OFFICE MEMO

TO:

Date

FROM: 1978 Wyoming Specimens

SUBJECT: for 79 Rep. IV

REMARKS:

bouvieri	Klar	Utah	golden
– Heidy L.	Teepee	Country	Washakie
– Turquoise L.	Big Sandstone		L. Deep Cr.
– Cottonwood L.			

CHARACTER ANALYSIS SHEET - COLORADO COOPERATIVE FISHERY UNIT

SPECIES ______________ LOCALITY LEIDY LAKE

COLLECTED BY ______________ DATE 6/29/78

Cat. # __________ Measurements by ______________ DATE __________

Specimen #	1	2	3	4	5	6	7	8
Total L.	238	223	201	243	210	198	214	197
Standard L.	207	192	172	213	182	172	185	171
Body D								
Head L								
Orbit L								
Upper Jaw L								
Dors. Orig. to Snt. tip								
Dorsal fin basal L								
Dorsal fin depressed L								
Adip. fin depressed L								
Caudal peduncle D								
Caudal peduncle L								
Vertebrae								
1st Arch gillrakers (up)	7 | 0	7 | 1	6 | 0	7 | 0	7 | 0	7 | 0	8 | 0	8 | 1
(lower)	12 | 0	12 | 0	12 | 0	12 | 0	13 | 0	13 | 0	13 | 0	12 | 0
(total)	19	19	18	19	20	20	21	20
Branchiostegal rays right								
(left)								
Dorsal rays								
Anal rays								
Pectoral fin rays								
Scales in lateral line								
Scales above lateral line	39	44	44	46	44	45	45	42
Scales 2 rows above lat.	179	175	176	186	184	181	191	177
Pelvic fin rays								
Pyloric caeca	41	35	36	48	36		43	38
Dentition	22	21	13	41-42	20	27	12	7

CHARACTER ANALYSIS SHEET - COLORADO COOPERATIVE FISHERY UNIT

SPECIES S. C. LOCALITY Turquoise LAke

COLLECTED BY ______ DATE ______

Cat. # ______ Measurements by ______ DATE ______

Specimen #	1	2	3	4	5	6	7
Total L.	274	179	234	171	293		
Standard L.	235	149	195	143	248		
Body D							
Head L							
Orbit L							
Upper Jaw L							
Dors. Orig. to Snt. tip							
Dorsal fin basal L							
Dorsal fin depressed L							
Adip. fin depressed L							
Caudal peduncle D							
Caudal peduncle L							
Vertebrae							
1st Arch gillrakers (up)	7 | 3	7 | 0	7 | 0	7 | 0	7 | 1		
(lower)	12 | 1	12 | 0	10 | 0	13 | 0	12 | 1		
(total)	19	19	17	20	19		
Branchiostegal rays right							
(left)							
Dorsal rays							
Anal rays							
Pectoral fin rays							
Scales in lateral line							
Scales above lateral line	39	41	46	40	40		
Scales 2 rows above lat. <	162	140	158	143	154		
Pelvic fin rays	9	10	10	10	9		
Pyloric caeca	44	45	47	45	50		
Dentition	4	1	3	4	3		
Pectoral	14	14	14	14	16		
Dorsal	11	12	12	11	12		
Anal	11	11	13	10	11		

CHARACTER ANALYSIS SHEET - COLORADO COOPERATIVE FISHERY UNIT

SPECIES ______________________ LOCALITY Hidden Creek

COLLECTED BY ______________________ DATE __________

Cat. # __________ Measurements by ______________ DATE __________

Specimen #

	1	2	3	4			
Total L.	295	343	338	257			
Standard L.	261	301	299	224			
Body D							
Head L							
Orbit L							
Upper Jaw L							
Dors. Orig. to Snt. tip							
Dorsal fin basal L							
Dorsal fin depressed L							
Adip. fin depressed L							
Caudal peduncle D							
Caudal peduncle L							
Vertebrae							
1st Arch gillrakers (up)	8 | 3	8 | 4	7 | 2	7 | 4			
(lower)	12 | 1	11 | 2	12 | 2	13 | 2			
(total)	20	19	19	20			
Branchiostegal rays right							
(left)							
Dorsal rays							
Anal rays							
Pectoral fin rays							
Scales in lateral line							
Scales above lateral line	43		49	46			
Scales 2 rows above lat.	154		189	175			
Pelvic fin rays							
Pyloric caeca	29	36	30	25			
Dentition	~~13~~ 15	17	11	8			

CHARACTER ANALYSIS SHEET - COLORADO COOPERATIVE FISHERY UNIT

SPECIES ______________ LOCALITY Hidden Cr.

COLLECTED BY ______________ DATE ______________

Cat. # __________ Measurements by ______________ DATE ______________

Specimen #

	1	2	3	4	5	6	7	
Total L.	337	242	234	289	250	247	272	
Standard L.	293	213	203	252	216	210	232	
Body D								
Head L								
Orbit L								
Upper Jaw L								
Dors. Orig. to Snt. tip								
Dorsal fin basal L								
Dorsal fin depressed L								
Adip. fin depressed L								
Caudal peduncle D								
Caudal peduncle L								
Vertebrae								
1st Arch gillrakers (up)	8 / 4	9 / 5	8 / 5	7 / 4	7 / 4	8 / 4	8 / 4	
(lower)	12 / 4	13 / 1	12 / 1	12 / 2	13 / 4	14 / 5	12 / 4	
(total)	20	22	20	19	20 / 8	22 / 9	20 / 8	
Branchiostegal rays right								
(left)								
Dorsal rays								
Anal rays								
Pectoral fin rays								
Scales in lateral line								
Scales above lateral line	45	47	49	40	40	45	42	
Scales 2 rows above lat.	187	200	189	173	168	176	182	
Pelvic fin rays								
Pyloric caeca	36	47	34	37	37	22		
Dentition	17	8	13	9	8	6	16	

CHARACTER ANALYSIS SHEET - COLORADO COOPERATIVE FISHERY UNIT

SPECIES ______________ LOCALITY Cottenwood LAKE

COLLECTED BY ______________ DATE ______________

Cat. # ______________ Measurements by ______________ DATE ______________

Specimen #

	1	2	3	4				
Total L.	318	295	307	290				
Standard L.	273	253	262	254				
Body D	45	4	45					
Head L								
Orbit L								
Upper Jaw L								
Dors. Orig. to Snt. tip								
Dorsal fin basal L								
Dorsal fin depressed L								
Adip. fin depressed L								
Caudal peduncle D								
Caudal peduncle L								
Vertebrae								
1st Arch gillrakers (up)	8 / 5	9 / 4	7 / 2	8 / 5				
(lower)	12 / 1	13 / 2	(9) / 0	12 / 4				
(total)	20	22	16	~~19~~ 20				
Branchiostegal rays right			aberrant					
(left)			first 3 not					
Dorsal rays			developed					
Anal rays								
Pectoral fin rays								
Scales in lateral line								
Scales above lateral line	45	49	48	43				
Scales 2 rows above lat.	198	195	176	187				
Pelvic fin rays								
Pyloric caeca	O	O	46	O				
Dentition	17	24	13	12				

Yellowstone - like
but #3 - dense, smaller spots on peducle
almost as "west-slope"
perhaps fine-spotted hybrid
- #3 is deformed - L. ~~maxillary~~ dentary
missing, maxillary & opercle bones
deformed.

CHARACTER ANALYSIS SHEET - COLORADO COOPERATIVE FISHERY UNIT

SPECIES S. c. pleuriticus LOCALITY Big Standstone Cr. near headwaters

COLLECTED BY ______ DATE 10/13/78

Cat. # ______ Measurements by ______ DATE ______

Specimen #	1	2	3	4	5	6	7	8	9
Total L.	194	140	185	155	171	189	186	155	141
Standard L.	165	121	158	133	146	160	157	129	121
Body D									
Head L									
Orbit L									
Upper Jaw L									
Dors. Orig. to Snt. tip									
Dorsal fin basal L									
Dorsal fin depressed L									
Adip. fin depressed L									
Caudal peduncle D									
Caudal peduncle L									
Vertebrae									
1st Arch gillrakers (up)	7 / 4	4 / 2	7 / 2	8 / 1	8 / 3	7 / 4	7 / 3	7 / 0	7 / 4
(lower)	11 / 5	13 / 3	13 / 7-8	14 / 4	12 / 4	13 / 4	12 / 7	12 / 7	13 / 4
(total)	18	17	20	22	20	20	19	19	20
Branchiostegal rays right									
(left)									
Dorsal rays									
Anal rays									
Pectoral fin rays									
Scales in lateral line									
Scales above lateral line	○	51	○	46 ?	45	50	44	49	44
Scales 2 rows above lat.	194	185	167	172	181	187	186	189	192
Pelvic fin rays	9	9	10	10	9	10	9	10	10
Pyloric caeca	29	35	39	36	35	32	34	35	29
Dentition	9	6	21	9	8	11	5	17	5
anal ray	11	11	11	12	11	11	11	12	12
pectoral	16	15	15	15	15	15	15	16	16
DORSAL	11	11	11	(12)	11	(11) ??	(12)	12	(12)?

10
152
133

7	3
13	2
20	

	56	
	(235)	?
?	10	pelvic
	33	caleca
	15	TEETH
	11	anal
	16	pectoral
	12	dorsal

CHARACTER ANALYSIS SHEET - COLORADO COOPERATIVE FISHERY UNIT

SPECIES S. c. pleuriticus LOCALITY Tepee Cr. to Tosi Cr. Trib. to Upper Green River.

COLLECTED BY Jim Kurtz DATE

Cat. # Measurements by DATE

Specimen #	1	2	3	4	7	6	5	8
Total L.	166	112	210	164	161	183	208	
Standard L.	140	93	175	137	136	156	176	
Body D								
Head L								
Orbit L								
Upper Jaw L								
Dors. Orig. to Snt. tip								
Dorsal fin basal L								
Dorsal fin depressed L								
Adip. fin depressed L								
Caudal peduncle D								
Caudal peduncle L								
Vertebrae								
1st Arch gillrakers (up)	7 / 2	7 / 5	7 / 3	7 / 1 (8)	8 / 2 (0)	8 (7) / 4	7 / 2	
(lower)	13 / 9	13 / 3	13 / 3	13 / 6	13 / 2	13 / 5	11 / 4 (6)	
(total)	20 (4)	20	20	20 (5)	21 (6)	21 (6)	18	
Branchiostegal rays right								
(left)								
Dorsal rays	12	12	11 (12)	10 (11)	11	9 (11)	11	
Anal rays	9	9 (11)	9 (11)	10 (11)	9 (10)	10	10	
Pectoral fin rays	12 (13)	12 (14)	14	14 (15)	13	12	12 (14)	
Scales in lateral line								
Scales above lateral line	39	34	(37) 38	37	40	(90) 37	38 (43)	
Scales 2 rows above lat.	169 (153)	190??	(140) 167	178 (151)	165 (159)	176	169 (150)	
Pelvic fin rays	10 (9)	9	11 (9)	9	8 (9)	9	9	
Pyloric caeca	44	41	41	41	40	44	39	
Dentition	0 (4)	8	0	1	13 (11)	7 (5)	0	

CHARACTER ANALYSIS SHEET - COLORADO COOPERATIVE FISHERY UNIT

SPECIES S. c. Utah LOCALITY Coantay Crk (Hobble Crk - ~~Smith Fk., Bear R.)~~

COLLECTED BY Binns DATE Wyo. - 78

Cat. # ______ Measurements by ______ DATE ______

Specimen #

	1	2	3	4				
Total L.								
Standard L.								
Body D								
Head L								
Orbit L								
Upper Jaw L								
Dors. Orig. to Snt. tip								
Dorsal fin basal L								
Dorsal fin depressed L								
Adip. fin depressed L								
Caudal peduncle D								
Caudal peduncle L								
Vertebrae								
1st Arch gillrakers (up)	6 / 0	6 / 0	6 / 0					
(lower)	9 / 0	11 / 1	11 / 2					
(total)	15	17 / 1	17 / 2					
Branchiostegal rays right								
(left)								
Dorsal rays								
Anal rays								
Pectoral fin rays								
Scales in lateral line								
Scales above lateral line	35	46	43					
Scales 2 rows above lat.	130	180	175					
Pelvic fin rays								
Pyloric caeca								
Dentition	1	7	9					

CHARACTER ANALYSIS SHEET - COLORADO COOPERATIVE FISHERY UNIT

SPECIES ______________ LOCALITY Lower Deep Creek Lake (LDC) Lander, Wyoming

COLLECTED BY ______________ DATE ______________

Cat. # ______________ Measurements by ______________ DATE ______________

Specimen #	1	2	3	4	5	6	7	8
Total L.	372	300	283	302	263	290	260	210
Standard L.	327	250	250	277	230	235	230	175
Body D								
Head L								
Orbit L								
Upper Jaw L								
Dors. Orig. to Snt. tip								
Dorsal fin basal L								
Dorsal fin depressed L								
Adip. fin depressed L								
Caudal peduncle D								
Caudal peduncle L								
Vertebrae								
1st Arch gillrakers (up)								
(lower)								
(total)								
Branchiostegal rays right								
(left)								
Dorsal rays								
Anal rays								
Pectoral fin rays								
Scales in lateral line								
Scales above lateral line	← 48	46	51	40-42	45	47-48	(53)	42
Scales 2 rows above lat. L	272	173*	*144	265	145*	264	123*	112*
Pelvic fin rays	↰185	↰190	↰210	↰190		↰183		
Pyloric caeca								
Dentition								

*Not Full scale Counts, due to badly Preserved Fish

These specimens may be essentially pure "aguabonita"

9	10
326	317
296	292

43	44
276	270
189	190

CHARACTER ANALYSIS SHEET - COLORADO COOPERATIVE FISHERY UNIT

SPECIES ______________________ LOCALITY WASHAKIE LAKE (WL)
LANDER, Wyoming

COLLECTED BY ______________________ DATE ____________

Cat. # ____________ Measurements by ______________________ DATE ____________

Specimen #

	1	2	3	4	5	6	7	
Total L.	330	405	440	321	203	217	360	
Standard L.	300	366	390	292	176	185	320	
Body D								
Head L								
Orbit L								
Upper Jaw L								
Dors. Orig. to Snt. tip								
Dorsal fin basal L								
Dorsal fin depressed L								
Adip. fin depressed L								
Caudal peduncle D								
Caudal peduncle L								
Vertebrae								
1st Arch gillrakers (up)			9					
(lower)			13					
(total)			22					
Branchiostegal rays right								
(left)								
Dorsal rays								
Anal rays								
Pectoral fin rays								
Scales in lateral line	41 ↓			39 ↓				
Scales above lateral line	(43)	37?	42	40	(41)	38	37	
Scales 2 rows above lat.	181	184 ?	179	203	179	180	206	
Pelvic fin rays	179 ↑	198 ↑	175 ↑	190 ↑	184 ↑	150 ↑	198 ↑	
Pyloric caeca								
Dentition								

(?)
Giraffe Crk. spec.
w/o spots

NATIVE CUTTHROAT TROUT OF WYOMING

IV: Evaluation of 1978 Collections

Robert J. Behnke
May 1, 1979

This is the fourth report dealing with the evaluation of relative purity of various trout populations in Wyoming.

The 1978 report (III) included a distribution map showing the original ranges of the six subspecies of cutthroat trout native to Wyoming. The greenback cutthroat trout, _Salmo clarki stomias_, is native to a small area in southeastern Wyoming (South Platte River basin) and has probably been extinct in the state for many years. The cutthroat trout native to the upper Missouri River basin (excluding Yellowstone River drainage), _S. c. lewisi_, is restricted to the extreme northwest corner of the state and persists in only a few small streams.

This report concerns the examination of five samples of trout from the Yellowstone and Snake River drainages (_S. c. bouvieri_), two samples from the Green River basin (_S. c. pleuriticus_), one sample from theBear River drainage (_S. c. utah_), and two samples of unusual golden trout hybrids from Washakie and Lower Deep Creek lakes.

An update of information is provided on Bear River cutthroat trout for the purpose of facilitating the selection of populations to be used as brood stock for hatchery propagation.

Some of the samples did not have precise locality data (or the label was unreadable) and I have assigned these samples to _S. c. bouvieri_ on the basis of their taxonomic characters.

The samples from Hidden Creek, Leidy Lake, and Turquoise Lake are considered to represent pure populations of _S. c. bouvieri_, although they are recognizeably distinct from each other. The sample from the headwaters of Big Sandstone Creek represents a pure form of the Little Snake drainage S. c. pleuriticus. Coantag Creek probably contains a pure population of S. c. utah, but only three specimens were available for study. The hybrid golden trout of Washakie Lake may possess unique genetic recombinations of practical value in fisheries management.

Yellowstone-Snake River Drainages, Salmo clarki bouvieri:

In previous reports I pointed out that the name S. c. lewisi, long associated with Yellowstone cutthroat trout, is incorrect. The name lewisi is correctly applied to the subspecies native to the Upper Missouri basin (not including the Yellowstone drainage) and is a distinctly different subspecies.

Hidden Creek:

Two samples of 11 specimens were examined from Hidden Creek, a tributary to the Thoroughfare River in the headwaters of the Yellowstone drainage. These specimens are resident stream trout (not migratory from Yellowstone Lake). However, they have a similar appearance to Yellowstone Lake trout in the spotting pattern and have similar numbers of gillrakers (19-22 [20.1]) and scales above the lateral line (40-47 [43]) and in the lateral series (168-200 [179]). They differ from Yellowstone Lake cutthroat by averaging about 10 fewer pyloric caeca (25-39 [32.3]) and about 9 fewer basibranchial teeth (8-17 [13.2]). Evidently, during an early stage in the evolution of Yellowstone Lake, several thousand years ago, the Lake was much larger in size. After downcutting occurred at the upper falls of the Yellowstone, the lake level dropped and some stocks were isolated from the lake and its direct tributaries. These isolated stocks such as Hidden Creek and Sedge Creek (above Turbid Lake) became resident stream fish and initiated some genetic divergence from the main body of trout in Yellowstone Lake. The well developed gillrakers in Hidden Creek (and Sedge Creek) specimens, indicate that they were subjected to lacustrine selective pressures in their recent evolutionary history. The Hidden Creek trout are still similar in appearance to Yellowstone Lake trout and can only be differentiated on the basis of mean differences in pyloric caeca and basibranchial teeth. The Sedge Creek trout, on the other hand, isolated in a very small environment, evidently initiated more rapid differentiation and have a strikingly different spotting pattern than Yellowstone Lake trout.

I detect no sign of a hybrid influence in the Hidden Creek trout and consider them as a pure population of _S_. _c_. _bouvieri_, representing an isolated stock, separated for a few thousand years from the Yellowstone Lake cutthroat.

Cottonwood Lake:

Unknown locality. Four specimens, labeled "Cottonwood Lake", but with additional locality data washed off the label, are probably the result of the introductions of Yellowstone cutthroat trout and the fine-spotted Snake River trout. Three of the specimens are typical of Yellowstone Lake cutthroat trout in all characters. One specimen has a profusion of small spots and is quite distinct from the other three. The three "Yellowstone" specimens have 20-22 gillrakers on the anterior portion of the first left gill arch and 6-9 rakers on the posterior side. The finely spotted specimen has 16 rakers on the anterior side and 2 on the posterior.

Although the data are very sparse, I interpret the specimens to indicate that Cottonwood Lake was originally barren of trout. Many years ago, Yellowstone Lake cutthroat trout were introduced and became established. In recent years the lake was stocked with fine-spotted Snake River cutthroat (or stocked in a lake tributary to Cottonwood Lake). If this interpretation appears to contradict other information, I would suggest a larger sample be obtained from this lake in 1979.

Leidy Lake (R114WI43N):

I identify these specimens as a probable pure population of S. c. bouvieri, native to Leidy Lake. They possess some distinctive traits that distinguish them from Yellowstone Lake trout. The general appearance of the 8 specimens is typical of Yellowstone Lake trout and the scale counts and pyloric caeca counts are similar to Yellowstone Lake trout (average of 43 above lateral line, 181 in lateral series, and 41 caeca). The gillrakers of the Leidy Lake trout are clearly distinct from Yellowstone Lake trout. On the posterior side of the first gill arch, two specimens have one small raker and six specimens have no rakers (posterior arch is smooth). Yellowstone Lake Trout have 5-14 posterior rakers on the first arch and this is a strongly inherited character, not under environmental modification to any extent. Yellowstone Lake trout established in new environments still have 5-14 posterior rakers. Leidy Lake is in the headwaters of Leidy Creek, tributary to Spread Creek of upper Snake River drainage. The geographic separation between the large-spotted cutthroat trout (S. c. bouvieri)and the Snake River fine-spotted cutthroat (undescribed subspecies) is in this area. In previous collections I found the native trout in the Spread Creek drainage to be large-spotted (bouvieri); both subspecies were found in the

Gros Ventre drainage immediately to the south of Spread Creek, but the fine-spotted subspecies is more prevalent in the Gros Ventre. South of the Gros Ventre, all tributaries down to Palisades Reservoir contain the fine-spotted form.

Leidy Lake should receive special recognition for management purposes and should not be stocked.

Turquoise Lake. No locality.

Sent from Lander Office. Five specimens of cutthroat trout from Turquoise Lake represent a distinctive population of *S. c. bouvieri*. The specimens differ from all others examined by possessing very large, round spots, few in number, and restricted almost entirely to the posterior half of the body. In this character they resemble the Sedge Creek trout mentioned above. The Turquoise Lake trout are clearly not derived from Yellowstone Lake or any other known source of cutthroat trout propagated in hatcheries. Besides the spotting pattern, the other taxonomic characters of the five specimens are quite distinct from most other members of this subspecies. I counted 17-20 (18.8) anterior gillrakers and 0-3 posterior rakers. There is a low number of scales in the lateral series (143-162 [152]) and a low number of basibranchial teeth (1-4 [3]). The number of pyloric caeca is relatively high (44-50 [46]).

Although the sample size is small, the spotting is uniform with little variation. The meristic characters are distinctive. There is no indication of a hybrid influence. The Turquoise Lake population is judged to represent a pure population that has been isolated for some time and, as with Leidy Lake, should receive special management considerations to preserve the unique genotype.

Green River Basin, Salmo clarki pleuriticus:

In previous reports I discussed the fact that there are two distinct types of S. c. pleuriticus native to the Green River basin in Wyoming. The typical form with medium size spots is native to the upper Green River proper and its tributaries. A form with very large spots is native to the Little Snake drainage (Yampa River Tributary). These two forms were illustrated in Allen Binns publication, "Present status of indigenous populations of cutthroat trout in southwest Wyoming" (Fish. Tech. Bull. 2).

A sample of 7 specimens from Teepee Creek, a tributary to Tosi Creek in the upper Green River drainage above Kendall, represent the typical form. The Teepee Creek population, although phenotypically resembling S. c. pleuriticus, is hybridized with rainbow trout and perhaps other subspecies of cutthroat trout. Three of the specimens lack basibranchial teeth and scale counts above the lateral line (34-43) and in the lateral series (156-178) are much too low for pleuriticus (40-48 and 170-200+ typically expected in pure populations). For identification purposes I would classify these specimens as S. c. pleuriticus because they certainly have more pleuriticus heredity than S. gairdneri heredity, but using the ranking system devised by Binns (cited above) I would grade the Teepee Creek sample as "B-- or C+" pleuriticus.

A sample of 10 specimens from the headwaters of Big Sandstone Creek (Little Snake drainage) in Carbon County (R87 T14) represents what I consider to be a pure population of the large-spotted, Little Snake drainage pleuriticus. The specimens are very uniform in appearance. All have basibranchial teeth (6-21 [11]). Scale counts are high, 44-52 (47) above the lateral line and 175-205 (188) in the lateral series. Pyloric caecal counts are low (29-34 [34]). It has been mentioned in previous reports that the small headwater tributaries in the Little Snake drainage are the greatest "stronghold" of the rapidly vanishing S. c. pleuriticus. The headwaters of Big Sandstone Creek appears to be as pure as any sample yet examined and could be considered as a possible source for introductions into new waters. Before this is done, however, the degree of isolation should be checked. In 1970 I collected specimens in a downstream area of Big Sandstone Creek (below confluence with Douglas Creek) and some hybrid influence was detected in these specimens. Can the hybrids in lower Big Sandstone Creek reach the headwaters where the 1978 sample was obtained, or is there a physical barrier isolating the population?

Bear River Drainage, Salmo clarki utah:

Three specimens from Coantag Creek, a headwater tributary to Hobble Creek (Smith Fork) were examined. I have previously sent my diagnosis of these specimens to Allen Binns. They are typical of pure S. c. utah of the Bear River drainage in spotting pattern and other taxonomic characters; however, the sample size is too small to make a more positive declaration on their purity.

Problems have arisen concerning the creation of a base of genetic diversity (heterozygosity) in a brood stock of S. c. utah maintained at the Daniel Hatchery. The present stock is derived from a few spawners from Raymond Creek. In last year's report I cited Raymond Creek and upper Giraffe Creek to contain the purest populations of S. c. utah known from the Bear River drainage. I also cited Alice Lake fish as probably pure, but they do have recognizeable differentiation from the trout of Raymond and Giraffe Creeks. It was planned to obtain spawn from Giraffe Creek trout to add to the Raymond Creek brood stock to broaden the base of heterozygosity. In

1978; however, trout from the Idaho section of Giraffe Creek exhibited indications of a hybrid influence. Dr. Richard Wallace, University of Idaho sent me the results of his examination of Giraffe Creek trout from Idaho. The 1978 Idaho sample and the 1977 Wyoming sample are clearly not a single, homogeneous population. The Wyoming sample has basibranchial teeth present in 33 of 34 (97%) specimens. Basibranchial teeth are absent in about 15% of the Idaho specimens. Due to the slight movement typical in small streams, it is not unusual to find slight differences in samples taken from different parts of the same stream. Obviously, the trout in the Idaho section of Giraffe Creek have been exposed to hybridization. Idaho Fish and Game records indicate stocking with Henry's Lake cutthroat trout, but the absence of basibranchial teeth in 15% or more of the population definitely indicates a rainbow trout influence.

Dr. Wallace recommended that no further stocking be made in Giraffe Creek in Idaho. From the example of the trout in other waters of the Thomas Fork and Smith Fork drainages, it can be expected that the non-native genes will be "weeded out" by natural selection and the Giraffe Creek trout should essentially revert to its pure form before the effects of hybridization spreads into Wyoming sections of the stream. Allen Binns sent me a photo of an unusual specimen from Giraffe Creek. The specimen has virtually no spots on the body. I have observed this phenomenon in other _S_. _c_. _utah_ populations (Trout Creek, Utah) and believe it is due to a rare combination of genes and not from a hybrid influence (the Paiute Trout, _S_. _c_. _seleniris_ is an isolated population of Lahontan cutthroat trout, in which all of the fish exhibit an essentially spotless body).

In view of the potential contamination of Giraffe Creek fish, I would recommend that they not be used in 1979 to develop the brood stock of _S. c. utah_. Samples should be made in 1979 and every year or two thereafter to check their purity. If subsequent samples are similar in purity to the 1977 sample, I would see no reason not to use Giraffe Creek fish in the future.

A larger sample from Coantag Creek should be examined. The remote location of this creek suggests a good possibility that they are pure.

Alice Lake fish could be used in brood stock development and would stimulate heterozygosity (based on their divergent characters) and would likely endow some lacustrine adaptations into the brood stock. However, the resulting spotting pattern would likely be highly variable.

More spawners from Raymond Creek should be used also to obtain a fair sample of the heterozygosity present in that population. In any event, the objective of creating heterozygosity by using fish from different populations is definitely to be commended, particularly when the pure populations are so limited in numbers. The resulting brood stock should yield offspring much more adaptable and successful when stocked into new waters than if only a single source was used.

Washakie Lake and Lower Deep Creek Lake:

Specimens from Washakie Lake (N=7) and Lower Deep Creek Lake (N=10) were sent from the Lander office for identification. These specimens are golden trout hybrids.

Unfortunately, the specimens were gutted and in poor condition. The specimens from Lower Deep Creek Lake evidently had been frozen and thawed several times and they partially distintegrates on examination. The only characters that could be obtained from these specimens were scale counts (but very difficult) and observations on coloration and spotting.

The spotting pattern on the Washakie Lake fish definitely indicates hybridization between golden trout (S. aguabonita) and rainbow trout (S. gairdneri). The strong coloradion indicates a predominance of golden trout. The high scale counts (150-198) also indicates a strong golden trout influence. Golden trout freely hybridize with both rainbow and cutthroat trout and in the upper Wind River drainage hybrids between all three species are not uncommon.

The significance of the Washakie Lake trout is not their taxonomic status, but rather their genetic constitution that results in large size. Fish of 10 lbs. and more have been known from this lake. It has long been known that desirable qualities such as rapid growth and survival is often obtained from crossing distinct strains of hatchery trout, wild and hatchery strains and between rainbow and cutthroat trout.

The unique and potentially useful aspect of the Washakie Lake trout is that the hybridization here has been completely under natural selection for many generations and the unique genetic combinations have been rigorously selected for survival under natural conditions.

I would advise that some experimental propagation and stocking of new waters be made from the offspring of the Washakie Lake trout to test the possibility that the Washakie Lake trout is a valuable genetic resource which could increase trout production and produce trophy size trout when introduced into new waters. This would be a "try it and see" situation, but from a theoretical viewpoint, the chances of success are good.

I have frequently noted that hybrids of golden trout with rainbow trout and with cutthroat trout attain a much greater size than do pure golden trout. In Alpine Lake, on the Wind River Reservation, golden trout reached a maximum weight of about 2 lbs. In 1960's Snake River cutthroat trout were inadvertently stocked into lakes in the watershed and hybridization occurred in Alpine Lake. Hybrids attained weights of 5-6 lbs. Almost certainly, the "world record" golden trout reputedly from Cooks Lake, Wyoming, was actually a golden-rainbow hybrid.

The specimens from Lower Deep Creek Lake were in such poor condition that no real conclusions can be reached. My overall assessment is that they are less influenced by hybridization than is the Washakie population. Scale counts are higher (42-53 above lateral line and 183-210 in lateral series) and from what could be made out of the coloration and spotting they appeared to be quite typical of golden trout, S. aguabonita.

To obtain a more definitive analysis of both the Washakie Lake and Lower Deep Creek Lake populations, to ascertain the relative influence of golden trout, rainbow trout, and perhaps, cutthroat trout in their ancestry, further samples should be taken and preserved in formalin.

prob. barren - stocked Yellowstone -
finespotted S.R. -

Wyo. - Cottonwood L. N=4
- 3 typical Yellowstone 20, 20, 22 rakers (16-9 post) -
1 dense, small spots on peduncle - (west-slope-like) - (#3 also has
deformed L. dentary, missing maxillary, & deformed opercle bones.
bouvieri this spec. - 16 rakes (2/0) - 176 scales vs. 187, 195, 198
12, 14, 24 teeth (+ 13 in #3)

-? - check spots
Leidy L. - Yellowstone Lin - N=8 - 7 - 42 teeth - - 35 -
but - 18-21 (19) rakes & 0-1 post. !) - native race -

Hidden Crk. - 2 sample . 4+7 N=11
- Yellowstone - When lake larger - - lacustrine trout - allow
- 19-22 (5/2 rakers) - - caeca - low - teeth low -

N=3
Counting Crk. - S.C. utah. N=4
caeca - typical UT23 - large, rnd spots evenly distrib -
rakes - 15, 17, 17
all w/ teeth * recheck #1 - 35/130 scales - scales -
Discuss Giraffe Crk - spotting Idaho

bouvieri Turquoise L. - N=5
Spots 0 - bouvieri - low scale, high ca
like Sedge Crk. - low teeth - 1-4 -
17-20 rakers 1/(0-1) -

Big Sandstone - N=10 - near headwaters -
all teeth . 172-205 - - 29-39 caeca -
* large, round spots -
pleuriticus
37-43 scales
173-202
gutted - Washakie - Lower Deep Crk L N=10 44-49 210-372 mm
N=7 22 rake N=1 181-205 (190) -
203-440 mm. T.L. coly. most golden - like - partially decomposed,
- spotting (rainbow

look at specimens
Teepee Crk. - Trib. Tosi. Crk → upper Green
N=7 18-21 (20.0) rakers well developed post (Yellowstone
teeth 3 of 7 no teeth 4 w/ 1 = 11 (7.2)

THE STATE OF WYOMING

ED HERSCHLER
GOVERNOR

Game and Fish Department

~~CHEYENNE, WYOMING 82002~~
Box 342
Lander, Wyoming 82520
March 22, 1979

EARL M. THOMAS
DIRECTOR

Dr. Robert Behnke
Department of Fishery
and Wildlife Biology
Colorado State University
Fort Collins, Colorado 80523

Dear Bob:

Thank you for the information on the cutthroat trout from Coantag Creek. I was glad to hear that you feel they are Utah cutthroat trout. Their external characters looked good at the time of collection, but one can never be sure from a field examination. The small sample size is regretable, but we found the fish in Coantag Creek difficult to collect with fishing gear.

Regarding the spotless cutthroat trout picture, this fish was taken from Giraffe Creek about two miles downstream from the site of the 1977 collection. The exact location was SE1/4 of Section 32, R.119W., T.29N.. Thank you for your comments on this fish, I found them very interesting.

Regards,

N. Allen Binns

NAB/ab

HABITAT BIOLOGIST
WYOMING GAME & FISH DEPT.
260 BUENA VISTA
LANDER, WYOMING 82520

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A

Giraffe Cr.
spotless
fish

Dr. Robert Behnke
Department of Fishery and Wildlife Biology
Colorado State University
Fort Collins, Colorado 80523

GF-40

WYOMING GAME & FISH DEPARTMENT

No.________

INTER-DEPARTMENT COMMUNICATIONS

Date March 26 19 79

TO: John Baughman

FROM: Glen Dunning

COPIES TO: File

SUBJECT: Expanding Utah Cutthroat broodstock

At the work schedule meeting in February we set up job no.4079-00-7907 to obtain fingerling(or possibly adult male) Utah cutthroat trout from Giraffe Creek to mix with the Utah cutthroat stock being held at the Daniel Hatchery as brood stock. The objective was to dilute the gene pool of the fish being held at Daniel. These fish(there are about 200 of them) are the progeny of about four female trout and perhaps six or eight male fish which were from a small population of Utah cutthroat found in Raymond Creek.

Dr. Robert Behnke (1978)[1] had indicated the fish from upper Giraffe Creek were also "pure" or nearly so but since then a collection of fish taken from Giraffe Creek in Idaho upstream from where the Wyoming collection was obtained have been labeled as less than pure (Wallace 1978)[2]. As a consequence of Idaho's collection Allen Binns has strongly expressed a negative opinion about mixing the two stocks for brood purposes. This is a logical conclusion but leaves us with only two other sources of stock to "dilute" our brood stock if we are to pursue this objective.

B

We could return to Raymond Creek for fresh stock and hope the relationship to the fish in the hatchery is sufficiently remote so as to avoid seroius inbreeding. Orv Landen has expressed serious reservations toward this action and with some justification. In 1977, when we obtained the eggs from which the present hatchery stock came, there was very little water flow in Raymond Creek and nearly the entire population of trout was restricted to about 1½ miles of stream. A population estimate obtained that summer indicates there were 605 fish per mile or only about 900 fish including immature fish other than young-of-the-year. A few additional fish are suspected to have survived in the upstream branches of Raymond Creek but the numbers would have been very limited.

The third option would be to take stock from Lake Alice, a source for which I have reservations. I don't know if these fish were stocked into the lake or occurred there naturally. In either event they have been there for many generations and may have developed a trait to seek lentic waters except during spawning. A survey in August 1973 failed to find fish holding in any of the three tributaries of the lake although a few were observed in the channel where Poker Creek flows into the lake. If such a trait does exist we may find it difficult to hold fish from this stock in a stream. Also, Behnke (1978)[1] indicated some differences between these fish and those in Raymond Creek and Giraffe Creek.

The work season is rapidly approaching so a decision concerning this project will need to be made soon. Some considerations that should be taken into account are that Idaho has expressed interest in our broodstock and may request eggs from us to restock Idaho waters in the Bear River drainage and Utah might also become interested as the development of the brood stock allows initiation of our proposed Bear River Management program.

The proposed Bear River program involves stocking of Bear River proper, Smith's Fork, Hobble Creek and Woodruff Reservoir and could require up to 150,000 fingerling or advanced fingerlings. In each instant the water to be stocked contains a Bear River Cutthroat population very much inferior to any of those waters suggested as a source for brood stock.

That brings up another consideration.

Behnke (1976)[3] suggests that the absence of basi branchial teeth in 10% of Utah cutthroat may be normal. If this is so then the upper Giraffe Creek fish may be more nearly pure than Wallace believes even though he found basi branchial teeth in only 83% of his collection. Also, Behnke originally indicated Raymond Creek contained a contaminated population of Bear River Cutthroat but a later collection was declared "pure" and, I understand, led Behnke to believe we had selected the fish to be analyzed the second time. He later suggested a slightly contaminated population would tend to breed out the unpure characteristics over a period of time "due to a strong negative selection against non-native genes"(Behnke, 1978).[1]

At any rate I suggest some form of communication with all the interests involved in developing the Utah cutthroat brood stock so we can resolve the conflict, identify the weaknesses and move ahead with the project.

Incidentally, if a strong enough demand was developed for lake oriented stock there is a good chance a spawning operation could be developed at Lake Alice. The Department previously used the lake as an egg source.

1 Behnke, Robert J., 1978, The Native Cutthroat Trouts of Wyoming III, Evaluation of 1977 Collections from the Green River and Bear River Drainages.

2 Wallace, Richard L.,Sept. 1978, Report on Purity of Bonneville Cutthroat Trout, Salmo clarki utah from Upper Giraffe Creek, Bear River Drainage, Department of Biological Sciences University of Idaho,Moscow,Idaho.

3 Behnke, Robert J., Summary of Information on the Status of the Utah or Bonneville Cutthroat Trout, Salmo clarki utah, Prepared for Wasatch National Forest, Salt Lake, Utah, June 1976.

STATE OF WYOMING
GAME AND FISH DEPARTMENT
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Dr. Robert Behnke
Department of Fishery and Wildlife Biology
Colorado State University
Ft. Collins, Colo. 80523

THE STATE OF WYOMING

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GOVERNOR

Game and Fish Department

CHEYENNE, WYOMING 82002

EARL M. THOMAS
DIRECTOR

April 2, 1979

Dr. Robert Behnke
Department of Fishery and Wildlife Biology
Colorado State University
Ft. Collins, Colorado 80523

Dear Bob:

I received your letter of March 28, 1979. I do not anticipate any more fish before summer, so proceed with the report. You will shortly receive a requisition/voucher for you to sign and return to us for payment. Presumably you will have the report done by May 15, and that is the latest date that we would like to have the voucher sent to us so that we can make payment out of this years' budget.

I am enclosing a letter from Glen Dunning concerning our Utah cutthroat broodstock. As you know we are trying to improve and expand this broodstock. The problem is getting enough fish from different sources so the broodstock will have a sufficiently large gene pool. As you can see from Glen's letter we suspect some rainbow contamination in Giraffe Creek. My question is, would we be safe in adding Giraffe Creek fish to our broodstock if we check each fish for the presence of basibranchial teeth, i.e. upgrade the sample? The other possibility would be getting fish from Coantag Creek if you feel this is a pure population.

I assume we will be sending you some more fish later in the summer, and I will keep in contact concerning development of broodstocks.

Sincerely,

John Baughman/ak

John Baughman
Fisheries Resource Manager

JB/ak
cc: Glen Dunning
    Allen Binns

STATE OF WYOMING
GAME AND FISH DEPARTMENT
CHEYENNE, WYOMING 82002

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Dr. Robert Behnke
Department of Fishery & Wildlife Biology
Colorado State University
Ft. Collins, Colorado 80523

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THE STATE OF WYOMING

MIKE SULLIVAN
GOVERNOR

Game and Fish Department

July 13, 1988

BILL MORRIS
DIRECTOR

Bob Behnke
Department of Fisheries and Wildlife Biology
Colorado State University
Fort Collins, Colorado 80523

Bob:

Here's a couple of old reports that may be of interest as per earlier discussions. I had nothing to do with the editing of Pechacek's and Kent's reports!

I checked with Glen Dunning. Last year's Lead Creek collection was taken below the previous sample site. Apparently Snake River cutthroat have invaded by moving up an irrigation ditch from Lead Creek into a small reservoir in an adjacent drainage. We are looking for a barrier site to prevent further movement upstream.

Green Timber Creek in the Little Snake country was also lost this year due to an uncontrolled spill and washout from the Stage II pipeline. It hasn't been a good year for Colorado River cutthroat.

Your contract proposal and Invoice look fine. It may be a few weeks on the payment due to our change in fiscal years.

Keep in touch,

John

John Baughman

JB/kw

Headquarters: 5400 Bishop Boulevard, Cheyenne, Wyoming 82002

[ca 1969]

WYOMING GAME AND FISH COMMISSION

FISH DIVISION

ADMINISTRATIVE REPORT

Project: 02A69-14-6502

Title: Mackinaw - Brook Trout Relationships, Beartooth Lake, Wyoming

Personnel: Fish Management Crew 2A, Cody

Introduction:

Beartooth Lake is located in Range 105W, Township 57N, Sections 6 and 7 on the Beartooth Plateau at elevation 8,900 feet in the Shoshone National Forest. The lake is 110 surface acres, has a maximum depth of 86 feet, with the thermocline usually between the 30 and 40 foot depths. Summer temperatures reach the low 60's at the surface and the ice cover season extends from approximately the first part of December through May. The hydrogen ion concentration is generally about 7.3, with the dissolved oxygen usually between 7 and 8 ppm from top to bottom.

Official fish stocking records on Beartooth Lake go back to 1935 at which time fish were stocked according to the size, kind and number on hand. During the first two years of recorded planting, brook, rainbow and cutthroat were stocked. However, according to reports of early users and visitors to the area, several of the most accessible lakes had stocks of brook trout in the 1920's. Cutthroat trout were also present for unknown periods of time before the first records on fish were kept. With their introduction, the brook trout soon became the predominant species in most waters of the area. This species was periodically supplemented by hatchery stock of any species that were the most readily available.

After completing surveys of Beartooth Lake and fisheries of other waters in this immediate drainage, it became apparent that the presence of larger size trout would add to the attractiveness of the sport fishing in this area. In 1956, the creel limit was changed from a number and weight limit to a simple weight limit. This allowed anglers to take a restricted number of large fish to as many as 140 small brook trout to meet their limit. This did encourage the fishing for and taking of the abundant small brook trout that were not previously sought after. This regulation is in effect at this writing.

In 1959, to provide variety and improve the quality of the fisheries in the area, mackinaw trout were stocked in Beartooth Lake. Stocking of this specie continued for the next five years, at which time the mackinaw trout were well established. Creel census and gill netting was used to determine changes in the average size of fish present.

Findings:

Since 1935 there have been 540,540 trout planted in Beartooth Lake or an average of 15,440 fish per year (Table 1). Of these stocked fish, 205,027 were brook trout, 116,400 were rainbow, 146,206 were cutthroat and 72,907 were mackinaw trout. Of this number, 183,806 were fry, 346,734 were fingerling and 10,000 were sub-catchable in size (Table II). There is no apparent relationship of fish stocked to any of the vital statistics of the fish population either in its entirety or its individual members. It would be well to establish that there are several factors that may influence the findings throughout this survey, such as kind of gill nets fished and the time and locations of the sets. Sample size certainly was influenced by netting differences.

Figure 1 shows the basic data on which a comparison is made. The average lengths of both the brook and mackinaw trout are plotted by years, with the year noted in which the creel limit was changed and the years of lake trout introductions.

There was an improvement in the average size of the brook trout seven years after the creel limit change was made and four years after mackinaw trout introductions. There are indications that this change could have resulted from either of one or both management procedures put into use. An increase in angling pressure during this time also increased the total harvest. Whether this increased pressure resulted from the relaxed creel limit and/or the presence of mackinaw trout or from a general increase in fishing pressure in the area is not known.

A basic premise that most, if not all, fisheries managers work under an inverse relationship of a fish population (numbers of fish) to the annual harvest, condition factor of fish, and average length of fish has some theoretical refinements that seem to be apparent in the following comparison.

Using data collected from Lake Solitude, a similar lake in the Big Horn Mountains which received very much the same management considerations as Beartooth Lake, there is no obvious change in the average length of brook trout (Figure 1).

The average length of the Beartooth brook trout has shown some improvement in the past three years, but a significant change has not been noted in condition factor as there has never been an indication of over population using this criterion. The condition factor by length classes is typical of normal brook trout populations with larger fish exhibiting a poor condition (Figure 2). The length-weight relationship is also typical with (rule of thumb) a 14 inch trout weighing one pound (Figure 3).

Discussion and Conclusions:

There has been an increase in the average size of brook trout recovered in gill nets and in the creel. This increase cannot be specifically attributed to a reduction in brook trout numbers resulting from predation by mackinaw or due to the relaxation of the brook trout creel limit. In adjacent lakes managed under similar conditions, no comparable improvement in the brook trout was observed. Continued surveillance and refined data analysis in the next few years may indicate a more positive relationship.

Similarity, mackinaw trout stocked in Lake Solitude as a biological control have had no apparent effect, to date, on the brook trout population. These two lakes are very similar in size, elevation and general habitat characteristics. Access is dissimilar in that an oiled highway passes along the shore of Beartooth Lake while Lake Solitude is reached by trail only. In Beartooth Lake the stocking of mackinaw trout and a relaxing of the brook trout creel limit in 1956 should have been effective on the total population size, the condition factor and the average size of the fish. Any single factor or combination of factors might be expected to change as increased harvest and predation by the lake trout took effect. Until 1966, it appeared that the average size of the brook in Beartooth Lake was showing such effects. In this lake, brook trout increased from an average length of 7.5 inches in 1960 to 10.25 inches in 1966.. This trend was sharply interrupted in 1968 and 1969 when the average length dropped to 8 and 8.75 inches, respectively.

During the same period of time following the establishment of mackinaw trout in Lake Solitude, no apparent change in the size of brook trout has occurred.

This leads to the premise that the cropping of an over population (the annual increment plus) will affect the average length and the average condition factor more until the optimum population is reached. Apparently, a significant reduction in the number of brook trout in a population having maximum density proportions will be recognized by an improvement in the average length as well as condition factor, with the average length demonstrating a greater change than the condition factor (Figure 4).

Recommendations:

1. Collect data that can be subjected to multiple analysis of variances to determine inter-species relationships.
2. Determine the success of the development of naturally reproduced mackinaw trout in terms of contribution to the sport fishery.
3. Include Lake Solitude as a designated part of a study on mackinaw-brook trout relationships in small high elevation lakes.

Report by: Louis S. Pechacek
Area Fisheries Biologist

Table I. A Summary of Gill Netting in Beartooth Lake - Park County, Wyoming

Date	Number of Nets and Type	Temperature	Species	Number	Total Length	Average Length	Range	Total Weight	Average Weight	Range
9/11/69	2-200' exp.	Air - 54	Brook	128	1109.7	8.7	4.3-14.5	38.14	0.30	0.03-1.12
	monof. gill	Water - 54	Mackinaw	6	92.2	15.4	12.9-19.4	7.93	1.32	0.75-2.74
	37¼ hrs.		Rainbow	3	38.0	12.7	10.1-15.9	2.09	0.70	0.36-1.06
			Grayling	12	143.3	11.9	9.7-13.8	7.21	0.60	0.30-0.86
			Lake Chub	10	-	-	4.4- 6.5	0.54	0.05	-
			C.W. Sucker	4	-	-	15.1-16.7	6.59	1.65	-
7/25-68	2-200' exp.	Air - 50	Brook	38	306.8	8.1	4.3-11.8	8.85	0.23	0.04-0.56
	nylon gill	Water - 57	Mackinaw	6	82.2	13.7	11.5-17.0	5.08	0.85	0.48-1.69
	25 hrs.		Rainbow	1	4.7	4.7	-	0.05	0.05	-
			Grayling	1	9.6	9.6	-	0.30	0.30	-
			Lake Chub	1	-	-	-	-	-	-
8/22/66	1-175' exp.	Air - 54	Brook	23	236.3	10.3	7.4-19.8	10.95	0.48	0.13-2.88
	nylon	Water - 54	Mackinaw	10	155.8	15.5	13.2-26.7	14.36	1.44	0.58-7.00
	14½ hrs.		Rainbow	2	24.4	12.2	-	1.29	0.64	0.63-0.66
			Grayling	1	14.8	14.8	-	0.98	0.98	-
			Mt. Sucker	1	8.4	8.4	-	-	-	-
10/ 1/65	1-200' exp. ny.	-	Brook	52	531.7	10.2	7.1-12.9			
	1-175' exp. ny.	-	Mackinaw	11	179.3	16.3	13.1-39.0			
	33 hrs.		Rainbow	3	30.7	10.2	10.0-10.4			
			Grayling	3	37.7	12.6	10.0-14.0			
			C.W. Sucker	1	13.8	13.8	-			
8/15/63	2-175' exp.	Air - 65	Brook	60	584.7	9.7	7.4-16.9			
	nylon	Water - 59	Mackinaw	3	31.4	10.5	10.2-10.9			
	25 3/4 hrs.		Rainbow	8	84.6	10.2	8.1-12.7			
			Grayling	4	49.8	12.4	9.9-13.7			
			Lake Chub	9	61.9	6.9	6.6- 7.2			
			C.W. Sucker	3	32.7	10.9	8.0-13.0			
			L.N. Sucker	2	21.9	10.9	9.2-12.7			
10/ 4/60	1-Jap gill	-	Brook	20			5.7- 9.0			
			Mackinaw	4	17.5	4.4	3.7- 5.0			
	17 hrs.		Grayling	1	7.4	7.4	-			
			Lake Chub	4	-	-	4.5- 6.5			

Table II. A Summary of Fish Planting in Beartooth Lake, 1935 - 1969.

Species	Years Planted	Fry	Fingerling	Sub-Catchable	Total
Brook Trout	1935-37-38-40-41-42-43-48 through 53	0	205,027	0	205,027
Rainbow Trout	1936-45-56-62	96,400	10,000	10,000	116,400
Cutthroat Trout	1936-38-39-41-65	87,406	58,800	0	146,206
Mackinaw Trout	1959-60-61-62-64	0	72,907	0	72,907
Total		183,806	346,734	10,000	540,540

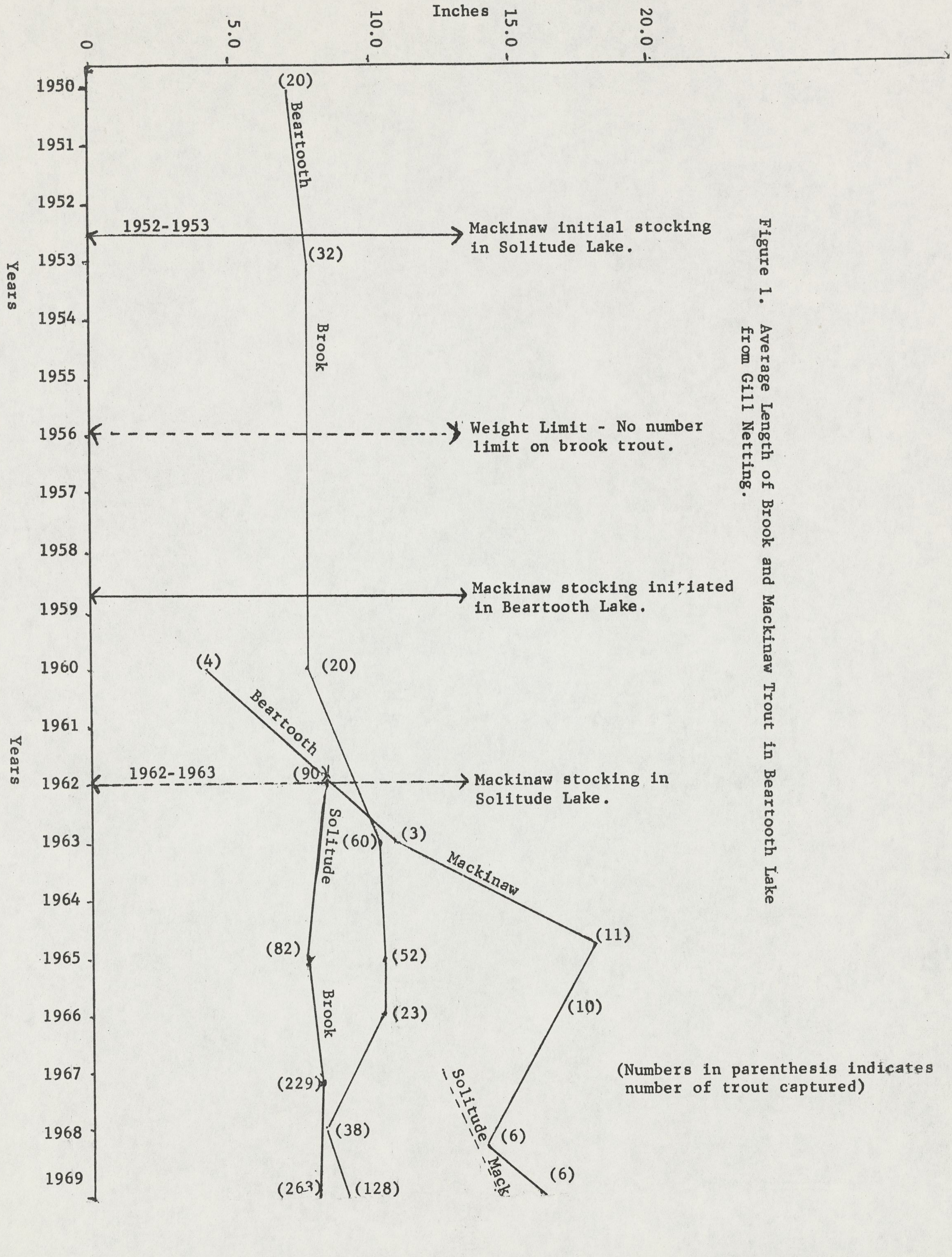


Figure 1. Average Length of Brook and Mackinaw Trout in Beartooth Lake from Gill Netting.

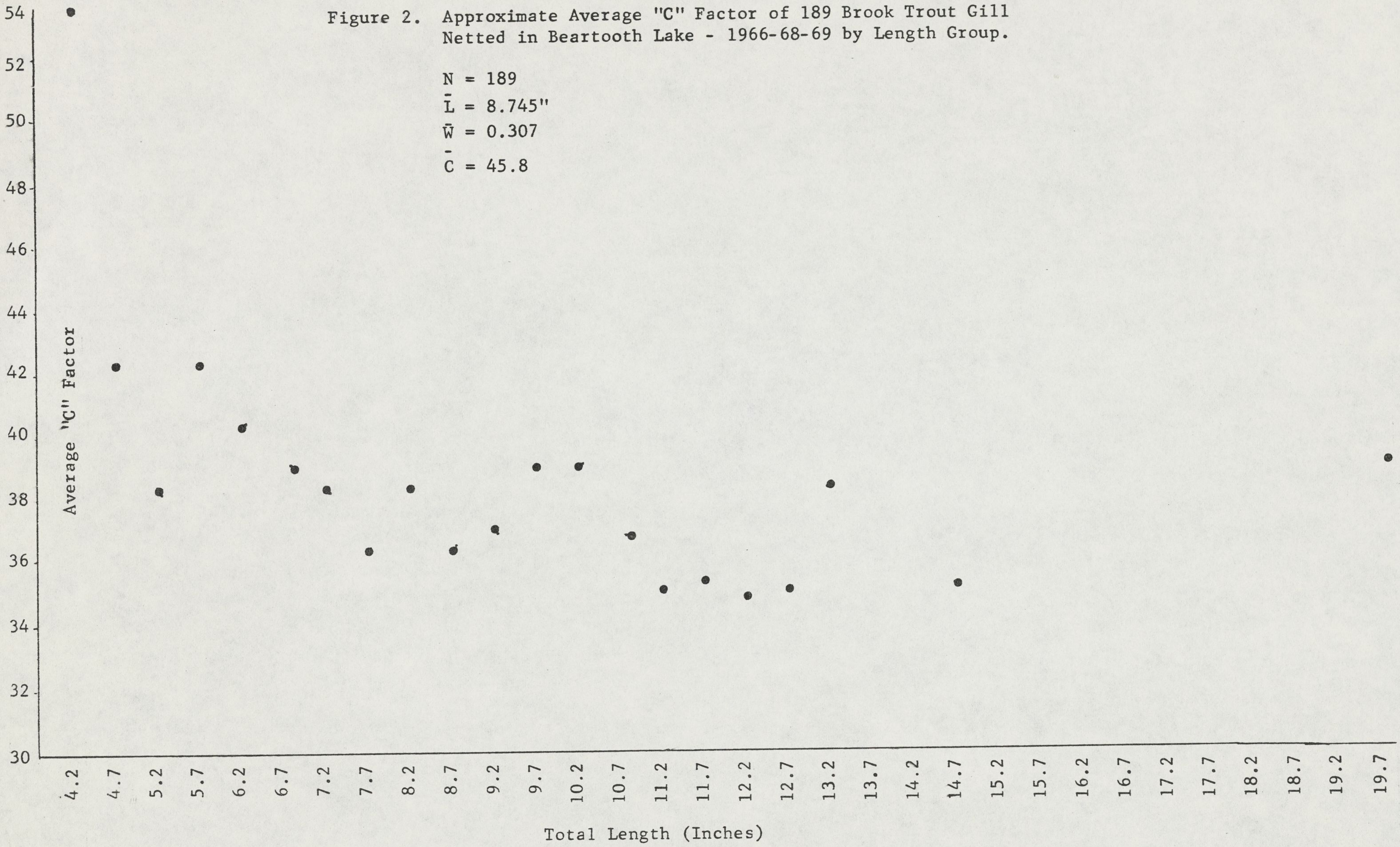


Figure 2. Approximate Average "C" Factor of 189 Brook Trout Gill Netted in Beartooth Lake - 1966-68-69 by Length Group.

N = 189

$\bar{L}$ = 8.745"

$\bar{W}$ = 0.307

$\bar{C}$ = 45.8

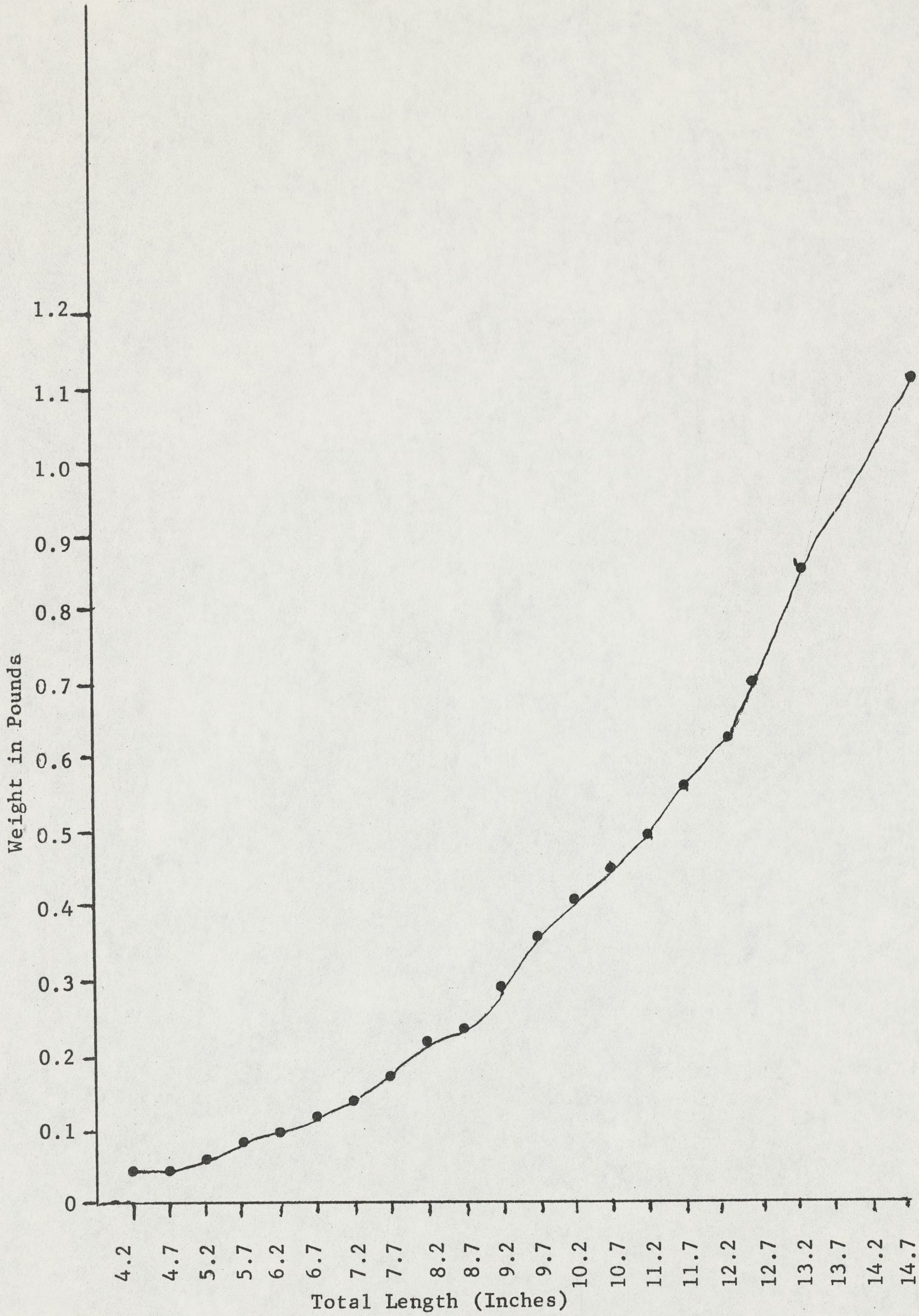
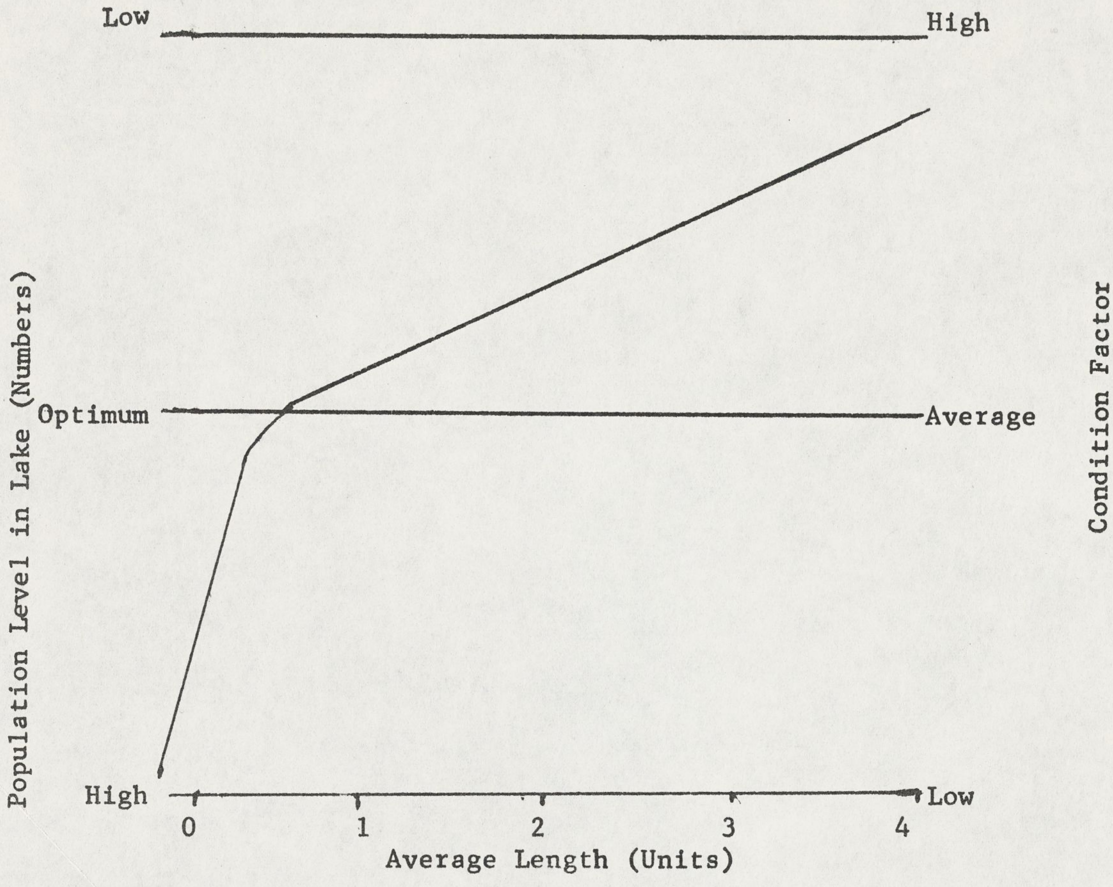


Figure 3.

Length-Weight Relationship of 189 Brook Trout Gill Netted from Beartooth Lake, 1966-68-69. Regression curve drawn by eye.

Figure 4. Cropping Effect on Fish Population. (Premise from Beartooth Lake and Lake Solitude data comparison).



WYOMING GAME AND FISH DEPARTMENT

FISH DIVISION

ADMINISTRATIVE REPORT

Project: 02A73-14-6501

Title: Observations on Brook Trout Populations Associated with Mackinaw and Other Fish in Three High Mountain Lakes

Personnel: Fisheries Management Crew 2A, Cody

Date: February 11, 1974

Introduction:

Brook trout were unofficially stocked during the early 1900's in many of Wyoming's mountain lakes and streams. Since these early introductions, the species has become well established in almost every drainage throughout the Absaroka and Big Horn Mountain region. Because they are extremely prolific and efficient competitors, low fishing pressure and sparse food supplies, brook trout often became over-populated with small, poor conditioned fish, which were not well accepted by the angler.

In Wyoming's Big Horn Basin, comprising Park and Big Horn counties, three alpine lakes, which have abundant brook trout populations, are Solitude, Beartooth and Deep Lakes. Although no fishery research emphasis has been directed toward any inter-relationships between these three lakes, previous management effort has been related to each individual lake's fishery. Beartooth and Deep Lakes are located about nine miles apart and within the Clark's Fork River drainage. Solitude is situated on the Big Horn River drainage approximately 115 miles southeast of Beartooth Lake (Table 1).

Solitude and Beartooth Lakes have been stocked with mackinaw to encourage biological control of brook trout as well as providing a trophy fish for the angler. To provide an additional sport fish, as well as a predator species, Deep Lake has been stocked with silver salmon.

In addition to brook trout, each lake supports at least one other fish species. The indigenous Yellowstone cutthroat occurs at varying densities in each lake. Mackinaw, through planned stocking, are established in Solitude and Beartooth Lakes. Beartooth Lake also contains rainbow trout, grayling, lake chub, mountain sucker, longnose sucker and common white sucker.

In 1956, the creel limit of brook trout was liberalized on these lakes, as well as other state waters. This change, from a weight and number limit, to a weight limit only, was made to encourage greater angler harvest of brook trout. A weight limit only regulation of 8 pounds and one fish is presently in effect.

Pechacek (1972) reported on mackinaw-brook trout relationships in Beartooth Lake. Results of studies at Deep Lake, as a follow-up on silver salmon plants, was published in 1973 (Kent).

This report presents information gathered from gillnetting efforts on Solitude Lake. Brook trout and mackinaw length-frequencies, length-weight relationships, condition factors and net catch-rates are analyzed and compared with similar data from Beartooth and Deep Lakes.

GENERAL DESCRIPTION

Solitude Lake

Solitude Lake is located in Big Horn County (Cloud Peak Primitive Area), at elevation 9,375 feet msl (Figure 1). The 72 surface acre lake, tributary to

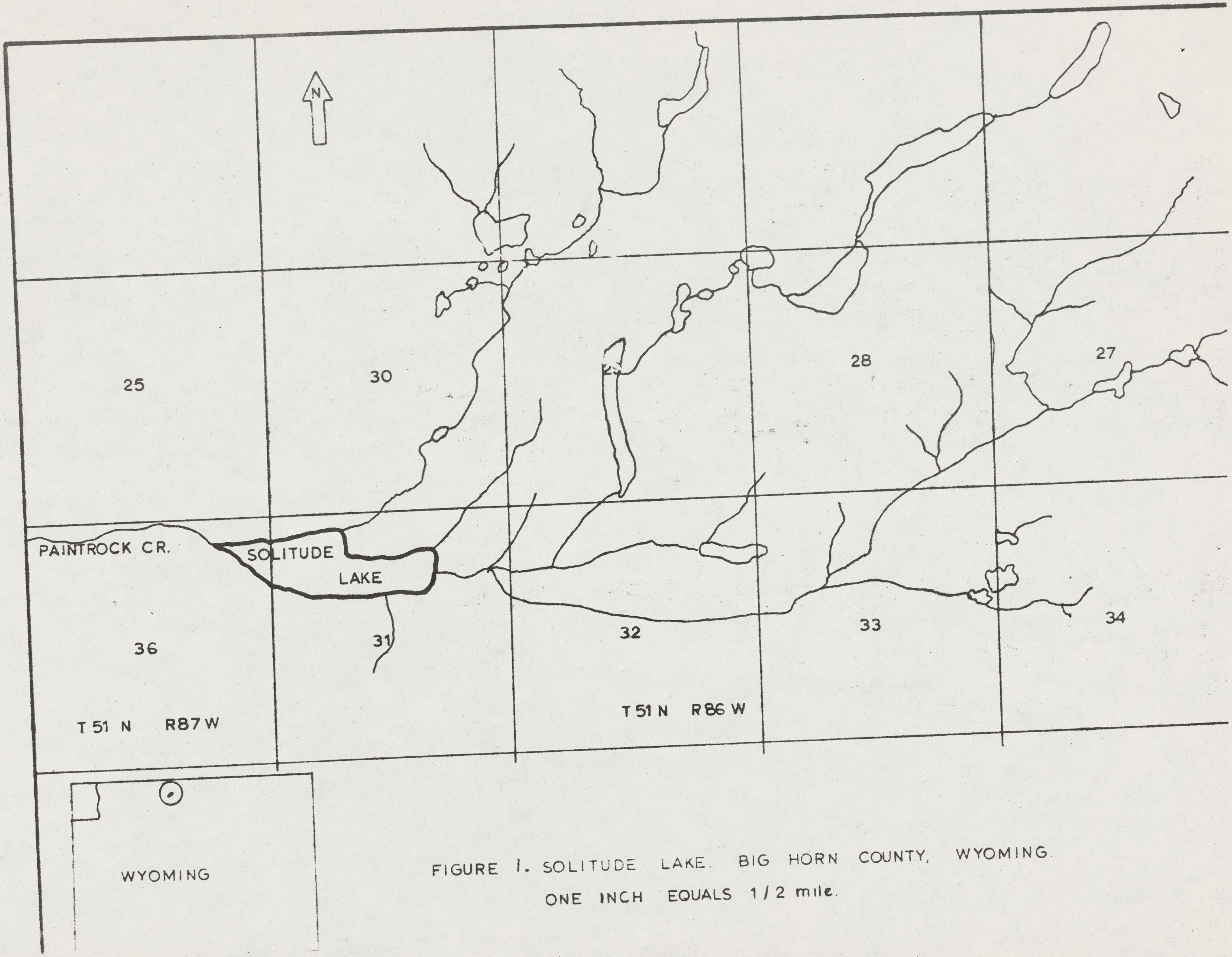


FIGURE 1. SOLITUDE LAKE. BIG HORN COUNTY, WYOMING.
ONE INCH EQUALS 1/2 mile.

Paintrock Creek, lies within a steep granitic canyon, and is accessible by about two and one-half miles of foot or horse trail. The known maximum depth is 161 feet and the littoral zone is limited (estimated about three percent less than 15 feet in depth) (Table 1). The lake thermally stratifies near mid-July, the thermocline forming between depths of about 16 to 32 feet. Fall overturn returns the lake to homothermic condition by late September. Surface temperatures up to 62°F. have been recorded in August. The growing season is short, with an ice-cover extending from about December through May. Recorded pH ranges from 6.5 to 6.8. One late-summer check showed a surface D.O. of 8 ppm, M.O. alkalinity of 17.1 ppm and hardness of 34.2 ppm. Transparency is probably good year around, one sample showing 27 to 30 feet.

Since at least early 1940, brook trout have become a dominant fish species in the lake. Several smaller lakes, which drain into Solitude, support golden trout. No records are available to show authorized stocking of brook or golden trout in the drainage above and including Solitude Lake.

Biological surveys of Solitude Lake, in 1941 and 1952, revealed an over population of poor conditioned brook trout. This information resulted in a decision to stock mackinaw as a possible biological control. Establishment of a larger game fish would also provide more variety and incentive to anglers.

In 1952 and 1953, 7,847 fingerling mackinaw were aerial planted into Solitude Lake. Following these initial mackinaw plants, a fishery survey was made in 1962. This check showed little improvement in brook trout size or condition, and also indicated poor survival of mackinaw plants made nine years previously. Subsequently, in 1962 and 1963, 40,124 fingerling and sub-catchable mackinaw were aerial planted into the lake. Following these plants field surveys were made in 1965, 1967, 1969 and 1973.

Table 1. Characteristics of Three High Mountain Lakes within the Big Horn Basin.

	SOLITUDE LAKE	BEARTOOTH LAKE	DEEP LAKE
COUNTY	Big Horn	Park	Park
DRAINAGE	Big Horn River	Clark's Fork River	Clark's Fork River
TRIBUTARY TO	Paintrock Creek	Beartooth Creek	Little Rock Creek
LOCATION	R86W; T51N; S31	R105W; T57N; S6,7	R104W; T57N; S25, 26,27
MT. RANGE	Big Horn	Absaroka	Absaroka
SIZE (SA)	72	110	317
ALTITUDE	9,375 ft.	8,901 ft.	7,993 ft.
MAX. DEPTH	161 ft.	86 ft.	150 ft.
LITTORAL AREA (under 15')	3%	20%	5%
ACCESS	2½ mi.-foot trail	Vehicle	3 mi.-foot trail
EST. FISHING PRESSURE	Low-5 fmn days/SA/yr	Moderate-10 fmn. days/SA/yr.	Low-0.2 fmn days/ SA/yr.
GAME FISH SPECIES PRESENT	Brook, cutthroat, mackinaw	Rainbow, brook, cutthroat, mackinaw, grayling	Brook, cutthroat, silver salmon*
NON-GAME FISH SPECIES PRESENT	0	Mountain, white, longnose suckers, lake chubs	0
CHEMISTRY			
D.O.	8 ppm	7.0 to 7.8 ppm	10 ppm
pH	6.5 to 6.8	7.0 to 7.9	6.8 to 7.0
MO Alkalinity	17 ppm	20 to 32 ppm	7 to 34 ppm
Hardness	34 ppm	-	17 to 34 ppm
Total Acid	2.3 ppm	-	13.6 ppm
Free Acid	0	-	0
Max. Temp.	62°F	60°F	58°F

*Probably no longer present at this writing.

Date	Species Planted	Number Planted	Weight Planted	Approximate Size	Hatchery
9/5/52	Mackinaw	5,957	23 lbs.	2½"	Story
9/16/53	Mackinaw	1,890	9 lbs.	3"	Story
9/13/62	Mackinaw	27,489	119 lbs.	1½ - 3"	Daniel
7/23/24, 25/63	Mackinaw	12,635	665 lbs.	5"	Daniel

Beartooth Lake

Beartooth Lake lies in Park County, near the Montana border and within a high granitic area known as the Beartooth Plateau. The Lake is intermediate to Solitude and Deep Lakes in size (110 s.a.) and altitude (8,901 ft. msl). Beartooth Lake stratifies during the summer months, and is probably the most productive in terms of littoral area (about 20 percent less than 15 feet in depth) (Pechacek and Kent, 1972).

Mackinaw were stocked in the early 1960's to provide predatory competition with brook trout. Since these plants, mackinaw survival has enabled them to become established in fair numbers. Natural recruitment rate has not been determined at this time. Pechacek (1972), noted an improvement in the average size of brook trout, after several years of mackinaw stocking. Reasons for the increased size were not determined, but could have been related to mackinaw predation, increased fisherman harvest, a relaxed brook trout creel limit and/or variations in sampling methods. Fishing pressure is probably greatest on Beartooth Lake because of vehicle access and availability of recreational facilities.

Deep Lake

Deep Lake, located in Park County, is the largest (317 s.a.) and lowest in altitude (7,993 feet msl) of the three lakes. Thermal stratification is evident in July and August. Because of its steep canyon shoreline, littoral habitat is quite limited (est. 5 percent less than 15 feet in depth). The lake, tributary to the Clark's Fork River via Little Rock Creek, has no surface outlet and possibly because of this, annual water elevation appears to fluctuate much more than in Solitude or Beartooth Lakes.

No mackinaw have been planted or recovered from Deep Lake. In 1966, silver salmon were aerial planted into the lake. Salmon survival was evident in 1967 and 1969. In 1972, no salmon were found, and it was felt that original plants were probably phased out through natural mortality. No evidence of salmon natural recruitment was found.

In addition to brook trout, Deep Lake supports a good population of Yellowstone cutthroat reaching about 16 inches in length. Fishing pressure is estimated at 50 angler days annually, which is well below its capacity in relation to brook trout density. Access is by foot or horse.

FINDINGS

Gillnetting

Five years of gillnetting records for Solitude Lake were available for review (Table 2). Brook trout were the primary species taken, comprising from 97 to 100 percent of the net catch. The remainder were Yellowstone cutthroat, mackinaw and mackinaw x brook trout hybrid. Of 790 brook trout netted, lengths ranged from 3.3 to 11.1 inches and averaged 8.38 inches. These fish averaged 0.22 pounds in weight. During the sample years, average length fluctuated from a low of 7.7 inches in 1965 to 8.9 inches in 1973. In 1973, both the average length and average weight were higher than in any preceeding sample year.

The first mackinaw were netted in 1967 and continued to enter the net catch the following two sample years. Average length and weight of these fish steadily increased from 12.1 inches and 0.46 pound in 1967, to 16.6 inches and 1.64 pounds in 1973. In 1973, mackinaw length distribution ranged from 9.1 to 24.6 inches.

Table 2. A Summary of Gillnetting in Solitude Lake - Big Horn County, Wyoming.

Date	Number of Nets and Type	Temperature	Species	Number	Average Length	Range	Average Weight	Range	Catch Per Net Hour
8/15/73	4-200' exp.mono.	Air-55°F	Brook	298	8.90"	4.2-11.1	0.25	0.02-0.52	3.59
	2-150' exp.mono.	Wat-55°F	Mackinaw	8	16.55"	9.1-24.6	1.64	0.18-4.74	0.10
	83 net hours		Br x Hybrid	1	9.70	-	0.28	-	0.01
8/28/69	5-200' exp.mono.	Air-54-60°	Brook	263	7.91	3.3-10.5	0.21	0.01-0.43	4.03
	65¼ net hours	Wat-59°	Mackinaw	8	14.24	13.2-14.9	0.80	0.64-1.02	0.12
			YS Cutthroat	1	6.90	-	0.12	-	0.02
10/7/67	2-200' exp.nylon	Air-28°	Brook	229	8.26	5.4-10.1	0.21	0.06-0.40	3.41
	1-125' exp.nylon	Wat-44°	Mackinaw	2	12.10	11.0-13.2	0.46	0.33-0.58	0.03
	67¼ net hours		YS Cutthroat	2	7.65	7.1- 8.2	0.14	0.10-0.18	0.03
9/8/65	1-175' exp.nylon	Air-56°	Brook	82	7.70	6.5- 9.9	-	-	3.28
	1-200' exp.nylon	Wat-52°							
	25 net hours								
8/7/62	1-200' exp.nylon	Air-59-60°	Brook	119	8.30	6.4-10.5	-	-	1.83
	1-175; exp.nylon	Wat-54°							
	1-125' exp.nylon								
	65 net hours								
Total - 1967-69-73			Brook	790	8.38	3.3-11.1	0.22	0.01-0.52	3.66
			Mackinaw	18	15.03	9.1-24.6	1.14	0.18-4.74	0.08
			Br x M Hybrid	1	9.70	-	0.28	-	0.01
			Ys Cutthroat	3	7.40	6.9- 8.2	0.13	0.10-0.18	0.01

In general, sinking experimental gillnets were set with the small mesh in shallow water and the large mesh in deeper water. In 1973, after a very high catch of brook trout using this method, two gillnets were set several hundred feet from shore at depths over 30 feet. These two overnight sets produced only three brook trout and three mackinaw. Although no exact depth ranges were measured, mackinaw were generally taken in water ranging from 10 to 40 feet in depth. Because of a steep shoreline, a 200 foot gillnet, set perpendicular to shore, would often sample to a 100 foot or greater depth.

Length-Distribution

A length distribution of brook trout taken in gillnets during the five sample years is shown in Table 5 and Figure 2. There has been a steady increase in number of brook trout within the larger length groups. The number of brook trout over 9.9 inches in length has increased from less than one percent in previous years, to 11 percent in 1973.

Table 3. Size Composition of Solitude Lake Brook Trout taken in Gillnets.

Sample Year	Total Brook Trout Netted	Number Under 9.9 Inches	Number Over 9.9 Inches
1973	298	265 (89%)	33 (11%)
1969	263	262 (99%)	1 (1%)
1967	229	228 (99%)	1 (1%)
1965	82	82 (100%)	0 (-)
1962	119	118 (99%)	1 (1%)

The paucity of larger (over 9.9 inches) brook trout in Solitude Lake is emphasized when compared with their length-distribution in Beartooth and Deep Lakes.

Table 4. Size Composition of Brook Trout Taken in Gillnets. Three High Mountain Lakes.

Lake	Sample Years	Total Brook Trout Netted	Number Under 9.9 Inches	Number Over 9.9 Inches
Solitude	1967-69-73	790	754 (95.4%)	36 (4.6%)
Beartooth	1966-68-69	189	123 (65.1%)	66 (34.9%)
Deep	1967-69-72	279	215 (77.1%)	64 (22.9%)

Length-distribution of 18 mackinaw taken in gillnets is shown in Table 6. Apparently, natural reproduction is occurring in Solitude Lake, in view of the small 9.1 inch fish taken in 1973. The origin of larger mackinaw is questionable. If the 1962-63 plants produced these fish, ranging from 15.5 to 18.0 inches, they would be ten years old.

Based on growth in high elevation Colorado lakes (Nolting, 1958) ten year old mackinaw would be larger, generally over 22 inches in length. In Colorado waters, mackinaw reached 18 inches in five to seven years. Considering this information, it is suspected that most of the 18 mackinaw netted from Solitude Lake are the result of natural reproduction.

Table 5. Brook Trout Length-Frequency Distribution, Empirical and Calculated Weights and Condition Factors. Taken by Gillnetting in Three Big Horn Basin Lakes.

	SOLITUDE LAKE						BEARTOOTH LAKE						DEEP LAKE					
Length Group	N	Avg. L.	Avg. W.	Calc. Wt.	Avg. C.	Calc. C.	N.	Avg. L.	Avg. W.	Calc. Wt.	Avg. C.	Calc. C.	N.	Avg. L.	Avg. Wt.	Calc. Wt.	Avg. C.	Calc. C.
3.0- 3.4	1																	
3.5- 3.9	1																	
4.0- 4.4	7	4.30	0.028	0.028	35.7	37.3	4						3					
4.5- 4.9	16	4.68	0.038	0.039	37.2	37.2	13						12	4.81	0.036	0.036	32.8	35.2
5.0- 5.4	11	5.23	0.050	0.053	35.2	37.1	8						22	5.20	0.048	0.049	33.9	35.2
5.5- 5.9	7	5.66	0.061	0.069	34.0	37.1	4						18	5.73	0.064	0.065	34.2	35.2
6.0- 6.4	14	6.22	0.091	0.089	37.3	37.0	4						15	6.23	0.091	0.084	37.3	35.3
6.5- 6.9	44	6.71	0.115	0.111	37.7	36.9	10	6.65	0.112	0.116	38.1	38.0	23	6.74	0.109	0.106	35.6	35.3
7.0- 7.4	58	7.22	0.144	0.138	38.4	36.8	10	7.27	0.143	0.143	37.3	37.8	16	7.12	0.128	0.133	35.3	35.4
7.5- 7.9	82	7.67	0.176	0.167	39.0	36.8	14	7.64	0.163	0.174	36.6	37.7	14	7.71	0.171	0.162	36.9	35.4
8.0- 8.4	138	8.19	0.212	0.201	38.3	36.7	16	8.14	0.211	0.209	38.9	37.5	18	8.18	0.205	0.196	37.4	35.5
8.5- 8.9	178	8.68	0.243	0.240	37.1	36.6	17	8.78	0.237	0.248	36.4	37.4	20	8.75	0.246	0.235	37.0	35.5
9.0- 9.4	118	9.10	0.280	0.283	36.2	36.6	10	9.16	0.284	0.292	36.8	37.3	24	9.17	0.287	0.278	37.2	35.6
9.5- 9.9	80	9.67	0.327	0.330	35.9	36.5	12	9.67	0.354	0.340	39.0	37.2	30	9.68	0.324	0.327	35.5	35.6
10.0-10.4	23	10.11	0.385	0.383	36.7	36.4	15	10.19	0.409	0.393	38.4	37.0	22	10.18	0.373	0.381	35.0	35.6
10.5-10.9	12	10.67	0.446	0.441	36.8	36.3	20	10.70	0.451	0.451	36.8	36.8	16	10.67	0.429	0.440	35.4	35.7
11.0-11.4	1						10	11.19	0.502	0.515	36.1	36.6	13	11.26	0.497	0.506	34.5	35.7
11.5-11.9							9	11.64	0.556	0.584	35.1	36.5	8	11.72	0.550	0.578	34.0	35.8
12.0-12.4							6	12.08	0.647	0.660	36.7	36.4	5					
12.5-12.9							3											
13.0-13.4							2											
13.5-13.9																		
14.0-14.4																		
14.5-14.9							1											

	Solitude Lake	Beartooth Lake	Deep Lake
Total Number	790	189	279
Avg. Length	8.38"	8.74"	8.20"
Avg. Weight	0.22 lb.	0.29 lb.	0.23 lb.
Avg. Calc. "C"	36.7	37.4	35.5
L-Wt a	-3.3820	-3.3238	-3.4863
Regression b	2.9396	2.8933	3.0408
Condition a	37.90	39.97	34.77
Regression b	-0.1454	-0.2960	0.0849
Sample Years	1967-69-73	1966-68-69	1967-69-72

#-Calculated weight and condition at length group mid-point.

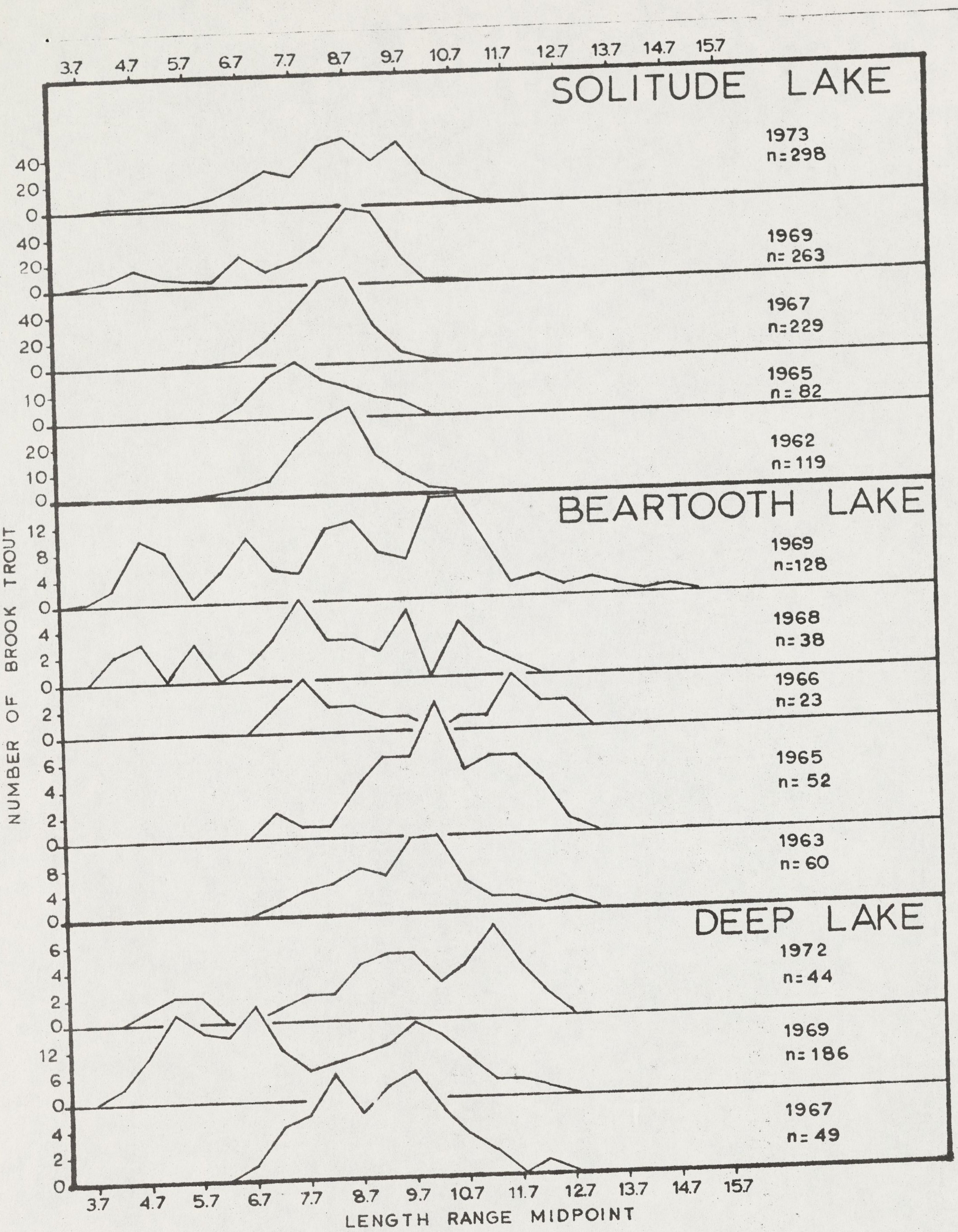


FIGURE 2 LENGTH FREQUENCY OF BROOK TROUT IN THE GILL NET CATCH. THREE BIG HORN BASIN LAKES.

Table 6. Length-Frequency, Average Length, Weight and Condition of Mackinaw taken in Gillnets. Solitude and Beartooth Lakes.

Length Group	Solitude Lake				Beartooth Lake			
	N	Avg. Length	Avg. Weight	Avg. Condition	N	Avg. Length	Avg. Weight	Avg. Condition
9.0- 9.4	1	9.1	0.180	23.9				
9.5- 9.9								
10.0-10.4								
10.5-10.9								
11.0-11.4	1	11.0	0.330	24.8				
11.5-11.9					1	11.5	0.480	31.6
12.0-12.4					1	12.4	0.580	30.4
12.5-12.9					3	12.8	0.623	29.7
13.0-13.4	2	13.2	0.635	27.6	2	13.2	0.605	26.3
13.5-13.9	1	13.8	0.640	24.4	2	13.7	0.775	30.1
14.0-14.4	3	14.1	0.753	26.9	1	14.1	0.750	26.8
14.5-14.9	3	14.8	0.947	29.2	2	14.8	0.920	28.4
15.0-15.4					5	15.2	1.056	30.1
15.5-15.9	2	15.6	1.160	30.6	1	15.5	1.180	31.7
16.0-16.4	2	16.1	1.330	31.9	1	16.0	1.200	29.3
16.5-16.9								
17.0-17.4	1	17.2	1.550	30.5	1	17.0	1.690	34.4
17.5-17.9								
18.0-18.4	1	18.0	1.680	28.8				
18.5-18.9								
19.0-19.4					1	19.4	2.740	37.5
24.5-24.9	1	24.6	4.740	31.8				
25.0-25.4								
25.5-25.9								
26.0-26.4								
26.5-26.9					1	26.7	7.000	36.8
Total Number		18				22		
Avg. Length		15.03"				15.05"		
Avg. Weight		1.14 lb.				1.24 lb.		
Sample Years		1967-69-73				1966-68-69		

Age-Growth

Based on length-frequencies, the age-growth features of brook trout in Solitude Lake have been estimated as shown in Table 7.

Table 7. Estimated Age-Growth of Solitude Lake Brook Trout.

AGE GROUP	LENGTH	LENGTH INCREMENT
I	4.7"	-
II	7.2"	2.5"
III	8.7"	1.5"
IV	9.7"	1.0"

These growth estimates for Solitude Lake appear to be comparable with other high mountain Wyoming lakes, at least during the first two years of life. Growth rates decrease in three and four year old brook trout, the annual growth increment reaching only one inch during the fourth summer.

Length-Weight Relationship

The length-weight relationship determined for brook trout from Solitude Lake, during each of the sample years 1967, 1969 and 1973, is shown in Figure 3. This data represents brook trout collected after mackinaw were established in Solitude Lake. Plotted values indicated a possible improvement within the larger size groups, from 8.7 inches and up.

The length-weight relationship determined for 787 brook trout from Solitude Lake (combined sample years) was Log W = -3.3820+(2.9369) Log L. The curve for the calculated antilog values of L and W is shown in Figure 4. Calculated length and weight values show a good fit with plotted emporical points, the largest weight variance being 0.011 pound in the 8.0 to 8.4 inch size group.

In comparing the length-weight relationship of brook trout from Solitude Lake with those from Beartooth and Deep Lakes, some differences are apparent

(Table 5, Figure 4). Calculated weights, at each of the 14 length group mid-points, are lowest for Deep Lake, highest for Beartooth Lake with Solitude Lake falling between.

Condition Factor

Condition factors (C), were determined using the formula

$$C = \frac{100,000W}{L^3}$$

where W = weight in pounds and L = total length in inches. Condition factors were found for each of 787 brook trout collected from Solitude Lake. Fish were grouped within 0.5 inch length intervals, and the average "C" was determined by dividing total condition by number of fish. The condition factor means for each of 14 one-half inch length groups is shown in Table 5.

Mean condition ranged from 34.0 at 5.7 inches to 39.0 at 7.7 inches. Mean values plotted by length group indicate a significant condition loss in the smaller trout, from 5.0 to 5.9 inches (Figure 5). This loss is recovered rapidly in the 6.0 to 6.4 inch group and condition continues to improve, reaching a peak of 39.0 at 7.7 inches. Following this optimum, condition decreases somewhat and levels off to about 36.5 from 8.5 to 10.9 inches.

A regression line, as described by the formula $Y = a + bx$, was computed for the 14 empirical condition means (Figure 5). This line shows a gradual condition loss from 37.3 at 4.2 inches, to 36.3 at 10.7 inches. The mean condition factor for all brook trout, averaging 8.38 inches, was 36.7 as derived from the formula $Y = 37.90+(-0.1454)x$.

Mean condition factors of brook trout from Beartooth and Deep Lakes are also shown in Table 5 and Figure 5. Small brook trout in Deep Lake also exhibits condition loss, which is recovered after reaching a size of about seven inches.

After peaking at 7 to 9 inches, larger brook trout in each of the three lakes show a condition loss.

A condition regression of 12 length groups from Beartooth Lake is described by the formula Y = 39.97+(-0.2960)X; of 15 length groups from Deep Lake by the formula Y=34.77+(0.0849)X. The calculated mean condition factor of brook trout from Beartooth Lake was 37.4 (avg. length-8.74 inches); from Deep Lake, 35.5 (avg. length-8.20 inches).

Calculated condition factors of brook trout Beartooth Lake are best, at a given length, when compared with those from Solitude and Deep Lakes (Figure 4). The absence of small fish in the Beartooth Lake sample may, however, bias comparisons.

Although the mean calculated condition factor of brook trout from Solitude Lake is below that of Beartooth Lake (36.7 vs 37.4), the difference is not great. The absence of small fish in the Beartooth Lake sample may tend to raise its regression line and likewise, if small fish were eliminated from the Solitude Lake sample, its regression line would be higher. Mean empirical condition factors, at given length intervals, do not differ greatly between the three lakes.

Condition factors of brook trout from Towner Lake in the Snowy Range were generally higher than the three lakes studied ranging from 36 to 45 (White, 1965; Christensen, 1965). Brook trout conditions in Solitude Lake compares favorably with that of lakes in the Montana portion of the Beartooth Plateau (Domrose, 1963). Carlander (1969) reports brook trout condition factors in Wyoming lakes ranging from 38 to 52.

The condition factor of 18 mackinaw, netted from Solitude Lake, ranged from 28.4 for those fish below 14.9 inches, to 31.8 for one specimen 24.6

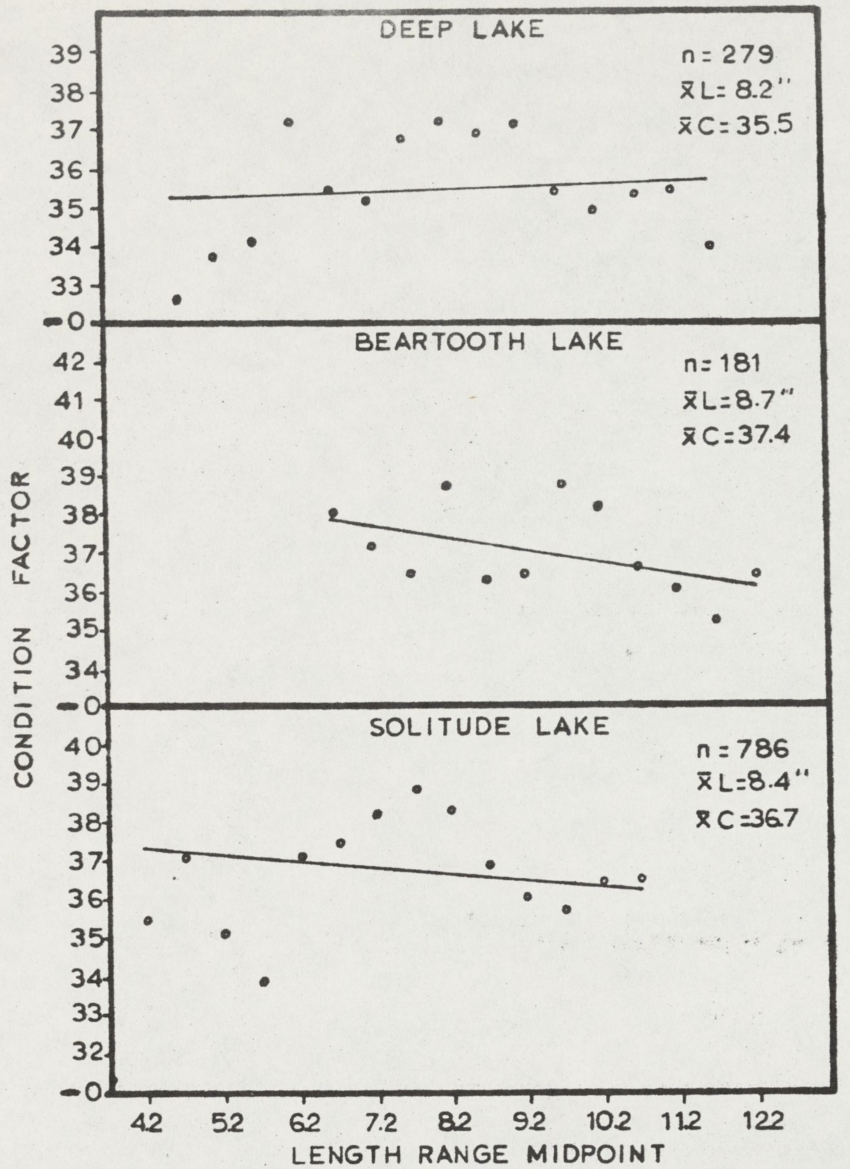


FIGURE 5. MEAN CONDITION FACTORS OF BROOK TROUT, BY LENGTH GROUP. THREE BIG HORN BASIN LAKES.

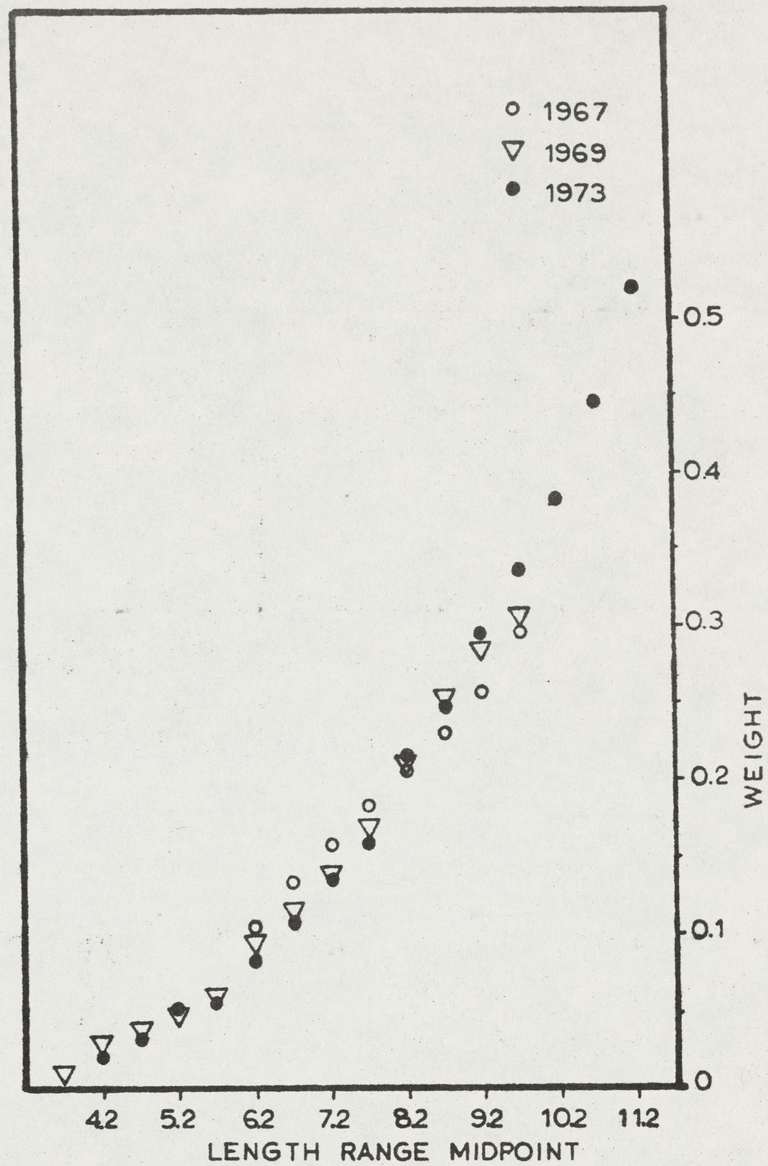


FIGURE 3. LENGTH WEIGHT RELATIONSHIP OF 787 BROOK TROUT GILL NETTED IN SOLITUDE LAKE. 1967, 1969 & 1973.

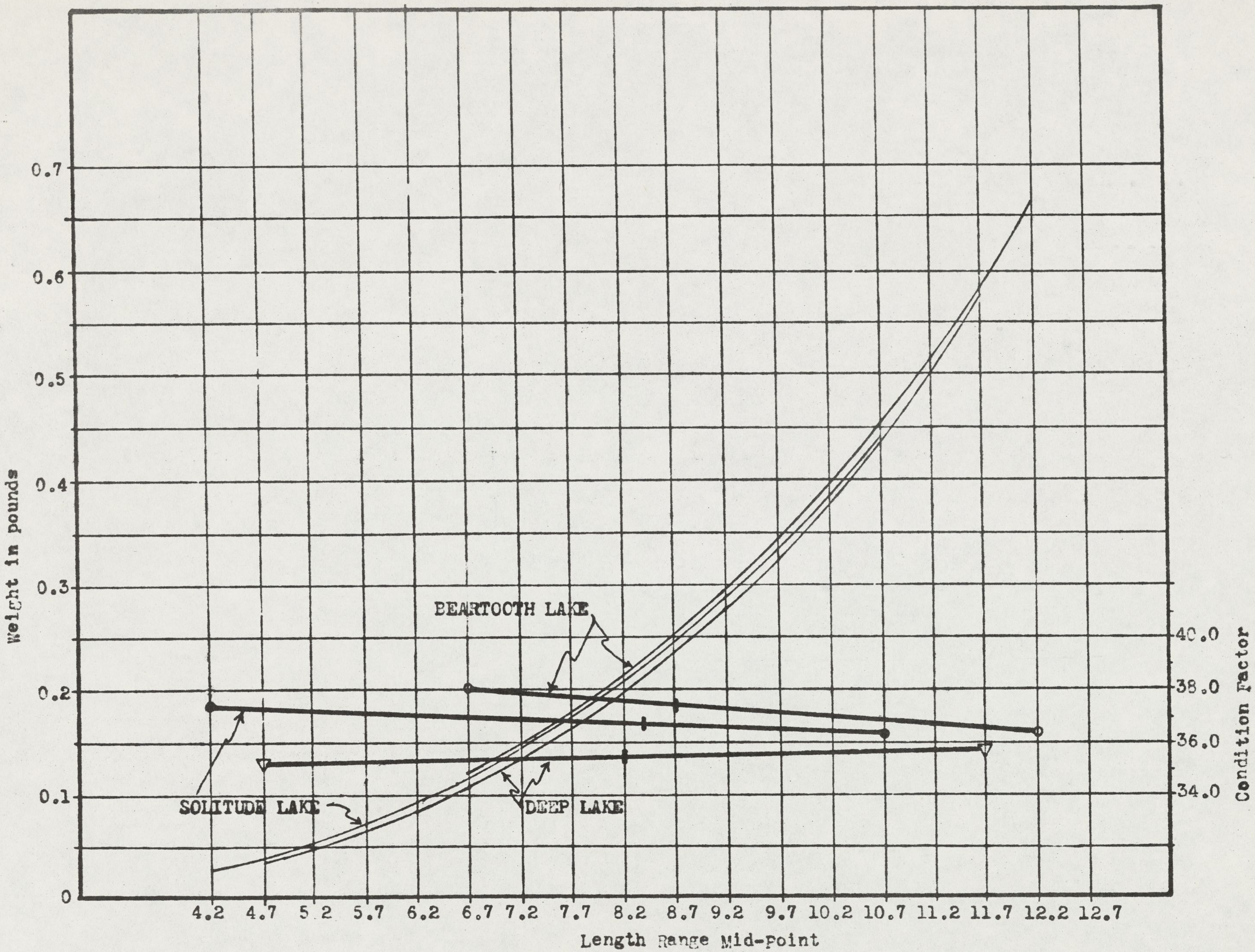


Figure 4 . Calculated length-weight relationship and condition factor of brook trout.

inches in length. At least four of the seven mackinaw over 14.9 inches were sexually mature males. No mature females were noted. Mackinaw conditions appear, from a limited sample, to improve as they become larger, indicating availability and use of suitable food (probably brook trout) for the larger predatory individuals.

Condition of mackinaw from Solitude Lake is somewhat lower than that of mackinaw from Beartooth Lake.

Table 8. Size and Condition of Mackinaw taken in Gillnets. Solitude and Beartooth Lakes.

	Solitude Lake				Beartooth Lake			
Size Range	N	Avg. Length	Avg. Weight	Avg. Condition	N	Avg. Length	Avg. Weight	Avg. Condition
Under 14.9"	11	13.4	0.68	28.4	10	13.3	0.69	29.3
14.9"-19.4"	6	16.4	1.37	31.1	11	16.0	1.34	32.7
Over 19.4"	1	24.6	4.74	31.8	1	26.7	7.00	36.8

Net Catch-Rate

Domrose (1963), found a positive correlation between brook trout net catch-rate, average weight and average condition in several Beartooth plateau lakes within Montana. In veiw of the high catch rates in Solitude Lake, it might be expected that brook trout would exhibit low weights and condition factors. In reviewing these values, no apparent relationship can be noted. The occurrence and density of other fish species, as well as each lake's productivity would certainly influence these relationships.

Table 9. Relationship of Brook Trout net Catch-Rate to Size and Species Composition of the Net Sample. Three High Mountain Lakes.

Lake	Net Hours Effort	Brook Netted	Catch Per Net Hour	Avg. Length	Avg. Weight	Avg. "C"	Brook As % of Total Sample No.	Brook As % of Total Sample Wt.
Solitude	216	790	3.66	8.4	0.22	36.7	97	90
Beartooth	77	189	2.46	8.7	0.29	37.4	77	56
Deep	248	279	1.12	8.2	0.23	35.5	87	74

Feeding Habits

Random field checks of mackinaw stomachs from Solitude Lake show a primary diet of chironomid larvae and small clams. A stomach from one large (24.6 inch) mackinaw contained skeletal remains of a fish about five inches in length. Brook trout diet consisted of a variety of terrestrial insects, zoo and phytoplankton.

DISCUSSION

Mackinaw have probably become established in Solitude Lake as a self sustaining population. The appearance, however, of one dominant size group and possibly age class, during each of the last three field surveys, suggests erratic spawning success.

In Solitude Lake, mackinaw may be exerting a desirable effect on existing brook trout populations. The number of larger brook trout in the net sample has increased considerably. The length-weight relationship of larger brook trout has improved since 1967, and is comparable with that of brook trout from Beartooth and Deep Lakes.

Both the average length and weight of brook trout in Solitude Lake improved in 1973, over previous sample years. However, as in Beartooth Lake, average length fluctuates and is probably dependent on a number of variables not directly related to changes associated with population structure.

Condition of Solitude Lake brook trout, within equal length groups, is comparable with Beartooth and Deep Lakes. Condition factors are not abnormally low in relation to other similar waters.

In terms of net catch-rate, brook trout density in Solitude Lake is greater than in Beartooth and Deep Lakes. Net catch-rates in Solitude Lake has not decreased significantly over the past nine years. If in 1973, all gillnets had been set to harvest maximum numbers of brook trout, the catch-rate may have been higher.

Although angler use is estimated to be increasing on all three lakes, brook trout harvest is probably much less than that necessary to induce any favorable changes in the brook trout fishery. If mackinaw begin to enter the Solitude Lake sport fishery, angler use may increase accordingly. Restrictions placed on wilderness users, difficult access and the abundance of fishing waters in the Solitude Lake region, pose a situation not especially conducive to a great influx of anglers.

A low relative abundance of larger brook trout seems to be the primary difference between Solitude and Beartooth-Deep Lakes. It is suggested that the high brook trout density, in a rather sterile habitat, retards brook trout growth. Of the three lakes compared, productivity is possibly lowest in Solitude Lake.

Although each lake's ecology is different, their brook trout fishery is surprisingly similar. Perhaps minor differences in morphology, limnology, etc., is overshadowed by gross similiarities in lake size, depth, altitude and geography.

RECOMMENDATIONS

It is recommended that periodic field surveys of Solitude Lake continue to determine:

1) Population dynamics of the brook trout, mackinaw and cutthroat fishery including: density, longevity, age-growth, length-weight, condition, maturation, fecundity, spawning and feeding habits.
2) Invertebrate food availability.
3) Fishing pressure and harvest patterns.
4) Physical and chemical properties.

Report by: Ronald L. Kent, Fisheries Biologist
Date: November 13, 1973 (re-write 2/15/74)

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WYOMING GAME AND FISH DEPARTMENT

FISH DIVISION

ADMINISTRATIVE REPORT

Title: Evaluation of Splake and Their Effect on Grayling Populations in Willow Lake, Johnson County

Project: 3085-13-5503

Personnel: Bob McDowell, Bill Wichers, Paul Beels (USFS)

Author: Bob McDowell

Date: November 1985

INTRODUCTION

Willow Lake is a tributary to Oliver Creek at an altitude of approximately 9,300 feet in the Bighorn Mountains. Maximum depth is 15 feet and surface area is about 11.5 acres.

Abundant populations of grayling have been reported in Willow Lake since 1938. Excellent natural reproduction for grayling has caused an over-populated, stunted condition which resulted in a general lack of interest by fishermen. In 1958 the number limit on grayling was removed and a 10 pound weight limit imposed to encourage more harvest. In 1967 an 8 pound weight limit was implemented to conform with regulations for the rest of the area. Since January of 1982, angling regulations have restricted the harvest to 12 grayling (or other trout and salmon in combination) with no weight limit. In addition, present statewide regulations permit only one salmonid over 20 inches. Angler use on Willow Lake has increased with greater human population densities in the area, but angler harvest has been ineffective in significantly reducing grayling populations or increasing their average length and weight.

Biological control of the over-populated grayling was suggested in 1961. Although lake trout were initially recommended, a pilot error resulted in accidentally stocking Willow Lake with 1,103 splake trout (2.25 pounds at 490/pound) on September 13, 1961. An experimental plant of 1,004 Snake River cutthroat (12.4 pounds at 81/pound) was introduced on September 3, 1974. An additional 946 splake (5.7 pounds at 166/pound) were stocked in Willow Lake on August 26, 1981.

METHODS

Fish populations in Willow Lake have been sampled every 4 years by gill netting (1961, 1965, 1969, 1973, 1977, 1981 and the current study - 1985). Results of this sampling have been previously reported (Mueller and Rockett 1966, Mueller 1970, 1974, 1977 and 1981).

Methods for sampling Willow Lake have been fairly standard over the last several sampling periods using two 150 foot experimental, monofilament gill nets set for 1 daylight hour, checked and reset for overnight. Gill net samples in 1985 were supplemented with information gathered from angling while biologists waited to run the gill nets. Length and weight information was gathered and condition factors calculated. In 1985 a cursory examination of stomach contents was made to determine general forage habits of the grayling and splake.

RESULTS

The catch per net hour of grayling ranged from 0.60 in 1965 to 2.67 in 1981 while splake catch per net hour ranged from 0.03 in 1977 to 0.57 in 1969 (Table 1). Catch per net hour in 1985 was 0.73 for grayling and 0.34 for splake. The only cutthroat taken were two in 1977, and these were 3 years old and averaged 10.6 inches at the time. Snake River cutthroat were apparently ineffective in exerting the desired control on grayling and failed to survive very well (Mueller 1981).

The first evidence of any change in the size structure of grayling was noted in 1969, 7 years after the introduction of splake (Table 2). Grayling in the 1969 and 1973 sampling averaged 10.1 inches with individuals up to 14.3 inches. The larger grayling coincided with splake averaging 16.0 and 21.6 inches in 1969 and 1973, respectively. By 1977 only one 15 year old splake was taken and the average length and weight of grayling had declined (9.0 inches and 0.10 pounds) to levels similar to the period when splake were first introduced.

By 1981 75 of the grayling sampled ranged from 7.3 to 13.0 inches (average 9.6 inches) and the remaining 21 averaged 5.0 inches (4.6 - 5.5 inches). The first evidence of splake reproduction was seen in the 1981 sampling with splake averaging 12.3 inches (range 11.2 - 13.0 inches). Based on growth of the 1961 plant of splake, the splake in the 1981 sampling must have been 4 to 5 years old from spawning that must have occurred about 1976 or 1977.

By 1985 most of the splake caught were less than 12 inches and likely survivors from the 1981 plant (Table 2). Only one splake (14.5 inches and 0.96 pounds) was possibly from the earlier cohort of natural reproduction. The average size of grayling in 1985 (9.5 inches and 0.21 pounds) indicates a slight improvement over 1981. However, average condition factors for grayling and splake have generally declined over the maximum size structure seen for both species in 1969 and 1973. Condition factors were lowest (24.5 for grayling and 32.8 for splake) in 1985 (Table 2). Numerous small fish were observed around the rocks of the inlet area in 1985. None of the fish could be captured but they were assumed to be grayling young of the year.

A cursory examination of grayling stomachs found 11 which contained plankton, five contained various unidentified insect pieces, four contained ants, three had beetles and three had pine needles, two contained grasshoppers; midges were in one stomach, a wood stick was found in one and one grayling stomach contained fish guts discarded by a fisherman. Of the splake stomachs examined, five contained caddis fly larvae, three contained discarded fish guts, two had midges and one stomach was empty. Mueller (1981) reported a 12.9 inch splake had a 7.6 inch grayling in its stomach from the 1981 sampling but no complete

Table 1. Summary of experimental gill net sets and catch per hour at Willow Lake.

Year	Number of Nets and Type	Period Set (Appx. Total Hours)	Catch Per Net Hour Grayling	Splake	Cutthroat	Total
1961	1 200' Nylon	Overnight (24)	0.75	-	-	0.75
1965	2 125' Nylon	Overnight (30)	0.60	0.07	-	0.67
1969	2 125' Monofilamet	Daylight & Overnight (30)	2.07	0.57	-	2.63
1973	2 150' Monofilament	Daylight & Overnight (36)	2.19	0.14	-	2.33
1977	2 150' Monofilament	Daylight & Overnight (33)	0.85	0.03	0.06	0.94
1981	2 150' Monofilament	Daylight & Overnight (36)	2.67	0.08	-	2.75
1985[1]	2 150' Monofilament	Daylight & Overnight (41)	0.73	0.34	-	1.07

1 Catch per hour based on gill netted fish only (angling excluded) as: 30 grayling and 14 splake.

Table 2. Number, length, weight and condition factor summary for grayling, splake and cutthroat sampled from Willow Lake, Johnson County (R85, T50, S26) for 1961, 1965, 1969, 1973, 1977, 1981 and 1985.

	Grayling				Splake				Cutthroat			
Date Sampled	Number	Avg. Length (Range)	Avg. Weight (Range)	Avg. Cond. (Range)	Number	Avg. Length (Range)	Avg. Weight (Range)	Avg. Cond. (Range)	Number	Avg. Length (Range)	Avg. Weight (Range)	Avg. Cond. (Range)
07/24/61	18	8.4 (7.1-10.5)	0.15 (0.10-0.29)	25.6 (18.5-29.5)								
07/15/65	18	8.5 (7.8-10.6)	0.16 (0.11-0.33)	25.8 (22.0-32.5)	2	11.0 (11.0-11.0)	0.46 (0.44-0.48)	34.5 (33.0-36.0)				
08/18/69	62	10.1 (5.0-13.5)	0.35 (0.04-0.80)	30.2 (26.0-36.0)	17	16.0 (13.9-22.3)	1.54 (0.88-4.44)	35.4 (31.0-40.0)				
07/23/73	79	10.1 (7.1-14.3)	0.33 (0.12-0.84)	30.5 (24.0-41.0)	5	21.6 (20.0-24.5)	4.20 (3.02-5.64)	41.2 (32.5-46.5)				
08/11/77	28	9.0 (7.9-12.3)	0.20 (0.12-0.54)	25.9 (22.0-29.0)	1	23.5	4.64	36.0	2	10.6 (10.0-11.3)	0.39 (0.28-0.50)	31.2 (28.0-34.5)
08/11/81	96	8.6 (4.6-13.0)	0.21 (0.03-0.64)	26.9 (20.2-34.0)	3	12.3 (11.2-13.0)	0.69 (0.44-0.91)	35.3 (31.5-42.0)				
08/06/85[1]	55	9.5 (8.3-10.9)	0.21 (0.14-0.29)	24.5 (20.3-28.0)	15	11.0 (9.2-14.5)	0.46 (0.23-0.96)	32.8 (29.5-37.3)				

1 1985 data includes 25 grayling and one splake caught angling (size range of fish angled were same as by gill netting).

grayling were found in the stomachs of splake in 1985. The majority of splake caught in 1985 were apparently too small to feed on the average size grayling present in Willow Lake this year.

SUMMARY AND CONCLUSIONS

1. Splake have been effective in improving the average length, range and condition of stunted grayling populations in Willow Lake as evidenced in the 1969 and 1973 sampling when splake averaged 16.0 and 21.6 inches, respectively and grayling averaged 10.1 inches.

2. Based on the size structure of the present splake population, it is expected that the average size of grayling will continue to improve as these splake increase in size.

3. Average condition factors of the grayling and splake in 1985 were lower than any previous sampling period. Currently the grayling population is dominated by fish in the 8 to 11 inch size group and largely unavailable as forage for the splake which are presently of similar size. However, the splake should continue to forage on young grayling as they become available. The stomachs of examined splake contained mostly caddis fly larvae and fish guts discarded by fishermen. There was no evidence of splake feeding directly on grayling.

4. The present population of splake is maintained from a 1981 plant and some limited natural reproduction. Natural reproduction of splake in Willow Lake is apparently limited and erratic and probably inadequate to maintain a balance in this fishery. Periodic plants of splake or lake trout will likely be necessary to supplement natural reproduction and continue to exert the desired control on grayling.

5. Forage for grayling is limited and largely supported by plankton and terrestrial invertebrates. Without the present biological control, this population would likely become extremely stunted and offer very little attraction to anglers. Present use of the fishery indicates that some fishing pressure is being exerted on the grayling population.

RECOMMENDATIONS

1. Continue to monitor Willow Lake by gill netting and angling every 4 years. The next scheduled sampling will be in July or August 1989.

2. Assuming the present splake population is made up of fish primarily from the 1981 plant, they should be sexually mature by 1987 (age VI). Look for evidence of successful reproduction in the 1989 sampling.

3. Willow Lake is recommended for stocking every 4 years and is scheduled to receive a plant of 900 splake in 1986.

4. While visiting Willow Lake, it is recommended that any anglers be interviewed to determine catch rates and composition and size of their catch as an indication of fishing use and acceptance of this fishery.

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