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BIOMASS AND DENSITY OF BROWN AND RAINBOW TROUT IN NEW MEXICO STREAMS

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Summary

Mean stream numerical density of the brown trout (*Salmo trutta m. fario* Linnaeus, 1758) and the rainbow trout (*Onchorhynchus mykiss* Walbaum, 1792) was 0.090 fish/m^2 of which brown trout averaged 69% (72% in total biomass) in 15 high–elevation New Mexico streams (1,661–2,560 m above sea level). Total trout density varied from 0.008/m^2 in 1988 and 1989. Mean trout density ranged between 0.023–0.121 fish/m^2 at sites open to public fishing. Considerably higher densities (0.142–0.409 fish/m^2) were observed at sites closed for fishing. In the seven selected streams shared by both species, brown trout density exceeded raibow trout density except at the two sites closed to fishing.

Brown trout were stocked only as fingerlings (average 7,000 fish/stream/year) while rainbow trout were stocked only in harvestable sizes (11,000 fish/stream/year). Reported total trout yield rates exceeded the total number of fish estimated to be in the stream by 1.01 to 11.63 in most small streams open to fishing. The proportional stock density (PSD) ranged between 0 and 50 percent. Streams with low to moderate intensities of fishing had the highest PSD.

Key Words: Salmo trutta m. fario, Onchorhynchus mykiss, density, biomass, streams, New Mexico, management

INTRODUCTION

Trout management in streams of the Western United States has emphasized regulations, stocking and, secondarily, habitat considerations. Yet most research has emphasized the relationship between habitat and lightly fished populations (e. g., Lewis, 1969; Griffith, 1972; Binns, 1979) with less attention paid to the impact of angling and stocking on trout population density, growth, mortality, and production. Most management tactics used at

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moderately to intensely fished streams in the Southwest have been established by trial and error and have changed relatively little over recent decades. Stocking rates and harvest regulations remain as they have been for many years, with the exception of a growing number of special regulations waters managed to rely less on stocking. Even so, the fraction of the stream surface area with special protective regulations generally is small. Many intensively fished sites have become little more than a temporary receptacle for artificial stocks of »catchable« size rainbow trout. Brown trout also are stocked as small fingerlings to supplement natural reproduction, with little documentation of stocking effectiveness.

Brown and rainbow trout occur together in many streams. Several authors have suggested that brown trout in some way dominate other trout populations in the genera *Salvelinus* and *Oncorhynchus*, and have suggested that reducing brown trout abundance will somehow favor other species of trout (Shetter and Alexander, 1970; Kozel and Hubert, 1989). Other authors have indicated that brown trout often predominate because they are less likely to be caught by anglers (e. g., Shetter and Alexander, 1965; Millard and MacCrimmon, 1972). The fact that other species of trout persist with brown trout in many lightly fished streams suggest that factors other than the brown trout determine success and failure of *Oncorhynchus spp.* and *Salvelinus spp.* (e. g., Binss and Eiserman, 1979; Platts and McHenry, 1988).

This study was conducted to evaluate the roles that fishing intensity and fishery management play in determining the relative density of brown and rainbow trout in representative streams of New Mexico (Southwestern United States). Included among the studied streams were several sections closed to public fishing. Otherwise streams were selected with a range of fishing intensities and compositions, including streams that were exclusively one species or the other. Several general management recommendations are made from these research.

MATERIAL AND METHODS

Density and Biomass of trout

Fish were progressively captured and removed during three to four passes with a Type VII or Type XI Smith–Rooth DC–current electroshocking unit. Included among 32 study sites at 15 streams were seven sections closed to public fishing (Table 1). Sampled sections were blocked at the upper and lower ends with 6–mm seines. Captured fish were indentified, measured, weighted and returned outside the blocked area if not kept for age determination and other analysis outside of the aim of this paper. Density and biomass were estimated separately for the two species of trout in the streams using the

removal method (Zippin, 1958; Seber and Le Cren, 1967) as defined in a compute program in Platts et al. (1983).

Table 1. Study sites in New Mexico during 1988 and 1989.
Tablica 1. Istraživane postaje u državi New Mexico u tijeku god. 1988. i 1989.

Stream	Code name	Months when sampled	Status and regulations	County
Cebolla River				Sandoval
upper site	Ceb 1	Jun89	NF	
lower site	Ceb 2	Jun89	NF	
Rio de Las Vacas				
upper site	Vac 3	Jun89	NF	
lower site	Vac 4	Jun88	NF	
Guadalupe River	Gdl 3	Jun89	NF	Sandoval
San Antonio River				Sandoval
closed site	San C	Jun88	P, C	
upper site	San 6	Jun88	SR	
		May89		
		Aug89		
		Oct89		
middle site	San 7	Jun88	SR	
		May89		
		Aug89		
		Oct89		
lower site	San 8	May89	NF	
		Aug89		
East Fork of the Jemez River				
closed site	Jem C_1	Jun88	P, C	
closed site	Jem C_2	Jun88	P, C	
upper site	Jem 9	Jun88	NF	
		May89		
		Aug89		
		Oct89		
lower site	Jem 10	May89	NF	
		Aug89		
		Oct89		
Jaramillo Creek				Sandoval
upper site	$JarC_3$	Jun88	P, C	
lower site	$JarC_4$	Jun88	P,C	
Cimarron River				Colfax
upper site	Cim11	Jul88	WA, CG	
middle site	Cim12	Jul89	WA	
lower site	Cim13	Jul88	C&R	

Table 1. Continued

Red River				Taos
upper site	Red14	Jul89	NF, CG	
lower site	Red15	Jul89	SH, C	
Rio Grande				Taos
upper site	RGr16	Jul88	SP, CG	
middle site	RGr17	Oct89	SP, CG	
lower site	RGr18	Oct89	SP, CG	
Rio Pueblo de Taos	Pbo19	Jul88	SP	Taos
Pecos River				San Miguel
upper site	Pec20	Aug88	F&R, CG	
lower site	Pec21	Aug88	F&F, CG	
Mogollon Creek	Mog22	Oct88	P, C	Grant
West Fork of the Gila River	GWF23	Oct88	NM, CG	Catron
		Feb89		
		May89		
		Aug89		
		Oct89		
Penasco River	Pen24	Jul89	NF	Chaves
Mimbres River	Mim25	Mar89	NF, CG	Grant
		May89		
		Aug89		
		Oct89		

*NF=national forest (public fishing), P=private land, SR=special regulations, WA=wildlife area, C&R=catch and release fishing, CG=campground, SP=state park, F&F=fish for fun, NM=national monument, C=sections closed to public fishing, SH=State Hatchery

Analysis

For comparability, trout density and biomass for New Mexico streams were expressed as summarized for 11 Western States by Platts and McHenry (1988). Stream sections that were open to the public were analyzed separately from sections that were closed to the public activities (private land and/or specially protected). USGS topographic maps (7.5 minute series), New Mexico Department of Game and Fish (1991), and USGS Water Resources Data were used to calculate open and closed stream areas that support salmonids. The New Mexico Department of Game and Fish stocking records and angler data survey for 1988–89 were used to estimate number, size, species, areas stocked, and trout yields to anglers.

The proportion of quality-size fish present, the Proportional Stock Density (PSD) of Anderson and Gutreuter (1983) developed for warm water fish species, was estimated for New Mexico brown and rainbow trout. Quality trout size was determined from special regulations used at the streams regulated to provide a quality fishery where trout have to be at least 12 inches

long (30.5 cm) to be legally retained (New Mexico Department of Game and Fish, 1991). A 28–cm length was determined to be the minimum length for the quality category, and an 18–cm minimum length was used for the minimum stock length. The range of 10–cm for stock length was within the ranges used by Anderson and Gutreuter (1983) for several species of warm–water fish.

RESULTS

Density, Biomass, Individual Weight

Brown trout dominated trout density among those streams sampled where both species occurred together. Brown trout were captured in 14 of 15 streams sampled, while rainbow trout were captured in 10 streams (Table 2). Mean stream numerical density of trout was $0.090/m^2$ of which brown trout averaged 69 percent. Mean brown trout density, expressed as biomass, also exceeded rainbow trout density expressed as biomass. Total trout density varied from $0.008/m^2$ to $0.348/m^2$ at the different sites. Brown trout density varied from 0.006 to $0.214/m^2$ and rainbow trout density varied from 0.002 to $0.240/m^2$. Based on monthly data, the rainbow trout density range exceeded the brown trout density range (Appendix Tables 1 to 4). In the seven selected streams shared by both species, brown trout density exceeded rainbow trout density except at two sites closed to fishing, the Red river and Mogollon Greek (Appendix Table 5). The third highest fraction of rainbow trout also occurred at a closed site, on the East Fork of the Jemez River.

Mean individual trout weight varied between 17.5 g and 187.7 g. The mean individual weight of brown trout exceeded that of rainbow trout living together in closed sections of rivers. The mean weight/individual fish averaged lowest at the Mimbres, where small rainbow trout dominated the monospecific trout population, and at Penasco and Cebolla Rivers, where small brown trout dominated the monospecific trout populations. The mean individual weight was greatest in the Rio Pueblo, Cimmaron, and San Antonio where it was open to fishing, and in Jaramillo Creek and the East Fork of the Jemez, which were both closed to fishing.

Fish Yield and Fishing Impact

The total number and weight of fish in the study streams were simple functions of stream surface area and density (Table 3). Consequently small streams had lower trout numbers and weight available in total to anglers. Brown trout were stocked only as small fingerlings (about 25 mm in length) while rainbow trout were stocked only in harvestable sizes (175–225 mm in length). No stocking occurred in closed sites except for the Red River, which received stocked fish from immediately upstream of the closed section. Brown trout were stocked in most open sites; the Pecos, West Fork of the Gila and

Table 2. Density and biomass of rainbow trout (Onchorhynchus mykiss) *and brown trout* (*Salmo trutta*) *in closed and open sections of studied streams in New Mexico for the period 1988 and 1989. W = weighted mean.*

Tablica 2. Gustoća i biomasa dužičaste pastrve (O. mykiss) *i potočne pastrve* (S. trutta m. fario) *zatvorenih i otvorenih dijelova istraživanih vodotoka u državi New Mexico za god. 1988. i 1989. W = srednja težina.*

Stream	Density (D) /range/ ($Fish/m^2$)	$\bar{D}$	Biomass (B) /range/ (g/m^2)	$\bar{B}$	Fish weight (W) /range/ (g)	$\bar{W}$	% Total trout (No)	(B)
Open only								
Cebolla								
Brown	0.085–0.205	0.135	1.49–7.07	4.00	13.1–55.8	34.5	100	100
Cimarron								
Brown	0.004–0.103	0.054	0.26–11. 34	5.80	105.0–257.0	157.3	95	96
Rainbow	—	0.003	—	0.23	—	160.0	5	4
Total	0.004–0.103	0.057	0.26–11.34	6.03	105.0–257.0	105.8	100	100
Las Vacas								
Brown	0.010–0.060	0.037	0.80–4.34	2.65	66.2–77.9	72.1	100	100
Guadalupe								
Brown	0.028–0.069	0.048	2.26–5.69	3.93	1.0–195.0	81.2	100	100
Mimbres								
Rainbow	0.003–0.396	0.159	0.11–10.69	4.02	20.6–38.4	27.5	100	100
Penasco								
Brown	0.030–0.051	0.040	0.95–1.65	1.30	22.0–180.0	32.0	100	100
Pecos								
Brown	0.022–0.122	0.056	0.81–5.57	2.43	37.2–45. 7	41.4	82	54
Rainbow	0.006–0.018	0.012	1.03–3.19	2.11	35.0–292.0	180.0	18	46
Total	0.028–0.140	0.068	1.84–8.76	4.54	92.2–337.7	66.76	100	100
Rio Pueblo de Taos								
Brown	0.025–0.052	0.038	4.64–9.72	7.22	4.0–360.0	187.7	100	100

Table 2. Continued

Rio Grande								
Brown	0.018–0.108	0.050	2.79–5.45	3.99	50.3–196.0	112.3	92	89
Rainbow	0.000–0.0095	0.0045	0.003–1.03	0.51	64.4–310.0	182.8	8	11
Total	0.018–0.1175	0.0545	2.793–6.48	4.50	114.7–506.0	82.6	100	100
W. Fork of the Gila								
Brown	0.002–0.009	0.006	0.10–1.18	0.64	17.0–220.0	96.6	75	88
Rainbow	0.000–0.004	0.002	0.00–0.18	0.09	0.01–0.180	0.075	25	12
Total	0.002–0.013	0.008	0.10–1.36	0.73	17.01–220.2	91.3	100	100
Open only								
Mean (a)	0.023–0. 21	0.065	1.52–6.71	3.89	45.6–222.8	60.3	100	100
Brown							84	83
Rainbow							16	17
Open and closed								
Open								
E. Fork of the Jemez								
Brown	0.026–0.210	0.098	1.13–7.80	4.08	21.4–93.3	47.9	97	94
Rainbow	0.000–0.006	0.003	0.00–0.49	0.25	66.0–260.0	82.6	3	6
Total	0.026–0.216	0.101	1.13–8.29	4.33	87.4–353.3	42.9	100	100
San Antonio								
Brown	0.005–0.064	0.032	0.35–7.78	3.25	16.6–183.5	111.1	100	100
Red River								
Brown	0.012–0.024	0.018	0.54–1.08	0.81	9.0–82.0	44.5	86	40
Rainbow	—	0.003	—	1.21	—	400.0	14	60
Total	0.012–0.024	0.021	0.54–1.08	2.02	9.0–82.0	96.2	100	100
Open								
Mean (b)	*0.014–0.099*	*0.051*	*0.67–5.05*	*3.20*	*37.7–206.3*	*62.7*	*100*	*100*
Brown							*94*	*78*
Rainbow							*6*	*22*

Table 2. Continued

Closed								
E. Fork of the Jemez								
Brown	0.008–0.435	0.214	2.67–35.66	19.33	81.9–354.3	218.1	63	59
Rainbow	0.011–0.253	0.124	2.05–25.98	13.42	102.6–187.4	145.0	37	41
Total	0.019–0.688	0.338	2.72–61.64	32.75	184.5–541.7	96.9	100	100
San Antonio								
Brown	0.118–0.144	0.131	11.36–13.89	12.63	42.0–142.0	96.4	100	100
Red River								
Brown	0.088–0.129	0.108	15.08–22.13	18.61	2.0–1.100	172.0	31	74
Rainbow	0.200–0.258	0.240	5.60–7.22	6.41	2.0–168.0	28.0	69	26
Total	0.288–0.369	0.348	20.68–29.35	25.02	4.0–1.268	71.9	100	100
Closed								
Mean (c)	*0.142–0.400*	*0.272*	*11.59–34.96*	*23.47*	*76.8–650.6*	*86.4*	*100*	*100*
Brown							*65*	*78*
Rainbow							*35*	*22*
Closed and open								
Mean (b,c)	*0.078–0.250*	*0.162*	*6.13–20.01*	*13.34*	*57.1–428.5*	*82.4*	*100*	*100*
Brown							*80*	*78*
Rainbow							*20*	*22*
Only closed								
Jaramillo Creek								
Brown	0.013–0.032	0.023	0.91–3.52	2.22	70.0–158.0	114.0	60	54
Rainbow	0.013–0.016	0.015	1.35–2.48	1.92	104.0–156.0	130.0	40	46
Total	0.026–0.048	0.037	2.26–6.00	4.14	174.0–314.0	111.9	100	100
Mogollon Creek								
Brown	0.009–0.016	0.013	0.33–0.57	0.45	6.5–140.0	35.0	28	55
Rainbow	0.028–0.039	0.034	0.31–0.43	0.37	5.5–51.0	11.0	72	45
Total	0.037–0.055	0.047	0.64–1.00	0.82	12.0–191.0	17.5	100	100

Table 2. Continued

Only closed								
Mean (d)	*0.032–0.052*	*0.042*	*1.45–3.50*	*2.48*	*93.0–252.5*	*59.1*	*100*	*100*
Brown							44	55
Rainbow							56	45
GRAND MEANS								
Only open + Open and closed								
(a)–(b,c)	*0.051–0.185*	*0.113*	*3.83–13.36*	*8.62*	*51.4–325.7*	*76.3*	*100*	*100*
Brown							82	81
Rainbow							18	19
Only closed + Open and closed								
(d)–b,c)	*0.055–0.151*	*0.102*	*3.79–11.76*	*7.91*	*75.1–340.1*	*77.5*	*100*	*100*
Brown							*62*	*67*
Rainbow							*38*	*33*
GRAND GRAND MEAN								
	0.044–0.141	*0.090*	*3.03–10.07*	*6.57*	*65.2–301.3*	*73.0*	*100*	*100*
Brown							*69*	*72*
Rainbow							*31*	*28*

Cimmaron rivers were exceptions. Rainbow trout were stocked in all open waters except those managed for special use, where brown trout sustained fishing. The numbers provided for brown trout represent early 1989, but similar amounts were stocked annually for at least seven years before the study. Rainbow trout in the Mimbres River were selfreproducing; no stocking occurred there.

Table 3. The total number, weight, stocking, and yield of trout in studied streams of New Mexico. PSD=the proportional stock density expressed as a percentage; y=reported trout yield to anglers

Tablica 3. Ukupni broj, težina, umjetni unos i izlov pastrva u istraživanim vodotokovima države New Mexico. PSD = proporcionalna gustoća kvalitetne dužine izražena u postocima; y = ulov sportskih ribolovaca

Stream	Area (ha)	Total number	Total weight (kg)	Number stocked as 200 mm	25 mm	y	PSD
Only open							
Cebolla	3.1						
Brown		4,190	124	—	34,290	4,991	8
Rainbow		—	—	9,290	—	8,670	
Total						13,661	
Cimarron	71.3						
Brown		38,491	4,134	—	—	18,484	6
Rainbow		2,138	164	20,905	—	22,754	1
Total		40,629	4,298			41,238	
Las Vacas	25.8						
Brown		9,561	685	—	8,283	7,785	4
Rainbow		—	—	9,100		11,141	
Total		—	—	—	—	18,926	
Guadalupe	11.8						
Brown		5,654	463	—	20,000	6,463	8
Rainbow		—	—	—	—	61	
Total						6,524	
Mimbres	38.4						
Brown		—	—	—	—	—	
Rainbow		61,056	1,544	—	—	1,173	0
Total						1,173	
Rio Penasco	69.8						
Brown		27,918	907	—	7,300	3,142	0
Rainbow		—	—	16,127	—	19,772	
Total						22,914	
Pecos R.	100.5						
Brown		56,280	2,442	—	—	7,600	0
Rainbow		12,060	2,121	24,390	—	29,300	12
Total		68,340	4,563			36,900	

Table 3. Continued

Rio Pueblo de Taos	19.7							
Brown		7,469	1,419	—	20,000	3,196	50	
Rainbow		—	—	20,000	—	9,606		
Total						12,802		
Rio Grande	416.3							
Brown		208,150	16,610	—	100,780	12,420	27	
Rainbow		18,734	2,123	31,000	—	13,452	9	
Total		226,884	18,733			25,872		
W. Fork of the Gila	3.1							
Brown		187	20	—	—	112		7
Rainbow		62	3	2,894	—	2,783	4	
Total		249	23			2,895		
Open only								
Mean: Brown		35,790	2,680	—	21,000	7,132	12	
Rainbow		9,405	596	13,000	—	11,871	3	
Open and closed								
Open								
E. Fork of the Jemez	8.9							
Brown		8,673	361	—	20,000	6,118	3	
Rainbow		266	22	5,148	—	2,198	0	
Total		8,939	383			8,316		
San Antonio	10.6							
Brown		3,379	343	—	35,000	854		16
Rainbow		—	—	11,143	—	5,021		
Total						5,875,		
Red River	27.6							
Brown		4,968	224	—	—	3,267	0	
Rainbow		828	334	23,690	—	20,109	0	
Total		5,796	558			23,367,		
Open								
Mean: Brown	*5,673*	*309*	—	18,300	3,413	6		
Rainbow		*365*	*119*	13,300	—	9,109	0	
Closed								
E. Fork of the Jemez	5.1							
Brown		10,828	978	—	—	—	17	
Rainbow		6,274	679	—	—	—	22	
Total		17,102	1,657	—	—	—		
San Antonio	6,8							
Brown		8,960	864	—	—	—	4	
Rainbow		—	—	—	—	—		
Red River	7.6							
Brown		8,165	1,407	—	30,000	256		43

Table 3. Continued

Rainbow			18,144	485		6,080	—		64			0
Total			26,309		1,892				320			
Closed												
Mean: Brown			9,318		1,083			10,000	256			21
Rainbow			12,209	582		2,027			64			11
Closed and open												
Mean: Brown			7,487	696		—		14,200		1,834		14
Rainbow			6,237	119		9,700	—			4,587		6
Closed only												
Jaramillo Creek	2.1											
Brown		481		46	—		—		—			0
Rainbow		313		40	—		—		—			0
Total		794		86	—		—		—			
Mogollon Creek	15.6											
Brown			2,028	70	—		—		—			0
Rainbow			5,304	128	—		—		—			
Total			7,332	128	—		—		—			
Closed only												
Mean: Brown			1,255	58	—		—			—		0
Rainbow			*2,809*	*49*	—		—			—		0
GRAND MEANS												
Only open + open and closed												
Brown			21,639		1,688	—		17,600		4,483		13
Rainbow			7,819	358		11,350		—		8,229		5
Total			29,458		2,046	11,350		17,600		12,712		18
Closed only												
Brown			1,255	58								
Rainbow			2,809	49								
Total			4,064	107								
Open only												
Brown			35,790		2,680	—		21,000		7,132		12
Rainbow			9,405	596		13,000		—		11,871		3
Total			45,195		3,276	13,000		21,000		19,003		15
GRAND GRAND MEAN												
Brown			14,844		1,145							
Rainbow			6,150	255								
Total			*20,994*		*1,400*							

Reported total trout yield rates in small streams open to fishing, other than the Mimbres and Rio Penasco, exceeded the total number of fish estimated to be in the stream by 1.01 to 11.63 or more. Most trout in the Mimbres and Rio Penasco were smaller than harvestable size. The fraction taken was substantially lower in the large Rio Grande (0.11). In streams

exclusively occupied by brown trout, in which this fish were stocked only as fingerlings to augment natural reproduction, the yield was near to or lower than density of fish estimated in the stream, such as in the San Antonio, Rio Pueblo, and Guadalupe. Small size may have influenced the fraction of brown rout harvested in the Rio Penasco.

Rainbow trout harvest relied greatly on stocking catchable sizes of fish as shown particularly by reports for the Cebolla, Rio de Las Vacas, the upper Red, Pecos, Rio Penasco, and Cimmaron rivers. The relatively high ratio of rainbow trout yielded to number estimated in the stream reveals the high efficiency in capturing stocked rainbow trout. Of the 180,000 total rainbow trout stocked, 67 percent were estimated to be caught based on the angler mail survey (Table 3).

Natural reproduction must have occurred at sites where no stocking has occurred for many years, i. e., the upper San Antonio, East Fork of the Jemez, Mogollon Creek, Mimbres rivers, and, for brown trout alone, the West Fork of the Gila River. Rainbow trout also reproduced in certain closed waters, including the East Fork of the Jemez, Mogollon Creek, and the open for fishing Mimbres River.

The PSD reflects both the growth rate and the impact of fishing intensity. The PSD generally was lowest in the smaller fished streams and higher in the larger Rio Grande. It was generally highest in the closed East Fork of the Jemez, the closed Red river and in Pueblo de Taos River for brown trout (Table 3). Streams with low to moderate intensities of fishing has the highest PSD.

DISCUSSION

The range of biomass and density observed fits within the renges reported by Platts and McHenry (1988) for 313 western trout streams. Conditions in New Mexico streams are generally similar to other western streams, but intermittent flows may be a more frequent occurrence, particularly in the Gila Mountains. Streams prone to intermittent flows in riffles, such as the Mogollon, Mimbres, and Jaramillo, had low biomass mostly because of undependable stream flow. Greater fluctuation in annual precipitation, erosion, silitation and loss of cover were the cause of observed weak year classes of trout in a small Minnesota stream (Waters, 1983). Thus, small streams without reliable spring–water contributions were among the least productive trout habitats. Both brown trout and rainbow trout populations appeared to be well sustained by natural reproduction in streams closed to public fishing where both species had become established, even in streams affected by intermittent surface flows in riffles. The closed section of the Red River was too short to judge reproductive success, and it was heavily influenced by stocking upstream (State Hatchery).

Fished streams were all stocked with fingerling brown trout. The low PSD in most fished streams indicated a need to stock brown trout to augment low

biomass of reproductive females. Other fished streams, such as the Rio Pueblo and Rio Grande, appeared to be able to sustain fished brown trout populations from natural recruitment. A management alternative to stocking brown trout as fingerlings would be to increase harvest length and forbid bait fishing to reduce mortality of returned fish (Barwick, 1985).

Rainbow trout were not stocked in sufficient quantities for natural reproduction to occur with the fishing intensity and yield that occurred. Angler catch rates in New Mexico streams has almost indentical impact on numbers of rainbow trout stocked as reported by Moring (1985) for Oregon streams (25 to 50% reduction). Encouraging more natural reproduction or maintaining fisheries with fingerling stocking would require changes in regulations, such as bigger size limits and prohibition of natural baits.

Brown trout and rainbow trout appear to sustain coexisting populations in waters closed to the public, without competitive or predatory exclusion. Binns and Eiserman (1979) also reported many streams with populations of both species in lightly fished and lightly managed waters. Kondolf et al. (1991) believed brown trout may have a reproductive advantage in natural waters because brown trout egg incubation and hatching generally proceeds earlier than that of rainbow trout and before most scouring flows occur. Brown trout also evidence broader diets, eating other fish more frequently than rainbow trout (e. g., Mills, 1971). The tendency for brown trout to dominate trout populations may be related to both factors. Also, based on populations in the Mimbres River and Mogollon Creek, rainbow trout may better tolerate intermittent flow in riffles, leaving isolated pools.

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Sažetak

BIOMASA I GUSTOĆA POTOČNE I DUŽIČASTE PASTRVE U VODOTOCIMA DRŽAVE NEW MEXICO

Srednja brojčana vrijednost gustoće potočne (*Salmo trutta m. fario* Linnaeus, 1758) i dužičaste pastrve (*Oncorhynchus mykiss* Walbaum, 1792) u 15 vodoka (nadmorska visina između 1.661 i 2.560 m) države New Mexico iznosila je 0,090 riba/m^2, s prosječnom zastupljenošću potočne pastrve od 69%, odnosno

72% ukupne biomase. Variranje ukupne gustoće u god. 1988. i 1989. procijenjena je između 0,023 i 0,121 riba/m^2 na istraživanim postajama otvorenima za sportski ribolov. Znatno je veća gustoća (0,142–0,409) riba/m^2) zabilježena na postajama na kojima je ribolov bio zabranjen. Na sedam izabranih vodotoka, čija su staništa zauzimala obje vrste, gustoća je potočne pastrve bila veća od gustoće dužičaste, uz izuzetak na dvjema postajama zatvorenima za športski ribolov.

Umjetno unošenje (introdukcija) potočne pastrve bilo je temeljeno na juvenilnim stadijima (prosječno 7. 000 riba po vodotoku na godinu), a dužičasta je unošena isključivo u lovnoj dužini (prosječno 11.000 riba po vodotoku na godinu). Prijavljeni ukupni ulov procijenjen je kao veći u odnosu na procijenjeni broj riba u većini malih vodotoka otvorenih za ribolov, a izražen je koeficijentom od 1,01 do 11,63.

Proporcionalna gustoća kvalitetne dužine (PSD) pastrva bila je u rasponu od 0 do 50%. Vodotokovi s niskim do umjerenim intenzitetom ribolova imali su i najviši PSD.

Ključne riječi: Salmo trutta m. fario, Oncorhynchus mykiss, gustoća, biomasa, vodotokovi, New Mexico (jugozapad SAD), gospodarenje

Appendix/Table 1. The total catch of brown trout per sampling area and population estimated for New Mexico streams during 1988 and 1989. Stream sites are defined in Table 1. T. C. = total catch per area sampled; P. E. = population estimated; S. E. = population estimated standard error; A = area sampled; W = average trout weight; B = total biomass per sampled area; p = capture probability.

Prilog/Tablica 1. Ukupni ulov potočne pastrve po uzorkovanoj površini i procjena populacije za vodotokove države New Mexico za god. 1988. i 1989. Postaje su definirane u tablici 1. T. C. = ukupni ulov prema uzorkovanoj površini; P. E. = procjena populacije; S. E. = standardna pogreška procjene populacije; A = uzorkovana površina; W = prosječna težina pastrve; B = ukupna biomasa prema uzorkovanoj površini; p = vjerojatnost ulova.

Site	Date	T. C.	P. E.	S. E.	A(m^2)	W(g)	B(kg)	*p*
Ceb 1	JUN89	27	30+/–30%	4.5	187	13.1	0.39	0.51
Ceb 2	JUN89	29	31+/–20%	3.1	293	55.8	1.73	0.58
Vac 3	JUN89	32	34+/–19%	3.2	613	66.2	2.25	0.58
Vac 4	JUN88	13	14+/–44%	3.1	779	77.9	1.09	0.54
Gdl 5	JUN89	23	27+/–44%	5.9	558	81.2	2.19	0.45
SAn 6	JUN88	13	13+/–20%	1.3	647	151.9	1.97	0.72
	MAY89	9	9+/–49%	2.2	425	128.0	1.15	0.60
	AUG89	2	2		391	145.0	0.29	
	OCT89	9	9+/–16%	0.7	410	113. 9	1.03	0.90
SAn 7	JUN88	10	10+/–40%	2.0	295	183.5	1.84	0.63
	MAY89	20	21+/–25%	2.6	824	128.0	2.69	0.49
	AUG89	36	37+/–12%	2.2	795	75.2	2.78	0.55

Appendix / Table 1. Continued

	OCT89	24	26+/–27%	3.5	791	77.8	2.02	0.55
SAn 8	MAY89	27	28+/–16%	2.3	513	91.0	2.55	0.63
	AUG89	12	12+/–23%	1.4	437	16.6	0.20	0.71
Jem 9	JUN88	15	15+/–13%	1.0	502	93.3	1.40	0.79
	MAY89	35	36+/–11%	2.0	398	51.0	1.84	0.67
	AUG89	47	54+/–24%	6.4	396	46.4	2.51	0.49
	OCT89	42	43+/–9%	2.0	405	48.4	2.08	0.86
Jem10	MAY89	31	32+/–14%	2.2	520	46.6	1.49	0.65
	AUG89	33	42+/–47%	9.8	435	21.4	0.90	0.40
	OCT89	59	71+/–26%	9.3	424	28.4	2.02	0.44
Cim11	JUL88	4	4		1006	257.0	1.03,	
Cim12	JUL89	33	35+/–19%	3.3	558	105.0	3.67	0.58
Cim13	JUL88	61	65+/–11%	3.7	699	109.8	7.14	0.50
Red14	JUL89	6	6+/–33%	1.0	330	44.5	0.27	0.86
Red15	JUL89	74	86+/–19%	8.3	795	172.0	14.79	0.47
RGr16	JUL88	48	52+/–16%	4.2	2400	196.0	10.19	0.56
RGr17	OCT89	33	33+/–9%	1.5	979	90.7	2.99	0.72
RGr18	OCT89	111	132+/–17%	11.3	1423	50.3	6.64	0.46
Pbo19	JUL88	26	30+/–36%	5.4	780	187.7	5.63	0.47
Pec20	AUG88	20	22+/–36%	4.0	660	37.2	0.82	0.51
Pec21	AUG88	39	54+/–55%	14.9	683	45.7	2.47	0.34
Mog22	OCT88	14	14+/–27%	1.9	1093	35.0	0.49	0.64
GWF23	OCT88	6	6+/–60%	1.8	1052	131.0	0.79	0.67
	FEB89	4	4		527	17.0	0.07,	
	MAY89	5	5		685	59. 0	0.30,	
	AUG89	1	1		575	56.0	0.06,	
	OCT89	1	1		514	220.0	0.22,	
Pen24	JUL89	35	40+/–27%	5.5	988	32.0	1.28	0.39
Sum	*40*	*1,069*	*1,186*		*26,785*		*95.26*	
Average		*26.73*	*29.7+/–26%*		*669.6*	*89.7*	*2.38*	*0.58* .

Appendix/Table 2. Density and biomass of brown trout in selected streams of New Mexico estimated for the period 1988 and 1989. The source data are tabulated in Appendix Table 1.
Prilog/Tablica 2. Gustoća i biomasa potočne pastrve u izabranim vodotokovima države New Mexico procijenjene za god. 1988. i 1989. Izvorni su podaci prikazani u Prilog/Tablica 1.

Stream	Density (range)	$\bar{X}$	Biomass (range)	$\bar{X}$
	Fish/m^2		g/m^2	
Cebolla 1	0. 114 to 0.205	0.160	1.49 to 2.69	2.10
Cebolla 2	0.085 to 0.127	0.110	4.74 to 7.07	5.90
	0.085 to 0.205	*0.135*	*1.49 to 7.07*	*4.00*
L. Vacas 3	0.045 to 0.066	0.055	3.00 to 4.34	3.70
L. Vacas 4	0. 10 to 0.026	0.018	0.80 to 2.00	1.60
	0.010 to 0.060	*0.037*	*0.80 to 4.34*	*2.65*
Guadal. 5	*0.028 to 0.069*	*0.048*	*2.26 to 5.62*	***3.93***
S. Anto 6	0.016 to 0.024	0.020	2.44 to 3.66	3.05
	0.011 to 0.031	0.021	1.42 to 4.01	2.71
	0.005	—	0.37	—
	0.019 to 0.025	0.022	2.14 to 2.89	2.50
S. Anto. 7	0.021 to 0.047	0.034	3.79 to 8.65	6.22
	0.019 to 0.032	0.025	2.49 to 4.04	3.27
	0.041 to 0.052	0.047	3.09 to 3.91	3.50
	0.024 to 0.042	0.033	1.88 to 3.24	2.56
S. Anto 8	0.046 to 0.064	0.055	4.15 to 5.78	4.97
	0.021 to 0.034	0.027	0.35 to 0.56	0.46
	0.005 to 0.064	*0.032*	*0.35 to 5.78*	*3.25*
Jemez 9	0.026 to 0.034	0.030	2.43 to 3.14	2.79
	0.081 to 0.100	0.090	4.11 to 5.11	4.61
	0.105 to 0.168	0.136	4.85 to 7.80	6.33
	0.096 to 0.116	0.106	4.66 to 5.61	5.13
Jemez 10	0.053 to 0.071	0.062	2.48 to 3.25	2.87
	0.053 to 0.142	0.097	1.13 to 3.01	2.07
	0.125 to 0.210	0.167	3.54 to 5.97	4.76
	0.026 to 0.210	*0.098*	*1.13 to 7.80*	*4.08*
Cimar. 11	0.004	—	0.26	—
Cimar. 12	0.051 to 0.074	0.063	5.328 to 7.79	6.59
	Fish/m^2		*g/m^2*	
Cimar. 13	0.083 to 0.103	0.093	9.08 to 11.34	10.21
	0.004 to 0.103	*0.054*	*0.26 to 11.34*	*5.80*
Red 14	0.012 to 0.024	0.018	0.54 to 1.08	0.81
Red 15	0.88 to 0.129	0.108	15.08 to 22.13	18.61

Appendix/Table 2. Density and biomass of brown trout in selected streams of New Mexico estimated for the period 1988 and 1989. The source data are tabulated in Appendix Table 1.
Prilog/Tablica 2. Gustoća i biomasa potočne pastrve u izabranim vodotokovima države New Mexico procijenjene za god. 1988. i 1989. Izvorni su podaci prikazani u Prilog/Tablica 1.

Stream	Density (range)	$\bar{X}$	Biomass (range)	$\bar{X}$
	Fish/m^2		g/m^2	
Cebolla 1	0. 114 to 0.205	0.160	1.49 to 2.69	2.10
Cebolla 2	0.085 to 0.127	0.110	4.74 to 7.07	5.90
	0.085 to 0.205	*0.135*	*1.49 to 7.07*	*4.00*
L. Vacas 3	0.045 to 0.066	0.055	3.00 to 4.34	3.70
L. Vacas 4	0. 10 to 0.026	0.018	0.80 to 2.00	1.60
	0.010 to 0.060	*0.037*	*0.80 to 4.34*	*2.65*
Guadal. 5	*0.028 to 0.069*	*0.048*	*2.26 to 5.62*	***3.93***
S. Anto 6	0.016 to 0.024	0.020	2.44 to 3.66	3.05
	0.011 to 0.031	0.021	1.42 to 4.01	2.71
	0.005	—	0.37	—
	0.019 to 0.025	0.022	2.14 to 2.89	2.50
S. Anto. 7	0.021 to 0.047	0.034	3.79 to 8.65	6.22
	0.019 to 0.032	0.025	2.49 to 4.04	3.27
	0.041 to 0.052	0.047	3.09 to 3.91	3.50
	0.024 to 0.042	0.033	1.88 to 3.24	2.56
S. Anto 8	0.046 to 0.064	0.055	4.15 to 5.78	4.97
	0.021 to 0.034	0.027	0.35 to 0.56	0.46
	0.005 to 0.064	*0.032*	*0.35 to 5.78*	*3.25*
Jemez 9	0.026 to 0.034	0.030	2.43 to 3.14	2.79
	0.081 to 0.100	0.090	4.11 to 5.11	4.61
	0.105 to 0.168	0.136	4.85 to 7.80	6.33
	0.096 to 0.116	0.106	4.66 to 5.61	5.13
Jemez 10	0.053 to 0.071	0.062	2.48 to 3.25	2.87
	0.053 to 0.142	0.097	1.13 to 3.01	2.07
	0.125 to 0.210	0.167	3.54 to 5.97	4.76
	0.026 to 0.210	*0.098*	*1.13 to 7.80*	*4.08*
Cimar. 11	0.004	—	0.26	—
Cimar. 12	0.051 to 0.074	0.063	5.328 to 7.79	6.59
	Fish/m^2		*g/m^2*	
Cimar. 13	0.083 to 0.103	0.093	9.08 to 11.34	10.21
	0.004 to 0.103	*0.054*	*0.26 to 11.34*	*5.80*
Red 14	0.012 to 0.024	0.018	0.54 to 1.08	0.81
Red 15	0.88 to 0.129	0.108	15.08 to 22.13	18.61

Appendix / Table 2. Continued

	0.012 to 0.129	*0.063*	*0.54 to 22.13*	*9.71*
Rio G. 16	0.018 to 0.025	0.022	3.57 to 4.97	4.25
Rio G. 17	0.031 to 0.047	0.034	2.79 to 3.33	3.06
Rio G. 18	0.077 to 0.108	0. 093	3.88 to 5.45	4.67
	0.018 to 0.108	*0.050*	*2.79 to 5.45*	*3.99*
Pueblo 19	*0.025 to 0.052*	*0.038*	*4.64 to 9.72*	*7.22*
Pecos 20	0.022 to 0.045	0.033	0.81 to 1.68	1.24
Pecos 21	0.036 to 0.122	0.079	1.66 to 5.57	3.61
	0.022 to 0.122	*0.056*	*0.81 to 5.57*	*2.43*
Mogol. 22	*0.009 to 0.016*	*0.013*	*0.33 to 0.57*	*0.45*
GWF 23	0.002 to 0.009	0.006	0.31 to 1.18	0.75
	0.008	—	0.13	—
	0.007	—	0.43	—
	0.002	—	0.10	—
	0.002	—	0.42	—
	0.002 to 0.009	*0.006*	*0.10 to 1.18*	*0.64*
Penas. 24	0.030 to 0.051	0.040	0.95 to 1.65	1.30
Averaged for all sites	*0.002 to 0.210*	*0.033*	*0.10 to 11.34*	*2.79*

Apendix/Table 3. Total catch of rainbow trout per area sampled and population estimated for the selected New Mexico streams during 1988 and 1989. Stream sites are defined in Table 1. T. C. = total catch per sampled area; P. E. = population estimated; S. E. = population estimated standard error; A = area sampled; W = average trout weight; B = total biomass per sampled area; p = capture probability.

Prilog/Tablica 3. Ukupni ulov dužičaste pastrve po uzorkovanoj površini i procjena populacije za izabrane vodotoke države New Mexico za god. 1988. i 1989. Postaje su definirane u tablici 1. T. C. = ukupni ulov prema uzorkovanoj površini; P. E. = procjena populacije; S. E. = standardna pogreška procjene populacije; A = uzorkovana površina; W = prosječna težina pastrve; B = ukupna biomasa prema uzorkovanoj površini; p = vjerojatnost ulova

Site	Date	T.C.	P.E.	S.E.	A (m^2)	W (g)	B (kg)	p(%)
Jem 9	JUN 88	1	1		502	112.0	0.11	
	MAY 89	1	1		398	140.0	0.14	
	AUG 89	1	1		396	66.0	0.07	
	OCT 89	0	0		405	0.0	0.00	
Jem 10	MAY 89	3	3		520	260.0	0.78	
	AUG 89	0	0		435	0.0	0.00	
	OCT 89	0	0		424	0.0	0.00	
Cim 13	JUL 88	2	2		699	160.0	0.32	

Appendix / Table 3. Continued

Red 14	JUL 89	1	1		330	400.0	0.40	
Red 15	JUL 89	156	189+/–13%	11.8	795	28.0	5.10	0.47
Rgr 16	JUL 88	4	4+/–85%	1.7	2400	310.0	1.24	0.67
Rgr 17	OCT 89	1	1		979	174.0	0.17	
RGr 18	OCT 89	11	11+/–24%	1.3	1423	64.4	0.71	0.73
Pbo 19	JUL 88	1	1		780	140.0	0.14	
Pec 21	AUG 89	8	8+/–52%	2.1	683	180.0	1.44	0.62
Mog 22	OCT 88	35	37+/–17%	2.1	1093	11.0	0.41	0.59
GWF 23	OCT 88	1	1		1052	11.0	0.011	
	FEB 89	2	2		527	18.0	0.036	
	MAY 89	3	3		685	40.0	0.120	
	AUG 89	0	0		575	0.0	0.000	
	OCT 89	1	1		514	19.0	0.019	
Mim 25	MAR89	49	57+/–25%	7.1	216	24.0	1.37	0.47
	MAY 89	54	67+/–31%	10.5	221	27.0	1.81	0.42
	AUG 89	4	4+/–75%	1.5	380	38.4	0.15	0.80
	OCT 89	13	13+/–6%	0.9	232	20.6	0.27	0.81
Sum	*25*	*352*	*408*		*16,644*		*14.82*	
Average		*14.1*	*16.3+/–36%*		*666.6*	*89.7*	*0.59*	*0.62*

Appendix/Table 4. Density and biomass of rainbow trout in selected streams of New Mexico estimated for the period 1988 and 1989. The source data are tabulated in Appendix Table 3.
Prilog/Tablica 4. Gustoća i biomasa dužičaste pastrve u izabranim vodotokovima države New Mexico procijenjene za god. 1988. i 1989. Izvorni su podaci prikazani u Prilog/Tablica 3.

Stream	*Density (range) Fish/m²*	$\bar{X}$	Biomass (range) *g/m²*	X
Jemez 9	0.002	—	0.22	—
	0.003	—	0.35	—
	0.003	—	0.17	—
	—		—	
Jemez 10	0.006	—	0.49	—
	—		—	
	—		—	
	0.000 to 0.006	*0.003*	*0.00 to 0.49*	*0.25*
Cimar. 13	*0.003*	—	*0.23*	—
Red 14	0.003	—	1.21	—
Red 15	0.200 to 0.258	0.240	5.60 to 7.22	6.41
	0.003 to 0.258	*0.130*	*1.21 to 7.22*	*4.22*
Rio G. 16	0.000 to 0.003	0.002	0.003 to 1.03	0.52

Appendix / Table 4. Continued				
Rio G. 17	0.001	—	0.18	—
Rio G. 18	0.006 to 0.0095	0.0077	0.385 to 0.611	0.50
	0.000 to 0.0095	*0.0045*	*0.003 to 1.030*	*0.51*
Pueblo 19	*0.001*	—	*0.18*	—
Pecos 21	*0.006 to 0.018*	*0.012*	*1.03 to 3.19*	*2.11*
Mogol. 22	*0.028 to 0.039*	*0.034*	*0.31 to 0.43*	*0.37*
GWF 23	0.001	—	0.01	—
	0.004	—	0.07	—
	0.004	—	0.18	—
	—		—	
	0.002	—	0.04	—
	0.000 to 0.004	*0.002*	*0.00 to 0.18*	*0.09*
Mimb. 25	0.200 to 0.328	0.264	4.79 to 7.88	6.33
	0.210 to 0.396	0.303	5.68 to 10.69	8.19
	0.003 to 0.018	0.011	0.11 to 0.70	0.40
	0.049 to 0.063	0.056	1.00 to 1.31	1.15
	0.003 to 0.396	*0.159*	*0.11 to 10.69*	*4.02*
Average for all sites	*0.000 to 0.396*	*0.060*	*0.00 to 10.96*	*1.82*

Appendix/Table 5. Average percentage contribution to density and biomas of brown and rainbow trout in selected New Mexico streams for the period of study, 1988 to 1989. Source for the presented data are listed in Appendix Table 2 and 4.

Prilog/Tablica 5. Prosječna postotna zastupljenost gustoće i biomase potočne i dužičaste pastrve u izabranim vodotokovima države New Mexico u istraživanom razdoblju, od god. 1988. do 1989. Izvor podataka prikazan je u Prilog/Tablica 2. i Prilog/Tablica 4.

Stream	Species	*Density Fish/m²*	(%)	Biomass *g/m²*	(%)
East Fork of the Jemez R.	*Brown*	0.098	(97)	4.08	(94)
	Rainbow	0.003	(3)	0.25	(6)
	TOTAL	0.101	(100)	4.33	(100)
Red River	*Brown*	0.063	(33)	9.71	(70)
	Rainbow	0.130	(67)	4.22	(30)
	TOTAL	0.193	(100)	13.93	(100)
Rio Grande R.	*Brown*	0.050	(92)	3.99	(89)
	Rainbow	0.0045	(8)	0.51	(11)
	TOTAL	0.0545	(100)	4.50	(100)
Pecos River	*Brown*	0.056	(82)	2.43	(54)
	Rainbow	0.012	(18)	2.11	(46)
	TOTAL	0.068	(100)	4.54	(100)

Appendix / Table 5. Continued

Cimarron R.	*Brown*	0.054	(95)	5.80	(96)
	Rainbow	0.003	(5)	0.23	(4)
	TOTAL	0.057	(100)	6.03	(100)
Mogollon Cr.	*Brown*	0.013	(28)	0.45	(55)
	Rainbow	0.034	(72)	0.37	(45)
	TOTAL	0.047	(100)	0.82	(100)
West Fork of the Gila R.	*Brown*	0.006	(75)	0.64	(88)
	Rainbow	0.002	(25)	0.09	(12)
	TOTAL	0.008	(100)	0.73	(100)
Averaged for all streams	Brown		72		78
	Rainbow		28		22
	TOTAL		100		100

REFERENCES

Anderson R. O., Gutreuter S. J. (1983): Length, weight, and associated structural indices, pp 283–300. In L. A. Nielsen and L. Johnson (editors), Fisheries Techniques. Southern Printing Company, Blacksburg, Virginia.

Barwick D. H. (1985): Stocking and hooking mortality of planted rainbow trout in Jocassee Reservoir, South Carolina. North American Journal of Fisheries Management 5: 580–583.

Binns N. A. (1979): A habitat quality index for Wyoming trout streams. Monograph Series, Fishery Research Report 2. Cheyenne, Wyoming: Wyoming Game and Fish Department, 75 pp.

Binns N. A., Eiserman F. M. (1979): Quantification of fluvial trout habitat in Wyoming. Transactions of the American Fisheries Society 108: 215–228.

Griffith J. S., Jr. (1972): Comparative behavior and habitat utilization of brook trout (*Salvelinus fontinalis*) and catthroat trout (*Salmo clarki*) in small streams in Northern Idaho. Journal of the Fisheries Research Board of Canada 29: 265–273.

Kondolf G. M., Cada G. F., Sale M. J., Felando T. (1991): Distribution and stability of potential salmonid spawning gravel in steep boulder–bed streams of the Eastern Sierra Nevada. Transactions of the American Fisheries Society 120: 177–186.

Kozel S. J., Hubert W. A. (1989): Factors influencing the abundance of brook trout (*S. fontinalis*) in forested mountain streams. Journal of Freshwater Ecology 5: 113–122.

Lewis S. L. (1969): Physical factors influencing fish populations in pools of a trout stream. Transactions of the American Fisheries Society 98: 14–19.

Millard T. J., MacCrimmon H. R. (1972): Evalution of the contribution of supplemental plantings of brown trout *Salmo trutta* (L.) to a self–sustai-

ning fishery in the Sydeham River, Ontario, Canada. Journal of Fish Biology 4: 369–384.

Mills D. (1971): Salmon and Trout: A resource, its ecology, conservation and management. St. Martin's Press. New York.

Moring J. R. (1985): Relation of angler catch rates and effort to reductions in numbers of trout stocked in five Oregon streams. North American Journal of Fisheries Management 5: 575–579.

New Mexico Department of Game and Fish (1991): New Mexico Fishing Proclamation. Santa Fe, New Mexico, 16 pp.

Platts W. S., Megahan W. F., Minshall G. W. (1983): Methods for evaluating stream, riparian, and biotic conditions. General Technical Report INT–138. Ogden, Utah: United States Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station, 71 pp.

Platts W. S., McHenry M. L. (1988): Density and biomass of trout and char in western streams. General Technical Report INT–241. Ogden, Utah: United States Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station, 17 pp.

Seber G. A. F., Le Cren E. D. (1967): Estimating population parameters from catches large relative to the population. Journal of Animal Ecology 36: 631–643.

Shetter D. S., Alexander G. R. (1965): Results of angling under special and normal trout fishing regulations in a Michigan trout stream. Transactions of the American Fisheries Society 94: 219–226.

Shetter D. S., Alexander G. R. (1970): Results of predator reduction on brook trout and brown trout in 4. 2 miles (6. 76 km) of the north branch of the Au Sable River. Transactions of the American Fisheries Society 99: 312–319.

Waters T. F. (1983): Replacement of brook trout by brown trout over 15 years in a Minnesota stream: production and abundance. Transactions of the American Fisheries Society 112: 137–146.

Zippin C. (1958): The removal method of population estimation. Journal of Wildlife Management 22: 82–90.

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