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Age Structure of Rainbow and Brown Trout Populations of the Ruby and Beaverhead Rivers and Their Reservoirs

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Introduction

The Beaverhead and Ruby rivers, along with their reservoirs, provide popular trout fisheries near Dillon, Montana. These streams are predominantly comprised of brown trout (Jaeger and Bateman 2019) and annually receive about 21,500 angler-days combined (Selby and Skaar 2019). Clark Canyon and Ruby River reservoirs mainly support rainbow trout populations and receive about 10,000 angler-days. Historically, these fisheries have supported abundant trout populations consisting of relatively large fish, which have resulted in high angler expectations of the fisheries (Oswald and Rosenthal 2007). Although it has been speculated that discharge is a limiting factor for growth and survival of trout in the Beaverhead River (Oswald 2009), empirical assessments have been limited. Furthermore, little is known about the age structure of these populations.

The goal of this study was to gain a better understanding of the growth and survival of trout populations in the Ruby and Beaverhead rivers and their reservoirs. The objectives were to 1) assess differences in the length-at-age and growth of brown trout within and between the Beaverhead and Ruby rivers, 2) assess differences in the length-at-age and growth of rainbow and brown trout within and between Clark Canyon and Ruby reservoirs, and 3) assess whether growth rates of the aforementioned populations are influenced by stream discharge or reservoir elevation.

Study Area

The Beaverhead River originates at Clark Canyon Dam and flows 120 km until its confluence with the Big Hole River. Clark Canyon Reservoir was created in 1964 to provide about 250,000 acre-feet of water storage for irrigation supply, flood control, and recreation. The Ruby River originates in the Gravelly and Snowcrest mountains and flows 122 kilometers until its

confluence with the Beaverhead River. Ruby River Reservoir was created in 1938 to provide about 38,000 acre-feet of water storage for irrigation supply, flood control, and recreation.

Methods

Sampling occurred in the Beaverhead, Ruby, and Red Rock rivers and the Clark Canyon and Ruby reservoirs during select years from 1992 to 2008. Analyses were completed on the data collected from the Hildreth, Fish & Game, Poindexter Slough, and Anderson shocking sections of the Beaverhead River and the Maloney, Silver Springs, and Seyler sections of the Ruby River. The Red Rock River was sampled immediately upstream of Clark Canyon Reservoir.

Riverine sampling was conducted in April and May using a mobile anode electrofishing unit from a modified drift boat. A 3,500-watt gas generator and Leach type rectifying box maintained a 1,000 to 1,800 watt straight or continuous wave of DC current. Total lengths of all trout >203 mm was recorded. Additional information about the study sections and sampling methodology are in Oswald (2009).

Reservoir sampling was generally conducted in May and October using 1.8-m x 38.1-m experimental gill nets. Panels were constructed with bar mesh braided twine with openings ranging from 1.9 cm to 5.1 cm. Floating gill nets were positioned perpendicular to the shoreline in the top of the water column and fished from the water surface down 6 ft deep at historically repeated sites in each reservoir. Nets were typically set in the late afternoon around 5 or 6 pm and fished for about 14 to 16h. The total length in mm and weight in grams of all captured trout was recorded.

Scale samples for age determination were collected from a subsample of about 10 fish per one-inch length group captured in each river segment. Scales were collected from all fish captured in the reservoirs. Several scales were removed from the left side of the body between the lateral line and the dorsal fin and placed in an envelope. The scales were washed in the laboratory and acetate slide impressions were made of three scales collected from each fish. Scales were aged using the Leica LAS Interactive Measurement module. The distances between annuli were measured along a transect from the focus to the anterior edge of the scale. Back-calculated lengths at ages of fish were determined by multiplying the length at captured by the proportional lengths between annuli and the total length of the transect used to measure each scale.

Kruskal-Wallis tests were used to assess differences in fish lengths among segments or years.

Results

Brown Trout— Mean back-calculated length at age of age-1 Beaverhead River brown trout was greater than Ruby River brown trout (P = 0.04; Tables 1; Figure 1). Although mean lengths at age of Beaverhead brown trout were about 10% greater than Ruby River brown trout for fish younger than five years, there were no statistical differences of lengths at ages for fish

greater than age-1 ($P \geq 0.12$). Few age-5 or older brown trout were captured in the Ruby River preventing reliable growth comparisons of older age classes.

Means lengths at capture of age-1 brown trout sampled in the Beaverhead River were 6.2" (Table 2). Total lengths of age-1, age-2, and age-3 ranged from 3.4" to 9.0", 7.0" to 18.4", and 10.2" to 20.6", respectively. Only one brown trout was older than nine years; a 27.2" age-10 fish. Although mean back-calculated lengths at age of brown trout captured in the Beaverhead River were statistically similar among sampling sections for age-1 fish ($P = 0.11$), the mean back-calculated length of age-1 fish captured in the Hildreth section was 8% (≈ 0.25") greater than other sections (Table 3). Mean back-calculated lengths of age-2 ($P < 0.01$) and age-3 fish ($P < 0.01$) brown trout captured in the Beaverhead River were greatest in the Hildreth section. Mean lengths at age of age-2 and older brown trout captured in the Hildreth section were typically at least 12% (≥ 1") greater than those captured in other sections.

Growth of Beaverhead River brown trout was positively correlated with discharge in all sampling sections except in the Poindexter segment (Figure 2). Below average growth (less than zero) was generally limited to years with low minimum, maximum, and mean daily discharges during the year prior to capture. The strongest relationships between growth and discharge of brown trout in the Beaverhead River were in the Anderson section. However, the Fish & Game regressions had the greatest regression slopes of any of the Beaverhead sections. Similar relationships were observed when limiting comparisons of growth and discharge to age-0 brown trout in the Beaverhead River (Figure 3).

Mean length at capture of brown trout in the Ruby River ranged from 5.6" to 17.1" (Table 4), which represented fish ranging from age-1 to age-6. Total lengths of age-1, age-2, and age-3 ranged from 3.3" to 9.2", 5.6" to 16.8", and 9.4" to 19.6", respectively. Mean back-calculated lengths at age of Ruby River brown trout were typically greatest in the Maloney section generally followed by the Silver Spring and Seyler sections (Table 5). Age-1 ($P = 0.79$) and age-2 ($P = 0.06$) mean lengths at age were similar among sections; however, mean lengths at age were typically at least 10% greater in the Maloney section than the Silver Spring and Seyler sections for age-1 and older fish. Mean length at age of age-3 brown trout captured in the Maloney section was significantly greater than brown trout captured the Seyler section ($P = 0.03$). Length at age of age-4 fish was greater in the Maloney section than both the Silver Spring and Seyler sections ($P = 0.01$).

Growth and mean daily discharge were positively correlated for brown trout captured in the Ruby River (Figure 4). However, no relationship between growth and minimum or maximum daily discharge existed. Growth of age-0 brown trout captured in the Ruby River was not correlated with discharge (Figure 5).

Mean length at capture of brown trout in Clark Canyon Reservoir ranged from 7.7" for to 24.9" for (Table 6); back-calculated lengths at age were similar among years ($P > 0.05$) except for age-3 fish ($P = 0.02$; Table 7). Mean length at capture of brown trout in Ruby River Reservoir ranged from 6.8" to 23.0" (Table 8); back-calculated lengths at age were similar among years ($P > 0.24$; Table 9). Although back-calculated age-1 growth of brown trout was similar between

reservoirs (P = 0.94), mean back-calculated lengths of age-2, age-3, and age-4 brown trout captured in Clark Canyon Reservoir were greater than in Ruby River Reservoir for ($P \leq 0.03$; Tables 7, 9, and 10).

Rainbow trout—Mean back-calculated lengths at ages of rainbow trout were significantly greater in the Roe Section of the Red Rock River and Clark Canyon Reservoir than the Ruby River Reservoir ($P < 0.01$ for age-1 to age-4 fish; Table 11). Clark Canyon and Red Rock River rainbow trout exhibited high growth until reaching 18" at age-2 (Tables 12 and 13) after which an additional 1-3" of growth was typical of older age classes. Back-calculated lengths at age varied among sampling years for age-1 to age-2 Clark Canyon rainbow trout ($P \leq 0.05$) but were similar for older age classes ($P \geq 0.15$). Back-calculated lengths at age of Red Rock River rainbow trout were similar among sampling years ($P \geq 0.07$). Back-calculated lengths at age of Ruby Reservoir rainbow trout were similar among sampling years ($P \geq 0.09$). Back-calculated mean lengths at age of Ruby Reservoir rainbow trout captured in 1998 increased until age-4 whereas growth of fish captured in 2002 and 2008 nearly ceased after age-2.

Growth of rainbow trout captured in Clark Canyon and the Red Rock River were positively correlated with reservoir storage (Figure 6). However, growth of rainbow trout captured in Ruby River Reservoir was negatively correlated with reservoir storage (Figure 7).

Management Implications

The trout populations in the Beaverhead and Ruby rivers and their reservoirs provide a wide range of management challenges. Both rivers frequently experience periods of low discharge and elevated water temperatures while pool elevations in the reservoirs fluctuate substantially because of flood control and irrigation needs throughout the year. Despite these similarities, the responses of the brown trout populations to stream discharge appear to differ between the Beaverhead and Ruby rivers. Significant positive relationships exist between various aspects of stream discharge and growth of individuals for several sections of the Beaverhead River. However, based on the limited data available, brown trout in the Ruby River do not appear to respond similarly to low stream discharges that is evident with brown trout in the Beaverhead River. Such conclusions of the Ruby River brown trout population should be met with some skepticism until a more thorough analysis that includes additional discharge data can be completed.

Rainbow trout populations in Clark Canyon and Ruby reservoirs appear to be dominated by age-4 or younger fish. However, limited environmental data precludes inferences into the potential factors limiting growth and survival of individuals in these populations. In addition to securing a better understanding of the abiotic factors influencing the trout populations in the Clark Canyon and Ruby reservoirs, the stocking strategies (e.g., number stocked, timing of stocking) in each reservoir should be closely evaluated to assess the effects of hatchery-reared rainbow trout on the growth and survival of rainbow trout in each fishery.

Literature Cited

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Table 1. Mean back-calculated lengths at age of brown trout captured in the Beaverhead and Ruby rivers from 1992 to 2008.

		Age									
Location	***N***	1	2	3	4	5	6	7	8	9	10
Beaverhead River	2,331	4.8	10.3	14.2	16.8	18.7	20.4	21.9	23.1	26.2	26.9
Ruby River	1,722	4.4	9.2	13.0	15.5	16.9	16.0	--	--	--	--

Table 2. Sample sizes and mean total lengths at capture (in) of brown trout captured in selected sections of the Beaverhead River.

		Age									
Section/**Year**	***N***	1	2	3	4	5	6	7	8	9	10
Hildreth	**398**	**8.2**	**12.9**	**16.7**	**19.2**	**21.6**	--	--	--	--	--
1993	161	--	13.0	17.0	19.7	21.6	--	--	--	--	--
1998	115	8.2	12.3	16.0	16.7	--	--	--	--	--	--
2002	122	--	13.4	17.1	19.5	--	--	--	--	--	--
Fish & Game	**596**	**7.4**	**11.2**	**14.5**	**17.4**	**18.7**	**20.6**	--	--	--	--
1992	176	7.4	11.3	14.6	16.8	17.8	--	--	--	--	--
1998	148	--	11.1	14.3	17.3	18.6	19.8	--	--	--	--
2002	149	--	11.0	14.3	17.9	19.5	21.1	--	--	--	--
2008	123	--	11.6	14.7	16.4	16.7	--	--	--	--	--
Poindexter Slough	**574**	**5.7**	**10.0**	**13.5**	**16.0**	**17.3**	--	--	--	--	**27.2**
1992	204	5.5	9.4	12.7	14.9	16.1	--	--	--	--	--
1998	223	5.9	10.3	13.8	16.6	18.0	--	--	--	--	--
2002	147	5.7	10.3	14.0	16.5	18.9	--	--	--	--	27.2
Anderson	**763**	**6.6**	**11.9**	**15.3**	**17.5**	**19.3**	**20.8**	**21.9**	**22.4**	--	--
1992	209	6.5	11.3	15.1	16.6	18.1	18.6	--	--	--	--
1999	188	6.5	11.9	15.3	17.5	19.8	20.6	21.9	21.7	--	--
2002	198	6.7	12.4	15.4	18.8	19.6	22.0	--	23.1	--	--
2008	168	--	12.3	15.4	17.6	19.4	21.9	--	23.1	--	--
Total mean	**2,331**	**6.2**	**11.5**	**15.1**	**17.4**	**19.0**	**20.8**	**21.9**	**22.4**	--	**27.2**
Standard deviation		1.2	1.7	1.8	1.8	1.8	2.0	3.0	1.0	--	NA[a]
Minimum		3.4	7.0	10.2	11.4	13.8	17.2	19.8	21.7	--	27.2
Maximum		9.0	18.4	20.6	22.4	23.8	26.4	25.3	23.1	--	27.2

[a] Standard deviation not reported when only one fish was measured

Table 3. Mean back-calculated lengths at age of brown trout captured in the Beaverhead River.

		Age									
Section/**Year**	***N***	1	2	3	4	5	6	7	8	9	10
Hildreth	**398**	**5.1**	**11.3**	**15.5**	**18.3**	**20.6**	**--**	**--**	**--**	**--**	**--**
1993	161	5.2	11.5	15.9	18.7	20.6	--	--	--	--	--
1998	115	4.8	10.8	14.5	16.1	--	--	--	--	--	--
2002	122	5.1	11.5	15.8	18.5	--	--	--	--	--	--
Fish & Game	**596**	**4.8**	**10.0**	**13.8**	**16.7**	**18.4**	**20.3**	**--**	**--**	**--**	**--**
1992	176	5.1	9.7	13.7	16.1	17.5	--	--	--	--	--
1998	148	4.7	10.0	13.9	16.7	18.2	19.5	--	--	--	--
2002	149	4.8	10.3	14.1	17.2	19.1	20.7	--	--	--	--
2008	123	4.3	10.1	13.5	15.3	15.9	--	--	--	--	--
Poindexter Slough	**574**	**4.5**	**9.2**	**13.0**	**15.3**	**17.2**	**22.5**	**24.1**	**25.0**	**26.2**	**26.9**
1992	204	4.4	8.6	12.0	14.3	15.5	--	--	--	--	--
1998	223	4.7	9.8	13.6	16.4	18.2	22.5	24.1	25.0	26.2	26.9
2002	147	4.2	9.2	13.3	15.1	18.5	--	--	--	--	--
Anderson	**763**	**4.9**	**10.5**	**14.6**	**17.1**	**18.9**	**20.3**	**21.5**	**22.1**	--	--
1992	209	4.8	9.8	13.9	15.8	17.3	18.3	--	--	--	--
1999	188	5.1	10.7	14.7	17.3	19.2	19.9	21.3	21.3	--	--
2002	198	5.3	11.1	14.9	18.1	19.4	21.5	--	--	--	--
2008	168	4.6	10.4	14.7	17.2	19.4	21.5	22.3	22.9	--	--
Total mean	**2,331**	**4.8**	**10.3**	**14.2**	**16.9**	**18.7**	**20.4**	**21.9**	**23.1**	**26.2**	**26.9**
Standard deviation		1.1	1.8	1.8	2.0	1.9	2.0	2.2	1.9	NA[a]	NA[a]
Minimum		1.7	5.4	8.3	10.9	13.6	17.0	19.4	21.3	26.2	26.9
Maximum		9.0	16.9	21.9	24.8	25.7	26.2	24.8	25.0	26.2	26.9

[a] Standard deviation not reported when only one fish was measured

Table 4. Sample sizes, mean total lengths at capture (in) of brown trout captured in selected sections of the Ruby River.

		Age					
Section**/Year**	***N***	1	2	3	4	5	6
Maloney	**544**	--	**10.7**	**14.8**	**17.9**	**20.0**	--
1994	62	--	10.6	15.9	17.2	--	--
1998	157	--	11.7	16.9	19.1	20.5	--
2002	158	--	10.5	14.6	17.3	--	--
2008	167	--	9.8	13.6	17.6	18.3	--
Silver Spring	**574**	**6.3**	**10.0**	**13.5**	**15.8**	**19.0**	--
1992	182	6.6	10.5	13.3	14.9	17.2	17.1
1998	200	5.6	9.6	12.7	15.4	15.1	15.7
2002	192	5.7	9.4	13.1	16.0	17.9	--
Seyler	**604**	**5.9**	**9.8**	**13.0**	**15.5**	**16.7**	**16.4**
1995	144	6.6	10.5	13.3	14.9	17.2	17.1
1998	224	5.6	9.6	12.7	15.4	15.1	15.7
2000	236	5.7	9.4	13.1	16.0	17.9	--
Total mean	**1,722**	**6.1**	**10.2**	**14.0**	**16.3**	**17.5**	**16.4**
Standard deviation		1.1	1.5	2.0	1.7	2.0	1.0
Minimum		3.3	5.6	9.4	12.1	12.8	15.7
Maximum		9.2	16.8	19.8	20.8	22.1	17.1

Table 5. Mean back-calculated lengths at age of brown trout captured in the Ruby River.

		Age					
Section/**Year**	***N***	1	2	3	4	5	6
Maloney	**544**	**4.3**	**9.9**	**13.8**	**17.1**	**19.0**	**--**
1994	62	4.4	9.4	14.2	16.5	--	--
1998	157	4.9	10.8	15.3	19.0	19.5	--
2002	158	4.2	9.8	13.7	16.6	--	--
2008	167	3.7	9.2	12.8	16.8	17.6	--
Silver Spring	**574**	**4.5**	**9.0**	**12.6**	**15.4**	**18.5**	**--**
1992	182	4.6	9.1	12.6	14.9	--	--
1998	200	4.4	8.5	12.5	14.5	--	--
2002	192	4.3	9.1	12.7	15.9	18.5	--
Seyler	**604**	**4.3**	**8.6**	**12.2**	**14.8**	**16.2**	**16.0**
1995	144	4.6	9.2	12.4	14.6	16.8	16.9
1998	224	4.3	8.4	12.0	14.2	14.6	15.2
2000	236	4.2	8.5	12.4	15.5	17.4	--
Total mean	**1,722**	**4.4**	**9.2**	**13.0**	**15.5**	**16.9**	**16.0**
Standard deviation		1.1	1.7	1.8	1.7	1.9	1.2
Minimum		1.6	4.0	7.2	11.0	12.3	15.2
Maximum		8.0	18.0	18.5	20.2	21.3	16.9

Table 6. Sample sizes, mean total lengths at capture (in) of brown trout captured in Clark Canyon Reservoir.

		Age							
Year	***N***	2	3	4	5	6	7	8	9
1992	35	10.2	14.0	17.9	19.4	22.1	22.9	24.2	--
1994	4	--	--	14.4	20.4	--	--	26.6	--
1995	19	8.7	13.6	16.0	19.1	21.3	--	--	--
1996	11	12.2	--	16.4	17.8	18.0	--	--	--
1998	17	7.7	13.7	16.1	20.2	20.4	--	21.7	--
1999	15	9.8	14.3	17.8	19.0	--	--	--	--
2000	28	9.7	17.1	19.3	19.8	21.1	--	22.3	--
2001	30	8.4	17.8	18.1	19.5	20.4	--	--	--
2002	17	10.1	--	18.5	21.0	--	23.0	--	--
2008	25	--	--	17.6	17.5	18.4	24.0	22.8	24.9
Total mean	**201**	**9.6**	**14.4**	**17.6**	**19.0**	**20.3**	**23.1**	**23.6**	**24.9**
Standard deviation		2.4	2.0	1.9	1.5	2.0	1.0	2.0	NA[a]
Minimum		6.2	11.2	13.5	15.7	16.3	21.1	21.5	24.9
Maximum		19.4	17.8	22.9	21.8	24.7	24.6	26.9	24.9

[a] Standard deviation not reported when only one fish was measured

Table 7. Mean back-calculated lengths at age of brown trout captured in Clark Canyon Reservoir.

		Age								
Year	***N***	1	2	3	4	5	6	7	8	9
1992	35	4.0	10.5	15.4	17.9	20.3	22.1	23.1	24.2	--
1994	4	3.8	9.0	14.4	18.1	21.5	25.5	25.9	26.6	--
1995	19	4.2	9.6	14.0	16.7	19.3	21.3	--	--	--
1996	11	4.5	10.4	14.4	16.5	17.5	18.0	--	--	--
1998	17	4.6	10.7	15.3	17.6	19.8	20.4	21.2	21.7	--
1999	15	4.6	10.5	15.6	17.8	19.0	--	--	--	--
2000	28	4.5	10.9	16.0	18.8	20.1	21.1	22.0	22.3	--
2001	30	4.4	9.7	15.9	18.2	19.5	20.4	--	--	--
2002	17	4.2	11.3	17.4	19.2	21.0	22.0	23.0	--	--
2008	25	5.3	10.8	14.7	17.0	17.9	19.4	22.5	22.8	24.9
Total mean	**201**	**4.4**	**10.4**	**15.3**	**17.8**	**19.4**	**21.0**	**22.9**	**23.5**	**24.9**
Standard deviation		1.2	2.3	1.9	1.7	1.7	1.9	1.4	1.9	NA[a]
Minimum		2.3	4.5	8.5	13.3	14.8	16.3	21.1	21.5	24.9
Maximum		9.8	19.4	19.7	22.9	23.8	25.5	25.9	26.9	24.9

[a] Standard deviation not reported when only one fish was measured

Table 8. Sample sizes, mean total lengths at capture (in) of brown trout captured in Ruby River Reservoir during.

		Age						
Year	***N***	2	3	4	5	6	7	8
1998	14	6.8	11.6	16.6	--	--	--	--
2002	5	--	13.6	--	--	--	--	--
2008	16	--	10.5	14.2	15.6	18.7	23.0	22.0
Total mean	**35**	**6.8**	**12.1**	**15.4**	**15.6**	**18.7**	**23.0**	**22.0**
Standard deviation		0.8	1.5	1.8	1.7	0.5	NA[a]	1.5
Minimum		6.3	9.4	13.3	14.0	18.2	23.0	20.3
Maximum		7.7	15.3	18.1	18.0	19.2	23.0	23.0

[a] Standard deviation not reported when only one fish was measured

Table 9. Mean back-calculated lengths at age of brown trout captured in Ruby River Reservoir.

		Age							
Year	***N***	1	2	3	4	5	6	7	8
1998	14	4.8	8.9	12.5	16.6	--	--	--	--
2002	5	4.3	9.5	13.0	--	--	--	--	--
2008	16	4.1	9.0	12.9	15.5	17.5	19.8	21.9	22.0
Total mean		**4.4**	**9.0**	**12.8**	**15.7**	**17.5**	**19.8**	**21.9**	**22.0**
Standard deviation		1.3	2.1	2.1	2.1	2.3	1.7	1.6	1.5
Minimum		2.3	5.2	9.1	12.1	14.0	18.0	19.4	20.3
Maximum		6.8	13.5	18.0	19.5	20.9	21.9	23.0	23.0

Table 10. Mean back-calculated lengths at age of brown trout captured in the Clark Canyon and Ruby reservoirs from 1992 to 2008.

		Age									
Location	***N***	1	2	3	4	5	6	7	8	9	10
Clark Canyon	201	4.4	10.4	15.3	17.8	19.4	21.0	22.9	23.5	24.9	--
Ruby Reservoir	35	4.4	9.0	12.8	15.7	17.5	19.8	21.9	22.0	--	--

Table 11. Mean back-calculated lengths at age of rainbow trout.

		Age						
Year	***N***	1	2	3	4	5	6	7
Red Rock River	424	11.3	18.6	20.8	21.9	23.2	23.5	22.0
Clark Canyon	725	11.0	17.8	20.1	21.3	21.6	23.4	23.1
Ruby Reservoir	386	9.1	13.4	14.5	14.8	14.9	--	--

Table 12. Mean back-calculated lengths at age of rainbow trout captured in Clark Canyon Reservoir.

		Age						
Year	***N***	1	2	3	4	5	6	7
1992	123	9.8	16.6	18.0	19.8	20.7	22.1	23.1
1994	84	10.4	18.4	20.1	20.4	--	--	--
1995	126	11.1	17.5	20.1	22.1	23.6	--	--
1996	56	11.5	18.0	19.3	--	--	--	--
1998	127	11.2	17.8	19.6	21.7	--	--	--
1999	61	11.3	18.1	21.3	22.2	22.6	--	--
2000	56	12.4	19.1	21.5	--	--	--	--
2001	51	11.9	18.7	20.9	21.9	23.9	24.7	--
2002	41	12.5	18.7	22.1	--	--	--	--
Total	**725**	**11.0**	**17.8**	**20.1**	**21.3**	**21.6**	**23.4**	**23.1**

Table 13. Mean back-calculated lengths at age of rainbow trout captured in the Roe Section of Red Rock River.

		Age						
Year	***N***	1	2	3	4	5	6	7
1994	195	10.7	18.2	20.0	21.4	22.7	23.0	--
1998	113	11.6	18.2	20.5	22.1	23.6	24.1	--
2002	116	12.2	19.5	22.0	23.3	23.5	23.0	22.0
Total	**424**	**11.3**	**18.6**	**20.8**	**21.9**	**23.2**	**23.5**	**22.0**

Table 14. Mean back-calculated lengths at age of rainbow trout captured in the Ruby Reservoir.

		Age				
Year	***N***	1	2	3	4	5
1998	131	9.3	14.1	15.8	18.0	--
2002	146	8.9	13.0	14.3	14.6	14.9
2008	109	9.1	13.4	13.4	14.5	--
Total	**386**	**9.1**	**13.4**	**14.5**	**14.8**	**14.9**

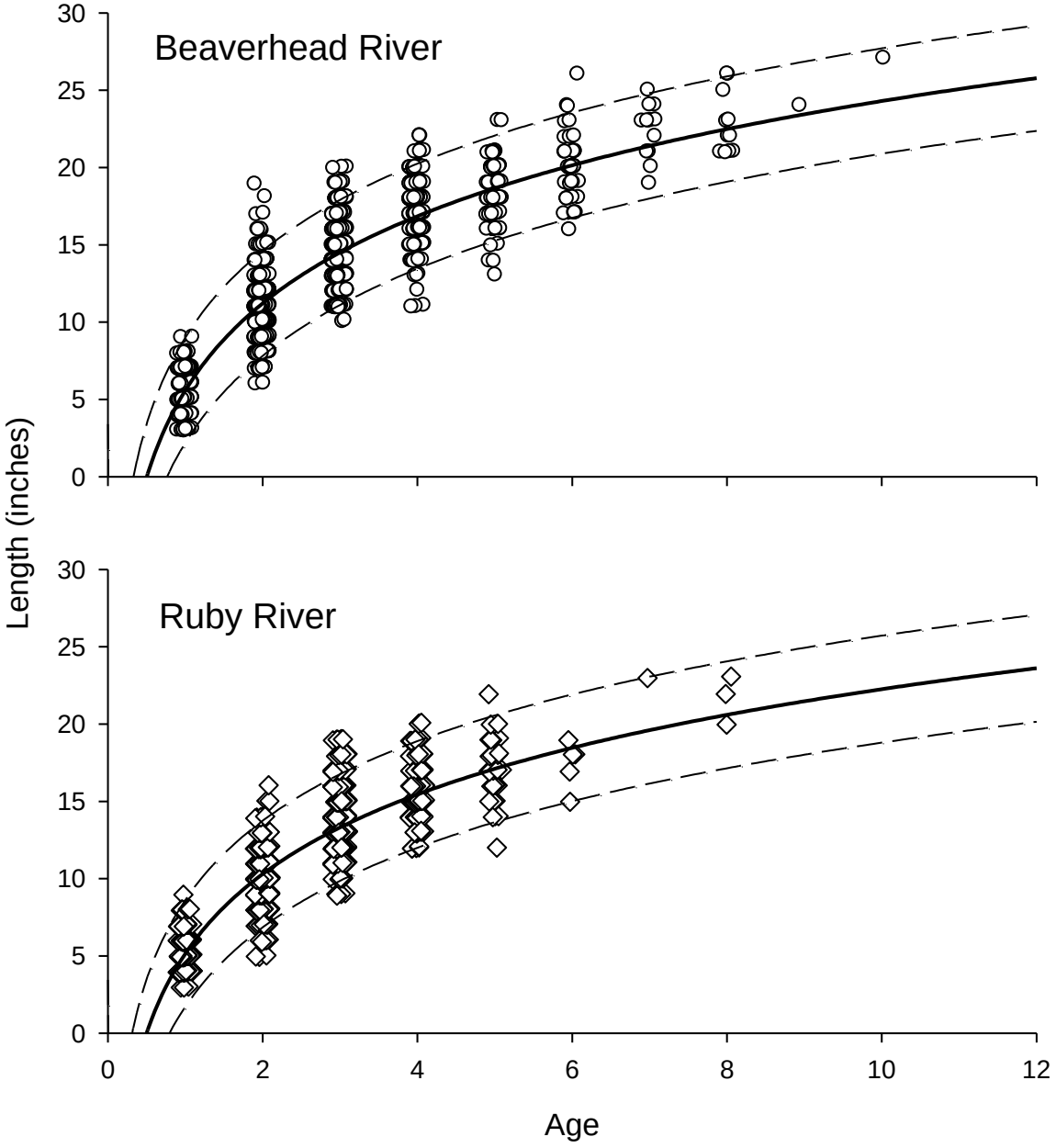

Figure 1. Jittered back-calculated lengths at age of brown trout captured in the Beaverhead and Ruby rivers. Dashed lines represent 95% confidence intervals.

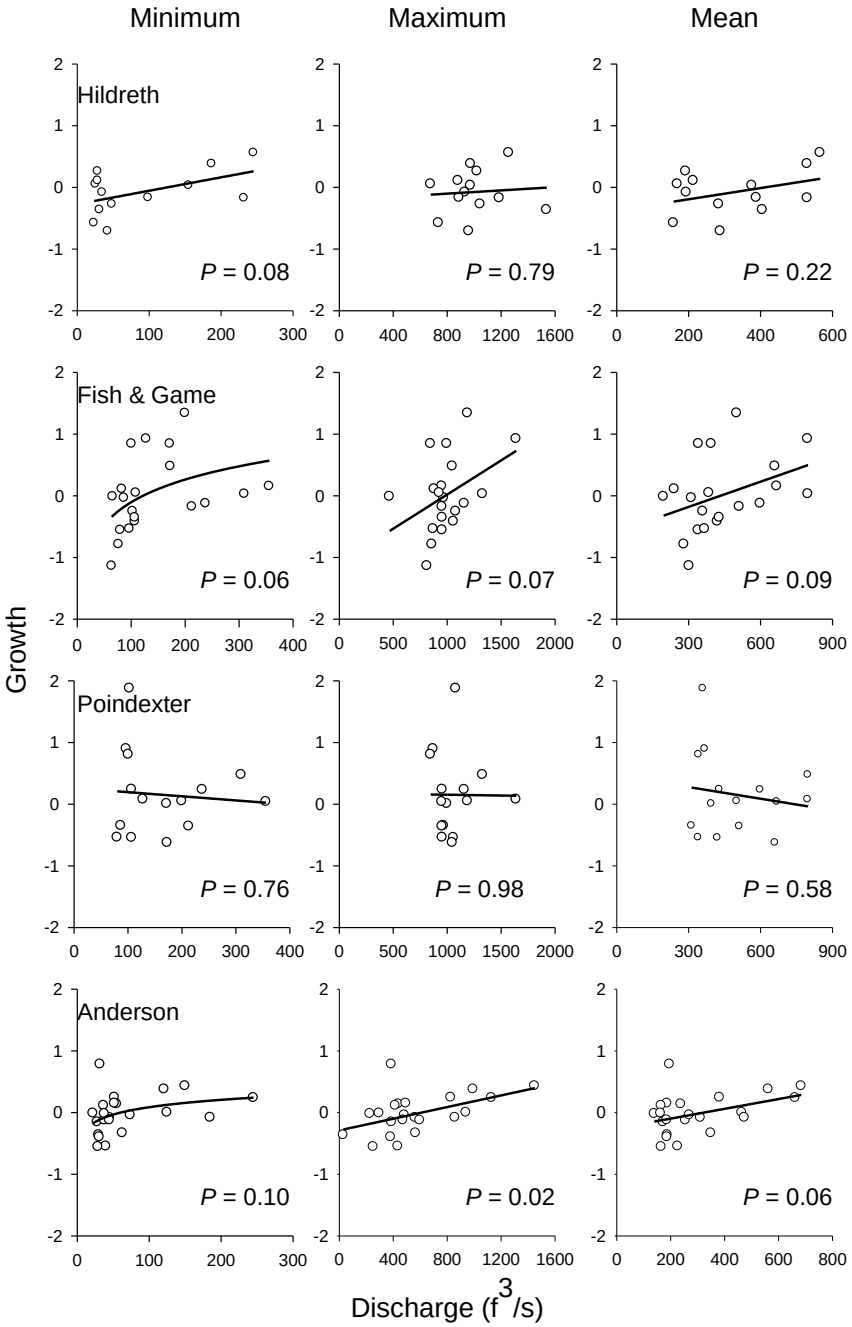

Figure 2. Departure of brown trout growth (inches) from the long-term mean and discharges in the Hildreth, Fish & Game, Poindexter Slough, and Anderson sections of the Beaverhead River. Growth represents difference between annual incremental growth and long-term mean. Discharges are minimum, maximum, and annual mean of mean daily discharges. Outflow data of Clark Canyon Reservoir (Bureau of Reclamation) were used for the Hildreth section. Discharges at Barretts, Montana (USGS gauge 06016000) were used for the Fish & Game and Poindexter Slough sections. Discharges near Twin Bridges (USGS gauge 06018500) were used for the Anderson section.

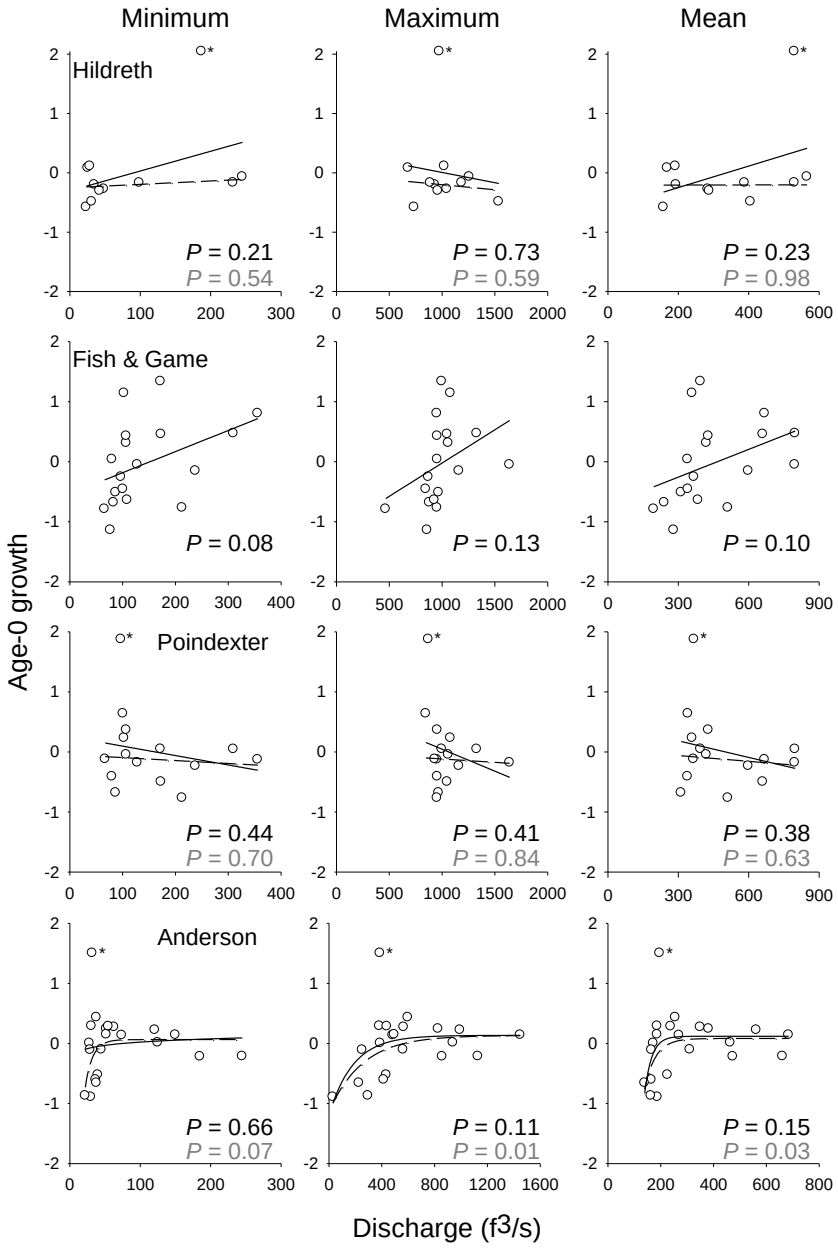

Figure 3. Departure of age-0 brown trout growth (inches) from the long-term mean and discharges in the Hildreth, Fish & Game, Poindexter Slough, and Anderson sections of the Beaverhead River. Growth represents difference between annual incremental growth and long-term mean. Discharges are minimum, maximum, and annual mean of mean daily discharges. Outflow data of Clark Canyon Reservoir (Bureau of Reclamation) were used for the Hildreth section. Discharges at Barretts, Montana (USGS gauge 06016000) were used for the Fish & Game and Poindexter Slough sections. Discharges near Twin Bridges (USGS gauge 06018500) were used for the Anderson section. Dashed lines and gray *P*-values are for regressions with outliers (*) removed.

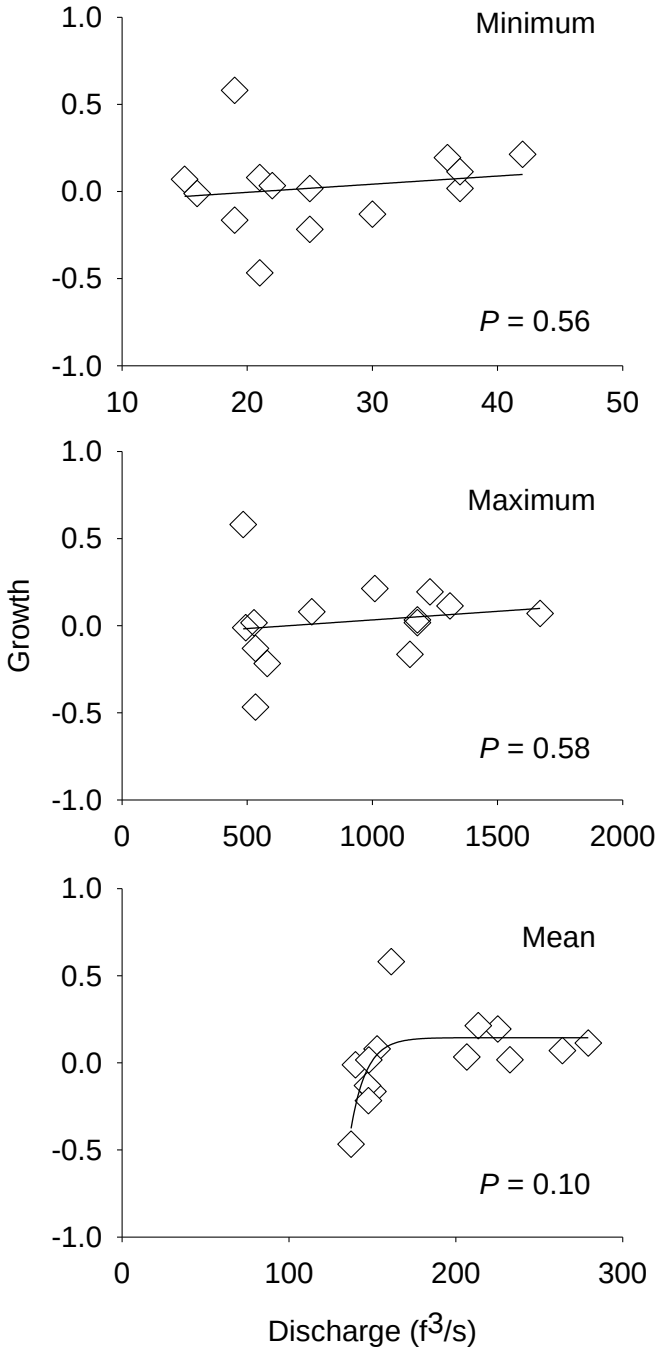

Figure 4. Departure of brown trout growth (inches) from the long-term mean and Ruby River discharge. Minimum, maximum, and mean discharges calculated using data from USGS gauge 0602066 near Alder, Montana. Growth represents difference between annual incremental growth and long-term mean.

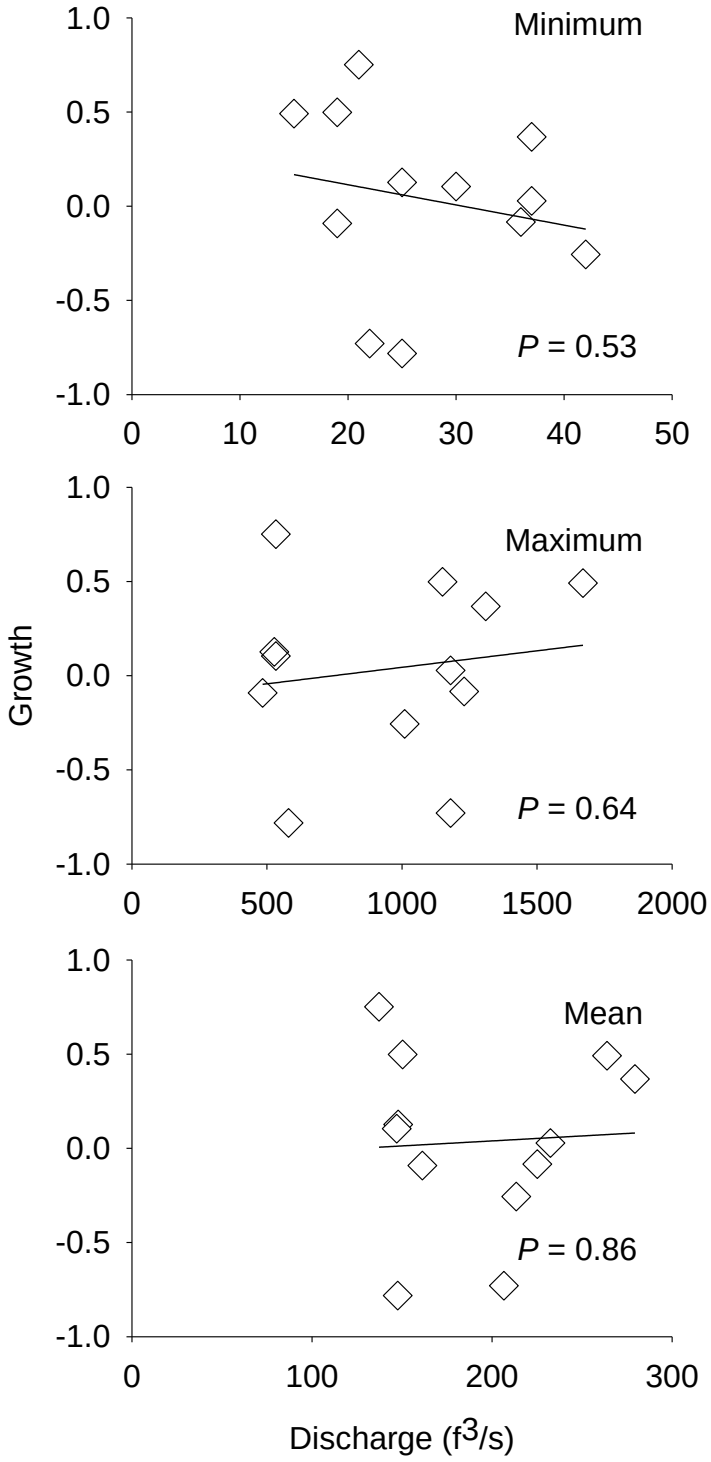

Figure 5. Departure of age-0 brown trout growth (inches) from the long-term mean and Ruby River discharge. Minimum, maximum, and mean discharges calculated using data from USGS gauge 0602066 near Alder, Montana. Growth represents difference between annual incremental growth and long-term mean.

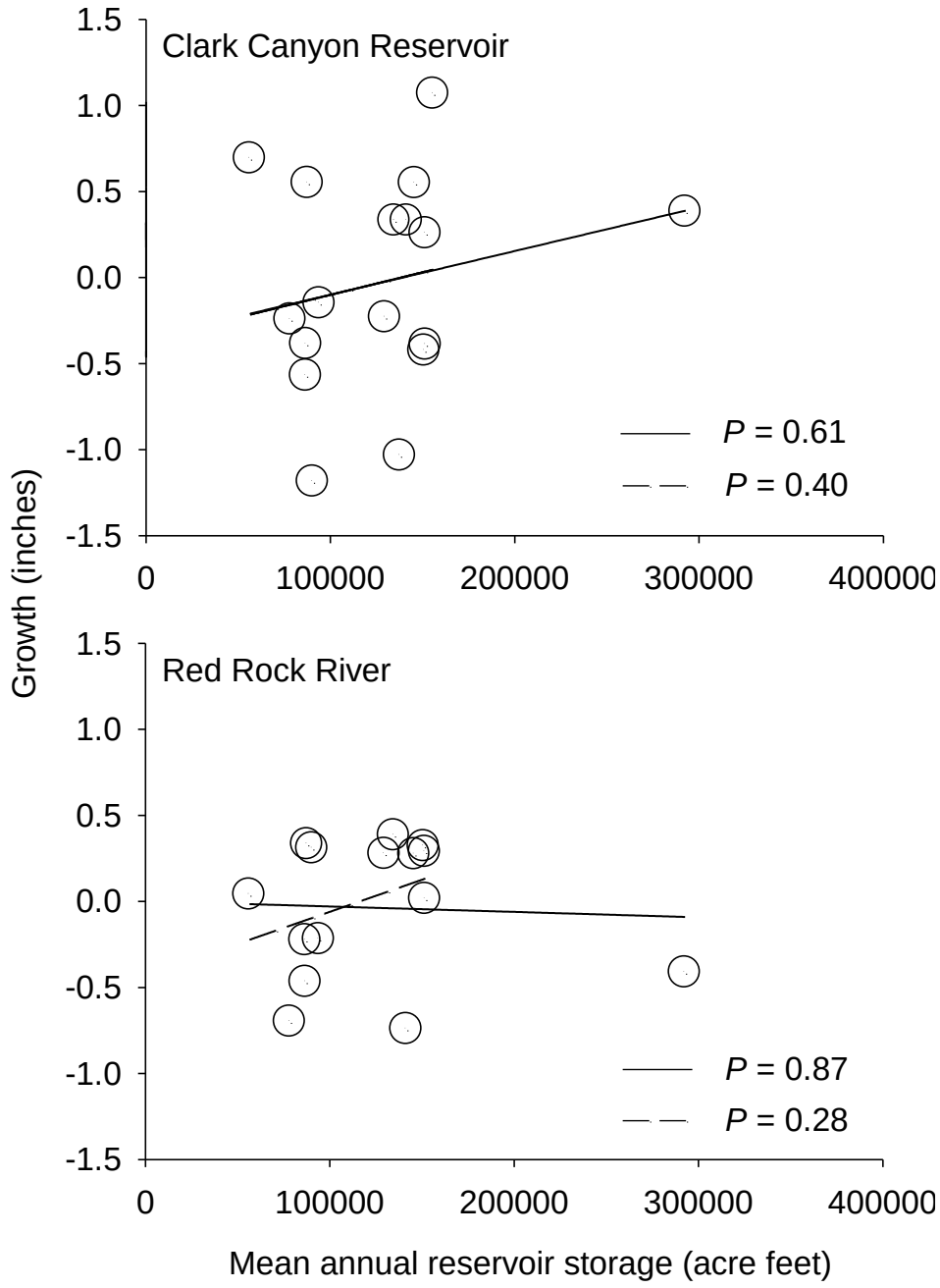

Figure 6. Departure of rainbow trout growth (inches) from long-term mean and mean annual reservoir storage of Clark Canyon Reservoir (1984 – 2001). Solid lines represent linear regressions for all data. Dashed lines represent linear regressions excluding outlier at 292,754 acre feet.

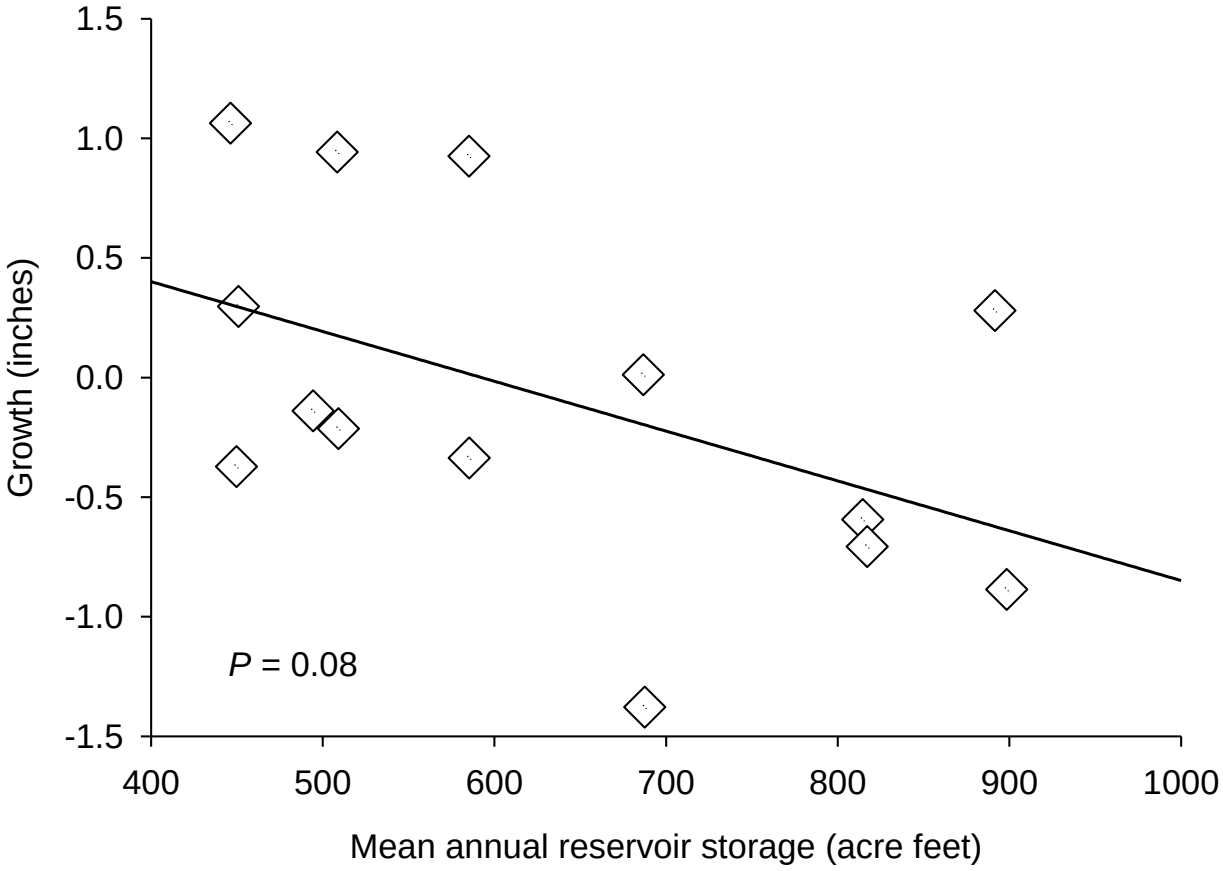

Figure 7. Departure of rainbow trout growth (inches) from long-term mean and mean annual reservoir storage of the Ruby River Reservoir (1993 – 2006).

Appendix

Table 15. Length at age probability of brown trout captured in the Beaverhead River.

Length	Age									
(in)	1	2	3	4	5	6	7	8	9	10
3	100									
4	100									
5	100									
6	100									
7	83	17								
8	28	72								
9	2	98								
10		99	1							
11		88	11	1						
12		79	20	< 1						
13		54	44	1	< 1					
14		21	73	5	1					
15		10	68	21	1					
16		2	60	34	3					
17		1	38	52	7	1				
18		1	26	52	20	1				
19			21	40	33	5	1			
20			9	29	29	29	3			
21				40	40	15		5		
22				50		50				
23					50	25		25		
24						100				
25							100			
26						100				
27										100

Table 16. Length at age probability of brown trout captured in the Ruby River.

Length	Age					
(in)	1	2	3	4	5	6
3	100					
4	100					
5	96	4				
6	97	3				
7	77	23				
8	7	93				
9	1	97	2			
10		91	9			
11		57	43			
12		30	66	3	1	
13		14	80	5		
14		5	70	25	1	
15		2	63	31	4	1
16		1	51	43	5	
17			44	43	11	1
18			46	38	16	
19			35	48	17	
20				60	40	
21						
22					100	

Table 17. Length at age probability of rainbow trout captured in Clark Canyon Reservoir.

Length	Age						
(in)	1	2	3	4	5	6	7
8	100						
9	100						
10	100						
11	100						
12	97	3					
13	100						
14	80	20					
15	75	25					
16	25	65	5		5		
17	2	84	13				
18	3	86	12				
19		87	13				
20		84	12	4			
21		56	37	6	2		
22		49	41	9	2		
23		16	65	8	8		3
24		8	69	15	8		
25						100	

Table 18. Length at age probability of rainbow trout captured in the Red Rock River.

Length	Age						
(in)	1	2	3	4	5	6	7
16		67	33				
17		92	8				
18		62	38				
19		42	45	13			
20		4	60	37			
21		2	26	66	6		
22			28	61	8	2	1
23			29	48	17	6	
24			18	41	36	5	
25					100		
26				50	25	25	

Table 19. Length at age probability of rainbow trout captured in Ruby Reservoir.

Length	Age				
(in)	1	2	3	4	5
9	100				
10	88	12			
11	92	8			
12	72	22	6		
13	19	50	31		
14	1	62	33	3	1
15		64	28	7	1
16		75	21	4	
17			100		
18			67	33	