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AGE AND GROWTH OF BLUEHEAD SUCKERS AND FLANNELMOUTH SUCKERS IN HEADWATER TRIBUTARIES, WYOMING

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ABSTRACT.—Bluehead sucker (*Catostomus discobolus*) and flannelmouth sucker (*Catostomus latipinnis*) populations are declining throughout these species' native ranges in the Upper Colorado River Basin. In order to conserve these populations, an understanding of population dynamics is needed. Using age estimates from pectoral fin rays, we describe age and growth of these 2 species in 3 Wyoming stream systems: Muddy Creek, the Little Sandy River, and the Big Sandy River. Within all 3 stream systems, flannelmouth suckers were longer-lived than bluehead suckers, with maximum estimated ages of 16 years in Muddy Creek, 18 years in Little Sandy Creek, and 26 years in the Big Sandy River. Bluehead suckers had maximum estimated ages of 8 years in Muddy Creek, 10 years in Little Sandy Creek, and 18 years in the Big Sandy River. These maximum estimated ages were substantially greater than in other systems where scales have been used to estimate ages. Mean lengths at estimated ages were greater for flannelmouth suckers than for bluehead suckers in all 3 streams and generally less than values published from other systems where scales were used to estimate ages. Our observations of long life spans and slow growth rates among bluehead suckers and flannelmouth suckers were probably associated with our use of fin rays to estimate ages as well as the populations being in headwater tributaries near the northern edges of these species' ranges.

Key words: bluehead sucker, flannelmouth sucker, catostomid, population dynamics, age, growth, fin rays.

Native fishes of North America have been in decline since the early 20th century (Williams et al. 1989, Moyle and Leidy 1992). The Upper Colorado River Basin (UCRB) has experienced a similar substantial decline in native fishes (Minckley et al. 2003). The bluehead sucker (*Catostomus discobolus*) and flannelmouth sucker (*Catostomus latipinnis*) are native to the UCRB and were once abundant, but they now occupy about half the area of their historic ranges in the UCRB (Bezzerides and Bestgen 2002).

Knowledge of age and growth rates of fish is important to their conservation because these factors, along with recruitment and mortality, regulate population size and biomass (Quist et al. 2007). Few studies have described age and growth of bluehead suckers and flannelmouth suckers in the UCRB. Carlson et al. (1979) used scales to estimate age and growth of bluehead suckers and flannelmouth suckers from the Yampa and White rivers in Colorado, where both species appeared to live up to 7–9 years. In those areas, bluehead suckers grew to 35–40 cm total length (TL), and flannelmouth suckers grew to 45–48 cm TL. Similar growth patterns (using scales to estimate age and growth) were described for flannelmouth suckers in the Green River in Utah (McDonald and Dotson 1960) and the Colorado, Yampa, and Green rivers in Colorado (McAda 1977).

Otoliths, fin rays, and scales are commonly used to age fish. Among the 3 structures, otoliths are typically considered the best structure for estimating the age of many fishes. The accuracy of age estimates using otoliths has been validated for white suckers (*Catostomus commersoni;* Thompson and Beckman 1995); however, use of otoliths requires that fish be sacrificed. Quist et al. (2007) found that fin rays yielded the same age estimates as otoliths 74% of the time and estimates within one year of the otolith estimates 94% of the time for bluehead suckers and flannelmouth suckers. Scales are often considered an unsuitable structure for aging long-lived fishes because ages of older fish are generally underestimated (Beamish and McFarlane 1983, Sylvester and Berry 2006). Nonetheless, previous studies of bluehead

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suckers and flannelmouth suckers were conducted using scales because of the ease of scale collection and the lack of knowledge regarding the inaccuracies of age estimates using scales (McDonald and Dotson 1960, McAda 1977, Carlson et al. 1979). Our purpose was to describe age and growth of bluehead suckers and flannelmouth suckers in 3 headwater stream systems in the UCRB of Wyoming using pectoral fin rays to estimate ages, as fin rays provide more accurate ages than scales.

STUDY AREA

Bluehead suckers and flannelmouth suckers were sampled from populations in 3 lotic systems in the UCRB in Wyoming: Muddy Creek, a tributary to the Little Snake River in Carbon County; Little Sandy Creek, a tributary to the Big Sandy River in Sublette and Sweetwater counties; and the Big Sandy River, a tributary to the Green River in Sublette and Sweetwater counties. The fish populations in the 3 stream systems were isolated from downstream fish populations by human-made structures, including a headcut stabilization structure on Muddy Creek, irrigation diversion dams on Little Sandy Creek, and Big Sandy Reservoir on the Big Sandy River.

Muddy Creek originates in the foothills of the Sierra Madre at about 2450 m elevation and flows onto a high-elevation, relatively treeless cold-desert plain and transitions into a low-gradient warm water stream. Segments of Muddy Creek often become intermittent during summer, restricting stream biota to isolated pools. The length of Muddy Creek within the study area was 80 km extending over an elevation range of 2115–2225 m above mean sea level (amsl).

Little Sandy Creek originates within coniferous forest on the southwestern slope of the Wind River Mountains and flows onto semiarid sagebrush plains. Segments of Little Sandy Creek often become intermittent during summer. The length of Little Sandy Creek within the study area was 58 km with an elevation range of 2054–2161 m amsl.

The Big Sandy River also originates on the southwestern slope of the Wind River Mountains and flows onto semiarid sagebrush plains. The Big Sandy River begins as a coldwater system in coniferous forest and transitions to a meandering warm water system with little riparian vegetation. The length of the Big Sandy River within the study area was 89 km over an elevation range of 2064–2183 m amsl. The Big Sandy River was the largest of the 3 streams, with perennial flows and a mean wetted width of 15 m during the late-summer base-flow period.

METHODS

Bluehead suckers and flannelmouth suckers representing the range of lengths of fish longer than 100 mm TL found in each stream were collected during summer 2006 using hoop nets, seines, and backpack electrofishing. All fish >100 mm TL captured from Muddy Creek were included in the sample. A sampling goal of 10 fish in each 50-mm length class beginning at 51 mm TL was set for Little Sandy Creek and the Big Sandy River, but a sample of 10 fish was not obtained for all length classes in both streams. Sampled fish were measured, and the left pectoral fin was removed where it met the body. Pectoral fins were dried in paper envelopes, embedded in epoxy, and sectioned (0.3–0.6 mm thick) using a saw as described by Koch and Quist (2007). Cross sections of fin rays were examined using a dissecting microscope with transmitted light, and annuli were counted.

Three independent readers were used to estimate age. The number of annuli was estimated independently by 2 different people without knowledge of the length of the fish. If the 2 readers' estimates agreed, the number was recorded as the estimated number of annuli. If agreement was not achieved between the 2 readers, a 3rd person without knowledge of the estimates of the previous readers counted the number of annuli. The estimated number of annuli was either the number that agreed between the 3rd reader and either the 1st or 2nd reader or the median estimated number of annuli among the 3 readers.

Mean lengths and 95% confidence intervals of fish at each estimated age were computed for the samples of both bluehead suckers and flannelmouth suckers from each of the study streams. The method described by Bettoli and Miranda (2001) to avoid bias when estimating mean length at age from subsampled data was used for the Little Sandy River and Big Sandy River samples.

TABLE 1. Mean total length (TL, mm) at estimated ages for bluehead suckers from Muddy Creek, Little Sandy Creek, and Big Sandy River in Wyoming and the Yampa River and White River in Colorado. The structure used to age fish is given for each stream.

	Estimated age (years)																		
Location (reference)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	Structure
Muddy Creek, WY (This study)	110	135	167	189	207	216	252	253											Fin ray
Little Sandy Creek, WY (This study)	115	165	188	239	201			321	332	316									Fin ray
Big Sandy River, WY (This study)	115			290	392	381	381	394	369	377	380			401				425	Fin ray
Yampa River, CO (Carlson et al. 1979)				220	305	324	353												Scale
White River, CO (Carlson et al. 1979)				259		340	360	430	401										Scale

RESULTS

Within all 3 of the Wyoming streams, flannelmouth suckers appeared to be longer lived, with maximum estimated ages of 16 years in Muddy Creek, 18 years in Little Sandy Creek, and 26 years in the Big Sandy River. Bluehead suckers had maximum estimated ages of 8 years in Muddy Creek, 10 years in Little Sandy Creek, and 18 years in the Big Sandy River (Table 1). Flannelmouth suckers also had greater mean total lengths (TL) than bluehead suckers of comparable estimated ages in all 3 streams (Table 2). Both bluehead suckers and flannelmouth suckers from the Big Sandy River had consistently longer mean total lengths compared to fish of comparable estimated ages from either Muddy Creek or Little Sandy Creek (Tables 1, 2).

Total lengths of fish at each estimated age displayed a great deal of variability among both bluehead suckers and flannelmouth suckers in all 3 streams. The 95% confidence intervals for mean total lengths at estimated ages began to overlap at age 5 for bluehead suckers in all streams and at age 8 for flannelmouth suckers in all streams (Tables 3, 4).

DISCUSSION

This study provides age and growth information on bluehead suckers and flannelmouth suckers in 3 headwater stream systems in the UCRB. Bluehead suckers and flannelmouth suckers in Muddy Creek, Little Sandy Creek, and the Big Sandy River appeared to have longer life spans than fish in other populations of these species (McDonald and Dotson 1960, McAda 1977, Carlson et al. 1979), but scales were used to estimate ages in these earlier studies and this method likely resulted in underestimates of ages of older fish. Scoppettone (1988) used opercle bones to estimate ages of bluehead suckers and flannelmouth suckers from the Green River in Utah and reported maximum estimated ages similar to those we estimated for these species from the Big Sandy River and Little Sandy Creek in Wyoming.

Mean lengths at estimated ages of bluehead suckers and flannelmouth suckers in Muddy Creek, Little Sandy Creek, and the Big Sandy River were less than mean lengths at estimated ages for these species from previously studied populations in Colorado and Utah where scales were used to estimate age

TABLE 2. Mean total length (TL, mm) at estimated ages for flannelmouth suckers from Muddy Creek, Little Sandy Creek, and Big Sandy River in Wyoming; the Yampa, Green, White, and Colorado rivers in Colorado; and the Green River in Utah. The structure used to age fish is given for each stream.

	Estimated age (years)																										
Location (reference)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	Structure
Muddy Creek, WY (This study)	120	151	182	228	245	263	277	373	361	375	382	384	397	386	387	358											Fin ray
Little Sandy Creek, WY (This study)	139	137	275	307	324	392	405	386	392	408	418	426	433	424	376		452	465									Fin ray
Big Sandy River, WY (This study)									433	461	450	461	474	462	456	428	470		465	472	490	529	535		511	527	Fin ray
Yampa River, CO (Carlson et al. 1979)			180	247	281	341		383	445	450																	Scale
White River, CO (Carlson et al. 1979)		143	225	241	289	325	347	394	449	484																	Scale
Colorado River, CO (McAda 1977)	68	128	250	354	419	460	484	498	514																		Scale
Yampa and Green rivers, CO (McAda 1977)	79	101	279	370	424	453	468	472																			Scale
Green River, UT (McDonald and Dotson 1960)	104	165	295	319	356	363																					Scale

TABLE 3. Mean total length (TL, mm), 95% confidence interval (C.I.), and number of fish at each estimated age of bluehead suckers from Muddy Creek, Little Sandy Creek, and Big Sandy River, Wyoming.

Estimated age (years)	Muddy Creek			Little Sandy River			Big Sandy River		
	Mean	95% C.I.	*n*	Mean	95% C.I.	*n*	Mean	95% C.I.	*n*
1	110	108–111	72	115	104–127	6	115		1
2	135	130–139	31	165	149–181	13			
3	167	157–176	18	188	175–200	9			
4	189	185–195	35	239	216–261	6	290		1
5	207	199–216	22	201		1	392		1
6	216	205–227	13				381		2
7	252	245–259	5				381		2
8	253	245–261	3	321		1	394		1
9				332		1	369	362–377	8
10				316		2	377	353–401	4
11							380	351–408	6
12									
13									
14							401		1
15									
16									
17									
18							425		1

TABLE 4. Mean total length (TL, mm), 95% confidence interval (C.I.), and number of fish at each estimated age of flannelmouth suckers from Muddy Creek, Little Sandy Creek, and Big Sandy River, Wyoming.

Estimated age (years)	Muddy Creek			Little Sandy River			Big Sandy River		
	Mean	95% C.I.	*n*	Mean	95% C.I.	*n*	Mean	95% C.I.	*n*
1	120	115–126	17	139	127–157	8			
2	151	142–160	21	137		1			
3	182	164–200	16	275	223–326	4			
4	228	199–257	6	307	250–364	6			
5	245	217–273	13	324		1			
6	263	219–306	5	392	342–442	3			
7	277	244–311	7	405		1			
8	373	321–426	5	386		2			
9	361	325–398	9	392	352–431	3	433	410-457	3
10	375	340–409	10	408		2	461	427–494	3
11	382	350–414	7	418	394–442	4	450		1
12	384	372–396	9	426	404–447	4	461	447–475	4
13	397	382–412	7	433	411–454	3	474		2
14	386	363–410	3	424		1	462		1
15	387	367–407	5	376		1	456	433–479	5
16	358		1				428		2
17				452		1	470		1
18				465		1			
19							465	430–499	3
20							472		2
21							490		2
22							529	479–579	3
23							535		2
24									
25							511		1
26							527		1

(McDonald and Dotson 1960, McAda 1977, Carlson et al. 1979). Our use of fin rays yielding older age estimates may not be the only explanation for our estimates of slower growth compared to estimates in previous studies. The bluehead sucker and flannelmouth sucker populations in the Wyoming headwater streams were near the northern edge of their ranges and at high elevations (i.e., 2052–2225 m amsl). Typically, more-northern populations exhibit slower growth because of a shorter growing season and cooler summer temperatures (Carlander 1969). Other studies have suggested that growth rates of fishes in the Colorado River Basin are slower in areas with cooler water temperatures (Vanicek and Kramer 1969, McAda and Wydoski 1983, Robinson and Childs 2001).

Among our study streams, the growth rates of both bluehead suckers and flannelmouth suckers in both Muddy Creek and Little Sandy Creek were substantially slower than they were in the Big Sandy River. Periods of very low discharge and intermittent surface flow during summer in Muddy Creek and Little Sandy Creek may reduce growth rates of fish in these 2 systems. During such periods fish are confined to remnant pools and there is likely substantial interspecific and intraspecific competition for limited food resources.

High variability in lengths of fish at estimated ages limits the use of length frequency data to infer age structure of bluehead suckers or flannelmouth suckers within our study streams. The high variation in lengths at estimated ages may be due to a number of factors. Sexual dimorphism was not considered in this study and may be an important determinant of individual fish lengths. Female white suckers (Quinn and Ross 1982) and flannelmouth suckers (Bezzerides and Bestgen 2002) have been shown to display faster growth than males. Growth of fish often slows once an individual reaches sexual maturity (Beamish and McFarlane 1983), and lengths at ages beyond sexual maturity may not change much, contributing to overlapping lengths among many age classes. It is also possible that some of the variation in lengths at estimated ages was due to aging errors.

Length frequencies of small bluehead suckers and flannelmouth suckers captured from all 3 Wyoming streams during summer had distinct modes that appeared to represent age-0 and age-1 fish of both species. The mode representing age-1 fish was about half the mean total length of fish with one annulus on the fin rays, indicating that fish with one annulus may have been age-2 fish. We did not add one year to the estimated ages from annuli observed on fin rays, but future researchers should take into account this potential bias in our age estimates.

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