DEVELOPING MANAGEMENT ORIENTATIONS FOR LARGEMOUTH BASS IN BLUFF LAKE, MISSISSIPPI, WITH HISTORICALLY VARIABLE DATA

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INTRODUCTION

Recreational fishing is an important use of Bluff Lake at the Noxubee National Wildlife Refuge in Mississippi. Fishing has been open to the public from March through October each year since 1984. Jennings (1985) reported that proportional stock density (PSD) of largemouth bass (*Micropterus salmoides*) decreased approximately four-fold during the first six months of fishing in Bluff Lake, indicating possible over-exploitation and need for management of the fishery. In addition to the seasonal restriction, a 356-mm minimum size limit was imposed in 1990 and remains in place.

Fisheries management can be as much art as science. Fisheries managers often have to make decisions based on piecemeal data and observations rather than thoroughly planned and statistically designed studies. This paper provides a case history showing how pieces of information such as catch per unit of effort (CPUE), relative condition (Kn; Swingle and Shell 1971), age and growth, creel surveys, and temporal trends in length frequency distributions and PSD (Anderson 1976; 1978) of largemouth bass can be combined to produce management evaluations and recommendations.

MATERIALS AND METHODS

Bluff Lake is a 404-hectare impoundment located on the Noxubee National Wildlife Refuge in the southern part of Oktibbeha County and the northern part of Noxubee County in northeastern Mississippi. The lake is subjected to fluctuating water levels that are primarily maintained for wintering waterfowl. The lake is shallow (mean depth <1.5 m) and has extensive snags and dead trees. The lake has low average conductivity (<100 µmhos), contributing to generally low productivity. In 1979, the levee on Bluff Lake was washed out by heavy spring floods. The lake was subsequently drained, the levee repaired, and the basin refilled. During spring 1982, 42,000 fingerling largemouth bass were released, and during October 1983, an additional 2,400 102-152-mm largemouth bass were released into the lake (Jennings 1985). After stocking, the lake was closed to fishing until 1 March 1984 so that the fish had an opportunity to grow and spawn to support a sport fishery.

Bluff Lake supports a wide variety of fishes, including bowfin (*Amia calva*), gar (*Lepisosteus* spp.), gizzard shad (*Dorosoma cepedianum*), minnows (Cyprinidae), catfishes (Ictaluridae), sunfishes (*Lepomis* spp.), largemouth bass, and crappies (*Pomoxis* spp.).

Fish for stock assessments were collected using a boat-mounted electrofisher with a Coffelt VVP-15 pulsator unit configured to produce 1-3 Amps and 275-300 volts of pulsed DC current (60 HZ). Fish for PSD and length frequency analyses were collected during spring 1984 and 1996 and during fall 1984, 1989, 1991, 1992, 1993, and 1995. Total length (mm) was recorded for each largemouth bass on all of these dates. Length frequency distributions were plotted and temporal trends of PSDs were presented for largemouth bass. Weight (g) for each largemouth bass was recorded during fall 1995 for calculation of condition factors (Kn; Swingle and Shell 1971). Age and growth analysis was conducted on the largemouth bass collected during spring 1996. Scales were removed from the left side of each fish below the lateral line at the tip of the pectoral fin. Back-calculated length at age was determined using the Fraser-Lee method and a standard intercept (Carlander 1981; 1982). The total amount of time spent electrofishing was recorded during fall 1995 and February 1996, and catch per unit effort (CPUE = number of fish per hour) was calculated for largemouth bass. The CPUE for all largemouth bass and those ≥381 mm were plotted on wing graphs (Dean and Wright 1992) and compared to criteria presented by Kirk and Nash (1991) for aid in determining length limits.

An access point creel survey was conducted during a 6-week period from 4 March through 14 April 1996. One randomly selected weekday and both weekend days were sampled during each of the 6 weeks. We assumed a 12-hour fishing day during the creel period. Any given day consisted of three 4-hour sampling units with equal sampling probabilities. A 4-hour sampling unit was randomly selected for each day. The entire lake was sampled during each time period from a single access point. Effort was calculated according to Malvestuto et al. (1978). The results of this survey were compared with those of Jennings (1985).

RESULTS AND DISCUSSION

Length-frequency

The length-frequency distributions of largemouth bass varied from year to year, and year class strength was sometimes low, e.g., during 1989 and 1993 (Figure 1). During those years, none of the length groups <20 cm ever exceeded 10% of the fish collected.

Age and Growth

Back-calculated total lengths at each annulus (Table 1) indicated that largemouth bass from Bluff Lake grow faster than average (178 mm) during the first year but slower than average thereafter. At least one individual attained an age of 9 years. On average, it takes at least 5 years for largemouth bass in Bluff Lake to reach the 356-*mm* minimum length limit.

Condition Factor (Kn)

Condition factor values were generally higher than 85% for largemouth bass between 203 and 305 mm. Condition factors for largemouth bass ≥305 *mm* were generally close to 100% (Figure 2). This is indicative of reduced prey availability for small largemouth bass but adequate prey availability among larger largemouth bass (Dean and Wright 1992).

Proportional Stock Density (PSD)

The PSD of largemouth bass before fishing began in 1984 was 45% (Table 2), indicating good fishing potential (Anderson 1976; 1978). In subsequent years PSDs have fluctuated from 32% to 77%. This range may indicate prey crowding, depleted game fish stocks, low recruitment to stock size (Anderson and Gutreuter 1983), or annual changes in year class strength (Dean and Wright 1992). Because of year class fluctuations, PSD information should be used in conjunction with CPUE data by size-group (Dent 1986; Dean and Wright 1992).

Creel

The 1996 creel survey revealed that 54% of the fishing effort was for crappie and 32% for largemouth bass. Fifty-five percent of the largemouth bass caught were kept during the 6-week creel period in 1996.

Harvest and associated confidence limits, and harvest per unit of effort for principal fishery resources, by bank and boat, are presented in Table 3. Combined bank and boat fishing effort in the 1996 creel was 13.4 hours/hectare. Jennings (1985) reported a combined fishing effort of 47.2 hours/hectare for a similar period during 1984. In the 6-week period during 1996, 0.15 kg/hectare of bass were harvested, compared to 1.20 kg/hectare during a similar time period in 1984. Angler harvest rates for bass were 0.011 kg/hour during 1996 and 0.025 kg/hour in 1984.

Harvest without a minimum length limit in 1984 significantly altered the stock structure of largemouth bass in Bluff Lake (Jennings 1985). Based on length frequency distributions, harvest under the 356-mm minimum length limit did not appear to alter the stock structure as much as in 1984, but still may have had some effect. Low harvest rates indicated a relatively low number of harvestable bass in the lake, although individuals larger than the legal size limit were present (Figure 1).

Catch per Unit of Effort (CPUE)

A plot of CPUE from largemouth bass collected during fall 1995 on a wing graph (Dean and Wright 1992) (Figure 3) indicates the need for a minimum length limit. In contrast, a plot of the spring 1996 data does not indicate the need for a size limit. Length frequencies and CPUE may vary considerably between fall and spring because larger adults may be inshore spawning during the spring, and thus more susceptible to electrofishing. These differences between fall and spring indicate that spring, and not fall, electrofishing data should be used to construct wing graphs. In spite of the wing graph indicating no immediate need for a length limit, we suspect that fishing without a length limit would reduce the number of larger fish as it did in the past. Therefore, these data suggest that the present minimum length limit, in conjunction with a closed season (October-March), is effective in keeping large fish in the population.

MANAGEMENT PERSPECTIVE

Dean and Wright (1992) stated that catch rates of <50 largemouth bass of all sizes per hour, and <4 largemouth bass with total lengths >381-mm per hour indicate a population in need of more protection regardless of size distribution or cause. This was the case for the fall 1995 CPUE but not for the spring 1996 CPUE. According to the spring 1996 data point on the wing graph, there is no need for a length limit (Figure 3). However, past experience indicated that fishing affected the size structure enough to require a length limit, and one was imposed in 1990. If the present length limit is removed, we suspect that size structure would again be altered so that a length limit would need to be re-instituted shortly thereafter.

The flow diagram in Kirk and Nash (1991) indicates that a minimum limit is preferred. Low CPUE of largemouth bass during fall 1995, fishing effort exceeding 10 hours/hectare in a low productivity system, better than average growth

during the first year, and occasional low recruitment were the determining factors.

Considering the relatively low productivity of the lake, relatively slow growth of older individuals, occasional low recruitment, and generally high PSDs, the 356-mm minimum size limit appears to be maintaining an adequate size structure, if not actual abundance, of largemouth bass in Bluff Lake. Therefore, we recommend that the current minimum length limit be maintained and that a more standardized approach to stock assessments be conducted for Bluff Lake. Assessments should include spring electrofishing with counts of fish per hour and measurement of total length and weight from each fish for use in the recently developed flow chart of Kirk and Nash (1991) and wing graph of Dean and Wright (1992).

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Table 1. Back-calculated total length (mm) at annulus for largemouth bass from Bluff Lake, Mississippi, 11 March 1996.

		Total length at annulus								
Year class	N	1	2	3	4	5	6	7	8	9
1994	9	132	174							
1993	4	149	232	250						
1992	5	152	242	275	295					
1991	6	193	261	295	317	334				
1990	4	223	269	300	320	344	360			
1989	3	221	266	291	324	349	371	391		
1988	5	176	241	282	319	350	376	391	408	
1987	1	175	216	253	323	364	389	419	441	457
Mean	37	178	238	278	316	348	374	400	425	457
North America[1]		118	215	287	341	389	434	463	495	510

[1]Carlander 1977

Table 2. Proportional Stock Density of largemouth bass from Bluff Lake, Mississippi.

Season	Year	N	PSD
Spring[a]	1984	565	45%
Fall	1984	209	4%
Fall[b]	1989	56	69%
Fall	1991	67	43%
Fall	1992	18	77%
Fall	1993	32	76%
Fall	1995	51	32%
Spring	1996	41	72%

[a] Fishing opened to the public during the following summer
[b] A 14-inch minimum length limit was implemented in March 1990

Table 3. Harvest (weight, kg) and associated 95% confidence limits(CI) and harvest per unit of effort (CPUE = kg/hour) for Bluff Lake, 1 March-14 April 1996.

	Lower CI	Harvest	Upper CI	CPUE
Bank Fishing Harvest				
Sunfishes	0.000	20.565	51.934	0.013
Largemouth Bass	0.000	0.000	0.000	0.000
Crappies	0.386	2.186	3.986	0.001
Total Bank Harvest	0.000	22.750	54.242	0.014
Boat Fishing Harvest				
Sunfishes	0.344	1.948	3.552	<0.001
Largemouth Bass	6.551	59.923	113.295	0.042
Crappies	67.355	709.327	1351.299	0.297
Total Boat Harvest	141.715	771.198	1400.682	0.339

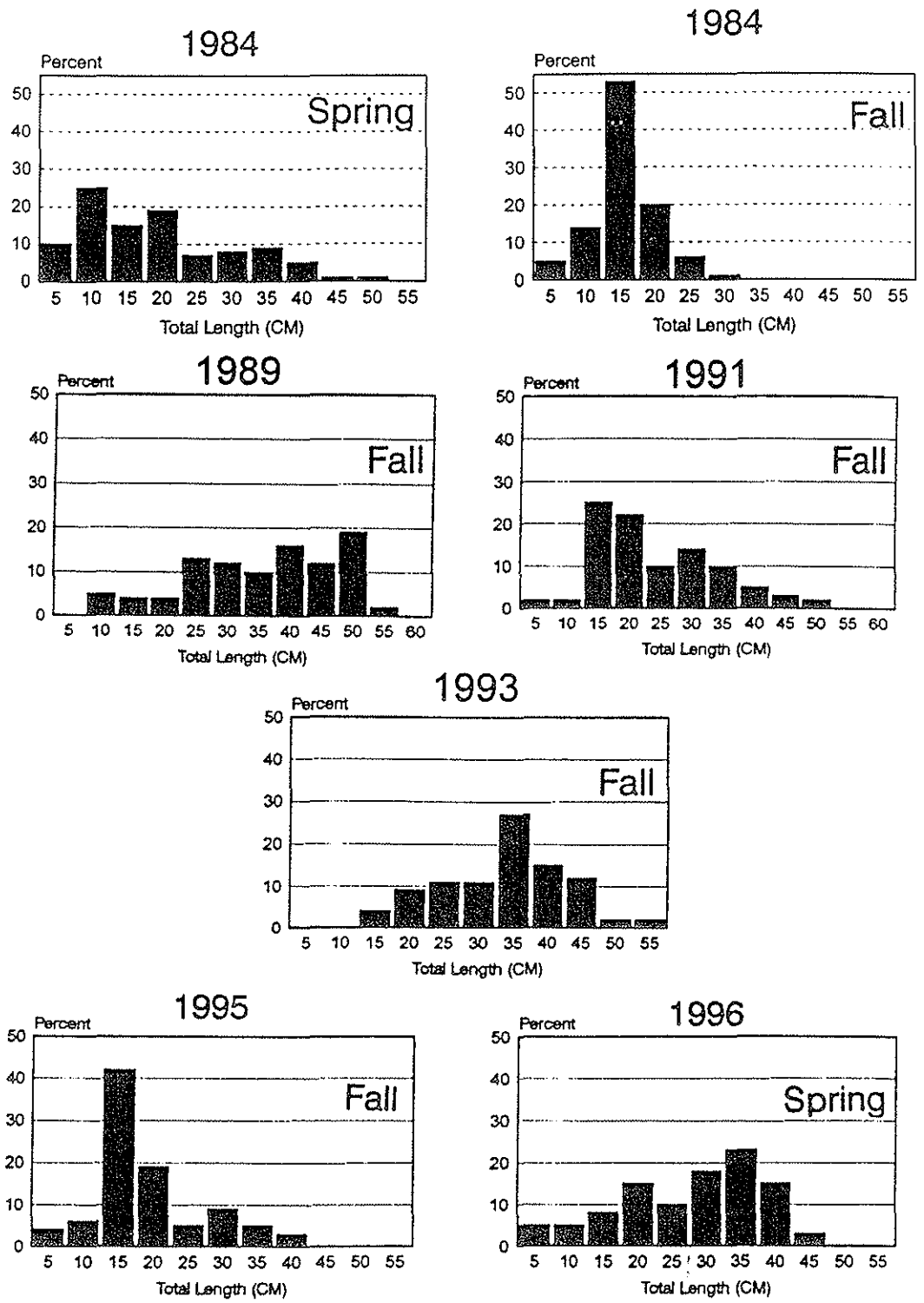

Figure 1. Historical length-frequency distributions for largemouth bass collected by electrofishing from Bluff Lake

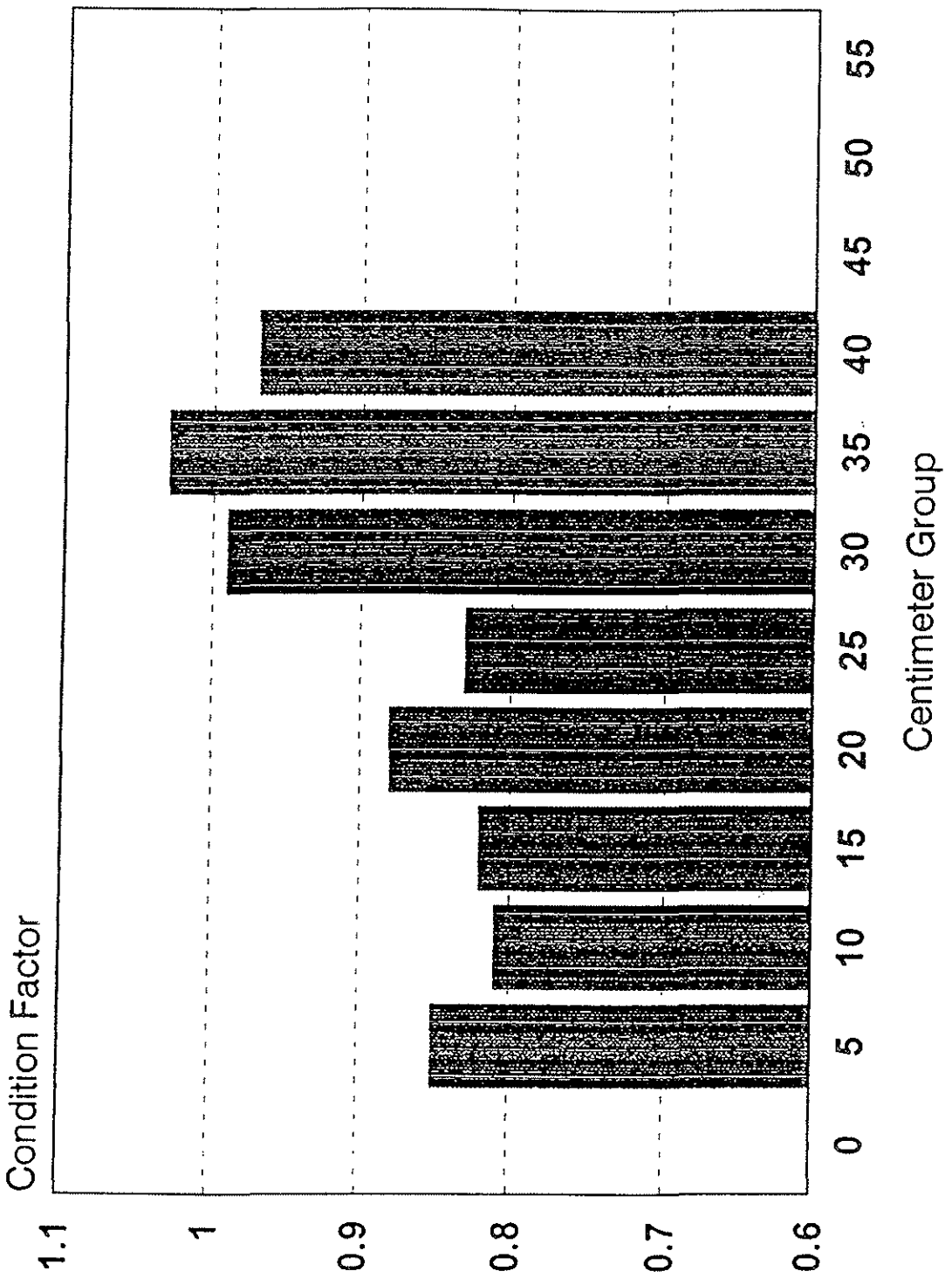

Figure 2. Mean coefficients of condition (Kn) for largemouth bass collected from Bluff Lake (Fall 1995).

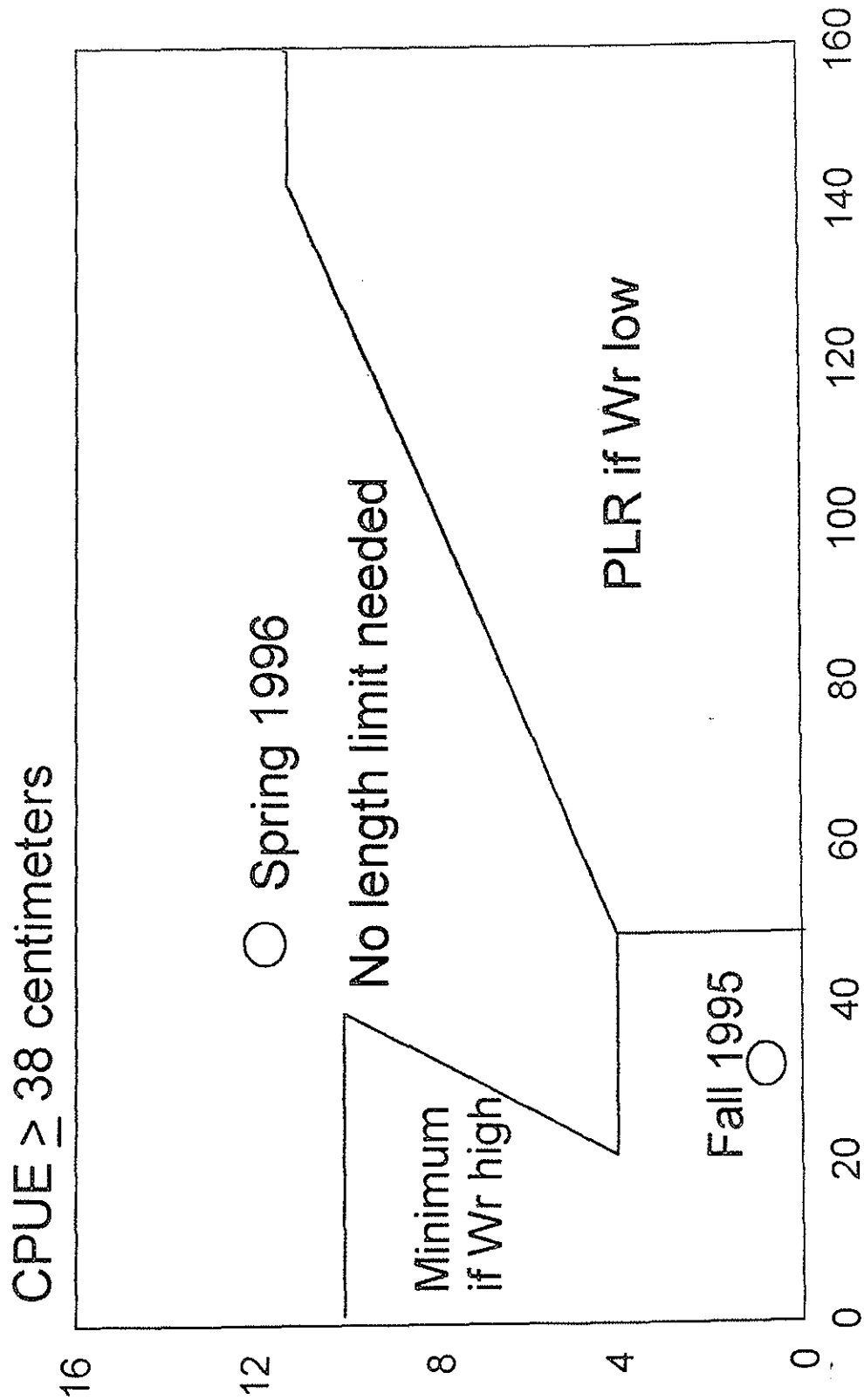

Figure 3. Wing diagram for determining needed length-limit regulations for largemouth bass (Dean and Wright 1992). PLR = protected length range (slot limit)