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A Length-Categorization System to Assess Fish Stocks

DONALD W. GABELHOUSE, JR.

Kansas Fish and Game Commission
832 East 6th Avenue
Emporia, Kansas 66801

ABSTRACT

A length-categorization system was developed to assess structure of fish stocks with greater precision than is possible using Proportional Stock Density (PSD). Three new size categories—"preferred," "memorable," and "trophy"—were developed to accompany previously established "stock" and "quality" lengths. Like minimum stock and quality lengths, minimum lengths for the new categories are defined as percentage lengths of the all-tackle, world-record fish. Length ranges from or near which minimum stock, quality, preferred, memorable, and trophy lengths should be selected were computed for all freshwater fish species having a world-record length listed by the International Game Fish Association in 1982. Minimum lengths corresponding to each of the five size categories are proposed for several species. By arraying samples of fish population data or angler catch data according to the five size-group categories, a length-frequency distribution can be easily assessed and verbalized. Relative Stock Density (RSD) or models for catch rates also can be developed to set management objectives that are easily understandable, yet reflect recruitment, mortality, and growth functions of fish populations and communities. Desirable percentages and catch rates for size-group categories may differ among individual waters or geographic regions depending upon management objectives and the capacity to produce the species of interest.

Johnson and Anderson (1974) first proposed an approach to assess largemouth bass (*Micropterus salmoides*) and bluegill (*Lepomis macrochirus*) stocks using length-frequency data. The approximate percentages that largemouth bass 8.0–12.0, 12.0–15.0, and 15.0 in long and longer should comprise of all largemouth bass 8.0 in and longer in desirable populations were stated. Recommended percentages for bluegill were given as proportions of all bluegill 3.0 in long and longer that should consist of 3.0–6.0-in and 6.0-in and longer individuals. Models for both species were developed using desirable growth and mortality rates. Anderson (1975) illustrated a dynamic pool model and calculated frequencies in 8.0–12.0, 12.0–15.0, and 15.0 in long and longer size-groups for northern and southern largemouth bass populations.

As confidence in the use of length-frequency data to assess fish stocks grew, the term Proportional Stock Density (PSD) was coined (Anderson 1976). At that time, PSD was defined as the percentage of "stock-length" fish that also were equal to or longer than a specified length. Lengths corresponding to stock length for largemouth bass and bluegill were designated as 8.0 in and longer and 3.0 in and longer, respectively. Fish shorter than these lengths were not considered when PSD was calculated. The "specified length" was not defined, but for largemouth bass, 12.0 in was used, and 6.0 in was applied to bluegill. Extensive application and evaluation of the PSD index was made in a study of fish populations in ponds in the midwest (Novinger and Dillard 1978).

Anderson (1978) further refined the PSD index by identifying a size category termed "quality length." This category replaced the "specified length" and PSD became equal to that percentage of stock-length fish that was of quality length (12.0 in and longer for largemouth bass and 6.0 in and longer for bluegill). Application of the PSD approach to assess stocks for species other than largemouth bass and bluegill began after Anderson and Weithman (1978) defined lengths equivalent to minimum stock and quality lengths as percentage lengths of the all-tackle, world-record length.

Use of PSD has flourished from the mid 1970's to the present. In the process, that portion of a largemouth bass stock that was 15.0 in long and longer has most frequently been lumped with that portion 12.0–15.0 in long to calculate a PSD. Anderson (1980) reemphasized the need to identify the percentage of stock-length largemouth bass 15.0 in long and longer when the quality of fish and fishing was a concern. He utilized the statistic Relative Stock Density (RSD), the proportion of a designated size group in a stock (Wege

Table 1. Continued.

Species	Size category: Stock	Quality	Preferred	Memorable	Trophy
Flathead catfish (*Pylodictis olivaris*)	8.8–11.4	15.8–18.0	19.8–24.2	26.0–28.2	32.6–35.2
White catfish (*Ictalurus catus*)	5.0–6.5	9.0–10.2	11.2–13.8	14.8–16.0	18.6–20.0
Black bullhead (*Ictalurus melas*)	4.8–6.2	8.6–9.8	10.8–13.2	14.2–15.4	17.8–19.2
Brown bullhead (*Ictalurus nebulosus*)	3.8–4.9	6.8–7.8	8.6–10.4	11.2–12.2	14.1–15.2
Yellow bullhead (*Ictalurus natalis*)	3.2–4.2	5.8–6.6	7.2–8.8	9.4–10.2	11.8–12.8
Suckers					
Bigmouth buffalo (*Ictiobus cyprinellus*)	9.7–12.6	17.5–19.9	21.8–26.7	28.6–31.0	35.9–38.8
Smallmouth buffalo (*Ictiobus bubalus*)	8.2–10.7	14.8–16.8	18.4–22.6	24.2–26.2	30.3–32.8
Silver redhorse (*Moxostoma anisurum*)	5.1–6.6	9.2–10.5	11.5–14.0	15.0–16.3	18.9–20.4
Shorthead redhorse (*Moxostoma macrolepidotum*)	4.0–5.2	7.2–8.3	9.1–11.1	11.9–12.9	14.9–16.1
Carp					
Common carp (*Cyprinus carpio*)	8.4–10.9	15.1–17.2	18.9–23.1	24.8–26.9	31.1–33.4
Pikes					
Muskellunge (*Esox masquinongy*)	12.9–16.8	23.2–26.4	29.0–35.5	38.1–41.3	47.7–51.6
Northern pike (*Esox lucius*)	11.5–15.0	20.7–23.6	25.8–31.6	33.9–36.8	42.6–46.0
Chain pickerel (*Esox niger*)	6.2–8.1	11.2–12.7	14.0–17.0	18.3–19.8	22.9–24.8
Trouts					
Huchen (*Hucho hucho*)	11.3–14.7	20.4–23.2	25.5–31.2	33.4–36.3	42.0–45.4
Lake trout (*Salvelinus namaycush*)	10.4–13.5	18.7–21.3	23.4–28.6	30.7–33.3	38.5–41.6
Chinook salmon (*Oncorhynchus tshawytscha*)	10.0–13.0	18.0–20.5	22.5–27.5	29.5–32.0	37.0–40.0
Inconnu (*Stenodus leucichthys*)	9.8–12.7	17.6–20.1	22.0–27.0	28.9–31.4	36.3–39.2
Rainbow trout (*Salmo gairdneri*)	8.6–11.2	15.5–17.6	19.4–23.2	25.4–27.5	31.8–34.4
Bull trout (*Salvelinus confluentus*)	8.1–10.5	14.6–16.6	18.2–22.3	23.9–25.9	30.0–32.4
Arctic char (*Salvelinus alpinus*)	8.0–10.3	14.3–16.3	17.9–21.9	23.4–25.4	29.4–31.8
Chum salmon (*Oncorhynchus keta*)	7.9–10.2	14.2–16.1	17.7–21.6	23.2–25.2	29.1–31.5
Cutthroat trout (*Salmo clarki*)	7.8–10.1	14.0–16.0	17.6–21.4	23.0–25.0	28.9–31.2
Brown trout (*Salmo trutta*)	7.8–10.1	14.0–15.9	17.5–21.4	23.0–24.9	28.8–31.1
Atlantic salmon (landlocked) (*Salmo salar*)	7.2–9.4	13.0–14.8	16.2–19.8	21.2–23.0	26.6–28.8
Tiger trout (*Salmo trutta* × *Salvelinus fontinalis*)	6.8–8.8	12.2–13.8	15.2–18.6	19.9–21.6	25.0–27.0
Sunapee trout (*Salvelinus aureolus*)	6.6–8.6	11.9–13.5	14.8–18.2	19.5–21.1	24.4–26.4
Lake whitefish (*Coregonus clupeaformis*)	6.4–8.3	11.4–13.0	14.3–17.5	18.7–20.3	23.5–25.4

Table 1. Continued.

Species	Size category Stock	Quality	Preferred	Memorable	Trophy
Brook trout (*Salvelinus fontinalis*)	6.3–8.2	11.3–12.9	14.2–17.3	18.6–20.2	23.3–25.2
Pink salmon (*Oncorhynchus gorbuscha*)	6.0–7.8	10.8–12.3	13.5–16.5	17.7–19.2	22.2–24.0
Arctic grayling (*Thymallus arcticus*)	6.0–7.8	10.8–12.2	13.4–16.4	17.6–19.1	22.1–23.9
Golden trout (*Salmo aguabonita*)	5.6–7.3	10.1–11.5	12.6–15.4	16.5–17.9	20.7–22.4
Splake (*Salvelinus fontinalis* × *Salvelinus namaycush*)	5.4–7.0	9.7–11.1	12.2–14.9	15.9–17.3	20.0–21.6
Sockeye salmon (*Oncorhynchus nerka*)	5.4–7.0	9.7–11.1	12.2–14.9	15.9–17.3	20.0–21.6
Kokanee (*Oncorhynchus nerka*)	4.9–6.4	8.8–10.0	11.0–13.5	14.4–15.7	18.1–19.6
Dolly Varden (*Salvelinus malma*)	4.2–5.5	7.6–8.6	9.4–11.6	12.4–13.4	15.5–16.8
Round whitefish (*Prosopium cylindraceum*)	4.1–5.3	7.3–8.4	9.2–11.2	12.0–13.1	15.1–16.3
Mountain whitefish (*Prosopium williamsoni*)	3.8–4.9	6.8–7.8	8.6–10.4	11.2–12.2	14.1–15.2
Herring					
American shad (*Alosa sapidissima*)	5.0–6.5	9.0–10.2	11.2–13.8	14.8–16.0	18.5–20.0
Bowfin					
Bowfin (*Amia calva*)	7.2–9.4	13.0–14.8	16.2–19.8	21.2–23.0	26.6–28.8
Gars					
Alligator gar (*Lepisosteus spatula*)	18.6–24.2	33.5–38.1	41.8–51.2	54.9–59.5	68.8–74.4
Longnose gar (*Lepisosteus osseus*)	14.4–18.8	26.0–29.7	32.5–39.7	42.6–46.2	53.5–57.8
Florida gar (*Lepisosteus platyrhincus*)	10.6–13.8	19.1–21.7	23.8–29.2	31.3–33.9	39.2–42.4
Shortnose gar (*Lepisosteus platostomus*)	6.4–8.3	11.4–13.0	14.3–17.5	18.7–20.3	23.5–25.4
Sturgeon					
Sturgeon (Acipenseridae family)	22.7–29.5	40.9–46.5	51.1–62.4	67.0–72.6	84.0–90.8

[a] Stock = 20–26% of world-record length; quality = 36–41% of world-record length; preferred = 45–55% of world-record length; memorable = 59–64% of world-record length; and trophy = 74–80% of world-record length.

[b] Length ranges for size categories calculated from length of a fish other than the world record.

anglers may like to catch a fish of quality length, most would prefer to catch something at least somewhat bigger, hence the category "preferred." "Memorable" is defined as a size most anglers remember catching, and "trophy" is a size considered worthy of acknowledgment. Fish of a given species that may be worthy of acknowledgment to anglers in some regions may, in reality, be less than trophies using the proposed system. This reflects the region's inability to produce large individuals of that species compared to a world-wide standard.

Uses of the Length-Categorization System

Calculation of RSD

The most common use of the length-categorization system has been to calculate RSD. RSD values have been calculated traditionally as the percentages of stock that are comprised of individuals equal to or longer than the defined minimum lengths for size categories. An incremental approach can determine the percentages of stock consisting of individuals between minimum

Table 2. Proposed minimum lengths for five size categories for selected species.

Species	Stock (in)	Stock (cm)	Quality (in)	Quality (cm)	Preferred (in)	Preferred (cm)	Memorable (in)	Memorable (cm)	Trophy (in)	Trophy (cm)
Drum										
Freshwater drum[a]	8	20	12	30	15	38	20	51	25	63
Perches										
Walleye[a]	10	25	15	38	20	51	25	63	30	76
Sauger[c]	8	20	12	30	15	38	20	51	25	63
Yellow perch[a]	5	13	8	20	10	25	12	30	15	38
Sunfishes										
Largemouth bass[b]	8	20	12	30	15	38	20	51	25	63
Smallmouth bass[a]	7	18	11	28	14	35	17	43	20	51
Spotted bass	7	18	11	28	14	35	17	43	20	51
White crappie[a]	5	13	8	20	10	25	12	30	15	38
Black crappie[a]	5	13	8	20	10	25	12	30	15	38
Rock bass	4	10	7	18	9	23	11	28	13	33
Redear sunfish[a]	4	10	7	18	9	23	11	28	13	33
Bluegill[b]	3	8	6	15	8	20	10	25	12	30
Green sunfish	3	8	6	15	8	20	10	25	12	30
Warmouth	3	8	6	15	8	20	10	25	12	30
Pumpkinseed[c]	3	8	6	15	8	20	10	25	12	30
Temperate basses										
Striped bass (landlocked)	12	30	20	51	30	76	35	89	45	114
White bass × Striped bass	8	20	12	30	15	38	20	51	25	63
White bass[a]	6	15	9	23	12	30	15	38	18	46
White perch[a]	5	13	8	20	10	25	12	30	15	38
Bullhead catfishes										
Blue catfish	12	30	20	51	30	76	35	89	45	114
Channel catfish[a]	11	28	16	41	24	61	28	71	36	91
Flathead catfish[a]	11	28	16	41	24	61	28	71	36	91
Black bullhead[a]	6	15	9	23	12	30	15	38	18	46
Carp										
Common carp[a]	11	28	16	41	21	53	26	66	33	84
Pikes										
Muskellunge[c]	20	51	30	76	38	97	42	107	50	127
Northern pike[a]	14	35	21	53	28	71	34	86	44	112
Chain pickerel[c]	10	25	15	38	20	51	25	63	30	76

[a] Minimum lengths for stock and quality were proposed previously by Anderson (1980).
[b] Minimum lengths for the categories of stock, quality, and a size equivalent to what is now defined as "preferred" were previously proposed by Anderson (1980).
[c] Proposed by Anderson and Gutreuter (1984).

lengths for size categories. For example, largemouth bass minimum stock (S), quality (Q), preferred (P), memorable (M), and trophy (T) lengths are 8.0, 12.0, 15.0, 20.0, and 25.0 in, respectively. A largemouth bass population consisting of 50 8.0–12.0-in fish; 35 12.0–15.0-in fish; 12 15.0–20.0-in fish; 2 20.0–25.0-in fish; and 1 25.0-in fish would thus, according to the "traditional approach," have a PSD of 50; RSD-P and RSD-15 of 15; RSD-M and RSD-20 of 3; and RSD-T and RSD-25 of 1. According to the "incremental approach," RSD S-Q and RSD 8–12 = 50; RSD Q-P and RSD 12–15 = 35; RSD P-M and RSD 15–20 = 12; RSD M-T and RSD 20–25 = 2; and RSD-T and RSD-25 = 1.

For the traditional approach, RSD values for individuals equal to or longer than minimum lengths for the size categories are expressed as nonadditive portions of PSD. For the incremental approach, RSD S-Q is the reciprocal of PSD and PSD = RSD Q-P + RSD P-M + RSD M-T + RSD-T.

The traditional approach is less definitive than the incremental approach and incorporates rep-

Table 3. Variable recommended percentages of largemouth bass in a body of water to achieve three management objectives, as computed by two methods.

Objective	Traditional approach				Incremental approach				
	PSD	RSD-P	RSD-M	RSD-T	RSD S-Q	RSD Q-P	RSD P-M	RSD M-T	RSD-T
High density (to produce preferred-length panfish)	20–40	0–10			60–80	20–40	0–10		
Moderate density (one of several species of equal importance in a balanced community)	40–70	10–40	0–10		30–60	30–60	10–30	0–10	
Low density (the single most important species, with large individuals desired)	50–80	30–60	10–25	0–5	20–50	20–50	20–40	10–20	0–5

etition not found in the incremental approach. Use of the incremental approach is appropriate when fish population changes, including year-class strength, are assessed for a single water body over a time period or when populations from different water bodies are assessed, given a similar treatment or management practice. The traditional approach is recommended when the population structure is to be correlated with another variable or variables using data from several water bodies. The influence of year-class strength could detract from interpretation of such relationships. Repetition built into the traditional approach would be desirable to "smooth out" length-frequencies reflecting weak or missing age groups. In general, the incremental approach is appropriate to measure data point "scatter" due to the treatment in question, but the traditional approach is recommended if scatter is due to other independent factors influencing population structure.

When using the traditional approach, one should be aware of potential problems with insensitivity similar to that described for PSD. Populations containing differing percentages of fish of memorable and trophy length could have similar RSD-P values. Ideally, an RSD-P should be given without RSD-M and RSD-T only if no memorable-length or longer fish are present or their presence is of no interpretive consequence. The same holds true for the use of RSD-M without RSD-T when "trophies" are considered.

Given either approach, abbreviation letters for the size categories are recommended as RSD qualifiers instead of numerals because confusion can result when the reader is unable to determine whether RSD is stated in English or metric units. It is often useful, also, to be able to compare RSD among species. This is easily done using size-category abbreviation letters; it may, for example, be hard to visualize or remember that a largemouth bass RSD-20 is comparable to an RSD-10 for bluegill and an RSD-34 for northern pike (*Esox lucius*).

Largemouth Bass RSD Objectives

Anderson (1980) suggested that a balanced largemouth bass population should have a PSD of 40–70 (RSD S-Q = 30–60) and an RSD-15 (RSD-P) of from 10 to 25. Largemouth bass can, however, play several roles in the fish community and length-frequency objectives could vary according to how managers choose to use the fish. Different RSD objectives may be set according to whether or not largemouth bass are used primarily as predators to produce preferred-length panfish, as one of several sport fish of equal importance, or as the single most important species with large individuals desired (Table 3).

High densities of largemouth bass less than quality length often exist in Kansas ponds as a result of high recruitment rates and low angling harvest caused by low use and/or nonacceptance of this size of fish. Predation by such largemouth bass populations can effectively produce preferred-length and longer bluegills, crappies, and bullheads (*Ictalurus* spp.). The stated largemouth bass RSD objectives are viable if catching large panfish is more important than the size of the largemouth bass that are caught. Such a fish community likely could be duplicated with high use and less discriminating anglers by implementing a 15.0-in minimum length limit for largemouth bass. Managed in this fashion, these bass would serve primarily as predators, while providing catch-and-release fishing for small bass but little harvest. Few largemouth bass would exceed 15.0 in because of slow growth and natural mortality.

Largemouth bass in Kansas public waters usually exist in low or moderate densities and are only one of several species considered to be important by managers in establishing or maintaining satisfactory structure and dynamics in the fish community. Fifteen-inch largemouth bass are desired, but nothing is deliberately done to produce memorable-length fish. Either 15.0-in minimum length limits or 12.0–15.0-in slot length limits are applied frequently in Kansas in such circumstances depending upon recruitment rates.

The third set of RSD objectives has not been applied in Kansas but might be achieved if circumstances warrant compromising the numbers harvested for size. To produce largemouth bass populations that consist of up to 25% memorable-length and longer individuals, minimum length limits near 20.0 in might be necessary if recruitment is low. If recruitment is moderate or high, a slot length limit with the upper end near 20.0 in might be appropriate.

RSD Observed for Other Species

To date, Kansas has applied RSD primarily to largemouth bass, bluegill, and crappie. Few Kansas state fishing lakes produce preferred-length bluegills. The bluegill RSD-P is usually less than 10, and most commonly zero. With a few exceptions, the state fishing lakes contain too few largemouth bass to reduce densities of small bluegills such that survivors attain preferred length. Less-than-desirable bluegill growth also probably exists because of competition with a diverse complement of other species, particularly small channel catfish (*Ictalurus punctatus*) that are supplementally stocked nearly every year. Also, many of these lakes contain gizzard shad (*Dorosoma cepedianum*), are turbid, and have little littoral habitat.

White crappie (*Pomoxis annularis*) RSD values vary more than largemouth bass RSD's in state fishing lakes, but commonly reflect high turnover rates with few crappies older than IV and few memorable-length individuals (T. D. Mosher, Kansas Fish and Game Commission, personal communication). Those state fishing lakes that do produce memorable-length individuals typically contain gizzard shad.

Reservoir fish populations in Kansas are just now starting to be assessed with RSD. Because several reservoir species are sampled with gill nets, the effect of mesh-size efficiency and selectivity needs to be considered to make RSD calculations meaningful (Willis et al. 1983).

Catch Rate

The length-categorization system can be used with catch-per-unit-effort data for stock assessment when catch rates reflect population densities. Either "traditional" or "incremental" approaches can be used, with the appropriate choice made according to conditions described previously for the calculation of RSD. Without an understanding of the relationship between density and length frequency, PSD or RSD used alone can, in fact, be misleading. To date, it has often been assumed that largemouth bass populations with a PSD of less than 40 contain high densities, while low population densities generally have higher percentages of quality-length fish. A plot of PSD as a function of catch rate should thus be inverse for water bodies of similar productivity. Usually this may be the case (especially in ponds) but exceptions do occur, particularly in the larger Kansas impoundments.

Based on information from five Kansas lakes in a black bass length-limit study, it appears that PSD and density, as reflected by electrofishing catch rate, may be inversely related only when catch rates exceed approximately 30 stock-length largemouth bass per hour of electrofishing (Fig. 2). Although there is considerable scatter, likely due to productivity differences among impoundments and variation in sampling efficiency, there appears to be a positive relationship between PSD and density for catch rates below 30 stock-length largemouth bass per hour of electrofishing. Populations producing the lowest catch rates thus also exhibit a population structure as poor as those populations with high catch rates. Therefore, it is important to recognize whether or not a low PSD for largemouth bass is a result of intraspecific competition (the right-hand side of the relationship), or other factors, such as poor habitat, food supply, overharvest, or a combination of factors (the left-hand side of the relationship).

Lakes in Kansas with low densities of small,

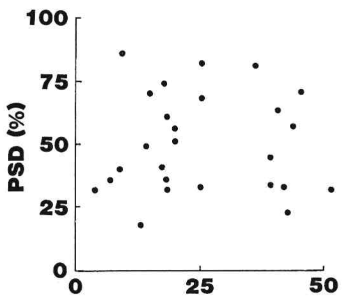

Figure 2. Relationship between largemouth bass Proportional Stock Density (PSD) and catch rate of "stock-length" (≥8.0 in) largemouth bass using spring electrofishing samples collected from five state fishing lakes involved in a Kansas black bass length-limit study, 1976-1981.

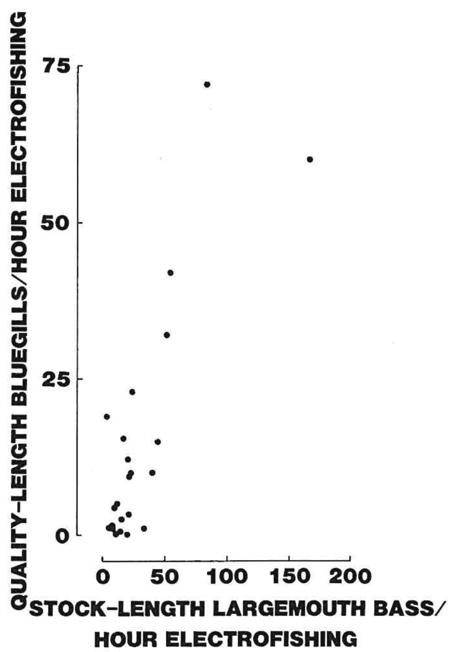

Figure 3. Relationship between electrofishing catch rate of "quality-length" (≥6.0 in) bluegills and "stock-length" (≥8.0 in) largemouth bass from 23 Kansas state fishing lakes sampled in spring 1981.

slow-growing or short-lived largemouth bass also frequently contain low densities of bluegills, with no fish over 8.0 in long and few exceeding 6.0 in. Samples collected from these five study lakes plus 18 additional lakes in 1981 revealed that impoundments that produce low electrofishing catch rates of stock-length largemouth bass also produce few quality-length bluegills per hour of electrofishing (Fig. 3). Catch rates of S-Q bluegill were as low in lakes represented by points near the zero intercept as they were in lakes with high densities of largemouth bass. In lakes with high densities of largemouth bass, densities of small bluegills were likely to be low because of bass predation. However, these bluegill populations contain more quality-length and even preferred-length bluegills than "problem" lakes near the zero intercept.

Without knowing the relationship between catch rate and RSD, use of relative density data alone can cause interpretation problems that affect management decisions. Brown State Fishing Lake was one of several Kansas impoundments thought to be able to benefit from a largemouth bass length limit. The impoundment had sustained a largemouth bass harvest of 20 lb/acre in 1974, with most fish taken being 12.0–15.0 in long. According to the 1976 electrofishing sample, the PSD was 40. It appeared that a 12.0–15.0-in slot length limit might be appropriate because stockpiling under a minimum length limit seemed possible based on the already high percentage of 8.0–12.0-in fish (RSD S-Q = 60). A slot length limit was imposed in 1977. What we did not realize was that the density as reflected by electrofishing catch rate was low in 1976 (Fig. 4). A potential for overharvest of the 8.0–12.0-in largemouth bass existed when, in fact, there was no surplus. We have, however, been able to bolster stocks in Brown State Fishing Lake and other state lakes in Kansas using slot length limits because Kansas anglers generally do not harvest largemouth bass less than 12.0 in long, and our slot length limits thus function much as 15.0-in minimum length limits. Unfortunately, this behavior also applies to those instances where densities of largemouth bass less than quality length are high and in need of reduction to improve growth to preferred length.

Angler Data

The length-categorization system lends itself well to assessment of angler catch data, as mon-

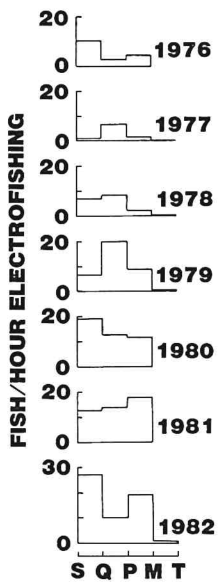

Figure 4. Number of largemouth bass in each size-group category captured per hour of electrofishing from Brown State Fishing Lake, Kansas, 1976-1982. S-Q = 8.0-12.0 in; Q-P = 12.0-15.0 in; P-M = 15.0-20.0 in; M-T = 20.0-25.0 in; T ≥ 25.0 in.

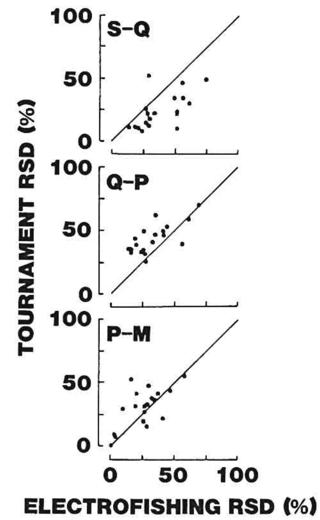

Figure 5. Largemouth bass Relative Stock Density (RSD) relationships between fishing tournaments and spring electrofishing from eight Kansas reservoirs, 1977-1982. S-Q = 8.0-12.0 in; Q-P = 12.0-15.0 in; P-M = 15.0-20.0 in. Diagonal lines locate the 1:1 relationship between variables.

itored through creel surveys and fishing tournaments. Maintenance of or increase in the angler catch of preferred-length sport fish is, after all, the principal standard by which most management strategies ultimately should be judged.

In the form of RSD or catch rates in size categories, angler data also can be related readily to other sampling information. Catch composition comparisons between electrofishing and fishing tournaments indicated that tournament data might be used to assess largemouth bass stocks in Kansas reservoirs after adjustments for biases are made. Based on data collected from eight reservoirs in 1977–1982, it appears that tournament anglers generally select against 8.0–12.0-in largemouth bass, have a slight preference for 12.0–15.0-in fish, and catch 15.0–20.0-in individuals approximately in proportion to their presence—if it can be assumed that spring electrofishing results reflect the population structure of stock-length largemouth bass (Fig. 5). No relationship between tournament and electrofishing catch composition for memorable-length (20.0-in and longer) largemouth bass could be seen because neither anglers nor electrofishing samples collect enough fish of this size to make appreciable contributions to population structure when compared to the other three size-group categories.

Tournament anglers probably select against largemouth bass of stock to quality length because they have no value for tournament scoring and are intentionally avoided by choice of lure size. One might expect tournament anglers to overestimate percentages of preferred to memorable length largemouth bass rather than quality to preferred length individuals, especially because larger fish are worth more in tournament scoring. Fish of quality to preferred length are, however, probably more abundant, less wary, and have a sufficient gape size to take most lures presented by anglers.

Application of the Length-Categorization System to Additional Species

The system must be applied with discretion to obtain meaningful stock assessment information. It should be applied only to species regularly caught by anglers. Records have been maintained long enough for most of the species discussed previously that a change in a world record would likely have little impact on appropriate length ranges from or near which minimum lengths for size categories are chosen. Therefore, updating minimum lengths for size categories as records change is not recommended.

The nature of record keeping does, however, cause complications in applying the length-categorization system to some species, especially cold-water fish. Because world records are recognized for most salmonids irrespective of location of catch, many record fish from this family are ocean-run individuals. Minimum lengths for size categories of these fish may be too high to be applied to landlocked fish.

Many species (including landlocked salmonids) not recognized by the International Game Fish Association have North American records listed by the National Fresh Water Fishing Hall of Fame. The length-categorization system might be applied to several of these fish but caution should be exercised because some of the fish recognized there are not commonly caught by anglers, and record lengths may be too short to serve as standards from which minimum lengths for size categories are calculated. A similar situation exists for the all-tackle, world-record muskellunge (*Esox masquinongy*). Muskellunge over 30 lb heavier than the record fish have been verified. If minimum lengths for size categories would have been selected from appropriate percentage lengths of the all-tackle, world-record fish, the minimum stock length would have been below a length corresponding to sexual maturity. Minimum lengths for size categories were, therefore, proposed by Anderson and Gutreuter (1984) from outside the appropriate percentage length ranges of the all-tackle, world record.

Discretion also should be exercised in selecting minimum lengths for size categories. Record fish, being exceptional, are not always characteristic of their species regarding body form. In some cases, a longer, lighter individual might best be used as the standard to calculate appropriate length ranges from or near which minimum lengths for size categories can be selected. For example, the world-record rock bass (*Ambloplites rupestris*) weighed 3.0 lb and was only 13.5 in long. The fish was such an anomaly that a 2.75-lb, 17.0-in Missouri specimen was used as the standard instead.

Problems in applying the system also can sometimes occur due to peculiarities in the life histories of particular species. The white bass (*Morone chrysops*), for example, is a relatively short-lived, fast-growing species that seldom stunts. Population density seems to have little effect on length distribution and fish nearly as long as the world record are commonly caught by anglers. Minimum lengths for size categories, therefore, were selected from beyond appropriate length ranges, as calculated by percentage lengths of world-record length. If the world record had been used as the standard, minimum stock, quality, preferred, memorable, and trophy lengths would have been only 4.0, 7.0, 9.0, 11.0, and 13.0 in, respectively, instead of the proposed lengths of 6.0, 9.0, 12.0, 15.0, and 18.0 in.

It is hoped that states and provinces will not apply the length-categorization system using their state or province record as standards. This would stifle communication among states and provinces and could make fish populations look better than they actually are by incorporating limiting factors into the standard.

Anticipated Future Use of the Length-Categorization System

The usefulness of any analytical approach has its limits and the use of PSD, RSD, and catch rates for size categories are no different. Two size categories, stock and quality, may sometimes be too few to accurately assess fish stocks but how often are five size categories needed? The answer depends primarily on the species in question and how it is to be managed. Game fish that are managed to produce large individuals probably need to be assessed with at least three, frequently four, and sometimes five categories. Production of panfish of memorable or trophy length is seldom a management objective. Percentages of stock that these sizes comprise, while interesting, are usually of secondary concern to the percentage of preferred-length panfish.

Anderson (1980) proposed minimum stock and quality lengths for gizzard shad. Like panfish, stocks of prey need be assessed with fewer size categories than game fish. In fact, most prey stocks probably only need to be assessed on the basis of PSD and a young-to-adult ratio (YAR). Others, such as some Cyprinidae with high turnover rates and short life spans, do not lend themselves to size categories.

A sample consisting of all representative lengths of stock-length fish present in the population is not always feasible or even possible, especially for species that exist in low densities such as striped bass (*Morone saxatilis*) and muskellunge. The length-categorization system need not, however, be applied in its entirety to be useful in assessing fish stocks. Changes in stocks can, for example, be reflected in changes in numbers of memorable-length fish caught per hour of effort.

I hope that the length-categorization system will be used by professionals to describe length-frequency distributions. Even if we could remember how many or what percent of fish sampled were in each inch or centimeter length group, few people would listen to us recite such figures and no one could interpret results. Even visual presentations of length-frequency distributions are sometimes hard for the viewer to interpret. The indices of PSD and RSD can thus facilitate communication.

In using the system to describe length-frequency distributions, professionals hopefully will go one step further, determine the physical, chemical, and biotic limitations and attributes of their areas for the production of given species, and incorporate this information in their percentages and catch rates for the five size categories. In so doing, I believe we will see cases where some species might best be managed at the expense of others which either do not thrive in that environment or are not highly sought by anglers. Whatever the species or area, a range of management objectives will require variability in fish population and community structure and dynamics. There are instances when optimum sustained yield is best achieved by establishing community imbalance instead of balance.

Ideally, an effort will be made to correlate RSD and/or catch rates for size categories with rate functions, as reflected through traditional indices. If this occurs, the collection of more labor-intensive data such as scale samples and population number and biomass estimates may eventually be minimized without sacrificing interpretive value. With increasingly tighter budgets, data that are quick, easy, and inexpensive to collect and analyze will certainly be the trend of the future, and use of the length-categorization system to assess fish stocks will be most appropriate.

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