A Preliminary Evaluation of Blue Tilapia Population Expansion in Lake Tohopekaliga, Florida

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Abstract: Blue Tilapia (*Tilapia aurea*) were introduced to Florida in 1961. Subsequently they have become established throughout the central part of the state. Tilapia were first collected from Lake Tohopekaliga in 1976. Since that time a considerable expansion in both numbers and biomass has been documented. The juvenile tilapia population has increased by a rate of approximately 500% per year from 1979 to 1981. Blocknet samples taken in the fall of 1981 indicated that young of the year and adults of this species conservatively comprised 0.5% by number and 16% by weight of littoral zone fish populations. Experimental gill nets of 127-, 152- and 178-mm stretch mesh have proven effective in sampling limnetic tilapia populations.

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Blue tilapia, a species native to Africa and the Middle East, were first introduced to Florida in 1961 by the Florida Game and Fresh Water Fish Commission. Subsequent evaluation both as a sportfish and a biological control agent for aquatic vegeta on showed it to be of low value for those purposes (Foote 1977). Earlier work had suggested that tilapia would be unable to expand in the presence of adequate bass numbers (Crittenden 1962). Unfortunately, this has proven not to be the case in Lake Tohopekaliga and other eutrophic Florida lakes.

Shallow water fish population sampling conducted with Wegener rings documented a lack of tilapia in 1972 and 1973 (Wegener and Williams 1974). Shallow water sampling was not conducted from 1974 to 1979. Blue tilapia were first collected from Lake Tohopekaliga by electrofishing in 1976 (W. Wegener, pers. commun.). During 1976–78 a slight increase in tilapia occurred. The first time tilapia were taken in blocknet rotenone samples (1

fish/ha by number and 0.47 kg/ha by weight) occurred in the fall of 1978 (Williams et al. 1979). A large adult population was observed during the Lake Tohopekaliga drawdown of 1979. Extensive spawning activity occurred and large numbers of young were present in the summer of 1979.

The tilapia population has been monitored, and several techniques have been evaluated for their respective efficiency in this regard.

Methods

Lake Tohopekaliga is a 7,618 ha lake located in Osceola County, Florida. Water levels are artificially fluctuated between 0.9 and 1.1 m annually through use of a control structure at the lakes south end. Maximum water depth is 5.2 m, and approximately 50% of the lake bottom (in water depths of 2.1 m or less) is densely colonized by emergent aquatic macrophytes. The lake was artificially drawn down in both 1971 and 1979 to oxidize and consolidate littoral zone substrate, re-establish desirable plant communities, and stimulate fish population increases. The lake is extremely eutrophic, receiving in excess of 91 million liters per day of secondarily treated sewage effluent from the greater Orlando metropolitan area. Nutrients from this source and additional runoff within the lake's watershed have caused severe blue-green algal blooms, with chlorophyll *a* values exceeding 250 mg/m^3 during the fall of 1981. This has created a prime environment for the expansion of blue tilapia.

Shallow water fish population samples were taken during spring and fall months of 1972, 1973 and 1979–81 using standard Wegener ring techniques (Wegener et al. 1973). These were used to document reproductive success and density of young of the year tilapia, since shallow (<0.6 m deep) littoral areas serve both as spawning sites and feeding and rearing areas for young. Individuals collected in this manner were placed in 10% formalin. Size ranges were later established and fish were weighed in total to the nearest 0.01 g; data were expanded to a per ha basis.

Nox-fish ® toxicant was distributed in 6 0.4 ha enclosed littoral areas at concentrations of 1 ppm to obtain standing crop estimates during fall months of 1970–1973 and 1977–1981. Fish were collected for 3 consecutive days, separated by species, measured to the nearest 2.54 cm in length and weighed to the nearest 0.24 kg.

Large mesh experimental gill nets employed in limnetic areas of Lake Tohopekaliga were 91.4 m long and 2.4 m deep, consisting of 4 22.8-m long panels, 1 each of 127-, 152-, 178- and 203-mm stretch mesh. Netting was #208 (11.8 kg test) monofilament nylon. The nets were designed to sink rather than float, but with the shallow water depths present at most sampling

sites nets usually fished from surface to bottom. In addition, a 102-mm stretch mesh gill net, 45 m long, was used in 1980 to determine if smaller tilapia could be effectively harvested with this technique.

Preliminary gill net sampling was conducted in May and October of 1980. The program was fully operational by 1981, and samples were taken during February, May, August and October of that year. Samples were collected from 2 distinct areas: one group of nets (N = 10 to 11) was placed approximately 3 m lakeward of and parallel to the outside edge of emergent vegetation; a second group (N = 8 to 9) was placed in open water at least 15 m from the nearest vegetation. All nets were set at sunset and pulled at the following sunrise providing a fishing period of 10-11 hours. Fish collected were separated by mesh size, measured in mm, and weighed to the nearest 0.02 kg.

Results and Discussion

Shallow Water Fish Population

Juvenile tilapia populations in water <0.6 m deep were estimated at 114 fish/ha ranging in size from 12-18 mm TL in April 1979 (Table 1). Tilapia comprised 1.4% of the total number and 0.7% of the total weight of fish collected in this sample period (Williams et al. 1980). In the spring of 1980, production of young of the year tilapia had increased to 470 fish/ha, ranging in size from 5-25 mm TL. Tilapia contributed 2.0% of the total number of fish collected, and 0.6% of the total weight (Williams et al. 1981). By the spring of 1981 juvenile tilapia had reached a density of 2,552 fish/ha, ranging in size from 7-37 mm TL, comprising 5% by number and 3.0% by sample weight (Williams et al. 1982). Production of young of the

Table 1. Size Ranges, Average Numbers, Average Weights, and Percent Composition of Young of the Year *Tilapia aurea* Collected in Spring Shallow Water Fish Population Sampling on Lake Tohopekaliga, Florida

Year	1979	1980	1981
Size Range	12–18 mm	5–25 mm	7–37 mm
Number/ha	114	470	2,552
Percent composition by number	1.4%	2.0%	5.0%
Weight (kg/ha)	0.01	0.04	0.59
Percent composition by weight	0.7%	0.6%	3.0%
Number of samples taken	32	31	30

year tilapia increased at a rate of 400%-500% per year from 1979 to 1981, and this rate of increase showed no sign of abating.

Rotenone Sampling

Average numbers and weights per ha for various size groups of tilapia collected from Lake Tohopekaliga during fall rotenone sampling for the years 1978–1981 are listed in Table 2. These data are conservative, since field observations indicate adult tilapia are relatively resistant to rotenone, and cannot be accurately sampled on a quantitative basis using rotenone at 1.0 ppm. This information does however show relative changes in the population from year to year.

Tilapia were not collected during 1977 rotenone sampling, and an average of only 1 fish/ha was taken in 1978. Fall 1979 samples showed a significant increase from the previous year, and for the first time indicated a separation in young of the year (age 0) and adult sizes: the former ranged from 65-241 mm TL, the latter from 317-433 mm TL. This observation was substantiated by aging tilapia using scale annulus formation. Annuli were not present on individuals within the 65-241 mm TL group, while adult ranging from 317-443 mm TL exhibited from 1-3 annuli.

Recruitment of the 1979 year class to adult size was evident in the 1980 rotenone samples, with the standing crop estimate increasing to 25 fish/ha. Data for 1981 indicated further population expansion; at this time tilapia were present at a density of 33.2 fish/ha and comprised 0.5% by number and 16% by weight for all fish collected from littoral rotenone samples.

Gill Net Sampling

Experimental gill nets having 76- to 152-mm mesh sizes have been used in the Kafus Flats of Zambia to effectively harvest *Tilapia andersoni* (Scully 1972). This species has a similar body shape as *T. aurea*. Tilapia species have also been harvested commercially in Rhodesia with gill nets having 20- to 200-mm mesh sizes (Bell-cross 1976).

Large mesh experimental gill nets (102-, 127-, 152-, 178- and 203-mm stretch mesh) have proven to be an effective and efficient method of collecting tilapia in open water areas (Table 3). The 102-mm stretch mesh captured few tilapia and large numbers of gizzard shad, consequently this size gill net was eliminated from later work. The 127-mm mesh size collected 23% of the total catch of blue tilapia, whereas, 63% were taken in the 152-mm mesh size. This mesh size was the most effective for collecting adult tilapia. The 178-mm mesh size harvested 14% of the total catch, and the 203-mm mesh gill net harvested <1% of the total catch.

Largemouth bass (*Micropterus salmoides*) proved to be the most sus-

Table 2. Length-Frequency Distribution and Weights of *Tilapia aurea* Collected in Blocknet Samples Taken in Lake Tohopekaliga from 1978–1981[a]

Millimeter Group (total length)	1978		1979		1980		1981	
	No/ha	Kg/ha	No/ha	Kg/ha	No/ha	Kg/ha	No/ha	Kg/ha
1– 12								
13– 38					4.4	0.02	0.7	
39– 64					0.7	0.01	0.8	
65– 89			0.1				2.7	0.04
90–114			1.0	0.02	0.1	0.01	0.7	0.02
115–139			5.4	0.24	0.1		1.9	0.06
140–164			7.1	0.45	0.1	0.01	1.7	0.09
165–190	0.1	0.05	4.7	0.54			0.9	0.11
191–215	0.2	0.04	1.5	0.26	0.2	0.04	1.5	0.25
216–241	0.5	0.23	.9	0.23	0.3	0.09	0.7	0.16
242–261	0.1	0.05			0.1	0.02		
262–291					0.2	0.17		
292–316					8.0	5.25	0.1	0.05
317–342	0.1	0.05	0.7	0.58	9.0	7.19	4.1	3.23
343–367			0.9	1.00	1.1	1.02	9.3	7.58
368–393			0.8	0.96	0.5	0.68	7.2	8.17
394–418			0.5	0.83	0.2	0.28	0.6	0.77
419–443			0.1	0.12			0.2	0.30
444–469							0.1	0.13
Mean No/ha and Kg/ha	1.0	0.47	23.7	5.23	25.0	14.79	33.2	20.96
Mean Length	231.1 mm		188.0 mm		259.1 mm		279.4 mm	
Number of Samples	4		6		6		6	

[a] No tilapia were collected in 1977 out of 6 samples.

Table 3. Length and Weight Parameters of (*Tilapia aurea*) Collected from Various Mesh Size Gill Net Panels in 1981 from Lake Tohopekaliga, Florida

Mesh Size	Number of Fish	Size Range (mm)	Mean Length (mm)	Standard Deviation	Confidence Limits (80%)
		Length			
127-mm	406	243–400	334	19.5	309–359
152-mm	1,122	240–426	360	15.7	340–380
178-mm	245	331–452	390	21.3	362–418
203-mm	15	325–426	386	25.6	353–419
		Weight			
Mesh Size	Number of Fish	Weight Range (kg)	Mean Weight (kg)	Standard Deviation	Confidence Limits (80%)
127-mm	406	0.36–1.50	0.87	0.18	0.64–1.10
152-mm	1,122	0.73–1.72	1.13	0.15	0.93–1.33
178-mm	245	0.82–2.34	1.48	0.24	1.17–1.79
203-mm	15	0.80–1.88	1.42	0.27	1.07–1.77

ceptible game fish to all mesh sizes. Largemouth bass caught ranged from 356-660 mm TL with several being in the "trophy" size range weighing upwards of 4 kg. Few other game fish were harvested.

Analysis of catches in different seasons showed considerable variation in success among mesh sizes.

Blue tilapia in the size ranges susceptible to the 127-mm mesh size gill net showed an average catch rate from the 6 sampling periods of 35 fish (28 kg) per net set.

The 152-mm stretch mesh proved to be the most effective of the 4 panels in harvesting blue tilapia. The 88 tilapia per net set harvested in the winter of 1981, was the highest recorded for the 6 sampling periods (Table 4). The spring sample for 1980 was the lowest. An average for the 6 periods provided a catch rate of 53 fish (59 kg) per 91.4 m net set.

The 178-mm mesh size was most effective in the fall of 1981 (Table 4). The average length of tilapia has been increasing since this sampling tool was implemented, and the larger size tilapia were susceptible to this mesh size in the fall of 1981. Lowest numbers and weights were collected during spring of 1980 and 1981. This is to be expected since at this time of year adult tilapia migrate to shallow littoral areas for spawning. Overall, this mesh size accounted for 13 fish (19 kg) per net set.

The 203-mm mesh size was too large to collect adult tilapia, and proved inefficient throughout the 6 sampling periods. No other conclusions could be determined with these data.

Table 4. Average Numbers and Weights of *Tilapia aurea* Collected by Experimental Gill Nets Set in Lake Tohopekaliga during 1980 and 1981

Size	1980				1981							
	Spring		Fall		Winter		Spring		Summer		Fall	
	No.	Kg.	No.	Kg.	No.	Kg.	No.	Kg.	No.	Kg.	No.	Kg.
127-mm	57.8	34.9	60.7	48.9	29.4	26.6	30.4	23.4	15.4	13.4	16.4	18.4
152-mm	10.0	11.7	78.2	79.5	88.4	93.9	46.6	50.9	36.4	39.2	60.9	77.6
178-mm	5.8	9.2	18.9	27.4	14.2	20.9	2.8	3.9	5.8	7.5	28.9	44.5
203-mm	0.6	1.0	0.4	0.7	0.8	1.0	0.6	0.8	0.0	0.0	1.8	2.7
Totals	74.2	56.8	158.2	156.5	132.8	142.4	80.4	79.0	57.6	60.1	108.0	143.2
No. of samples	20		18		20		20		20		18	

[a] Data averaged and expanded to 91.4 meter net sections.

Overall, in comparing the 6 sampling periods, peak sampling times for monitoring limnetic tilapia populations would be the winter and fall quarters. At this time, large numbers of adult tilapia are in limnetic areas of the lake.

Shallow water tilapia population estimates show substantial annual increases in reproductive success from 1979 to 1981.

Blocknet data show annual increases in littoral young of the year and adult tilapia for the same time frame, but not to the same degree as reproductive success.

The 152-mm mesh is the most effective gill net size used to harvest adult tilapia. The 127-mm and 178-mm mesh are also effective, harvesting both smaller and larger adult tilapia, respectively, than the 152-mm mesh. The 203-mm mesh should not be used due to its sampling inefficiency.

No determination of population expansion can be made at this time using gill net data, but this technique should prove valuable in assessing population changes in future years.

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