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Comparison of Otolith and Scale Age Characteristics for Black Crappies Collected from South Dakota Waters

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Abstract.—Scales and otoliths (sagittae) were collected from black crappies *Pomoxis nigromaculatus* sampled during the spring of 1991 in Red Plum Reservoir and Roy Lake, South Dakota. Red Plum Reservoir contained a slow-growing black crappie population, whereas Roy Lake had a fast-growing population. Annuli in scales and otoliths were identified independently by three readers. Within-structure (i.e., among-reader) and between-structure agreements in both population samples were 94% or greater for both scales and otoliths from fish of all ages. Our results indicated that for black crappies from South Dakota waters, precision of ages determined from scales and otoliths was similar.

Several researchers have reported that scales can provide unreliable estimates of fish age (Erickson 1983; Schramm and Doerzbacher 1985; Boxrucker 1986; Hammers and Miranda 1991). Because annuli are formed during cold months when growth is slow, the lack of a distinct cold season in southern waters likely results in scale annuli that are indistinguishable for some fish populations in southern North America (Huish 1954; Schramm and Doerzbacher 1985).

Several researchers have used otoliths to successfully age fish from warmer, tropical and subtropical waters (Moe 1969; McErlean 1973; Warburton 1978; Fagade 1980). Furthermore, otoliths have provided more precise estimates of age than scales for black crappies *Pomoxis nigromaculatus* and white crappies *P. annularis* in the southern United States (Schramm and Doerzbacher 1985; Boxrucker 1986; Crumpton et al. 1988; Hammers and Miranda 1991). Research to assess the precision of ages determined from scales and otoliths of crappies has not been conducted for inland northern waters of the United States. The objectives of this study were twofold. First, we wanted to determine if scales were as precise a measure as otoliths for ascertaining fish age. Second, we wanted to assess precision differences between scales and otoliths used to determine ages in a fast- and in a slow-growing black crappie population.

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Black crappies were collected from two South Dakota waters. Red Plum Reservoir is a 6-hectare impoundment with a mean depth of 5 m. The impoundment is located in central South Dakota and contained a slow-growing black crappie population (Figure 1). Roy Lake is a 685-hectare natural lake in northeastern South Dakota. It has a mean depth of 6 m, and contained a fast-growing black crappie population (Figure 1).

Black crappies were collected in late May and early June of 1991 with modified fyke (trap) nets. Total length of each fish was measured to the nearest millimeter. Scales and otoliths were collected from up to 10 fish in each centimeter length-group present at each study site; 115 fish were collected from Red Plum Reservoir and 33 were collected from Roy Lake.

Otolith aging was done with whole otoliths. Schramm and Doerzbacher (1985) suggested that the use of unsectioned otoliths satisfied the necessary criteria for determining age of black crappies from annuli, and Maceina and Betsill (1987) reported similar findings for white crappies. Otoliths were placed on a black background, submersed in immersion oil to clarify the opaque rings, and viewed by using a binocular microscope equipped with an ocular micrometer. The right and left otoliths were used interchangeably for aging, because Boxrucker (1986) found no difference between the two in white crappies. Otoliths were aged by counting the opaque bands (annuli) from the center (kernel) to the anterior edge.

Scales were collected from the tip of the pectoral fin, below the lateral line. Scales were pressed onto acetate slides and examined with a microfiche reader. Criteria used to identify scale annuli were close spacing of the circuli and "cutting over" of the annulus across previously deposited circuli (Jearld 1983).

All scales and otoliths were examined independently by three readers; all had experience aging scales but none had experience aging otoliths. We expected higher agreement for otoliths than scales because previous studies have found aging with

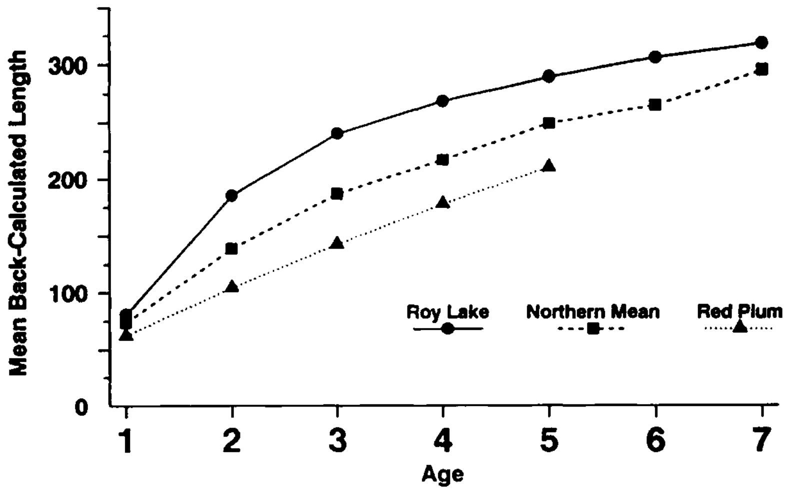

FIGURE 1.—Comparison of mean back-calculated total lengths (mm) at age for black crappies from northern U.S. waters (Carlander 1977), and for black crappies from Roy Lake (N = 33) and Red Plum Reservoir (N = 115), South Dakota (Guy and Willis 1993). Back-calculations were done with scales.

otoliths to be more precise than aging with scales. However, readers' estimates from scales disagreed only four times and their estimates from otoliths disagreed nine times for the Red Plum Reservoir sample (N = 115), the slower-growing black crappie population. For the fast-growing black crappies from Roy Lake (N = 33), readers' estimates from scales disagreed three times and their estimates from otoliths disagreed twice. In all cases, one reader disagreed with the other two; never did all three readers assign three different ages.

Precision of age determination was similar for otoliths and scales in the Roy Lake sample. In the Red Plum sample, precision was greater for scales than for otoliths. Schramm and Doerzbacher (1985), Boxrucker (1986), and Hammers and Miranda (1991) found that agreement between readers was much higher for otolith aging than for scale aging. The greater precision for scales from the Red Plum sample might have been due to the greater proficiency of the readers in aging scales than in aging otoliths when annuli were difficult to distinguish for this slow-growing black crappie population.

We had better than 96% within-structure agreement for both scales and otoliths (Table 1). In contrast, Hammers and Miranda (1991) found a 91% agreement in ages assigned to white crappie otoliths and a 71% agreement in ages assigned to white crappie scales. Boxrucker (1986) did not report within-structure agreement among readers, but did report ages assigned by three readers for otoliths and scales from 20 randomly selected white crappies. All three readers agreed on assigned age for 16 of 20 otoliths but for none of 20 scales.

We found between-structure agreement to be 94% or greater for both waters and for all ages (Table 1). Schramm and Doerzbacher (1985) found between-structure agreement to be 65% for black crappies in Florida, and Hammers and Miranda (1991) documented 74% between-structure agree-

TABLE 1.—Within-structure (i.e., among-reader) and between-structure percent agreement in ages assigned by three readers to scale and otolith samples of black crappies from South Dakota waters.

Assigned age	Agreement within structures: Scales N	%	Otoliths N	%	Agreement between structures N	%
			Red Plum Reservoir			
1	8	100	8	100	8	100
≤2	28	100	28	100	28	100
≤3	38	98	40	100	38	100
≤4	75	99	75	99	75	96
≤5	115	99	113	97	115	95
≤6	115	99	115	97	115	95
			Roy Lake			
1	4	100	4	100	4	100
≤2	4	100	4	100	4	100
≤3	5	100	5	100	5	100
≤4	16	98	15	100	16	94
≤5	32	98	32	99	32	97
≤6	32	98	32	99	32	97
≤7	33	97	33	98	33	97

ment for white crappies in Mississippi. Although our between-structure agreement was considerably higher than that of Schramm and Doerzbacher (1985) and that of Hammers and Miranda (1991), we all concurred that agreement was highest for younger fish (Table 1).

There may be a latitudinal gradient influencing the precision of ages determined from crappie scales. Our data indicated that precision of scales and otoliths for aging black crappies from South Dakota waters was similar and high, probably because distinct winters allow distinguishable annuli to be formed on scales as well as otoliths. In contrast, otoliths were superior to scales in Florida (Schramm and Doerzbacher 1985), Mississippi (Hammers and Miranda 1991), and Oklahoma (Boxrucker 1986) waters.

We had some indication, as did Schramm and Doerzbacher (1985) and Hammers and Miranda (1991), that aging was easier and less time-consuming with otoliths than with scales because of more distinct annuli. There was little difference in collection and preparation time between scales and otoliths. Otoliths took longer to remove, but scales had to be pressed. However, the need to sacrifice a fish to obtain an otolith is a shortcoming, although the effects on a population can be minimized by subsampling length-groups (Boxrucker 1986).

Emphasis on proper animal care in the fisheries profession would justify the use of the scale method in areas where the two methods provide similar results, or even in areas where scales are slightly less precise. Because of the similarity in precision between the two aging methods and the fact that fish can be released after obtaining a scale sample, we recommend the use of scales for aging black crappies from South Dakota waters.

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