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REPRODUCTION AND GROWTH OF BLACK DRUM, *Pogonias cromis*, IN NORTHEAST FLORIDA

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ABSTRACT: Age, growth, and reproduction of black drum, *Pogonias cromis*, in northeast Florida were investigated between December 1983 and April 1985. Male black drum began maturing at 450-499 mm total length (TL), with 50% of them reaching maturity at about 590 mm (age 4 or 5). Vitellogenesis began at 450-550 mm TL, with 50% of the females reaching maturity at 650-699 mm (age 5 or 6). Spawning occurred during January - April. Thin sections of otoliths displayed distinct opaque bands; the first three or four of these bands were verified by marginal increment analysis as being annuli deposited during March - May. The growth rate was about 100 mm yr^{-1} for ages 1-3 and gradually slowed to 10-30 mm yr^{-1} for ages 15-20. Male and female growth rates did not differ significantly, at least through age 4. Length at age was predicted well by the equation mm TL = 1172 mm (1 − exp (− 0.12 (AGE + 1.3))). The apparent maximum age of black drum is about 50-60 years.

Black drum, *Pogonias cromis*, support moderate commercial and recreational fisheries in Florida. Recreational catches of black drum along the Florida Atlantic coast increased from 122,000 lbs in 1981 to 628,000 lbs in 1984[1]. In northeast Florida, a recreational fishery for large black drum develops during the spring as adults congregate in sounds and passes. Smaller "puppy" drum are caught by recreational fishermen, and incidentally in commercial catches, throughout the year. Annual commercial landings of black drum ranged from between 35,000 to 150,000 lbs on the Florida Atlantic coast between 1950 and 1985 and have averaged about 60,000 lbs since 1978[2]. Recent development of a purse seine fishery for large black drum and red drum (*Sciaenops ocellatus*) in the northern Gulf of Mexico, however, suggests that the potential exists for exploitation of the large, offshore stocks of adults[2].

Knowledge of the biology of Florida black drum has primarily been obtained from ancillary information included in faunal studies. The spawning season, as determined by studying larval and juvenile collections, occurs during late fall and winter in south Florida (Jannke, 1971) and during winter and early spring in northern and central Florida (Reid, 1954; Kilby, 1955; Joseph and Yerger, 1956; Springer and Woodburn, 1960). Scales and/or otoliths have been used to determine the ages and to describe the growth of adult drum in Georgia (Music and Pafford, 1984), Virginia (Richards, 1973), and Texas (Pearson, 1929; Simmons and Breuer, 1962; Cornelius, 1984). The growth rates of juvenile black drum in Texas have been determined by analyzing length-frequency modes (Pearson, 1929; Simmons and Breuer, 1962). Tagging programs have also provided information

[1]Robert Muller, Florida Marine Research Institute, Department of Natural Resources, 100 Eighth Ave. S.E., St. Petersburg, FL 33701, personal comm., Marine Recreational Fisheries Statistics Survey data.

[2]NOAA, National Marine Fisheries Service. Proposed secretarial fishery management plan, regulatory impact review, initial regulatory flexibility analysis, and draft environmental impact statement for the red drum fishery of the Gulf of Mexico. August 1986.

on drum growth in Texas bays (Doerzbacher, 1988).

This study describes the maturation, spawning, age determination, rates of growth, and the weight-length and length-length relations of black drum sampled from the inshore Atlantic waters of northeast Florida. The fishery implications of these results are briefly discussed.

METHODS AND MATERIALS

Black drum were collected monthly from the commercial and recreational catches made at Amelia Island (30°35′N, 81°30′W), in northeast Florida, south to St. Augustine (29°55′N, 81°15′W) from December 1983 through April 1985. No samples were obtained in September and November 1984 and February 1985.

All fish were measured for total (TL), fork (FL), and standard lengths (SL); sexed; and weighed for whole weight (W) to the nearest ounce. Each month, up to 40 of these fish were also sampled for gonads and otoliths (sagittae). Gonads were preserved in Davidson's fixative (Humason, 1972). Otoliths were washed in water and then stored dry in vials stoppered with cotton. Unless otherwise noted, all lengths presented are total length (TL).

Preserved gonads were soaked in water for 24 h in the laboratory, blotted dry, and weighed to the nearest 0.1 g. After drying, a sample of each gonad was stored in 70% ethanol. This sample was later embedded in paraffin, sectioned to 6 um thickness, stained with Mayer's haematoxylin and eosin Y, and mounted for microscopic examination. The seasonal cycle of male and female gonadal development was divided, based on the histological criteria of Wallace and Selman (1981) for oogenesis and Grier (1981) for spermatogenesis, into eight classes (Table 1). Individuals of each sex were considered functionally mature at Class 4 or greater. Size at maturity was determined by grouping fish by sex into 50 mm size classes and calculating the percentage of mature fish in each size class.

Spawning season was determined by noting changes in mean oocyte diameters throughout the study period. Oocyte diameters were measured with an ocular micrometer, and only oocytes whose nuclei were included in the cross section were measured (Foucher and Beamish, 1980). One hundred oocytes in a common, randomly selected lamella were measured in each ovary to calculate mean oocyte diameters within samples. Ten of the largest oocytes from each gonad section were also measured to calculate the mean-maximum oocyte diameter.

Sagittae were sectioned for age determination using a Beuhler Isomet Low-Speed Saw with a diamond blade. Two 0.5-mm-thin transverse sections were cut from each sagitta and mounted on microscope slides with Coverbond Mounting Media. The section that intersected the core of the otolith was examined for age marks under a dissecting microscope using reflected light. The medial transverse distances from the core to the proximal edge of each opaque band and to the edge of each section (otolith radius, OR) were measured with an ocular micrometer. Ages were determined for all fish, including those age 0+, by assuming a biologically realistic hatching date of 1 April and incrementing ages from this date. The suitability of using otolith sections to back-calculate fish lengths in order to study individual fish growth was tested by least squares regression of fish length on otolith section radius. The modified direct proportionality formula was used to back-calculate

Table 1. Reproductive classes of black drum gonads by sex.

CLASS	FEMALE	MALE
1. **Immature**	Few folds of ovigerous lamellae; few or no primary oocytes; oogonia predominate; diameter of ovary <3.0 mm.	Non-reproductive; only spermatogonia present; no evidence of tubule development.
2. **Developing / Resting Virgin**	Ovigerous lamellae fill lumen of entire gonad; abundant primary oocytes; oogonia present at periphery of lamellae. Absence of atretic bodies; tunica thickened.	Early spermatogenesis; few scattered cysts of primary spermatocytes; peripheral tubules differentiating; lumen not developed.
3. **Maturing**	Early vitellogenesis; oogonia, primary oocytes and oocytes with yolk vesicles present; commences in late October-November.	Mid spermatogenesis or ripening; spermatogonia and cysts of spermatocytes present along tubules, limited production of spermatids.
4. **Mature**	Late vitellogenesis; oogonia, primary occytes, oocytes with yolk vesicles and globules present.	Late spermatogenesis; ripe; few spermatogonia along tubule; spermatozoa collecting in tubules and central lumen.
5. **Gravid**	Maturation, oogonia, primary oocytes, oocytes with yolk vesicles and yolk globules present; nuclei of most advanced oocytes have migrated in preparation for ovulation.	Declining number of spermatogenic cysts; efferent ducts filled with spermatozoa; lumen of central duct partially filled with spermatozoa.
6. **Spawning**	Amorphorus, hydrated oocytes present; oocytes in all stages of development; fragments of ruptured oocytes scattered throughout; collapsed empty follicles present; yolk remnants usually present in connective tissue and lamellae; tunica greatly thickened.	Efferent ducts filled with spermatozoa; spermatozoa streaming into main collecting duct; distal portions of a few efferent tubules empty and somewhat thickened; spermatogonia absent.
7. **Spent**	Oogonia and primary oocytes present in budding ovigerous lamellae; ovary with "empty" areas; "plugs" of unshed oocytes present, atretic bodies scattered throughout, usually in association with blood vessels.	No spermatogonia or spermatocytes present; efferent tubules empty; lumen of central collecting duct with small amount of residual sperm; testis greatly reduced in size; tunic of previous spawners thickened and convoluted.
8. **Recovering**	Prolific recrudescence of ovigerous lamellae with myriad oogonia and stage II oocytes; atretic bodies present; the tunica with many convolutions.	Network of efferent tubules lined with spermatogonia; numerous PAS leukocytes "cleaning up" the central sinus; some cysts of spermatocytes re-appear in mid May-June.

lengths (Bagenal and Tesch, 1978) only for black drum ages 1-4 because few older fish were sampled.

The Statistical Analysis System (SAS Institute, Inc. 1982) was used to calculate all regressions; PROBIT analysis of size-class midpoints was used to calculate the lengths at 50% maturity. The NLIN procedure (Marquardt option) of SAS was used to fit age-length data to the von Bertalanffy growth model (Vaughan and Kanciruk, 1982) and weight--length data to the allometric growth model, $W = a\ TL^b$. Estimates of "a" and "b" of the allometric growth model were tested for differences using the Student's t - test ($\alpha = 0.05$).

RESULTS AND DISCUSSION

Size and Age at Maturity

In northeast Florida, male black drum (n = 181) matured at slightly smaller sizes and younger ages than did females (n = 158). Male sexual maturation began when lengths of 450-499 mm were reached at age 2 (Table 2). PROBIT analysis indicated that 50% of all males reached maturity at lengths of about 590 mm at ages 4 or 5. Total maturity was attained at approximately 675 mm and probably age 6. Early vitellogenisis was evident for immature females at lengths of 450-550 mm. All females less than 650 mm were immature and all greater than 650 mm were mature; consequently, 50% and total maturity were attained when lengths of between 650 mm and 699 mm were reached at age 5 or 6 (Table 2).

Maturation of male black drum had not been described prior to this study. The size and age at which female black drum from northeast Florida mature were similar to those figures reported for female black drum in Georgia waters; female black drum in the western Gulf of Mexico, however, were smaller and younger at maturity than were those from northeast Florida. In Georgia, Music and Pafford (1984) found that the smallest female exhibiting developing ovaries was 582 mm and age 4. Macroscopic examination of females in Texas with "granular gonads" suggested maturity was reached at 275-320 mm, at the end of their second year (Pearson, 1929; Simmons and Breuer, 1962).

Spawning Season

Mean and mean-maximum oocyte diameters of black drum peaked in April 1984 and March 1985 (Fig. 1). Some spawning activity during January - March 1984 was evidenced by elevated mean

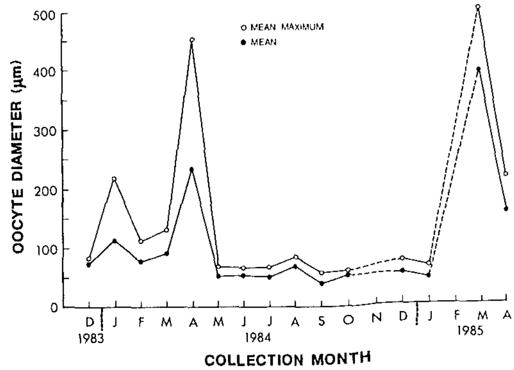

Figure 1. Mean and mean-maximum oocyte diameters for *P. cromis* for each monthly collection.

and mean-maximum oocyte diameters. Adult black drum of both sexes sampled from Tampa Bay, which is located along the Florida Gulf coast, were also in spawning condition during February and March 1984[3]. The overall observed sex ratio (202M:169F) for black drum 202-1275 mm long was not significantly different (x^2 test, p>0.05) from the expected 1M:1F sex ratio.

Data gathered from adult, juvenile, and larval collections made in other areas generally agree on black drum spawning seasonality. Adults were in advanced stages of maturity during March and April off Georgia (Music and Pafford, 1984). In the Biloxi marsh complex of southeast Louisiana, black drum had ripe gonads during March - May (Fontenot and Rogillo, 1970). Examination of larval and juvenile collections provided evidence that suggested a late fall and winter spawn in south Florida (Jannke, 1971) and a winter - early spring spawn in central and northern Florida (Reid, 1954; Kilby, 1955; Joseph and Yerger, 1956; Springer and Woodburn, 1960). Two spawning peaks per year have been noted for black drum in Texas: a main peak in late winter - early spring and a lesser peak in early fall (Pearson, 1929; Simmons and Breuer, 1962). Most adults with advanced gonadal development have been collected during February - May; however, a few nearly ripe black

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Table 2. Fraction of black drum mature (sample size in parentheses) in 50 mm size classes and for age groups 1 - 14, ⩾15.

LENGTH			AGE		
TL (mm)	Male	Female	Age (yrs)	Male	Female
200-249	0 (16)	0 (17)	0	0 (24)	0 (27)
250-299	0 (25)	0 (19)	1	0 (48)	0 (47)
300-349	0 (7)	0 (13)	2	0.10 (49)	0 (33)
350-399	0 (30)	0 (18)	3	0.17 (30)	0 (18)
400-449	0 (21)	0 (25)	4	0.33 (12)	0 (9)
450-499	0.11 (20)	0 (15)	5	0.75 (4)	0.50 (2)
500-549	0.21 (14)	0 (9)	6	— (0)	1.0 (2)
550-599	0.29 (24)	0 (13)	7	— (0)	— (0)
600-649	0.83 (6)	0 (7)	8	1.0 (3)	1.0 (1)
650-699	1.0 (3)	1.0 (2)	9	1.0 (1)	1.0 (3)
700-749	1.0 (2)	— (0)	10	1.0 (1)	1.0 (1)
750-799	— (0)	— (0)	11	1.0 (1)	— (0)
800-849	1.0 (2)	1.0 (1)	12	1.0 (1)	— (0)
850-899	1.0 (4)	1.0 (2)	13	1.0 (1)	1.0 (2)
900-949	1.0 (1)	1.0 (4)	14	— (0)	1.0 (1)
⩾ 950	1.0 (13)	1.0 (13)	⩾ 15	1.0 (13)	1.0 (12)

drum have been collected in July and August (Pearson, 1929). Examination of juvenile length frequencies reveals evidence that supports the possibility of a secondary spawning season in June or July (Simmons and Breuer, 1962). More recently, analysis of gonosomatic indices (GSI) of south Texas black drum showed a primary spawning peak in March, with a secondary peak in August for males, and a primary peak in February, with a secondary peak in October for females (Cornelius, 1984). However, mean oocyte diameters were largest during February - April 1978 and January - May 1979 and smallest during August 1978 and July 1979 (Cornelius, 1984). Spawning adults have been collected in 5-37 m water off Texas during November - April; peak spawning activity occurred during January - April (Ross *et al.*, 1983; Cody *et al.*, 1985). Spawning apparently occurs slightly later in more northern latitudes along the Atlantic coast, *e.g.*, from March - May in Chesapeake Bay and Delaware Bay (Frisbie, 1961).

Age Determination and Growth

Thin opaque and wide translucent bands were clearly discernable on black drum otolith sections. Two independent readers agreed on 82% (326 of 399) of the total opaque band count after their first reading. After a second, joint reading, all but two band counts were agreed upon, providing 397 fish for age and growth analysis. Most initial disagreements concerning band counts (75%) involved fish collected during the period of January - March, when newly formed age marks were difficult to discern. Fish having 0-58 opaque bands were analyzed; about 80% had 0-4 bands. Males with up to 48 bands were sampled; 4.6% (9 of 198; all greater than 1150 mm) had more than 30 bands. Females with up to 58 bands were sampled; 6.7% (11 of 164; all greater than 1115 mm) had more than 30 bands.

The trends in the monthly mean marginal increment give evidence that supports the designation of opaque bands as annuli for ages 1-3 and probably age 4. For ages 1-3, mean marginal increments were greatest during December 1983 through March 1984 and then declined in April and May (Fig. 2). The mean marginal increment for the few age 4 fish sampled declined from December

1983 through March 1984. The mean marginal increment was smallest in the spring; it then increased and remained large for ages 1-4 through the end of 1984. After January 1985, the mean marginal increment generally declined, although few fish ages 2-4 were sampled. Although validation is still needed to define opaque bands that are distal to the third or fourth band as annuli, we assume in this report that all opaque bands are annuli. Recent findings for a closely related species, red drum (*Sciaenops ocellatus*), confirmed that opaque bands were annuli through at least age 18 (Murphy and Taylor[3]).

Prior to this study, indirect verification of the efficacy of using thin-sectioned otoliths to determine black drum ages had not been demonstrated. The lengths of one- to two-year-old fish whose ages were determined by scale examination have been shown to be consistent with the lengths of fish these ages that were estimated by using length frequencies (Pearson, 1929; Simmons and Breuer, 1962). Marginal increment analysis of the scales of small (<493 mm) black drum sampled in Georgia suggested annulus formation during February - April (Music and Pafford, 1984). However, marginal increment analysis of the scales of older fish has not revealed an annual periodicity in growth check formation (Richards, 1973; Cornelius, 1984), possibly due to the difficulty of reading the heavily calcified scales taken from black drum larger than 600 mm (Pearson, 1929). Based on data gathered by using an analog triangulation procedure for estimating von Bertalanffy growth equation parameters, Richards (1973) hypothesized that black drum scales form two marks per year after approximately their fourth mark. However, this conclusion has not been verified.

[3]Murphy, M.D., and R. G. Taylor. Florida Marine Research Institute, Department of Natural Resources, 100 Eighth Ave. S.E., St. Petersburg, FL 33701, unpubl. data.

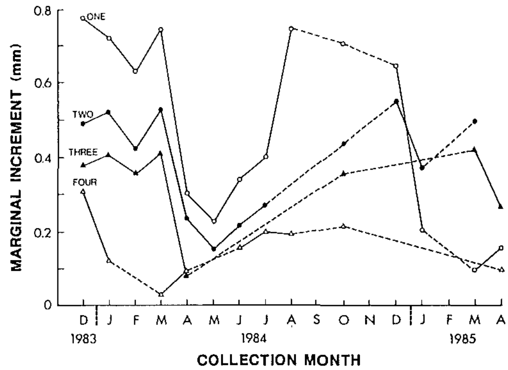

Figure 2. Monthly mean marginal increment for *P. cromis* with 1-4 annuli.

Average observed lengths for males and females were not significantly different ($p>0.05$) for ages 1-4 (Table 3). Although sample sizes for males and females at older ages were too small to test for statistical differences, both sexes appeared to reach similar observed maximum lengths (females, 1275 mm; males, 1257 mm). Therefore, age and length data for both sexes were pooled for growth analysis. The growth rate for black drum ages 1-3 was about 100 mm yr^{-1}, then slowed gradually to 10-30 mm yr^{-1} for ages 15-20 (Table 3). Mean back-calculated lengths for ages 1-4 were similar to the average observed lengths at those ages (Table 3). Growth rates were predicted well by the von Bertalanffy growth model with parameter estimates ($\pm$ standard error) of $L_\infty = 1172$ (± 9), $K = 0.124$ (± 0.003), and $t_0 = -1.29$ (± 0.08). In general, growth rates determined by using the von Bertalanffy growth model were similar to those determined from observed mean lengths (Fig. 3). The two age 6 fish collected appeared to be anomalously large.

Growth of adult black drum (Table 4) has been described in Texas, Georgia, and Virginia (Pearson, 1929; Simmons and Breuer, 1962; Richards, 1973; Cor-

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nelius, 1984; Music and Pafford, 1984). Estimates of lengths-at-age of black drum in Texas waters were generally similar to our predicted sizes for fish in northeast Florida waters (Pearson, 1929; Simmons and Breuer, 1962); however, back-calculated lengths for south Texas black drum were smaller after age 4 (Cornelius, 1984). In Georgia, black drum ages 2-6 were similar in lengths to drum in northeast Florida, but were apparently smaller after age 6 (Music and Pafford, 1984). Back-calculated lengths for 1-year-old Virginia black drum were smaller than those determined for northeast Florida black drum the same age. Lengths were similar for 2-year-old drum from both locations, but lengths for subsequent ages were much greater for black drum from Virginia, even without a "correction" for the possible formation of two rings per year after age 4 (Richards, 1973).

Parameters of the von Bertalanffy growth model for black drum have been estimated for scale-aged fish from Virginia (Richards, 1973) and by using tag-return data from Texas (Doerzbacher *et al.*, 1988). Richards' (1973) parameter estimates, made with the assumption that two scale rings are formed per year after age 4, were $K = 0.158$ and $L_\infty = 147.4$ cm FL. These estimates predict much faster

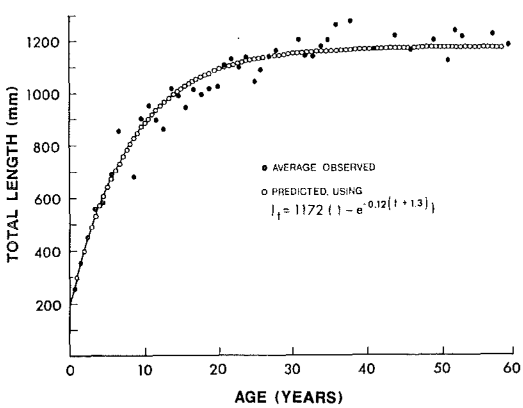

Figure 3. Average observed and predicted growth of *P. cromis* in northeast Florida.

Table 3. Average observed, back-calculated, and predicted total lengths (mm), with 95% confidence intervals in parentheses, for northeast Florida black drum, ages 1-10, 15, 20, and 30 years.

	AGE													
	0+	1	1+	2	2+	3	3+	4	4+	5	5+	6	6+	7
Sample Size	74		87		87		51		20		5		2	
Average observed	256 (188-324)		355 (254-456)		451 (347-555)		556 (466-646)		584 (488-680)		692 (419-965)		854 (826,882)	
Back-calculated		243 (191-295)		378 (296-460)		486 (402-570)		555 (472-638)						
Predicted		288		388		477		555		625		687		742

	AGE												
	7+	8	8+	9	9+	10	10+	15	15+	20	20+	30	30+
Sample Size	0		2		5		4		2		1		1
Average observed	—		680 (637,722)		899 (767-1031)		951 (876-1026)		941 (890,991)		1103 —		1198 ..
Back-calculated													
Predicted		790		834		872		1006		1081		1145	

Table 4. Total length (mm) at age (yrs) for black drum (taken from the literature). Literature values of fork length were converted to total length using equation in Table 5. Symbols are l/f = length frequency, back-calc. = back-calculated lengths, and v.B. eq. = von Bertalanffy equation.

Study	Age 1	2	3	4	5	6	7	8	9	10	11	12	13
Pearson (1929); l/f and scales	255	378			616		771-874 (ages 7–9)						
Simmons and Breuer (1962); l/f and tag returns	187-234	361-408	489-524										
Richards (1973) (uncorrected); back-calc.	198	405	569	687	774	833	889	926	955	984			
Richards (1973) (corrected); predicted, v.B. eq.	227	416	578	714	832	932	1018						
Music and Pafford (1984); back-calc.	198	336	440	538	625	662	666	716	763	809	832	859	883
Cornelius (1984); back-calc.	246	375	443	505	557	605	642	675					
This study; predicted, v.B. eq.	288	388	477	555	625	687	742	790	834	872	906	936	963

growth rates for fish after age 2 than we found in this study. The greater estimate of L_∞ in Virginia may reflect the common observation that larger fish are more available in the more northerly part of their range, as has been suggested for menhaden, *Brevoortia tyrannus* (Nicholson, 1971); weakfish, *Cynoscion regalis* (Wilk, 1979); and red drum *Sciaenops ocellatus* (Welsh and Breder, 1923). Parameter estimates (standard error) for the von Bertalanffy model for black drum growth in Texas, $L_\infty = 798$ (42) mm and $K = 0.219$ (0.027), suggested faster relative growth but to a smaller maximum size than we found for fish in Florida (Doerzbacher *et al.*, 1988). The limited length distribution (98% of data from fish 220--800 mm TL) of tag returns available for growth analysis from the Texas tagging program may restrict the effective fit of their growth model to only fish under about 800 mm.

Assuming that all opaque bands are annuli, the observed maximum age for black drum off the northeast coast of Florida is 58 years. The previous maximum age reported for black drum was 35 years (Richards, 1973). A maximum opaque band count of 46 has been reported for large black drum (1,132 mm) sampled off Georgia (Music and Pafford, 1984). Several drum tagged in Texas bays have been recaptured after 10 to 12 years of freedom (Green, 1986), which confirms a life span of at least 12 years.

Weight-Length and Length-Length Relations

Parameter estimates of allometric weight-length relationships for males and females were not significantly different (p>0.05 between both "a's" and "b's"); therefore, relationships were calculated after data for both sexes were pooled (Table 5). The pooled estimate of "b" was not significantly different (p>0.05) from 3, therefore, black drum growth is

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Table 5. Weight-length and length-length regressions of black drum, with supporting statistics. All regressions were significant ($p<0.05$). Measures are grams and millimeters. Abbreviatins are W = whole weight, FL = fork length, TL = total length, and SL = standard length.

Equation	Sample Size	Total Length Range	r^2	Corrected Total SS_y	Mean $\bar{x}$	Mean $\bar{y}$
$W = 1.16 \times 10^{-5}\ TL^{3.0439}$	347	202-1275	0.9925	2.95×10^{10}	535	4897
$FL = 3.8 + 0.97\ TL$	386	202-1275	0.9997	2.72×10^{7}	524	511
$TL = -3.8 + 1.03\ FL$	386	202-1275	0.9997	2.91×10^{7}	511	524
$SL = -21.2 + 0.86\ TL$	396	202-1275	0.9991	2.21×10^{7}	523	430
$TL = 25.1 + 1.16\ SL$	396	202-1275	0.9991	2.97×10^{7}	430	523
$FL = 28.3 + 1.12\ SL$	387	202-1275	0.9995	2.72×10^{7}	430	511
$SL = -25.0 + 0.89\ FL$	387	202-1275	0.9995	2.16×10^{7}	511	430

isometric.

Weight-length regressions for black drum have been calculated for adult populations along most of its range within the United States. Black drum from northeast Florida and South Texas appear to be, on the average, a similar weight at a given length; black drum in Louisiana, Texas, and Virginia are lighter, and those sampled in Georgia are heavier (Table 6).

FISHERIES IMPLICATIONS

Biological characteristics of black drum suggest that it is a poor candidate for an intensive or even moderate fishery. Their apparent life span of more than 50 years implies an extremely low natural mortality rate that suggests that, under equilibrium conditions, little surplus production is available for fishery yield. Low natural mortality and relatively slow growth suggest that at low levels of exploitation black drum populations could be depleted by growth overfishing, even when size at first capture is quite large. Also, a moderate level of fishing could severely reduce black drum abundance and juvenesce the 50 year-class

Table 6. Predicted weights (grams) for black drum of given lengths, based on length-weight relations from the literature. FL converted to TL using equation in Table 5.

Study / Area	Total Length (mm) 300	600	900	1200
Cornelius (1984); South Texas	391	3,241	11,176	26,899
Richards (1973); Virginia	359	3,071	10,719	26,052
Music and Pafford (1984); Georgia	445	3,748	13,041	31,585
Hein *et al.* (1980); Louisiana	348	2,729	9,102	21,396
Harrington *et al.* (1979); Texas	378	3,029	10,225	24,245
This study; Florida	402	3,318	11,399	27,364

age structure that makes up the spawning population. It has been hypothesized that a large number of year classes in a spawning population could be an adaptation that ensures an adequate spawning population, even in the face of fluctuating recruitment (Murphy, 1968; Leaman and Beamish, 1984). Therefore, juvenesced black drum spawning stocks would probably be more susceptible to recruitment overfishing.

Behavioral characteristics of black drum also make them highly susceptible to fishing. In the spring, adult black drum congregate in large schools often associated with spawning. These fish can easily be captured while congregated, especially by encircling gear (run-around gill nets, trammel nets, purse seines). Off the Gulf coast of Florida, adult black drum purse-seine catches have been estimated to be as great as 120,000 lbs[4]. Off northeast Florida, shrimp trawlers occasionally make large catches of adults during the spring.

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[4]Beverly Roberts, Florida Marine Research Institute, Department of Natural Resources, 100 Eighth Ave. S.E., St. Petersburg, FL 33701, personal comm.

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