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# Application of a Length-Categorization System for Pallid Sturgeon (*Scaphirhynchus albus*)

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## ABSTRACT

Length-frequency data can be quantified using proportional stock density and relative stock density indices. However, standardized length categories must be available for each fish species. Thus, we developed standard length categories for calculation of stock density indices for pallid sturgeon (*Scaphirhynchus albus*). Based on the longest fish (1,638 mm fork length) that we could find in sampling records or from angler catches, we propose the following length categories: stock = 33 cm (13 in); quality = 63 cm (25 in); preferred = 84 cm (33 in); memorable = 104 cm (41 in); and trophy = 127 cm (50 in). Using these length categories, we then calculated the size structure indices for pallid sturgeon populations in which recruitment had been supplemented with hatchery-produced fish.

## INTRODUCTION

The pallid sturgeon (*Scaphirhynchus albus)* was formally listed as an endangered species in 1990 (U.S. Fish and Wildlife Service 1990), which prompted various recovery and management actions by biologists, researchers, and resource managers at federal, state, and university levels (U.S. Fish and Wildlife Service 1993). These actions included population augmentation, biological monitoring, and detailed life history research. To date, it has been difficult to measure the success of some programs due to a lack of biological data and a framework for population analysis.

Fish population size structure (i.e., length-frequency data) is commonly used to qualitatively assess fish populations (Anderson and Neumann 1996). However, length frequencies are difficult to quantitatively compare among populations or within a population over time. Thus, size structure indices were developed to quantify length-frequency data. Anderson (1976) first proposed the use of proportional stock density (PSD), which uses a two-cell model for indexing length-frequency data (PSD = number of fish ≥ quality length/number of fish ≥ stock length X 100). Wege and Anderson (1978) expanded the concept to a three-cell model for relative stock density (RSD) (RSD = number of fish ≥ specified length/number of fish ≥ stock length X 100). Gabelhouse (1984) recommended the use of a five-cell categorization for length-frequency data, and that method continues to be used for development of new standards (Anderson and Neumann

1996). Thus, our objectives were to develop standard length categories for pallid sturgeon and then use those standards to assess length-frequency data for populations from the Missouri River.

## DETERMINATION OF STANDARD LENGTH CATEGORIES

Gabelhouse (1984) recommended that standard length categories fall within the range of 20-26% (stock length), 36-41% (quality length), 45-55% (preferred length), 59-64% (memorable length), and 74-80% (trophy length) of the world record length for that species. These percentages were based on a fish quality index developed by Weithman (1978). To find the longest pallid sturgeon captured, we searched the pallid sturgeon range-wide database maintained by the U.S. Fish and Wildlife Service at the Missouri River Fish and Wildlife Management Assistance Office (FWMAO) in Bismarck, North Dakota, as well as the International Game Fish Association and the National Fishing Hall of Fame databases.

The longest fish of 1,633 pallid sturgeon in the Missouri River FWMAO database had a fork length (FL; tip of snout to fork of tail) of 1,638 mm. This fish was captured downstream of the Yellowstone River and Missouri River confluence in North Dakota during 1994. This is the longest pallid sturgeon of which we are aware, including sport fishing records, and this length was thus used to determine standard length categories (Table 1). By precedent, both metric and English categories are standardized (Gabelhouse 1984). We propose the following length categories: stock = 33 cm (13 in); quality = 63 cm (25 in); preferred = 84 cm (33 in); memorable = 104 cm (41 in); and trophy = 127 cm (50 in). We recommend that pallid sturgeon be measured to fork length for standardization because this measure is less affected by fin damage than is total length.

Table 1. Recommended standard fork length categories for pallid sturgeon based on the Gabelhouse (1984) five-cell model and a maximum fork length of 1,638 mm.

| | | | Proposed standards | |
|---|---|---|---|---|
| Length category | Minimum (mm) | Maximum (mm) | Metric (cm) | English (in) |
| Stock | 328 | 426 | 33 | 13 |
| Quality | 590 | 672 | 63 | 25 |
| Preferred | 737 | 901 | 84 | 33 |
| Memorable | 966 | 1,048 | 104 | 41 |
| Trophy | 1,212 | 1,310 | 127 | 50 |

## APPLICATION OF THE LENGTH-CATEGORIZATION SYSTEM

To demonstrate the utility of stock density indices for assessment of pallid sturgeon size structure, we assessed sampling data from two Missouri River sites (Fig. 1). Both are pallid sturgeon recovery priority areas (RPA) (U.S. Fish and Wildlife Service 1993). The Missouri River between Ft. Peck and Lake Sakakawea as well as the lower Yellowstone River (North Dakota and Montana)

constitute RPA 2. The Missouri River between Ft. Randall Dam, South Dakota, and Lewis and Clark Reservoir is RPA 3.

Historic sampling data from 1988 to 1997 in RPA 2 are summarized in Figure 1. These fish were collected prior to successful conservation stocking efforts. Some fish were measured for length, some for weight, and some for both measures. When only weight data were collected, we predicted length to the nearest centimeter from a weight-length regression ($r = 0.88$, $N = 330$, $P<0.0001$). We lumped all years to provide sufficient sample size for size-structure analysis. The PSD, relative stock density of preferred-length fish (RSD-P), and relative

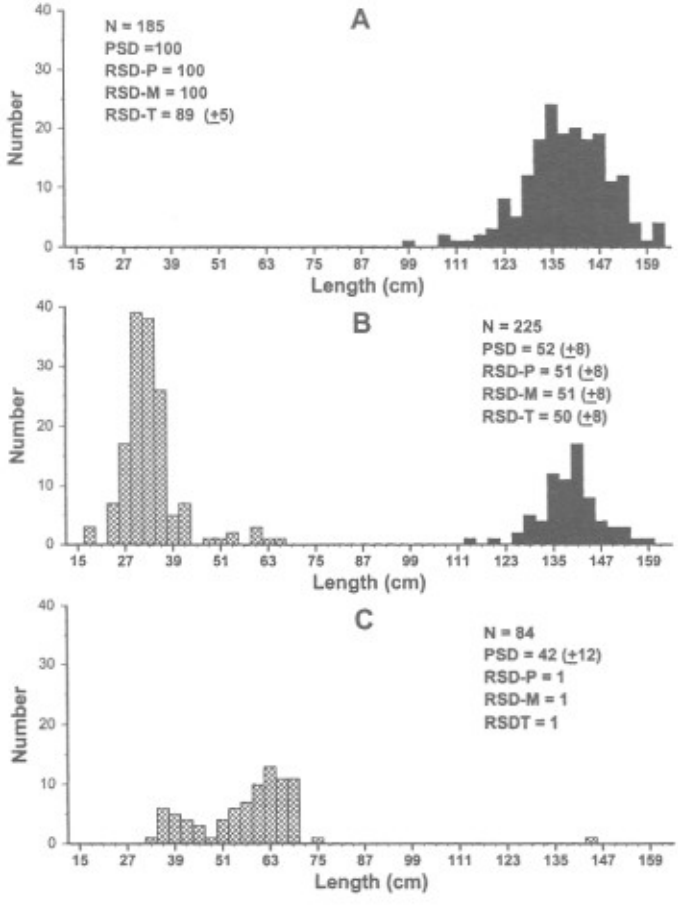


Figure 1. Length-frequency histograms and stock density indices for three pallid sturgeon population samples (95% confidence intervals [Gustafson 1988] in parentheses, when appropriate). A: pallid sturgeon collected near the confluence of the Missouri River and Yellowstone River, Montana and North Dakota, from 1988 to 1997 prior to the initiation of conservation stocking. B: pallid sturgeon collected near the confluence of the Missouri River and Yellowstone River during 2003 and 2004. C: pallid sturgeon collected from the Missouri River below Ft. Randall Dam in South Dakota during 2003 and 2004. Solid bars indicate wild fish and hatched bars represent stocked fish (i.e., tagged). PSD = proportional stock density; RSD = relative stock density (see text for definitions).

stock density of memorable-length fish (RSD-M) were all 100, while the relative stock density of trophy-length fish (RSD-T) was 89. Such stock density index values are always indicative of low or nonexistent recruitment of a fish species, and certainly this explanation was correct for this federally endangered species.

Pallid sturgeon stockings (juvenile fish) occurred in 1998, 1999, and 2001-2004 in RPA 2 (Krentz et al. 2004). Thus, we also assessed pallid sturgeon length frequency for samples collected from this river reach in 2003 and 2004 (Fig. 1). Pallid sturgeon PSD and RSD values declined to more moderate values near 50. The lack of fish between the ones provided by the stocking program and the larger, wild fish resulted in PSD, RSD-P, RSD-M, and RSD-T values being quite similar. Over time, we expect the stocked fish to grow into these intermediate sizes, and thus expect the RSD-M and RSD-T values to further decline. Regardless of whether recruitment is a result of natural (wild) fish or stocked fish, stock density indices declined to moderate levels because of the young fish being added to the population.

Pallid sturgeon either were extremely rare or may have been extirpated from RPA 3 along the Missouri River in South Dakota (an inter-reservoir reach). Pallid sturgeon stockings occurred in 2000 and 2002-2004. Thus, the 2003-2004 pallid sturgeon sample from this river reach included only stocked fish (Fig. 1). A total of 10 fish was captured in 2003 and 2004 without passive integrated transponder or visible elastomer tags, but all were the size of stocked fish and thus were considered hatchery fish. However, we cannot exclude the possibility of natural recruitment. The sample PSD was 42, while RSD-P, RSD-M, and RSD-T were 1. Such stock density index values would be expected in a newly introduced population that is dominated by small fish, in this case by fish less than preferred length (84 cm; Table 1). As these fish continue to grow, and if stocked fish continue to recruit to the population, then we expect RSD-P, RSD-M, and RSD-T values to eventually increase once fish grow into those length categories. The single large specimen (143 cm) in Figure 1 was one of nine brood fish that were released into this river reach. They had been collected at RPA 2, but because of concerns at that time over potential iridovirus contamination at the hatchery, they were released into RPA 3 with the other stocked pallid sturgeon.

## DISCUSSION

Stock density indices were initially developed to assess sport-fish populations (Willis et al. 1993). However, more recent developments have allowed assessment of nongame and riverine fishes (e.g., Brown and Murphy 1993, Bister et al. 2000, Quist et al. 2002).

In actuality, any fish population that exhibits an extended length and age range could be assessed using stock density indices. Pallid sturgeon exhibit these population characteristics. Keenlyne and Jenkins (1993) found that male pallid sturgeon sexually mature between ages 5 and 7. Female pallid sturgeon began egg development at ages 9-12 and spawned for the first time near age 15. These generalizations were based on 14 fish collected from the Mississippi River drainage in Louisiana, Missouri, North Dakota, Nebraska, and South Dakota.

Fish populations that exhibit moderate rates of recruitment, growth, and mortality will exhibit moderate values for PSD (Willis et al. 1993). Low or high PSD values are indicative of potential concerns. For example, consistently high (e.g., $\geq$90) PSD values typically indicate low recruitment rates, which obviously would be of concern for rare or endangered fishes. These interpretations certainly held true for the pallid sturgeon samples that we provided in Figure 1.

The endangered status of the pallid sturgeon requires aggressive yet sound scientific management practices to ensure recovery (U.S. Fish and Wildlife Service 1993). The use of stock density indices provides an accepted method for population size structure analysis along with a comprehendible means of communication. To the best of our knowledge, this is the first endangered fish for which standard length categories have been proposed. Our hope is that standard length categories will provide one more tool to improve data analysis and improve communication among fisheries professionals.

## ACKNOWLEDGEMENTS

Biologists from the Montana Department of Fish, Wildlife and Parks; the U.S. Fish and Wildlife Service; and the North Dakota Game and Fish Department collected and contributed pallid sturgeon data summarized in Figure 1. Their long-term efforts are gratefully acknowledged. We also thank Ryan Wilson of the U.S. Fish and Wildlife Service and others who helped organize and update the range-wide pallid sturgeon data that were utilized for this project.

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