Conservation Assessment
for
Bantam Sunfish *(Lepomis symmetricus)*

Photo credit: L. M. Page

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Diane K. Zeman and Brooks M. Burr
Department of Zoology
Southern Illinois University
Carbondale, Illinois 62901-6501
Email: **burr@zoology.siu.edu**

This Conservation Assessment was prepared to compile the published and unpublished information on the subject taxon or community; or this document was prepared by another organization and provides information to serve as a Conservation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 Forest Service. It does not represent a management decision by the U.S. 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 at 626 East Wisconsin Avenue, Milwaukee, Wisconsin 53203.

FRONTISPIECE

Frontispiece: Top photo: 31mm SL male of *Lepomis symmetricus*, swamp, Groves Co., KY, 7 November 1981. Photo by L. M. Page. Center photo: 48 mm SL male, Chenerie Lake, Ouachita Parish, LA, 21 June 1980. Photo by L. M. Page. Bottom photo: 40 mm SL female, slough south of Wickliffe, KY, May 87. Photo by W. N. Roston.

Table of Contents

FRONTISPIECE 3
EXECUTIVE SUMMARY 6
INTRODUCTION 7
BACKGROUND 7
TAXONOMY 7
DESCRIPTION 8
COLOR 8
VARIATION 8
- Allometric 8
- Geographic 8

HABITAT 9
DISTRIBUTION AND ABUNDANCE 9
BIOLOGY/NATURAL HISTORY 10
- Reproductive biology 10
  - Sexual dimorphism 10
  - Reproductive cycle-Males 10
  - Reproductive cycle-Females 10
  - Sex ratios 11
  - Spawning behavior 11
  - Nest associates, nest sites, nesting behavior 11
  - Agonistic behavior 12
  - Larval behavior 12
- General Life History 13
  - Longevity 13
  - Feeding and food 13

THREATS 13
- Destruction, modification, or curtailment of species' habitat or range 13
- Overutilization for commercial, recreational, scientific, or educational purposes 14
- Predation 14
- Parasites and disease 14

SUMMARY OF LAND OWNERSHIP AND EXISTING HABITAT PROTECTION FOR POPULATIONS 14
- Arkansas 14
- Illinois 14
- Indiana 15
- Kentucky 15
- Louisiana 15
- Missouri 15
- Mississippi 16
- Oklahoma 16
- Tennessee 16
- Texas 16

SUMMARY OF EXISTING MANAGEMENT ACTIVITIES 16
PAST AND CURRENT CONSERVATION ACTIVITIES 17
RESEARCH AND MONITORING 17

Existing surveys, monitoring and research 17
Research Priorities 17
Surveys 17
Population estimates 17
Aquaculture 18
Breeding habitat management 18
REFERENCES 19
LIST OF CONTACTS 23
APPENDIX 2
Habitat of Lepomis symmetricus (above) LaRue Pine Hills Swamp, Union County, Illinois. Habitat of L. symmetricus (below) Wolf Lake, Union County, Illinois, 30 July 1981. Photos by B. M. Burr. 2

EXECUTIVE SUMMARY

The Bantam Sunfish (*Lepomis symmetricus*), one of the least studied and most diminutive centrachids, is considered a sister species (i.e., genealogically closest relative) of the Green Sunfish (*L. cyanellus*). The species typically inhabits lowland sloughs, oxbows, lakes, ponds, and swamps with mud-bottoms; often associated with heavy vegetation, stumps, and logs. Preferred substrates include decomposed vegetation, silt, and mud. Populations of *L. symmetricus* exist or existed in Arkansas, Illinois, Kentucky, Louisiana, Missouri, Mississippi, Oklahoma, Tennessee, and Texas. We consider reports of this species in Indiana to be erroneous (i.e., based on misidentifications of other small centrarchids) and no vouchered records are known from that state. Populations are vulnerable to decline for the following reasons: specialized habitat (heavily vegetated swamps, wetlands), human alteration or elimination of this habitat, short lifespan, and a somewhat fragmented distribution. Protection of wetlands and swamps that harbor the species is needed throughout the range of *L. symmetricus*. Illinois, Missouri, Kentucky, and Tennessee are the only known States with limited protection of selected swamplands on which this species thrives. Protection of additional fish populations in swamps and wetlands on the Coastal Plain in general will enhance the long-term stability of *L. symmetricus* populations.

INTRODUCTION

The goal of this report is to provide information for the U. S. Forest Service regarding the life history, status, and distribution of *Lepomis symmetricus*, the Bantam Sunfish, as well as addressing current research, conservation, and management practices on this species. One comprehensive report (Burr 1977) made a detailed study of the life history of the species in Wolf Lake, Union County, Illinois. The species affinity for dense, submerged aquatic vegetation has hindered observations of spawning activities and has made collections with conventional collecting gear difficult and incomplete. Difficulty in sampling suitable habitat has contributed to our inability to make reasonably accurate population estimates. The present document compiles the known information on *L. symmetricus*, and 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 *Lepomis*, commonly referred to as "pan-fish," because of the deep, strongly compressed body, is composed of eleven species distributed throughout eastern North America (Page and Burr 1991). These fishes are typically found in vegetated lakes, ponds, swamps, and pools of creeks and small to large rivers usually over mud or sand substrate (Page and Burr 1991).

Lepomis symmetricus was originally described by S.A. Forbes in Jordan & Gilbert (1883: 473-474) from fifteen specimens collected 16 April and 2 June 1880 from the Illinois River (Mississippi drainage) at Pekin, Tazewell County, Illinois (Burr 1977). Populations of *L. symmetricus* are secure in Louisiana, Mississippi, Tennessee, and Kentucky. The species is considered vulnerable in Texas, Arkansas, Oklahoma, and Missouri and state threatened in Illinois and Indiana.

TAXONOMY

Lepomis symmetricus belongs to the class Actinopterygii, order Perciformes, family Centrarchidae. During the late 1800s and early 1900s various scientists proposed different taxonomic assignments. Boulenger (1895) assigned the Bantam Sunfish to the genus *Apomotis*; in 1929 the species was transferred to a new genus *Lethogrammus* by C. L. Hubbs (in Jordan 1929). The species was again reclassified by Bailey (1938) when he adopted the use of subgenera, placing *L. symmetricus* in the subgenus *Lethogrammus*.

Several studies have revisited the taxonomic relationships of the family Centrachidae using morphological, biochemical, and molecular methods. According to ontogenetic change and pigment pattern development studies by Mabee (1993, 1995), *L. symmetricus* is considered a sister species of *L. macrochirus* (Bluegill*)* plus *L. cyanellus* (Green Sunfish). Other studies based on the structure of the acoustico-lateralis system (Branson and Moore 1962) and on karyotypic data (Thompson 1991) have concluded that *L. symmetricus* is a specialized species most closely related to *L. cyanellus*, the Green Sunfish. According to a more recent molecular-based study (Near et al. 2004), this sister species pair (*L. symmetricus* plus *L. cyanellus*) was also found, with very strong support,

in the maximum parsimony (MP) and Bayesian maximum likelihood analyses (BML) as judged from mitochondrial and nuclear DNA sequence data.

DESCRIPTION

The following description is taken from Burr (1977) and Page and Burr (1991). *Lepomis symmetricus* is described as having usually 30-40 lateral scales, 12-13 pectoral rays, 9-11 dorsal spines, 10-12 dorsal rays, 3 anal spines, and 10 anal rays. A black spot at rear of dorsal fin is characteristic of young (spot diminishes as fish grows, is absent in large adult) [see Frontispiece]. Lateral line is usually interrupted (as many as 6 times), and incomplete (1-18 scales unpored). Pectoral fin short and rounded usually not reaching past eye when bent forward. Mouth fairly large with upper jaw extending under eye pupil. Ear flap short; stiff rear edge on gill cover (excluding ear flap). Gill rakers on 1st gill arch long (longest in the genus) and thin (7-9 times longer than wide), numbering 12-15, modally 13. Body chubby (less compressed) with total length to 3.5 inches (9 cm); standard length of 75.5 mm. *Lepomis symmetricus* is the smallest of the 11 species in the genus. We kept an individual male in an aquarium for 3-4 years and it reached about 90 mm SL under these artificial conditions.

COLOR

Unlike other sunfishes, the bantam sunfish lacks bright coloration [see Frontispiece]. Body coloration is dusky olive green on back and side with many rows of yellow flecks and scattered small dark brown spots on side of adult. The head and face are blackened and unpatterned with cheeks also unpatterned. Black earflap has white edge, yellow-brown below. Dorsal and anal fins clear to dusky on adult; red on young. Juvenile and subadult have a prominent ink-black blotch in the posterior rays of the soft dorsal fin and irregular vertical bands on body (Page and Burr 1991).

VARIATION

Allometric

Allometric variation in meristic characters was not found and was not investigated in morphometric characters in Burr's (1977) study. Some character traits were noted. These traits included the number of vertical bands which were the same in juvenile and adult, juvenile body proportions similar to those of other juvenile sunfish, and a more robust symmetrical shape in adults, hence the name of the species. The most notable variations occur in the soft dorsal fin where red-orange coloration and a black spot is prominent in the smallest young and becomes more diffuse and disappears with age.

Geographic

Specimens examined by Burr (1977) showed no significant geographic color or pattern variation or in body proportions measured. Meristic characters, including numbers of caudal-peduncle scales, lateral-line scales, and anal soft rays, did vary clinally. Caudal-peduncle scales and lateral-line scales show a slight increase towards the north, whereas anal soft rays show an increase from the Gulf Coastal region northward and ending with a similar count at the northernmost location of the Wabash River drainage in White County, Illinois.

HABITAT

Lepomis symmetricus typically inhabits sloughs, oxbows, ponds, backwaters, lakes, and swamps [see photographs in Appendix of Figures at end of report]. The vegetated margins are dominated by *Nymphaea advena* (spatterdock), *Nelumbo lutea* (American lotus), *Sagittaria latifolia* (common arrowhead), *Ceratophyllum demersum* (coon tail), and *Lemna* spp. (duckweed) and are the preferred habitat for this fish. Substrates commonly consist of detritus, mud, and silt, with some sand (Burr 1977).

DISTRIBUTION AND ABUNDANCE

Lepomis symmetricus occurs on the former Mississippi Embayment from southern Illinois to the Gulf (Page and Burr 1991) (Map 1 in Appendix of Figures). The species occurs along the Gulf Coast from Eagle Lake (Colorado Rive drainage) in Texas east to the Biloxi River system in Mississippi (Ross 2001). The species is common only in some southern states including Louisiana (Douglas 1973) where it occurs statewide, extreme southeastern Texas, southern Arkansas (Robison and Buchanan 1988), and parts of western Kentucky (Burr and Warren 1986) and western Tennessee (Etnier and Starnes 1993). *Lepomis symmetricus* is also known to occur, less commonly, in parts of extreme southwestern Illinois, the bootheel of Missouri, McCurtain County, Oklahoma, and some Mississippi and Gulf Coast drainages of the State of Mississippi (Ross 2001).

Historically, isolated populations occurred above the Fall Line in the Illinois River at Pekin, in backwater ponds and sloughs of the Wabash River drainage in White County, Illinois (Burr 1977), and the Pine Hills Research Natural Area. In Illinois, Smith (1979) considered the range of *L symmetricus* to be limited to the LaRue Pine Hills-Wolf Lake region of Union County. New records from Burr et al. (1988, 1996) extend the Illinois range of this species south through the Clear Creek drainage to Horseshoe Lake, Alexander County, and through the Cache River drainage in Buttonland Swamp, Limekiln Slough, and Grassy Slough (Map 2 in Appendix of Figures). The Clear Creek drainage has a near continuous occurrence of *L. symmetricus*, including records from three mainstem sites. Previous collections in the Cache River Drainage (e. g. Smith 1979, Phillippi et al. 1986, Warren and Burr 1989, Muir et al. 1995) failed to produce the species. The collections in July 1995 in the Cache River drainage represent two age classes indicating successful reproduction has occurred in the drainage (Burr 1996). The dispersal of this species and its occurrence in atypical mainstem stream habitats in Clear Creek has been attributed to the historically unprecedented Mississippi River flood of 1993 (Cook 1994).

Although reported common in some states, little is known regarding the actual abundance of *L. symmetricus*. Most states report that collection of the species is uncommon and difficult because of their habitat preference. Conventional sampling methods (i.e., seining, electrofishing) are ineffective in the densely vegetated habitat preferred by this species (Burr 1977) making population estimates unrealistic. In the most recent literature concerning the fishes of the southern United States, Warren et al. (2000) documented *L. symmetricus* occurring in sixteen drainage units and listed its population as currently stable in these areas.

In Winters Pond and Wolf Lake, Union County, Illinois, the species can be collected with regularity year-round. In appropriate habitat along the shoreline it is common to get 10-20 individuals in a single 20 foot-long seine haul (B. M. Burr, pers.

observ.). These observations are based on over 30 years of sampling Winters Pond annually.

BIOLOGY/NATURAL HISTORY

The general biology and life histories of most species in the genus *Lepomis* have been well studied. This is not the case for *L. symmetricus*, with only one in-depth study of its life history in Illinois (see Burr 1977).

Reproductive biology

Sexual dimorphism

Burr (1977) observed many breeding male coloration differences in contrast to non-breeding males and females. Males in breeding condition exhibit a darkened head and subdued vertical bars, and many small greenish flecks on the head and opercle, the latter outlined by a silvery-cream color with a hint of suffused red. The venter from the chin and throat to the anterior rays of the anal fin was grayish black, posterior edges of the pelvic fins were nearly solid black with the remainder of the fins cream colored, and the dorsal fin had many light spots surrounded by dusky brown or black areas.

Changes in coloration of females associated with the breeding season include the presence of 9 to 10 distinct dark bluish-purple vertical bars with light greenish flecks between. The cheek and the opercle contain bright spots of golden green, and fins are relatively clear. Both males and females exhibit a bright red iris with a black transverse bar though the center, noted as distinctive in males.

L. symmetricus observed in aquaria revealed similar coloration patterns with a few exceptions (E. G. Wetzel, 2004, unpublished data). On males, the dark opercular tab was outlined in copper and a blue speckled pattern occurred on the sides of the body. During aggressive behavior, males would also develop a dark barring pattern superimposed on the speckling. Females in aquaria became blanched with all fins (except pectoral) exhibiting a yellow hue.

Dimorphism was also evident in one proportional character and the sex organs. The pelvic fin length of the male was found to be significantly greater (0.05 level, F=8.29) than that of the female. During the spawning season, the adult female's urogenital papilla is enlarged and protruding, whereas the male's is only slightly enlarged (Burr 1977).

Reproductive cycle-Males

As spawning approaches, the genital papilla in breeding males transforms. Normally small, translucent, and elongate, the testes of breeding males become enlarged, opaque white, and thickened. Only large males at least 1+ years and 40 mm or longer appear to be sexually mature and probably do most of the spawning (Burr 1977).

Reproductive cycle-Females

Burr (1977) made several observations about the reproductive cycle of the female. Females become sexually mature at one year of age (as short as 34 mm SL). However, the largest females develop the earliest mature ova and probably contribute most to the spawning effort. Ova are conspicuously present in females 1+ year of age and 35 mm long as early as September. Females 1+ year and 40 mm or longer are known to have larger, yellowish ova by January and February. From March to May, large coarse, maturing orange ova are detected in females over 34 mm and 1 year of age.

Mature ova become translucent orange just prior to spawning and range from 0.6 to 0.9 mm in diameter. In aquaria, eggs were noted as adhesive surrounded by an oil droplet (E. G. Wetzel, 2004, unpublished data). The number of mature ova in sexually mature females ranged from 219 to 1600 and was significantly correlated with adjusted body weight and SL. Ovaries were the smallest during July and August then increased in size from late fall into the spawning period of April and May. The ovaries again decreased in size in June; however, they were slightly heavier than the ovaries in March (Burr 1977).

Sex ratios

All sex ratios were calculated from 233 *L. symmetricus* collected in Wolf Lake, Illinois, by Burr (1977). The sex ratio of young of the year (<1 year) age class, which comprised 85.4 percent of the sample, was 1.5 females to 1 male. For the entire sample the ratio was 1.4 females to 1 male. In the <1 year class females significantly predominated, however for the 1+ age class males were slightly more common than females.

Spawning behavior

Little has been observed of the spawning behavior of *Lepomis symmetricus* in the wild because of the habitat in which it resides. One of the few accounts in nature is from Robison (1975:56); observations were made in a roadside pool, Saline County, Arkansas, where *L. symmetricus* had recently spawned in "depressions in the mud and leaf litter substrate were filled with numerous eggs." Burr (1977) noted that the typical spawning period for the species throughout its range is from mid-April to early June.

A recent aquarium study has been conducted to document spawning behavior and eliminate gaps concerning reproductive behavior of *L. symmetricus* (E. G. Wetzel, 2004, unpublished data). Duration and intensity of courtship varied depending on the stage of the female and the presence of competing males. During courtship a male patrols his territory by charging and attempting to bite any conspecific that enters the nesting site. A different behavior results when a receptive female rotates her ventral surface in the direction of the oncoming male. The male breaks off the charge, swims close without stopping, turns sharply, and returns to the nest exaggerating the movement of the rayed portions of his dorsal and anal fins. The return phase may be repeated several times in an attempt to lead the female to the nest; if unsuccessful the male will challenge and attack the female until she leaves his territory. These courtship routines, which appear to have females assessing the male's quality, frequently occur within 24 hours of spawning.

Successful courtship proceeds with the female following the male to the nest where a circling behavior ensues. Simultaneous gamete extrusion, lasting approximately 30 minutes, occurs as the female rolls and raises her vent up against the male's side in a quivering motion. As spawning draws to a close, the male begins to intersperse challenges with spawning bouts driving the female from the nest. The aquarium spawning events took place at approximately dawn, in water temperatures ranging from 22 to 26 degrees.

Nest associates, nest sites, nesting behavior

There is little published data on the nest associates, nest sites and nesting behavior of *L. symmetricus* in the wild. It seems, however, that the nest building and prespawning behavior of *L. symmetricus* does not vary greatly from other species of *Lepomis* (Breder

1936, Breder and Rosen 1966). Wetzel (unpublished data, 2004) made several observations of nest sites and nesting behavior in aquaria and in the wild. Nesting sites at LaRue Pine Hills were situated near *Ceratophyllum demersum* (coon tail) over substrate that contained fibrous root wads. In aquaria, nest sites were bowl shaped approximately 2 cm deep, 7 cm in diameter and 1.5 times the length of the male.

Construction and protection of nesting sites is the responsibility of the male. Nest building is often preceded by courtship and stimulated by the presence of ripe females. Powerful movements of the pelvic fins direct the male's caudal and anal fins into contact with the substrate resulting in finer particles being raised into the water column and coarser particles (i.e., gravel) being rolled about.

Post-spawn parental activity begins with the expulsion of the female from the nest site and the male adopting a color pattern that minimizes contrast with the substrate. Behaviors exhibited by males after spawning include territory defense, brood protection, and nurturing (fanning) of young. Further breeding efforts were observed resulting in overlap in parental investments directed towards separate broods. Male parental care continues for approximately five days until larvae leave the nest. Heightened aggressive behavior in the males was noted near dusk on the day of larval exodus. The parental male continues to defend the nest site as the larvae swim up into the water column, stopping when the larvae reach the vegetation and begin feeding. Filial cannibalism was noted by other *L. symmetricus*, including the maternal but excluding the paternal parent, upon larvae reaching the vegetation.

Agonistic behavior

Lepomis symmetricus are territorial and display agonistic behavior when defending nests. During courtship and spawning, males in aquaria challenged intruders with a forward movement, followed by the flaring of the opercula, and holding of the body in a shallow S-shape. If the intruder was another male the forward movement would be accelerated and attempts were made to bite the target (E. G. Wetzel, 2004, unpublished data).

Male aggressiveness increases as larvae begin to leave the nest. This heightened aggression starts as the larvae enter the water column and continues until the larvae have risen into the vegetation. During episodes of agonistic behavior, coloration displays included blue spangles on a dark background and a barred pattern over the body during heightened defense (E. G. Wetzel, 2004, unpublished data).

Larval behavior

Another gap in the literature exists between hatching and young of the year. The aquaria study by Wetzel (2004, unpublished data) described the larval behavior of *L. symmetricus*. In aquaria, hatching occurred 26 to 36 hours post-spawn with larvae clumping together until leaving the nest on day five. From day one to day five, the larvae are negatively photo-taxic and are capable of short bursts of directed movements into interstitial areas of substrate or into a pile in the nest. On day five, larvae begin to ascend short distances into the water column but return to the nest quickly. Approximately one hour after dusk the larvae ascend into the vegetation where they begin feeding.

General Life History

Longevity

L. symmetricus has a relatively short life span when compared to other *Lepomis* species that average a life span of 5 years. Specimens from throughout the range have been recorded at slightly over 3 years of age (INHS 17547, NLU 31572). Burr's (1977) calculations showed a very low survival rate after the first year. Only three individuals 3 years or older were found in his intensive survey.

Feeding and food

Examination of gut contents of *L. symmetricus* caught in the wild revealed a diverse diet dominated by gastropods, odonate larvae, and micro-crustaceans (Burr 1977). *L. symmetricus* less than 21 mm fed predominately on aquatic Hemiptera, micro crustaceans, and chironomids. Individuals more than 40 mm commonly ate gastropods, amphipods, and larger dipteran larvae. Dragonfly larvae were found to be common in all size classes.

Seasonal variation was also noted in the diet. Prior to and during spawning, the largest percentages of most food items were consumed. Gastropods were eaten primarily in winter and spring months while aquatic Hemiptera were eaten exclusively in the summer months. Surface feeding, by adults over 31 mm, was reflected by the presence of an exclusively terrestrial hemiteran family, Fulgoridae.

THREATS

Lepomis symmetricus is listed as threatened in Illinois (Illinois Endangered Species Protection Board 1999), of special concern in Indiana (Indiana Division of Fish and Wildlife), as imperiled in Missouri and Oklahoma, and vulnerable in Texas and Arkansas (NatureServe Conservation Status). It remains unlisted and apparently secure in Kentucky, Tennessee, Mississippi, and Louisiana (NatureServe Conservation. www.natureserve.org. Viewed 17 August 2004)).

Destruction, modification, or curtailment of species' habitat or range

Environmental degradation caused by anthropogenic disturbance, particularly drainage of wetlands, is probably the greatest threat to the persistence of *L. symmetricus* in the wild. This species occurs most frequently in swamps, oxbows, and bottomland lakes that have submerged vegetation. These habitat areas are disappearing quickly in southern Illinois (Phillippi et al. 1986) and other at localities where the Bantam Sunfish is known to occur. Wetlands and swamps have been channelized, dredged, drained, and converted to agricultural croplands (Fletcher and Burr 1992). Rapid population growth (84% from 1950 to 1990) in the southern portions of the United States pose multiple threats to aquatic biota as development of land and water resources continues to accelerate (Warren et al. 2000).

One of the few known sites of *L. symmetricus* in Illinois, Wolf Lake, was inundated with pollution in the mid to late 1970s. In 1974 and 1979, train derailments spilled several hundred pounds of acid compound and toxic chemical into the lake, killing fish and vegetation (Burr and Warren 1986). An accidental chemical discharge from the Trojan Powder Company plant in 1975 also had a negative impact on the fish fauna of the lake (Smith and Page 1981). Although *L. symmetricus* was exposed to these high levels

of pollution, it continued to do extremely well in the lake being the fourth most abundant sunfish in Wolf Lake during a 1981-1982 sampling period (Burr 1982).

Overutilization for commercial, recreational, scientific, or educational purposes

Due to its small size and drab coloration, *L. symmetricus* does not seem to be threatened by fishing or commercial use. However, over-collection for scientific research and educational purposes could become a problem given the species' short lifespan.

Predation

Many predatory fish coexist in the habitat of *L. symmetricus*. However, predation of *L. symmetricus* has not been documented in literature reports. Burr (1977) found no evidence of predation on this species in his extensive study at Wolf Lake, Illinois. Gut analysis of potential predators including *Micropterus salmoides* (Largemouth Bass*), Pomoxis nigromaculatus* (Black Crappie), *P. annularis* (White Crappie*), L. gulosus* (Warmouth*), L. macrochirus* (Bluegill), *and Ameiurus natalis* (Yellow Bullhead*)* revealed a lack of predation on *L. symmetricus*. *Lepisosteus oculatus* (Spotted Gar) and *L. platostomus* (Shortnose Gar) were not analyzed as potential predators, despite their presence in Wolf Lake, leaving to speculation their predatory effect on *L. symmetricus*, especially because these two species are exclusively piscivorous as adults.

Parasites and disease

According to Hoffman (1999), *L. symmetricus* are susceptible to Monogenea: *Anchoradiscus triangularis*, and Trematoda: *Caecincola latostoma*. Burr (1977) found twenty-five percent (44 of 176) of the Wolf Lake study population encysted with plerocercoids of the cestode *Haplobothrium globuliforme*. This stage usually affects the liver of fishes, however one to five plerocercoids were found in each stomach with the highest numbers occurring in the stomachs of the <1-year class.

SUMMARY OF LAND OWNERSHIP AND EXISTING HABITAT PROTECTION FOR POPULATIONS

Arkansas

The Bantam Sunfish occurs throughout the Coastal Plan lowlands in all major drainages. However, it is much more common in southern Arkansas than in the eastern part of the state (Robison and Buchanan 1988). These lowland areas are primarily privately owned lands used for various purposes including agriculture; because of this the species is considered vulnerable in this region. There are no known conservation management plans for *L. symmetricus* in Arkansas.

Illinois

L. symmetricus is concentrated in the southwestern portion of the state of Illinois occurring in the ecologically protected area of LaRue Pine Hills in Union County. The species has also been collected in the Cache River drainage and through the Clear Creek drainage to Horseshoe Lake in Alexander County. The Cache River drainage contains protected areas of the Shawnee National Forest and Cypress Creek National Wildlife Refuge. However, a large portion of this area (85%) is privately owned and includes cropland, grassland, and upland woods (Illinois Natural History Survey website. Cache River RRA, southern Illinois. http://www.inhs.uiuc.edu/cwe/rra/site29.html. Viewed 1 June 2004). Wetland drainage, agriculture runoffs, and tree harvesting are concerns for

the degradation of this watershed. L*epomis symmetricus* remains state threatened because so few populations remain in the upper Mississippi valley and little unaltered habitat for it is now extant (Smith 1979).

Personnel of the Illinois Department of Natural Resources are in the process of planning re-introduction efforts of Bantam Sunfish into the Illinois River drainage near its historic site at Pekin, Tazewell County. As of August 2004, only discussions have taken place, but there is strong support among biologists for such introduction efforts. The species has not been taken anywhere in the Illinois River drainage in over a century.

Indiana

Questionable historical data placed *L. symmetricus* in the southwestern corner of Indiana, Ohio River drainage. To date there are no known voucher specimens from Indiana; however, in a recent U. S. Geological Survey report of the White River Basin, *L. symmetricus* was listed as rare; collected post-1987. This region, however, lacks suitable habitat for *L. symmetricus* making the identification questionable and unverifiable without voucher material. Land usage in Indiana consists of row-crop agriculture, pasture, forest, and oil/gas production (Crawford et al. 1996). There are no known habitat protection areas for *L. symmetricus* and it remains listed (erroneously) as a species of special concern in Indiana.

Kentucky

Populations of *L. symmetricus* are known from several locations in extreme western Kentucky, where it is locally common (Burr and Warren 1986). These locations include Murphy Pond and Obion Creek, Hickman County, and Mayfield Creek located in Calloway County. Recent records are from Terrapin Creek, Graves County. Although restricted to a relatively small area, Burr and Warren recommended the conservation status of the species be changed from special concern to delisted. There are no known existing habitat protection areas for *L. symmetricus* populations within the state.

Land use in western Kentucky consists largely of row crop agriculture, many of the stream systems have been channelized, and wetlands continue to be drained for agriculture. Suitable habitat remains and the Terrapin Creek watershed is in the process of being protected by the Kentucky Nature Preserves Commission.

Louisiana

Although not commonly encountered in Louisiana, this is the only state where *L. symmetricus* occurs state wide (Douglas 1973). Land in northeast Louisiana is either owned privately or by paper mill companies. This area surrounds the Ouachita River system and degradation of this watershed has resulted from tree harvesting and subsequent loss of stable buffer zones surrounding backwaters and oxbows. Other areas of Louisiana suffer from extensive sediment loads diverted from the lower Mississippi River. Increased sediment loads could eliminate wetlands and swamps affecting the long-term stability of *L. symmetricus*. Populations are not currently protected within the state.

Missouri

L. symmetricus occurs in two of the largest remnants of relatively undisturbed swampland that remains in southeastern Missouri. Two of these swamplands, owned by U. S. Fish and Wildlife Service, include Mingo Swamp in the contiguous Duck Creek Conservation Area, and Mingo National Wildlife Refuge, Bollinger and Wayne counties.

Otter Slough Conservation Area, owned by Missouri Department of Conservation, is also a known locality (Pflieger 1997). Although this species is listed as imperiled in Missouri, what remains of its swamp habitat is being protected by federal and state agencies.

Mississippi

The range of *L. symmetricus* in Mississippi is widely separated ranging from the Pearl and Gulf Coastal River drainages in the extreme south to the Yazoo, Big Black, and lower Mississippi South drainages of the Mississippi River Basin (Ross 2001). Although uncommon in most collections, the species appears to be secure within the state and habitat protection plans have not been developed for the species.

Oklahoma

Considered imperiled in Oklahoma, *L. symmetricus* occurs only in the swamps of McCurtain County in the southeast corner of the state. This area of the state is a sparsely populated area (total county population, 34,187) and is partially protected by the Little River National Wildlife Refuge and the Ouachita National Forest. There are no known specific protection measures in place for *L. symmetricus*.

Tennessee

Existing only in the Mississippi River drainage in the far western part of the state, *L. symmetricus* is uncommon in Tennessee. This species is known to persist only in a few natural lakes and overflow swamps, but remains common in Reelfoot and Isom lakes (Etnier and Starnes 1993). Reelfoot Lake, much of which is protected as a natural wildlife refuge, has experienced accelerated aging and deterioration due to siltation caused by erosion from nearby agricultural fields. This siltation is filling the lake at an average rate of one foot every 30 years, a major problem considering that over 40 percent of the lake is three feet deep or less (USGAO 1992). However, in recent years, measures including building of silt retention dams on tributaries and anti-soil erosion programs have been implemented to preserve what remains of this unique habitat (Etnier and Starnes 1993).

Texas

The far eastern boundary and swamps and lakes along the Gulf Coast rivers are the only known localities of *L. symmetricus* within the state of Texas. These populations were listed as uncommon (Knapp 1953) and vulnerable (NatureServe 2004). Wetlands in Texas comprise less than five percent of the state's total land area. However, the state has exhibited a significant loss of wetland ecosystems (Texas Parks and Wildlife Wetlands web page. http://www.tpwd.state.tx.us/wetlands/ecology/texas_wetlands.htm. Viewed 17 June 2004). Although there are no specific protection areas for *L. symmetricus* within the state, the Texas Parks and Wildlife agency offers several conservation programs to landowners of wetlands within the state. These programs include technical and/or financial assistance, a conservation plan, and a site registry program that brings together landowners with individuals or companies interested in performing wetland restoration.

SUMMARY OF EXISTING MANAGEMENT ACTIVITIES

We are not aware of any current management activities being employed in any states focusing on populations of *L. symmetricus*, except that Illinois is apparently

planning possible introduction of the species back into its historic range on the Illinois River (probably backwaters or oxbow lakes) near Pekin.

PAST AND CURRENT CONSERVATION ACTIVITIES

We are not aware of any past or current conservation activities being employed in any states focusing on populations of *L. symmetricus*, except for its inclusion on State lists of endangered/threatened or special concern species.

RESEARCH AND MONITORING

Existing surveys, monitoring and research

Existing surveys, monitoring, or research aimed at conservation or management of *L. symmetricus* populations are not known at this time. Additional research on the breeding habits of *L. symmetricus* has been conducted recently at Southern Illinois University-Carbondale on aquarium held *L. symmetricus*, although no publications have resulted from this research. Additional research is needed on reproductive biology, demography, and management for different habitat types such as oxbows and mainstem streams. There are gaps in the literature, especially concerning breeding site fidelity, true population sizes, and oscillations in population numbers. In addition to monitoring currently known populations, protection of our remaining wetlands would do much to enhance the long-term stability of *L. symmetricus* populations.

Research Priorities

Surveys

There is still a need for surveys aimed at locating previously unreported locations of *L. symmetricus*, especially where swamp-like habitats are located. Although sampling efforts are difficult, at best, in these situations, the known sites of occurrence could increase if appropriate habitat is targeted. Surveys conducted in spring and very early summer might be most productive when individuals are grouping together during pre-spawning events. These surveys could possibly give a glimpse at the spawning habitat and behavior in the wild of this diminutive centrarchid.

Population estimates

Limited information on the spawning and nesting habits of *L. symmetricus* in the wild make it near impossible to determine if populations are reproducing at a sustainable level. The limiting nature of its habitat to observation and collection make accurate population estimates difficult. Density in Illinois populations studied by Burr (1977) ranged from 0.313 to 0.723 individuals per square meter. Low-density numbers and the low percentage (2.3%) of the total sample of fishes captured during Burr's 9-month study indicate that the population of *L. symmetricus* is comparatively low. Therefore, it is imperative that fundamental data on abundance needs to be addressed throughout the range of *L. symmetricus*. It does appear that the Illinois population in Winters Pond, Union County, on the north edge of the LaRue-Pine Hills Natural Area, has increased in density since the late 1970s. Sampling aimed at obtaining a representative community sample in Winters Pond annually for over 15 years has consistently produced individuals of *L. symmetricus* and samples made in May often yield over 20 adults in breeding condition. While this information is somewhat anecdotal it is based on years of experience at the same site.

Aquaculture

This species has been raised in aquarium settings with limited success and could be produced in an aquaculture pond setting where nesting behaviors could be monitored. In a pond with clear water, basic data on egg and larval production could be determined, as well as additional observations on spawning behavior. The addition of other centrarchid species could be helpful in determining nest associations and if any interbreeding could be occurring. These observations could be significant because of the lack of field data available. Although aquaculture is a controlled environment, lacking the varying conditions of a natural habitat, it would allow for easy observation, more accurate estimates of productivity, and a way of providing individuals for transplantation to natural settings.

Breeding habitat management

One of the most pervasive effects of human activities on any species is changes in land use and land cover, and the associated fragmentation of habitat (Davies et al. 2001) Continued maintenance and protection of swamp and other wetlands is crucial to the survival of *L. symmetricus*. While some of the localities known to harbor *L. symmetricus* are protected by ecological areas (LaRue Pine Hills, Illinois), the U. S. Fish and Wildlife Service (Mingo Swamp and Mingo National Wildlife Refuge, Missouri) or by individual state Conservation departments (Otter Slough, Missouri; Terrapin Creek wetlands, Kentucky), many of these wetland areas remain unprotected.

Climatic and land ownership patterns vary widely across the species' range suggesting that management and preservation of sites will differ. Surveys of the plant and fish communities where *L. symmetricus* is abundant may reveal common patterns useful for future management practices. Questions to be addressed could include the following: Are *L. symmetricus* using the same nests as other centrarchids within the same habitat? Since many of the areas of spawning take place in waters of low visibility are *L. symmetricus* interbreeding with other centrarchid species? Is there nest site fidelity (i.e., are the same nest sites revisited year after year)? Does fecundity vary geographically? Is spawning communal or are nests separated by significant gaps? Does filial cannibalism occur in the wild? If so, to what extent does it account for mortality? Are adults or young more susceptible to predation during the nesting season? Does the nesting season vary geographically? Are breeding systems polygamous as in many other centrarchids? Do sneaker or satellite males occur in this species as they do in other species of *Lepomis*? To what extent does a short life contribute to long-term survival of a diminutive sunfish?

Preservation and management of wetlands and swamplands are important practices needed for the continued success and sustainability of *L. symmetricus*. Although little is known of their post-breeding habitat use, most collections have occurred in wetland areas. Collections in the fall and winter months could give insight to any alternate habitat use or could increase the need for protection if *L. symmetricus* remains in these areas year-round.

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LIST OF CONTACTS

Texas

David Powell
Texas State Soil and
Water Conservation Board
PO Box 658
Temple, TX 76503
903-898-2508
dpowell@tsswcb.state.tx.us

Ross Brown
USDA-NRCS
Marshall Field Office
701A S. Washington
Marshall, TX 75670
903-935-2431
ross.brown@tx.usda.gov

Oklahoma

Dr. Loren G. Hill
Professor Emeritus
Department of Zoology
University of Oklahoma
Norman, Oklahoma 73019
Lghill@ou.edu

Illinois

Dr. Brooks M. Burr
Department of Zoology
Southern Illinois University
Carbondale, Illinois 62901-6501
618: 453-4112
burr@zoology.siu.edu

Louisiana

Mike Wood
Louisiana Department of
Wildlife and Fisheries
District 2 Supervisor
Wood_mg@wlf.state.la.us

Glenn Thomas
Louisiana Department of
Wildlife and Fisheries
225-765-2343
thomas_rg@wlf.state.la.us

Kentucky

Ronald R. Cicerello
Kentucky State Nature Preserves
Commission
801 Schenkel Lane
Frankfort, KY 40601-1403
(502) 573-2886

Mississippi

Dr. Stephen T. Ross (retired)
Museum of Southwestern Biology
MSC 03-2020
University of New Mexico
Albuquerque, NM 87131
stross1@unm.edu

Arkansas

Dr. Henry Robison
Professor of Biology
Southern Arkansas University
PO Box 9354
Magnolia, AR 71754
870-235-4273
hwrobison@saumag.edu

APPENDIX

Habitat of Lepomis symmetricus (above) LaRue Pine Hills Swamp, Union County, Illinois. Habitat of L. symmetricus (below) Wolf Lake, Union County, Illinois, 30 July 1981. Photos by B. M. Burr.