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Age, Growth and Mortality of the Common Snook, *Centropomus undecimalis* (Bloch), in EVER, Florida

NATIONAL PARK SERVICE
DEPARTMENT OF THE INTERIOR

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Age, Growth and Mortality of the Common Snook, *Centropomus undecimalis* (Bloch), in Everglades National Park, Florida

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ABSTRACT

A study was made of age, growth and mortality of 325 snook, Centropomus undecimalis (Bloch), collected from sportfishermen in Everglades National Park from May 1976 through December 1979.

Fish sampled ranged in length from 284-940 mm F.L. ($\bar{x}$ = 643 ± 11 mm) and in weight from 0.7-11.6 kg ($\bar{x}$ = 3.03 ± .17 kg). Females ranged in length from 464-940 mm ($\bar{x}$ = 680 ± 25 mm) and in weight from 1.0-11.6 kg ($\bar{x}$ = 3.64 ± .49 kg). Males ranged in length from 284-889 mm ($\bar{x}$ = 632 ± 14 mm) and in weight from 0.7-7.2 kg ($\bar{x}$ = 2.84 ± .18 kg). Mean lengths of fish were largest in spring and smallest in winter. There were no differences in mean length among areas of capture.

Snook were aged by scale annuli. Annulus formation occurred in spring (March-May). Ages of fish were mainly four- and five-year olds. Recruitment to the fishery began at age two and was completed by age six. The oldest fish sampled was eight-years old. The overall sex ratio favored males 3/1, but the ratio decreased steadily with age. The mean age of females was significantly greater than the mean age of males. There were no differences in mean age of fish among areas of capture.

Mean calculated growth of all snook was 375 mm F.L. in the first year and 57-90 mm F.L. thereafter. Females were significantly larger than males in calculated mean lengths at ages one through four. Calculated fish lengths at age differed among areas of capture. Fish taken from the Whitewater Bay-Coot Bay area were larger at ages one through four than fish of the same age taken from the north Florida Bay-Cape Sable area. Sexual differences in length-weight relationship were noted. Females weighed more at a given length than males.

Annual mortality rate of all fully recruited fish for the period 1976-1979 was 78%. Female mortality was lower than male mortality. Conditional fishing mortality was twice as high as conditional natural mortality for males but was the same for females. Conditional natural mortality and exploitation ratio was higher for males than for females.

INTRODUCTION

Fishery harvest in Everglades National Park has been monitored nearly continuously since 1958 (Higman, 1966; Davis, 1980). The monitoring program has revealed that harvest of all fish and shellfish in the park declined from 1972-1978 (Davis, 1980). Public concern over the decline in harvest prompted the park's research center to initiate an investigation of the age and growth, mortality, food habits, and spawning activity of the four gamefish species most preferred by sportfishermen in the park: spotted seatrout (Cynoscion nebulosus), red drum (Sciaenops ocellatus), gray snapper (Lutjanus griseus), and snook (Centropomus undecimalis). This paper, one of a series of papers reporting the results of these studies, describes the age, growth, and mortality of snook in Everglades National Park from 1976-1979.

The common snook, Centropomus undecimalis, is a subtropical estuarine fish that ranges from North Carolina to Brazil (Marshall, 1958; Martin and Shipp, 1971). It is the most common of four species of snook occurring in Florida waters (Rivas, 1962). It is prized by recreational fishermen for its fighting ability and food value. The Florida snook fishery is generally limited to the southern half of the state. Harvest of snook within south Florida is higher on the west coast than on the east coast. Snook harvest is seasonal and coincides with the spawning season from June to November (Marshall, 1958).

The biology of the snook has not been extensively studied. The distribution, food habits, and spawning activity of snook in southwest Florida were studied by Marshall (1958), and Fore and Schmidt (1973), while Volpe (1959) studied their age, growth, migration, and fecundity. Snook may grow up to 23 kg (50 lbs) and live to at least 7 years. Adult snook generally inhabit brackish water mangrove areas where salinities range from 0-36 ^{o}/oo, although they have also been recorded in man-made ditches and canals as well as around coral reefs. Juveniles up to 200 mm have been taken in the upper reaches of estuaries in shallow streams and marshlands as well as in dredged canals (Marshall, 1958; Harrington and Harrington, 1961; Linton and Rickards, 1965; Fore and Schmidt, 1973). Snook appear relatively nonmigratory, moving only short distances along the coast inshore and offshore (Marshall, 1958; Volpe, 1959). They are carnivorous, primarily eating fish and crustaceans (Marshall, 1958; Fore and Schmidt, 1973). Nearly 50% of the fish examined by Marshall (1958) reached maturity at 400 mm (F.L.) and nearly all were mature by 500 mm. Fecundity of a ripe 584-mm (23 in) snook was estimated at 1,440,000 eggs (Volpe, 1959).

Description of Study Area

The mainland shoreline of Everglades National Park extends from the Florida Keys to Everglades City on Florida's west coast (Fig. 1). It contains numerous bays, inlets, and rivers which lie at the terminus of the historically immense Everglades and Big Cypress swamp drainages. Tabb, Dubrow, and Manning (1962) have described the animal and plant communities of park waters and identified distinct ecological zones. Their work provided the basis for delineating the six fishing areas used in Everglades National Park fishery investigations since 1960 (Higman, 1966) (Fig. 1). These areas vary in their topographical, hydrological, and biological characteristics (Tabb, Dubrow, and Manning, 1962).

METHODS

Catches of sportfishermen fishing out of Flamingo, in Everglades National Park, were censused from May 1976-December 1979. Samples taken from Flamingo were felt to be representative of all park areas except the upper west coast (Ten Thousand Islands) (Fig. 1). Time and economic constraints prevented collecting samples of the Ten Thousand Island area at Everglades City (Area 6). For every fish sampled, the sex, length (mm F.L.), weight (.01 kg), and area of capture were recorded and scales for age and growth analyses were collected. Sex and reproductive condition were determined by inspection of the gonads. Stomachs were examined in the field for food items. Detailed methods for the collection and processing of data followed those reported by Rutherford, Thue and Buker (1982). The following criteria (Bagenal, 1979) were used to evaluate the validity of age determinations from scale annular marks:

1. Fish body growth is proportional to scale growth.

2. Scale annulus formation is seasonal and occurs only once each year.

3. Back-calculated lengths of fish at age N are between observed lengths at capture of fish aged N-1 and N.

4. Lengths at capture of fish aged by scales agree with modal lengths of age groups determined by the Petersen length-frequency method.

Scales were collected for age analyses from behind the left pectoral fin. A motorized roller type Ann Arbor fish scale impression press was used to press the scales on plastic slides. Photographic enlargements (8.05 x) of the scales made from the slides on a 3M reader-printer were then examined for number of annuli.

Seasonality of scale annulus formation was estimated by plotting scale radius marginal increments against month of capture. Fish body length was regressed on total scale radius by sex and area of capture to determine proportionality of fish body growth to scale growth. Scale magnification does affect slope but not the length intercept of this regression (Zar, 1974). The y intercept of this regression was used as the correction factor (a) in the Lee formula (Bagenal, 1979) to back calculate fish length at each annulus.

Differences in fish length among sexes and areas of capture were compared by a two-factor analysis of variance for both back-calculated lengths and lengths at capture. A Student Newman Keuls (SNK) test was used to indicate what specific differences were significant (Zar, 1974).

Mean calculated fish lengths at annulus were fitted to the von Bertalanffy growth equation (Bayley, 1977) to describe snook growth. Length-weight relationships were calculated (Bagenal, 1979) for each sex and area of capture and compared by analysis of covariance (Zar, 1974).

Annual survival rates (S) and total instantaneous mortality coefficients (Z) were calculated for fully recruited snook by using the age distribution of harvested fish (Robson and Chapman, 1961). Natural mortality coefficients (M) were estimated utilizing Pauly's (1980) equation. Fishing mortality coefficients were obtained by subtracting natural mortality coefficients from total mortality coefficients. Conditional fishing and natural mortality rates and exploitation ratios were then calculated from these mortality coefficients (Ricker, 1975).

RESULTS

Three hundred and twenty five snook were collected from North Florida Bay and the inland waters of the park (Areas 1, 3, 4, and 5) (Fig. 1). No fish from South Florida Bay (Area 2) or the Ten Thousand Islands (Area 6) were sampled. Fish ranged in length from 284-940 mm (F.L.) and in weight from 0.7-11.6 kg. Two hundred ninety four snook were examined for age and growth information, 269 of which the sex was determined.

Length Frequency

The mean length of all fish was 643 $\pm$ 11 mm F.L. (Fig. 2). The mean length of females ($\bar{x}$ = 680 $\pm$ 25 mm, n = 71) was not significantly different from the mean length of males ($\bar{x}$ = 632 $\pm$ 14 mm, n = 222) (Fig. 3). Mean lengths and length distributions of males, females and combined sexes were not significantly different among areas of capture.

Length distributions of all fish (combined sexes and unsexed fish) differed significantly (x^2 = 22.739; $p < .01$) by season. Small fish (< 500 mm) occurred proportionately more often in winter (December, January and February) than in any other season. Mean fish length was smallest in winter and greatest in spring (March, April and May). There were no significant seasonal differences in length distributions of males or females when they were considered separately.

Verification of Aging Technique

Scales from 294 snook were analyzed for annular marks. Figure 4 shows a ctenoid scale from a 3-year-old male snook with annuli, circuli, radii, and focus labeled. Annular zones are distinguished primarily by complete circuli surrounded by discontinuous or broken circuli. The last few circuli laid down before the annulus are often incomplete in that they do not continue all the way around to the ctenii. Annular circuli are complete and cut across the ends of the incomplete circuli inside of them. New radii often originate in the immediate vicinity of annuli and provide especially useful clues to the location of annular marks in large scales of older fish.

The validity of aging snook by scale annuli was established by meeting all criteria listed in the methods section. Fish body length was regressed on total scale radius for each sex in each area of capture to determine if a relationship existed between fish growth and scale growth. Fish body length was significantly ($p < .001$) correlated with scale radius for each sex and area of capture. Two significantly ($.025 < p < .05$) different fish length-scale length relationships were determined by analysis of covariance: 1) males in north Florida Bay and Cape Sable (y intercept = 161.76) and; 2) females in north Florida Bay and Cape Sable together with males and females in Whitewater Bay and Shark River (y intercept = 241.41) (Fig. 5). The y intercept of each group was used as the correction factor "a" to back calculate lengths at age for that particular group.

To determine time of annulus formation, scale-margin increments were plotted by season for the dominant age class (IV) in the catch (Fig. 6). Most minimal scale-margin increments occurred in spring (March-May) and summer (June-August). The mean marginal increment was lowest in spring and rose steadily to reach a peak in winter (December-February), indicating that annulus formation occurs in spring.

A comparison of mean back-calculated lengths and mean observed lengths at capture for 294 scale-aged snook is shown in Figure 7 and Appendices I-III. Mean lengths at capture are similar to, but larger than, back-calculated lengths at each annulus because of growth since annulus formation.

The Petersen length-frequency method substantiated the age analysis of snook using scale annuli. Mean lengths at capture of scale-aged fish agreed with modal lengths determined by Cassie's (1954) method for length-frequency distributions of snook collected in 1976 (Table 1).

Age Distribution

The age distribution determined from scale annuli of snook in Everglades National Park consisted mainly of four- (32%) and five- (27%) year-old fish (Fig. 8). Recruitment to the fishery began at age two and was complete by age four for females and by age six for males. The number of fish caught dropped sharply after age six; only three eight-year-old fish were examined. No fish older than eight years were sampled. One-year-old fish were not sampled due to a legal size limit of 18 inches (457 mm F.L.).

The mean age for all fish was 4.4 ± 0.1 yrs. The mean age of females ($\bar{x} = 4.8 \pm 0.3$ yrs) was significantly older than the mean age of males ($\bar{x} = 4.3 \pm 0.2$ yrs). There were no differences in age distribution or mean age of snook among areas of capture.

Sex Ratio

The overall sex ratio favored males by 3/1. The ratio remained constant during the year. This ratio decreased significantly ($x^2 = 13.747$; $p < .01$) with age from favoring males (11/1) at age two to favoring females (2/1) at age eight (Table 2). The sex ratio varied significantly ($x^2 = 11.084$; $p < .01$) among areas of capture. Proportionately more females were taken from the Coot Bay-Whitewater Bay area (Area 4) than from other areas.

Growth

Back calculations based on scale annuli indicate that snook achieve their greatest growth (465 mm) in the first two years (Fig. 9). Thereafter, yearly growth of all fish (males, females, and combined sexes) ranged from 58-75 mm through age seven. The negative growth increment of males and the great increase in growth of females in the eighth year are probably artifacts of the small sample sizes of fish from which they were calculated.

Significant ($p < .025$) differences in calculated growth were found for snook from various areas. Fish taken from the Whitewater Bay-Coot Bay area were consistently largest and fish taken from the north Florida Bay and Cape Sable areas were consistently smallest at ages one through four (Fig. 10). Fish taken from north Florida Bay and Cape Sable grew significantly ($p < .025$) faster than fish taken from other areas at ages two and three. No differences in length at capture were found among areas. Differences in calculated growth existed between males and females at ages one through four (Fig. 11). Females were significantly ($p < .05$) longer than males at every age. No sexual differences in observed length at capture were found.

The relationship of G, the instantaneous growth coefficient, to the reciprocal of mean calculated length at age was significant ($.025 < p < .05$) and provided estimates of the von Bertalanffy parameters K, L_∞ and t_o according to Bayley's (1977) method (Fig. 12). Lengths predicted by the von Bertalanffy equations approximated calculated lengths closely (Fig. 13). The von Bertalanffy equations derived for park snook were:

males: $L_t = 987\ (1\text{-}e^{-.16(t + 1.95)})$

females: $L_t = 1173\ (1\text{-}e^{-.12(t + 2.72)})$

combined sexes: $L_t = 1615\ (1\text{-}e^{-.07(t + 2.68)})$

Growth parameters for combined sexes were different than for each sex considered separately because growth varied between the sexes. The maximum theoretical length (L_∞) provided by these equations, when converted to weight by our length-weight regression, approximates the size of the largest snook on record, a 23 Kg (50.5 lb) fish (Marshall, 1958).

Confidence intervals (95%) for K, $1/L_\infty$ and t_o are listed in Appendix IV. $1/L_\infty$ confidence intervals for all snook were wide because of the poor fit, and subsequent high variance of the length-weight regression to small (age 2) and large (age 8) fish. The high variance created wide confidence intervals around $1/L_\infty$, and thus L_∞. Confidence intervals around K and t_o were smaller.

Length-Weight Relationship

Length-weight relationships for Everglades National Park snook were determined from 303 fish ranging in size from 430-950 mm (Fig. 14). The most accurate predictions of weight based on length were obtained when using log 10 transformation (males $r = .95$, females $r = .95$ combined sexes $r = .93$). The length-weight relationship calculated for males was different than for females; the regression slopes differed but intercepts did not, indicating females grew significantly ($.01 < p < .02$) more in body weight at a given length than males.

There were no differences in the length-weight relationship of fish among areas of capture.

Food Habits

Twenty-one snook stomachs were examined for food items. All of these stomachs were found to be empty, therefore no information on food habits could be obtained.

Mortality

Annual mortality rates were calculated for fully recruited snook. Female snook were fully recruited by age four, male snook and combined sexes were fully recruited by age six.

Annual mortality rate of all fish was $A = 0.78 \pm .10$. Annual mortality rate of males ($0.86 \pm .12$) was higher than that of females ($0.46 \pm .09$). Conditional natural mortality of males ($n = 0.32$) was higher than for females ($n = 0.25$).

Conditional fishing mortality was twice as high as conditional natural mortality for males but equal to conditional natural mortality for females. Exploitation ratios were also higher for males ($E = 0.81$) than for females ($E = 0.53$) (Table 3).

DISCUSSION

This study represents the first investigation of adult snook age and growth since Volpe's study in 1959, and only the second reported in the literature. The lack of biological information on snook is surprising considering its popularity among sport fishermen and drastic decline in catch in park waters (National Park Service Fishery Assessment, 1979). As a result of this study, age and growth information essential for sound management of snook can now be obtained without having to kill the fish to obtain otoliths.

Calculated lengths determined for snook in the park were similar at ages four through eight to lengths reported for the southwest Florida snook population aged by otoliths (Volpe, 1959) (Fig. 15). At ages one through three, lengths of park snook were greater than in Volpe's study because of the back calculation formula used. Volpe back calculated snook lengths directly, without a correction factor, according to the formula:

$$L_n = \frac{Sn}{St} Lt$$

where:

L_n = length at age; L_t = length at capture; S_n = scale radius to annulus n; S_t = total scale radius.

The correction factor used in the present study elevated the fish lengths at ages one through three. A larger sample size of small snook would have probably decreased the correction factor, making our estimated lengths of snook at ages one through three smaller. When lengths of park snook were calculated using Volpe's approach, lengths were similar at every age in both studies (Fig. 15). Both studies found that calculated lengths of males were smaller than females at every age.

Back-calculated growth of snook was greatest at ages one through four in the seasonally brackish areas of Coot and Whitewater Bays, and least in the hypersaline areas of north Florida Bay and Cape Sable. This could be an artifact of the larger proportion of faster growing females taken from Whitewater Bay. Analysis of variance used for lengths at capture failed to substantiate area differences in calculated lengths. The differences in back-calculated growth may have also been caused by the species' environmental tolerances. Snook is an estuarine gamefish species that can tolerate salinities ranging from 0-36% (Marshall, 1958). The largest catches in this study were taken in seasonally brackish water mangrove areas where salinities normally range from 0 to $47^{o}/oo$ (Tabb et al., 1962). Although snook are believed to spawn in saline waters and mature in brackish waters, tagging studies have shown that they are relatively non-migratory as adults (Volpe, 1959). Local environmental factors could affect snook growth because of their non-migratory habits.

Most snook in the park fishery were not fully recruited until age six, four years beyond the age (or size) at which they can be legally harvested. The high age at recruitment may reflect fishermen preference for large individuals. It may also reflect either the unavailability of snook at younger ages to fishermen or variable year-class recruitment. If yearly recruitment of park snook is highly variable, our estimates of annual mortality should be treated with caution because the method used to obtain annual mortality rates assumes constant recruitment.

The difference in age at full recruitment between males (6 yrs) and females (4 yrs) may be an artifact of the small sample size of fish at each age. Within our data, it is possible to artifically change the age at recruitment of each sex to five years by assuming the age of only three fish were to change by one year. The difference in ages at recruitment may also be due to size difference between males and females. The faster growing females might be caught by sportfishermen at an earlier age.

The sex ratio of the catch reflected sexual differences in annual mortality found in this study. Male mortality was greater than female mortality, therefore the number of males caught relative to females decreased with age. The sexual difference in annual mortality was not an artifact of the different ages of recruitment. If one assumes females were fully recruited at the same age as males, female mortality is still lower.

Estimates derived from Volpe's (1959) study provide the only other estimate of snook mortality in the literature. Annual mortality rate of all fish in his study was $0.67 \pm .05$. Males outnumbered females in the catch and had greater mortality. The size range (120-970 mm F.L.) of snook in Volpe's study was different than in the present study. His fish were collected by beach seine and included undersized ($<$ 18 in) fish.

CONCLUSIONS

1. Snook can be aged by scale annuli.

2. Although snook varied among areas in calculated growth at age, there were no other sufficient differences in population parameters to indicate unit stock.

3. The majority of harvested snook are much older than the age at which they reach legal size, suggesting recruitment failure of juveniles. Because little is known about the snook's early life history, future studies should determine larval and juvenile distribution and the effects of temperature, salinity, and food availability on their growth and survival.

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Table 1. Medians of modes determined for length-frequency distributions and mean lengths at capture of scale-aged snook sampled in 1976, in Everglades National Park, Florida.

	Age			
	II	III	IV	V
Medians of lengths at capture of scale-aged fish (mm F.L.)	460	540	595	690
Medians of modes of length-frequency distributions (mm F.L.)	485	560	623	713

Table 2. Number of snook males and females observed in sportfishermen catches, Flamingo boat ramp, Everglades National Park, 1976-1979. Numbers in parentheses are percentages of totals.

	Age						
	II	III	IV	V	VI	VII	VIII
male n = 203	11 (5)	42 (21)	63 (31)	55 (27)	28 (14)	3 (1)	1 (<1)
female n = 66	1 (2)	8 (12)	21 (32)	16 (24)	13 (20)	5 (8)	2 (3)

Table 3. Annual mortality rate (A), coefficients of total (Z), natural (M) and fishing (F) mortality, exploitation ratios (E) and ratios of conditional fishing to conditional natural mortality (m/n) for snook in Everglades National Park, 1976-1979.

	A*	Z	F	M	E	m/n
males	0.86 ± .12	1.97	1.59	0.38	0.81	2.50
females	0.46 ± .09	0.62	0.33	0.29	0.53	1.12
males, females and unsexed fish	0.78 ± .10	1.51	1.32	0.19	0.87	4.23

* = ± 2 standard deviations around estimate.

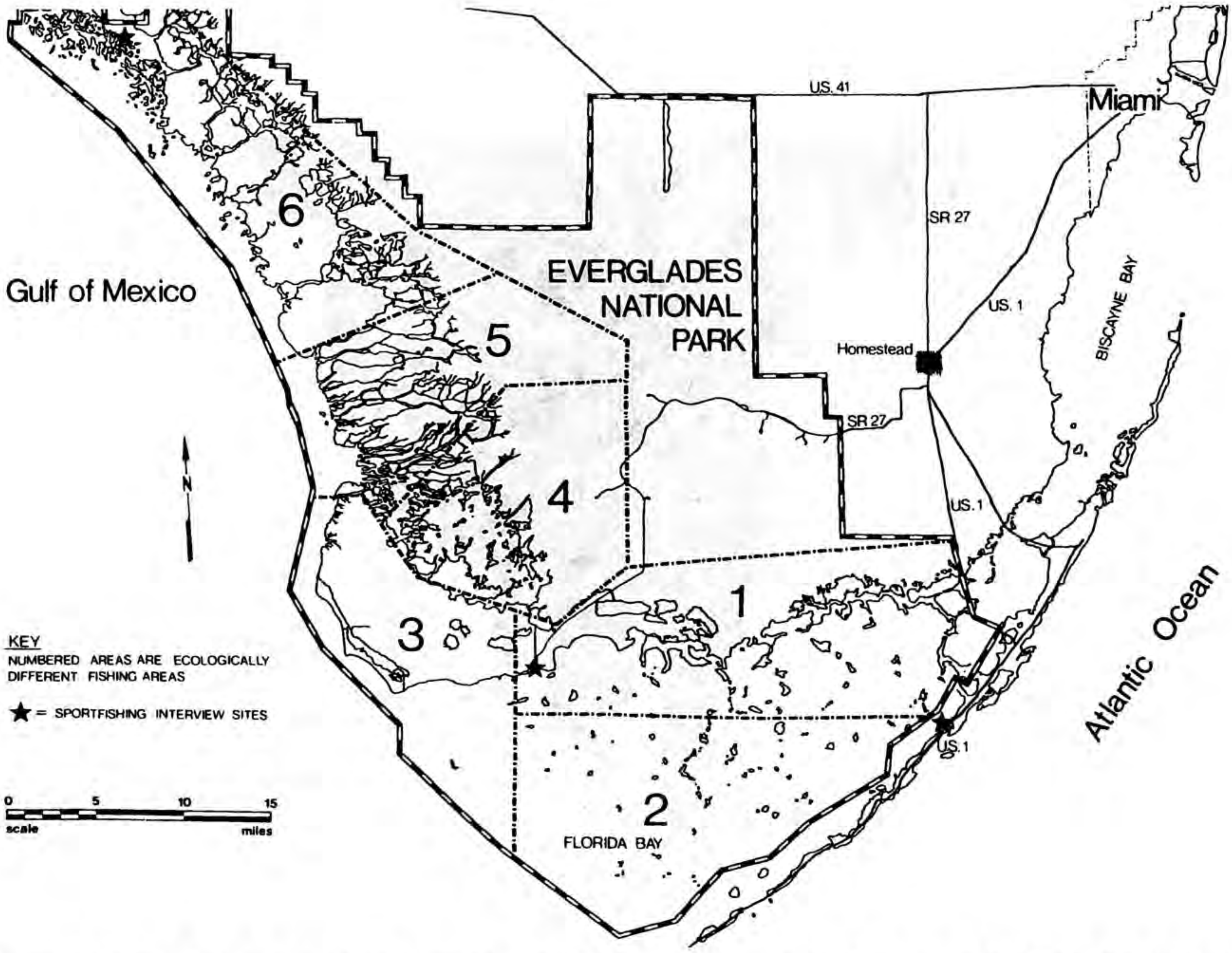

Figure 1. Fishing areas in Everglades National Park, Florida. Numbered areas are: (1) North Florida Bay (2) South Florida Bay (3) Cape Sable (4) Coot-Whitewater Bays (5) Shark River area (6) Ten Thousand Islands.

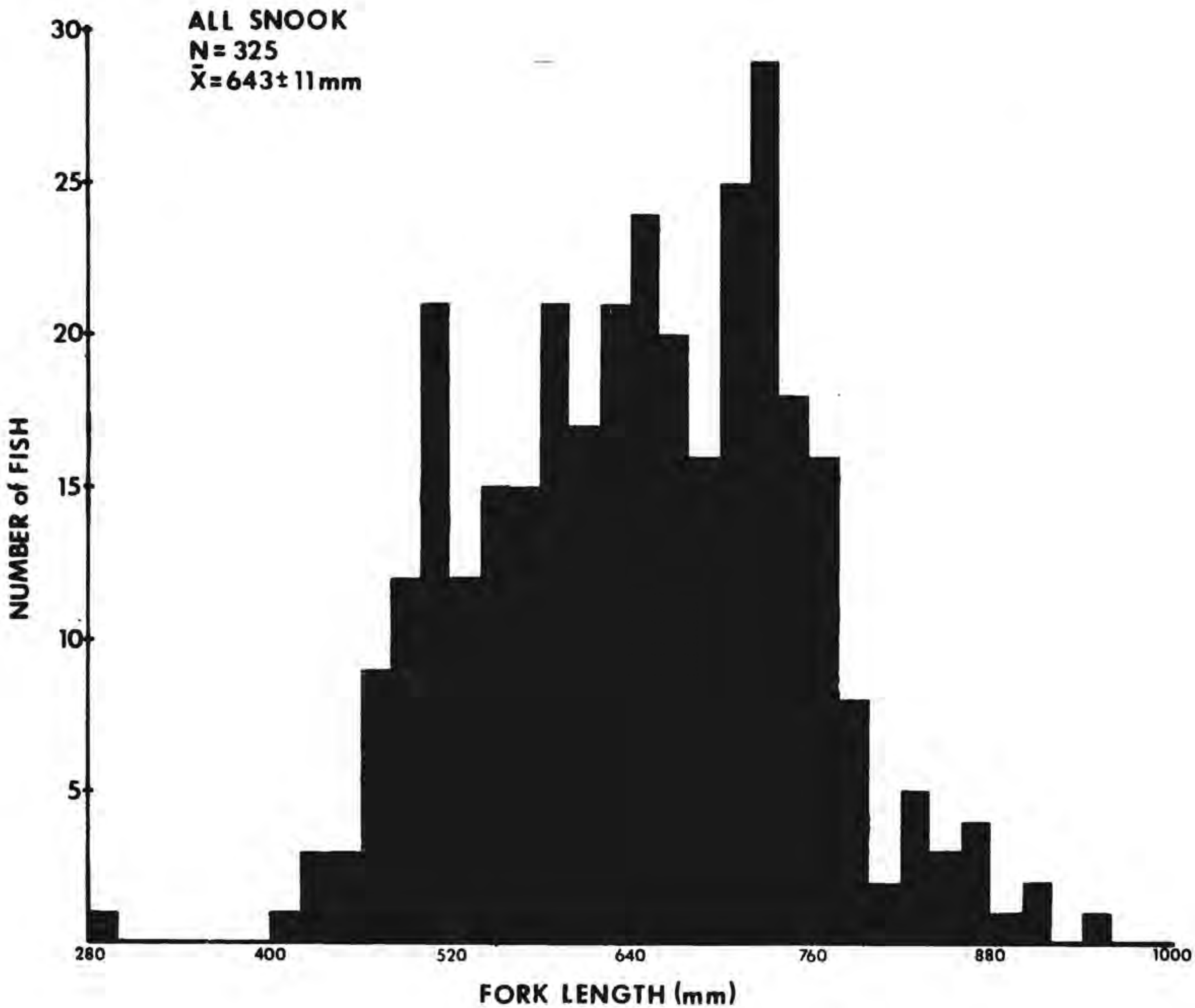

Figure 2. Length-frequency distribution for all snook collected from sportfishermen catches in Everglades National Park, Florida, 1976-1979.

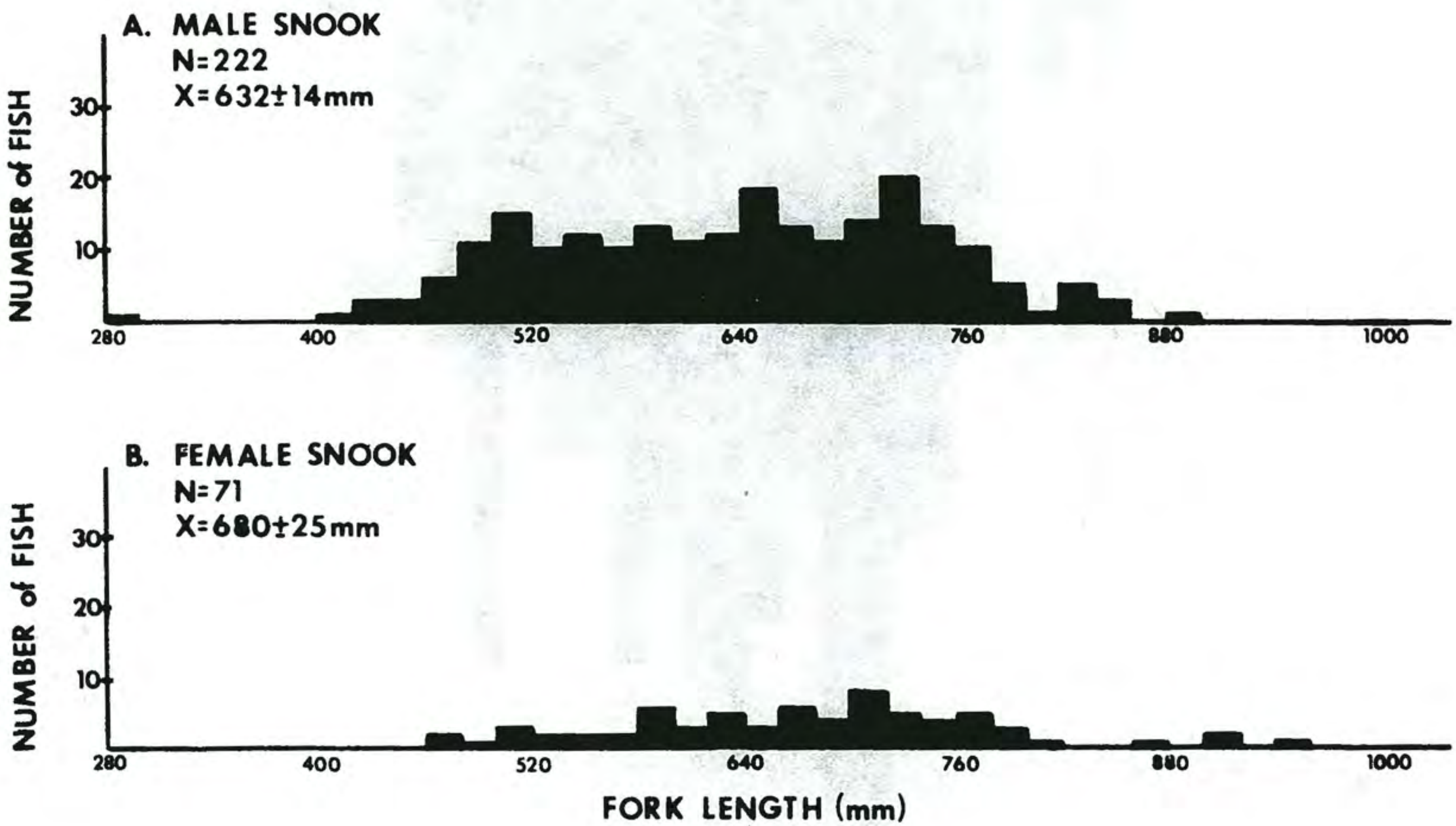

Figure 3. Length-frequency distribution for male and female snook collected from sportfishermen catches in Everglades National Park, Florida, 1976-1979.

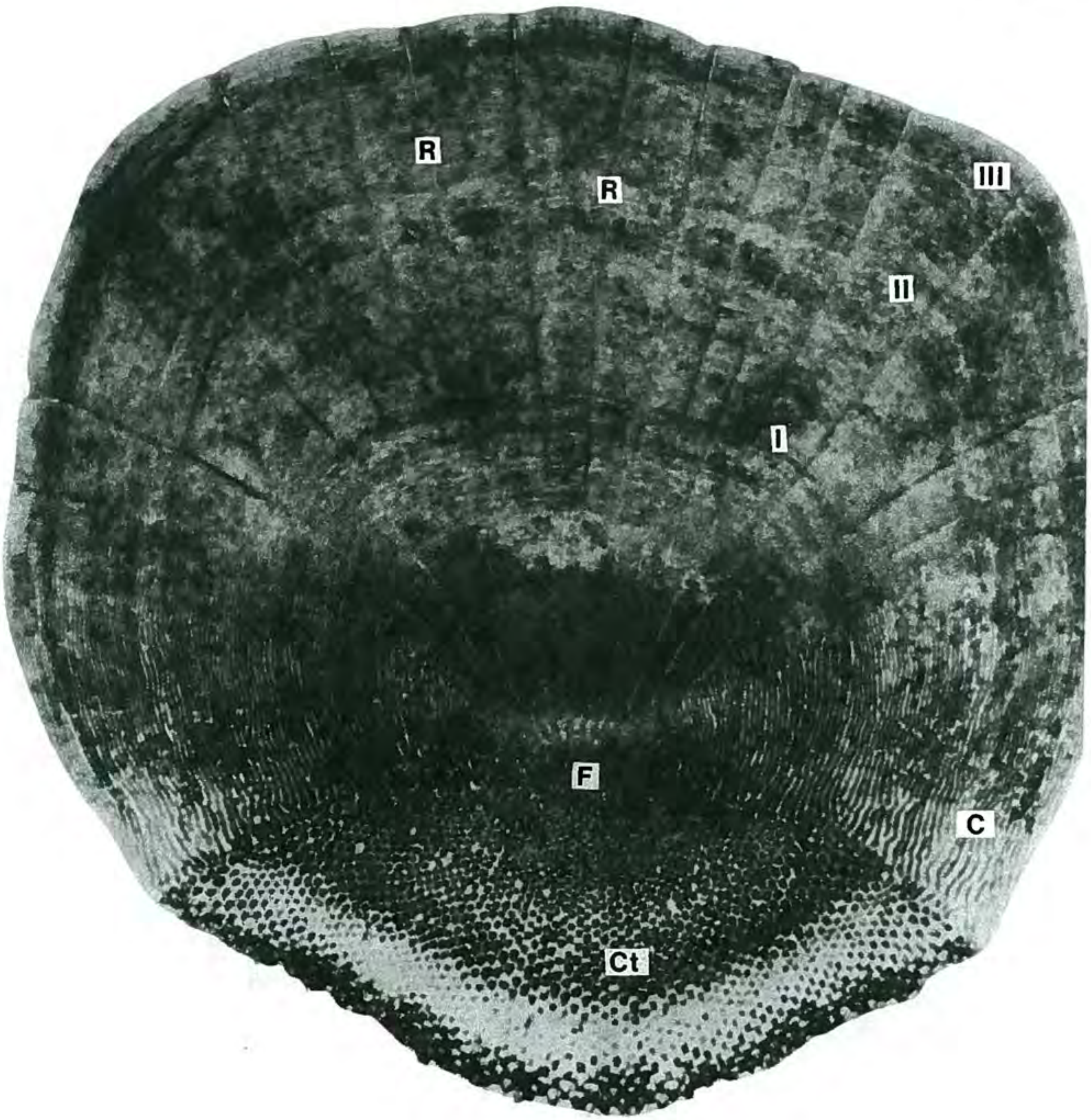

Figure 4. Enlarged (8.05x) scale of a three-year-old snook (548 mm) (1.9 kg) collected from north Florida Bay, Everglades National Park. Circuli (C), radii (R), focus (F), ctenii (Ct), and annuli (I, II, III) are labeled.

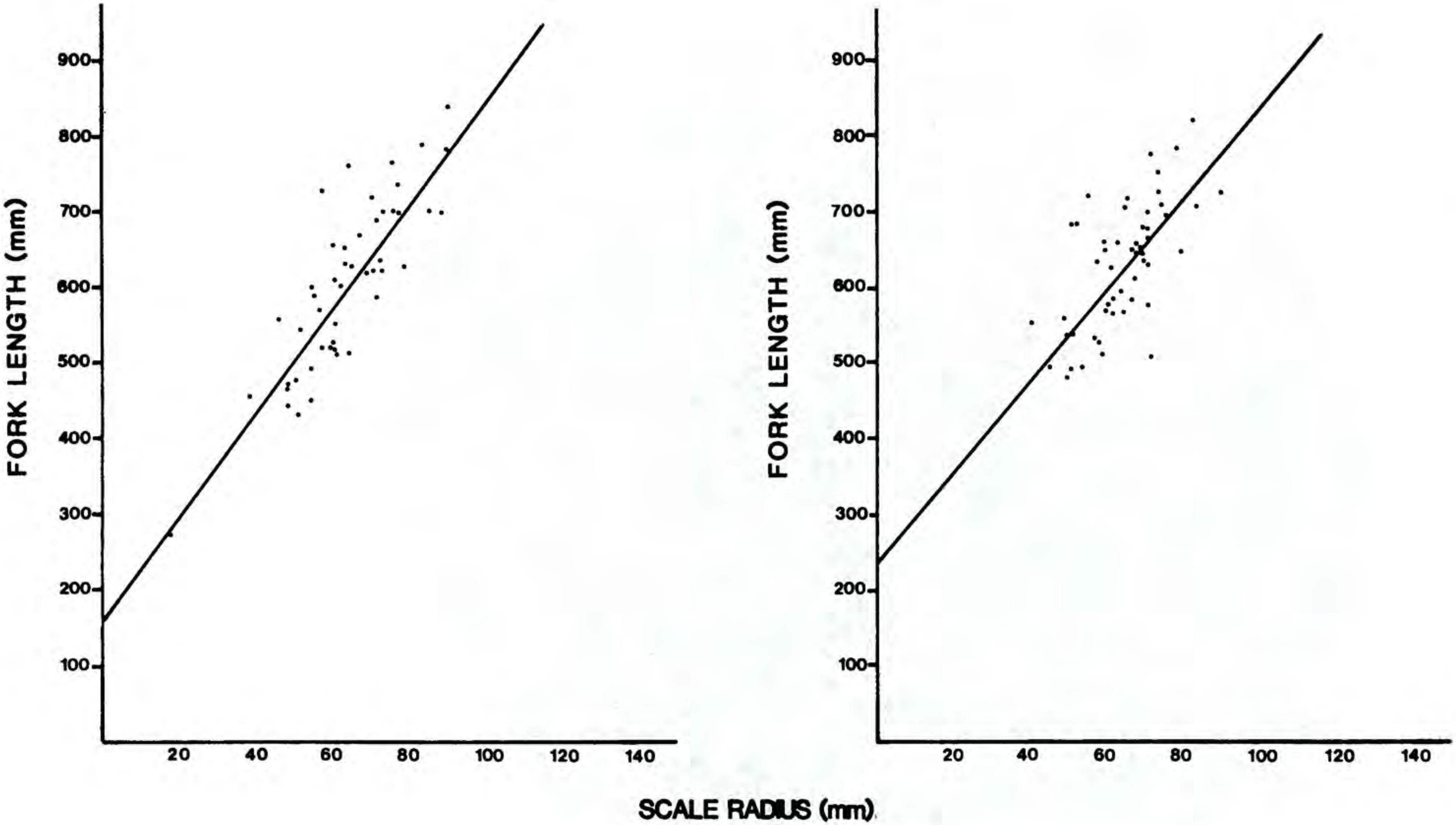

Figure 5. Fish length-scale radius regressions for snook in Everglades National Park, Florida, 1976-1979. (A) Males, Cape Sable and North Florida Bay. L = 161.76 + 6.91 (scale radius); N = 79; r = .80. (B) Females, Cape Sable and North Florida Bay; males and females, Whitewater Bay and Shark River. L = 241.41 + 6.23 (scale radius); N = 205; r = .75.

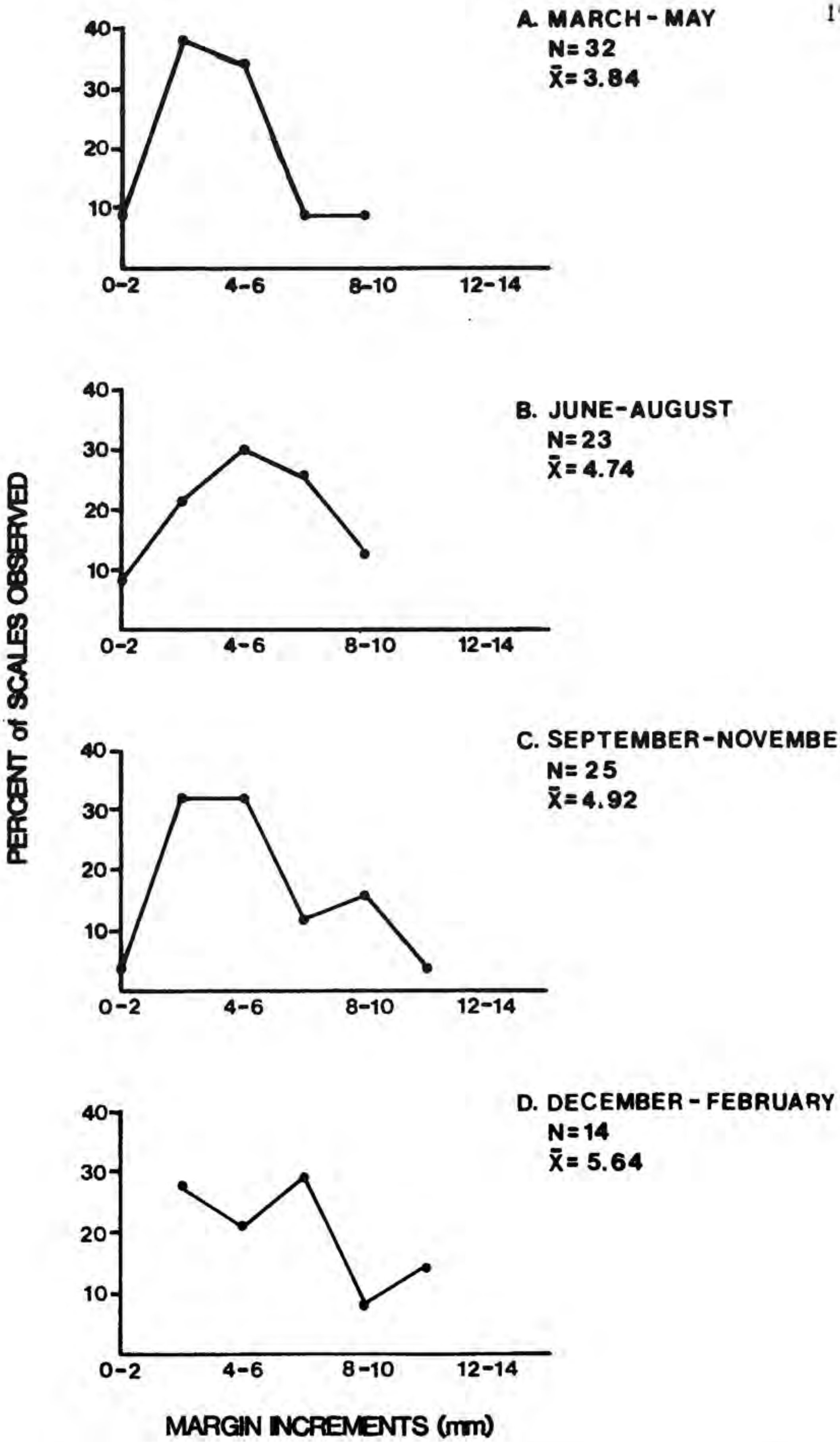

Figure 6. Scale margin increments by season for all four-year-old snook in Everglades National Park, Florida, 1976-1979.

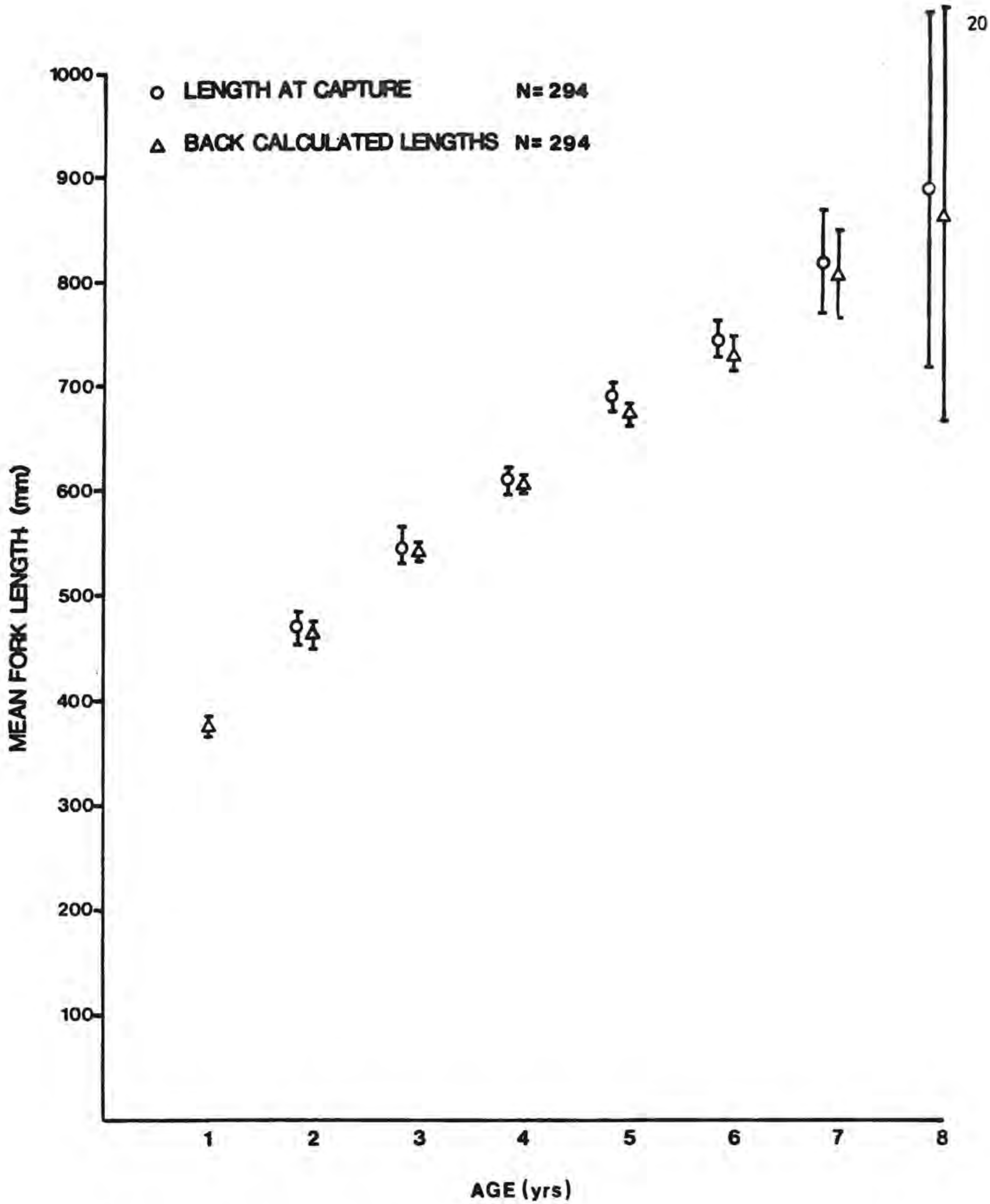

Figure 7. Lengths at capture and back-calculated lengths at age of all snook in Everglades National Park, Florida, 1976-1979 (bars represent 95% confidence intervals around mean).

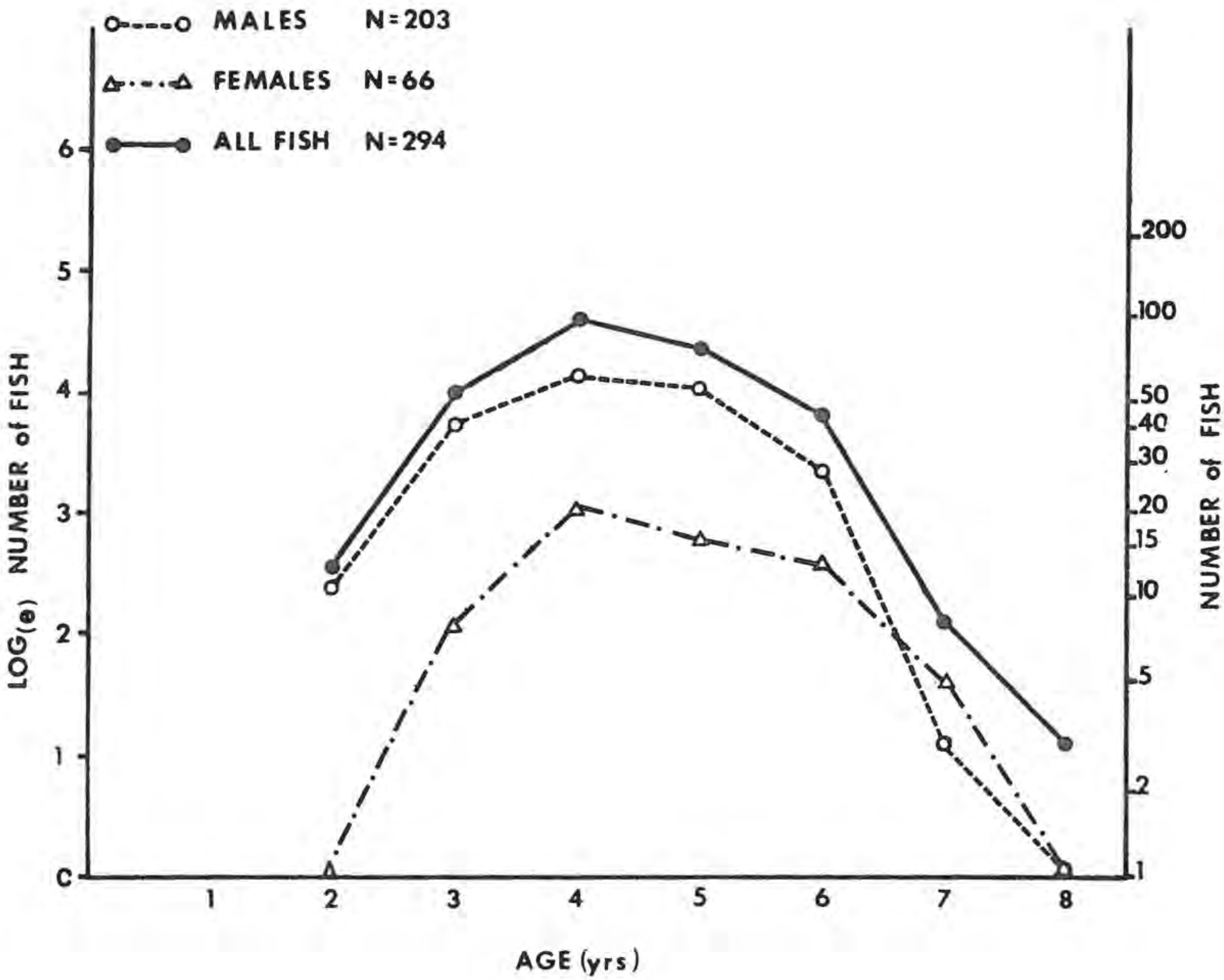

Figure 8. Age distribution of snook collected from sportfishermen catches in Everglades National Park, Florida, 1976-1979.

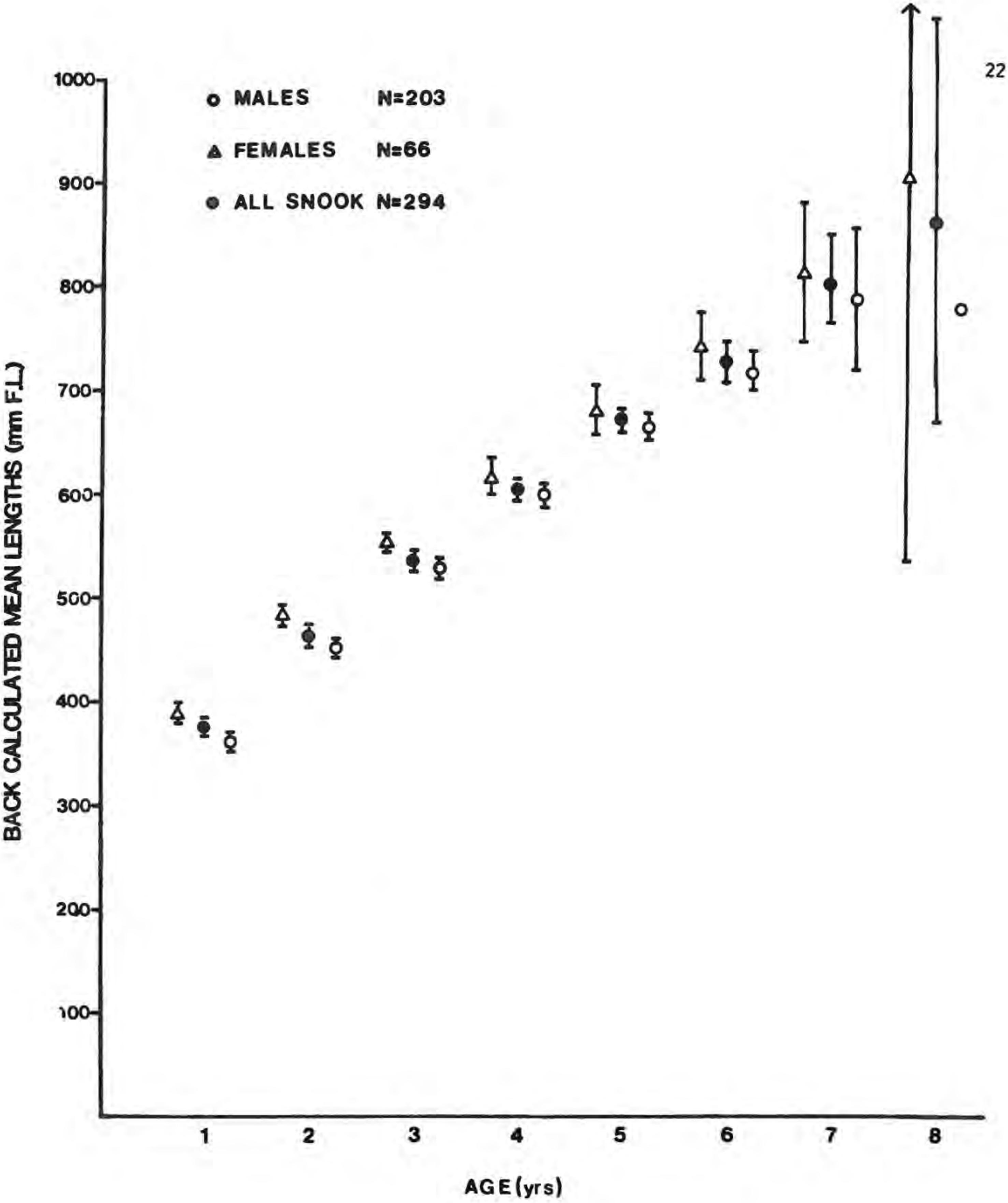

Figure 9. Back-calculated mean lengths at age for snook males, females, and combined sexes in Everglades National Park, Florida, 1976-1979 (bars represent 95% confidence intervals around mean).

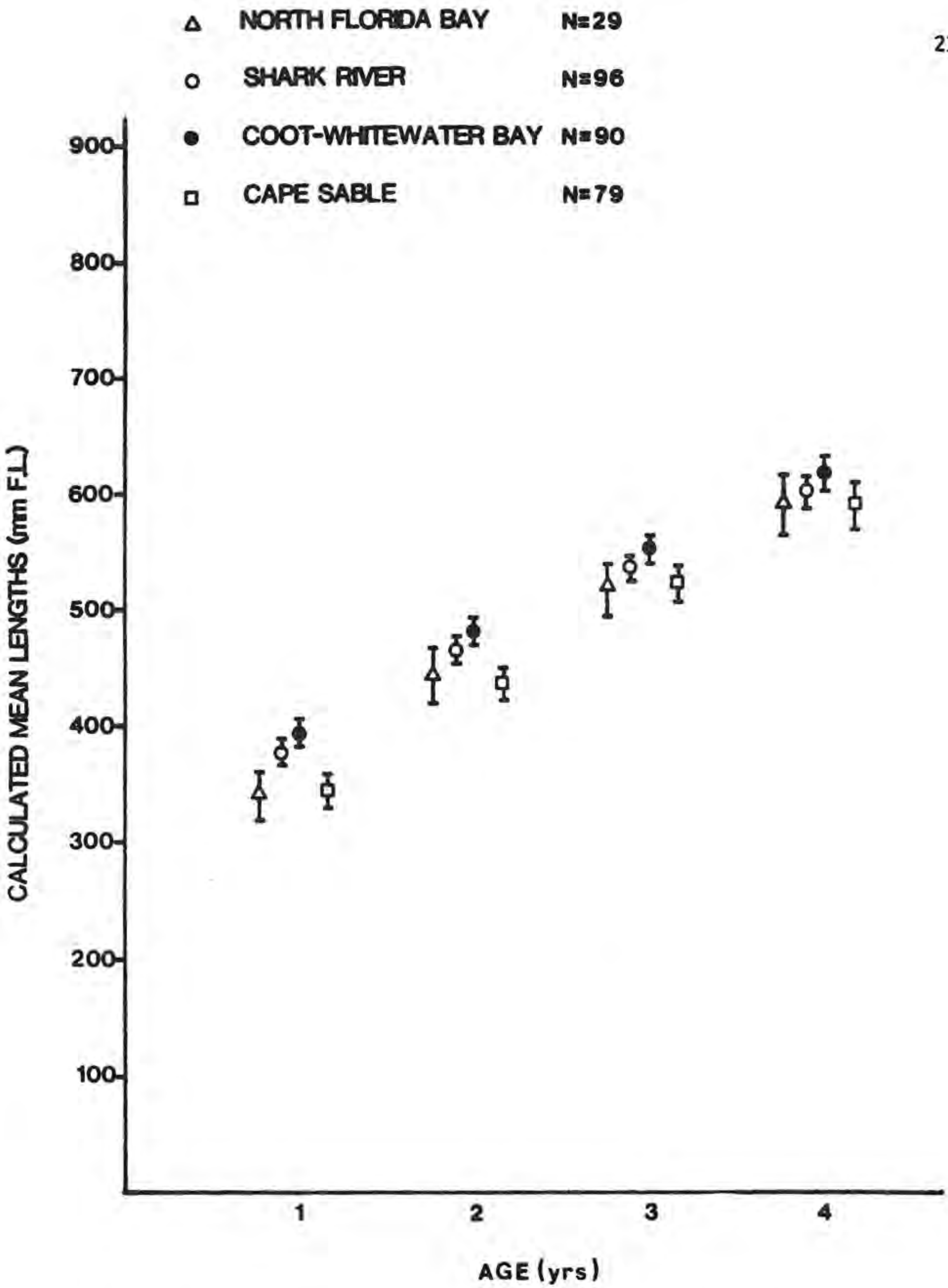

Figure 10. Mean back-calculated lengths at age for all snook collected from areas in Everglades National Park, Florida, 1976-1979 (bars represent 95% confidence intervals around mean).

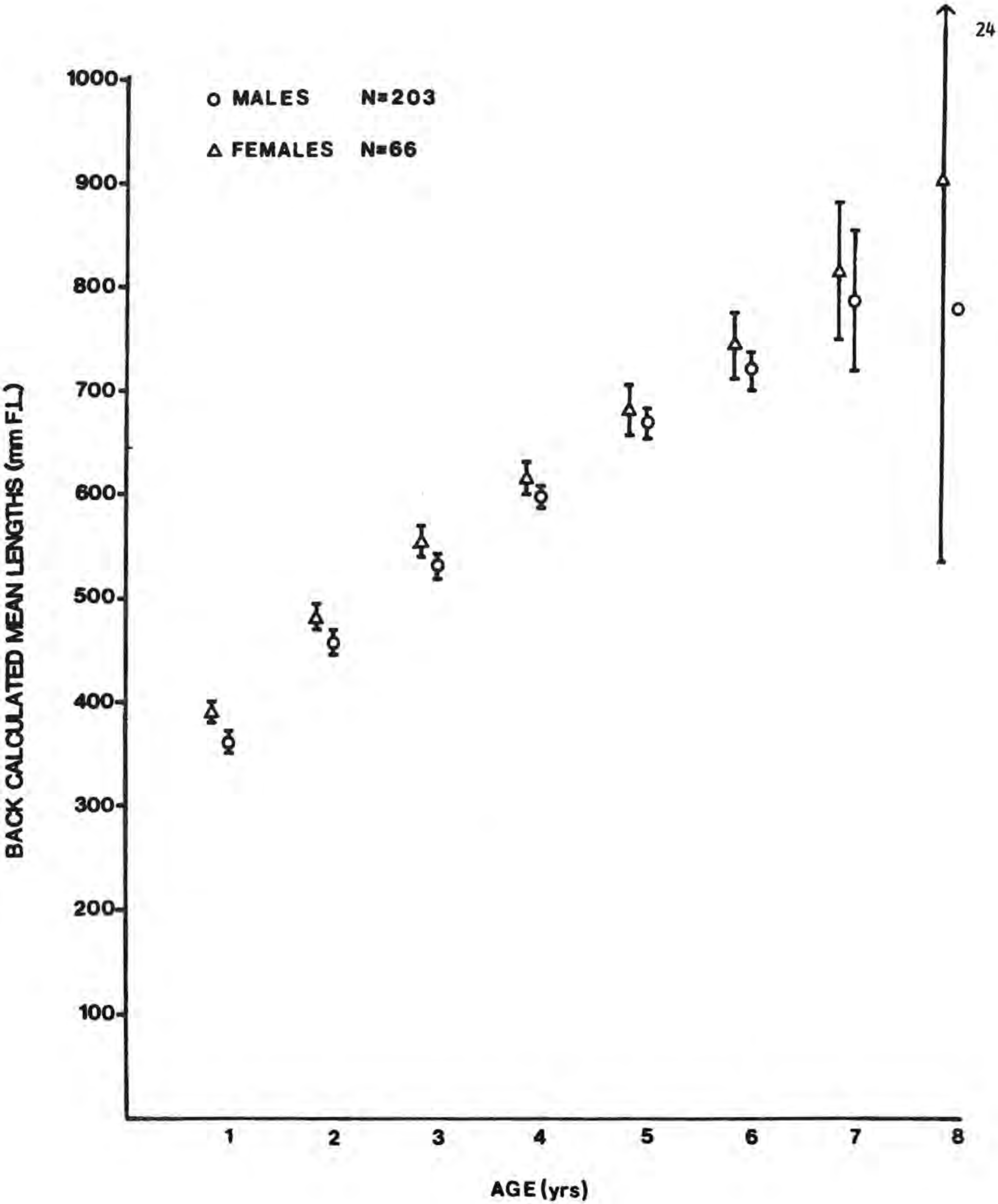

Figure 11. Mean calculated lengths at age of male and female snook in Everglades National Park, Florida, 1976-1979 (bars represent 95% confidence intervals around mean).

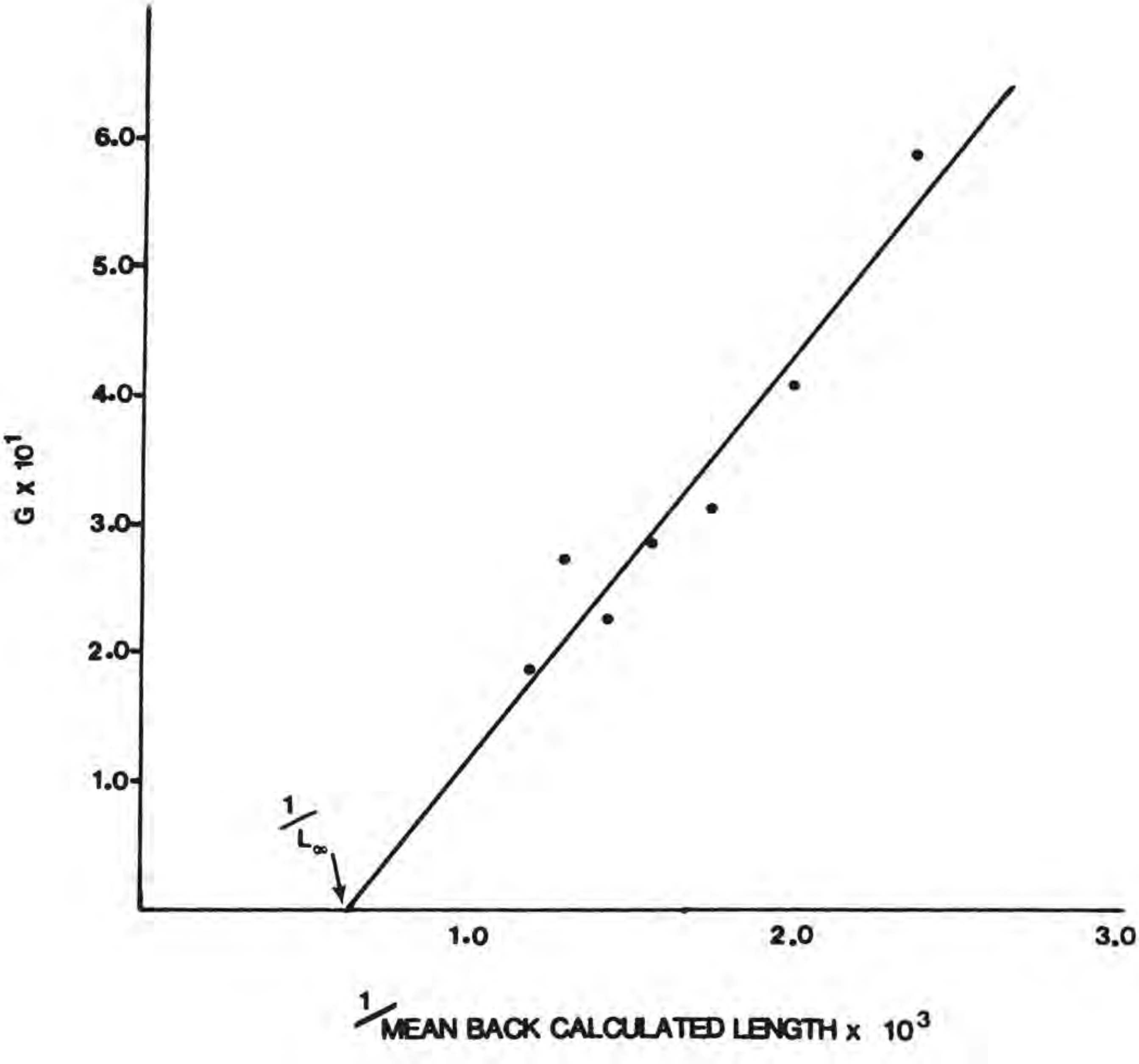

Figure 12. Regression of G, the instantaneous growth coefficient, on the reciprocal of mean back-calculated length for all snook, Everglades National Park, Florida, 1976-1979. $G = -.1941 + .3135\ (^1/_{L_t} \times 10)$; $N = 7$; $r = .96$; $P < .05$; $L_\infty = 1615$ (mm F.L); $K = .07$; $t_o = -2.68$.

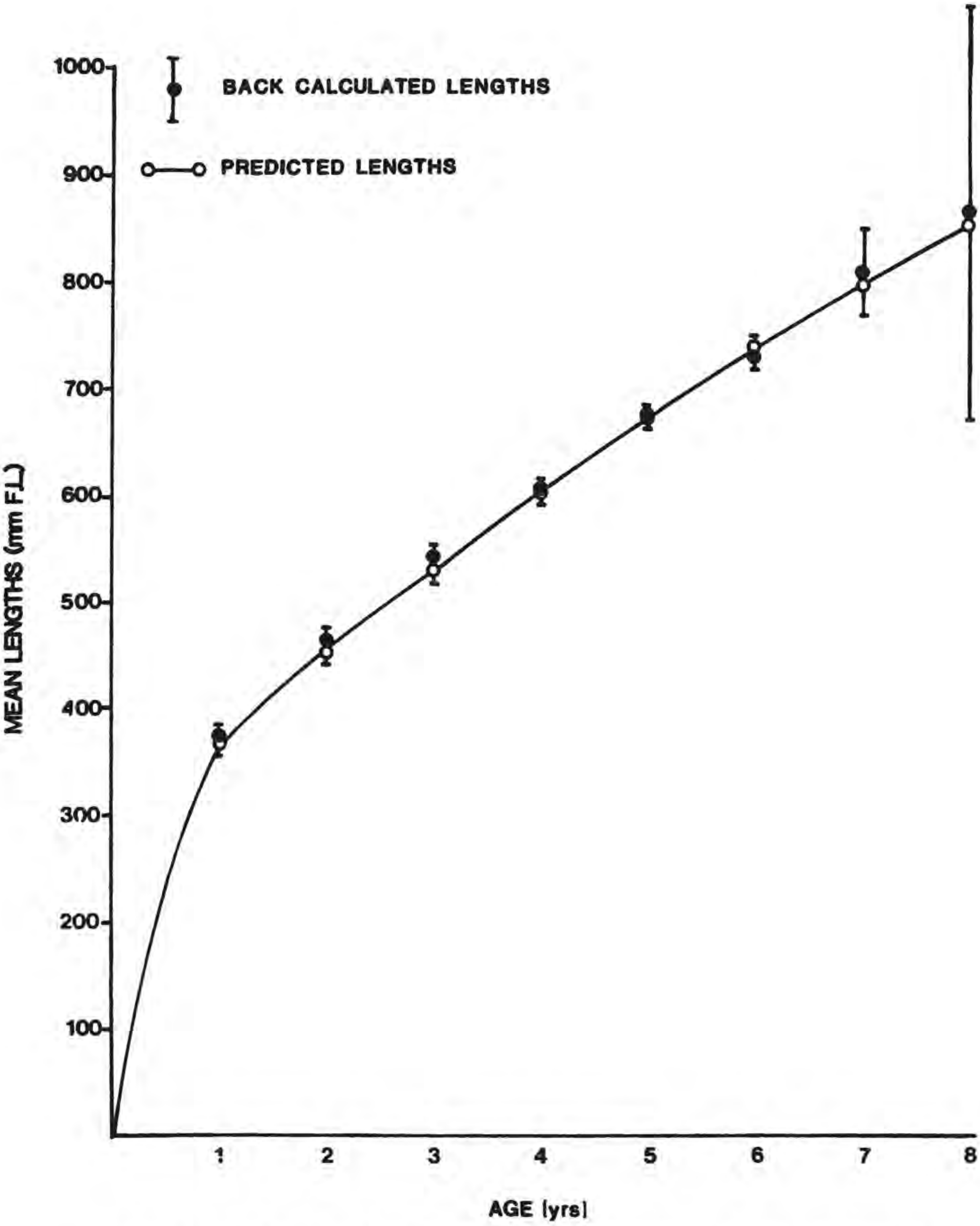

Figure 13. Comparison of mean back-calculated lengths at age and lengths predicted by von Bertalanffy equation for all snook in Everglades National Park, Florida, 1976-1979.

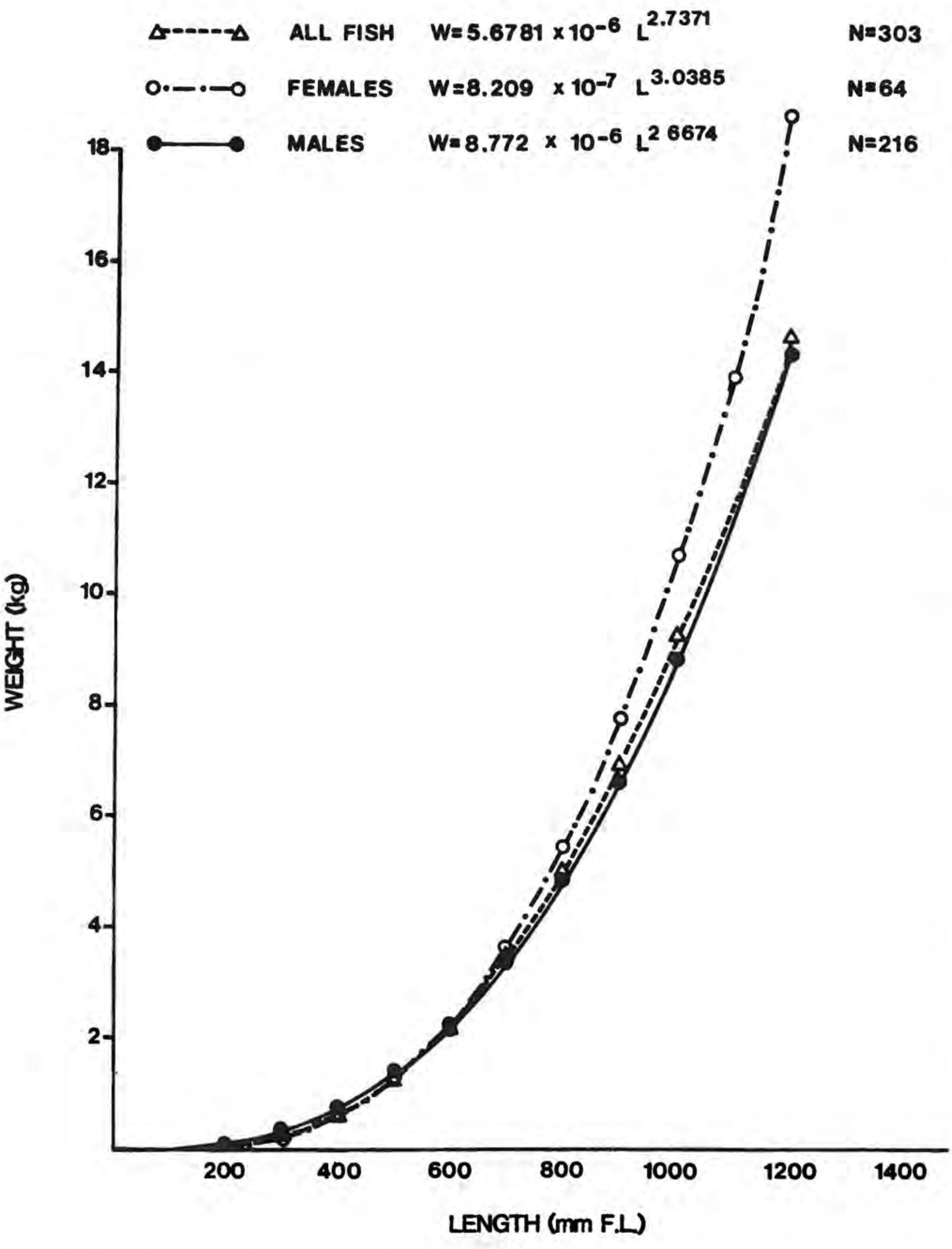

Figure 14. Length-weight relationships for snook in Everglades National Park, Florida, 1976-1979. Weights estimated by equations are in decagrams.

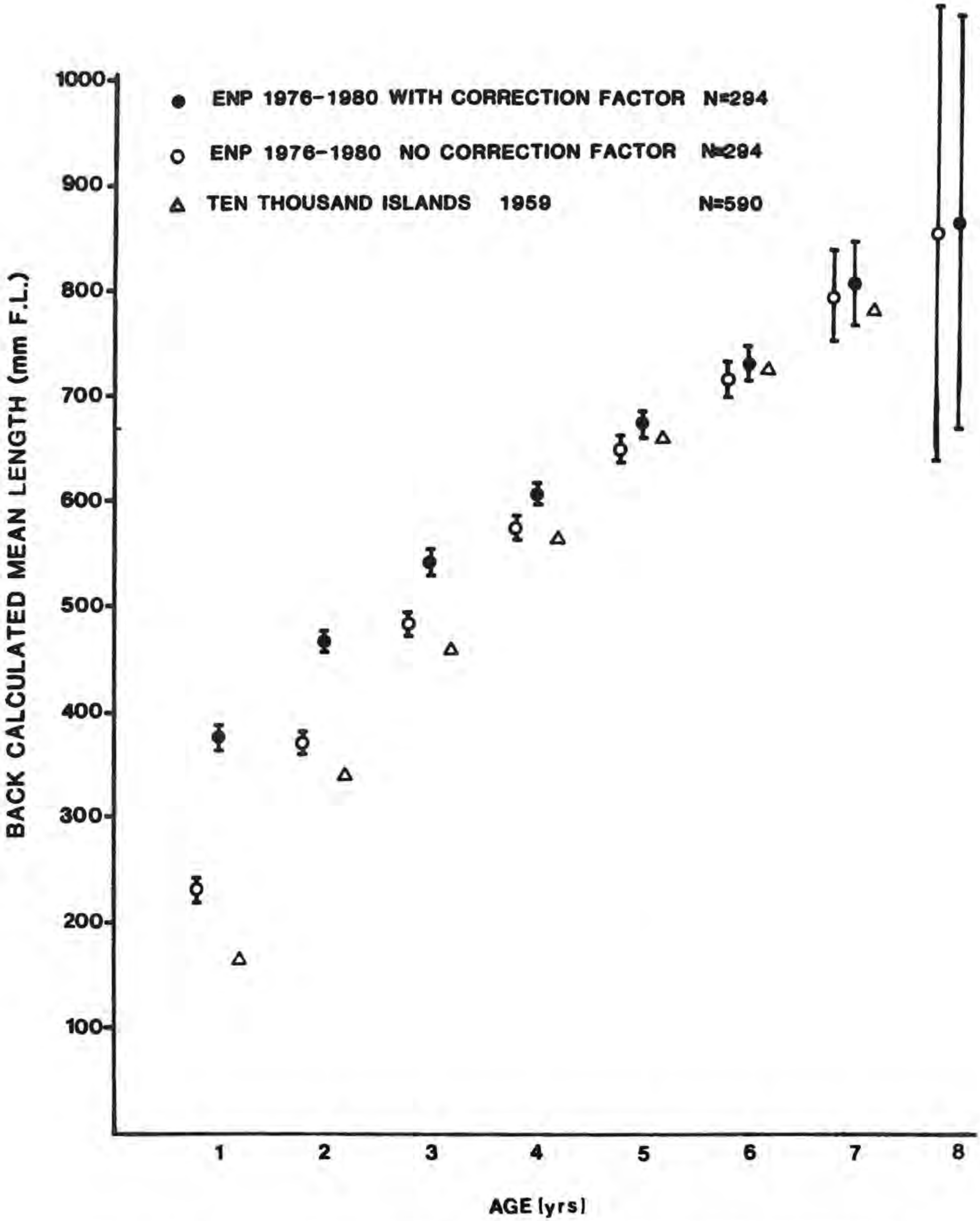

Figure 15. Calculated mean lengths at age for snook in Everglades National Park, Florida, 1976-1979 and for southwest Florida, 1959 (Volpe, 1959) (bars represent 95% confidence intervals around mean).

Appendix I. Distribution of all snook back-calculated lengths (C) and lengths at capture (O) at ages I through VIII in Everglades National Park 1976-1979.

ANNULUS	I		II		III		IV		V		VI		VII		VIII	
LENGTH (mm)	C	O	C	O	C	O	C	O	C	O	C	O	C	O	C	O
220-239																
240-259	1															
260-279	2															
280-299	16															
300-319	16															
320-339	27		1													
340-359	43		4													
360-379	54		7													
380-339	48		15		1											
400-419	34		29		3											
420-439	31		43	2	7	1										
440-459	13		44	2	12	1	2									
460-479	8		38	5	15	1	2	1								
480-499	1		36	3	32	7	10									
500-519			30	1	39	10	7	9	1	1						
520-539			23		38	5	12	7	2							
540-559			13		40	9	15	5	2							
560-579			8		20	7	27	6	4	1						
580-599			1		32	6	30	11	3	4	1					
600-619			2		19	1	32	10	11	2		1				
620-639					13	1	29	12	14	8		0				
640-659					5	1	21	12	25	10	2					
660-679					1	1	12	8	18	5	6	2				
680-699					3	1	16	6	14	7	8					
700-719					1	0	4	1	10	13	12	12				
720-739						2	4	4	13	10	8	8	1			
740-759							2	1	1	5	3	6	3	2		
760-779									2	8	5	6	1		1	
780-799							2		3	3	4	3		2		
800-819									1		2	1	1			
820-839									2	1	1	2	3	0		1
840-859											1	1		2		
860-879											2	3		1	1	
880-899											1					
900-919													2	1		1
920-939															1	
940-959																1
N	294	0	294	13	281	54	227	93	134	78	56	45	11	8	3	3
$\bar{x}$	375		465	467	540	548	605	609	672	690	730	745	806	818	863	887
S	45.93		52.02	24.49	56.58	61.03	61.75	62.13	60.65	60.16	58.84	54.78	62.23	58.23	78.91	68.13

Appendix II. Distribution of male snook back-calculated lengths (C) and lengths at capture (O) at ages I through VIII in Everglades National Park 1976-1979.

JLUS	I		II		III		IV		V		VI		VII		VIII	
GTH n)	C	O	C	O	C	O	C	O	C	O	C	O	C	O	C	O
:39																
:59	1															
:79	2															
:99	16															
319	16															
339	30		1													
359	40		4													
379	34		8													
399	26		13		1											
419	19		27		3											
439	9		33	2	7	1										
459	7		32	2	9	1	2									
479	2		25	3	11	1	2	1								
499	1		17	3	25	6	8									
519			21	1	29	7	5	7								
539			15		26	4	9	6	2							
559			3		25	8	8	4	2							
579			3		16	5	17	4	3	1						
599					21	4	20	6	1	3	1					
619			1		9	1	20	6	6	2		1				
639					8		23	8	10	4						
659					1	1	11	9	19	7	2					
679					0	1	11	4	9	5	3	2				
699					1	1	11	5	10	4	4					
'19						0	1		6	9	8	6				
'39						1	2	2	11	7	3	6				
'59								1	6	4	3	4	1			
'79									1	7	3	3	1		1	
'99									1	1	3	3		1		
819											2		1			
839										1		2	1			1
859												1		2		
879																
899																
919																
939																
959																
	203	0	203	11	192	42	150	63	87	55	32	28	4	3	1	1
	361		453	465	530	543	599	604	667	692	719	738	787	824	777	820
	44.51		50.41	26.53	54.42	60.23	58.71	64.10	55.62	58.46	49.79	51.34	41.91	37.98		

Appendix III. Distribution of female snook back-calculated lengths (C) and lengths at capture (O) at ages I through VIII in Everglades National Park 1976-1979.

ANNULUS	I		II		III		IV		V		VI		VII		VIII	
LENGTH (mm)	C	O	C	O	C	O	C	O	C	O	C	O	C	O	C	O
220-239																
240-259																
260-249																
280-299																
300-319																
320-339	3															
340-359	7															
360-379	14															
380-399	15															
400-419	15		4													
420-439	7		7													
440-459	2		10		3											
460-479	3		11	1	1											
480-499			11		5	1	2									
500-519			8		8	1	1	1	1	1						
520-539			7		10	1	2	1								
540-559			2		13	1	6	1								
560-579			4		6	2	4									
580-599			2		6	2	8	4	1							
600-619					4		9	3	4							
620-639					2		7	3	3	2						
640-659					4		7	1	4	2						
660-679							1	4	9		2					
680-699					2		2	1	3	3	3					
700-719					1		3	1	3	3	4	4				
720-739							3	1	1	1	4	2	1			
740-759									2	1	1	1	2	2		
760-779							0		1	1	1	3				
780-799							2		2	2	1	0		1		
800-819												1				
820-839									2		1		2			
840-859																
860-879											2	2	0	1	1	
880-899											1					
900-919													2	1		1
920-939															1	
940-959																1
N	66	0	66	1	65	8	57	21	36	16	20	13	7	5	2	2
$\bar{x}$	393		485	478	556	552	619	624	683	693	745	757	816	814	905	921
S	33.07		46.40		57.17	33.67	66.88	55.40	69.74	69.33	67.56	58.87	72.37	71.90	41.04	26.87

Appendix IV. Von Bertalanffy growth parameters K, $1/L_\infty$ and t_o with 95% confidence intervals for male, female and all snook in Everglades National Park, Florida, 1976-1979.

	K	$1/L_\infty$		t_o
males	.16 ± .15	1.01×10^{-3}	1.56×10^{-3} 2.86×10^{-5}	-1.95 ± 0.80
females	.12 ± .10	8.53×10^{-4}	1.25×10^{-3} 1.68×10^{-5}	-2.72 ± 1.42
combined sexes and unsexed fish	.07 ± .10	6.19×10^{-4}	1.01×10^{-3} -4.93×10^{-6}	-2.68 ± 0.22