Identification of a collection of cutthroat trout
from Trappers Creek, Parachute Creek drainage,
Garfield County, Colorado

Prepared for BLM, Denver

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In a previous report prepared for the BLM on cutthroat trout in the Parachute Creek drainage (March, 1976), I pointed out that the population in Northwater Creek, despite known stocking records, ideally approximates the characteristics of the Colorado River cutthroat trout, *Salmo clarki pleuriticus*, and is one of the best representatives of this rare trout presently known. It was also mentioned that 1500 rainbow trout were stocked into Northwater Creek in 1965. Although no indication of rainbow trout hybridization could be detected in 12 specimens collected from Northwater Creek in 1975, there is a possibility such hybridization has occurred and its effects will be evident in the future. If such an unfortunate situation arises, the Northwater Creek cutthroat population would lose its value as a source for establishing new populations of *S. c. pleuriticus* in other waters.

Considering the possible loss of purity of the Northwater cutthroat trout, Mr. Robert Byars, former BLM biologist, Grand Junction, decided to check the purity of the cutthroat trout in Trappers Creek which joins Northwater Creek to form the headwaters of the East Middle Fork of Parachute Creek. A barrier falls, about 2.5 miles below the junction of Trappers and Northwater creeks, isolates the streams above from invasion of rainbow x cutthroat hybrids occurring below the barrier.

The 10 specimens examined were collected on August 20, 1976 from Trappers Creek (T. 55, R. 94W, Sec. F) by Mr. R. Krager, Colorado Division of Wildlife.

Table 1.

Character analysis of some Parachute Creek drainage trout samples

Locality	Gillrakers	Pyloric caeca	Scales above lat. line and in lat. ser.	Basibranchial teeth
Northwater Creek 1972-1975 N = 41	16-21 (18.8)	23-46 (33.9)	43-51 (46.8) 172-206 (187.2)	2-15 (6.8)
Trappers Creek 1976 N = 10	17-21 (19.1)	34-42 (38.4)	44-51 (46.1) 167-203 (190.4)	9 with 1-11 (3.4) 1 w/o teeth
East Middle Fork (partially hybridized) 1972-1973 N = 31	17-21 (19.0)	24-43 (35.1)	42-54 (47.7) 164-191 (171.2)	16 with 1-7 (2.9) 15 w/o teeth

The data comparing the Trappers Creek collection with Northwater Creek specimens are presented in Table 1. Phenotypically, the general morphology and spotting pattern of the Trappers Creek trout are identical to Northwater Creek specimens. There are no significant differences in scale counts or gillraker numbers. Trappers Creek specimens average slightly fewer basibranchial teeth and slightly higher number of pyloric caeca. The Trappers Creek and Northwater Creek cutthroat trout samples examined are very similar but they represent discrete populations. All 41 specimens collected from Northwater Creek from 1972-1975 have basibranchial teeth and this led me to expect that such teeth should be found in all specimens from any pure population in the Parachute Creek drainage. The absence of basibranchial teeth in one of 10 Trappers Creek specimens immediately raises the question: is the absence of basibranchial teeth due to rainbow trout genes in the population? Preliminary examination recorded basibranchial teeth in 8 of 10 specimens. The two specimens recorded without teeth were re-examined in greater detail. The presence or absence of basibranchial teeth is determined by staining the basibranchial plate with alizarin (specific for calcium) and noting the stained, ossified teeth projecting from the plate. One of the two specimens in which teeth were not observed during the first examination, was found to possess a faintly stained projection under high magnification which I counted as a basibranchial tooth. Other incipient, but unossified, teeth were present. The other specimen had only incipient, unossified teeth and I consider it to lack basibranchial teeth (no stained projections). Obviously some factor has suppressed calcium deposition and normal development of teeth on the basibranchial plate in two of 10 specimens from Trappers Creek. If the factor suppressing basibranchial tooth development is the result of rainbow trout genes in the population is not known, but comparison of the two specimens with suppressed tooth development, shows no other indication of rainbow trout influence. The spotting pattern, scale (190 and 200) and caecal (34 and 42) counts are typical of *S. c. pleuriticus*.

Stocking records of the Colorado Division of Wildlife from 1962-1972 cited in my previous report, revealed four streams, Northwater, Middle Parachute, East Fork Parachute, and Anvil Creek, were regularly stocked during that period. It is possible that a previous unrecorded stocking occurred in Trappers Creek.

For cutthroat trout subspecies, in general, I have assumed that in pure populations 10% of the specimens may lack basibranchial teeth as a natural phenomenon. I based this on finding no teeth in some ancient museum specimens collected prior to introductions (1872 specimens from Bonneville basin and Rio Grande basin). Also, the Dolly Varden trout, *Salvelinus malma*, may be found without basibranchial teeth (10% to 50% in certain populations) and the absence of teeth is not attributable to hybridization.

An example of the effects of more obvious hybridization on basibranchial teeth is found in the trout inhabiting the East Middle Fork of Parachute Creek, below the barrier falls isolating Northwater and Trappers Creeks from upstream invasion. Data from 31 specimens collected from the East Middle Fork in 1972-73 are presented in Table 1. Note that basibranchial teeth are absent in 15 of 31 specimens. Also the reduced number of lateral series scales denotes a rainbow trout influence in these specimens.

In summary, I find that the Trappers Creek specimens exhibit the typical appearance (spotting pattern, general morphology) and possess the typical character values of *S. c. pleuriticus*. The absence of basibranchial teeth in 10% of a sample is not sufficient grounds to declare a hybrid influence as long as there is no indication of a hybrid influence in other characters.

The Trappers Creek sample is very similar but not identical with Northwater Creek samples. As such, it can be considered as a suitable alternative source to Northwater Creek for future transplants to establish new populations of *S. c. pleuriticus*.

The degree of physical isolation between the trout populations of Northwater and Trappers Creeks should be verified. If no complete barrier to upstream migration of Northwater Creek trout into Trapper Creek exists, such a barrier should be constructed if the effects of hybridization becomes apparent in the Northwater trout at some future time.

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Management Implications of Ecological Segregation Between Two Introduced Populations of Cutthroat Trout in a Small Colorado Lake

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ABSTRACT

Ecological differences reflected in food and habitat preference and angling vulnerability were investigated between two introduced sympatric populations of cutthroat trout, *Salmo clarki*. The Pikes Peak cutthroat fed to a large extent on *Daphnia* (68% by volume), whereas the Snake River cutthroat fed primarily on terrestrial insects (68% by volume). Other food habit differences were observed in the brook trout, *Salvelinus fontinalis*, and rainbow trout, *Salmo gairdneri*, populations.

The Snake River cutthroat trout was more vulnerable to angling than the Pikes Peak cutthroat. This was due in part to the opportunistic and surface feeding behavior of the Snake River cutthroat and angling restrictions which resulted in most fishermen angling on or near the surface. The Pikes Peak cutthroat had a high mortality rate during August and September. This coincided with the period of greatest competition with the longnose sucker, *Catostomus catostomus*, for *Daphnia*.

The results illustrate the practical application of intraspecific variability in fisheries management programs. The establishment of interacting populations of the same or different species can result in more efficient use of the food resources of a lake and greater fish production. It is urged that every effort be made to preserve the remaining genetic diversity in polytypic species such as *S. clarki*.

Many salmonid fish species are noted for an extravagant expression of intraspecific variability which is manifested in taxonomic characters, life history, and behavioral differences. This genetic diversity provides a virtually untapped resource for application in creative and innovative fisheries management programs. Two sympatric populations of cutthroat trout were studied to elucidate the potential role of intraspecific variability. Ecological differences were investigated which could be reflected in food and habitat preferences and angling vulnerability.

A particularly interesting phenomenon of intraspecific variability among certain salmonid species such as lake whitefish, *Coregonus clupeaformis*, the common European whitefish, *C. lavaretus*, the arctic char, *Salvelinus alpinus*, and sockeye salmon, *Oncorhynchus nerka*, concerns sibling species in which two or more morphologically similar populations occur in sympatry with reproductive isolation. Behnke (1972) reviewed many examples of salmonid sibling species and discussed the perplexing taxonomic problems involved. The taxonomic difficulties center on the biological species concept which

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emphasized reproductive isolation as a major criterion for full species status. However, in salmonid fishes with a strong, innate, reproductive homing behavior, reproductive isolation can be maintained between two populations with slight genetic differentiation. This phenomenon is so common that to recognize all populations exhibiting reproductive isolation as full species would result in a chaotic taxonomy. Despite the confusion and lack of agreement on their taxonomic status, coexisting genetically distinct populations should be recognized as separate entities for management purposes.

Ignoring the taxonomic aspects of the coexistence of closely related populations, one must recognize that evolutionary strategy minimizes competition between sympatric populations through specialization and ecological divergence. Publications concerned with ecological segregation between naturally occurring populations of salmonid fishes have largely dealt with interspecific or intergeneric populations. However, the evolutionary history of indigenous populations with thousands of years of sympatry would be expected to result in niche separation (Nilsson 1955, 1958, 1960, 1963, 1965, 1967; Nilsson and Anderson 1967; Andrusak and Northcote 1970, 1971; Schutz and Northcote 1972). The existence of sympatric salmonid sibling species suggests that closely related populations with only a brief history of genetic divergence have the potential for ecological separation. The two discrete groups of rainbow trout with different life history characteristics in Kootenay Lake, British Columbia, which were discussed by Cartwright (1961) and Hartman (1969), are an example of naturally occurring intraspecific populations (Behnke 1972). Ecological segregation between two discrete char populations in Lake Övre Björkvattnet, Sweden, has been described by Nilsson and Filipsson (1972). Although these populations were considered distinct species by these authors, Behnke (1972) discussed reasons why it is more practical and a better representation of evolution and phylogeny to treat the Övre Björkvattnet chars as intraspecific populations of the variable arctic char.

Previous studies comparing introduced intraspecific stocks in sympatry have been mainly concerned with differential survival of various hatchery stocks or hatchery and wild stocks [Webster 1954; Vincent 1960; Flick and Webster 1964; Flick 1971 (with brook trout, *Salvelinus fontinalis*); Cordone and Nicola 1970 (with rainbow trout, *Salmo gairdneri*); Boles and Borgeson 1966 (with brown trout, *Salmo trutta*)].

In our study with two coexisting intraspecific populations of cutthroat trout the pertinent question was asked: Can divergent stocks (in this case, subspecies) of a species without natural selection for coexistence in their evolutionary histories be introduced together and initiate ecological segregation? The two populations of cutthroat trout studied have provided an affirmative answer to that question and illustrate the practical ramifications and application of intraspecific genetic diversity in fisheries management programs.

STUDY SITE AND ITS FISHES

North Michigan Lake was constructed in 1962 as a recreation reservoir when the headwaters of the North Michigan River, Jackson County, Colorado were dammed. The lake is at an elevation of 2719 m. It has a surface area of 27 ha, a maximum depth of 13 m and drains a watershed of 65 km^2. The lake can be described as mesotrophic. Heavy algal blooms and dense growths of rooted macrophytes occur during August and September.

The North Michigan River is part of the North Platte River drainage and trout are not indigenous to this basin. Brook trout, brown trout, rainbow trout and various strains of cutthroat trout had been introduced and established in the headwaters of the North Michigan River prior to the construction of the lake. The cutthroat trout and rainbow trout have hybridized and various degrees of intergradation between the two species can be found. The brook trout has established a dense population in the lake. The brown trout is rare with only a few individuals taken by anglers or gill nets. A small population of wild rainbow trout (mainly rainbow × cutthroat hybrids) is present in the lake. Most of the cutthroat trout in the lake are the result of annual stocking. It is possible that a few of the large spotted

COLORADO RIVER CUTTHROAT TROUT
INVENTORY

JOB PROGRESS REPORT

COLORADO RIVER CUTTHROAT TROUT INVENTORY

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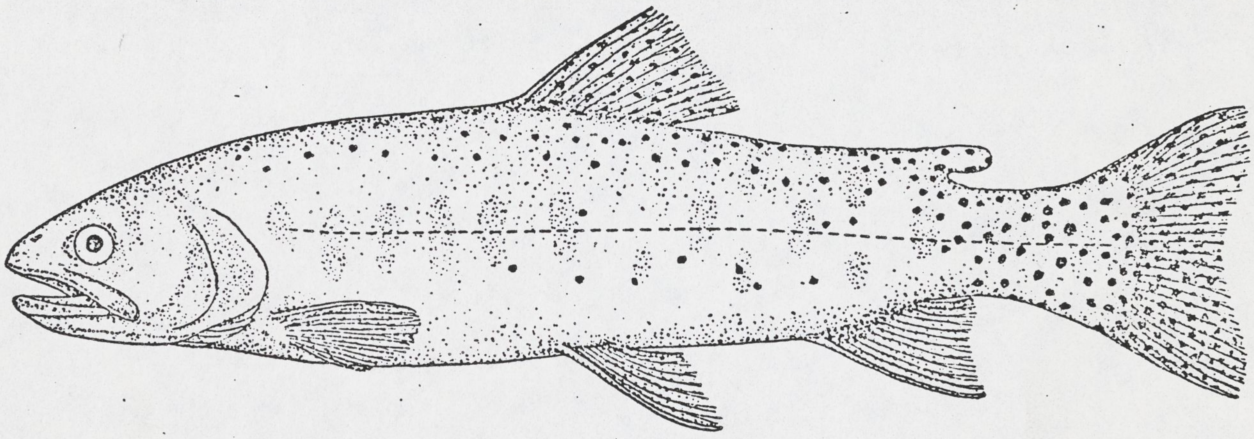

Colorado River Cutthroat Trout
Salmo clarki pleuriticus

Locality	Legal Description	County	Species Sampled	Sample Size	Stocking History	Barrier
First Creek	T9N R87W S24	Routt	CRN, MTS, Bits, SDD	11	1978-R	Beaver Dam
Little Green Cr.	T4N R83W S24	Routt	CRN	10	NS	?
Cataract Cr.	T3S R80W S21	Summit	CRN	4	Middle Cataract Lake 1978-N	Rock
N. Fk. Elliot Cr.	T2S R80W S32	Summit	CRN, B	10	?-N	Rock
Lake 10794	T3S R80W S16	Summit	CRN	7	—	—
Spruce Cr.	T7S R78W S23	Summit	CRN	11	Mohawk Lakes N-1978	?
N. Fk. Swan R.	T6S R76W S18	Summit	CRN	10	?-N	Beaver Dams
Arapahoe Cr.	T1N R74W S16	Grand	CRN	10	NS	?
Big Park Cr.	T1N R82W S28	Grand	CRN	10	NS	Beaver Dams
Bobtail Cr.	T3S R76W S33	Grand	CRN	10	NS	Water Diversion Structure
Columbine Cr.	T3N R75W S27	Grand	CRN, B	10	NS	Beaver Dams
S. Fk. Ranch Cr.	T1S R75W S35	Grand	CRN, B	10	?-B,N	Diversion Structure
Roaring Fk. Cr.	T2N R75W S12	Grand	CRN	10	NS.	Large Falls.
Avalanche L.	T10S R87W S34	Pitkin	CRN	6	1977-N	Rock
Difficult Cr.	T11S R84W S27	Pitkin	CRN	4	?-R,B,N	Rock
Express Cr.	T12S R84W S4	Pitkin	CRN, R	5	NS	Beaver Dams
Mid Fk Thompson	T9S R89W S3	Pitkin	CRN	10	?-N,B,L	?
N. Fk. Thompson	T8S R89W S28	Pitkin	CRN	10	1978-R	?
Yule Creek	T12S R87W S18	Pitkin	CRN, B	3	NS	Rock
Cattle Creek.	T7S R86W S15	Eagle	CRN	10	NS	Rock

	Locality	Legal Description	County	Species Sampled	Sample Size	Stocking History	Barrier
1.	JQS Gulch	T5S R94W S23	Garfield	CRN	11	NS	Rock
2.	Northwater Cr.	T5S R94W S18	Garfield	CRN	10	?-N	Rock
3.	E. Fk. Parachute Cr.	T5S R94W S33	Garfield	CRN	10	NS	Rock
4.	E. Mid. Fk. Parachute Cr.	T5S R95W S14	Garfield	CRN	10	NS	Rock
5.	Trappers Cr.	T5S R94W S7	Garfield	CRN	10	?-N	Rock
6.	N. Fk Wallace Cr.	T8S R95W S20	Mesa	CRN	10	CRN, (R?)	?
7.	S. Fk. Crystal R.	T12S R87W S1	Gunnison	R, CRN	1	?	Rock

~~Table~~ [illegible] Streams not containing [illegible]

	Locality	Legal Description	County	Species present	Stocking History	Barrier
	Green Creek	T4N R83W S21	Routt	B	NS	?
.	Harrison Creek	T5N R84W S25	Routt	B	NS	?
	King Salomon Cr.	T11N R85W S35	Routt	B	NS	Beaver Dams
	Service Creek	T3N R83W S5(8)	Routt	B	NS	Beaver Dams
:	N. Fk. Silver City Creek	T11N R84W S21	Routt	B.	NS	?
,	S. Fk. Summit Cr.	T11N R86W S34	Routt	—	NS	?
:	N. Fk. Whiskey Cr.	T12N R85W S14	Routt	B	NS	?
:	~~[illegible]~~	~~[illegible]~~				
3.	W Fk. Whiskey Cr.	T12N R85W S21	Routt	B	NS	?
:.	Rock Creek.	T4S R78W S18	Summit	B	NS	?
).	Stafford Creek	T6S R79W S33	Summit	B	NS	Beaver Dams
.	Hamilton Creek	T1S R75W S3	Grand	B		?
2.	Jim Creek	T2S R75W S13	Grand	—	?-N	Water Diversion Structure.
3.	Muddy Creek	T5N R82W S6	Grand	B	NS	?
4.	N. Fk. Ranch Cr.	T1S R75W S23	Grand	—	NS	Water Diversion Structure.
5.	S. Fk. Williams Fk.	T4S R77W S14	Grand	—	NS	Water Diversion Structure.
.	Avalanche Creek	T10S R87W S19	Pitkin	—	NS	?
7.	Gift Creek	T10S R87W S30	Pitkin	—	?-N	Rock
3.	Midway Creek	T10S R83W S16	Pitkin	B	NS	?
9.	Spruce Cr.	T9S R84W S25	Pitkin	—	NS	?

Streams not containing S. c. pleuriticus.

Locality	Legal Description	County	Species present	Stocking history	Barrier
0. S. Branch of Mid. Fk. Thompson Cr.	T 9S R89W S22	Pitkin	B	?-N,B,L	?
1. Woody Cr.	T 9S R84W S25	Pitkin	B	NS	?
2. ~~[illegible]~~					
2. Game Creek	T 5S R80W S19	Eagle	B	?-R,B,N	Rock
3. Notch Mtn. Cr.	T 6S R81W S22	Eagle	B	? - B,N	Beaver Dams.
4. Battlement Cr.	T 7S R95W S36	Garfield	B	Battlement Lake (R,N)	?
5. N. Fk. Crystal R.	T 11S R86W S19(20)	Gunnison	B	?	Rock

Table 2. Character Analysis of 1981 collections of Colorado River cutthroat trout (*Salmo clarki pleuriticus*) from the upper Colorado River Drainage in Colorado.

Locality	Gillrakers	[illegible]	Caeca	Basibranchial teeth	Grade	Spotting Comments
[illegible] N.FK. Elliot Cr N=10 T2S R80W S12	17-[illegible]	[illegible]-43 ([illegible]3.2) 16[illegible]	29-46 (37.2)	[illegible] (9.1) 1 w/o teeth	(6) B	Fairly uniform - spots common below lateral line
Cataract Creek N=4 T3S R80W S21	17-21 (19.[illegible])	[illegible] 175-192 [illegible]	33-46 [illegible]	1-13 ([illegible])	(6) B+	Spots common below lateral line. Somewhat variable.
Lake 10794 N=7 T3S R80W S16	1[illegible]-20 (19.1)	[illegible] 163-18[illegible]	32-45 (39.4)	3-10 (6.9)	(6) B+	Spotting is slightly variable [illegible] - occurence below lat. line.
N.FK. Swan River N=10 T6S R78W S18	17-21 (19.0)	[illegible]-53 (48.8) 191-2[illegible] ([illegible]5.1)	33-48 (38.6)	0-9 (4.4) 1 w/o teeth	(5) A-	Spots are profuse and fairly uniform. Common below lat line.
Spruce Creek N=10 T7S R78W S23	19-23 (2[illegible])	32-52 (42.3) 190-210 (198.7)	27-56 (35.6)	0-10 (4.3) 2 w/o teeth	(7) B	Spots profuse - some variability is evident. Occurence below lat line common.
Crystal Creek N=1 T7S R77W S13	19	41 183	31	0	B?	[illegible] spotting; occurence below lat. line.
[illegible] [illegible] Creek N=10 T5S R[illegible]W S1?	17-20 (19.0)	40-50 (46.7) 168-194 (183.9)	26-43 (34.1)	0-8 (5.2) 1 w/o teeth	(4) A-	Spotting very uniform, spots [illegible] and irregular in outline.
[illegible] N=10 T5S R94W S7	17-20 (19.0)	37-43 (40.8) 174-202 (190.2)	27-45 (32.0)	0-5 (1.6) 5 w/o teeth	(9) C	Spots [illegible] with regular occurence below the lateral line. Some specimens show larger spots.

Locality	Total [illegible]	Lat. [illegible] and [illegible]	Pyloric Caeca	Basibranchial Teeth	Purity Grade	Spotting Comments
JQ's Gulch N=10 T5S R94W S7	17-19 (18.1)	42-51 (45.4) 176-192 (185.8)	23-38 (32.7)	2-7 (4.2)	(4) A+	Spots are concentrated on the caudal peduncle and are very uniform. Typical *pleuriticus*.
E. Fk. Parachute Cr. N=10 T5S R94W S33	17-21 (18.2)	36-51 (45.4) 154-190 (174.1)	28-46 (36.[illegible]3)	0-8 (2.6) 4 w/o teeth	(8) C+	Spotting shows slight variability and the spots are relatively small
E. Mid. Fk. Parachute Cr. N=10 T5S R95W S14	16-20 (17.9)	35-43 (39.6) 152-198 (170.2)	30-38 (33.3)	0-3 (0.5) 7 w/o teeth	(9) C	Spotting is concentrated towards the tail; slight variability yet typical *pleuriticus*. overall.
N. Fk. Wallace Cr. N=10 T8S R89W S28	16-20 (17.5)	29-41 (37.0) 125-202 (170.2)	24-37 (29.4)	0-4 (1.0) 5 w/o teeth	(11) D	Variability is evident in this sample, the spots are relatively small.
Bobtail Creek N=10 T3S R76W S33	18-21 (19.6)	45-54 (50.5) 192-211 (203.9)	39-50 (43.2)	2-13 (6.6)	(5) A+	Uniform spotting though spots are small and common below the lateral line.
Roaring Fk. Creek N=10 T2N R75W S12	18-21 (19.4)	40-49 (44.8) 165-220 (197.2)	27-45 (32.1)	0-11 (1.7) 6 w/o teeth	(10) C	Sample shows large spots that are common below the lateral line. Somewhat variable
Columbine Cr. N=10 T3N R75W S35	18-21 (20.2)	43-54 (48.7) 172-216 (203.6)	34-57 (41.6)	0-9 (3.8) 2 w/o teeth	(7) B	Spotting is slightly variable occuring over most of the body.
Arapahoe Creek N=10 T1N R74W S16	18-22 (19.7)	40-55 (48.5) 168-208 (190.7)	26-43 (34.2)	1-17 (8.3)	(7) B	Spotting variable; some large, some small; possible S.C. *lewisi* influence.
Little Green Creek N=10 [illegible]N R83W S22	15-19 (17.3)	40-47 (42.9) 153-207 (181.6)	35-47 (40.3)	0-6 (2.0) 2 w/o teeth	(5) A-	Typical *pleuriticus*. spotting.
Big Park Creek N=10	19-20 (19.2)	39-49 (43.9) 174-210 (184.9)	37-50 (42.5)	0-8 (1.6) 5 w/o teeth	(9) C	Slight variability in spotting—spots are few and concentrated on caudal peduncle.

Locality	Total Gillrakers	lat. line and Lat. Series	Caeca	Teeth	Purity Grade	Comments
[illegible] River Drainage First Creek N=11 T9N R87W S21	16-21 (18.6)	38-49 (45.6) 160-197 (182.3)	31-47 (39.1)	0-5 (1.6) 1 w/o teeth	(7) B-	Slight variability - Otherwise typical *pleuriticus*.
[illegible] River Drainage S. Fk. Ranch Cr. N=10 T1S R75W S35	18-21 (18.9)	42-46 (43.4) 190-210 (198.6)	28-47 (37.2)	2-12 (5.4)	(5) A	Typical *pleuriticus* spotting. Only slight variability.
[illegible] Fork R. Drainage Cattle Creek N=10 T7S R88W S23	17-20 (18.0)	39-50 (43.7) 170-212 (187.7)	35-45 (39.0)	3-11 (7.0)	(4) A+	Good, uniform, typical *pleuriticus*.
Expresso Creek N=5 T12S R84W S4	17-19 (17.8)	40-45 (42.8) 177-198 (189.0)	27-33 (30.6)	2-12 (8.0)	(6) B+	Spots are large and profuse - looks similar to S.c. *stomias*
Difficult Creek N=4 T11S R84W S22	18-21 (19.5)	39-50 (44.3) 172-214 (189.3)	31-44 (37.3)	8-18 (11.5)	(6) B	Spotting shows some variability and in general the spots are large and numerous. Reminiscent of *stomias*.
Crystal River Drainage Avalanche Lake N=6 T10S R87W S34	17-23 (20.5)	43-55 (48.3) 160-211 (190.0)	32-51 (39.5)	2-24 (7.3)	(6) B	Some variability in spotting occuring throughout the body. Perhaps S.c. *bouvier* influence.
Yule Creek N=3 T12S R87W S18	18-20 (19.3)	48-55 (51.3) 172-203 (190.0)	36-50 (44.0)	15-21 (18.7)	(8) C+	Spotting pattern is variable among specimens. Large, round spots are characteristic.
. Fk. Thompson Cr. N=10 8S R88W S28	18-20 (18.6)	38-47 (43.3) 177-199 (186.5)	26-44 (36.6)	0-4 (1.9) 3 w/o teeth	(7) B	Typical *pleuriticus* spotting pattern exhibiting slight variability
1. Fk. Thompson Cr. N=10 R89W S=3	15-20 (17.6)	41-44 (41.8) 181-215 (200.4)	29-39 (33.7)	0-3 (1.0) 5 w/o teeth	(8) C+	Slightly variable though still typical.

Locality	Total Gillrakers	lat. line and Lat. Series	Caeca	Teeth	Grade	Comments
S. Fk. Crystal R N=1 T12S R87W S1	20	41 152 4	45 2	4 1	C-D?	Big spots all over the body.

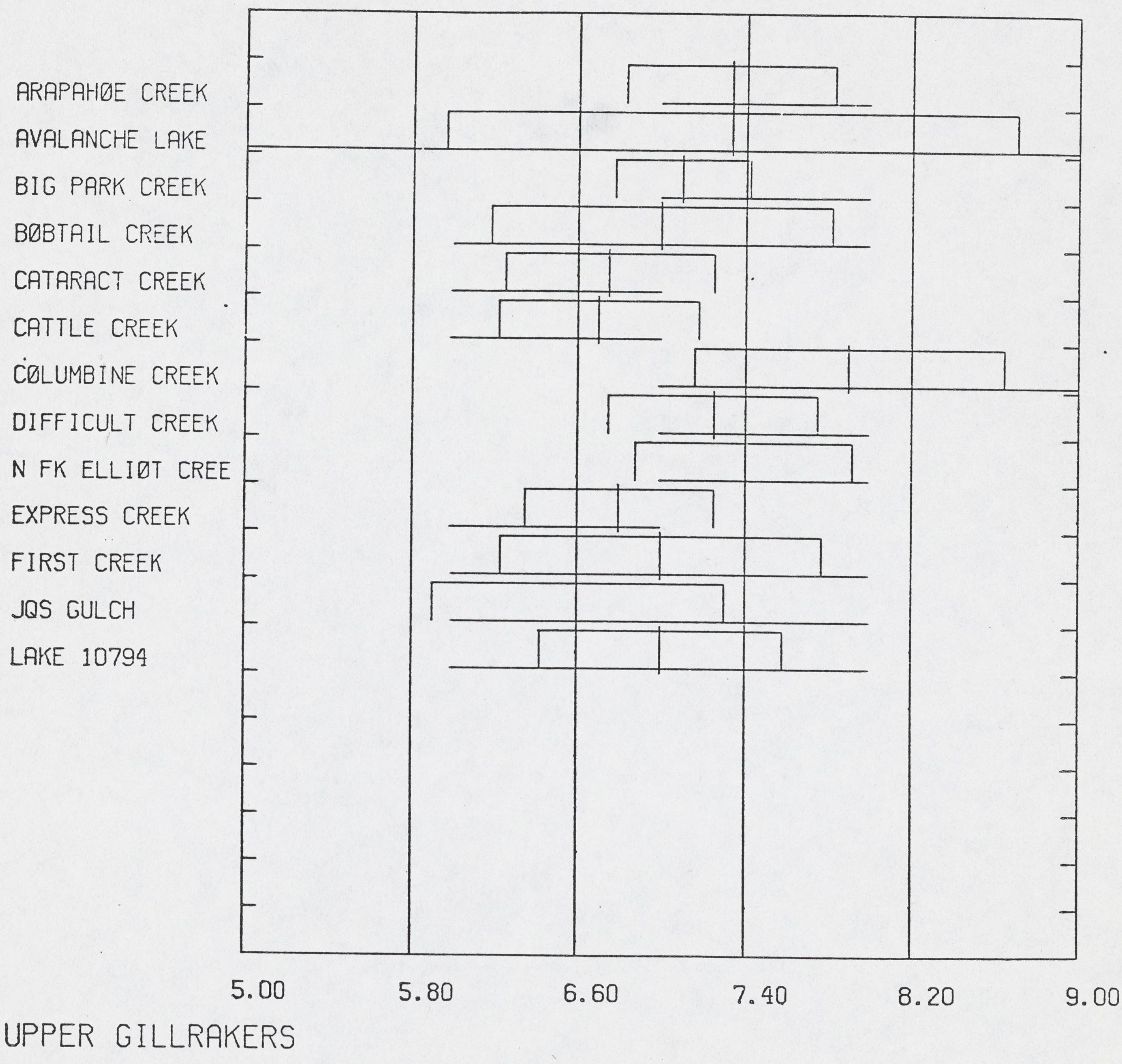

Figure 2. Hubbs and Hubbs diagram of upper gillraker data.

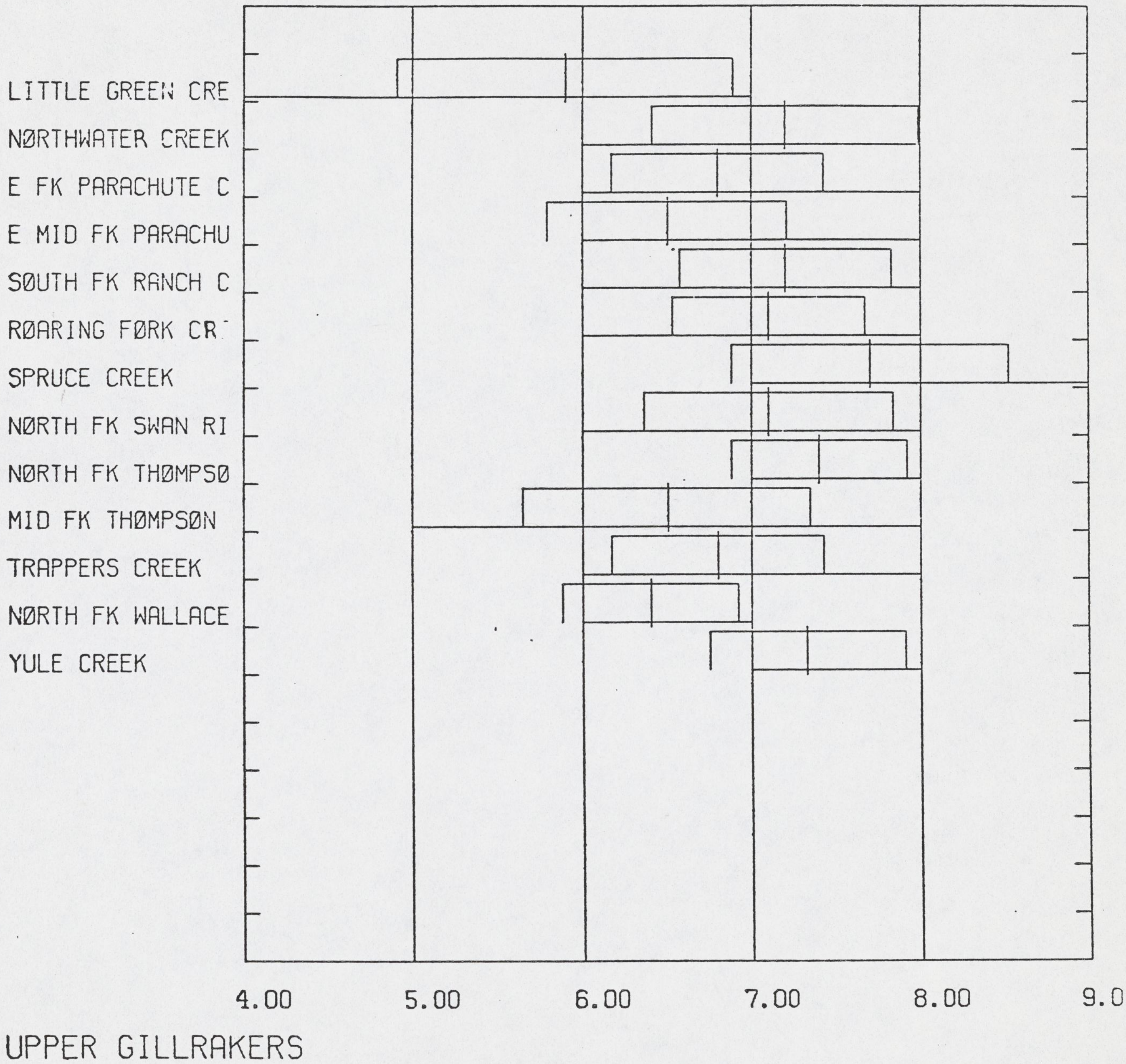

Figure 2a. Hubbs and Hubbs diagram of upper gillraker data.

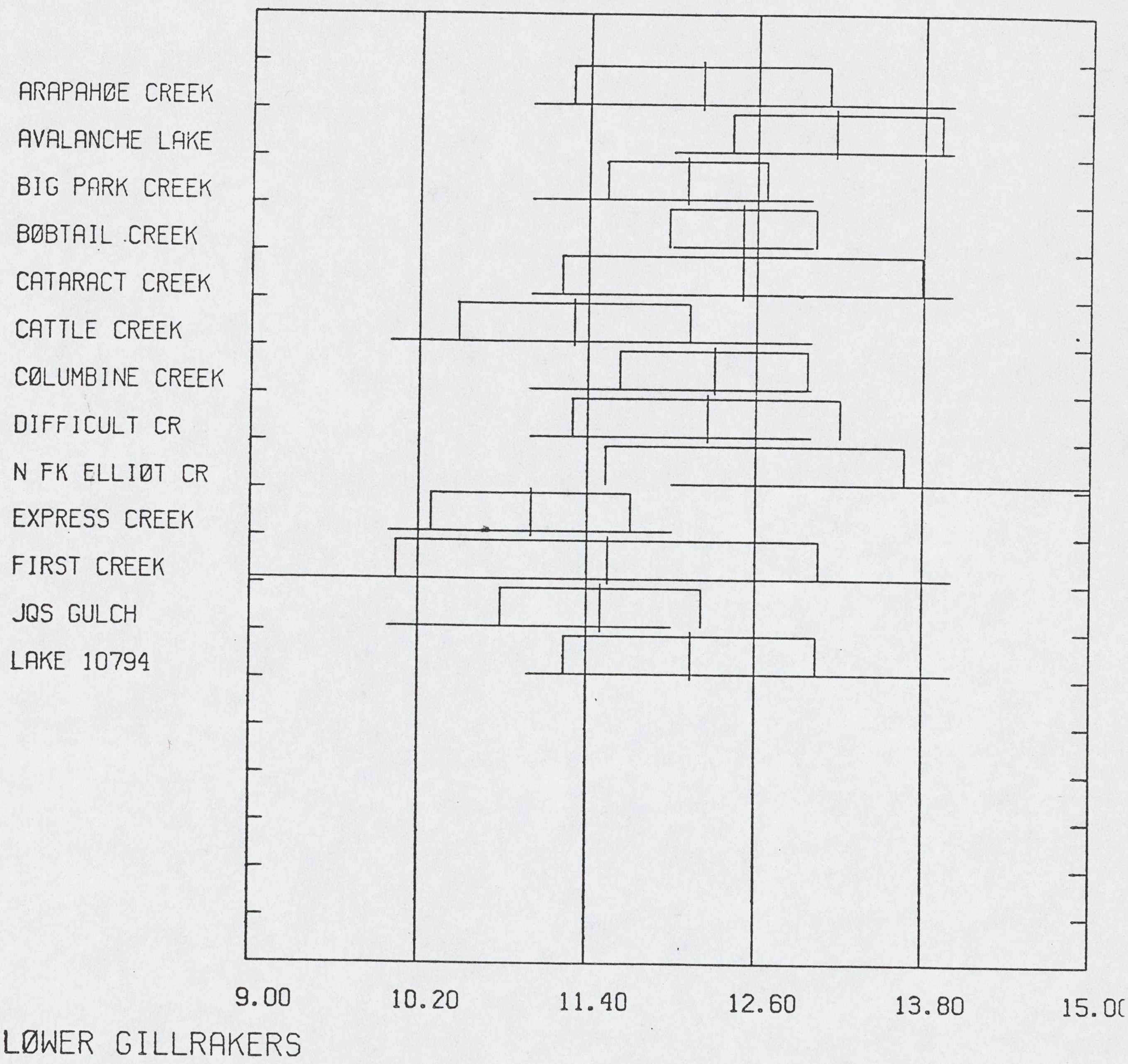

Figure 3. Hubbs and Hubbs diagram of lower gillraker data.

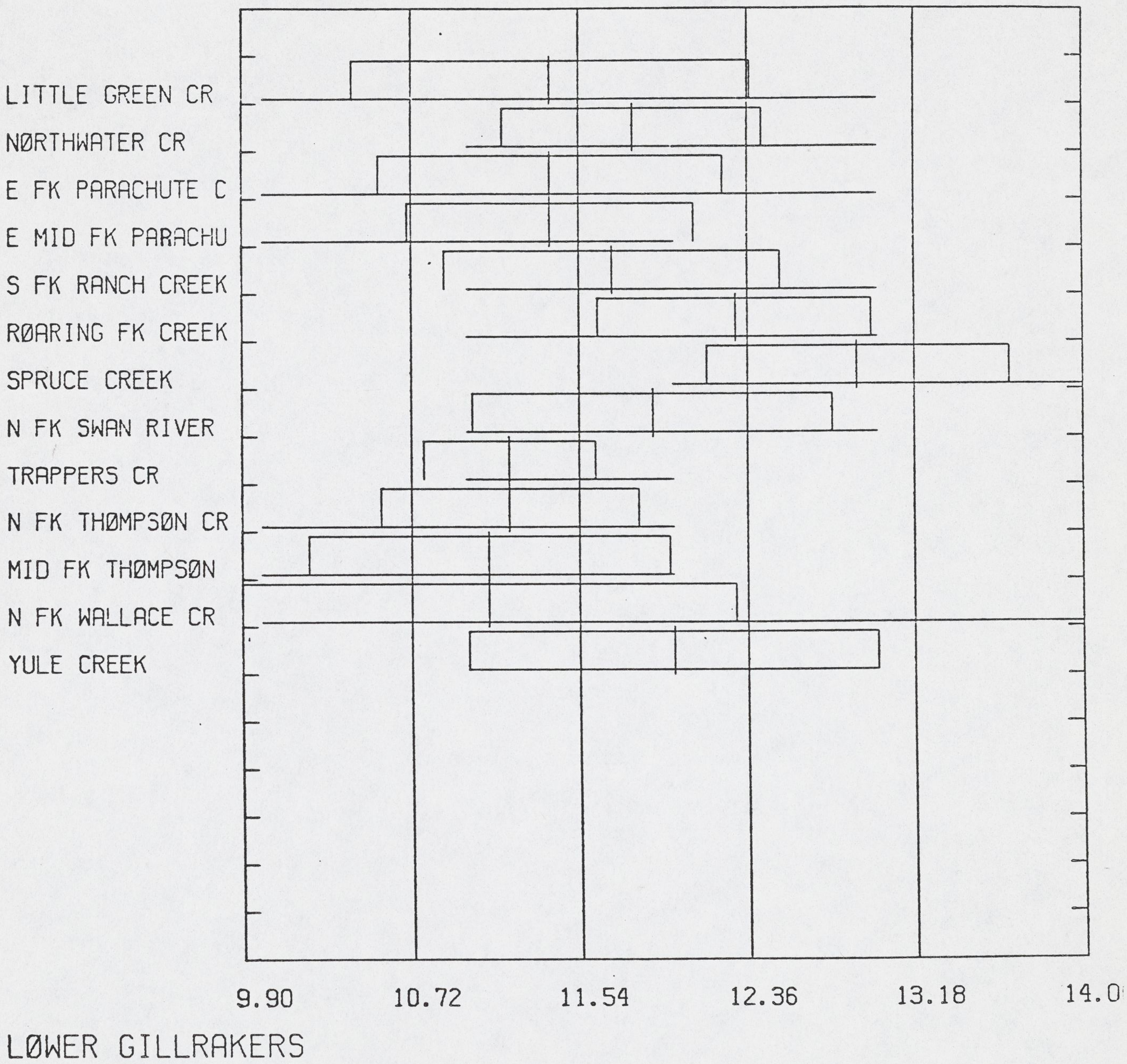

Figure 3a. Hubbs and Hubbs diagram of lower gillraker data.

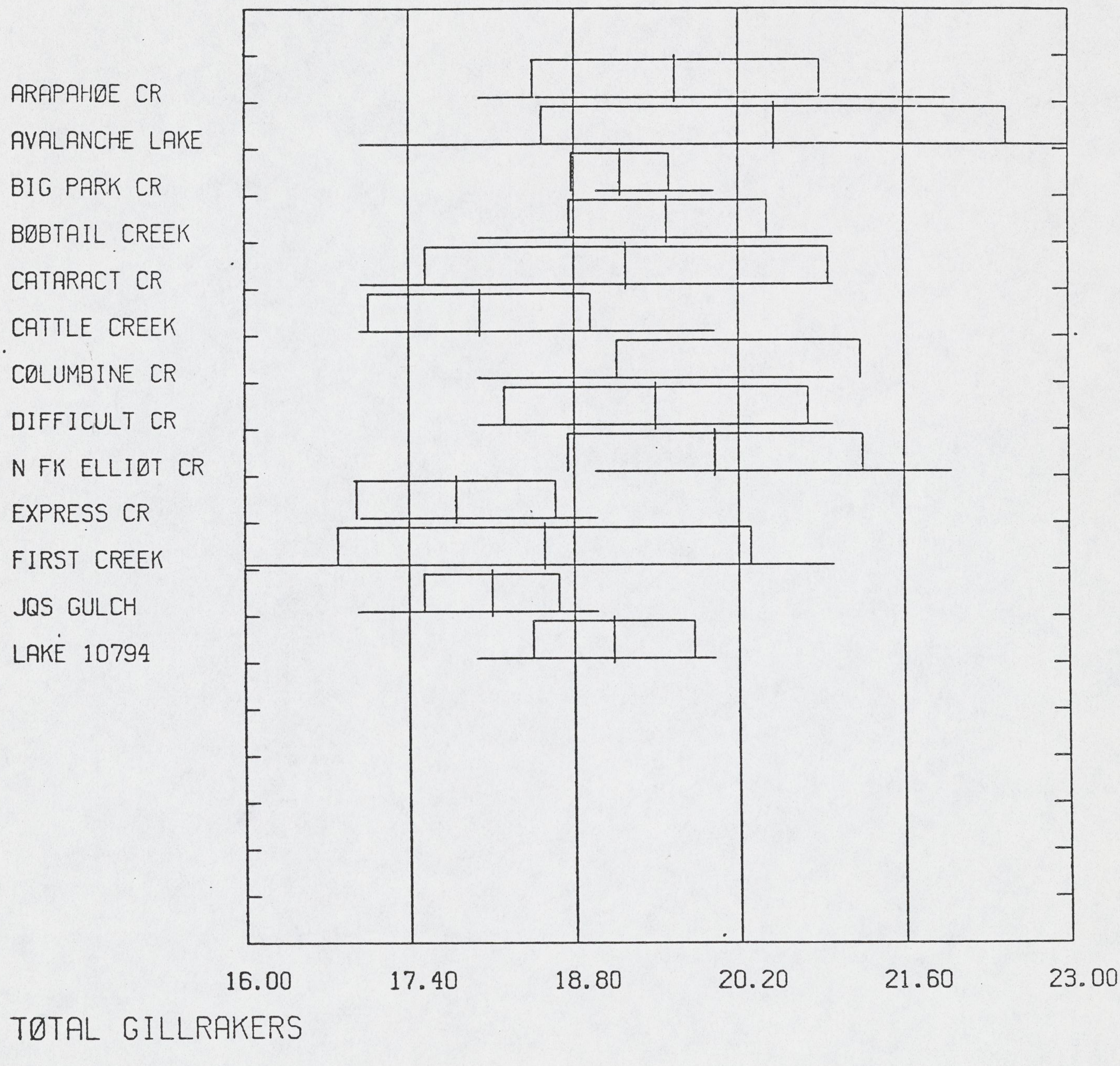

Figure 4. Hubbs and Hubbs diagram of total gillraker data.

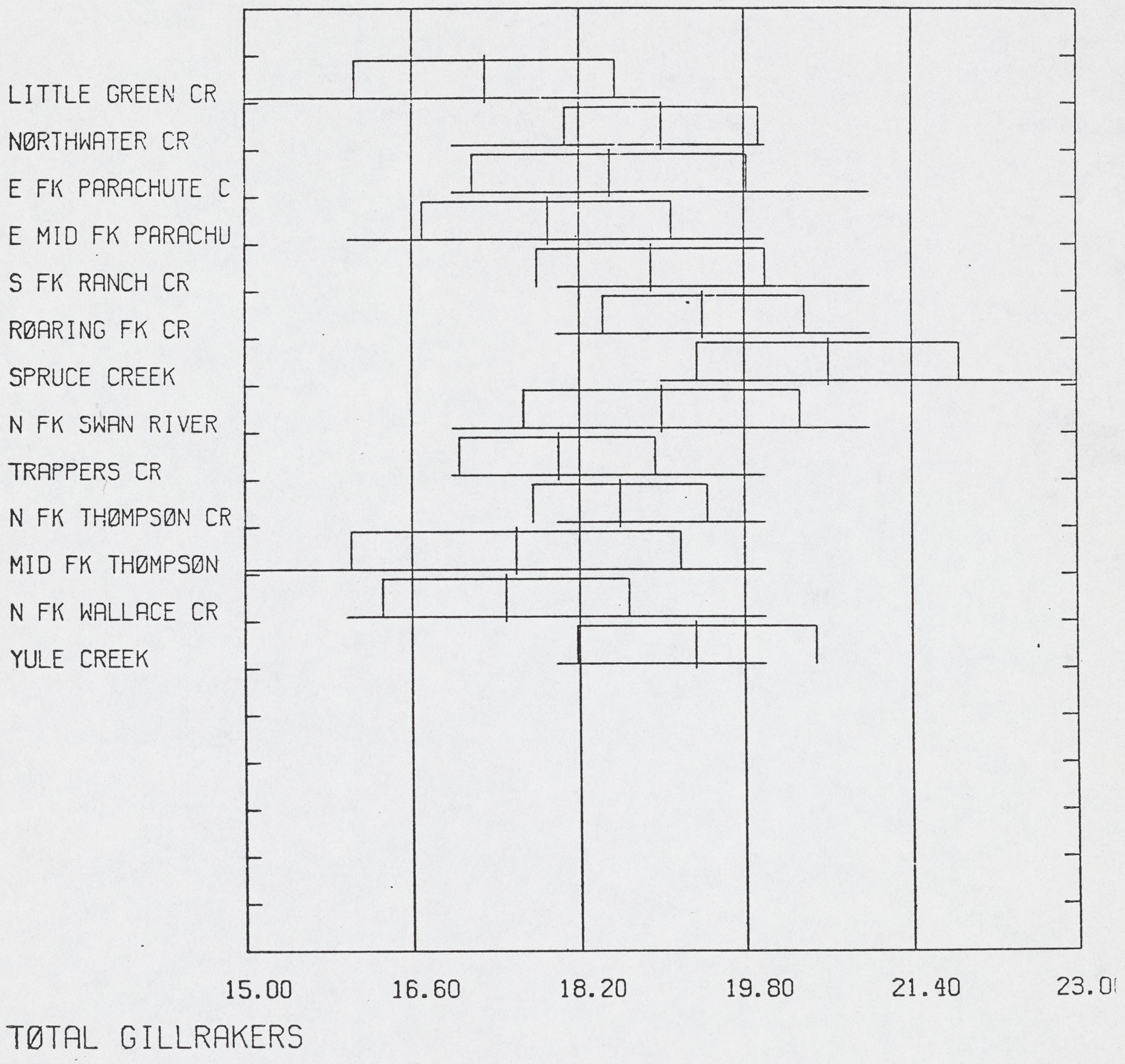

Figure 4a. Hubbs and Hubbs diagram of total gillraker data.

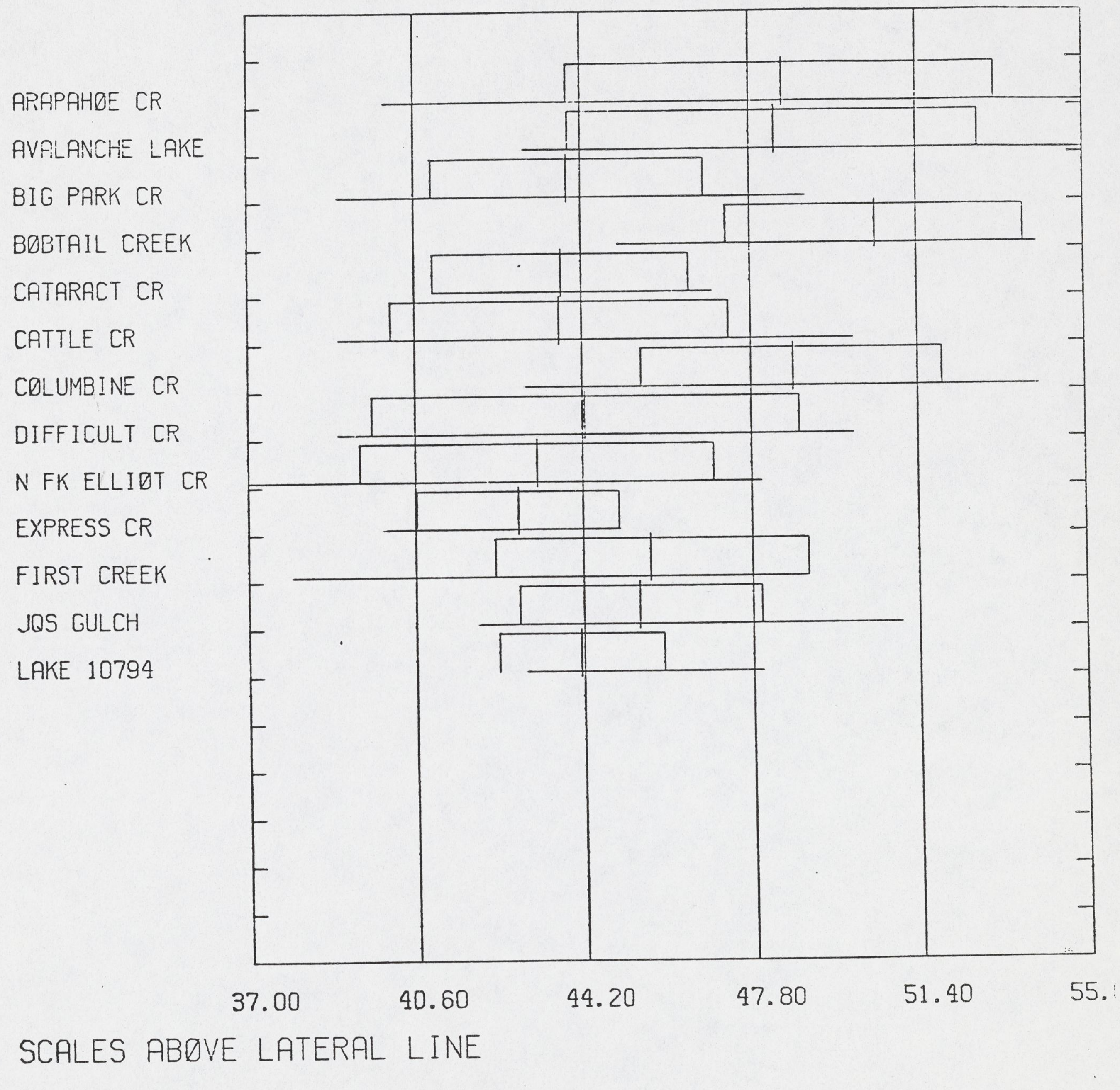

Figure 5. Hubbs and Hubbs diagram of scales above the lateral line data.

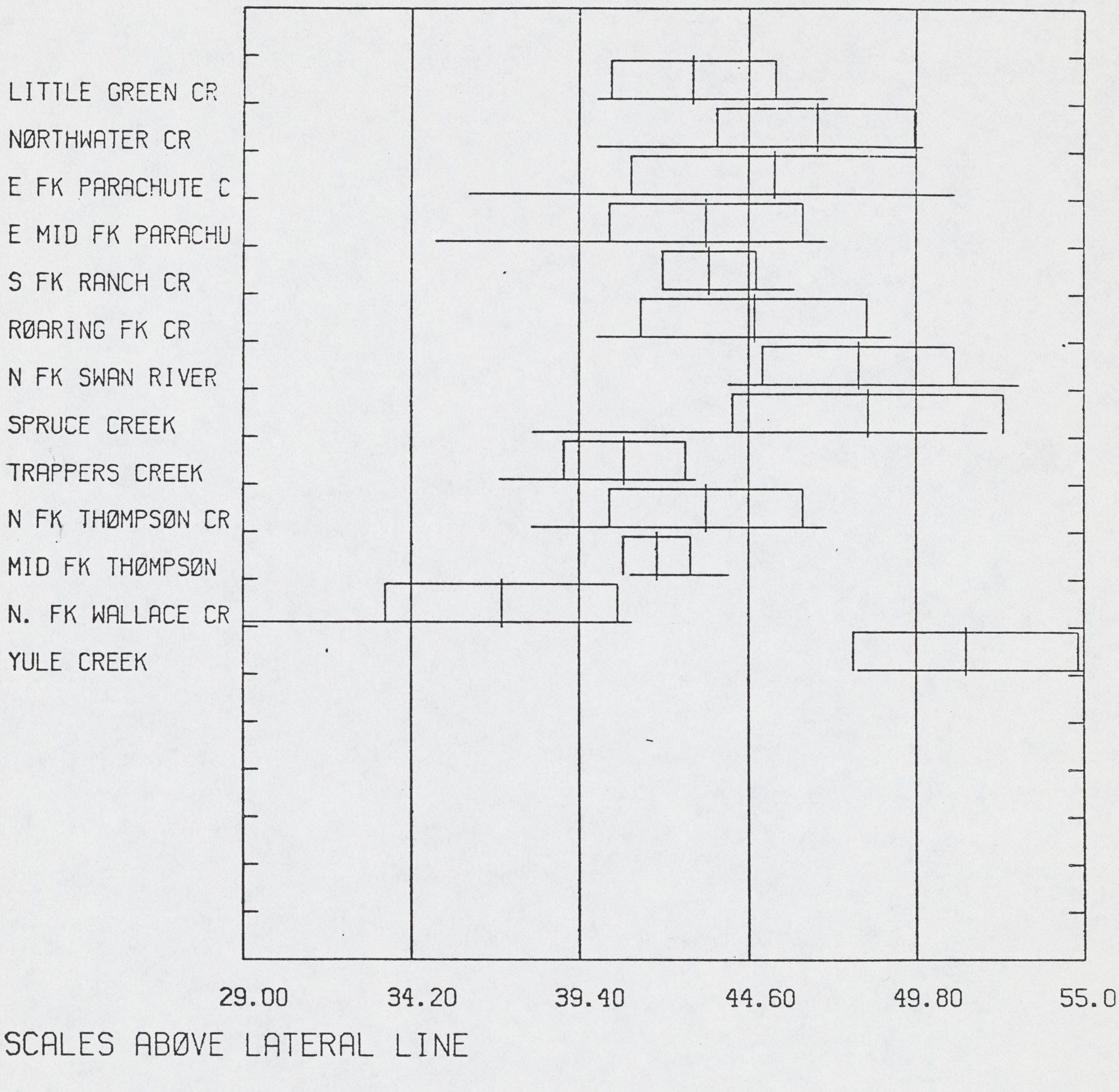

Figure 5a. Hubbs and Hubbs diagram of scales above the lateral line data.

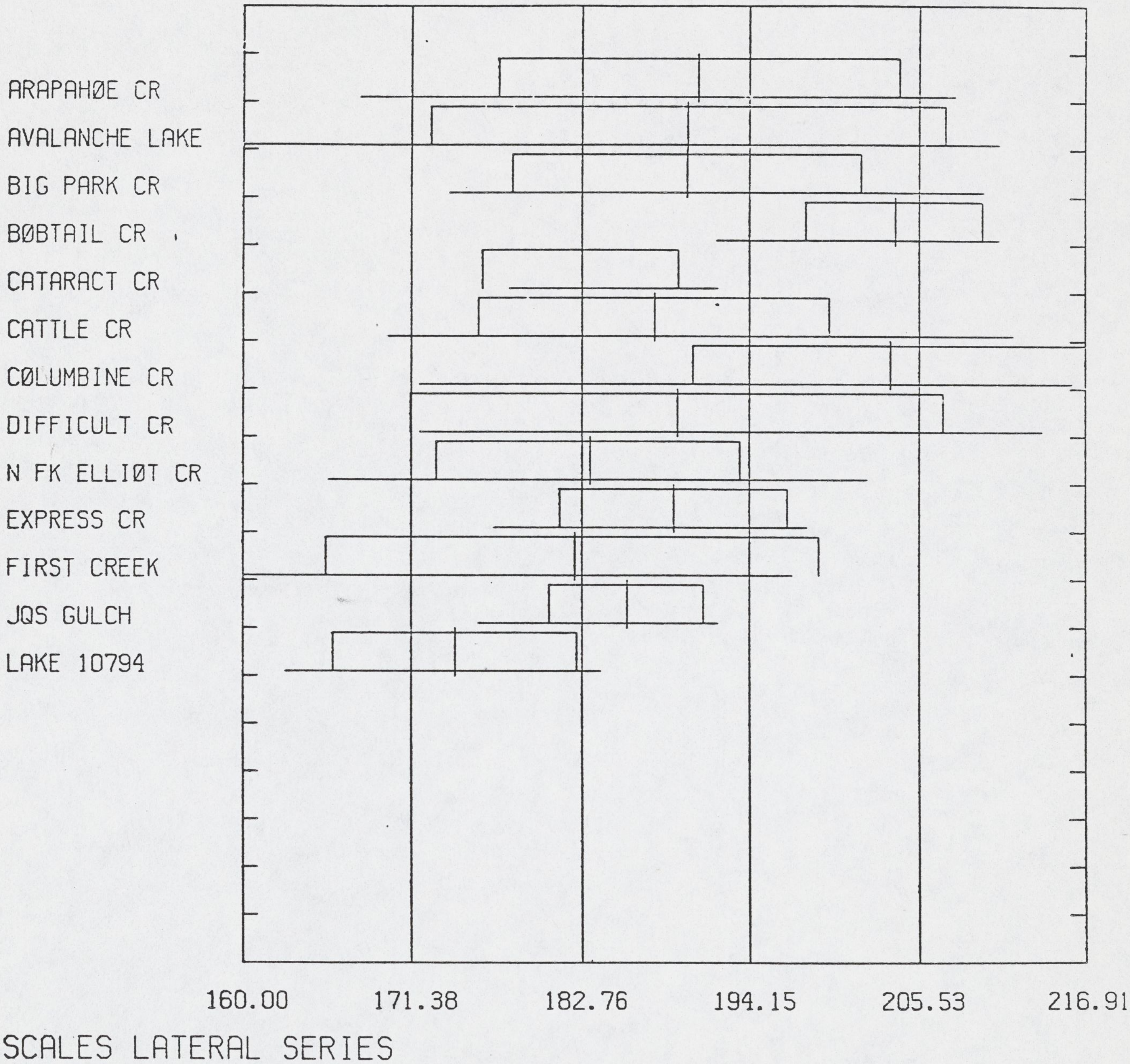

Figure 6. Hubbs and Hubbs diagram of scales in lateral series data.

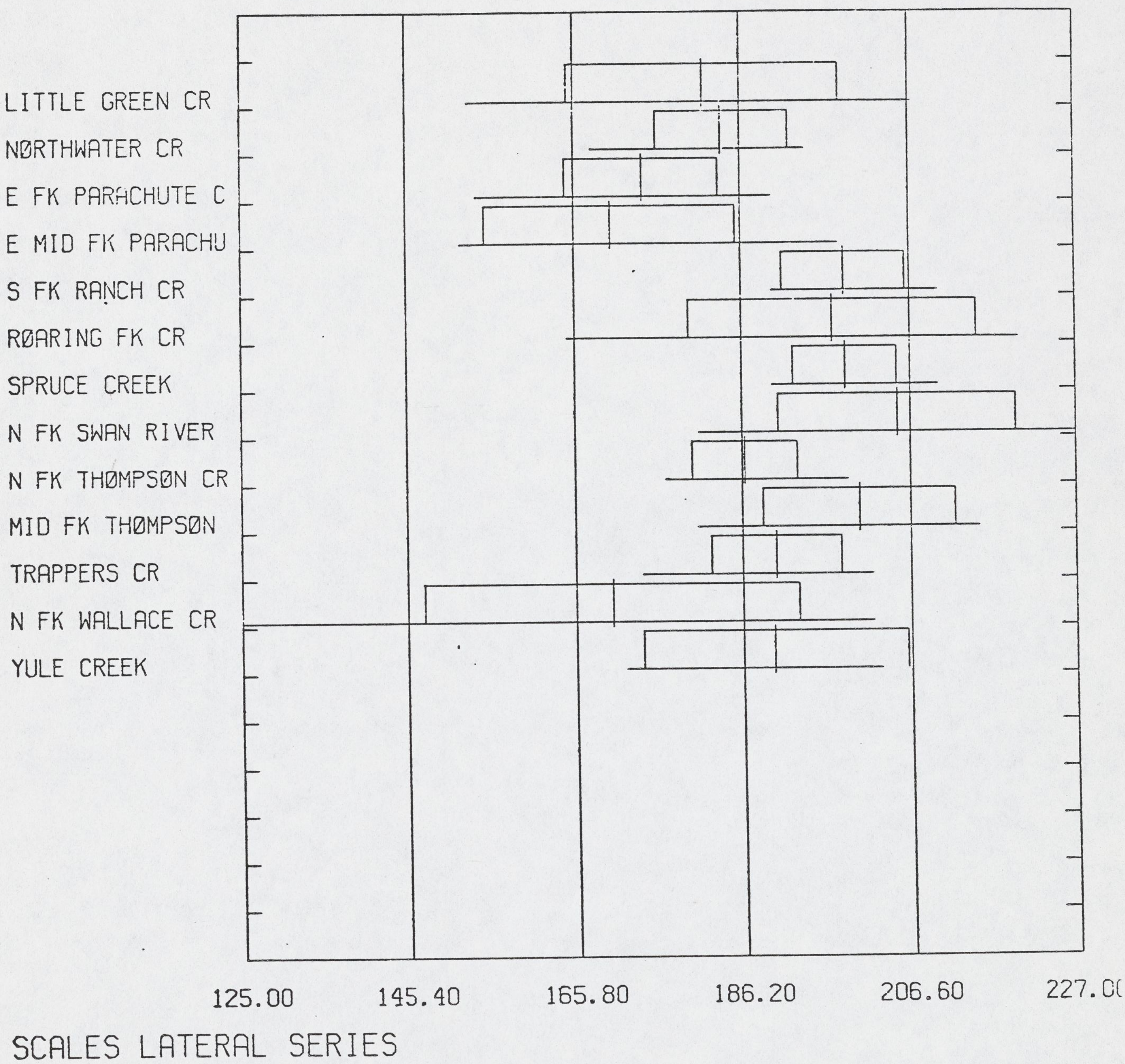

Figure 6a. Hubbs and Hubbs diagram of scales in lateral series data.

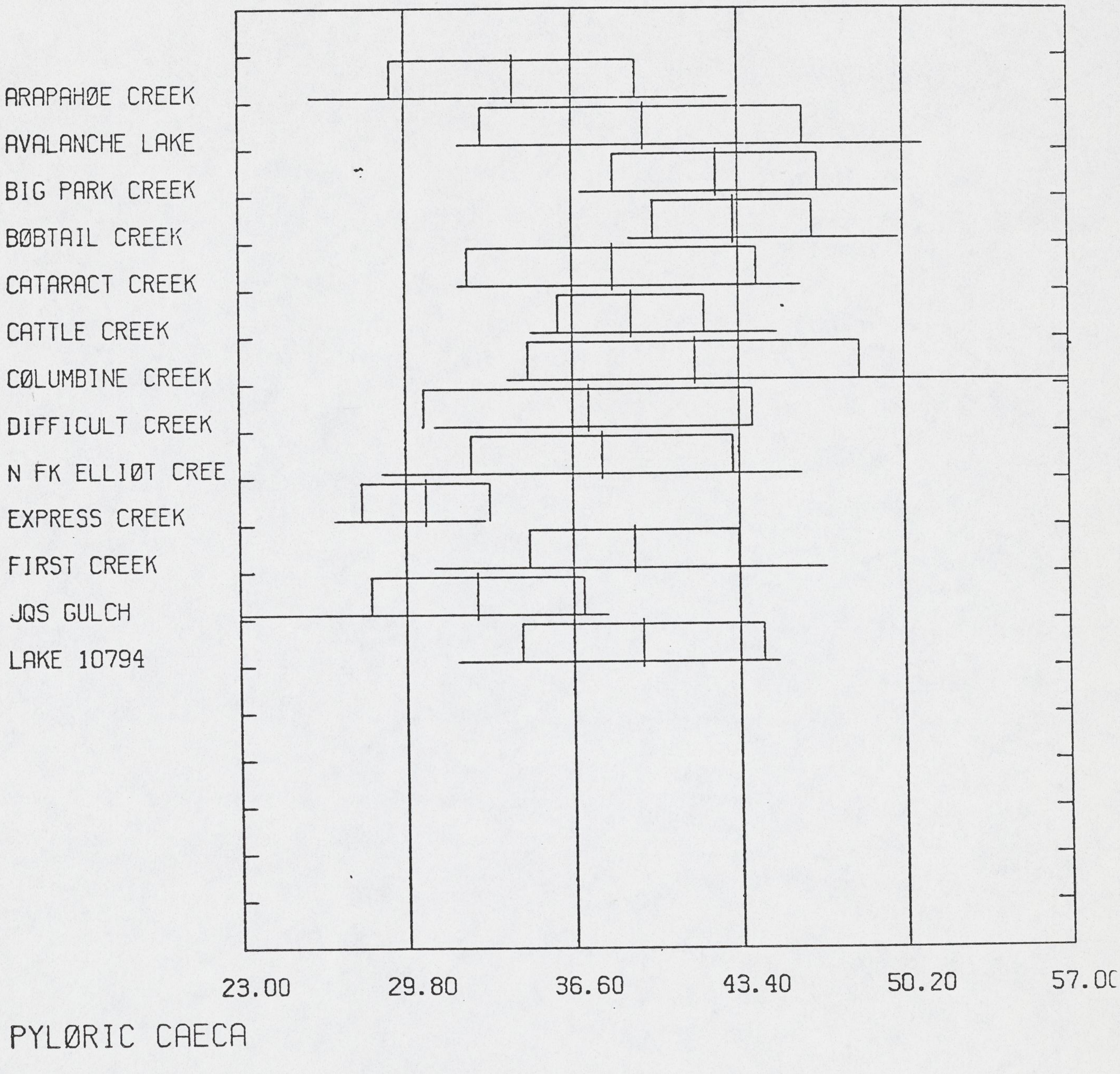

Figure 7. Hubbs and Hubbs diagram of pyloric caeca data.

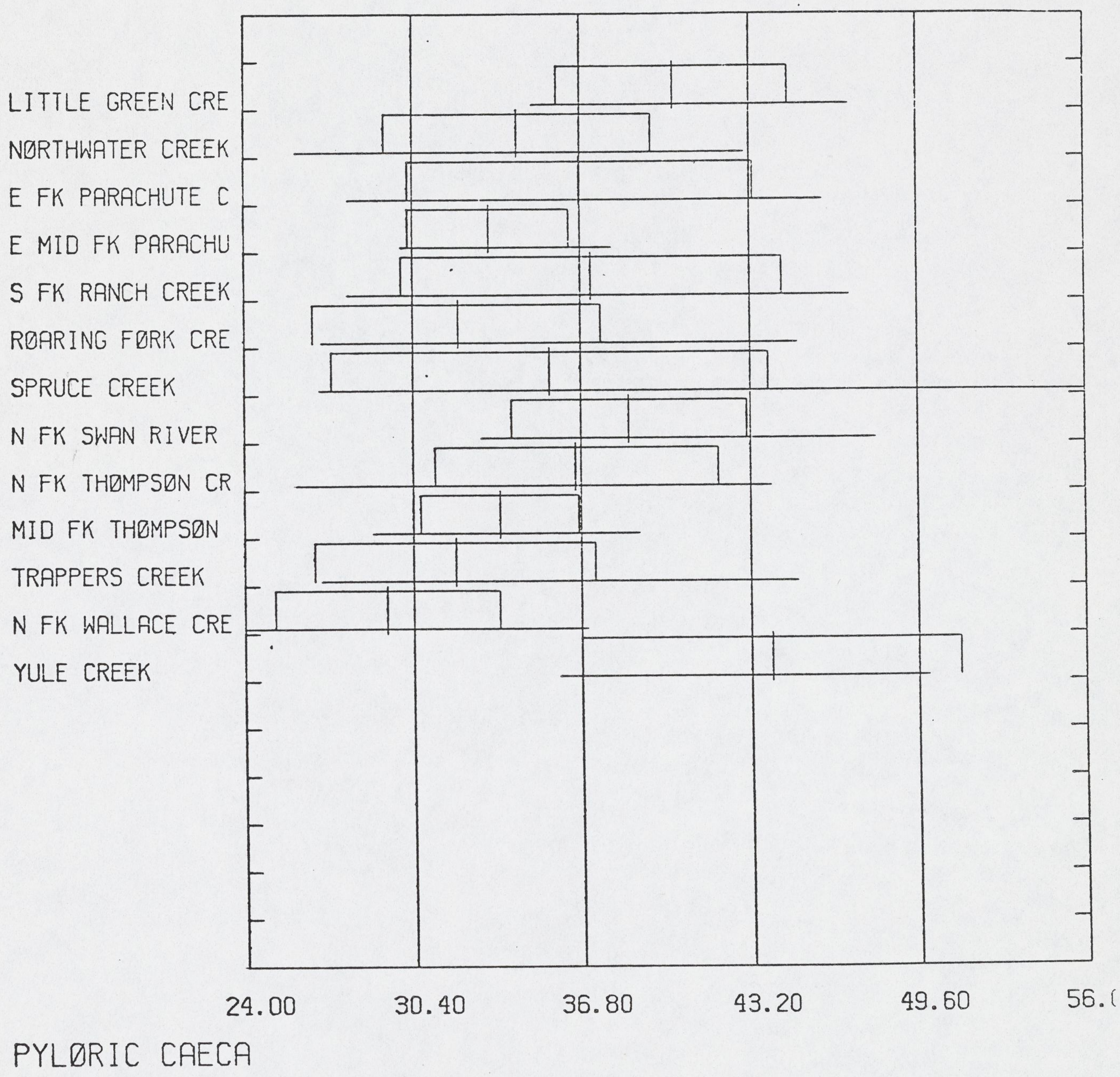

Figure 7a. Hubbs and Hubbs diagram of pyloric caeca data.

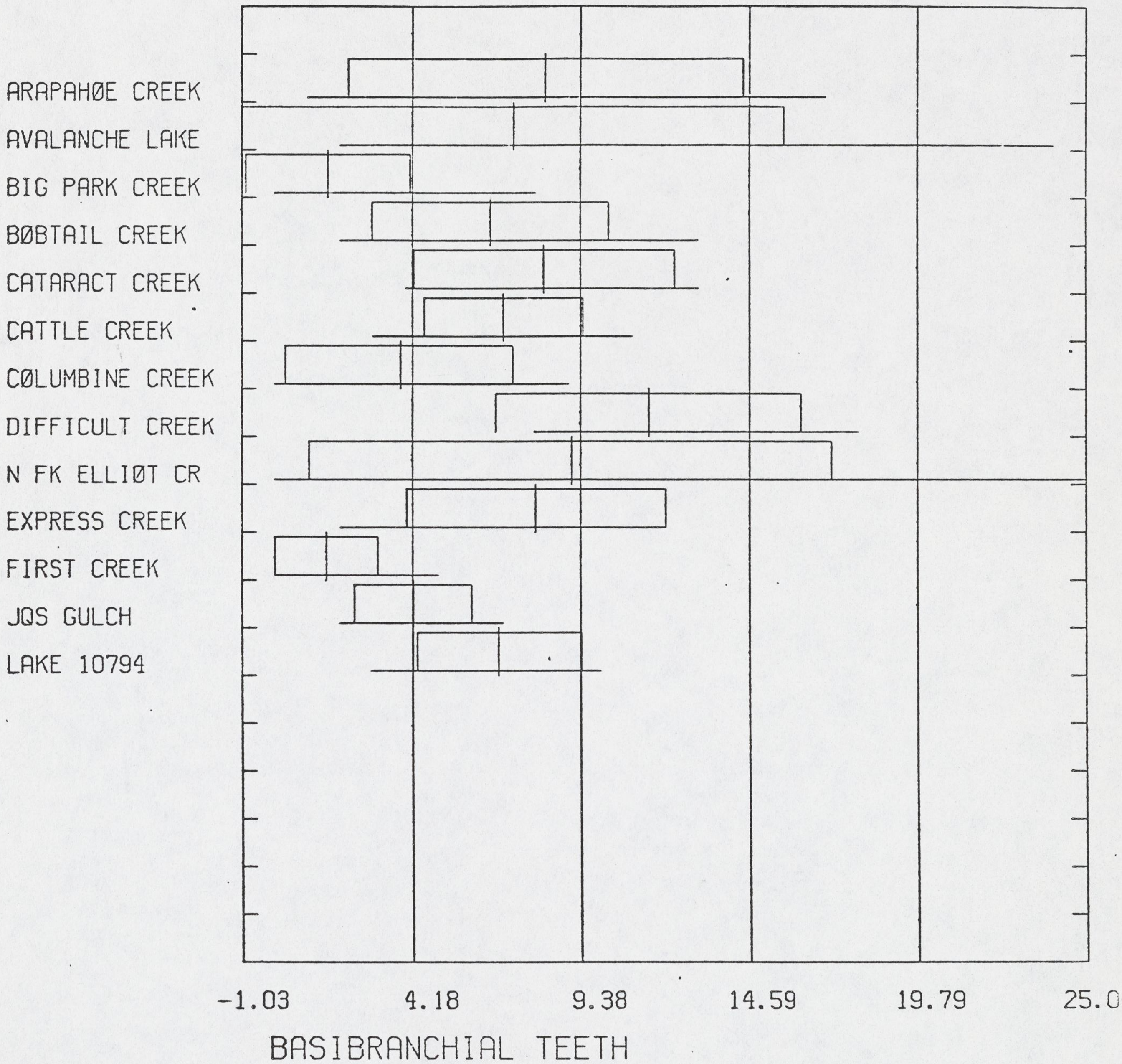

Figure 8. Hubbs and Hubbs diagram of basibranchial teeth data.

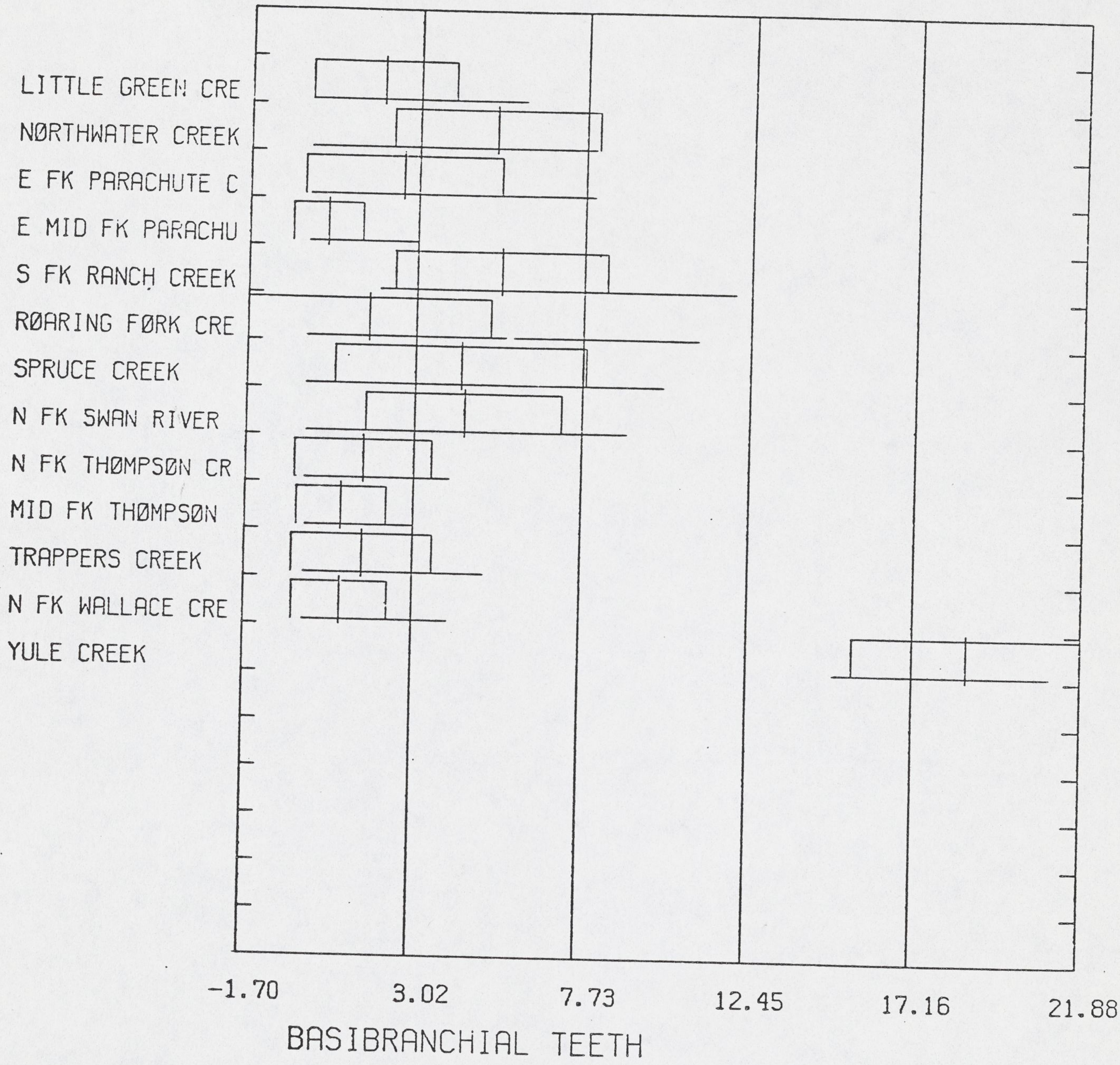

Figure 8a. Hubbs and Hubbs diagram of basibranchial teeth data.

location, physical characteristics, and species present. The purity grade for cutthroat populations is discussed and management recommendations are added here also. None of the streams or lakes found to contain cutthroat trout should be stocked with non-native trouts such as rainbow trout or brook trout. Non-native subspecies of cutthroat trout should not be stocked either, in order to preserve the genetic integrity of populations of S.c. pleuriticus.

Table 3 is a summary of selected stream characteristics noted at the sampling sites (see Table 1 for legal descriptions). A dash indicates missing information. Numeric values, other than temperature, were estimated, rather than measured, due to time and equipment limitations. Substrate materials are listed in order of abundance, with the most common material at the top and least common at the bottom.

Table 3. Selected characteristics of streams sampled during the 1981 Colorado River cutthroat trout inventory.

Creek	Surrounding Vegetation	Pools	Substrate	Gradient	Water (°F) Temp.	Avg. Width Depth
First Cr	Willow Spruce-Fir	Up to 3'd Several Pools	Rubble Fine Sed.	10%	-	-
Circle Cr.	Alder Spruce-Fir	-	Rubble Gravel Fine Sed.	-	-	-
Slater Cr.	Spruce-Fir	-	Rubble	-	56°	3' w 6" d
Fish Cr.	Aspen Spruce-Fir	Abundant 2-5' d	Boulder Rubble	steep	60°	13' w 36" d
Harrison Cr.	Willow Spruce-Fir	-	Fine Sed.	5%	-	-
King Solomon Cr.	Alder Willow Aspen	Max 1' Stream, 2-3' Bvr.Pond	Gravel Rubble Fine Sed.	5%	-	-
N. Fork Silver City Cr.	Willow Meadow	-	Rubble	10%	50°	5' w 6" d
N. Fork & W. Fk. Whiskey Cr.	Grass Lodgepole	To 1½' d	Rubble Fine Sed.	15%	50°	5' w 8" d
Summit Cr.	Spruce-Fir	To 1' d	Rubble	-	50°	3' w -
Muddy Cr. above Dumont L.	Willow Spruce-Fir	-	Gravel Rubble Fine Sed.			

Creek	Surrounding Vegetation	Pools	Substrate	Gradient	Water (°F) Temp.	Avg. Width Depth
Green Cr.	Engelmann Spruce Lodgepole	-	Rubble Gravel Sand	5%	50°	3' w 6" d
Little Green Cr.	Grass Lodgepole	To 2½' d	Gravel Sand	-	-	5' w 10" d
Service Cr.	Willow Lodgepole	To 6' d in Bvr.Ponds	-	5%	71°	8' w -
Big Park Cr.	Willow Lodgepole	Ponds to 3' d	Gravel Fine Sed.	10%	59°	1.5'w 2" d
N. Fork Elliot Cr.	-	-	Rubble Boulder	-	-	-
Cataract Cr.	Willow Spruce-Fir	To 10' w 4' d	Boulder Rubble	25%	55°	-
Rock Cr.	Grass Willow Lodgepole	little meandering	Rubble Gravel boulder	10%	52°	11' w 12" d
Columbine Cr.	Alder Willow Lodgepole	Ponds to 4' d, pools to 3' d	Rubble	25%	-	-
Roaring Fork Cr.	Willow Spruce-Fir	To 2' d	Rubble Gravel Sand Boulder	20%	55°	9' w 7" d
Arapaho Cr. (Wheeler Basin)	Willow Spruce-Fir Subalpine meadow	Pools common	Rubble Boulder Gravel	20%	42°	8' w -

Creek	Surrounding Vegetation	Pools	Substrate	Gradient	Water (°F) Temp	Avg. Width Depth
Jim Cr.	Willow Spruce-Fir	Little meandering	Rubble Boulder Gravel	20%	48°	8' w 7" d
S. Fork Ranch Cr.	Grasses Willow Lodgepole	To 2' d & 12' w	Rubble Gravel Boulder	15%	56°	7' w 5" d
Hamilton Cr.	Willow Alder Aspen Lodgepole	To 1' d	Rubble Boulder Gravel Fine Sed.	15%	50°	6' w 6" d
Bobtail Cr.	Willow Spruce-Fir	few; to 1' d	Rubble Boulder	10%	58°	10' w -
S. Fork Williams Fk. River	Willow Subalpine meadow	To 1½' d	Rubble Boulder Gravel	15%	52°	8' w 5" d
Spruce Cr.	Spruce-Fir	To 3' d & 10' w 2-3/100'	Rubble Boulder Gravel	25%	50°	8' w 7" d
Crystal Cr.	Forbs Spruce-Fir	-	Rubble Boulder Gravel Fine Sed.	30%	47°	9' w 7" d
N. Fork Swan River	Grasses Forbs Spruce-Fir	To 3' d 3/100'	Rubble Gravel Fine Sed.	15%	48°	8' w 6" d
Stafford Cr.	Willow Spruce-Fir	Most less than 1' 3-4/100'	Rubble Gravel Fine Sed.	15%	53°	8' w 6" d
Notch Mt. Cr.	Willow Spruce-Fir	Scarce & small	Rubble Fine Sed. Gravel	15%	47°	5' w 5" d

Creek	Surrounding Vegetation	Pools	Substrate	Gradient	Water (°F) Temp.	Avg. Width Depth
Game Cr.	Cow Parsnip Alder Aspen	3-4/100' To 8"deep	Gravel Fine Sed. Rubble Boulder	30%	53°	5' w 3" d
Cattle Cr.	Alder Willow Mixed Conifer	5-7/100' To 12' w deep riffles	Bedrock Rubble Gravel Fine Sed.	15%	-	8' w 5" d
Avalanche Cr. (at Gift Cr. jct.)	Willow Spruce-Fir	Few;1/100' To 5' d	Rubble Boulder	-	53°	22' w 12" d
S. Fork Crystal River	Willow Spruce-Fir	To 12" d in turns;channels to 2'	Rubble Gravel Fine Sed. Boulder	10%	49°	8' w 8" d
Yule Cr.	Willow Spruce-Fir	To 3' d & 20' w	Marble & granite bedrock, Rubble Gravel	30%	53°	18' w 12" d
Express Cr.	Willow Lodgepole	To 2' d & 6' w	Rubble Gravel Fine Sed. Boulder	-	47°	7' w 5" d
Difficult Cr.	Forbs Spruce-Fir	To 3' d	Rubble Boulder Sand Gravel	20%	53°	15' w 8" d
JQS Gulch	Serviceb. Snowberry Aspen	To 12" d 3-4 pools in ½ mi. Ponds to 3'd	Shale bedrock Gravel Silt	5%	59°	2' w 2" d
E. Fork Parachute Cr.	Serviceb. Aspen Snowberry	infrequent	Bedrock Gravel Silt	5%	64°	5' w 2" d

Creek	Surrounding vegetation	Pools	Substrate	Gradient	Water (°F) Temp.	Avg. Width Depth
East Mid. Fork Parachute Cr.	Serviceb. Willow Douglas Fir	To 12" d 1-2/100'	Bedrock Shale flakes Silt	8%	73°	10' w 5" d
Trappers Cr.	Grass Forbs Sage	Bvr. ponds to 5' d	Sand Silt	8%	-	3' w 4" d
North-water Cr.	Grass Forbs Spruce-Fir	Fairly frequent to 18" d	Bedrock Sand Silt	10%	-	3' w 4" d
Battlement Cr.	Alder Aspen	To 1½' d	Rubble Boulder Gravel	20%	51°	9' w 7" d
N. Fork Wallace Cr.	Alder Willow Juniper Oakbrush	To 1½' d & 5' w 2-3/100'	Gravel Silt	10%	65°	3' w 3" d
N. Fork Thompson Cr.	Willow Alder Spruce-Fir	3-4/100'	Rubble Silt	15%	55°	10' w 12" d
Mid. Fk. Thompson Cr.	Alder Willow Aspen	pools abundant	Rubble Sand Gravel Fine Sed.	20%	59°	6' w 7" d
S. Branch Mid. Fk. Thompson Cr.	Alder Spruce-Fir	Small pools common	Rubble Silt Gravel	15%	52°	6' w 6" d
Spruce Cr. (Trib. to Woody Cr.)	Forbs Spruce-Fir	To 2½' d & 12' d 4-6/100'	Rubble Boulder Sand Gravel	25%	47°	10' w 6" d
Woody Cr.	Forbs Spruce-Fir	Few pools Many Bvr. Ponds	Rubble Boulder Sand Gravel	15%	48°	12' w 6" d

Creek	Surrounding Vegetation	Pools	Substrate	Gradient	Water (°F) Temp.	Avg. Width Depth
Midway Cr.	Forbs Willow Spruce-Fir	To 2½' d & 20' w 4-5/100'	Boulder Rubble Sand Gravel	20%	53°	20' w 7" d
N. Fk. Crystal River	Grass Forbs Spruce-Fir	To 5' d	Bedrock Boulder Rubble	15%	53°	25' w 11" d

First Creek: This creek is located at the southern end of California Park in Routt Ntl. Forest. It is somewhat/meandering, strewn with several beaver dams. Access is good with a 4WD road going to within a few hundred feet of the sampling site. It is recommended that exotics not be stocked as the B- population is doing fine. The beaver dams are functioning as good barriers at the present time, although they should be monitored and supplemented with a permanent barrier if funds permit.

Circle Creek: Just west of California Park, this stream runs through a large meadow. Entry involves a 1/2 to 3/4 mile hike west from California Park. Management potential possibly exists for pleuriticus further upstream within the beaver ponds. If so, eradication by rotenone treatment and reintroduction of pure pleuriticus would be appropriate.

Slater Creek: At the sample site, Slater Creek runs through dense spruce-fir and has a steep gradient. Because of the small size of the habitat, no management effort is recommended.

Fish Creek: Directly east of Steamboat is Fish Creek. A series of very adequate barrier falls exist and above these falls lies ideal habitat in a moderate sized stream. This would be a good location to eliminate brook trout and begin a pleuriticus stocking program, although several miles of stream and a lake must be treated.

Harrison Creek: This creek, located close to Rabbit Ears Pass, contained only brook trout. The headwater portion sampled is a series of mudlined ponds with an almost imperceptible gradient. The stream is considered to have poor management potential.

~~King Solomon Creek: This stream is close to Little Red Park in Routt National Forest, and is easily reached by a four wheel~~

King Solomon Creek: This stream is close to Little Red Park in Routt National Forest, and is easily reached by a 4WD road. There is alot of old beaver activity, although none recently. The stream provides fairly good habitat with alder and willow providing good cover. The upper ponds are barren and could be restocked with natives. The brook trout in the lower ponds should be treated with rotenone as well.

Silver City Creek: A tributary to the Little Snake River, this stream meanders through open meadow and is shaded by dense willow. Due to the presence of brook trout and the probable lack of any significant barrier, this stream is not considered as a worthwhile management site.

North Fork & West Fork Whiskey Creek: These creeks produced only brook trout and are in an area of intermittent clear-cutting operations. The habitat is suitable, though not excellent and it is recommended that nothing be done in terms of management.

Summit Creek: This small stream is also in logging country and suffers bad siltation from a road cut. The stream is barren and offers poor habitat. No stocking is recommended.

Upper Muddy Creek: It is a very small stream at this point, with dense willow along most of its length. Only one brook trout was taken and it is recommended that no management steps be taken unless a barrier can be found.

~~Green Creek: Because of its relative inaccessability, this stream is~~ considered ...

Green Creek: Because of its relative inaccessability, this stream is considered to have a poor management potential. The stream itself is fairly small and currently supports only a population of brook trout.

Little Green Creek: This beautiful stream meanders through a large meadow that shows some evidence of previous logging activity and is easily accesed from Buffalo Park Road. There should be no fish stocked here, as there is a healthy reproducing population of A- pleuriticus. The presence of a barrier was not confirmed, but it is implied since their are no brook trout or other exotics. This population may prove to be valuable as a limited stocking source.

Service Creek: Several beaver dams create deep, wide pools in this stream section adjacent to Buffalo Park Road. Since there are only brook trout present, this would be a good location to treat with rotenone and reintroduce natives.

Big Park Creek: At this point, the creek exits from a narrow valley out into a large meadow area and extensive beaver activity is evident. Only a very isolated population was found living in a beaver pond right at the edge of private property. Because the access is across private land and the marginal nature of the habitat, management should be restricted to monitoring of the present C population.

North Fork Elliot Creek: The section sampled contained a couple of good barrier falls (6 and 12 ft high) and represented good habitat with plenty of sizable pools and cover. The fish collected show a trace of hybridization (B purity grade). The population is somewhat sparse, and there are some brook trout invading. The access involves a ¼ mile hike through heavily forested terrain. A management scheme may involve maintaining the current population or rotenone treatment to eliminate brook trout competition and reintroduce pure pleuriticus.

Upper Cataract Creek: Located in the Gore-Eagles Nest Wilderness Area, this section lies above Mirror Lake. The creek has a couple of good falls and yielded a population of B+ cutthroats. The only management suggestion would be to monitor and maintain the present population.

Lake 10794: This lake is NW of Mirror Lake and has B+ fish also. Stocking should be restricted to pleuriticus. The fish all are of roughly the same age class.

Rock Creek: This creek was sampled near the Gore trailhead parking lot. The presence of a barrier falls was undetermined and brook trout were the only species present. Although the habitat looks fairly good, until a barrier is confirmed management for pleuriticus should be delayed.

Columbine Creek: Permission was granted by the National Park Service to collect on this stream that empties into

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7. Hubbs and Hubbs diagram of pyloric caeca data.

8. Hubbs and Hubbs diagram of basibranchial teeth data.

Acknowledgements

We wish to thank all the Division of Wildlife and Bureau of Land Management field personnel and fishermen that helped us in our search for the elusive cutthroat. Many thanks also go to Steve Culver for his help with the computer analysis and to Dr. Robert Behnke and CSU for use of their laboratory facilities. We are also grateful to Dr. Behnke for permission to reprint the cutthroat picture on the cover and the distribution figure; both taken from Behnke and Benson (1980).

COLORADO RIVER CUTTHROAT TROUT INVENTORY

1981

Introduction:

History: The Colorado River cutthroat trout, Salmo clarki pleuriticus, was first described by Cope in 1872 as a result of Hayden's geological survey of Wyoming. In 1891, Jordan gave a more complete description of scale counts, spotting and coloration. Present day diagnosis of population purity is based upon this data (Wernsman 1973). ~~Figure 1 shows the past and present distribution of pleuriticus.~~

The former range of S.c. pleuriticus extended from the headwaters of the Colorado River basin downstream to the Dirty Devil River, Utah, on the west and to the San Juan drainage of Colorado, New Mexico and Arizona on the east (Behnke and Zarn 1976). Presently, however, pure populations of S.c. pleuriticus are rare. Figure 1 shows the past and present distribution of pleuriticus (reprinted with permission, Behnke and Benson 1980).

Habitat loss and changes as well as the introduction of non-native trouts have caused the decline. Brown trout (Salmo trutta) and rainbow trout (S. gairdneri) have completely displaced S.c. pleuriticus in the larger rivers, and brook trout Salvelinus fontinalis, have invaded many of the smaller headwater streams (Behnke and Zarn, 1976). Wernsman (1973) reported finding only three populations of relatively pure pleuriticus in tributaries of the main Colorado River: Cunningham Creek, tributary to the Frying Pan River, Pitkin Co., Colorado;

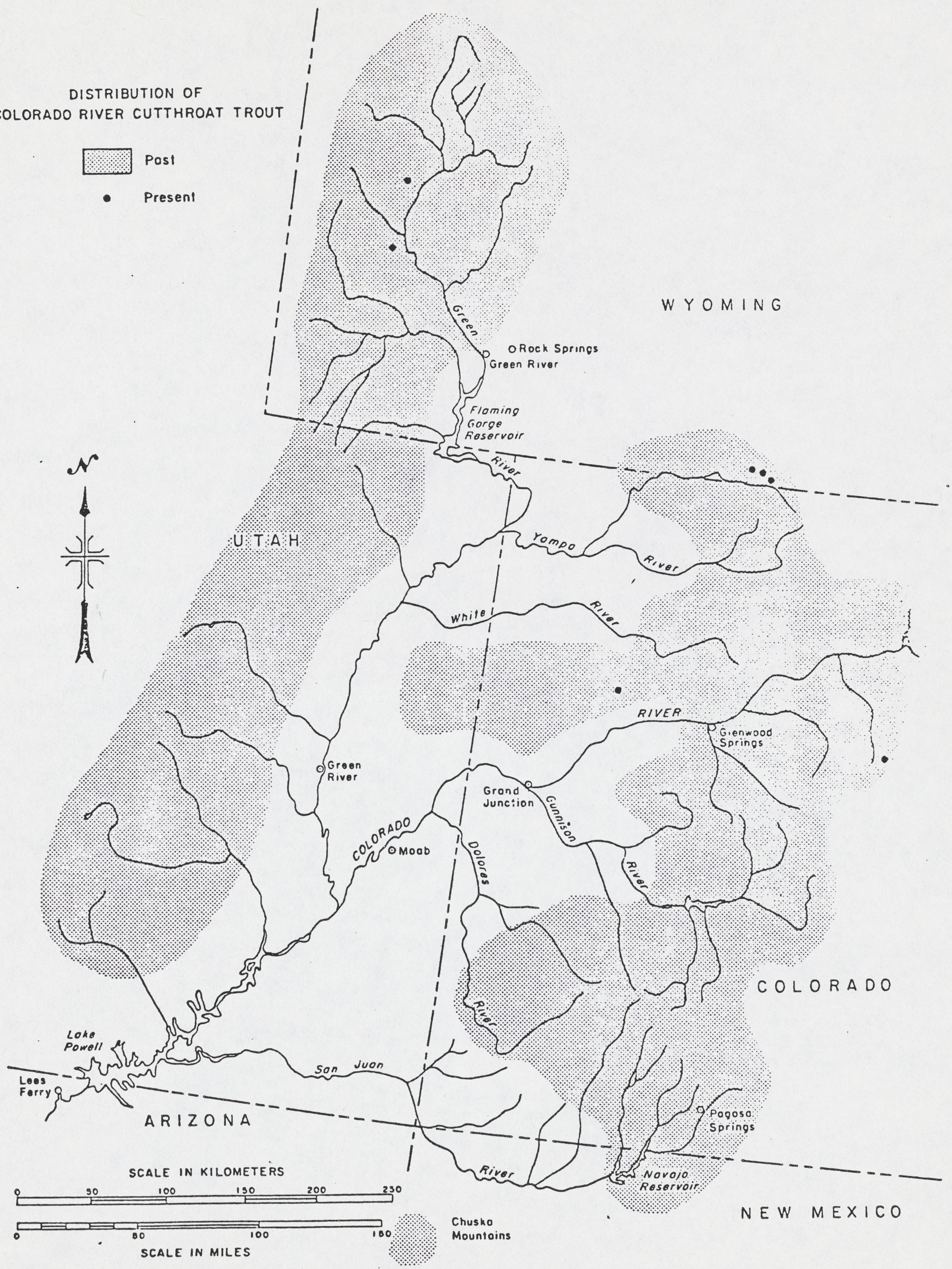

Figure 1. Past and present distribution of Colorado River cutthroat trout.

Northwater Creek, tributary to Parachute Creek, Garfield Co., Colorado; and the very headwater source of the Colorado River, Rocky Mountain National Park, Colorado. This latter population was not isolated from non-native trouts and is now extinct for all practical purposes (Behnke and Zarn 1976). Additionally, Behnke's (1978) analysis of collections made in Wyoming determined that four streams in the Little Snake River drainage have virtually pure S.c. pleuriticus and also found that specimens from Lead Creek of the upper Green River drainage are pure.

In 1980, under the direction of Tom Lytle, nongame biologist for the northwest region of Colorado, an inventory project discovered thirteen pure populations of S.c. pleuriticus in Colorado. Seventeen other populations were predominantly pleuriticus, but showed evidence of hybridization with rainbow trout and other non-native cutthroat trout.

Presently, Salmo clarki pleuriticus is recognized as threatened by the Colorado Division of Wildlife. The Utah Fish Committee of the American Fisheries Society's Bonnieville Chapter lists S.c. pleuriticus as endangered (Behnke and Zarn, 1976). Miller (1972) also included S.c. pleuriticus in his list of threatened freshwater fishes of the United States.

Objectives:

1) To determine if and where populations of Salmo clarki pleuriticus exist.
2) To assess the purity of existing populations.
3) To reintroduce S.c. pleuriticus into suitable streams and lakes within its historic range.
4) To monitor and protect known populations of S.c. pleuriticus.

Methods and Materials:

Field: Candidate waters for the 1981 inventory were almost exclusively restricted to streams because they were believed to have better potential as habitat for pure or relict populations. Last year's inventory revealed only one pure 'A' population from lacustrine habitat.

Selection of streams was based on a list compiled by Clee Sealing that tabulated waters with a "known history of cutthroat." In most cases, the chosen streams were cross-referenced with stocking records and eliminated if rainbow trout had been introduced. Streams supposedly containing cutthroat were not eliminated if non-native species other than rainbow had been reported in a previous survey.

Several streams were surveyed on the recommendation of various Division of Wildlife and Bureau of Land Management field personnel. In the interest of efficiency and optimal utilization of collection time, their suggestions were used to further discriminate against poor or unlikely candidates. Suggestions from some local fishermen were used similarly.

Actual sampling was usually accomplished using a Coffelt BP-2 backpack electroshocker[1] In situations that involved extensive hiking, sampling was accomplished by angling. The samples were taken as close to headwater situations as possible since this is the most likely location for pure populations of S. c. pleuriticus. (Behnke 1976, Langlois et. al. 1979). Whenever possible, sampling was done above barrier falls which would prevent the upward migration of exotics. An adequate barrier falls is considered to be one greater than three feet in height (Langlois et.al. 197?). Beaver dams were encountered on many streams and they function as effective temporary barriers in some situations. Critical habitat may need to be preserved by upgrading certain beaver structures with permanent ones. A Division of Wildlife stream survey sheet was completed for each stream sampled and additional notes were taken on habitat appraisal and general stream characteristics.

The fish were preserved in 10% formalin with .4% borax used as a buffer (Wernsman 1973), and placed in one gallon Nalgene bottles. The bottles were initially stored in a horizontal position to allow the specimens to stiffen flat without curling. A small (less than one inch) ventral slit was placed in each fish anterior to the vent to facilitate penetration of the formalin. A minimum size requirement of 75mm was placed on each specimen at Dr. Behnke's suggestion. This is the size at which basibranchial teeth are fully developed.

Ten specimens are considered an adequate sample for determining statistical significance (Behnke and Zarn 1976). In all but eight samples, ten fish were preserved. Those samples of less than ten were a result of sparse populations or various extenuating circumstances. The samples that could not be immersed in formalin quickly, were injected with formalin at several points throughout the body until they could be properly preserved. Each sample was photographed to record color and spotting patterns before being preserved. A standard collection card was filled out for each sample which describes location and characteristics of the particular stream and was included in the sample. Maps were color-coded for those streams sampled and the location of barrier falls as was done in the 1980 survey.

Taxonomic Analysis: The purity of S. c. pleuriticus is assessed by analysis of various meristic characteristics and spotting patterns. The first adequate description of S. c. pleuriticus was published in the work of Behnke and Zarn (1976). The Colorado River cutthroat trout is characterized by high scale counts, (170-200+) in the lateral series and (38-42) above the lateral line, low pyloric caeca counts (25-45), (17-21) gillrakers, and basibranchial teeth present in at least 90% of the populations, (but low in number). The spotting pattern is variable according to geographic locality and S.c. pleuriticus has a genetic basis to develop brilliant bright red, orange and golden-yellow colors, especially in mature males (Behnke and Zarn 1976; Behnke 1979).

Morphological measurements were performed according to the procedures described by Hubbs and Lagler (1958). Alizarin was used to stain both the first arch gillrakers and basibranchial teeth by soaking cheesecloth in the dye and placing a small swab in the mouth of the fish overnight. This procedure facilitated the counting of both the gillrakers and the basibranchial teeth. Scale definition was enhanced by the use of malachite green dye applied directly to the scales after the epidermis had been scraped away. Scale counts in the lateral series were made by counting the scales two rows above the lateral line, (scale counts of the pored scales are similar in many species). Pyloric caeca counts were made by pulling every complete tip loose from the intestine. When possible, all counts and measurements were made on the left side of the fish.

Purity Rating: Hybridization is one major problem that has led to the demise of pure S.c. pleuriticus populations. The introduction of non-native trouts to the Colorado River drainage has resulted in all degrees of hybridization and thus renders taxonomic evaluation of pure S.c. pleuriticus populations difficult. Hybridization between Salmo species and subspecies is detectable by analysis of genotypic and phenotypic characters. Populations of supposed endemic pleuriticus are given a purity rating taken from a matrix evaluation of the characteristics analyzed

Hybridization with rainbow trout is usually detected by an absence of basibranchial teeth, lower scale counts, higher pyloric caeca counts and a profusion of spots. Hybridization with other subspecies of cutthroat is not usually determined by a single character, rather a combination of meristic characters will usually distinguish S.c. pleuriticus from most other non-native cutthroats.

In the process of determining the purity of S.c. pleuriticus, the guidelines established by Binns (1977), in which the letters A through F designated various degrees of hybridization, were followed. The rating scheme is presented here:

A = Pure S.c. pleuriticus.

B = Essentially pure, but with a trace of contamination from other Salmo (sub)species.

C = Good representative of S.c. pleuriticus stock, but some hybridization is evident.

D = Definite evidence of hybridization, but external characters suggest that it is still representative of S.c. pleuriticus.

E = Populations not examined by a taxonomist.

F = Obvious hybrid and rainbow trout characteristics and are poor representatives of S.c. pleuriticus.

Questions arise, however. What defines "essentially"? "Some"? In an attempt to quantify our purity assessment, we have developed a character matrix that uses: 1)the number of scales two rows above the lateral line, 2)pyloric caeca, 3)basibranchial teeth, and 4)spotting pattern. This will help to remove some of the subjective judgements involved, although intuitively an experienced taxonomist can judge purity fairly accurately.

One limitation that should be pointed out is that spotting descriptions are still somewhat subjective and spotting evaluation should be performed by someone experienced in recognizing degrees of hybrid spotting. However, almost anyone can recognize variability. The greater the variability in size, shape and position of the spots, the greater the rainbow trout and/or non-native cutthroat trout influence (Behnke 1978).

Shown below is the character matrix used to determine the purity of a population. Gillrakers and scales above the lateral line have similar values for pure pleuriticus and rainbow trout, so these were not used. Typical pleuriticus values were taken from Behnke and Zarn (1976) and the obvious hybrid values that define the other end of the spectrum were taken from rainbow trout characters described in Behnke's (1979) Salmo monograph. The ranges given for scales and caeca represent mean values.

	A(1)	B(2)	C(3)	D(4)	F(5)
No. of scales two rows above lateral line.	180+	168-179	155-167	142-154	120-142
No. of pyloric caeca.	<40.9	41.0-44.5	44.6-48.5	48.6-53.0	53.1+
Percent of spec. lacking basibranchial teeth..	<10%	10-20%	20-40%	50-75%	75%-100%
Spotting variability	Uniform No variability	Slight Variability	Some variability yet still typical pleuriticus	Quite variable yet still pleuriticus	Obvious hybrid spotting.

To use this system: 1)compare the data gathered from the population with the ranges in the matrix and determine which the letter grade each character merits. 2)Convert the letter grades to numbers shown to the right of each letter (ie. C = 3). 3)Sum the numbers for the four characters. 4)Compare the sum with the table below for a final purity rating.

A = 4-5

B = 6-7

C = 8-10

D = 11-13

F = 13+

Pluses and minuses are assigned depending upon where in the range the sum falls, or if other variables outside the matrix (such as pelvic rays) indicate a greater or lesser purity. For example, Little Green Creek fish have an average of: 181.6 scales, 40.3 caeca, 2 specimens of 10 without teeth, and typical pleuriticus spotting. Therefore, using the matrix:

scales = A = 1

caeca = A = 1

teeth = B = 2

spotting = A = 1

5

Comparing '5' with the table shows that Little Green Creek is an "A" population, but caeca counts are on the high side and 20% of the fish lack teeth, so a (-) is appropriate. Thus, the purity of Little Green Creek is an "A-".

This matrix works well for pleuriticus/non-native hybrids as well. Genetic influence from subspecies such as the Yellowstone cutthroat, (S.c. bouvieri), can be seen in the spotting variability which will result in B or C purity grades. Yellowstone cutthroat typically have a lower number of scales in the lateral series, (165-180), somewhat higher gillraker counts (18-23) and many more basibranchial teeth (average of 22) (Behnke 1979).

It is obvious that standardization of the purity rating system is necessary in order to insure consistent application. This scheme has worked well for the 1981 collection. Further refinement may be needed if complications or contradictions arise in the future.

Inventory Results:

The following list comprises all those streams sampled by Eric Wagner and Scott Chapal in 1981. Table 1 provides a quick summary of every stream sampled, their location, the stocking history, species present and the type of barrier(s).

Stocking history is based upon Division of Wildlife stocking records. If a stream is known to have been stocked, the species and most recent year of the stocking is given. "NS" indicates that the stream has not been stocked, at least according to records we have access to.

The standard Colorado Division of Wildlife abbreviations for species sampled are used and consist of the following: CRN = *S.c. pleuriticus*, B = *Salvelinus fontinalis* (brook trout), R = *Salmo gairdneri* (rainbow trout), MTS = *Cottus bairdi* (mottled sculpin), BHS = *Catostomus discobolus* (Bluehead Sucker), and SD = *Rhinichthys osculus* (Colorado speckled dace).

Table 2 presents data from five meristic characters analyzed in this study and also includes comments on spotting for each of the 28 populations. Ranges are given for each character and mean values are provided within the parenthesis. Legal site descriptions and sample size (N) are also included.

Hubbs and Hubbs diagrams are included here (Fig. 2-8) to present the data in a more graphic manner. The diagrams illustrate the mean (centerpoint), ~~95 pe. conf. confidence limits of t the mean (outer~~ standard deviation (outer limits of the open rectangle), and sample range (basal line).

Included under each stream is a description of the stream's

Table. 1 Summary of streams and lakes in northwestern Colorado examined for presence of Colorado River cutthroat trout (*Salmo clarki pleuriticus*), 1981.

1a. Streams containing *S. c. pleuriticus*.

1b. Streams not containing *S. c. pleuriticus*.

Lake Granby. About one mile up the stream is an area of intensive beaver activity. Below this complex of dams are brook trout; above are both brook trout and slightly hybridized cutthroat(B purity). Eventually, in the upper portion of the stream, only cutthroat exist. The brook trout are obviously encroaching on the native population. Perhaps a rotenone application and reintroduction program would be appropriate if the Park Service agrees.

Roaring Fork Creek: There is a large set of falls on this creek near its terminus that obviously functions as a barrier. Cutthroats were the only species found and the habitat is fairly productive. Management should be restricted to maintaining the present *pleuriticus* population (C purity) or restoring purer *pleuriticus*.

Arapahoe Creek: This is a major drainage in the Indian Peaks Wilderness Area. The cutthroat population at the upper end (B purity) is doing fine. It may be useful to supplement the numbers by stocking some additional cutthroat of wild, stream adapted stock, since this stream is supporting a small population. Special fishing regulations may also be necessary in the future. A small tributary of Arapahoe Creek that drains Wheeler basin is barren of fish. The habitat appears excellent and is a prime candidate for *pleuriticus* stocking. Barrier falls over 6 ft high isolate this branch.

Jim Creek: This creek is located close to Winter Park. Above the water diversion site, the creek is barren of fish. The habitat here is poor because there are few pools and sparse cover. It should be considered as a low priority stocking site when barren waters are being stocked.

South Fork Ranch Creek: The lower end of this creek contained brook trout, but these gave way to cutthroat above a 3 ft log jam barrier. The population is good A pleuriticus though they are somewhat sparse. Midway through the sampling section is a block of private land that has a holding pond on the creek. If the pond were to be stocked with exotics, it would substantially affect the pleuriticus population. The landowner should be informed of the situation and given stocking alternatives if stocking is desired.

Hamilton Creek: Since this creek is small and travels mostly through private land, it is recommended that nothing be done in terms of managing for pleuriticus.

Bobtail Creek: This stream appears to be excellent habitat and lies just west of Jones Pass. The access is by 4WD road to the creek itself. It runs through intermittent open areas and spruce-fir and yielded an A- population of pleuriticus. The present population should be monitored and maintained if possible.

South Fork Williams Fork River: Although this creek is isolated and somewhat difficult to get to, it is full of brook trout. This makes the presence of a barrier doubtful. Management potential based on these criterion is poor and a pleuriticus program should not be pursued here.

Spruce Creek: South of Breckenridge, this creek is possibly affected by fish coming out of the Mohawk Lakes. They have been stocked with natives, but the possibility of non-pleuriticus influence remains. There is a good reproductive B population that should maintained and the presence of an adequate barrier should be confirmed.

Crystal Creek: Appears to be barren above the road that goes to Spruce Creek. Only one cutthroat was found below that point and it is assumed that this fish was a member of the Spruce Creek population. The stream has a 30% gradient, but is strewn with frequent pools and good cover. Stocking with pleuriticus may be feasible in the upper section of this stream.

North Fork Swan River: This stream provides excellent habitat for pleuriticus, yet the population observed was quite sparse. Access is quite good by truck, and this is likely to be a favorite fishing spot due to its close proximity to Breckenridge and Dillon. The A- population may need special regulations or be supplemented by stocking in order to counteract fishing pressure.

Stafford Creek: The lower terminus of this stream is near the summit of Vail Pass. A hike of approximately 3 miles was needed to get to the sample site. Since only brook trout were found and the habitat is good, a pleuriticus restoration program may be appropriate. Beaver dams are providing a temporary barrier, but a permanent one should be constructed if cutthroat are stocked.

Notch Mountain Creek: This creek is accessible through Half Moon Campground, although it is very small at this point. Downstream there are beaver ponds containing brook trout, yet this remains a poor candidate for management.

Game Creek: East of Minturn, this stream contains very good habitat. The presence of a 3 ft barrier makes it a good site for rotenone treatment of the brook trout and reintroduction of natives.

Cattle Creek: This stream has the characteristics of a perfect pleuriticus stream including an A+ population. A falls of approximately 40-50 ft lies about three miles up the valley from the end of the road. The falls are above the Iola Creek junction. Habitat is excellent, with many pools and good cover. The abundant population may provide a good stocking source. In any case, this population should be monitored and protected.

Avalanche Creek: The upper portion of this creek, close to the confluence with Gift Creek, was surprisingly unproductive. No fish were caught by angling for several hours on this section, although cutthroat are reported (Randy Cote, District Wildlife Manager). Only one fish was seen in this section. If there are cutthroat in the creek, they should be maintained or perhaps supplemented by stocking of pleuriticus. The creek may be receiving intense fishing pressure since it is a major drainage in the Snowmass Wilderness. Avalanche Lake lies at the top of a series of tall, steep waterfalls that form an effective barrier. The population in the lake is B purity.

Gift Creek: The steep gradient and small size of this creek make it a poor candidate for pleuriticus management.

South Fork Crystal River: This stream offers good habitat and has good access from Schofield Pass Road. The large barrier falls make the upper portion of the stream an ideal location for rotenone treatment and reintroduction of pure pleuriticus.

Yule Creek: This creek is best entered from the quarry near marble. In the lower sections there were only brook trout. Above a series of barrier falls both cutthroat and brook trout were found, although the brook trout are definitely predominant. Since the Yule Creek population is C+ and the brook trout are obviously encrouching, this would appear to be an ideal site for reintroduction. However, due to the length of the stream, and the position of the

Yule Lakes, the effort required may be excessive. This should be a low priority project.

Express Creek: This small stream near Ashcroft pruduced surprisingly large fish that have a purity of B+. The population was quite small and rainbow trout were found also. A rotenone and restoration program may be appropriate, but the small size of the stream may limit productivity.

Difficult Creek: This creek has excellent habitat in the upper sections and should be accessed from Taylor Pass. It proved to be barren above a series of 2 and 3 ft cascading waterfalls just downstream from Bruin Creek (also barren). Cutthroat did turn up, however, below this area and they rated as a B for purity. The habitat throughout is excellent and should be considered for pleuriticus stocking.

JQS Gulch: The next five streams were sampled on the recommendation of Marc O'meara, fish biologist for the BLM. Marc and Leonard Coleman assisted in the collection. This stream is a small tributary to the E. Fk. of Parachute Creek. Despite its size, it is unusually productive with up to 20 fish per pool. Bank degredation is evident from grazing, and pools are scarce. The population is A+ and merits management attention. Marc O'meara and Leonard Coleman mention that a small, barely adequate barrier isolates JQS Gulch from E. Fk. Parachute Creek. Several beaver dams also may act as temporary barriers. A more permanent barrier is recommended to preserve the purity of this rare population. An estimate of the population should be taken so it can be rated as a stocking source. Habitat improvement may be necessary to make this creek productive.

East Fork Parachute Creek: The habitat here is very similar to JQS Gulch. Although the cutthroat look pure phenotypically, some hybrid evidence has been revealed through meristic characters giving this population a purity of C. Further down stream there is a rock barrier according to BLM biologists. Managers can either maintain and monitor the population and the barrier between JQS and the East Fork Parachute, or they can treat with rotenone from the JQS barrier to the lower barrier falls and restock with JQS cutthroats, thus enlarging the stocking resource.

East Middle Fork Parachute: The habitat here is similar to the above two streams. The population here has a purity rating of C and again, the fish are very abundant. It would be interesting and useful to determine why these streams are so productive, and how they support these large populations of pleuriticus. This population should be either monitored and maintained or replaced with a purer population. A large waterfall exists near the Shale Reserve boundary, isolating the drainage from exotics.

Trappers Creek: This population was located in a series of beaver dams and the Creek above is little more than a trickle. This is a C population also and as such merits protection. According to Marc O'meara, a short section of stream has a high gradient shale bedrock falls that makes upward migration of trout nearly impossible.

Northwater Creek: This creek has habitat similar to JQS Gulch and E. Middle Fk. Parachute, and is extremely productive. One pool approximately 8ft wide and 16 inches deep contained 75-100 trout. This has been the population that was considered an ideal representation of pure pleuriticus (Behnke 1976). This creek is isolated from Trappers Creek and E. Middle Fork Parachute Creek by a barrier falls composed of steep shale bedrock. O'meara also mentions another tall log jam that functions as a barrier on Northwater. This is also recommended as a stocking source.

Battlement Creek: Assessment of habitat was difficult here since the water was quite cloudy (silt). In general, however, the habitat appears marginal at best and management efforts might be better spent elsewhere.

North Fork Wallace Creek: Due to the small size, lack of barriers, silty conditions and access through private property, this creek is considered a poor candidate for management. The landowners (Mr. and Mrs. Dean Knox) ~~mentioned that brook trout were stocked in 1976 and that rainbows were stocked over 15 years ago. Surprisingly~~

mentioned that brook trout were stocked in 1976 and that rainbow were stocked over 15 years ago. Surprisingly there is no hybrid "swarm". Hybridization has obviously occurred (low scale counts, 50% without basibranchial teeth, and variable spotting), yet they are still essentially pleuriticus. No brook trout were ever found and the presence of a barrier is undetermined.

North Fork Thompson Creek: This creek was very silty, but it contains a healthy, reproducing population of B purity cutthroats. The trout in this fork and also in the middle fork were beautifully colored. There are frequent pools and a road that parallels the creek provides good access. The cause of siltation is undetermined. Management should be designed to maintain the present population.

Middle Fork Thompson Creek: This creek provides good habitat and lacks the siltation found on the north fork. The reproducing population of C grade pleuriticus should be monitored and maintained and the presence of a barrier should be confirmed.

South Branch Middle Fork Thompson Creek: Although this stream provides fairly good habitat, no reintroduction program should be instituted until the status of barriers is known.

Spruce Creek: This creek flows into Woody Creek, southeast of Aspen. Although the habitat is excellent, with ~~numerous pools and good cover, the stream is barren above where the Woody Creek trail crosses. If a barrier is found or constructed, this would be an ideal~~

numerous pools and good cover, the stream is barren above where the Woody Creek trail crosses. If a barrier is found or constructed, this would be an ideal pure pleuriticus reintroduction site.

Woody Creek: Although the habitat is good here also, the unknown status of a barrier falls and the length of this stream make it a low priority reintroduction area.

Midway Creek: Located south of Independence Pass, in the Hunter-Fryingpan Wilderness, access to this stream involves a five mile hike over Midway Pass. Even though this section is quite isolated, brook trout are the only inhabitants. This makes the presence of a barrier doubtful and thus it is considered a poor candidate for management.

North Fork Crystal River: This stream is in the Snowmass Wilderness Area northeast of Crystal. There are a couple of adequate sets of barrier falls along its length. The habitat in the Love's Cabin area would support a good population though it is presently barren. Further downstream are brook trout, and these should be eradicated if a pleuriticus restoration program is instituted. This stream is highly recommended for that purpose.

Table 4 was compiled to summarize management recommendations for the streams surveyed. First priority should be given to stocking barren waters with pure pleuriticus. Second and third priority actions involve restoration of pleuriticus in streams with some type of barrier and that are overrun with brook trout or other exotic trouts. Further restoration action on streams sampled in 1981 will entail barrier construction and eradication of exotics.

Table 4 . List of sites for introduction of _Salmo clarki_ pleuriticus in Colorado based on 1981 inventory data.

First Priority: Streams that are barren of fish and have natural barriers

Management Action: Stock with pure _Salmo clarki pleuriticus_

Arapaho Creek(Wheeler Basin)
Bruin Creek and upper Difficult Creek
Crystal Creek(above the Mohawk Lake road)
Jim Creek
Spruce Creek(Trib. to Woody Creek)

Second Priority: Streams with a rock barrier over 3 ft and exotic fish species.

Management Action: Treat with rotenone above falls to remove exotics and restock with pure _pleuriticus_

East Fork Parachute Creek
Fish Creek
Game Creek
North Fork Crystal River
South Fork Crystal River
Yule Creek

Third Priority: Streams with a beaver dam barrier and exotic fish species

Management Action: Treat with rotenone above the dam to remove exotics and restock with pure _pleuriticus_

Circle Creek
King Solomon Creek
Stafford Creek

DISCUSSION & CONCLUSION

In general, all 28 populations sampled should be considered as Salmo clarki pleuriticus. Purity grades ranged form A to D, although only two populations could be considered absolutely pure (A+). These two are JQS Gulch, a small tributary to Parachute Creek within the Naval Oil Shale Reserve in Garfield Co., and Cattle Creek, tributary to the Roaring Fork River, Eagle Co. Five other populations with A or A- were discovered. There were also 14 B populations, seven C populations, and one D population (North Fork Wallace Creek).

As evidenced by this report, pure populations of Salmo clarki pleuriticus are indeed rare. Table 5 contains a list of 59 streams and lakes in Colorado with A, B, or C grade pleuriticus. Of these waters presently known to contain pleuriticus, only 23 are relatively pure (A+,A,A- populations). Undoubtedly there are more populations undiscovered as yet, but few remain. Some unsampled lakes may contain pure populations of Trappers Lake stock. However, hybridization with Yellowstone Lake cutthroat, which was commonly stocked in mountain lakes from 1905 to 1955 (Behnke 1979), has often diluted the genetic purity of pleuriticus. Behnke also mentions in last years pleuriticus inventory report that Colorado lakes have had several other stocking sources that have affected purity, such as the Haypress Lake stock, which was a mixture of several subspecies of cutthroat with a slight rainbow influence.

The frailty of the remaining populations has also been evidenced in this project. Trappers Creek, tributary to Parachute Creek, was sampled in 1976 and considered to be relatively pure (Behnke 1976). When it was sampled again in 1981, analysis revealed some hybrid influence as half of the specimens lack basibranchial teeth and spotting was variable.

Northwater Creek, also in the Parachute drainage, was also a pure population despite 1500 rainbow trout that were stocked in 1965 (Behnke 1976). This year's collection contained one fish (120 mm) that lacked basibranchial teeth. The alizarin did not stain well so the small teeth may have been broken off during analysis, if they existed. No teeth were seen, however, so it was recorded as having none. The other characters show the trout to be typical pleuriticus and no other evidence of hybridization can be found and is still considered as an A population.

Both Northwater Creek and Trappers Creek have barriers, yet Trappers Creek has some evidence of hybridization and Northwater is still relatively pure, despite rainbow stocking. It is possible that the barrier that isolates Trappers Creek from E. Middle Fork Parachute Creek is not big enough to stop upstream migration. Another explanation in that Trappers Creek was mistaken for Northwater Creek when rainbow were stocked (Behnke 1976).

What lies in the future for the wild native trout of the Colorado River Basin? Management suggestions have been made for each stream sampled in 1981 and a summary list of introduction and restoration sites is provided in Table 5. There are over 90 streams with history of cutthroat yet to be inventoried, yet many of these contain exotic trouts or have already been taken over by brook trout. Further management activities should follow the guidelines within the "Narrative Task Description" in the *~~Colorado~~ River Cutthroat Trout Recovery Plan*.

Hopefully, the present range of *S. c. pleuriticus* will be expanded to secure pure and productive populations so that *S. c. pleuriticus* will ~~is~~ no longer be threatened with extinction.

Purity	Date of Survey	Water
B+	1980	Deadman Gulch
		Indian Creek
		Luna Lake
		Mandall Creek
		Polk Creek
	1981	Cataract Creek
		Express Creek
		Lake 10794
B	1980	Lake Diana
		Little Skinny Fish Lake
		Pitkin Creek
		Porcupine Lake
	1981	Arapahoe Creek
		Avalanche Lake
		Columbine Creek
		Crystal Creek?
		Difficult Creek
		N. Fk. Elliot Creek
		N. Fk. Thompson Creek
		Spruce Creek
B-	1980	Lake of the Crags
		E. Fk. Red Dirt Creek
		W. Fk. Red Dirt Creek
	1981	First Creek

Purity	Date of Survey	Water
C+	1981	Middle Fk. Thompson Creek
		E. Fk. Parachute Creek
		Yule Creek
C	1980	Carter Lake
		Lost Creek
		Lost Dog Creek
		Possum Creek
	1981	Big Park Creek
		E. Middle Fk. Parachute Cr
		Roaring Fork Creek
		Trappers Creek
D	1981	N. Fk. Wallace Creek

The long term goal of this project is to locate and protect pure populations of S. c. pleuriticus where they exist, reintroduce them into their native waters where they have been replaced or gentically diluted by exotic salmonids, and eventually remove them from the Colorado state threatened species list. Although only two populations are considered to be "wholly pure" by Behnke (Behnke et.al. 1976), he considers Trappers Lake cutthroat to be "virtually pure". Trappers Lake cutthroat were exposed to S. c. boweri from 1948-1952. (Sealing 1980), yet they appear by every meristic character analysis to have retained their purity. In 1931, prior to any contamination with any exotic salmonids, Trappers Lake fish were stocked in Williamson Lakes, California, which was barren at the time. Descendants of these fish are morphologically and meristically identical to present day Trappers Lake cutthroats, indicating that Trappers Lake S. c. pleuriticus remain genotypically pure in spite of their exposure to Yellowstone cutthroats (Gold et.al. 1978). These same fish have been stocked by the Colorado Division of Wildlife in many high lakes and streams since 1951, and therefore these waters may also contain meristically pure S. c. pleuriticus. Hopefully, other populations besides those originating from Trappers Lake can be found and used as spawn stock, thereby increasing the genetic diversity of stocked cutthroat beyond the single population of S. c. pleuriticus now used by the Division of Wildlife.

Since morphologic characters such as spotting patterns and coloration are inadequate determinants of genetic purity (Legendre 1972, Wernsman 1973), no attempt will be made to describe these characters in fish taken. This will eliminate premature speculation on the value of populations sampled, and will hopefully prevent introduction of a bias in the determination of meristic characters. Below is a discussion of various physical aspect and streams and lakes sampled, including recommendations for possible restoration of S. c. pleuriticus into specific waters.

Lakes

Big Creek Lake: Although two gill nets were set here for three hours during the day, the three fish obtained were taken by angling. A very slow outlet and lack of a distinct inlet coupled with the uniform 16 inch size of fish taken suggests that stocked Trappers Lake cutthroats are unable to reporduce here, eliminating Big Creek Lake as a likely candidate for introduction of a non-Trappers Lake gene pool.

Bowen Lake: This lake was extremely overpopulated with small brook trout, was quite shallow, and is considered a poor candidate for stocking.

Brady Lake: Two nets were set in Brady Lake overnight in a full moon and yielded no fish, although, cutthroat trout have been stocked and reported on previous high lake surveys. Several small cutthroats were taken by angling, and resampling in 1981 is recommended. An identical situation occurs with Sopris Lake, which was sampled unsuccessfully the same night.

Crater Lake: Crater Lake, in spite of reported natives, yielded no fish and gill nets pulled after ten hours contained scores of aquatic amphibians. The lake is quite shallow and silty, and is not considered to be good *S. c. pleuriticus* habitat.

Carter Lake: Carter Lake yielded 25 natives ranging from three inches to 15 inches, possesses an excellent inlet and outlet, and is fairly remote in terms of access. However, gill nets also yielded one 20 inch rainbow, although there are no records indicating stocked rainbows. Upstream migration from the Frying Pan River is impossible due to numerous natural barriers and a diversion. Upper Carter Creek is barren of fish above a barrier falls found 0.25 of a mile upstream from the lake, and the entire drainage is considered an excellent candidate for removal of existing fish and reintroduction of pure *S. c. pleuriticus*.

Fishhawk Lake: This lake yielded only brook trout, in spite of reports on previous surveys of cutthroat trout. The banks are extremely overgrown, muddy, and crowded with downed timber. These considerations, coupled with the relative ease of upstream and downstream migration, make it a poor choice for reintroduction. This recommendation also applies to Snowstorm Lake, located 0.50 mile upstream. Lake Margaret, located 1.00 mile upstream from Fishhawk Lake, and at the head of the drainage, produced several age groups of cutthroat trout upon angling, and should be sampled with gill nets in 1981. If the cutthroat trout present are still pure Trappers Lake fish, an artificial barrier should be constructed to prevent contamination of the lake by brook trout from below.

Frying Pan Lakes: The second and third lakes of this chain were sampled and produced a variety of size of cutthroats, indicating good reproduction in the 0.25 mile stream which connects them. Both lakes are surrounded by excellent riparian habitat and are excellent choices for preservation of Trappers Lake fish stocked in 1959. No barrier falls was noted in the Frying Pan River leading from them, and the construction of one should be considered.

Hack Lake: Hack Lake was surveyed with Bureau of Land Management personnel and yielded cutthroats ranging from four inches to 18 inches. The lake has no outlet, but is fed by an ample spring which apparently allows reproduction. Its small size and isolation lend Hack Lake as an excellent location for a population of pure *S. c. pleuriticus* should the fish taken prove meristically unsatisfactory.

Independence Lake: Three gill nets produced only eight large brook trout. This headwater lake has a good outlet capable of supporting spawning activity, with several barrier falls below it. It is recommended that existing brook trout be eradicated and a pure, non-Trappers Lake population of *S. c. pleuriticus* be introduced.

Lake of the Crags: This lake produced 11 cutthroats ranging from five inches to 11 inches which, if found hybridized, should be replaced with a pure strain of S. c. pleuriticus. Upstream migration from Luna Lake is impossible, and water flowing into the lake is from springs and year-round snow melt. The outlet is adequate for spawning and the lake is considered to provide excellent cutthroat habitat.

Lake Diana: Lake Diana produced 20 natives from three inches to 14 inches and fish were observed spawning at the time of sampling. The nets also produced one 25 inch lake trout. Several barrier falls exist below this lake, which is located at the headwaters of its drainage. It provides excellent cutthroat habitat, and should be managed as such if the Trappers Lake pleuriticus stocked are no longer pure.

Lake Margaret: See Fishhawk Lake.

Little Skinny Fish Lake: This headwater lake produced cutthroats ranging from six inches to 15 inches, has a good outlet for spawning, and is considered excellent pleuriticus habitat. There is a seven foot barrier falls downstream from the outlet which prevents upstream migration of rainbows from Skinny Fish Lake.

Luna Lake: Luna Lake produced a variety of age classes of cutthroat and both the inlet and outlet provide good spawning grounds. The lake, however, drains a large area and is fed by numerous streams; if the trout found are impure a restoration program is therefore not recommended.

Paradise Lakes #1-3: These lakes produced only one cutthroat in spite of a total of four gill nets left for 17 hours. They did, however, yield a large number of brook trout. Lake #1 is in a separate drainage from Lake #2, as are Lakes #3 and #4. Lake #1 has no good spawning water, but Lake #2, the largest, is isolated by several barrier falls downstream and the outlet is adequate for spawning. It is recommended that the brook trout present in Lake #2 be eradicated and replaced with pure S. c. pleuriticus, while the fish in Lakes #1 and #3 be left alone. Lake #3 was not sampled.

Porcupine Lake: This headwater lake produced several age classes of fish, is quite isolated, and contains a good outlet for spawning. Porcupine Creek has a barrier falls 0.75 of a mile below the lake and above its confluence with Elbert Creek. The lake is a prime candidate for restoration if meristic analysis reveals anything other than pure S. c. pleuriticus.

Skinny Fish Lake: This man-made lake produced both cutthroat and rainbow trout; a sample of the cutthroats was preserved in spite of this. In the likely event that these fish are found to be hybrids, it is recommended that the lake's population be eradicated and replaced with pure S. c. pleuriticus, as a barrier falls exists below the lake. This of course assumes the purity of fish in Little Skinny Fish Lake, which could potentially provide natural stocking of Skinny Fish Lake below it.

Snowstorm Lake: See Fishhawk Lake.

Sopris Lake: See Brady Lake.

Streams

Abrams Creek: This stream was sampled on Bureau of Land Management property with Bureau of Land Management personnel. Although there was considerable bank erosion from livestock, the stream was well shaded and contained a good age distribution of cutthroats. No barrier falls was noted, and the stream is not considered prime habitat for S. c. pleuriticus unless those fish taken are determined to be pure.

Carter Creek: Carter Creek above Carter Lake provides an excellent habitat for cutthroat trout, but was found to be barren of fish. It is deep with good shade, deep pools, and undercut banks. A massive barrier falls exists 0.25 miles above lower Carter Lake, and, pending a lake survey of the upper Carter Lakes, would be a prime location for stocking a non-Trappers Lake strain of S. c. pleuriticus. Barrier falls also exist below lower Carter Lake, but the presence of rainbow trout in Carter Lake eliminates cutthroats there as a good source of S. c. pleuriticus.

Corral Creek: Although a sample of natives was obtained from Corral Creek, its small size and significant disturbance from the construction of I-70 over Vail Pass make it a poor choice for the introduction of S. c. pleuriticus in the event that the sample reveals hybridization. The fish taken are reproducing; however, the upper section of the stream is fairly isolated and its small size may have spared it from previous stocking.

Deadman Gulch: This stream was the smallest sampled (0.2 cfs) yet it yielded cutthroats ranging from one inch to eight inches in surprisingly large numbers. The trickle is heavily shaded with willows and contains several deep pools. Although not a likely candidate for restoration of S. c. pleuriticus due to its small size, the fish taken may prove to be good specimens due to the inconspicuous nature of the stream and the unlikelihood of its being stocked even prior to 1951.

Elk River, North Fork of: This sizable stream was sampled in two locations based on the presence of a 100 foot barrier falls above Diamond Park in the Zirkel Wilderness area. Rainbow, brown, brook, and cutthroat trout were taken below this falls, and while the lower section of the stream provides excellent cutthroat habitat, eradication of these exotics is not recommended due to the likelihood of upstream migration from the main Elk River. Furthermore, this water provides an excellent fishery for exotics and is relatively accessible to fishermen. The stream above the aforementioned barrier falls was surveyed and found barren of fish in 1976, and was subsequently stocked with Trappers Lake cutthroats. These fish were surveyed by angling for this study, and appear to be reproducing based on the nine inch variation in size between the three fish taken. It is excellent habitat and could either be left with Trappers Lake fish, or restocked with a new strain of _S_. _c_. _pleuriticus_. It is recommended that an adequate sample for meristic analysis be obtained by electroshocking in 1981 to confirm the purity of the fish in question.

Fawn Creek: This stream contains good _S_. _c_. _pleuriticus_ habitat, and the cutthroats present showed good evidence of reproduction. No barrier falls was noted, but the stream is a good candidate for reintroduction if fish taken are hybridized, as is likely the case based on records which reveal stocking of rainbow fry in 1954. The stream was, however, sampled near the headwaters and perhaps rainbow influence has _not_ permeated that far upstream.

Fourmile Creek: This extremely small stream contained rainbow trout, and after sampling it was discovered that rainbows were stocked in 1965. It is a poor candidate for any management program due to its small size.

Frying Pan River: This stream was surprisingly unproductive, possibly due to the intense fishing pressure it receives. Both the north and south forks were sampled well above their diversions, yet only the south fork yielded natives and these were very few in number. Brook trout dominated the upper stretches of river to within two miles of Frying Pan Lakes. Due to its size, length, and lack of barrier falls, it is considered a poor candidate for reintroduction of _S_. _c_. _pleuriticus_.

Hahn Creek: This headwater stream was highly productive and yielded a variety of age groups. It is a good candidate for reintroduction of native cutthroats if those found are hybridized.

Hat Creek: This stream provides excellent habitat for its existing population of natives, with a good meander, deep pools, log jams, and good riparian habitat. It will be seriously impacted by the development of the Adams Rib Ski Area, and therefore special attention should be paid to the results of meristic analysis on this stream. Fish were taken from two inches to 13 inches and hence represent a viable, reproducing population with no history of stocking.

Indian Creek: This stream revealed a healthy, reproducing population of cutthroats within 1.00 mile of its headwaters. The stream is densely shaded by willows, being only occasionally visible where it widens into deep pools. No barrier falls was seen between its headwaters and confluence with Red Sandstone Creek, and it is not a likely candidate for any restoration program due to its small size. Like Deadman Gulch and Hat Creek, however, it is unlikely that the stream has been stocked, and meristic evaluation could prove it to be a valuable source of S. c. pleuriticus.

Lost Creek: Although this stream produced a variety of age classes and was productive, the presence of suckers and sculpin indicate movement of fish upstream from the White River. If an artificial barrier is constructed, it is considered a fair choice for reintroduction.

Lost Dog Creek: This stream exhibited classical upstream speciation, with abundant brook trout in the lower waters and mainly cutthroat trout in the upper stretches. The stream is fishable with good pools and shady banks, and is a good candidate for restoration of S. c. pleuriticus, pending results of meristic analysis on the existing population. The stream is steep and it is likely a barrier falls exists before its confluence with the Elk River but none was noted in the short sections sampled for this study.

Lost Trail Creek: Both Lost Trail Creek and the north fork of Lost Trail Creek are considered poor choices for a restoration program. They are extremely swift, straight streams, and offer very little suitable habitat for *S. c. pleuriticus* in the sections sampled. Although six fish were taken, they were widely dispersed and showed very little variation in size. No fish were found in the north fork near its confluence, although perhaps near its headwaters the stream is more hospitable. A seven foot barrier falls is found just upstream from the Colorado Outward Bound School.

Mad Creek, North Fork of: This stream was sampled below Luna Lake and serves as an excellent spawning grounds for it. No barrier falls exists for at least 0.75 miles below Luna Lake. The stream should be considered in conjunction with any management program involving Luna Lake, neither of which is considered a high priority.

Mandall Creek: This stream was sampled 1.00 mile below Black Mandall Lake, which was not surveyed. It provides excellent cover and is easily fishable. Pending a survey of the Mandall Lakes and the results of meristic analysis on stream fish, this system of lakes and Mandall Creek provide an excellent candidate for a restoration program.

Meadow and East Meadow Creek: Although East Meadow Creek yielded a sample of natives, they were present in extremely low numbers and showed little age distribution. Meadow Creek produced no fish in 100 yards of shocking. Before any restoration attempt is made on either of these streams, the cause of such low numbers of fish in what appears to be excellent cutthroat habitat should be investigated. They are both considered low priority.

Miller Creek: Miller Creek yielded a good population of cutthroats with considerable size distribution. Although small, the stream is well shaded and has many deep pools and log jams. It is not easily fishable and therefore should receive only moderate priority for restoration if the existing population is hybridized. A six foot barrier falls was located below the sample site.

Mitchell Creek: This stream has a steep gradient with deep pools and numerous barrier falls. Cutthroats were taken from two inches to eight inches, and brook trout were abundant. It is an excellent choice for eradication and reintroduction due to controlled access through the Glenwood Springs fish hatchery.

Nickelson Creek: The headwaters of Nickelson Creek consist largely of beaver ponds located in cow pastures on private property. The sample taken should be considered statistically with the two fish taken by Hickman (1979) which he graded "B" on a scale of A to F. It is not a good choice for restoration due to heavy cattle damage and its location on private property.

Nolan Creek: Six fish were taken from Nolan Creek above Fulford, based on findings and recommendations from Hickman's 1978-1979 study. He felt the trout represent a good population of S. c. pleuriticus, and the fish taken in 1980 should be considered with his statistical sample. If found to be hybridized, the stream is a good candidate for restoration. Hickman (1979) reports that Nolan Lake and the stream below to within 1.50 miles of Fulford are barren. This upper section of stream is an excellent candidate for introduction of S. c. pleuriticus, as the stream disappears underground for a short distance 1.50 miles above Fulford, serving as an inpenetrable barrier to upstream or downstream migration.

Piney River, South Fork: This stream was barren within 1.00 mile of its headwaters; no fish were seen despite 150 yards of electroshocking. It would provide excellent S. c. pleuriticus habitat, and is an excellent choice for restoration. A barrier falls in located on the river below its confluence with Pine Creek, which should be surveyed before fish are introduced.

Pitkin Creek: Although small, Pitkin Creek contains excellent pools, good shade, and riffles for spawning. Although it is close to Vail, access is limited to a foot trail, and it is considered a good candidate for restoration of pure S. c. pleuriticus. Any management procedures should be preceded by a survey of Pitkin Lake. A barrier falls protects the stream from upstream migration of exotics from Gore Creek.

Polk Creek: This stream presents a situation identical to that of Miller Creek with the exception that no barrier falls was observed. It is likely that an artificial barrier would have to be constructed if a restoration program were undertaken.

Porcupine Creek: This stream drains Porcupine Lake, and the first 0.75 miles serves as a spawning ground for the lake. It also contains a barrier falls which protects the lake from invasion of brook trout existing below, and should be considered in any management program involving Porcupine Lake.

Possum Creek: This stream has good reproduction of natives, a barrier falls, and deep pools. A pack trail follows the stream which causes some disturbance, and the stream is rated "fair" for restoration work.

Red Dirt Creek, East and West Forks: Both of these streams offer excellent pleuriticus habitat, and yielded cutthroats in a variety of age classes. Several barrier falls exist on the east fork 1.50 miles above its confluence which isolates it from the west fork. A barrier falls exists 2.00 miles below the confluence which isolates both streams from the Colorado River. They are both excellent choices for a cooperative restoration program with the Bureau of Land Management, should the fish taken prove to be hybridized.

Red Sandstone Creek: This stream yielded only one native among numerous exotics and should be left as it is due to its close proximity to Vail, and its considerable length which would make any eradication procedure quite involved.

Resolution Creek: This stream was barren above T6S, R80W, Section 1, and would provide excellent S. c. pleuriticus habitat if a barrier falls were constructed to prohibit upstream migration of brook trout from below.

TAXONOMIC ANALYSES

Cope (1872) first described S. c. pleuriticus on the basis of specimens taken from the Green River basin in Wyoming, the South Platte River and the Yellowstone River. Jordan (1891) applied the name pleuriticus to those cutthroat trout inhabiting the Colorado River basin. The first adequate description of the Colorado River cutthroat trout was published in the work of Behnke and Zarn (1976). S. c. pleuriticus is characterized by high scale counts (170-200$^+$) in the lateral series and above the lateral line (38-48), low pyloric caeca counts (25-45), 17-21 gillrakers, basibranchial teeth present in at least 90 percent of the population (but low in number). The spotting pattern is variable according to geographical locality, and S. c. pleuriticus have a genetic basis to develop brilliant bright red, orange and golden-yellow colors (Behnke and Zarn 1976; Behnke 1978).

The presence of all degrees of hybridization, resulting from introductions of non-native trouts in the Colorado River drainage, renders taxonomic evaluation of pure S. c. pleuriticus populations difficult. Hybridization between various species and subspecies of *Salmo* usually can be detected in populations by analyses of phenotypic and genotypic characters. Hybridization with rainbow trout is usually detected by an absence of basibranchial teeth, lower scale counts, higher pyloric caeca counts and a profusion of spots. Hybridization with non-native cutthroat trout is not usually determined by a single character, rather a combination of meristic characters will usually distinguish *S. c. pleuriticus* from most other subspecies of cutthroat trout.

Morphological measurements were made according to the procedure described by Hubbs and Lagler (1958). Gillrakers were stained with alizarin and counts were made from the first gill arch. Alizarin stain was also used on the basibranchial teeth to facilitate counting, all teeth on the basibranchial plate were counted. Scale counts in the lateral series were made by counting the scales two rows above the lateral line (scale counts of the pored scales are similar in many of the trouts). Pyloric caeca counts were made by pulling every complete tip loose from the intestine. Where applicable, all counts and measurements were made on the left side of the fish.

Results

Table 2 presents data from five selected meristic characters from populations of 30 waters (21 streams, 9 lakes) analyzed in this study. Computer analysis, using Hubbs and Hubbs diagrams (Hickman, 1978), was used to display the data (Figures 1-5) in a more graphic comparison. The diagrams illustrate the mean (centerpoint), 95 percent confidence limits of the mean (outer limits of open rectangle), and sample range (basal line).

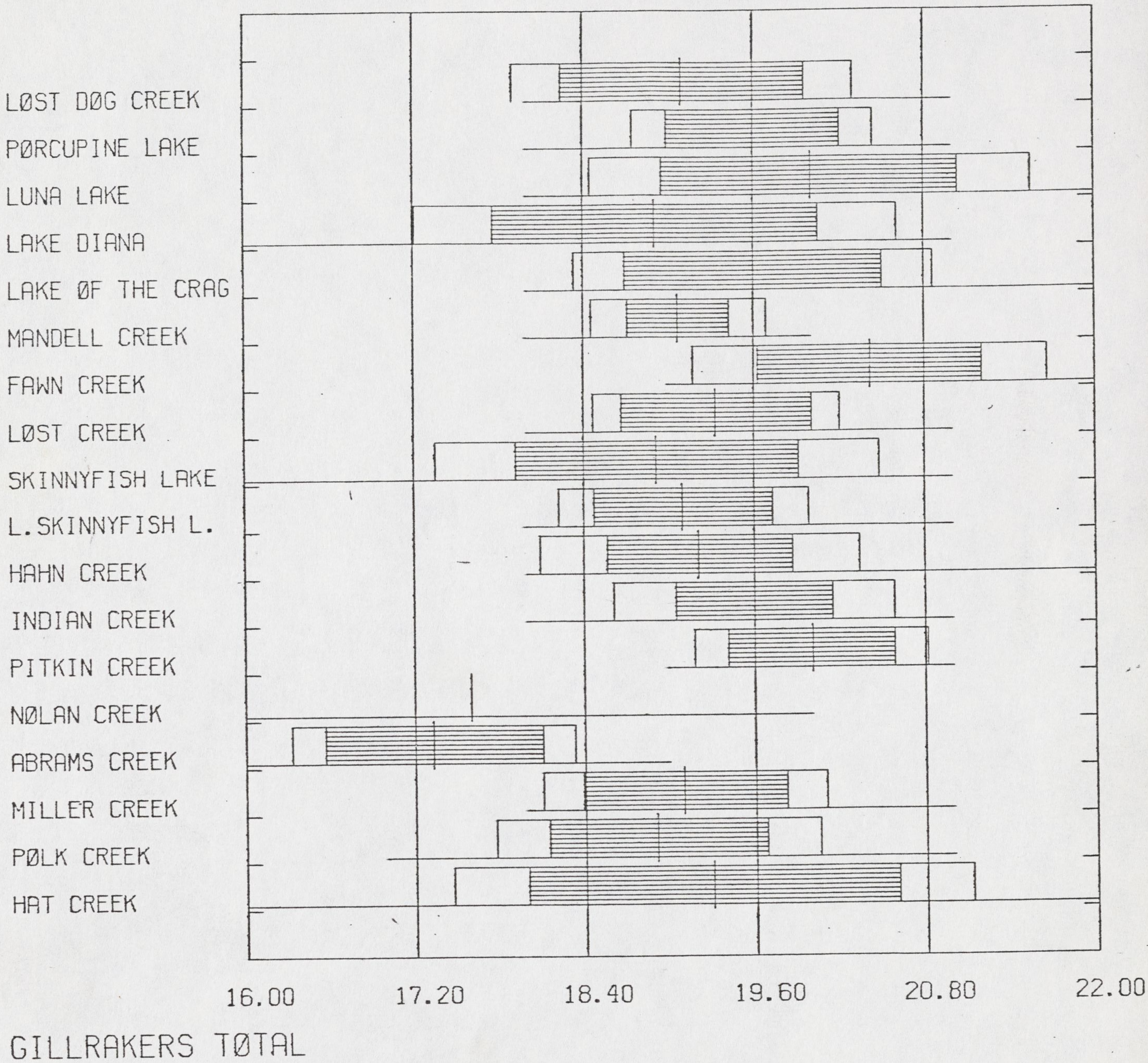

Figure 1. Gillrakers total, Hubbs and Hubbs diagram.

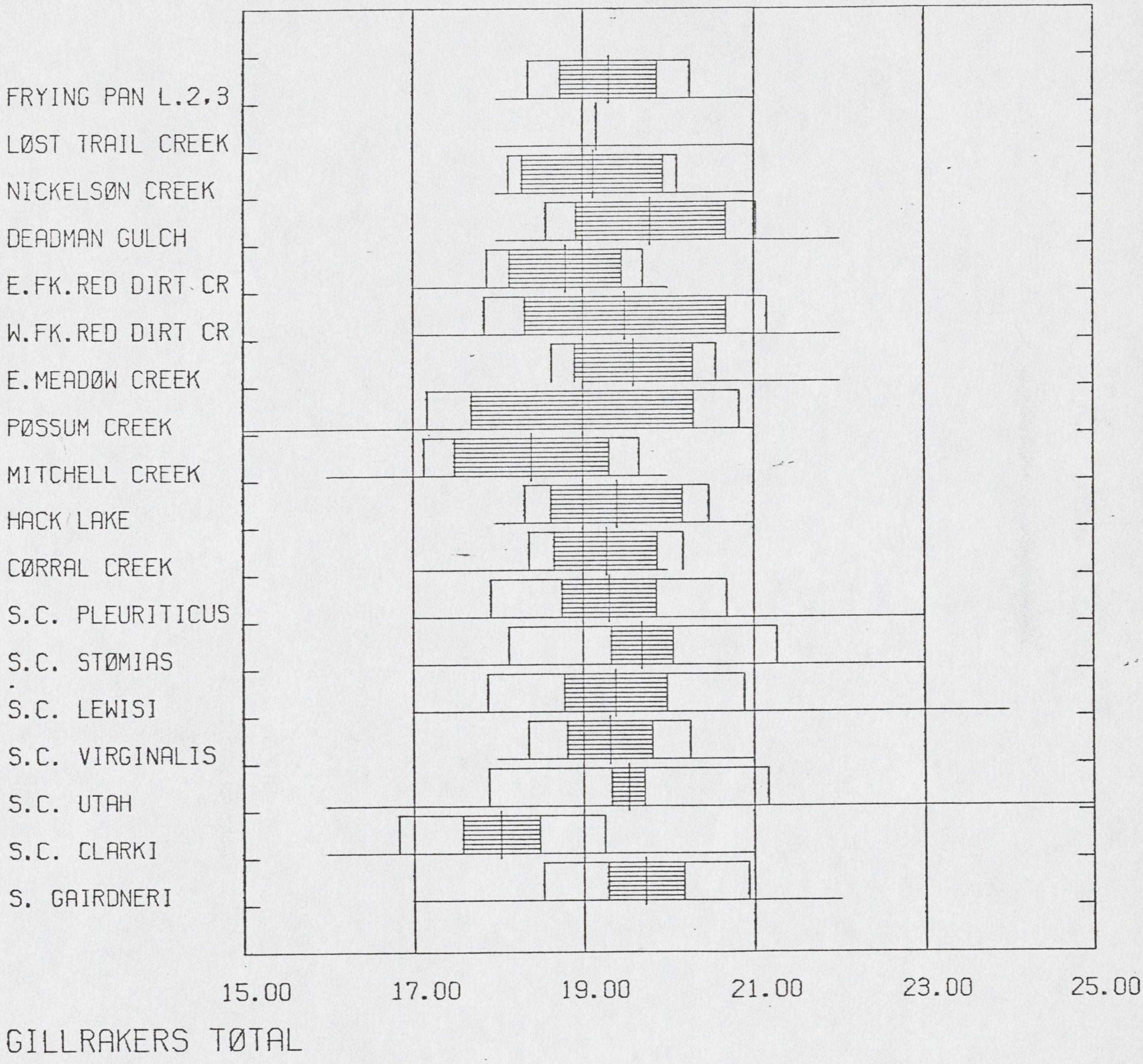

Figure 1a. Gillrakers total, Hubbs and Hubbs diagram.

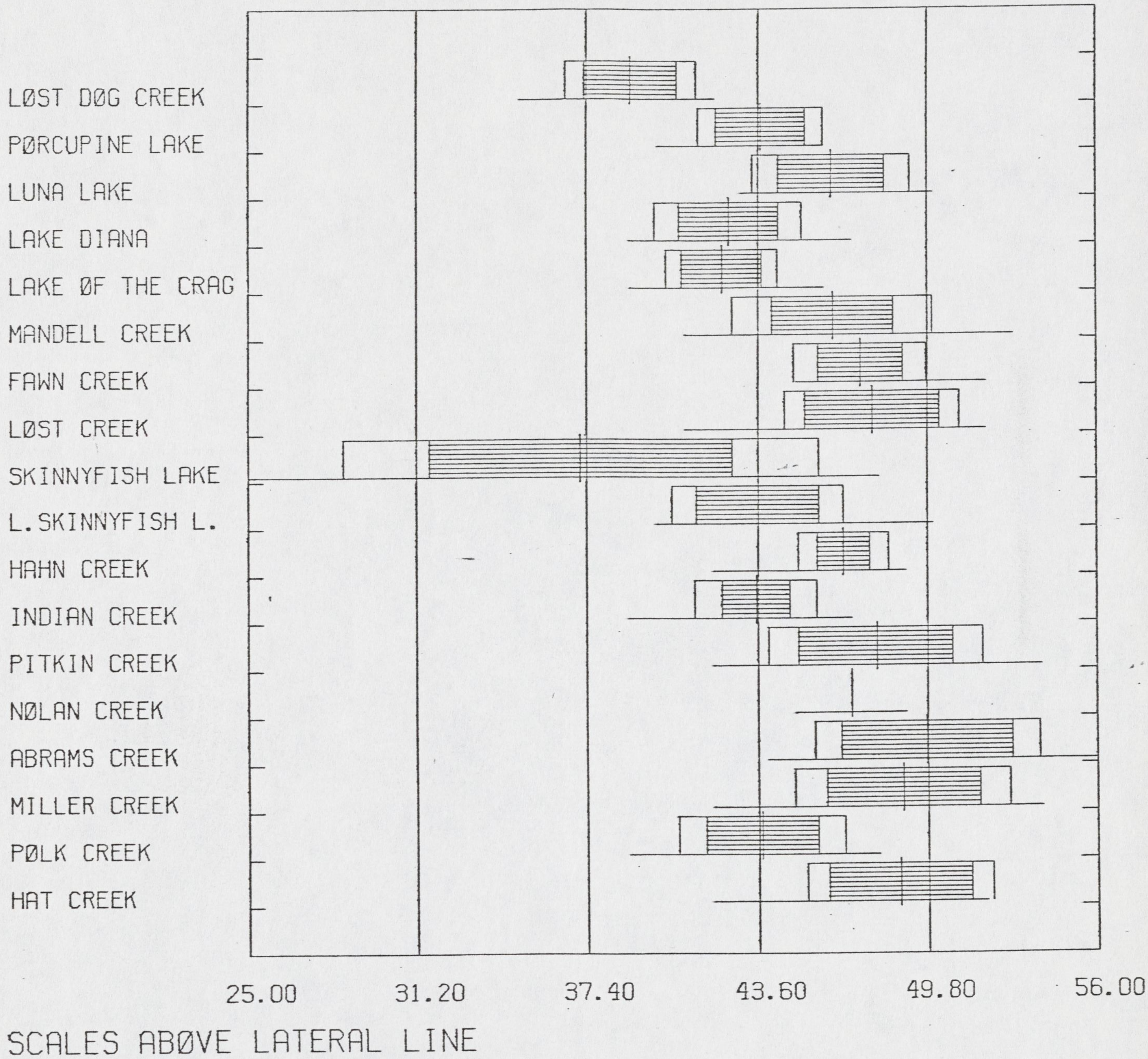

Figure 2. Scales above lateral line, Hubbs and Hubbs diagram.

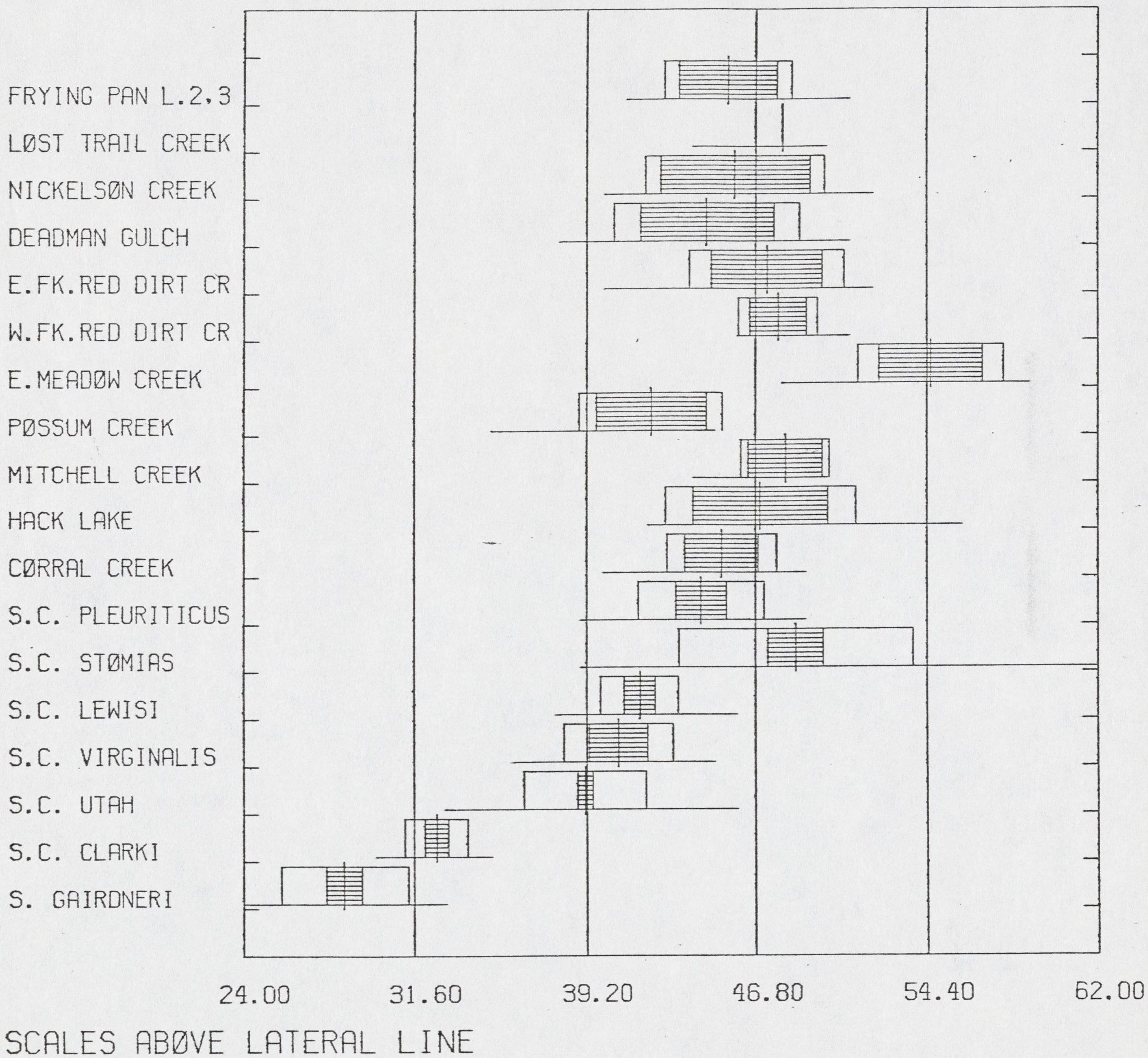

Figure 2a. Scales above lateral line, Hubbs and Hubbs diagram.

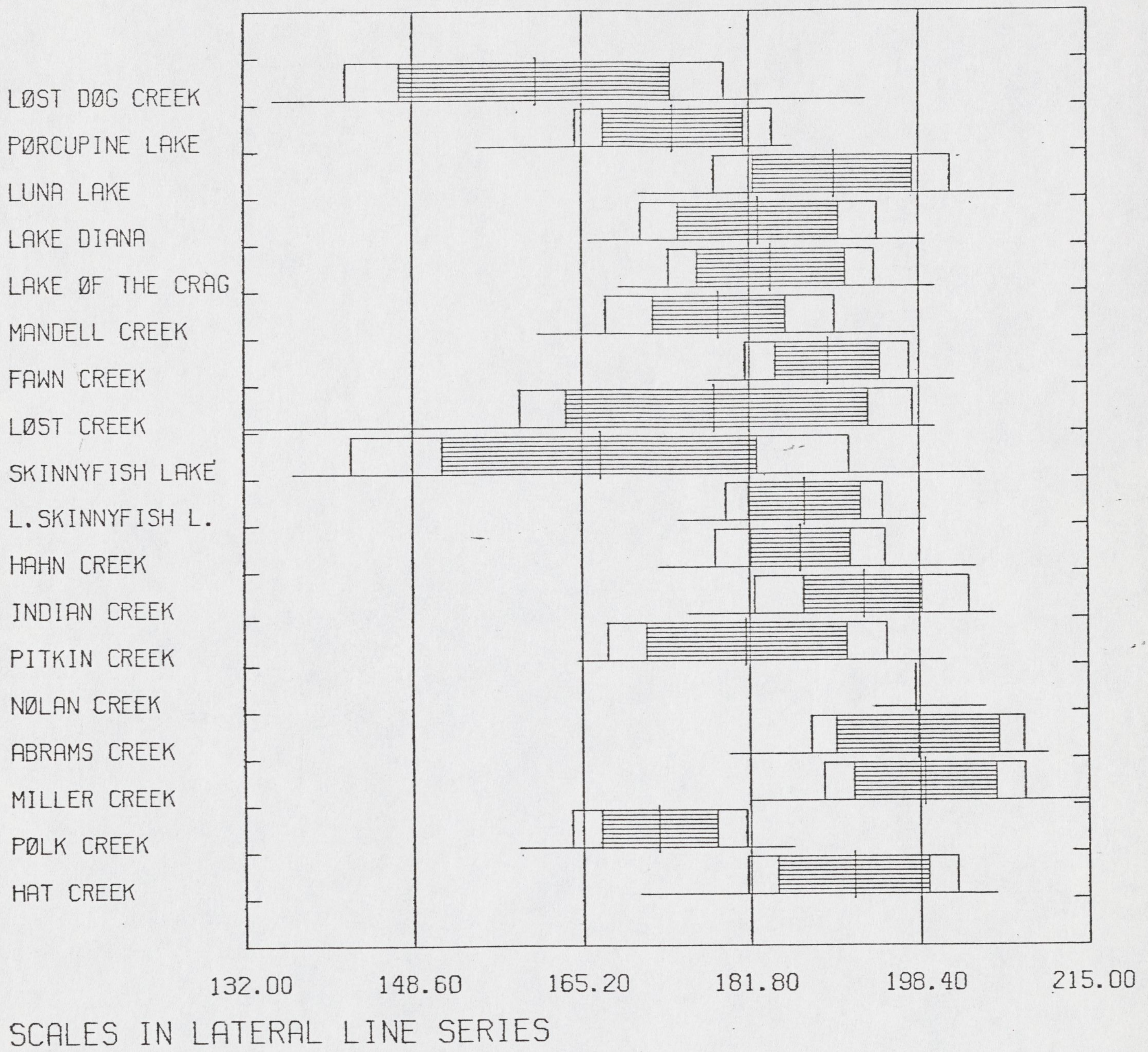

Figure 3. Scales in lateral line series, Hubbs and Hubbs diagram.

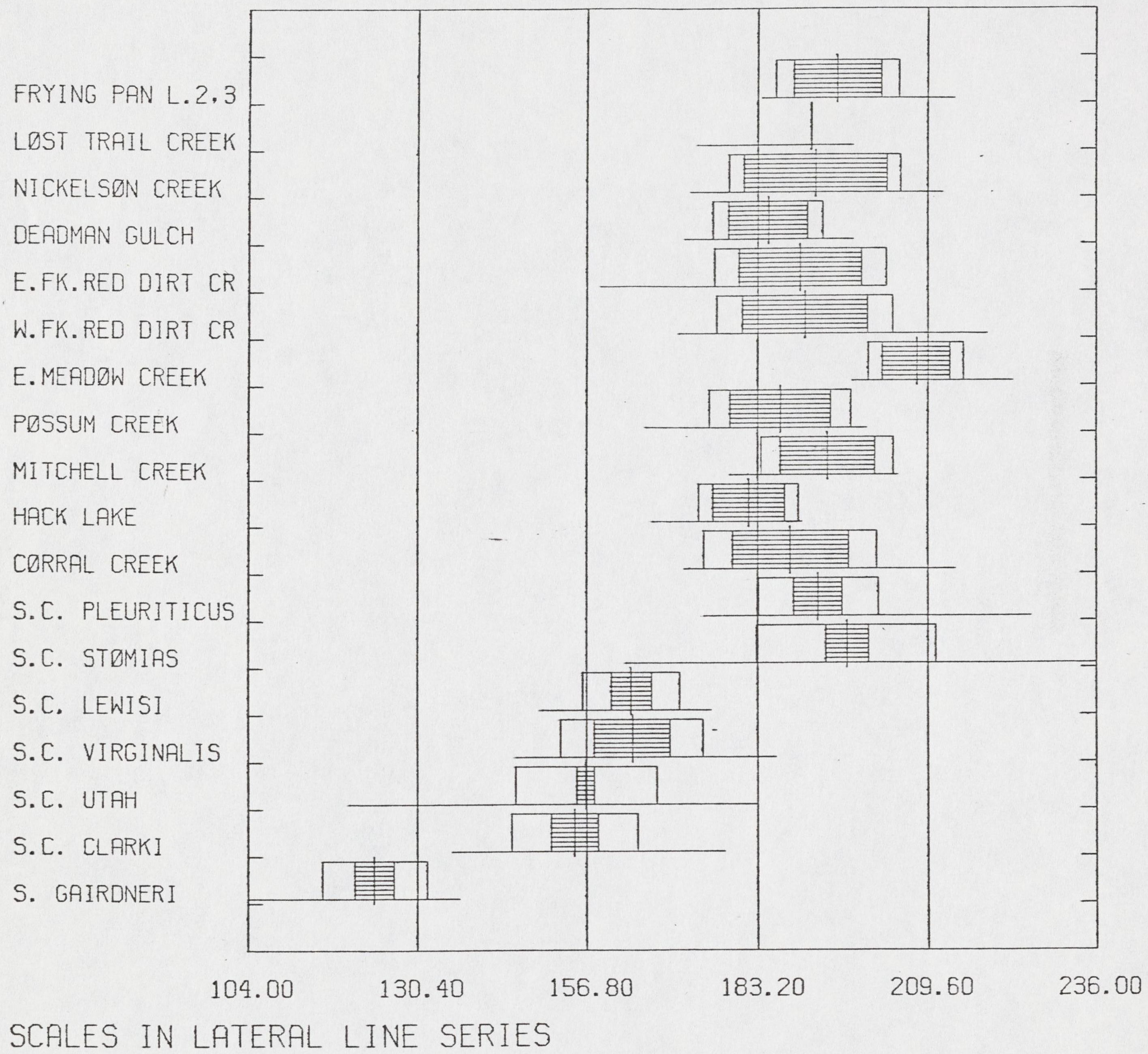

Figure 3a. Scales in lateral line series, Hubbs and Hubbs diagram.

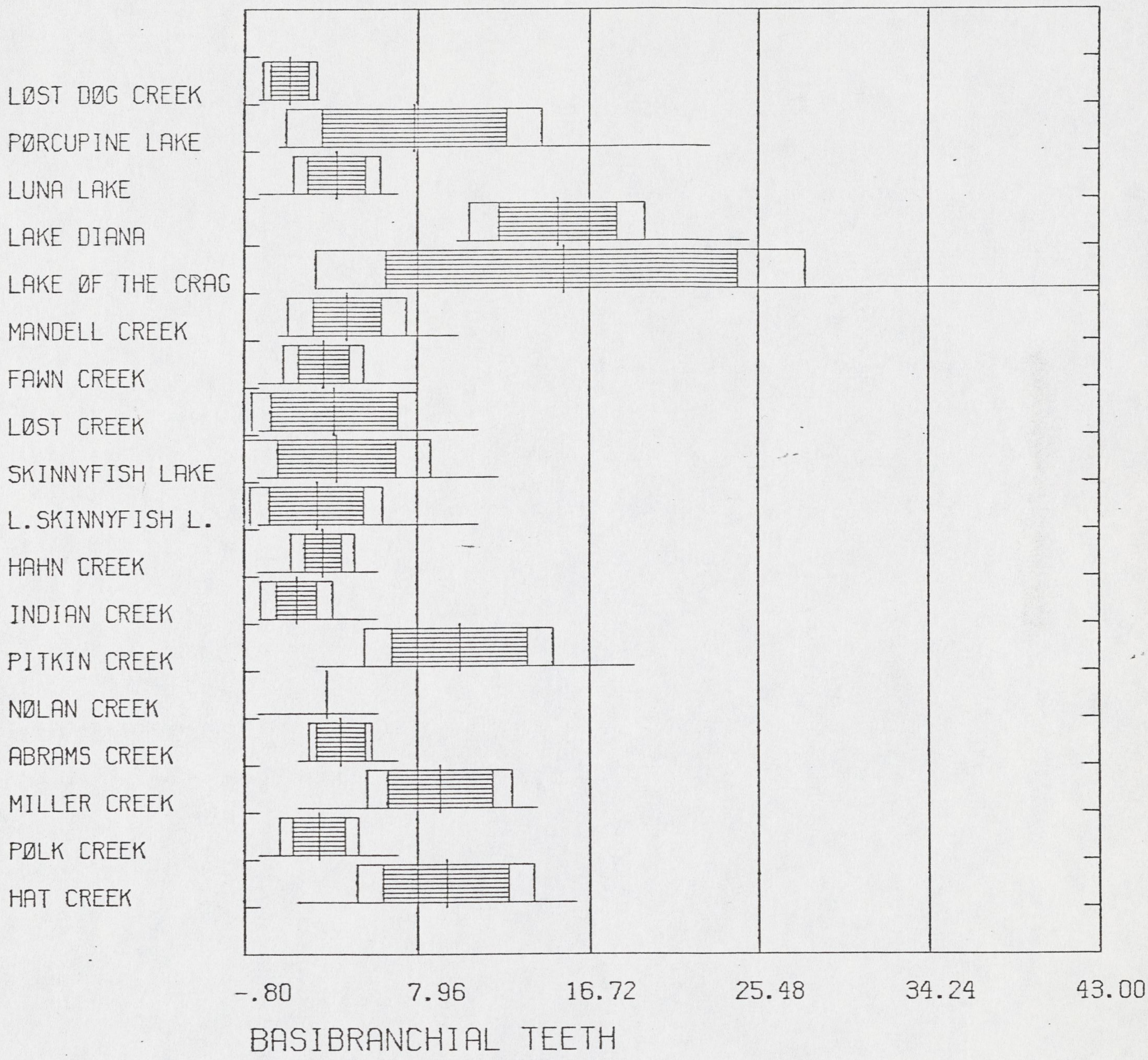

Figure 4. Basibranchial teeth, Hubbs and Hubbs diagram.

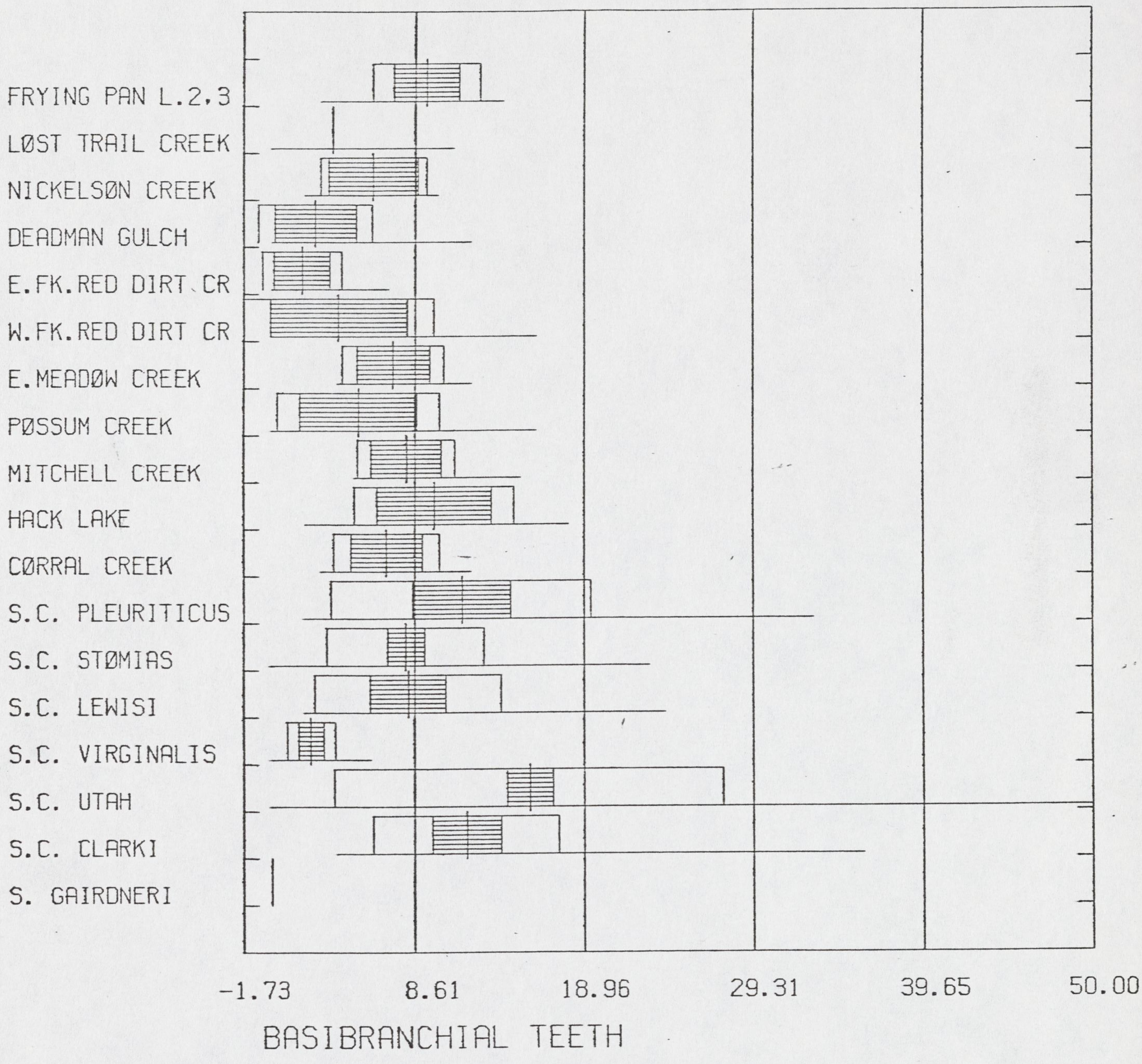

Figure 4a. Basibranchial teeth, Hubbs and Hubbs diagram.

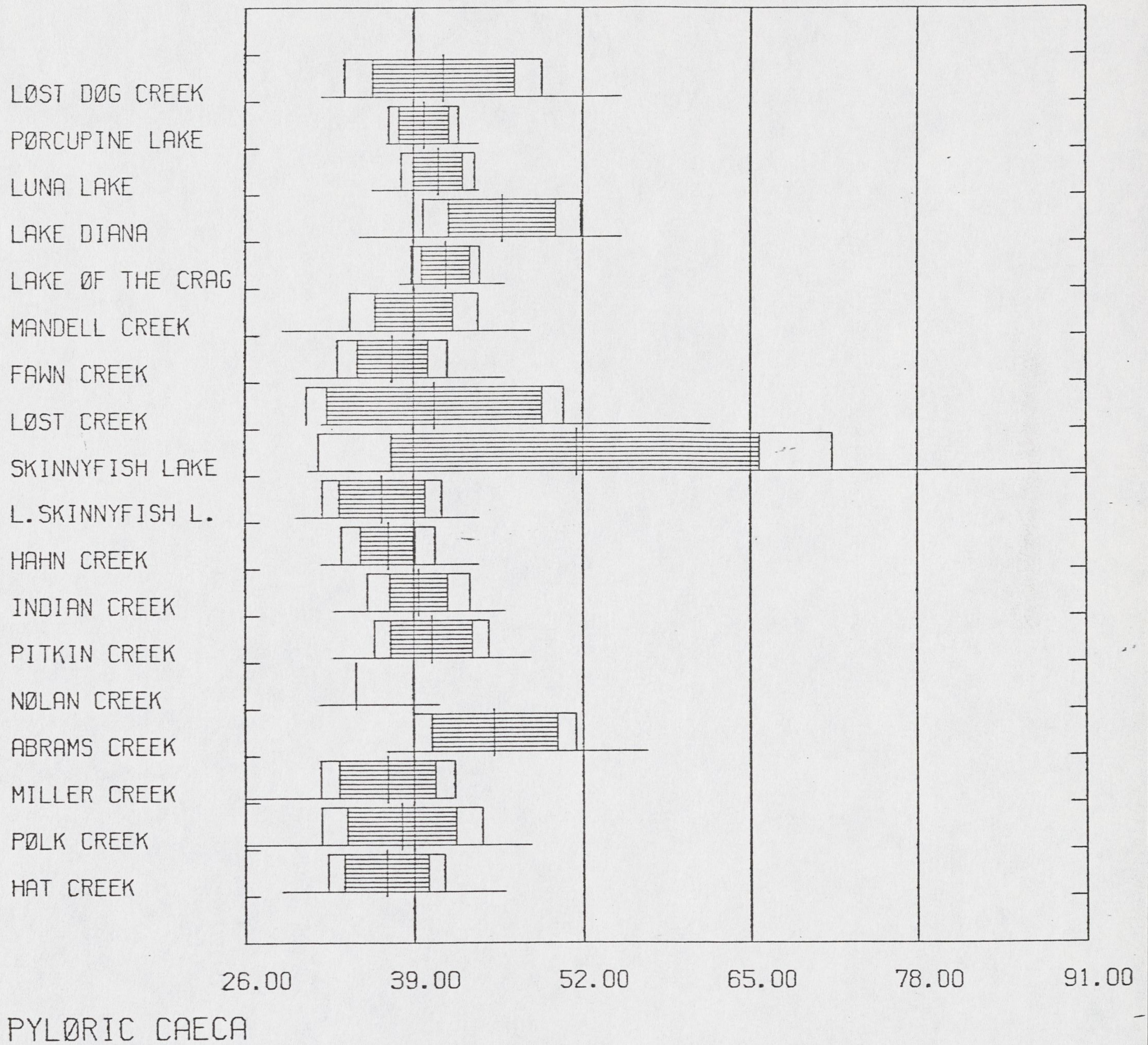

Figure 5. Pyloric caeca, Hubbs and Hubbs diagram.

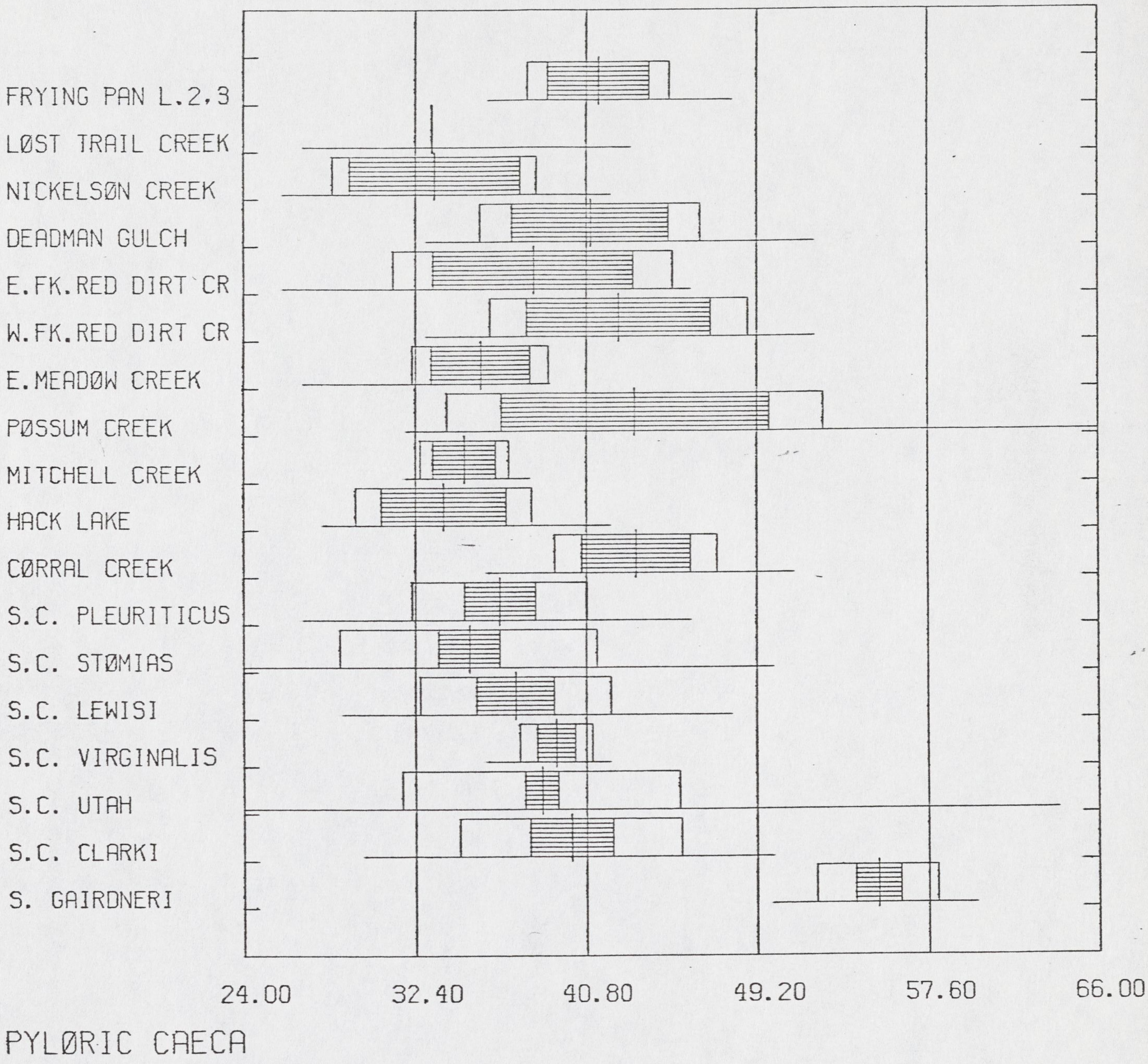

Figure 5a. Pyloric caeca, Hubbs and Hubbs diagram.

Discussion

Behnke (1978) discusses a rating system developed by Binns (1977) to facilitate protection and management of S. c. pleuriticus populations. Since so few pure populations exist and many populations phenotypically represent "good" S. c. pleuriticus, a rating system of "A" (pure) to "F" (obvious hybrids) was developed. Protection would then be given to those populations rated "A" to "C", with only the "A" populations being used for establishing new populations. An "A" rating would be based on collections from isolated streams where the specimens show no indication of hybrid influence. A "B" rating would indicate the population is essentially pure but contains some hybrid influence and/or stocking of non-native trout has occurred in the stream. A "C" rating would be one where the hybrid influence appears obvious from internal examination, but phenotypically they look predominantly like pure cutthroat trout. Genotypically these trout would be about 75 percent pure. The use of this method should avoid previous problems of taxonomic confusion and costly delays in management of threatened and endangered trout.

Based upon the rating system of Binns (1977), Table 3 gives an analysis of the purity of the streams surveyed containing S. c. pleuriticus.

The majority of the samples show some degree of hybridization with either rainbow trout (Salmo gairdneri) or non-native cutthroat trout. Two populations, East Meadow Creek and Mitchell Creek between the barrier falls above the Glenwood Fish Hatchery, show no hybrid influence.

Populations were graded for relative purity, assigning A, B, or C as impurity increased. Every population was predominantly S. c. pleuriticus. Thirteen populations were given an A rating: Fawn Creek and Hahn Creek of the White River Drainage; Nolan Creek, Abrams Creek, Miller Creek, and Hat Creek of the Eagle River Drainage; Lost Trail Creek, Nickelson Creek, and Frying

Pan Lakes #2 and #3, of the Roaring Fork Drainage; East Meadow Creek, Mitchell Creek, and Hack Lake that are tributary to the Colorado River; and Corral Creek which is tributary to the Blue River. None of the Yampa Drainage samples were A populations. The three populations in waters tributary to the Roaring Fork River were all graded as A, although there is some variability in spotting.

Four populations from a variety of drainages were graded C (Lost Dog Creek, Lost Creek, Possum Creek, and Carter Lake). A "C" grade indicates obvious hybridization, although specimens are still mostly pleuriticus.

Hybrid evidence was seen easily enough in this collection, but what pleuriticus has hybridized with is a difficult and complex question. Rainbow trout genes are evident in some populations. Other samples show influence from Yellowstone cutthroat (Salmo clarki bouvieri) and from other non-native cutthroats that have been stocked over the last 100 years. Lakes were stocked continually as a rule. Comparison of the data in this report with stocking records will give a better picture of what genotypes are existing in these streams and lakes.

The following critique of the samples was based on pure pleuriticus taxonomic characters (Behnke and Zarn 1976, Behnke 1979). Single values within the parentheses indicate mean values. All mention of teeth refers to basibranchial ("hyoid") teeth. Populations are arranged by major drainage.

Yampa Drainage

Lost Dog Creek: Lost Dog Creek was given a purity grade of C. Low scale counts (160.7), high caeca counts (41.3), and four of ten specimens lacking teeth indicate hybridization with rainbow trout.

Table 3. Purity of Colorado River cutthroat trout from 1980 collections.

Stream/Lake	Purity
Lost Dog Creek	C
Porcupine Lake	B
Luna Lake	B+
Lake Diana	B
Lake of the Crags	B-
Mandall Creek	B+
Fawn Creek	A-
Lost Creek	C
Little Skinny Fish Lake	B
Hahn Creek	A-
Indian Creek	B+
Pitkin Creek	B
Carter Lake	C
Nolan Creek	A
Abrams Creek	A-
Miller Creek	A
Polk Creek	B+
Hat Creek	A
Frying Pan Lakes #2 and #3	A-
Lost Trail Creek	A-
Nickelson Creek	A-
Deadman Gulch	B+
East Fork Red Dirt Creek	B-
West Fork Red Dirt Creek	B-
East Meadow Creek	A+
Possum Creek	C
Mitchell Creek	A+
Hack Lake	A
Corral Creek	A-

Porcupine Lake: Porcupine Lake was given a purity grade of B. Low scale counts (174.3) indicate possible rainbow genes, but the population is predominantly cutthroat. Spotting patterns indicate influence from Yellowstone cutthroat as well as Trappers Lake cutthroat stock.

Luna Lake: Meristic characters of this population are typical of *pleuriticus*, with only one of ten specimens lacking teeth. Spotting however, was quite variable, indicating hybrid influence from other cutthroat.

Lake Diana: High caeca counts (45.8) show the influence of rainbow genes, but high teeth counts (10-15) in combination with this indicate definite *bouvieri* influence. Scale counts (166-199) are typical of *bouvieri*. Perhaps *bouvieri* were stocked from Haypress Lake.

Lake of the Crags: Characters and spotting of this lake indicate a mixture of cutthroat genes. Scales, caeca, and teeth show *bouvieri* influence. Spotting is variable indicating mixtures of *bouvieri* and Trappers Lake stock with *pleuriticus*.

Colorado River Drainage - Tributary to Eagle River

Indian Creek: Caeca (39.4), gillrakers (19.6), and scale counts (192.8) are all typical of *pleuriticus*, but five of ten fish lacked teeth indicating a rainbow trout influence. Spotting was uniform with spots being relatively large indicating some other cutthroat influence. Since this population is predominantly *pleuriticus* it is given a B+.

Pitkin Creek: Most characters were typical of *pleuriticus* except caeca (40.4) which averaged higher counts than normal. Spotting shows considerable variation between specimens indicating hybridization with non-native cutthroats.

Carter Lake: Total length, standard length and basibranchial teeth were the only characters measured in this population because of the obvious rainbow hybrid spotting. Three fish lacked teeth. This population was graded as C.

Nolan Creek: Most characters are ideal *pleuriticus*, except one of five fish lacked teeth. Spotting also lacks uniformity between specimens. This population was given a doubtful A grade, but a larger sample might show more hybrid influence in the characters, thus lowering its purity grade.

Abrams Creek: Gillraker (17.3), scale (198.2), teeth (4.1) and spotting are all typical *pleuriticus*. Caeca counts ranged 37-57(4a.2) indicating some hybridization. This sample was given an A-.

Miller Creek: All characters are typical of *pleuriticus* and therefore an A grade. The spots, however, are more evenly distributed than typical *pleuriticus* indicating influence from lake adapted cutthroat--possibly Trappers Lake stock.

Polk Creek: Characters are mostly those of *pleuriticus*, although hybrid evidence appears in scales (159-186), spotting pattern, and teeth (one without teeth). This population is predominantly *pleuriticus* and received a B+ purity grade.

Hat Creek: All the meristic characters indicate typical *pleuriticus* and thus an A purity grade. Spotting, however, shows variation. Some are typical *pleuriticus*, some more typical of *stomias*.

Tributary to Roaring Fork River

Frying Pan Lakes #2 and #3: Meristic characters are typical of pleuriticus, although caeca (41.4) were a little high for *pleuriticus*. Spots were relatively large and mostly uniform. Purity grade was an A-.

Lost Trail Creek: Meristic characters here are also typical of *pleuriticus*, although one specimen lacked teeth. Some inconsistencies in spotting indicate hybridization. These fish were given an A- purity grade, but further sampling and examination is recommended.

Nickelson Creek: Meristic characters are typical of pleuriticus, giving a purity grade of A-. Spotting, however, shows considerable variation. Further sampling may show a greater percentage of genetic impurity.

Tributary to Colorado River

Deadman Gulch: Spotting is uniform and typical of *pleuriticus*, although some rainbow influence is found in caeca (33-52) and in the teeth (two of ten without teeth). This population is predominantly *pleuriticus* and given a B+ purity grade.

East Fork of Red Dirt Creek: Spotting indicates a mixture of non-native and *pleuriticus* cutthroat. Rainbow influence is seen in the fact that five of ten specimens lacked teeth, and scale values (159-203) show some low values.

West Fork of Red Dirt Creek: Although scales are typical of *pleuriticus* (190.5), three specimens of ten lacked teeth and caeca values were high (42.4) indicating rainbow influence. Three specimens showed hybrid spotting and seven were more typical of *plueriticus*. Both east and west forks of Red Dirt Creek appear to have been subject to rainbow trout hybridization and both have a B- purity grade.

East Meadow Creek: This population was one of the purest in the collection. Meristic characters and spotting were typical of *pleuriticus*, giving it a A+ purity grade.

Possum Creek: This population has obviously been subject to rainbow hybridization. Caeca ranged as high as 66, scales as low as 166, and one specimen lacked teeth. Spotting and pelvic rays (9.7) also show obvious rainbow trout influence, giving a purity grade of C.

Mitchell Creek: All characters and spotting indicate typical *pleuriticus*, thus an A+ grade.

Hack Lake: Spotting is somewhat variable, with some large sparse spotting indicating *bouvieri* influence. Meristic characters are typical *pleuriticus*, although scale counts (167-190) are closer to typical *bouvieri*. There is some lower anterior spotting indicating rainbow influence, but no rainbow influence is seen in the meristic characters.

Tributary to the Blue River

Corral Creek: Although caeca counts are high (43.3), the spotting pattern is typical of *pleuriticus* and uniform between specimens. This population received an A- purity grade.

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APPENDIX

Statement from R. J. Behnke

These samples are particularly difficult to render valid judgment on degree of purity. This is due to the fact that there is little correlation between the meristic characters and the spotting pattern in contrast to most situations in other areas.

With S. c. pleuriticus in Wyoming, I can readily separate two forms of native trout--one associated with the Upper Green River Drainage and one associated with the headwaters of the Little Snake Drainage (Yampa tributary). There is a pronounced difference in the size of the spots between these two forms of Colorado River cutthroat--thus we know that pleuriticus has considerable variation in its spotting pattern, but, in Wyoming at least, the spotting differences are associated with differenct geographical regions and are quite consistent within the region. In Wyoming samples, a hybrid influence from rainbow trout is frequently found and this influence consistently results in changes in the spotting pattern correlated with changes in meristic characters and loss of basibranchial teeth.

I would assume that 100 years ago, all Colorado River cutthroat in Colorado would have been phenotypically relatively uniform in appearance because of their continuous distribution allowing free interchange. Some differentiation (as in Wyoming) might have occurred between drainages long separated by distance and environment (that is, cutthroat trout could not freely migrate) such as Yampa, White, main Colorado, Dolores, and San Juan Drainages, but any slight differences should be uniform within a drainage.

There is tremendous variation in the spotting pattern of the 1980 collections. Only a few samples are typical of *pleuriticus*. Some appear more typical of *stomias* (very large spots) and most samples show a great range of variation from specimen to specimen, strongly indicating a diversity of parental forms which endowed the present populations with considerable heterogeneity. However, in most of the samples with "hybrid"-like spotting variability, the meristic characters are typical of *pleuriticus*. A great variety of sources were historically used to stock "black-spotted" or "native" trout in Colorado. The former hatchery stock in Haypress Lake was an example of a mixture of several subspecies of cutthroat with a touch of rainbow. I would assume that in those populations exhibiting great variability in spotting, this variability is the result of past introductions of various forms of cutthroat trout of diverse ancestry. Some of the spotting patterns observed are quite distinctive and beautiful. From a practical viewpoint, all of the samples can be classified as *S. c. pleuriticus* because they are more *pleuriticus* than anything else. For introductions into new waters, however, only grade A populations exhibiting the typical *pleuriticus* spotting pattern should be used.

Aug 18, 88 coll. Remmick

R114 T33 S30

Irene Crk. N = 12

- Spotting variable, small, profuse, definite S.R. influence

TL: 87, 144, 138, 124, 152, 180, 170, 184, 185, 217, 187, 182.

one spec. typ. S.R.

	teeth			
7/12 (3) / 19	4	42/161	29	
	6	39/164	34	29-46 (39)
8/12 (0) / 20	3	42/158	41	
	4		43	
7/13 (1) / 20	5	44/174	42	
	4		42	
7/11 (0) / 18	2	42/159		
	4			
9/13 (1) / 22	7	40/157		
	3			
7/12 (2) / 19	4	40/169		
7/12 (3) / 19				
7/13 (0) / 20				
7/12 (0) / 19				
8/12 (4) / 20				
8/12 (3) / 20				

39-44 (41.6)

157-174 (164)

2-7 (4.2)

18-22 (19.7)

12

Stone 86

Irene Crk. - Trib. N. Cottonwood Crk

1980 n B n

18-22

saw at Dubois hatch
for Sweetwater

S. C. Utah   Salt Crk. R119W, T29N, S26
Sept. 6, 1988 – Remmick & Dunning
N=16 TL: 111, 129, 143, 157, 155, 153, 187, 179, 185, 184, 189, 178, 178, 211, 212, 227. rel. bit smaller
spots typical – (slightly more profuse than ex. Raymond Crk. Giraffe Crk) pure
feeble but no obvious patches of S.R. as 1976

	Teeth		
6/13(2)/19	3	39/147	-8
6/12(0)/18	7	41/153	-2
6/12/18	9	44/160	+5
6/12/18	18	41/143	-7
7/12/19	4	40/174	+19
6/12/18	2	40/163	+8
7/13/20	0	44/167	+12
7/11/18	5	39/154	-1
7/12/19	16	43/155	
6/12/18	6	40/158	-18 +3 147
7/12/19, 6/11/17	9		-29
6/12/18, 6/12/18	0		
7/12/19, 6/12/18	6		
8/12/20	7		
	2		
	9		

17	18	19	20	
1	8	5	2	(18.5)

2 no teeth
14 / 2-18 (8.1)
39-44 (40.1)
143-174 (157.9)

calcs
42
41   39-48 (43-44)
39   38-49 (43)
46
47
43
(48

Daniel hatch. stock Utah
large – very sparse spots
Raymond – Giraffe – Crazy
rakers 15-20 (18.2)
34-42 (39)
152-193 (172)
38-54 (46)
5-50 (22)

N=14 1976	88	hatch. stock
18.4 rakers	17-20 (18.5)	– 18.2
40.6 –	39-44 (40)	– 39
163 –	143-174 (158)	– 172
45.6 –	38-49 (43)	– 46
2-12 (4.3)	14 2-18 (8.1)	– 22 5-50
	2 no teeth	

"B" Binns 81

— Rosenlund — ~~Eagle~~ Green R trip L. Chasing camp — [illegible] — — —

— O. [illegible]

— Hallock 1873 Fisher Angler Tourist — Dale Crk. — O. [illegible]

Wyo. — greenbacks — N. Platte

Carbonate Chronicle (Leadville, Co) June 17, 1901.

Trout were stocked in the Big and Little Laramie Rivers by Dr. Finfrock in early 1870's from Dale Creek and spread throughout the drainages by 1880's.

pleuriticus Green R. system

Devil's Hole Crk. R117 T27 S21, Aug. 25, 88

can't locate map in Fontenelle Crk. drainage, no previous coll. from Font. — or mention in Stone, & C, Binn's — — —

sim. Rock Crk. — "A"

N = 10 100 – 263 mm.

rakers 18 - 21 (19.5) 42-48 (45) / 178-196 (186)

29-44 (37), 1-6 (3.2) typical of spotting, pattern

mod. small - post - ant above l.l. — uniform — — no indic. hybrid. —

(Rock Crk.) — — —

Irene Crk. R 114, T 33, S30 Trib. N. Cottonwood

N = 12 87 – 217 mm TL Aug. 18, 88

S.R. hybrids — but only 1 typ. S.R. other more p. smaller profuse all over body

"C" (Sage Crk.) —

18 - 22 (19.7) 39-44 (41.6) / 157-174 (164), 2-7 (4.2),

29-46 (38)

— Stone (86) — "B"

1980 coll. N = 9

15 - 22 (18.8) 36-46 (40.7) 142-184 (165) 1/8 no teeth 8-24 (5.9)

29-48 (36) — prob. "C"

Binns (77) — Green R. westside trib. enclose southernmost — La Barge Crk. — Fontenelle.

Bonneville Bas. — Bear R. dr. — S.C. Utah

Salt Crk. — ...

O. c. pleuriticus Aug. 25, 88

Devil's Hole Crk. R117 T27 S21

Trib. (prob.) Fontenelle Crk. of Green R.

N = 10

TL 210, 263, 242, 233, 215, 150, 113, 100, 103, 116,

spotting pattern – excellent, pure pleuriticus.
*feeble post nalea

18	19	20	21
1	4	4	1 (19.5)

smallest spec.

teeth			
1	8/13 (2/2) 21	45/196	
4	7/12 (2/2) 19	48/183	
2	8/12 (0) 20		178 - 196 (186)
2	7/12 19	44/183	42-48 (45)
4	6/14 (2/2) 20	42/178	
6	7/13 20	45/191	29 - 44 (37)
1	7/13 (2/1) 20		
2	6/13 (0) 19		
6	6/12 (1) 18		
4	6/13 (2) 19		

44
40
34
38

1-6 (3.2)

excellent pleuriticus
* as Rock Crk. LaBarge

Not mentioned Stone 86
No Fontennelle Trib