Distribution of *Enneacanthus obesus* (Banded Sunfish) in the Central Pine Barrens of Long Island

Amber Jarrell

and

Yetunde Ogunkoya

Faculty and Student Teams (FaST)

Southern University and A&M College at Baton Rouge

Brookhaven National Laboratory

Upton, NY 11973

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Participants:

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Research Advisor:

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Abstract

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Amber Jarrell and Yetunde Ogunkoya (Southern University and A&M College, Baton Rouge, LA 70813),

Tim Green (Brookhaven National Laboratory, Upton, NY 11973).

Enneacanthus obesus, banded sunfish, are freshwater fish which inhabit the slow moving and highly vegetated rivers, lakes, and ponds of Long Island, New York. They are currently listed as a threatened species in the state of New York. The main aim of the current study is to compare the 2011 distribution of banded sunfish (BS) in the Central Pine Barrens of Long Island with that of previous years (1994-2010) conducted by the New York Department of Environmental Conservation. A total of 10 bodies of water were assessed from which 172 BS and 124 predators were collected using seine and dip nets. These bodies of water included Andy's, Block, Cheney, Grassy, Punzi South, Railroad, Swan, Sweezy, and two unnamed ponds. A ruler was used to measure the collected BS samples and their length ranged from 12–86 mm. The length of the netted predators ranged from 15–340 mm. Both BS and predators were released back into their habitat. Although there were differences in the mean number of collected samples over the years in these ponds, these differences were of no statistical significance. The ponds' water chemistry was measured using a Yellow Springs Instrument probe and a Multi-Parameter PCSTestr 35™. Optimum pH range for BS is between 4-5 and the optimum temperature range is between 25-35 °C. Also they seem to prefer a low level of dissolved oxygen and conductivity. Other factors such as air temperature seemed not to have any significant effect on the population of BS. The adverse factors that appear to influence the decline in BS population are: fluctuating water levels; the absence of certain protective vegetation such as, Bladderwort, Sweet Pepperbush, and Decodon, which harbor the BS from predators; the presence of 'foreign invasive plants;' the presence of predators; and high conductivity. In order to increase the BS population, the above listed factors have to be addressed. One solution to increasing the BS population is to maintain conductive water levels year round. Planting of protective vegetation in and around BS habitat is another solution. Other solutions include rigorous effort to prevent the introduction of foreign vegetation that is not supportive of the BS and total prevention in the introduction of predators, if possible, and if not, to reduce their population to a minimum in the BS habitat.

Introduction

Fig. 1 Banded Sunfish

The threatened *Enneacanthus obesus*, Banded Sunfish (BS), in the order Perciformes, family Centrarchidae, is the smallest freshwater sunfish in New York State with an average adult size of 50-75 mm [2], [1]. BS unique morphology consists of an upturned mouth, rounded pectoral fin, rounded tail fin, and medium-sized eyes. The olive-colored, flattened body is covered with iridescent gold, green, and purple specks with five to eight dark vertical bands on its side, and about 29 to 35 lateral scales. The anal fin has three spines and 9 to 12 rays. The caudal peduncle has 19 to 22 rows of scales. The dorsal fin has about 8 to 9 spines and 10 to 13 rays. As an added advantage, their spiny dorsal fin serves as a discouragement to predators [6]. According to O'Riordan (2010) and Tim Green (2010, personal communication) BS prefer small, slow moving bodies of water such as rivers, lakes, ponds, and bogs with an abundance of vegetation such as Bladderwort, Water lily, Reeds, and Sweet Pepperbush. BS also thrive better in water with a high temperature, low dissolved oxygen levels, and acidic conditions [5].

In New York State, BS are limited to a select few of ponds in the Peconic drainage and are listed as a threatened species due to its dwindling population levels and its vulnerability to environmental catastrophes. As a result it is important to restore the BS population to prevent them from being moved to the endangered species list [4]. The sunfish are voracious eaters and are carnivorous fish that eat crustaceans, mollusks, aquatic insects, and small invertebrates [5]. BS are of a biological and ecological importance through their consumption of mosquito larvae and thus help to reduce the adult mosquitoes and consequent transmission of disease agents [6].

The primary aim of the current study is to compare 2011 distribution of BS in the Central Pine Barrens of Long Island with that of previous years (1994-2010) conducted by the New York Department of Environmental Conservation and to know whether there is a change in the distribution of BS. Also possible suggestions may be made which may enhance the ongoing restoration efforts by New York State and Brookhaven National Laboratory.

Materials & Methods

The study team gathered the following items: an all weather spiral notebook, buckets, dip nets, life vests, paper towels, pens, rulers, seine nets, sled, a Yellow Springs Instrument probe, Multi-Parameter PCSTestr 35 ™, a Global Positioning System (GPS), and waders. All of these items were brought with the study team to the surveyed ponds. Before entering the ponds, the study team wore waders and life jackets. Other materials were loaded onto the sled for transportation to the pond. In the pond, the Yellow Springs Instrument probe was used to measure the water chemistry (pH, conductivity, water temperature, dissolved oxygen (D.O.), and air temperature) and the general appearance of the pond was evaluated. The GPS unit was used to map the coordinates of the surveyed ponds. The data was recorded in an all weather spiral notebook. The aquatic vegetation was identified and recorded as well. The fish were collected using seine and dip nets. Seining was done by two people with one person on each side holding the net. The net had to be dragged along the floor of the pond quickly and rapidly pulled out from the water. Dip nets were utilized as well to capture fish in areas closer to the shoreline and around vegetation such as bushes. Fishing took place for a predetermined period of time of fifteen minutes. If no BS were caught in the allotted time, fishing was conducted in a different area of the pond for another fifteen minute time period. The collected sunfish were removed

from the nets and placed in a bucket filled with water until they were processed. Processing consisted of counting and measuring the length of the fish using a ruler. The measurements were recorded in the all-weather spiral notebook. After processing was complete, the fish were returned back into the pond at the location where they were captured. Prior to leaving each body of water and at the end of the day, an anti-bacterial agent was employed to clean the gear. A maximum of three ponds per field day were assessed. Based on their length measurement, netted samples were grouped as immature 1-25 mm, growers 26-50 mm, and >50 mm as adults. 2011's data of all of the ponds were compared amongst themselves and with the data of previous years.

Results

The study began on June 22, 2011 and was concluded on July 28, 2011. During the period of study, ten bodies of water were assessed. The assessed bodies of water were Andy's, Block, Cheney, Grassy, Punzi South, Railroad, Swan, Sweezy, and two unnamed ponds (Fig. 8).

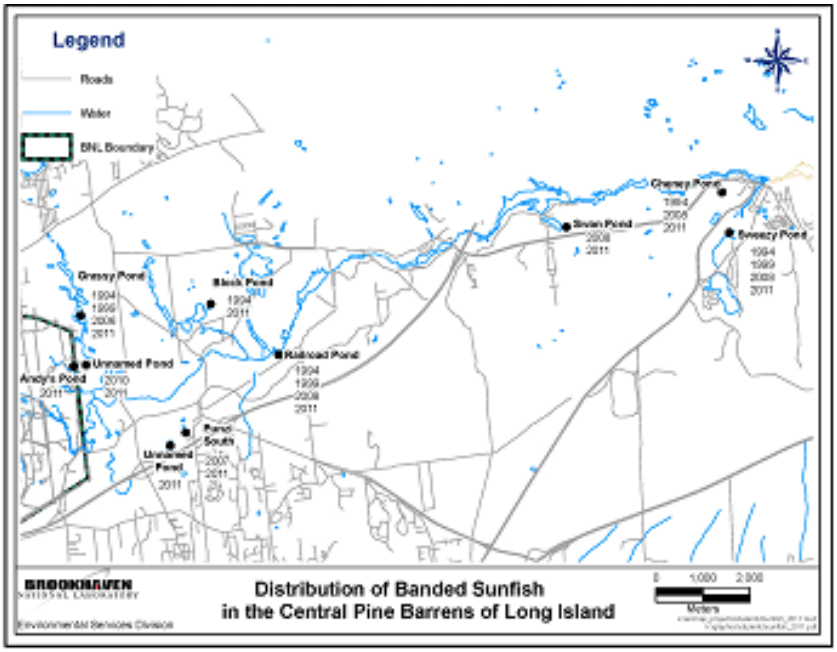

Figure 8 Map displaying the ponds surveyed in 2011 along with the ponds' previous years that surveying was conducted in Eastern Long Island using a Geographic Information System

Some of the ponds' surfaces were covered with lily pads while others were clear of lily pads (Fig. 2). Fallen, submerged tree trunks and dead and decaying plants were also observed in the ponds. Aquatic plants such as shrubs and trees were observed at the shoreline and within the ponds in some areas while other areas were devoid of vegetation. The predominant vegetation found in most of the bodies of water was Bladderworts and Water lilies. It was observed that areas that lacked vegetation, such as bladderwort, had little or no BS. It was also observed that ponds that contained excessive amounts of water lilies were difficult to seine. The number of BS that were captured was high in areas near bladderwort and button bush. Other vegetation that was observed was Decodon, Reeds, Sedges, and Water shields. The waters of the surveyed ponds were either brown or black in color with very poor visibility. The bottoms of these ponds were mostly muddy and boggy with decaying organic matter. A sandy bottom was observed in only two ponds, Grassy and Punzi pond south. Water marks were observed at different levels on the tree stems along the shoreline which depicted the fluctuation in water levels in these ponds. The **c**onductivity varied from 0.5 – 115 μS/cm, dissolved oxygen was from 0.3 – 6.4 mg/L, and the pH ranged from 3.76 – 7.21. Water temperature was from 23.3 – 32^{o}C while the air temperature ranged between 22 – 28^{o}C (Table 2). Captured BS varied with the conductivity of the pond, thus BS were captured from Punzi, Cheney, and Sweezy ponds all of which had moderate conductivity while little or no BS were captured in the pond with the highest conductivity of 115. However, more BS were captured in ponds with low conductivity (Table 2). Also more BS were netted from ponds with little dissolved oxygen compared to ponds with a

Fig. 2. Lily pads on pond's surface

higher level of dissolved oxygen. Ponds with a pH range of 4-7 had more BS compared to those with a higher pH range. More BS were netted in ponds with a temperature range of 26 to 32 °C. The air temperature was similar in all of the ponds.

Table 2. Water Chemistry and the total number of BS netted in 2011

	Andy's	Block	Cheney	Grassy	Punzi South	Railroad	Swan	Sweezy	Unnamed #1	Unnamed #2
Air Temp (°C):	27	31	28.5			25	26		25.3	24.7
Conductivity:	9.2	8.5	104	0.5	73.2	22.9	26	98.9	17.6	115
Dissolved Oxygen (mg/L):	5.4	3.1	5	6.4	2.39	1.9	1.2		0.3	1.2
pH:	4.74	4.5	4.2	5.67	3.76	4.71		7.21	5.68	4.86
Water Temperature (°C):	23.3	32	31	24.7	27.3	26.3	26	23.5	25.1	26.3
2011 BS	0	51	12	10	14	59	1	12	0	13

Water chemistry data is only available for ponds surveyed in 2008 (Railroad, Cheney and Swan ponds) and is not available for the other ponds that were surveyed in 2011. The observed effect of water chemistry on the BS appeared similar to that of 2011 (Table 1). More BS were netted at low conductivity, low dissolved oxygen and low pH while fewer or no BS were netted at high conductivity, high dissolved oxygen, and high pH. Water temperature in all three of the ponds is similar.

Table 1. Water Chemistry of Surveyed Ponds in 2008 and 2011

	Cheney		**Railroad**		**Swan**		**Sweezy**	
	2008	2011	2008	2011	2008	2011	2008	2011
Air Temperature ^{o}C		28.5		25		26		
Conductivity	72	104	55	22.9	172	26		98.9
Dissolved Oxygen (mg/L)	2.6	5	1.02	1.9	0.8	1.2		
pH	5.4	4.2	5.36	4.71	6.7			7.21
Water temperature	22	31	26.7	26.3	24.5	26		23.5
Population	51	12	101	59	1	1	8	12

In 2008, the average length of the immature BS in all the ponds was 22 mm while it was 20.9 mm in 2011; average length of the growers in 2008 was 34.9 mm while it was 32.5 mm, and the adults' average length was 58.76 mm in 2008 and in 2011, the average length of the adult was 69.3 mm (Figures 3 & 4). In 2011, a total of 172 BS were netted from the ten surveyed ponds, which was comprised of 78 immature specimens, 79 growers, and 15 adults (Fig. 4). The highest amount (34 %) of BS was collected in Railroad pond and the lowest percentage (0.05%) was from Swan pond (Fig. 5). The longest and largest specimen measured was 86 millimeters while the shortest specimen was 12 millimeters.

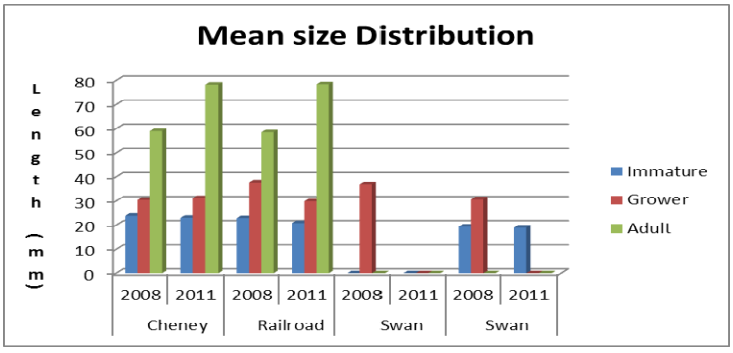

Figure 3 Mean Size Distribution of Sweezy 08 and 2011

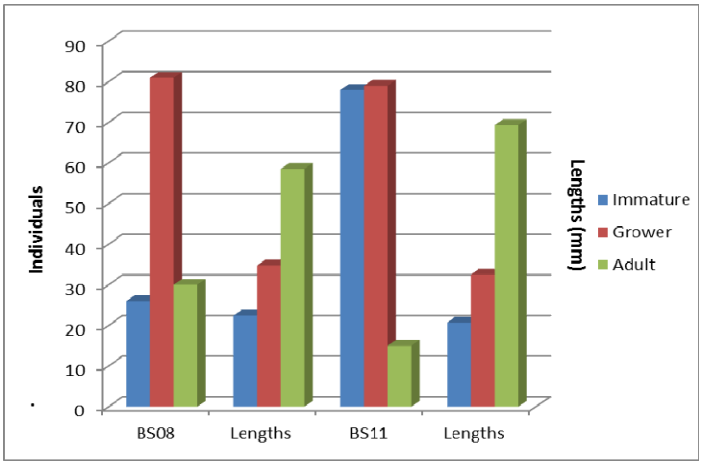

Figure 4 Netted BS and average lengths in 2008 and 2011

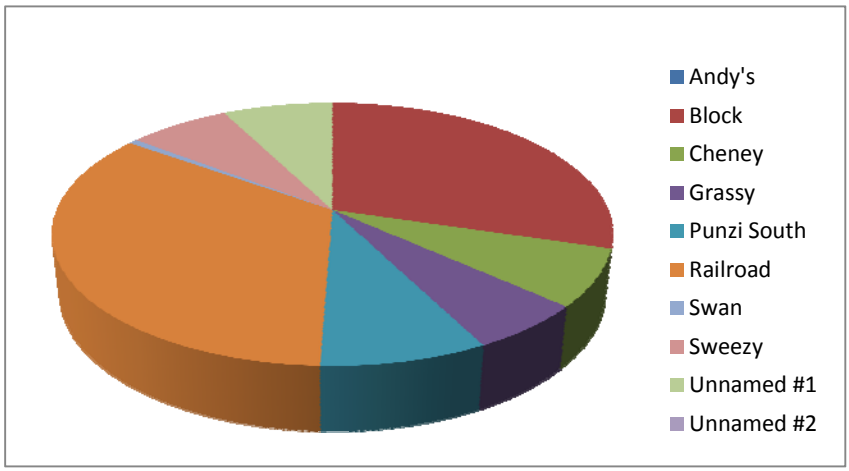

Figure 5 Netted individuals per pond in 2011

There were no surveys conducted for the following years: ’96, ’98, 2000, ’01, ’02, ‘03, ’04, ’05 on our ponds of interest. The distribution of BS over the years varied among ponds (Fig. 6). Total catch for 2008 and 2011 was 160 and 172 respectively. Although there were differences in the mean number of collected samples, these differences were of no statistical significance (P = 0.05). In 2008 the BS population was 101 in Railroad pond; however by 2011 this number has dropped to 59 individuals. The trend was the same in Cheney pond where the netted BS decreased from 51 BS to 12 in 2011. However in 1994 no BS was netted from this pond. Grassy Pond experienced an increase in its population and then a sudden decrease.

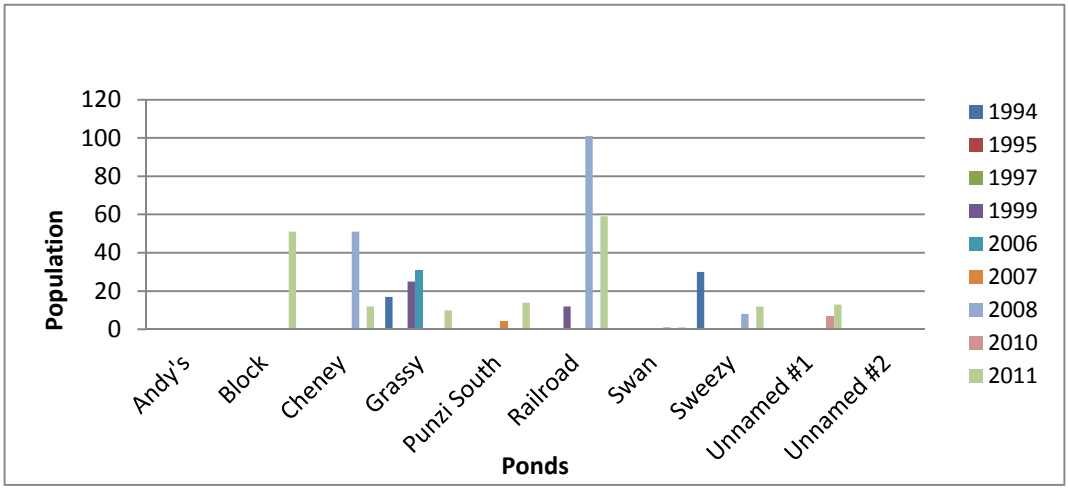

Figure 6 Distribution of BS in the surveyed ponds from 1994-2011

The total number of predators netted in 2011 was 124 (Fig. 7). The predators consisted of Golden shiners, Largemouth bass, Chain pickerels, and Rock bass. The largest and longest predator was about 340 millimeters in length. Other fish that were captured were Bluegills and Swamp darters. The data revealed that the presence of predators in the pond resulted in a consequent reduction in the BS population.

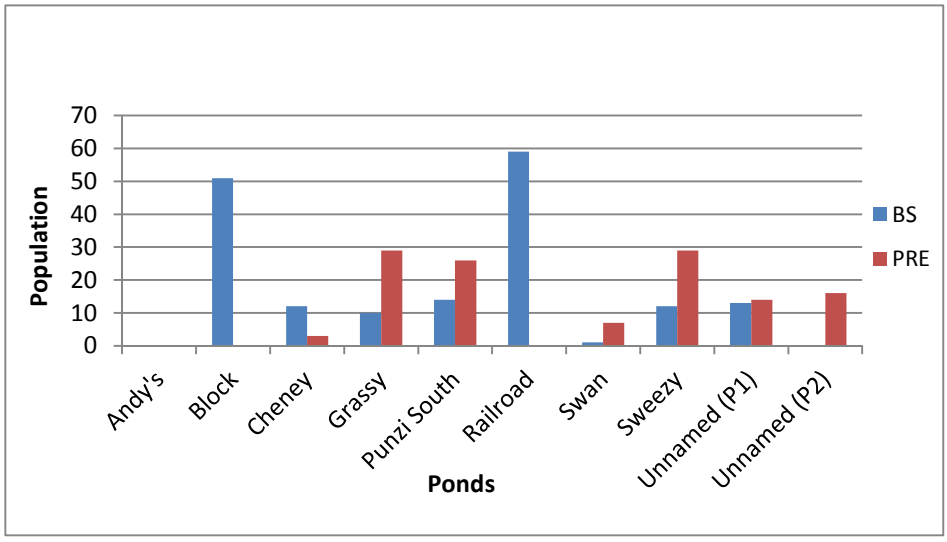

Figure 7 Total number of netted BS and predators in the surveyed ponds from 2011

Comparing the netted BS of 2008 and 2011, 26 immature BS were netted in 2008 while it increased to 78 individuals in 2011. The number of growers that were netted in 2008 was 81 while the number was 79 in 2011 and the adult BS number was 30 in 2008 and decreased to 15 in 2011 (Fig. 4)

Discussion

Although the overall observation of this study corresponds to that of earlier studies on *Enneacanthus obesus*, certain differences were identified. The observation that more BS are netted in ponds with low conductivity, low dissolved oxygen, and low pH agrees with the report of O'Riordan [5] and BS can tolerate temperatures ranging from 22-32 °C [6].

The current study observed that generally more BS were captured in vegetated areas of the pond. The above observation agrees with the statement that “Where there’s bladderwort, there are Banded Sunfish” (Timothy Green, personal communication). In areas where bladderwort was not present, no BS were captured. This may be due to the absence of the BS’s ideal environment or the speed in which seining was conducted. With the absence of bladderwort, the BS are capable of maneuvering around the seine and dip nets to avoid being captured. Also it was observed that BS were netted along the shoreline near vegetation such as the Sweet Pepperbush. BS prefer these types of vegetation because the bushes allow them to camouflage from their predators. Seining was difficult in areas that contained a large amount of water lilies due to their long stems.

The observation on the blackish and brown color of the ponds agrees with reports from previous surveys on the BS habitat. This color of the pond water offers protection to the fish [1]. The fluctuating water level may affect the BS distribution as seen in the observed ponds. A decrease in water level results in a decrease of dissolved oxygen in the pond. This may serve as an advantage to BS since they are able to survive in bodies of water with a low level of dissolved oxygen.

There is evidence of a direct relationship between the number of BS and the number of predators. In this study, ponds containing no predators had the greatest number of BS while those with a high number of predators had fewer BS. For example, Grassy pond contained the greatest number of predators which accounts for its low BS population of ten. Sweezy pond had the second largest number of predators and also possessed a low population of BS.
There is no significant difference in length of the different size groups in all of the observed ponds. However, there is correlation between the number of predators and the number of netted

BS. The more predators that were present resulted in fewer BS that were netted. There are fewer adults in all of the surveyed ponds indicating that there are factors preventing the immature and grower stages from becoming adults. However this may not be connected with the conditions enumerated above .

Conclusion

From the analyzed data, a decline in BS population is driven by so many factors such as environmental and natural factors:

- Drought results in fluctuating water levels which may both harm or benefit the BS.
- Vegetation: some vegetation (Bladderwort, Sweet Pepperbush, Decadon and Cotton Bush) provide protection and a place to spawn for the BS. Thus absence of these plants will expose BS to their natural enemies.
- Predators: To increase the population of Banded Sunfish, the predators can be removed from the ponds and this will allow the fish to grow and populate. Removal of predators must be done carefully to avoid causing harm to the BS.
- Conductivity – high conductivity is shown not to support the BS population.

  The observed optimum pH is within the range of 4-5. Obtaining the optimum pH may be difficult to achieve since pH is influenced by environmental and natural factors such as vegetation, leaf litter, and precipitation. To obtain the optimum water temperature, more water may be added into the pond but will only result in a minor change in temperature.

Acknowledgements

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