Use of Scale Pattern Analysis to Identify Age-0 Largemouth Bass Stocks in a Small Texas Reservoir

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Abstract: Scale pattern analysis was used to differentiate between stocked and wild age-0 largemouth bass (*Micropterus salmoides*) in New Mart Lake, Texas. Scale samples were collected from wild (intergrade) and stocked (Florida) largemouth bass during spring 1995. Stocked fish were tagged with coded wire tags to ensure proper identification. During fall 1995, 88 age-0 wild and stocked largemouth bass were collected by electrofishing. Using linear discriminant function analysis, correct classification for the 71 wild fish was 97%, while correct classification for the 17 stocked fish ranged from 53% to 82%. Scale pattern analysis is an alternative technique for evaluating largemouth bass stocking programs.

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Largemouth bass are an important component of the sport fishery in many Texas reservoirs. Stocking Florida largemouth bass (*M. s floridanus*) has become a fisheries management tool for the Texas Parks and Wildlife Department (TPWD). An increase in percentages of Florida alleles has resulted in faster growth and larger largemouth bass in many Texas reservoirs (Forshage et al. 1989). Since 1990, nearly 70 million Florida largemouth bass fingerlings have been stocked by TPWD. However, the success of individual stockings is largely unknown. A prerequisite to evaluating a stocking program is discriminating stocked fish from wild fish and estimating the relative contributions of each stock to the fishery. However, the cost of marking or tagging fish on a statewide basis is cost prohibitive.

Scale shape and circuli patterns have been used to discriminate fish stocks (Nielsen 1992, Guy et al. 1996). Scale circuli deposition is influenced by a variety of factors including growth rate, water temperature, water chemistry, genetic variation, and life

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history patterns (Seelbach and Whelan 1988, Nielsen 1992). Beckman (1942) found that variation in some environmental patterns, such as temperature and food availability, could be inferred from analysis of growth annuli on fish scales. Scale pattern analysis has been used with some success to distinguish various stocks of salmonids (*Oncorhynchus* sp.) (Cook 1982, McGregor et al. 1983, Schwartzberg and Fryer 1988, Seelbach and Whelan 1988), red drum (*Sciaenops ocellatus*) (Bumguardner and Colura 1993, Silva and Bumguardner 1998), and striped bass (*Morone saxatilis*) (Ross and Pickard 1990, Humphreys et al. 1990). If accurate, scale pattern analysis offers managers an alternative method of distinguishing between stocks of fish.

Scale pattern analysis has not been applied to freshwater sport fish in the southeastern United States. Evaluating Florida largemouth bass stocking by distinguishing between stocked and wild fish would provide biologists with an additional tool in managing reservoir fisheries. The objective of this study was to determine whether scale pattern analysis could be used to differentiate between wild and hatchery age-0 largemouth bass collected in the fall.

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Methods

This study was conducted at New Mart Lake, Texas, a 41-ha impoundment in eastern McLennan County near Waco. The lake was constructed in 1926 and is a municipal water supply for the city of Mart. New Mart Lake has a mean depth of 3.0 m, maximum depth of 9.1 m, secchi depth transparency <1.0 m, and a conductivity of 280 µmhos/cm. Largemouth bass, bluegill (*Lepomis macrochirus*), white crappie (*Pomoxis annularis*), channel catfish (*Ictalurus punctatus*), and gizzard shad (*Dorosoma cepedianum*) are the dominant fish species present in the lake. In 1992, the percentage of Florida largemouth bass alleles was 20% (TPWD, unpubl. data).

A sample of wild age-0 largemouth bass was collected at night from 4 stations with a boom-mounted, 5-kW direct current electrofishing boat on 30 May 1995. Total length (TL) of these wild fish ranged from 39 to 60 mm. On 1 June 1995, the lake was stocked (151/ha) with age-0 Florida largemouth bass (TL range 65–100 mm). Prior to stocking, hatchery fish were implanted with coded-wire tags (Copeland and Noble 1994) and a random sample of fish was placed on ice and returned to the laboratory. On 30 October 1995, age-0 largemouth bass were collected from New Mart Lake at night with the same electrofishing boat used earlier. All largemouth bass <200 mm TL were placed on ice and returned to the laboratory.

At the laboratory, otoliths were removed and aged in whole view to identify fish from the 1995 year class. These age-0 fish were checked for the presence of a coded wire tag indicating hatchery origination. Tag loss was assumed to be 0 (Fletcher et al. 1987). A scale sample was collected from the left side of each fish below the lateral line near the tip of the pectoral fin. A minimum of 6 scales were placed on a glass slide and allowed to dry. A cover slip was fixed to the slide with Permount to secure the scales.

Scale mounts were viewed with a compound microscope equipped with a video camera at 100×. Images were digitized and displayed on a high resolution video monitor using Optimas 6.0 software (Optimas 1996). For each fish, the scale with the most distinct circuli patterns was used for analyses. Samples in which all scales were regenerated were omitted. Using the digitized image, a reference line was drawn along the boundary between the widely and the closely spaced circuli in the anterior field (Ross and Pickard 1990). The intersections of circuli with the reference line were then marked and saved. Measurements were taken for the first 21 circuli (the fewest number of circuli for any 1 fish).

Digitized scale measurements were used to compute circuli distances and increments with the equations

$$D_x = M_x - M_1, \text{ and}$$

$$I_x = M_x - M_{x-1},$$

where M is the measurement recorded at the x th circulus, D is the distance from the first circulus to the x th circulus and I is the distance between 2 adjacent circuli.

Stepwise discriminant function analysis (SAS Inst. 1990) was used to develop baseline classification models for the age-0 hatchery and wild fish collected in the spring. Then, using scale measurements from fall-collected fish of known origin, variables selected in the stepwise analysis were entered in a discriminant function model to evaluate the accuracy of the discriminating criteria. Correct classifications were computed for each stock. The predicted number of each stock in the fall sample was also computed. The predicted number for each stock was equal to the correct number for that stock plus the incorrect number for the alternate stock.

Results

Scale circuli measurements were made on 110 wild largemouth bass and 110 hatchery-raised largemouth bass from spring collections. A total of 88 age-0 largemouth bass were collected in the fall. Seventeen of the fall collected fish were of known hatchery origin and 71 were wild fish.

A total of 15 distance (D) variables and 13 increment (I) variables were significant ($P \leq 0.05$) in the stepwise discriminant analysis of spring-collected wild and hatchery largemouth bass. Distances and increments for hatchery-raised fish were always equal to or greater than distances and increments for wild fish (Fig. 1). Stepwise discriminant analysis produced 6 models (Table 1) with R^2 values ranging from 0.51 to 0.74. The model with the highest R^2 included the variables I18, I19, I20 and D15. Using these variables, a discriminant function model correctly classified 13 hatchery fish (76%) and 69 wild fish (87%) from the fall-collected specimens (Table

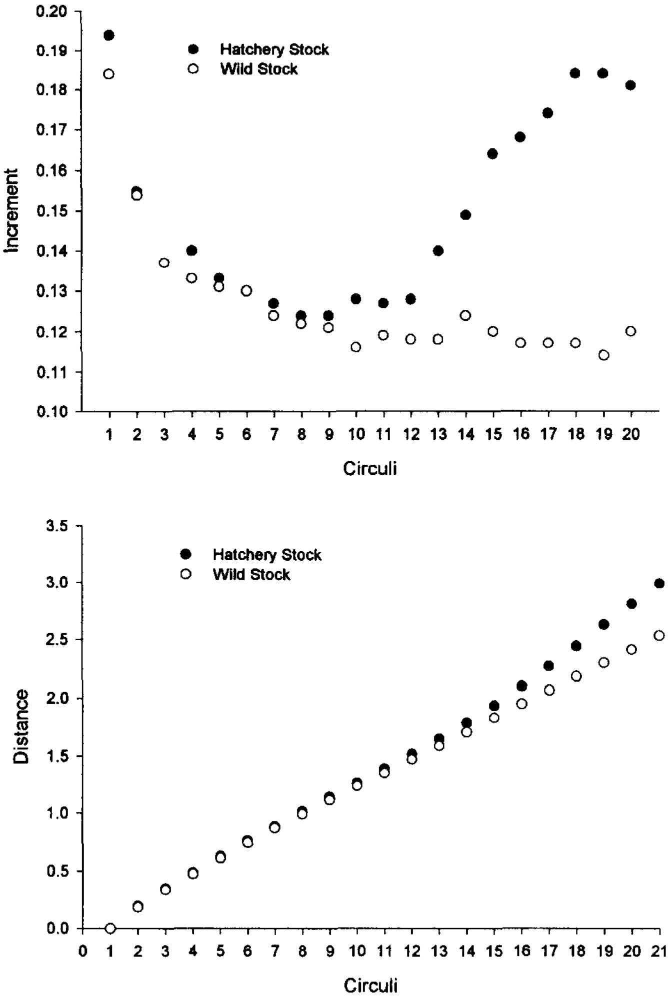

Figure 1. Circuli increments and distances for age-0 largemouth bass collected from New Mart Lake, Texas, spring 1995.

Table 1. Results of stepwise discriminant function analysis for spring-collected wild and spring-stocked hatchery largemouth bass from New Mart Lake, Texas, 1995. R^2 is the coefficient of determination, *F* is the statistic used to enter or remove variables, and *P* is the probability value.

Variable(s)	R^2	*F*	*P*
I18	0.65	410.07	<0.01
I18, I19	0.69	348.68	<0.01
I18, I19, I20	0.61	275.13	<0.01
I18, I19, I20, D15	0.74	221.34	<0.01
I18, I19, I20, D15, D19	0.51	196.70	<0.01
I18, I19, I20, D15, D19, D3	0.63	168.42	<0.01

Table 2. Results of 6 discriminant function models for 88 age-0 largemouth bass collected in the fall from New Mart Lake, Texas, 1995. Individual fish were classified as hatchery or wild. *N* is the number of fish that were classified correctly. Percent is the percentage of fish that were classified correctly and is based on 17 known hatchery fish and 71 known wild fish. The predicted contribution is the number of fish that were predicted to be in the hatchery or wild groups for each model.

	Hatchery		Wild		Predicted contribution	
Variable(s)	*N*	%	*N*	%	Hatchery	Wild
Known	17	100	71	100	17	71
I18	9	53	69	97	11	77
I18, I19	11	65	69	97	13	75
I18, I19, I20	14	82	69	97	16	72
I18, I19, I20, A15a	13	76	69	97	15	73
I18, I19, I20, A15, A19	12	71	69	97	14	74
I18, I19, I20, A15, A19, A3	11	65	69	97	13	75

a. Model with the highest R^2 in the stepwise discriminant function analysis (Table 1).

2). These classifications yielded an estimate of 15 hatchery fish and 73 wild fish from the fall sample, only slightly different than the actual values of 17 hatchery and 71 wild fish.

The remaining 5 models produced by the stepwise discriminant function analysis were also entered into a discriminant function model to determine the accuracy of each. Correct classification for the 17 hatchery fish ranged from 53% to 82%; for the 71 wild fish, correct classification was 97% for each model (Table 2). The discriminant function model with variables I18, I19, and I20 produced the highest classification rates for both hatchery and wild fish (82% and 97%, respectively). This model estimated a total of 16 hatchery fish and 72 wild fish were collected in the fall.

Discussion

Scale pattern analysis was effective at classifying wild and hatchery age-0 largemouth bass collected in the fall, though accuracy was higher for wild fish. These classification rates differ from those of other studies in which similar or higher classification rates were obtained for hatchery fish. Hatchery and wild striped bass were correctly classified at rates of 84% and 78%, respectively (Ross and Pickard 1990). Similarly, 92% of hatchery chinook salmon (*Oncorhynchus tshawytscha*) were classified correctly and 87% of wild stock were correctly classified (Schwartzberg and Fryer 1988).

Classification accuracy for hatchery fish varied slightly depending on what combination of variables was entered in the discriminant function model; the estimated relative contribution of both hatchery and wild stocks was high for many of the models. The stepwise discriminant function model with the highest R^2 did not distinguish fall-collected fish most accurately. However, selecting a discriminant model based on stepwise analysis still provided relatively accurate results.

This study focused on age-0 largemouth bass, but the potential for this technique to be applied to older age classes is not known. Scale pattern analysis was not effective for age-1 red drum (Silva and Bumguardner 1998) because scales became obscured by calcification. Future studies should seek to determine if scale pattern analysis can be accurately used on ≥ age-1 fish.

The genetic composition of hatchery and wild largemouth bass in this study was different. Hatchery fish were pure Florida largemouth bass; wild fish were comprised of intergrades (TPWD, unpubl. data). Differences in scale patterns observed in this study may have been influenced by genetic variability in addition to factors associated with hatchery and natural environments.

Results from this study indicate that scale pattern analysis can be used to discriminate between hatchery and wild stocks of age-0 largemouth bass. The primary advantage of scale pattern analysis is that scale samples are relatively easy and inexpensive to collect. Equipment necessary to use scale pattern analysis include a computer, compound microscope, video camera, and image analysis software. Computers and microscopes are usually readily available; software and a video camera can be purchased for <$10,000. Several disadvantages are associated with scale pattern analysis. First, scale pattern analysis is most effective on a short-term basis. Also, there is no assurance that scale patterns will be able to distinguish groups of fish. Other disadvantages of using scale patterns are that lost scales are regenerated and that scale edges are resorbed in times of stress, both of which can eliminate or obscure circuli (Guy et al. 1996).

Variables selected in this study could differ when applied to other largemouth bass populations. A prerequisite to using scale pattern analysis is first collecting fish of known origin and determining if differences exist in certain variables. If a difference exists, then discriminating criteria for the baseline groups should be established.

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