disproportionately higher somatic weights in terminal males. Smaller, initial males allocate energy more proportionally to both somatic and gonadal tissue development, resulting in nearly twice as large a GSI* as terminal males. It is unclear if initial males are reproductively mature, but several lines of evidence suggest they are, including the presence of motile sperm, well-developed testes, and they were observed chasing females (Fletcher and Burr, 1992).

Reproductive Allotment—Females Females were apparently sexually mature at one year of age (between 36 and 40 mm SL). Two groups of follicles were readily recognizable in the ovaries of sexually mature females: 1) synchronously developing larger follicles, and 2) an asynchronous mixture of smaller follicles. The smaller follicles could be further divided into a group of vitellogenic follicles and a group of smaller pre- or only slightly vitellogenic follicles. This bimodal distribution of follicle size-classes indicates that *P. hubbsi* probably spawn multiple clutches during the May-July spawning season (Fletcher and Burr, 1992; Taylor and Norris, 1992). The larger follicles probably make up the clutch to be spawned, with the next clutch developing from the asynchronous batch of smaller follicles. Mature follicles were yellow-orange in color and range from 0.70 to 1.20 mm in diameter (Burr and Warren, 1986; Fletcher and Burr, 1992; Taylor and Norris, 1992) and adhesive upon release into the water (Fletcher and Burr, 1992). The number of mature follicles in sexually mature female *P. hubbsi* ranged from 172 to 1,129 (Burr and Warren, 1986; Fletcher and Burr, 1992; Taylor and Norris, 1992) and was significantly correlated with SL (Taylor and Norris, 1992). Mean GSI did not decrease with increased SL as it did in males (Fletcher and Burr, 1992).

Sex Ratios All sex ratios were calculated from collections of 84, 81, and 124 adults examined from Chemin-a-haut Bayou, Louisiana, by Fletcher and Burr (1992). The sex ratio of adult *P. hubbsi* during the spawning season was 1.3 females to 1 male. The ratio among the two male phases was 6 initial males to 1 terminal male. The sex ratio of 25 young-of-the-year individuals was 1:1.

Spawning Behavior While *P. hubbsi* spawning has never been observed in the wild, Fletcher and Burr (1992) observed what may be representative of a spawning act while individuals were being transported in plastic bags. Two males aligned themselves on each side of a female, vibrating rapidly while their dorsal fins curved over her back. Because no development took place in released eggs, this was an apparently unsuccessful spawning event, and possibly an artifact of the unnatural conditions.

Terminal and initial males were both observed to chase females in ponds and aquaria as well. Males swam beside and slightly above females with fins erect and heads downward, pushing the female toward the substrate. This act may represent pre-spawning behavior, although no complete spawning act was observed (Fletcher and Burr, 1992).

Nest Associates, Nest Sites, Nesting Behavior *Pteronotropis hubbsi* are nest associates of sunfishes, a common behavior among several lineages of North American cyprinids. Fletcher and Burr (1992) observed a terminal male defending a nest

* Ed. note: GSI stands for gonado-somatic index: the ratio of gonadal mass to body mass.

at the base of a bald cypress tree at Chemin-a-haut Bayou. Upon removing embryos from the nest, hatching, and rearing them to an identifiable size in aquaria, Fletcher and Burr (1992) discovered that both *P. hubbsi* and *Lepomis gulosus* (warmouth) embryos were present. Of the 681 embryos removed from the nest, 515 were *L. gulosus* and 166 were *P. hubbsi*. A second nest found in a similar area revealed 2,619 *L. gulosus* embryos, 936 *P. hubbsi* embryos, and 140 unidentifiable embryos.

Nests at Chemin-a-haut Bayou were located in the diverging roots of the trunks of bald cypress trees. Very little underwater vegetation was present aside from moss growing on tree trunks. Floors of nest cavities were different from the surrounding substrate in that nest floors were covered with large, deciduous leaves, cypress fronds, and pine needles, and were free of silt, while surrounding areas were covered with mixed silt and detritus. Nest cavity floors were apparently swept clean by one or both of the nest associates. One nest was actively defended by a terminal male *P. hubbsi* (see below for description of agonistic behavior in defending nest territory). However, these nests were not the only sites of oviposition for *P. hubbsi* in Louisiana. Several hundred adult *P. hubbsi* and larvae were collected from an isolated pond about 0.3 km away from the Chemin-a-haut Bayou. While nests were not located at this site, larvae were observed and collected among the entangled root systems of buttonbush plants. Cavities between major root branches of these plants or centrarchid nests within them may have provided oviposition sites for *P. hubbsi* (Fletcher and Burr 1992).

Initial males were observed entering the territories and nest cavities of a guarding terminal male while the terminal male was defending his nest from other intruding terminal males (Fletcher and Burr 1992). It is possible that these initial males were nest stealing, and that they may also act as "sneaker males," darting into nests and releasing sperm during spawning events between a terminal male and female.

Agonistic Behavior *Pteronotropis hubbsi* are territorial and display agonistic behavior when defending nests. A terminal male defending a territory at the base of a bald cypress tree at Chemin-a-haut Bayou exhibited two defense responses depending on the developmental phase of the intruder. When the intruder was another terminal male, the defending male charged the intruding male, sometimes butting with his snout. Usually, the two terminal males then swam side by side in a straight line with their fins flared, and then performed a circling display where the defending male chased the intruder head-to-tail in tight circles. These displays were repeated until the less dominant male swam away. Immediately following removal of the intruding male, the defending male chased away all intruding initial males. The circling display was never observed between a terminal male and an initial male, probably because initial males were chased out of the territory without opposition. During these episodes of agonistic behavior, males developed a vertical bar pattern on their sides with the more dominant male having noticeably darker bars (Fletcher and Burr, 1992).

Larval Behavior Larvae of *P. hubbsi* are described in Fletcher and Burr (1992). Newly hatched larvae in aquaria remained on the bottom, moving little during the first three days. By the fourth day, some ascended into the water column, but sank when swimming stopped. Most larvae were suspended in the water column by the fifth day.

General Life History *Longevity* *Pteronotropis hubbsi* have a relatively short life span, usually living less than two years in the wild (Burr and Warren, 1986; Fletcher and Burr, 1992; Taylor and Norris, 1992). The high ratio of initial to terminal males (6:1) indicates that most initial males do not survive to their second breeding year (Fletcher and Burr, 1992; Taylor and Norris, 1992). Fletcher and Burr (1992) recorded two initial males nearly two years of age, and one terminal male living at least two years of age in an aquaculture pond. Of the approximately 100 adult fish held in aquaria by Fletcher and Burr (1992), one terminal male lived at least three years until it was killed by a water quality problem.

Feeding and Food Examination of gut contents of *Pteronotropis hubbsi* caught in the wild revealed a diverse diet dominated by microcrustaceans (Fletcher and Burr, 1992). Adults commonly ate cladocera, chironomid larvae, and adult copepods. Juveniles fed on cladocera, copepod nauplii and adults, chironomid larvae, rotifers, nematodes, and also a variety of diatoms, and green and filamentous algae. Traces of seeds, bryzoans, water mites, and various other insects were also found in the guts of adults and juveniles. *P. hubbsi* individuals fed primarily in the water column, but also picked items off of vegetation and the water surface. There was no difference in diets between males and females. Analysis of the diet of fish reared in a pond in southern Illinois revealed that the gut contents of many individuals were empty during the winter months (Burr and Heidinger, 1987).

Threats

Pteronotropis hubbsi was listed as endangered in Illinois in 1981 (Illlinois Endangered Species Protection Board, 1999),

is listed as threatened in Texas (Texas Parks and Wildlife, 2001), and of special concern in Arkansas (Arkansas Natural Heritage Commission, 2001). It remains unlisted in Louisiana, as well as in Oklahoma where its distribution is limited to only one county (McCurtain) (Miller, 1984; Lemmons et al., 1997).

Destruction, Modification, or Curtailment of Species' Habitat or Range Habitat degradation caused by anthropogenic disturbance is probably the greatest threat to the persistence of healthy populations of *P. hubbsi* in the wild. In fact, Fletcher and Burr (1992) suggest that the large gap between the *P. hubbsi* population in southern Illinois and the next closest population in Arkansas is not due to lack of collecting in suitable habitat, as suggested by Bailey and Robison (1978), but rather due to relatively recent habitat alteration. Swamp habitat is disappearing quickly in southern Illinois (Phillippi et al., 1986), southeastern Missouri (Pfleiger, 1997), western Kentucky (Burr and Warren, 1986), western Tennessee, and northeastern Arkansas (Robison and Buchanan, 1988) where *P. hubbsi* may have historically occurred. Many swamps have been channelized, dredged, cleared, drained, and converted to agricultural crops (Fletcher and Burr, 1992). Lowland streams of the Ouachita River sytem, including the type locality of *P. hubbsi* in Arkansas, are threatened by gravel removal operations (Robison and Buchanan, 1988). Pollution has presumably had severe impacts on the only known population of *P. hubbsi* in Wolf Lake, Illinois. In 1974 and 1979, train derailments resulted in the spilling of several hundred pounds of an acid compound and a toxic chemical into Wolf Lake, killing fish and vegetation (Smith, 1979; Burr and Warren, 1986). In 1975, an accidental chemical discharge from the Trojan Powder Company plant (the previous owners of the land surrounding the southern portion of Wolf Lake) lowered pH in a portion of the lake to 3.1, almost certainly having severe negative impacts on lake flora and fauna (Smith and Page, 1981). Despite intensive survey efforts, *P. hubbsi* has not been encountered in Wolf Lake since 1973, before the first polluting event.

Overutilization for Commercial, Recreational, Scientific, or Educational Purposes Because of their rarity in the wild and beautiful breeding colors, *P. hubbsi* are highly coveted in the aquarium trade. Over-collecting of *P. hubbsi* from the wild, coupled with their short lifespan, disjunct distribution, and already frail status, leave populations highly vulnerable to decline (Scharpf, in prep.).

Predation Predatory fishes commonly co-occur with *P. hubbsi*. These predatory fishes may or may not have noticeable negative effects on *P. hubbsi* populations. Fletcher and Burr (1992) found *P. hubbsi* individuals inside the stomachs of several predatory fish from Chemin-a-haut Bayou, Louisiana. One of eight large pickerels, three of five smaller pickerels, and both largemouth bass examined had *P. hubbsi* larvae or adults in their stomachs. Despite the fact that predators were eating them, *P. hubbsi* were found in large quantities at this site. Lemmons et al. (1997) collected *P. hubbsi* from bar pits in Oklahoma. However, they did not find *P. hubbsi* in a series of bar pits from which they collected a predatory bowfin, even though the habitat appeared similar. Both Wolf Lake and LaRue Swamp have relatively large populations of predators, all of which are known to feed on small cyprinids, possibly contributing to the extirpation of *P. hubbsi* in Illinois (Warren et al., 1991).

Parasites and Disease One stock of *P. hubbsi* removed from Chemin-a-haut Bayou was heavily infested with parasites and disease (Burr and Heidinger, 1987). Necropsies of dead or dying individuals revealed that gills, fins, and body surfaces were heavily infested with *Lernaea cyprinacea*, a copepod parasite. The gills of individuals were also infected with a *Trichodina*-like ciliate. Some individuals had columnaris disease caused by the bacterium *Flexibacter columnaris*. Within about two weeks, nine of 11 individuals placed in an aquarium died from these afflictions.

Summary of Land Ownership and Existing Habitat Protection for Populations

Arkansas *Pteronotropis hubbsi* has a rather restricted range throughout southern Arkansas and is considered a species of special concern due to continued environmental degradation (Robison and Buchanan, 1988). Even the species' type locality (Locust Bayou at Hwy. 4) has been severely altered by a gravel removal operation (H. W. Robison, pers. comm.). Runoff from the gravel operation causes the water in Locust Bayou to become very turbid during heavy rains. Much of the lands adjacent to where *P. hubbsi* occurs are non-populated, wooded, lowland areas in the hands of private owners used for various purposes including agriculture. There are no known conservation practices for *P. hubbsi* in Arkansas.

Illinois Wolf Lake, the only locality in Illinois known to historically support a *P. hubbsi* population, is owned by two entities. The northern portion of the lake is owned by the US Forest Service, while the southern portion of the lake, previously owned by the Trojan Powder Company (International Minerals and Chemical Corporation) is currently owned by Trojan Corporation of Ensign-Bickford, Inc. (Burr, 1982;

Warren et al., 1991). Wolf Lake is connected to Otter Pond and the LaRue-Pine Hills Ecological Area by bottomland swamp (Burr and Warren, 1986). Both of these sites are owned and managed by the US Forest Service. It is possible that *P. hubbsi* may have used these sites or the intermittent swampland as refugia from the catastrophic chemical spills in the 1970s, however considerable collecting in that area after the spills, and again after reintroduction efforts in 1992 revealed no individuals (Boyd et al., 1975; Burr and Warren, 1986; Cook and Burr, 1995).

Louisiana There are two small population centers for *P. hubbsi* in Louisiana. One is in the lower Ouachita River system in the northeast corner of the State, and the other is in the lower Atchafalaya River in south-central Louisiana. The land surrounding the Ouachita River system is either privately owned or has been purchased by some of the larger paper mill companies in the region. Degradation in this watershed could result from local tree harvesting and the subsequent loss of stable buffer zones along the river and areas surrounding the backwaters and oxbows. The Atchafalaya River suffers from extensive sediment loads diverted from the lower Mississippi River. Increased sedimentation usually causes turbidity, loss of vegetation communities, and burial of feeding and spawning sites. Any of these changes would have a negative effect on population numbers, recruitment, and long-term stability of the species at the southern edge of its geographic range.

Oklahoma Only two localities are known to support *P. hubbsi* in Oklahoma, Crooked Creek and its mainstream impoundment, Forked Lake, and a swampy area north of the Little River, both in McCurtain County (Miller 1984; Lemmons et al., 1997). Forested land surrounding the Forked Lake Area in Oklahoma is currently owned and managed by the Weyerhaeuser Timber Corporation, an international, multi-billion dollar timber corporation. This land is presumably logged periodically, but the exact impacts on surrounding bodies of water are not known.

Texas Only two localities are known to support populations of *P. hubbsi* in Texas: Caddo Lake and Big Cypress Bayou (Hubbs et al., 1991; Burr, 1992). Caddo Lake State Park, used primarily for fishing and hunting, encompasses Caddo Lake and is adjacent to the Big Cypress Bayou (R. Brown, pers. comm.). A vast majority of the land adjacent to Caddo Lake and Big Cypress Bayou is forested, while a large portion of the remaining land supports lakeside housing used primarily as private weekend houses. A small portion of the land is in pasture, hayland, or cropland adjacent to the lake. Big Cypress Bayou is used for recreation, including water skiing and fishing, and also for livestock water (R. Brown, D. C. Powell, pers. comm.). The U.S. Fish and Wildlife Service is in the process of establishing the old Thiokol Army Ammunition plant, which is adjacent to the main body of Caddo Lake, as a wildlife refuge approximately 4,500 acres in size.

Summary of Existing Management Activities

We are not aware of any current management activities being employed focusing on populations of *P. hubbsi*.

Past and Current Conservation Activities

In attempts to reestablish a viable population of *P. hubbsi* in Illinois, over 1000 individuals in breeding condition were taken from southern Arkansas, northern Louisiana, and east Texas and transplanted into Otter Pond, Illinois, prior to the 1992 spawning season (Burr, 1992). Subsequent visits to Otter Pond later that summer revealed large adults in breeding condition survived the reintroduction and were present in the pond in large numbers, however, there was no evidence of larval recruitment. In 1994, the status of the introduced *P. hubbsi* population was assessed. Cook and Burr (1995) report that even after 70 person-hours were spent on six surveys searching for *P. hubbsi*, no individuals were captured or observed in Otter Pond. While the authors were reluctant to conclude that the 1992 reintroduction project failed based on their inability to locate specimens, one of us (BMB) now believes that factors such as harsh winters and heavy pressure from *P. hubbsi* predators may have decimated the reintroduced population. While *P. hubbsi* remains listed as endangered in Illinois, it is probable that the species has been extirpated from all known localities within the state. We are not aware of any other activities currently being employed in any other states specifically targeted at conserving populations of *P. hubbsi.*

Research and Monitoring

Existing Surveys, Monitoring and Research We are not aware of any existing surveys, monitoring, or research aimed at conservation or management of *P. hubbsi* populations. Additional research is needed on demography, reproductive biology, and management across a variety of habitat types (e.g., bayou vs. oxbow). Little or nothing is known about larval recruitment, breeding site fidelity, survival and longevity, population sizes, or oscillations in population numbers. In

concert with long-term population breeding surveys, knowledge in some of these areas would do much for our understanding of the factors affecting long-term stability of *P. hubbsi* populations.

Research Priorities *Surveys* There is still a need for surveys aimed at locating previously unreported locations of *P. hubbsi*, especially in southeast Missouri where little swamp-like habitat is available and where the species has never before been reported. Sampling efforts in east Texas might also increase the number of known sites of occurrence if appropriate habitat is targeted. Spring and very early summer surveys might be most productive because individuals often group together in large numbers prior to spawning. Post-spawning surveys would help locate larvae and young-of-the-year, and would provide descriptions of habitat for these life stages.

Population Estimates Despite some information on spawning and nesting in natural settings, we do not have enough data to determine if populations are reproducing at a sustainable level. The rather dramatic population oscillations that have been reported in Louisiana are anecdotal but warrant study. These data indicate a life history pattern unknown to us in other North American fishes. Descriptive data on hydrological conditions during spawning and movement of individuals are needed. Does the species respond to "flood-pulse" conditions? Where do post-spawning adults go, or do they die off suddenly? Estimates of the number of individuals on the spawning grounds are unknown. It is clear that fundamental data on abundance at even a single locality is not available but needs to be addressed.

Aquaculture This species could be produced in aquaculture pond settings where the number and kind of predators can be controlled. We recommend that only a few pairs of centrarchids be introduced into ponds with *P. hubbsi* so that spawning will occur. In a pond with clear water, basic data on egg and larval production could be determined as well as additional observations on spawning behavior and the host-parasitoid relationship between the shiner and the sunfish. These observations could be significant because the earlier reports are largely anecdotal and need verification. Pond culture would allow for controlled conditions, easy observation, more accurate estimates of productivity, and a way of providing individuals for transplantation to natural settings.

Breeding Habitat Management Maintenance and protection of swamp-like habitats that harbor the species and its centrarchid nest hosts is desirable. We know of no aquatic preserves within the range of *P. hubbsi* designed especially to protect fish communities in swamp, bayou, or oxbow habitats. Ownership patterns vary widely across the range of the species and regional and climatic differences suggest that management and preservation of sites will differ. For example, Wolf Lake in southern Illinois lacks bald cypress trees around its margin even though we know that reproduction in the species occurred there in the past. Comparing plant communities in the different bayous and swamps known to harbor *P. hubbsi* might reveal common patterns useful in management schemes. Surveys for centrarchid inhabitants in these habitats would also aid in understanding how many nesting hosts *P. hubbsi* is compatible with across its range. For example, do they only spawn over warmouth nests or do they also utilize the nests of dollar sunfish (*Lepomis marginatus*), another common swamp-dwelling centrarchid? Is there any site fidelity? Do adults return to the same places to spawn every year?

One other large gap in our knowledge is post-breeding habitat use. There are almost no data on habitat or abundance of wintering populations of *P. hubbsi*. Although fish sampling during winter is often unproductive it would be instructive to know if adults and young stay in the backwater swamps or enter the bayous.

References

Amemiya, C. T., and J. R. Gold. 1990. Chromosomal NOR phenotypes of seven species of North American Cyprinidae, with comments on cytosystematic relationships of the *Notropis voucellus* species group, *Opsopoeodus emiliae*, and the genus *Pteronotropis*. *Copeia* 1: 68-78.

Arkansas Natural Heritage Commission. 2001. Animals of special concern. Department of Arkansas Heritage Inventory Research Program.

Bailey, R. M., and H. W. Robison. 1978. *Notropis hubbsi*, a new cyprinid fish from the Mississippi River Basin, with comments on *Notropis welaka*. Occasional Papers of the Museum of Zoology, University of Michigan 683: 1-21.

Boyd, J. A., B. M. Burr, L. M. Page, and P. W. Smith. 1975. Those on the brink of doom: a study of threatened and/or unique fishes within the boundaries of the Shawnee National Forest of southern Illinois. Illinois Natural History Survey and US Forest Service Cooperative Project. 29 pp.

Burr, B. M. 1982. Status of the bluehead shiner, *Notropis hubbsi*, and the bantam sunfish, *Lepomis symmetricus*, in Wolf Lake, Illinois. Report submitted to Division of Natural Heritage, Illinois Department of Conservation. 22 pp.

———. 1992. Reestablishing bluehead shiner (*Notropis hubbsi*) populations in Illinois. Report submitted to

Division of Natural Heritage, Illinois Department of Conservation. 21 pp.

———, and R. C. Heidinger. 1987. Biology and preliminary recovery plan for the endangered bluehead shiner in Illinois. Report submitted to Illinois Endangered Species Protection Board, Illinois Department of Conservation.

———, and M. L. Warren. 1986. Status of the bluehead shiner (*Notropis hubbsi*) in Illinois. *Transactions of the Illinois Academy of Science* 79: 129-136.

Cook, K. M., and B. M. Burr. 1995. Status of the bluehead shiner (*Pteronotropis hubbsi*): an assessment of reintroduction efforts in Otter Pond, Union County, Illinois. Report submitted to Division of Natural Heritage, Illinois Department of Conservation. 5 pp.

Dimmick, W. W. 1987. Phylogenetic relationships of *Notropis hubbsi*, *N. welaka*, and *N. emiliae* (Cypriniformes: Cyprinidae). *Copeia* 2: 316-325.

Douglas, N. H. 1992. Temporal variation in the abundance of *Notropis hubbsi* in the Ouachita River drainage of northeast Louisiana. 72nd Annual Meeting of the American Society of Ichthyologists and Herpetologists. p. 94 (abstract).

———, and R. J. Jordan. 2002. Louisiana's inland fishes: a quarter century of change. *Southeastern Fishes Council Proceedings* 43: 1-10.

Fletcher, D. E. 1999. Male ontogeny and size-related variation in mass allocation of bluenose shiners (*Pteronotropis welaka*). *Copeia* 2: 479-486.

———, and B. M. Burr. 1992. Reproductive biology, larval description, and diet of the North American bluehead shiner, *Pteronotropis hubbsi* (Cypriniformes: Cyprinidae), with comments on conservation status. *Ichthyological Exploration of Freshwaters* 3: 193-218.

Goldstein, R. J., R. W. Harper, and R. Edwards. 2000. *American aquarium fishes*. College Station, Tx.: Texas A&M University Press.

Hubbs, C., R. J. Edwards, and G. P. Garrett. 1991. An annotated checklist of the freshwater fishes of Texas, with keys to identification of species. *Texas Journal of Science*, Suppl. 43 (4): 1-56.

Illinois Endangered Species Protection Board. 1999. Checklist of endangered and threatened animals and plants of Illinois. 20 pp.

Lemmons, R. P., M. J. Hood, and L. G. Hill. 1997. New Oklahoma localities for shortnose gar (*Lepisosteus platostomus*), largescale stoneroller (*Campostoma oligolepis*), and bluehead shiner (*Pteronotropis hubbsi*). *Proceedings of the Oklahoma Academy of Science* 77: 125-126.

Mayden, R. L. 1989. Phylogenetic studies of North American minnows, with emphasis on the genus *Cyprinella* (Teleostei: Cypriniformes). University of Kansas Museum of Natural History. Miscellaneous Publication 80: 1-189.

Miller, R. J. 1984. The occurrence of *Notropis hubbsi* in Oklahoma. *Proceedings of the Oklahoma Academy of Science* 64: 45.

Page, L. M., and B. R. Burr. 1991. *A field guide to freshwater fishes of North America north of Mexico*. Peterson Field Guide Series 42. Boston: Houghton Mifflin.

Pflieger, W. L. 1997. *The fishes of Missouri*. Rev. ed. Jefferson City, Mo.: Missouri Department of Conservation.

Phillippi, M. A., B. M. Burr, and R. A. Brandon. 1986. A preliminary survey of the aquatic fauna of the Cache River in Johnson and Pulaski counties, Illinois. Report submitted to Illinois Department of Conservation. 252 pp.

Robison, H. W., and T. M. Buchanan. 1988. *Fishes of Arkansas*. Fayetteville, Ar.: University of Arkansas Press.

Scharpf, C. In prep. American beauties: sailfin shiners (*Pteronotropis*) of the Southeastern U.S.

Simons, A. M., K. E. Knott, and R. L. Mayden. 2000. Assessment of monophyly of the minnow genus *Pteronotropis* (Teleostei: Cyprinidae). *Copeia* 4: 1068-1075.

Smith, P. W. 1979. *The fishes of Illinois*. Urbana, Il.: University of Illinois Press.

———, and L. M. Page. 1981. Endangered and threatened fishes. *In*: M. L. Bowels et al. (Eds.). *Endangered and threatened vertebrate animals and vascular plants of Illinois*. Springfield, Il.: Illinois Department of Conservation.

Taylor, C. M., and S. M. Norris. 1992. Notes on the reproductive cycle of *Notropis hubbsi* (bluehead shiner) in southeastern Oklahoma. *Southwestern Naturalist* 37: 89-92.

Texas Parks and Wildlife. 2001. Texas threatened and endangered fishes. Web address: http://www.tpwd.state.tx.us/nature/endang/animals/fish/ .

Unger, L. M. 1983. Nest defense by deceit in the fathead minnow, *Pimephales promelas*. *Behavioral Ecology and Sociobiology* 13: 125-130.

Warren, M. L., B. M. Burr, and R. C. Heidinger. 1991. Bluehead shiner recovery plan: genetic profiles of potential donor populations. Report submitted to Division of Natural Heritage, Illinois Department of Conservation, Springfield. 27 pp.