FISH POPULATION AND YIELD ESTIMATES FROM CALIFORNIA TROUT STREAMS

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Abstract. Fish population estimates were collected by electro fishing and rotenone from 102 coldwater streams within northern Sierra Nevada. A mean late summer standing crop of 41 lbs./acre or 224 adult trout per mile was computed. The mean trout biomass of streams decreased as stream width increased. Stream gradient appears to have an influence on fish species composition. Trout seemed to be most abundant in stream sections with gradients of over 150 feet per mile while nongame species were most abundant in the streams with gradients of less than 100 feet/mile. Brown trout (*Salmo trutta*) dominance occurred most frequently in stream sections with gradients of less than 100 feet/mile.

Meadow streams contained the greatest trout densities while canyon streams had the lowest. Medium gradient forested streams were intermediate in productivity.

Some 46% of the 102 streams sampled contained one or more species of nongame fish. Although populations as great as 400 lbs./acre were encountered, two-thirds of the nongame fish waters contained populations of less than 50 lbs./acre.

Using biomass and yield information developed from typical California streams, the State's 18,000 miles of trout streams could be expected to yield a maximum harvest of about 5 million wild trout annually. Since the estimated catch has approached this level, stream angling for wild trout in California appears to have reached the saturation point.

INTRODUCTION

In order to learn more about trout populations in California trout streams and the factors which influence population size and the potential yield to the angler, late summer fish population estimates were collected from 289 study sections on 102 north Sierra streams which were assumed to be representative of California's coldwater streams.

METHODS

Fish population data in this report were collected by electrofishing or by rotenone from measured stream study sections isolated by block nets. Fish over three inches long were collected, measured and weighed. Planted catchable-sized trout were excluded from the samples. All streams sampled were located within the northern Sierra. Population estimates are based on simple expansion of collected data.

RESULTS

Biomass Estimates

Biomass data from 278 north Sierra stream sections produced a pattern with a mean of 41 lbs./acre (see Table 1).

In terms of cumulative frequency, two-thirds of the stream sections contained trout standing crops smaller than the mean (Figure 1). About a quarter of the sections contained populations greater than 60 lbs./acre.

In Figure 1, standing crop estimates from selected well-known streams are ranked in relation to the cumulative frequency of biomass means obtained from Table 1. For example, biomass means from intensively studied Sagehen Creek, the Little Truckee River and North Fork Mokelumne River are just below the mean for all north Sierra streams while biomass means from Silver King Creek, Hat Creek and Forest Creek (Calaveras Co.) are well above average. Trout populations from Indian and Spanish Creeks (Plumas Co.) and the South Yuba River, on the other hand, are well below average. A chart like this can be used to grade any study stream in relation to others.

The 41 pounds per acre mean computed for north Sierra streams is fairly comparable to trout biomass means from other portions of the state. For example, 65 test sections from south Sierra streams possessed a mean standing crop of 37 lbs./acre while a mean of 40 lbs./acre was computed for 22 coastal streams. In contrast to this, many of the more intensively studied Rocky Mountain and eastern streams contained much greater trout standing crops, frequently over 60 lbs./acre (Carlander 1953).

With respect to numbers of catchable-sized or adult trout per mile (fish over six inches), the frequency distribution was obtained from 280 study sections (see Table 2).

A mean of 224 adult trout per mile was computed from 280 stream sections. Half of these sections contained populations of from 100 to 400 adult trout per mile.

Some 17% of the streams contained more than 400 adult trout per mile, while only 2% contained populations of greater than 800 adult trout per mile.

Relationship of Standing Crop to Stream Width

Rounsefell (1946) demonstrated a negative correlation between the area of a lake and the standing crop. The same relationship appears to apply to streams, as Table 3 suggests.

As might be expected, numbers of adult trout per mile increase with stream width, though to a much lessor degree than one might anticipate.

Although ratio of edge habitat to surface area undoubtedly is a major factor in determining the pattern shown in the above table, there is another equally important factor. As Table 5 suggests, a large proportion of the biomass in small streams where recruitment is usually substantial is comprised of trout too small to be available to the angler while in larger streams where recruitment of small trout is usually less or lacking a much higher proportion of the biomass consists of catchable-sized trout vulnerable to removal by angling. Recruitment of trout in larger streams often originates as "drift down" of yearling trout from smaller tributaries. As a result, a much greater percentage of the trout biomass in a large stream may be removed by angling thus accounting in part for low end-of-season standing crops.

Affects of Stream Gradient on Fish Populations

An attempt was made to determine if there is any relationship between stream gradient and trout abundance.

Interestingly enough, stream sections with gradients greater than 150 feet per mile contained on the average twice as many trout (by weight) as stream sections with lesser gradients. Lower gradient streams are often characterized by higher water temperatures, competing nongame fish, greater silt accumulations and more man-made alterations.

Some 75% of the sections containing nongame fish had gradients of less than 100 feet/mile, but only few such fish were found in sections with gradients exceeding 160 ft./mile.

Gradient, as Table 6 suggests, does seem to have a very noticeable influence on brown trout dominance (that is, more than 50% by number). Brown trout occurred in 52% of the 274 stream sections studied and were dominant in 40% of these sections. Brown trout dominance occurred most frequently in sections with gradients less than 100 feet per mile although this species was observed in sections with gradients as great as 400 ft./mile.

Influence of Physical Factors

Study sections from unaltered northern Sierra streams were divided into three classes and produced a pattern as noted in Table 7.

These data indicate that study sections within meadow areas were most productive while canyon type study sections were least productive. Stream sections from forested flats appeared to be intermediate in productiveness. Streams from the east slope of the Sierra contained slightly larger trout densities (54 lbs./acre) than west slope streams (48 lbs./acre). However, the fact that a larger percentage of the east slope streams selected for study were situated in meadows may account for this difference.

Because so many meadow streams have been altered by bank erosion and channelization, the mean biomass of 48 lbs./acre is substantially smaller than the mean biomass for unaltered meadow streams. Stable meadow sections, for example, contained mean standing crops of 101 lbs./acre while unstable or altered meadow streams contained mean populations of only 24 lbs./acre.

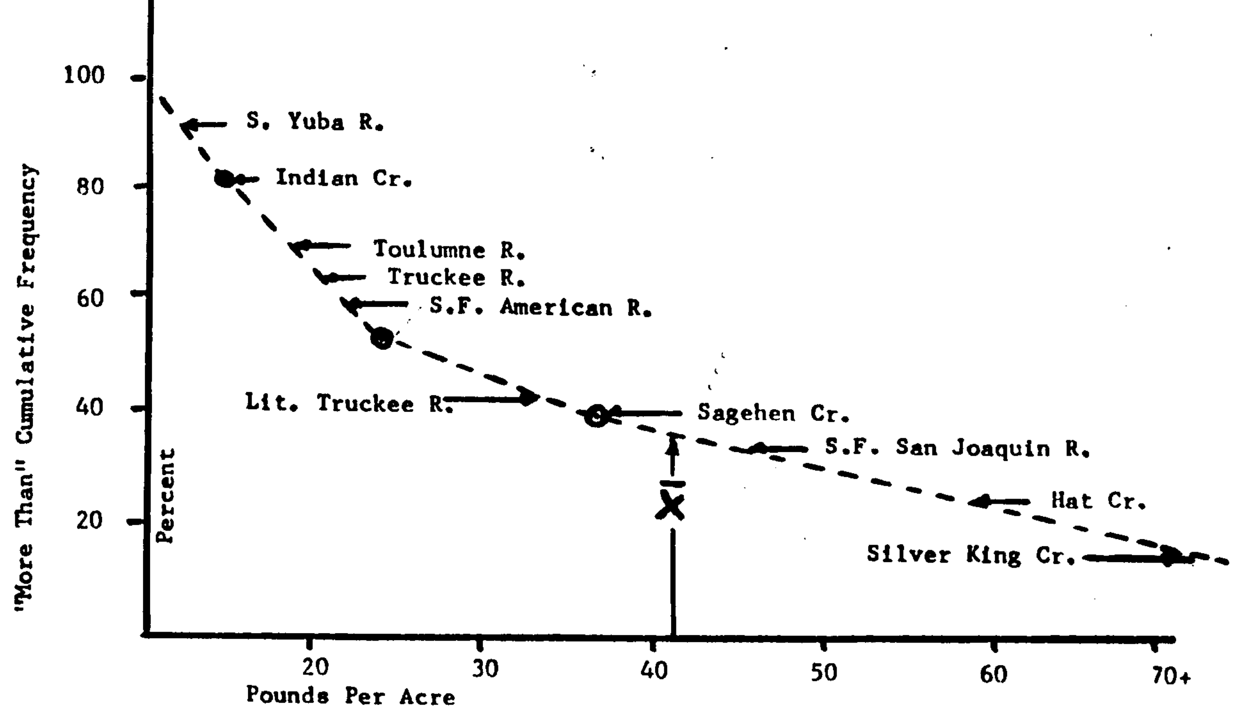
Impact of Nongame Species Competition

Out of 102 streams sampled, 46% contained one or more species of nongame fish.

Populations of over 400 lbs./acre, mostly suckers, were encountered in the N. F. Feather River, Putah Creek below Montecello Dam, the Kern River above and below Isabella Dam and in the Kaweah River. About two-thirds of the study sections, however, contained nongame fish populations of less than 50 lbs./acre (Table 8). Contrary to what one might expect, good trout populations are frequently found in streams containing nongame fish populations, particularly where the competing nongame species are small in size or where such populations are less than 50 lbs./acre. The Little Truckee River is a prime example of coexistence.

On the other hand there is ample evidence that excessive nongame fish populations inhibit trout production, particularly at low elevations. For example, in the North Fork Feather below Rock Creek dam where a biomass of 476 lbs./acre of nongame fish existed, the trout population increased from 3 to 18 lbs./acre following the removal of nongame fish. After similar treatment, the trout standing crop in Hat Creek increased from 11 to 63 lbs./acre. In large foothill streams such as the lower Kern, Kaweah, San Joaquin and N. F. Kings Rivers, where the nongame fish biomass exceeds 200 lbs./acre, trout populations are low, averaging only 4 lbs./acre. According to the California Fish and Wildlife Plan (1965), nongame fish are a major problem in 8,700 miles of stream.

Figure I - Stream Classification Relative To Frequency Distribution of Biomass Estimates From 278 Stream Sections



The impact of water development on trout production seems to be significant but difficult to evaluate because of many other factors which cloud the issue. At least 2,000 miles of Sierra streams have been adversely affected by water diversions.

One of the most dramatic changes in trout production occurred within sections of the N. F. Feather River downstream from Caribou Powerhouse where the mean minimum flow was reduced from 1,000 to 100 cfs. During 1954, before diversion, the stream yielded 63 lbs./acre of trout to the angler. The standing crop, though not measured, was probably of similar magnitude. In 1972, three years after the flow had been reduced, the wild trout population dropped to 10 lbs./acre.

Increased flows may indeed result in increased trout production. Following construction of Antelope Dam on Indian Creek, the mean minimum flow increased from 2 to 8 cfs. The pre-project trout standing crop which averaged 8 lbs./acre increased to 43 lbs./acre when the stream was sampled after four years of project operation.

Trout Yield Estimates

Trout yield information from California streams is very limited. Small streams which have been studied, like the M. F. Tule River, M. F. Sacramento River, Silver King Creek and the Rush Creek produced annual yields of 300 to 500 trout per mile, averaging mostly under 400 (Table 9).

Larger streams yielded 200 to 1,500 trout per mile depending on fertility and fishing pressure. The Kern River and South Fork American Rivers, which are typical west slope Sierra streams, yielded 1,400 and 680 trout per mile respectively to the angler even under heavy fishing pressure (Table 9).

The California Fish and Wildlife Plan (1965) breaks California's 18,000 miles of cold water streams into four size categories. By applying a potential maximum yield estimate to each category, based on standing crop and yield estimates from typical waters within each stream size-class, it is estimated that California's trout streams could produce a maximum sustained harvest of about five million wild trout annually (Table 10).

The California Department of Fish and Game (Emig 1971) estimates that 11.1 million angler days were expended statewide by trout fishermen in 1969 and that 38.5 million trout were harvested. The California Fish and Wildlife Plan (1965) estimates that in 1960 some 19% of the State's trout angling use (1.3 million angler days) occurred on "non-catchable" trout streams. If we assume that stream angling for wild trout has increased since 1960 at the same rate as trout fishing in general, two million angler days would have been spent on California's wild trout streams in 1969.

If we assume that the average wild trout stream angler creels 2 1/2 trout per day, as numerous creel surveys indicate, then the total stream trout catch in 1969 would have been about five million wild trout or the equivalent to the estimated maximum potential of California's 18,000 miles of cold water streams.

CONCLUSIONS

It would appear that stream angling for wild trout in California has reached the saturation point and that additional anglers cannot be accommodated without a decline in fishing success or a reduction in "kill". If additional anglers are to be accommodated with the present quality level of angling, then the individual angler's trout take must be correspondingly reduced. This might best be accomplished by enacting drastically reduced bag limits for all wild trout streams.

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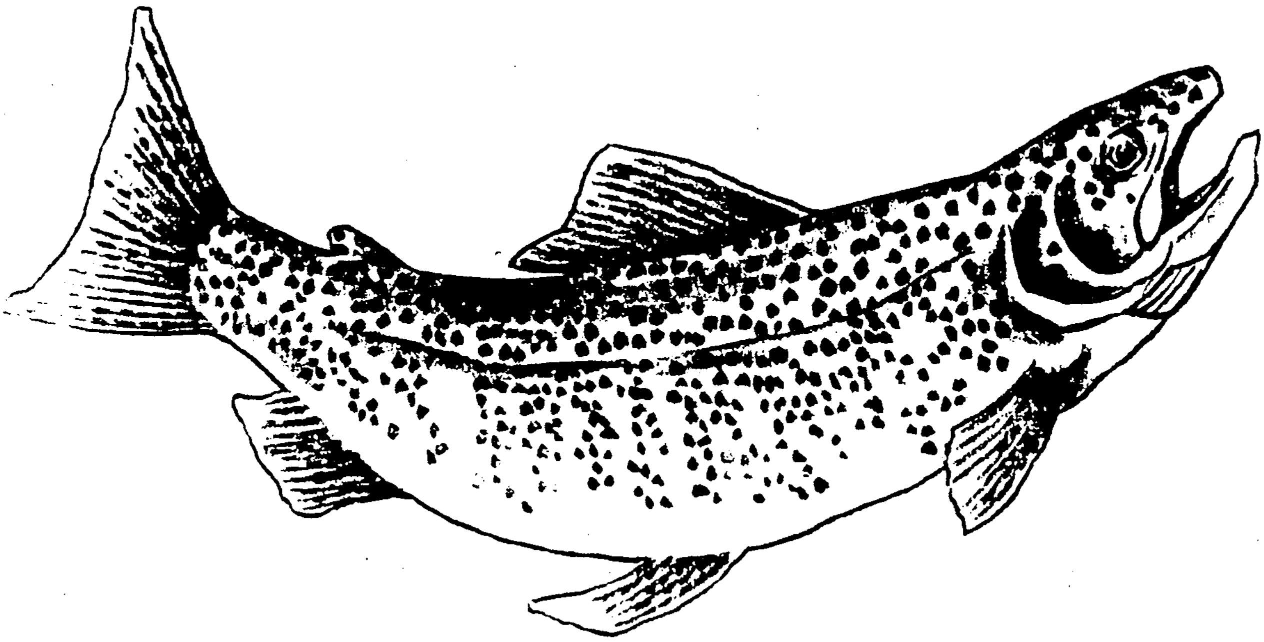

Table 1. Frequency distribution of stream trout biomass estimates.

Class	Range lbs/acre	No. of Test Sections	Frequency (percent)
I	0-9	50	18
II	10-24	82	29
III	25-39	45	16
IV	40-79	65	23
V	80+	36	13
		278	

Table 2. Frequency distribution of adult trout population estimates.

Adult Trout Per Mile	No. Study Sections Per Class	Percent Frequency
1-99	91	32
100-199	61	22
200-399	82	29
400-799	42	15
800+	4	2
	280	

Table 3. Relationship between stream width and biomass.

Section Width	No. of Sections	Mean Biomass
2 - 5'	7	76
6 - 10'	51	70
11 - 15'	69	35
16 - 25'	73	33
26 - 40'	44	24
41 - 70'	24	13

Table 4. Relationship between stream width and the abundance of adult trout.

Section Width	No. of Sections	Adult Trout/Mile
2 - 10'	50	232
11 - 25'	147	211
26 - 39'	25	235
40 - 70'	34	278

Table 5. Relationship between stream type and trout size composition.

	Percentage Composition by Weight		
	Fry (1"-2.9")	Yearlings (3"-5.9")	Adults (6"plus)
A. Small Heavily Fished Rainbow Trout Streams:			
N. Long Canyon Creek (Rubicon R.)	0	89	11
Canyon Creek (NF American R.)	7	81	12
Licking Fork (MF Mokelumne R.)	20	60	20
SF Rubicon River	2	77	21
Fall River (MF Feather R.)	27	33	40
Estray Creek (EB, NF Feather R.)	0	35	65
Average	9	62	28
B. Small, Moderately Fished Rainbow Trout Streams:			
Grizzly Creek (NF Feather R.)	2	28	70
Red Clover Creek (EB, NF Feather R. 1963-65)	0	45	55
Blue Creek (NF Mokelumne R.)	0	46	54
Big Grizzly Creek (MF Feather R. 1965)	10	40	50
Cole Creek (NF Mokelumne R.)	0	73	27
Average	2	46	51
C. Small Light to Moderately Fished Streams Containing Both Rainbow and Brown Trout:			
Bear Valley Creek (Smithneck Cr.)	1	8	91
Martis Creek (Truckee R.)	1	13	87
Squaw Creek (Truckee R.)	2	14	84
MF Yuba (at Milton)	4	12	84
Sutter Creek	1	39	67
Summit City Creek (MF Mokelumne R.)	T	37	63
Bear Creek (Truckee R.)	7	43	50
NF of NF American River	T	50	50
Average	2	27	72
D. Large Heavily Fished Streams:			
W. Carson River (Hope Valley)	0	4	96
SF Yuba River (Cisco)	0	5	95
Little Truckee R. (Stampede)	0	6	94
NF Feather, Seneca to Caribou	5	26	68
NF Feather, Caribou to Belden	0	5	95
NF Feather, Rock Cr. Dam to Cresta P.H.	0	2	98
Truckee R. (6 sects. Tahoe City to Prosser Cr.)	4	10	86
Average	1	8	90

Table 6. Relationship between stream gradient and brown trout dominance.

Gradient (Ft/Mi)	No. Sections with BN	No. Sections Where BN are Dominant	Percent of Sections Where BN are Dominant
10 - 60	56	27	48
61 - 100	41	21	51
101 - 160	22	7	31
161 - 250	13	3	23
251 - 400	2	1	-
	134	59	

Table 7. Relationship between trout abundance and stream environment.

Study Section Type	No. of Streams in Type	No. of Study Sections	Pounds of Trout Per Acre	
			Mean	Median
I. Meadow	19	68	48.0	50
II. Forested Flat	31	101	40.8	50
III. Canyon	31	75	29.3	30
Totals	91	244		

Table 8. Frequency distribution of nongame fish populations from 112 test sections.

Class	Pounds Per Acre Range	No. of Study Sections Per Class	Percentage Frequency
I	0-9	40	36
II	10-49	36	32
III	50-99	12	10
IV	100-299	14	13
V	300-700	10	8
		112	

Table 9. Trout yield estimates from California streams.

Stream	Yield to Angler Fish/Mile	Yield to Angler Lbs./Acre	Angling Pressure	Pounds/Acre Standing Crop	
Small Stream - Medium Fertility					
(1) M.F. Tule R.	360	-	Heavy	-	
(2) M.F. Sacramento	300	30	Light	60	
(3) Silver King Cr.	325	25	Light	60	A
Small Stream - High Fertility					
(1) Sagehen Cr.	390	20	Moderate	37	
(2) Rush Cr.	480	40	Heavy	40	B
Large Stream - Medium Fertility					
(1) Kern R.	1400	30	Heavy	-	C
(2) S.F. American	680	17	Heavy	22	D
(3) Toulumne R.	200	6	Light	18	E
Large Stream - High Fertility					
(1) N.F. Feather	1000	62	Heavy	-	F
(2) Putah Cr.	5000	50	Heavy	70	G
(3) Hat Cr.	500	30	Heavy	63	H
(4) Owens R.	1500	-	Heavy	-	I

A. Lower Fish Valley (1970)

B. Below Intake (1954)

C. Above Fairview Dam (1961)

D. Below Kyburz (1968)

E. Below Hetch Hetchy (1970)

F. Below Caribou (1954)

G. Below Monticello Dam (1964)

H. Below PG&E Powerhouse (1972)

I. Below Pleasant Valley Dam (1971)

Table 10. Estimated maximum potential yield of wild trout from California's coldwater streams.

Stream Width	Surface Biomass Acres	Surface Biomass Lbs/Acre	Total Est. Standing Crop	Potential Max. Yield Lbs/Acre	Potential Max. Yield Total Lbs.
0-7	6500	70	453,000	40	260,000
8-20	4900	35	171,000	35	172,000
21-100	7700	20	154,000	30	231,000
101+	6700	10	67,000	15	105,000
Total	25800		845,000		768,000

Estimated maximum potential annual yield in terms of catchable sized wild trout.

Stream Width	Stream Miles	Est. Max. Yield Per Mile	Est. Max. Yield of Adult Trout
0-7	13,400	200	2,680,000
8-20	3,100	400	1,240,000
21-100	1,300	700	910,000
101+	200	1,000	200,000
Total	18,000		5,030,000