A review of speciation and morphometric variation of *Lepomis megalotis*

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Introduction

The Long ear sunfish *Lepomis megalotis* has many phenotypic variations between individuals and isolated populations. There seems to be no definitive central record of subspecies or speciation in this fish, yet many claims of subspecies and speciation exist throughout the literature; some that completely contradict each other. Fish farmers and breeders also have their own strains, such as the 'Kansas subspecies', which according to all known literature is not a subspecies at all further complicating matters. In one such case of an attempt to understand this species, a northern sub-species and a western sub-species are established, and in a second paper the central and Great Plains sub-species are established (Jennings and Phillip 1992). In many papers the longear subspecies is left ambiguously blank, or not defined in terms of subspecies. In certain states such as New York and Wisconsin, the Department of Natural Resources is considering the Northern Longear Sunfish as a threatened species and is being looked at for possible aquaculture in the future. Although it is widely accepted that the northern Longear is in fact a subspecies, this leads to question the health of other populations and pseudo subspecies. If in fact they are deserving of a subspecies title, are they threatened due to their unique locality or genetics? This conservation work will not be necessary if the longear is shown to have no subspecies, just unique phenotypes based on microevolutionary forces.

This paper aims to review the literature and determine the species structure of this fish, and to determine whether certain populations deserve subspecies or even species

status. This will help determine the conservation status of exclusive populations if they are determined to be an offset.

Known Populations

Some literature cites up to eight unique populations based on everything from morphometrics to color alone, yet generally six unique populations are accepted (Barlow 1980). The six unique populations are the Northern, Central, Great Plains, Rio Grande, Western and Cuatro Ciengas Longear (Table 1). Many other papers attempting to clear up this geographic speciation issue are surprisingly confusing, absent or entirely too vague. The native range of the Longear Sunfish encompasses the entire eastern United States, with much of the variability in the south east, including all of the Gulf and Appalachian drainages, Florida, to southern Texas, and north to the Great Lakes (Page and Burr 1991). Many Southern populations are thought to be distinct and are in need of a good review, however the data are lacking and this paper will focus only on the better known populations.

Table 1: Broad North American Longear Populations

Lepomis megalotis peltastes Cope 1870	Northern Longear Sunfish
Lepomis megalotis megalotis Fisher 1962	Central Longear Sunfish
Lepomis megalotis breviceps Baird & Girard; Breukelman 1940; Cross 1954; Metcalf 1959; Deacon & Metcalf 1961	Great Plain Longear Sunfish
Lepomis megalotis aquilensis Baird & Girard.	Rio Grande Longear Sunfish
Lepomis megalotis occidentalis Meek 1962	Western Longear Sunfish (Jennings and Philipp 1992)
Lepomis megalotis ssp1	Cuatro Cienegas Sunfish

Table reproduced from David L. Sudradjad, University of Texas at Austin

Accepted Subspecies

Generally, two official subspecies are recognized out of all six of the unique populations. The subspecies are the Northern Longear *Lepomis megalotis peltastes* (Cope 1870), and the Central Longear *Lepomis megalotis megalotis* (Fisher 1962). These fish are very similar in appearance with a few exceptions (Figures 1 & 2). Recent mitochondrial DNA work has established one other subspecies, *Lepomis megalotis nuchalis* the Osage River Longear; however this has yet to become widely recognized due to its extremely small population and extreme southern locality (Vorderstrasse 1998, Table 2). Other known populations such as the White River Longear have been shown to in fact be nothing more than a uniquely colored *Lepomis megalotis* (Vorderstrasse 1998). The other six populations are often recorded as subspecies even if they are not widely accepted as such. This is due to the fact that little research has been accomplished in the area of genetic diversity amongst the six individual populations, so subspecies declarations are made from morphological differences alone.

Table 2: Southern Missouri Geographically Isolated Populations

Lepomis megalotis nuchalis	Osage River Longear
Lepomis megalotis hypotis.	White River Longear

Table created with data from: Vorderstrasse 1998

Problems with Populations

One main problem with defining different subspecies is that there is no standardized test or definition for acknowledging a subspecies. It is generally accepted

that a subspecies is an isolated population that has some distinction from the main population. This can be and is interpreted in a hundred different ways, which most likely is a major cause of this problem. It is also defined strictly as a morph of a species based on color size or shape. For this paper the first definition will be applied as it is more complete. I believe this subspecific definition is being confused with a morph of a species, which is just a distinctive variation that is not isolated. Although a morph of a species can lead to speciation, it in itself does not qualify a species. Individual populations can accumulate genetic differences that lead to divergence, such as genetic drift, chance mutations, or the founder effect. The genetic differences between populations are very minimal (allozyme variation) compared to the phenotypic and morphologic variability, including fin shape, size, and coloration (Jennings and Philipp). Avise and Smith (1977) found that speciation develops genetically independent evolutionary units, something not seen here. Color variation exists between populations within the same drainages and only miles apart, and so is a bad indicator or speciation. This morphological variability exists in traits which can be selected through sexual selection as opposed to deviation in allopatry (Jennings and Philipp). It has been shown that female longear sunfish prefer males with longer opercular flaps, and a lot of somatic growth is placed into the opercular flap growth. The flaps grow faster than pelvic fins in males which were argued by Goddard and Mathis to mean flap length is a signal of sexual health (Goddard and Mathis, 1997). This lends to the idea that many populations are indeed just populations, and not in need of a subspecies title. However, much deviation in sexual selection can create reproductively isolated populations in just a short time. Further testing of genetic markers will be needed to confirm whether or not the

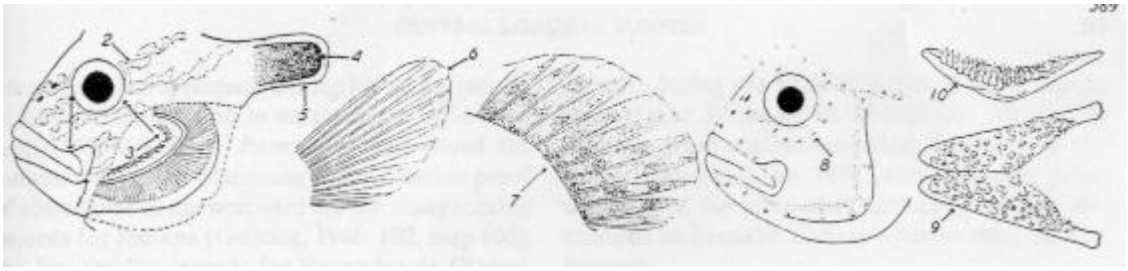
other populations have diverged enough to consider them a subspecies. With this genetic marker data lacking, meristics and morphometrics are used to designate populations and subspecies and so the other four populations will not be considered subspecies due to the lack of genetic data, or reasoning in definition. Rift Valley Cichlids have radiated into the many hundreds of forms in as little as 12,000 years to as many as 700,000 years all from a single ancestor based solely on sexual selection of brightly colored males (Seehausen & Bouton, 1997; Bouton et al., 1999). Likewise, sexual selection in the longear is based on flap length and coloration (Jennings and Philip, Goddard, and Mathis 1997). This can lead to diverse sympatric populations which considering the range of this species and potential allopatric isolation, genetic marker testing becomes all the more essential. Dodd (1989) found that reproductive isolation can occur through geographic isolation in her fruit fly experiments. Different populations of flies that were kept geographically isolated for eight generations and fed different diets became reproductively isolated as well by refusing to mate with the other populations once recombined. The populations appeared very similar, so it is hypothesized that genetic changes based on the different diets led to reproductive changes after so many generations, and this led to the beginnings of speciation. I believe that in order for these four other populations to be considered a subspecies with a lack of genetic data, they must be both: sexually isolated morphologically, and have some form of allopatric divergence. Based on this data, the majority of the populations are not subspecies because they lack allopatric divergence and only differ morphologically. However, I believe a few of them that are geographically isolated could in fact subspecies based on the two criteria, however further studies are needed. Northern and Central Longears share no home ranges, and are

therefore allopatric, they also are morphologically different, and therefore are completely supported by these criteria as subspecific of *Lepomis megalotis.*

L. m. megalotis Characters

Lepomis megalotis megalotis has a number of defining morphological characteristics (Figure 1). Most recognizable is the white outline of the opercular flap that gives the longear its namesake. This opercular flap is distinguishingly long. *Megalotis* ranges from east of the Mississippi and throughout the southern coastal plain. *Megalotis* varies in total length from 5 to 8 inches as an adult. Body highly compressed with a high arching nape. Complete lateral line with between 33 and 44 scales.

Figure 1: *L. m. megalotis*



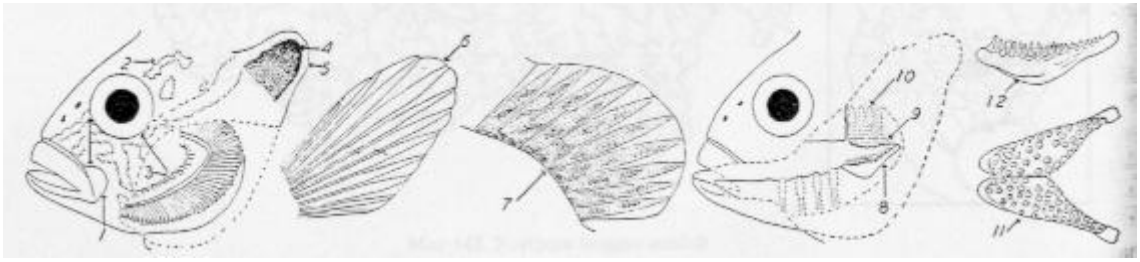
Trautman, Milton B. 1981. The Fishes of Ohio. Ohio State University Press. pp 588-594.

L. m. peltastes Characters

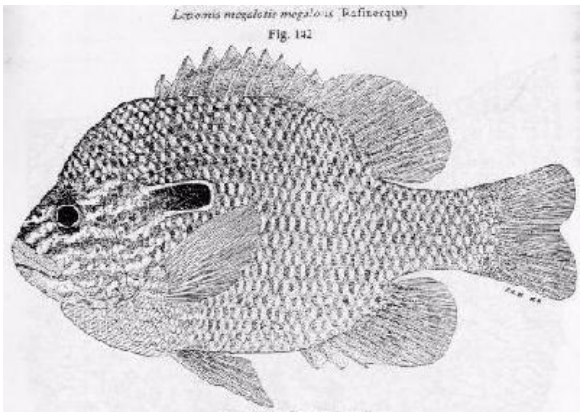
Lepomis megalotis peltastes ranges from northern Illinois, Ohio, Indiana, and Iowa. It rarely exceeds 5 inches in total length and has a large red spot on its opercular

flap. The opercular flap is also nowhere near as long and drawn out as the central longear, and is tilted upwards at a 45 degree angle. *Peltastes* has a complete lateral line with less than 40 scales. There is some evidence to suggest that this may actually be an entirely new species of *Lepomis* (Page and Burr). However no significant genetic differences exist (Jennings and Philip).

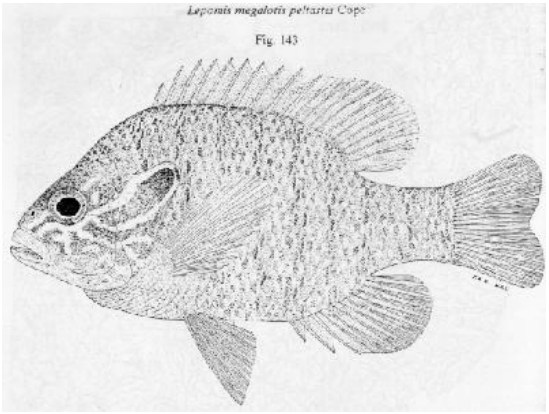
Figure 2: *L. m. peltastes*



Trautman, Milton B. 1981. The Fishes of Ohio. Ohio State University Press. pp 588-594.



Central Longear



Northern Longear

L. m. breviceps , aquilensis and Cuatro Cienegas

These three populations, *breviceps, aquilensis,* and the Cuatro Cienegas longear, vary slightly in color variations, and in geographic regions. No data can be found

regarding the genetic differences nor the exact morphometrics and meristics regarding these populations. It can only be assumed that slight variations exist, and that geography plays the biggest role in dividing them. Without genetic information or morphological data, the reasoning behind the classification of these fish into separate subspecies is unclear. Although I can not cite a source, I did come across some research that suggests the *L. m. ssp1*. are smaller, and have become reproductively isolated based on poor water conditions in Mexico. The idea is that a variation of the fish was able to live in poor conditions and has since become isolated from the main stock. This data can not be corroborated nor correctly cited; yet is interesting regardless as it would show neither geographic nor morphological segregation but rather pollution and water quality barriers.

Discussion

Fish farming and controlled reproduction of fish has been shown to work with a maximum avoidance of inbreeding strategy to produce viable offspring for conservation brood stock programs. Although some populations of longear sunfish need more genetic testing to determine whether they are a subspecies most are not, as the information stands to date, only the northern longear sunfish should be considered for conservation status. A standardized definition of a subspecies is needed to help differentiate between color morphs of the longear and avoid any future confusion.

These sunfish interbreed so extensively that even identifying a longear to the species level can be very difficult, let alone the subspecies level. I have personal experience in taking a picture of a beautiful longear I caught one summer, only to find out it was in fact not a longear at all, but what was believed to be green sunfish x longear

hybrid by a local expert. I thought that we had a special population of longear sunfish in Wilmington, which is probably what is happening in many other places in North America. The longear sunfish have also been introduced to many areas where they may take on color morphs based on their diets. Breeding males present vividly bright colors, however they have been known to vary greatly between drainages only a few miles apart due to diet and genetic drift. It is this natural variation in color, combined with the extensive natural and introduced range that has created these six populations, and in time they may fully speciate. However as of right now there is only enough information to agree with cited literature that the three subspecies exist, the northern, central and the Osage River subspecies. What is really needed is a full genetic comparison between all remaining four populations plus many of the other claims such as the 'Kansas Hybrid'. This genetic test, although potentially not conclusive, could solve all the confusion. It could be non conclusive considering the fact that the northern and central sunfish do not share any genetic differences in the selected markers, which required more studies to define it as a subspecies (Jennings and Philipp).

Some sources such as the Michigan Department of Natural Resources cite the northern longear as its own species, a fact that I will have to disagree with based on the reviewed information. It is morphologically unique, and it has its own distribution, making it a subspecies, however no arguments can be made for it to be its own species after Jennings' and Philip's molecular work.

I believe that conservation work through captive breeding or hormonal control of reproduction is warranted in the northern longear. If this work is completed, it would be trying to save a unique subspecies that may in fact be well on its way to becoming a new

species. This northern population could possibly be replaced by interbreeding with the central population; however it is most likely, although untested, that the two subspecies are sexually isolated. This is due to the sexual preference of central females to the long ear flap that is lacking in the northern subspecies (Jennings and Philip).

Conclusion

The Northern Longear *Lepomis megalotis peltastes* and the Central Longear *Lepomis megalotis megalotis* are distinct subspecies, and the northern longear is not its own species. The other populations have entirely too little data to clarify one way or another. At the time of this paper I could find no defining characteristics of any of the other populations. Why they are labeled as subspecifics is anybody's guess, which leads me to believe they are not a subspecies, but a color morph. As previously mentioned however, more studies are needed including standardized markers for genetic variability.

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