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Title: THE FEASIBILITY OF A CONSUMPTIVE WILD TROUT SPORT FISHERY ON THE NORTH FORK OF THE MIDDLE FORK OF THE WILLAMETTE RIVER

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John D. McIntyre

The objective of this study was to determine whether wild populations of trout in the North Fork of the Middle Fork of the Willamette River can support a catch rate of 0.3-0.5 trout per hour at current levels of effort and to predict how different size and bag limits would alter the number and ages of trout harvested. Angler use of the sport fishery in 1976 was estimated to be 2,730 angler days and 5,660 angler hours. The season average catch rate was 0.49 trout per hour. The number of trout counted in September 1975 and 1976 suggested that the trout populations had not declined between those two years. Rainbow trout are recruited to the fishery at about age II and 50% of the females are mature at age IV. Cutthroat trout are recruited to the fishery at about age III and 86% of the females are mature at that same age. Distribution of harvest among anglers and age specific lengths of native trout are used to demonstrate that size restrictions are the most effective means of selectively limiting trout harvest.

The North Fork can continue to support a consumptive sport fishery with a catch rate of between 0.3 and 0.5 trout per hour at present levels of effort under the following assumptions: (1) angler use and harvest was similar in 1975 and 1976, (2) natural mortality was similar in both years, and (3) trout counts were not biased by unequal movement of fish into study pools in the second year.

The Feasibility of a Consumptive Wild Trout Sport Fishery on the North Fork of the Middle Fork of the Willamette River

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Jay Woodburn Nicholas

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in charge of major

Redacted for Privacy

Head of Department of Fisheries and Wildlife

Redacted for Privacy

Dean of Graduate School

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THE FEASIBILITY OF A CONSUMPTIVE WILD TROUT SPORT FISHERY ON THE NORTH FORK OF THE MIDDLE FORK OF THE WILLAMETTE RIVER

INTRODUCTION

Fishery managers frequently plant hatchery trout in streams in order to maintain catch rates at some loosely defined minimum level. Although supplemental introductions of eggs (or fry) and stream fertilization are possible, wild trout management programs normally rely on the reproductive performance of the native population and the productivity of the system to maintain those minimum catch rates. A population that is unable to sustain itself under the pressure of a consumptive sport fishery will become depressed to levels where acceptable catch rates will not be achieved. Stream managers need to know if a population is embarked on such a declining trend before the fishery becomes depressed to unacceptable levels. This study was initiated to determine whether the trout populations of the North Fork of the Middle Fork of the Willamette River can support a catch rate of 0.3-0.5 trout per hour (criterion of District Biologist) at present effort levels and to predict how different size and bag limits would alter the number and ages of trout harvested.

STUDY AREA

The North Fork of the Middle Fork of the Willamette River (North Fork) originates in the central portion of Oregon's Cascade Range (Fig. 1), flowing west about 70 kilometers from Waldo Lake to the Middle Fork of the Willamette near Oakridge. Average monthly flows at its source range from about 0.14 m^3/sec in late summer to about 2.6 m^3/sec in the winter. Flows near its confluence with the Middle Fork range from a monthly average of about 4.3 m^3/sec in late summer to about 56.6 m^3/sec in winter (Fig. 2). Maximum summer stream temperatures were slightly lower in 1976 than 1975 but did not exceed 19° C in either year (Fig. 3). Road access ranges from excellent to fair along the lower 55 km. There are no roads along the uppermost 16 km and trail access is poor.

Major fish species present include non-anadromous populations of rainbow trout (*Salmo gairdneri*), cutthroat trout (*S. clarki clarki*), mountain whitefish (*Porsopium williamsoni*), coarsescale sucker (*Catostomus macrochilus*), blackside dace (*Rhinichthys osculus*), and at least two species of sculpin (*Cottus bairdi* and *C. confusus*). The North Fork was stocked with both spring and fall spawning rainbow trout for over 20 years. The last introductions were made in 1973.

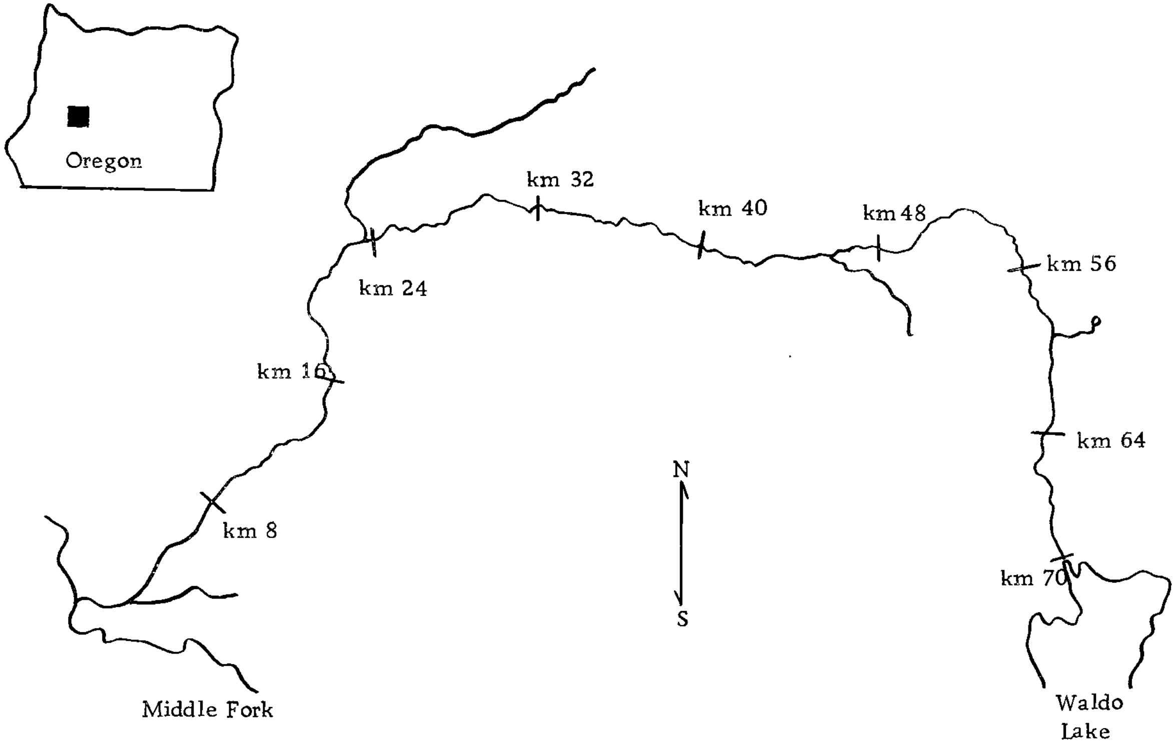

Figure 1. North Fork of the Middle Fork of the Willamette River.

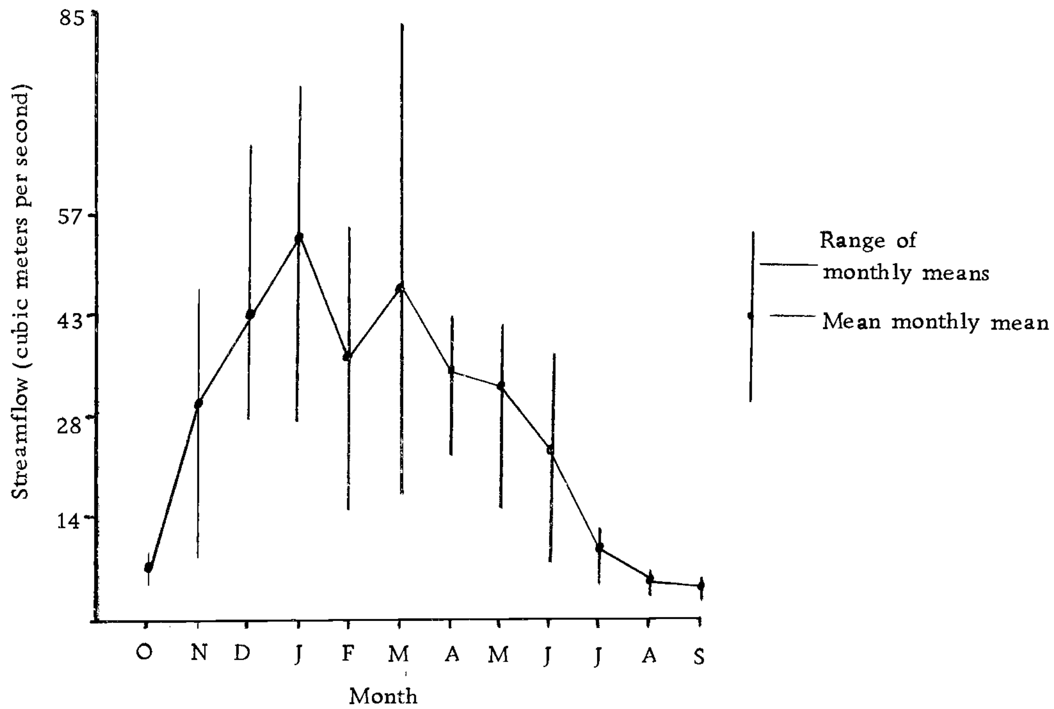

Figure 2. Typical seasonal variation in streamflow at river km 1. 6. Values represent data from water years 1971, 72, 73, and 74.

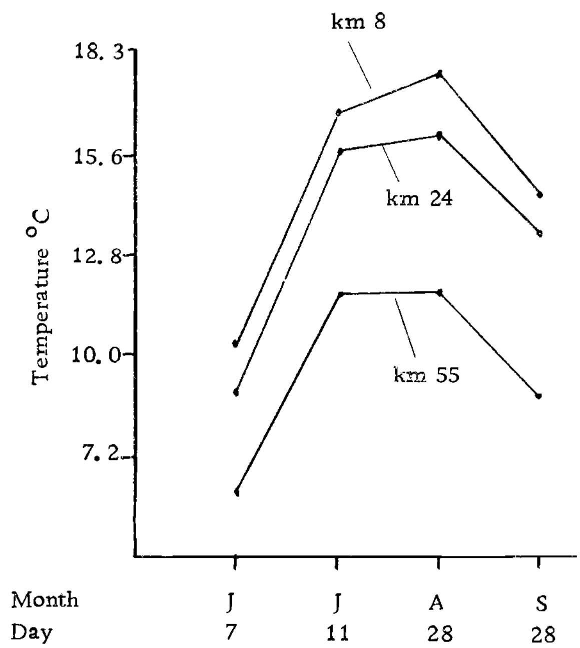

Figure 3. Maximum stream temperatures at various locations along the North Fork in 1976, recorded by hand thermometer between 1500 and 1700 hours.

METHODS

Creel Census

A creel census was conducted on the North Fork in order to document current levels of angler use and average catch rate. A secondary purpose of the creel census was to collect information that would define relationships between angling regulations and harvest. This information included the size distribution of the catch and the distribution of catch among anglers. Scale samples were taken for aging, and gonads of uncleaned trout were examined for information on age at maturity.

The census was conducted from opening day on 24 April 1976 through the month of September. It was not continued into the month of October. No anglers were observed on the North Fork during several days in October when various field observations were being completed. The season was stratified into weekdays and weekend days with one day in each stratum sampled weekly. Sample days were selected using a random number table with the additional stipulation that once a particular weekday was selected, at least four weeks must pass before it could be selected again. In this manner, 50 percent of the weekend days and 20 percent of the weekdays were selected for sampling. Two additional weekend days and one additional weekday were sampled to increase the sample size.

A roadside station was set up at about river kilometer 3.2 and identified by signs requesting anglers to stop at the station. The station was operated from approximately 0900 until dark and only anglers that had finished for the day (complete anglers) were interviewed. Anglers who intended to camp overnight or exit after dark (incomplete anglers) were given mail-in census questionnaires.

Population Parameters

Fish counts made in the same pools in two successive years were used as an indication of population stability. They were made underwater with the aid of a wetsuit and a snorkel breathing tube in late September of 1975 and 1976. The counts were made in September low water because visibility was good, trout were concentrated in the pools, and most of the angling harvest had already occurred. Sample pools were selected by subjectively dividing the river into four sections on the basis of similarity of stream gradient and morphology and then selecting five representative pools in each section (Tables 1 and 2). Trout were enumerated in two exclusive categories: at least 15 cm but less than 30 cm, and at least 30 cm. An initial difficulty with estimating the size of trout was overcome by placing markers of known length in several pools to act as a reference in judging trout lengths.

Table 1. Location of study sections and individual pools where fish counts were made in 1975 and 1976.

Section	Location	Length	Pool #	Location
			1	km 4.3
	km		2	4.8
1	3.7	13.7 km	3	5.4
			4	5.3
	17.4		5	5.6
	km		1	20.1
	17.4		2	21.2
2		8.3 km	3	21.4
	25.7		4	22.5
			5	23.3
	km		1	25.3
	25.7		2	25.6
3		20.1 km	3	29.8
	45.9		4	30.1
			5	30.6
	km		1	53.9
	45.9		2	54.1
4		24.9 km	3	54.1
	70		4	54.4
			5	54.6

Table 2. Description of study sections and pools on North Fork in 1975 and 1976.

Section	Description	Sample pool #	Approximate length	Description of pool
1	Low gradient; bedrock and large boulder substrate; stable streambed	1	80 m	Bedrock and large boulder substrate, deep water, 1 m falls at head
		2	80 m	Bedrock along North bank, cobbles midstream, sand and gravel south bank
		3	40 m	Wide shallow channel in bedrock, cobbles and sand substrate
		4	40 m	Narrow channel in bedrock cobble and boulder substrate
		5	45 m	Two channels in bedrock, boulders
2	Steep gradient; bedrock, large boulders and gravel substrate; cascades and deep pools and pockets; stable stream bed	1	50 m	Large riprap boulders along highway, cobbles and gravel at head
		2	65 m	*90° bend, boulders and sand substrate
		3	70 m	*90° bend, boulders and gravel substrate, deep water
		4	60 m	*45° bend, deep, bedrock and large boulder substrate
		5	25 m	Between rapids, large boulders, gravel substrate
3	Low gradient; few deep pools, many riffles; cobble and gravel substrate; unstable streambed	1	55 m	*45° bend along highway, large boulder riprap south shore, cobble substrate riffle at head
		2	35 m	Under cut north bank, gradually sloping to shallow south bank, cobble substrate
		3	70 m	Shallow head over gravel substrate and deep tail over cobble substrate
		4	60 m	Shallow head and a deep area on north bank under an overhanging bush
		5	60 m	*90° bend over bedrock at head
4	Gradient highly variable; small pools, riffles, cascades: boulders, cobbles, and gravel; stable streambed	1	30 m	Riffle over cobbles (shallow)
		2	30 m	Small boulders (shallow)
		3	20 m	Gravel and cobble substrate, swift
		4	50 m	Swift deep water along south bank and eddy along north bank
		5	50 m	Boulders and cobbles at head, bedrock channels at tail

*Approximate

I became familiar with these pools by making repeated qualitative observations in each pool over a period of months as water levels decreased each summer. Observation periods ranged from ten minutes to over one hour and three observational methods were employed.

Method 1. I entered the water at or above the head of a pool and drifted passively with the current, counting trout while drifting downstream. This method was only satisfactory for making preliminary qualitative observations, yielding inconsistent results due to the tendency of some trout to flee downstream ahead of the observer. Some of the larger individuals actually left the pool and went down through a riffle to the next pool below while others congregated at the downstream end of the pool until I came into view and then darted upstream.

Method 2. I entered the water at the side of the pool and lay quietly against the streambank and counted trout in the pool. Most trout continued feeding apparently undisturbed; trout in the immediate vicinity occasionally retreated downstream but usually returned to their original station within minutes to resume feeding on material that I dislodged. This method was satisfactory in smaller pools where the entire pool could be seen from one position.

Method 3. I entered the water at the extreme downstream end of the pool and slowly moved upstream along the edge of the stream by grasping rocks, and counted trout as they passed downstream of my position. This method was satisfactory in pools of all sizes.

Mean age specific lengths were calculated in order to determine the approximate age of recruitment to the sport harvest. Scales were collected from trout (of known capture location) checked in the creel census and from trout caught by experimental angling. Scale samples were taken from the left side of the fish between the lateral line and the insertion of the dorsal fin. Trout were measured to the nearest mm fork length. Scales were cleaned, mounted in glycerine under coverslips on microscope slides, and read on a microprojector screen. Three non regenerated scales were read to age each trout.

Age of maturity was investigated to determine the time between entry to the fishery and first spawning. Gonads from trout examined during the creel census and from trout collected in various parts of the river and several tributaries were inspected and the stage of development noted. In addition their fork length was recorded and a scale sample was taken. Gonads were classified as immature (undeveloped) or mature (ripe, spawning, spent, or mending) (Frost and Brown, 1967).

RESULTS AND INTERPRETATION

Sport Fishery

Expanded estimates of effort and use on the North Fork (Table 3) show approximately 2730 angler days and 5660 angler hours for the season covered by the 1976 census. The average angler day was about 2.1 hours of angling.

It was estimated that there were more trout released than were harvested: 4548 trout released compared to 2752 trout harvested. Rainbow trout comprised 53% of the catch and cutthroat trout made up the remaining 47%. Only 10% of the cutthroat trout sampled were larger than 20 cm while 48% of the rainbow trout were larger than 20 cm and a few were as large as 39 cm (Fig. 4).

The season average catch rate was 0.49 trout per hour. The season average landing rate, which includes both harvested and released trout, was 1.29 trout per hour. Harvest rates increased fairly consistently through the 1976 season from about 0.1 trout per hour to about 0.8 trout per hour (Fig. 5). As a group, anglers using artificial flies experienced higher average catch rates than anglers using either bait or lures (Table 4). Seasonal trends in catch rate are probably related to increasing water temperatures, decreasing streamflows, and seasonal variations in food availability and feeding behavior. Approximately 76% of the anglers interviewed caught no

Table 3. Expanded estimates of use and harvest on the North Fork in 1976.

	Estimate from complete interviews	95% confidence interval ±	Estimate from incomplete[2] interviews	Total
Number of anglers	2344	443	386	2730
Number of angler hours	4849	1021	811	5660
Number of rainbow trout harvested	1248	422	207	1455
Number of cutthroat trout harvested	1106	625	191	1297
Number of trout released	3899	1907	649	4548
Hours per angler (angler day)	2.1			2.1
Trout per hour (harvested)	0.49			0.49
Trout per hour (landings) [1]	1.29			1.29

(1) Landings = trout harvested + trout released (released trout were generally less than legal size)

(2) Based on an estimated 193 (95% CI, ±99) incomplete parties and the following assumptions:

anglers per party	= 2
hours per angler	= 2.1
catch rate	= 0.49
landing rate	= 1.29
rainbow:cutthroat	= 53%:47%

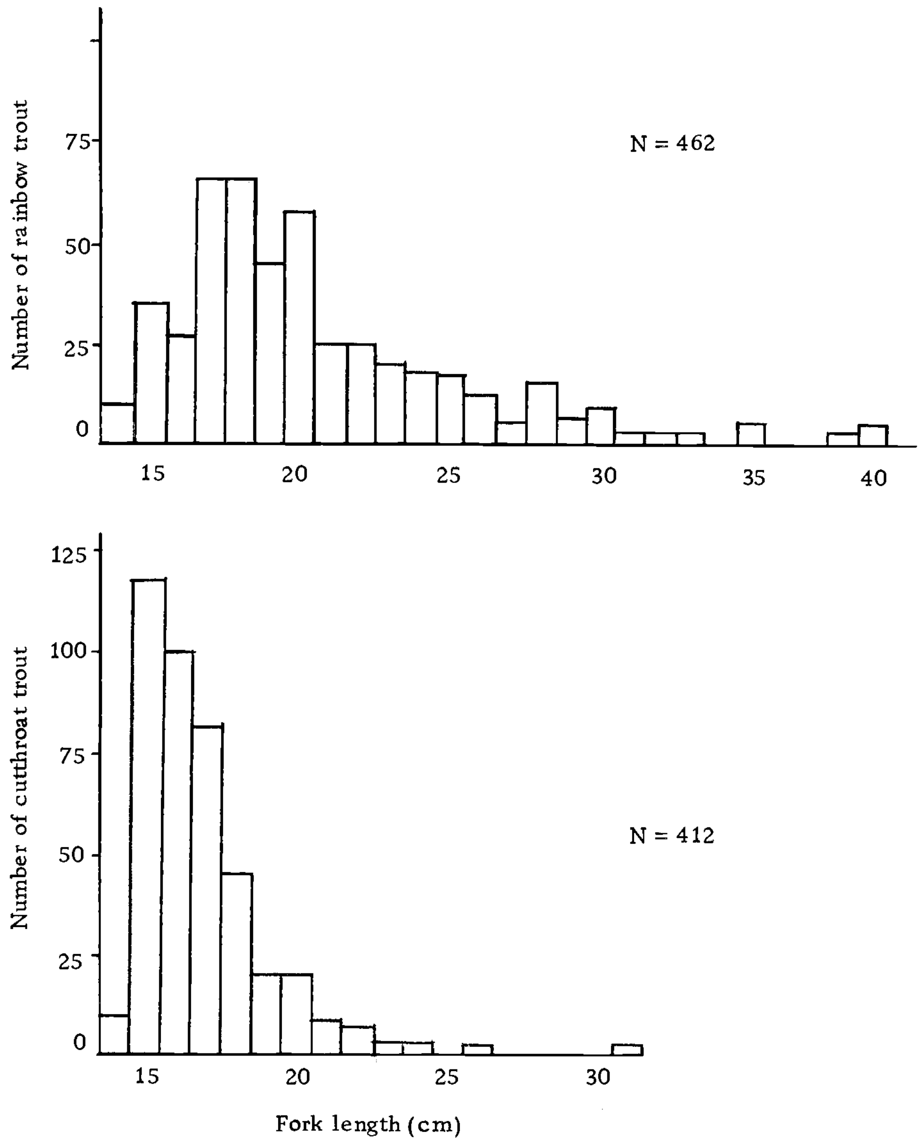

Figure 4. Size distribution of trout checked in creel census on the North Fork in 1976.

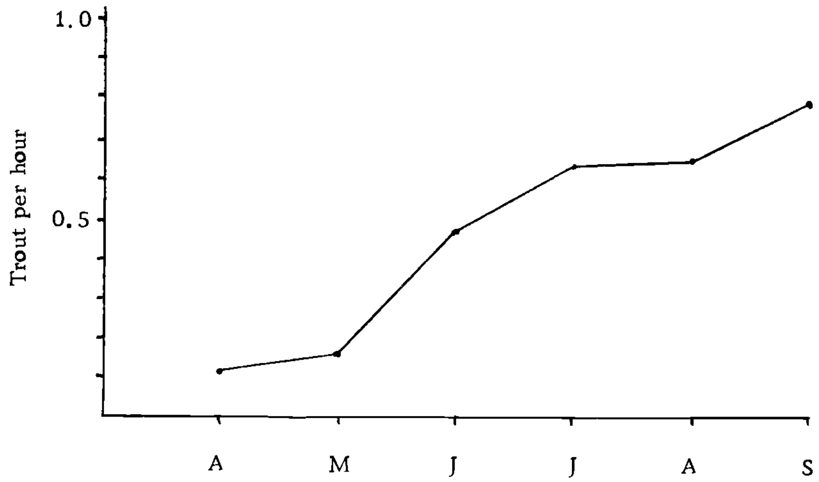

Figure 5. Seasonal trend in catch rate on the North Fork in 1976.

Table 4. Relative effort and season catch rate of anglers using different methods on the North Fork in 1976.

Method	Angler hours	% Effort	Season average catch per hour
Fly only	453.5	38	0.70
Bait only	616	51	0.47
Lure only	132	11	0.34

trout while the remaining 24% of the anglers caught 100% of the trout. Less than 2% of the anglers caught their limits but accounted for nearly 26% of the harvest (Table 5).

Relationships between Regulations and the Fishery

The effect of reduced bag limits on trout harvest is based on the distribution of harvest among anglers in 1976 (Table 5). Reducing the bag limit to five trout per day would reduce the harvest by about 19%, four per day by 27%, three per day by 37%, two per day by 49%, and a reduction to one trout per day would reduce harvest by about 69% (Fig. 6). Smaller bag limits reduce harvest by penalizing the most effective anglers and would not alter the age structure of the catch unless older trout became more abundant because of reduced angling mortality or if anglers selectively released younger trout in preference of keeping older, larger trout.

The effect of several alternative size limits on trout harvest was estimated by evaluating the size distribution of the catch in 1976 (Fig. 4). Size limits can be keyed to growth rate and age of maturity, and a size limit applies to each trout that is landed (Hunt, 1975). Thus, both the number and ages of trout harvested can be selectively altered by the application of different size regulations.

The present 15 cm minimum size limit protects many female cutthroat trout from harvest until after they mature and spawn in their

Table 5. Distribution of harvest among anglers on the North Fork in 1976. The number of trout harvested was noted by vehicle rather than by angler. Thus a vehicle with three anglers and ten fish is noted in this table as three anglers with from 3.0-3.9 trout each.

Average number of trout per angler	0-.9	1.0-1.9	2.0-2.9	3.0-3.9	4.0-4.9	5.0-5.9	6.0-6.9	7.0-7.9	8.0-8.9	9.0-9.9	10	Total
Number of anglers	706	87	52	21	17	21	11	1		8	23	947
Number of trout	32	102	108	70	73	111	67	7		74	230	874
% of anglers	76	9	5	2	2	2	1	0.1		1	2	
% of trout	4	12	12	8	8	13	8	1		8	26	

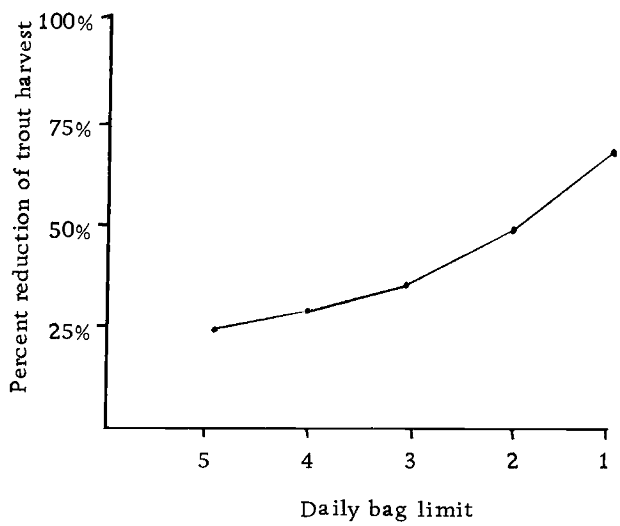

Figure 6. Estimated effects of various daily bag limits on trout harvest. Results are based on the distribution of harvest among anglers on the North Fork in 1976.

third year, while permitting harvest of immature female rainbow trout for two or three seasons before they mature. The different growth and life history characteristics of these species make it impossible to set size limits that will provide equal protection to both species. For example, a 20 cm minimum size limit would provide an additional year of protection to rainbow trout and reduce harvest of rainbow trout by 50%, but it would prevent harvest of most three and four year old cutthroat trout and reduce harvest of that species by over 90% (Fig. 7). The abundance of older age class rainbow trout (spawners) might be increased by the application of a 25 cm maximum size limit which, in conjunction with a 15 cm minimum size limit, would limit rainbow trout harvest to three year olds while essentially not altering the cutthroat trout harvest.

Population Trend

The number of trout counted in the same 20 pools in two successive years was used as an indication of population stability. I counted trout in each pool four times in both years (Table 6) and used the final count to make comparisons between years (Table 7). There was an 8% decrease in the number of small trout offset by an 80% increase in the number of large trout counted in the second year. The average number of legal size trout (15 cm) counted per pool in each section was nearly identical in the two years.

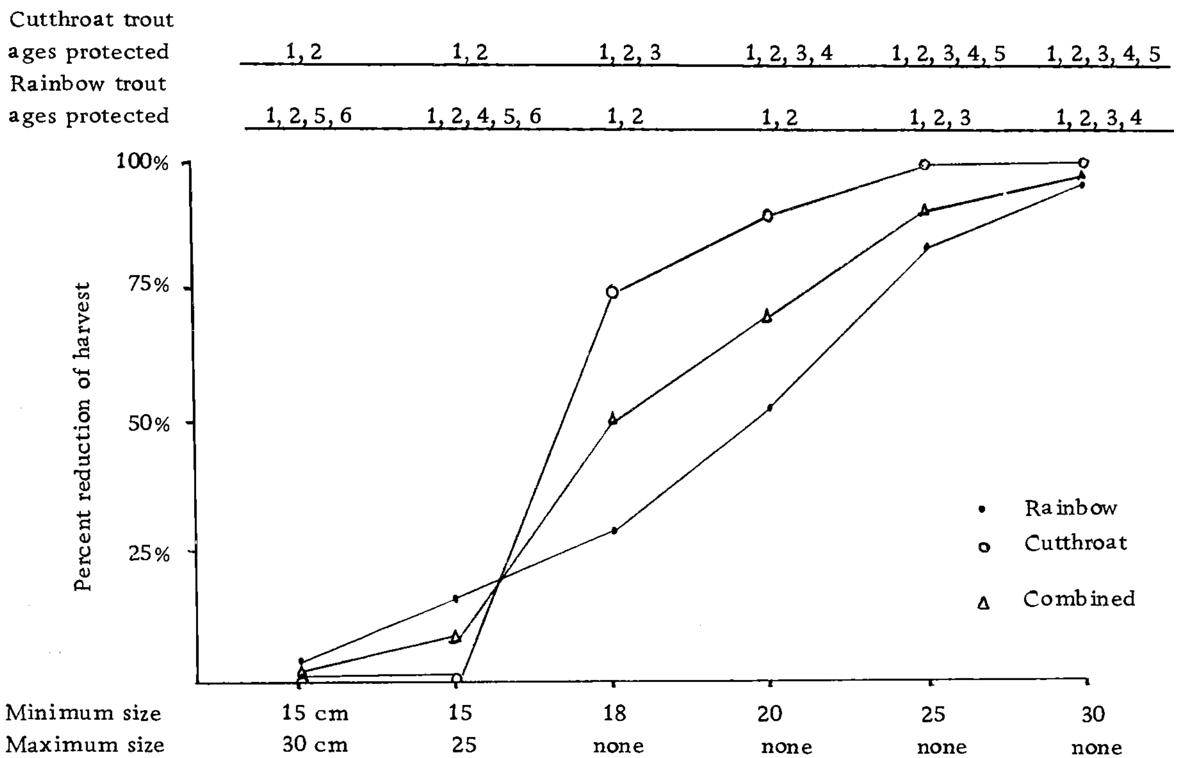

Figure 7. Estimated effects of various size limits on trout harvest. Results are predicted on the basis of the size distribution of the catch in 1976.

Table 6. Results of four replicate trout counts in 1975 and 1976 on the North Fork. Counts were very homogeneous within each pool.

		1975								1976							
		Small trout replicate count				Large trout replicate count				Small trout replicate count				Large trout replicate count			
Section	Pool	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
1	1	28	30	24	24	3	4	4	4	16	16	20	18	5	6	7	7
	2	11	10	10	10	2	1	2	2	10	13	12	12	2	3	3	3
	3	8	7	7	8	0	0	0	0	6	6	6	6	0	0	0	0
	4	5	3	4	4	1	1	1	1	6	6	6	6	3	3	3	3
	5	6	6	7	6	0	0	0	0	5	6	6	6	0	1	1	1
2	1	16	20	20	18	1	1	1	1	8	9	8	8	0	0	0	0
	2	8	8	8	8	1	1	1	1	7	6	6	6	2	2	2	2
	3	13	14	12	12	1	1	1	1	11	10	12	12	1	1	1	1
	4	6	6	6	6	0	1	1	1	8	8	8	8	0	0	0	0
	5	6	6	6	6	0	0	0	0	6	6	6	6	0	0	0	0
3	1	5	5	5	5	1	1	1	1	2	3	3	3	0	0	0	0
	2	7	6	6	6	0	0	0	0	6	5	5	5	0	0	0	0
	3	8	9	10	10	1	1	1	1	8	8	8	8	2	2	2	2
	4	2	1	1	1	0	0	0	0	4	3	3	4	1	1	1	1
	5	2	2	2	2	0	0	0	0	4	4	4	4	2	2	2	2
4	1	1	2	2	2	0	1	0	0	5	5	4	4	0	0	0	0
	2	1	0	0	0	0	0	0	0	4	3	4	4	1	1	1	1
	3	2	2	2	2	0	0	0	0	2	2	2	2	2	2	2	2
	4	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1
	5	4	4	4	4	1	1	1	1	2	2	2	2	1	1	1	1
	Sum	141	143	138	136	13	15	15	15	121	122	126	125	23	26	27	27

Table 7. Results of fish counts made by snorkel observation in the same 20 pools in 1975 and 1976.

Section	Pool	1975 Small trout ≥ 15 cm, ≤ 30 cm	1975 Large trout ≥ 30 cm	1975 Legal trout ≥ 15 cm average per pool per section	Section	Pool	1976 Small trout ≥ 15 cm ≤ 30 cm	1976 Large trout ≥ 30 cm	1976 Legal trout ≥ 15 cm average per pool per section
1	1	24	4	11.8	1	1	18	7	12.4
	2	10	2			2	12	3	
	3	8	0			3	6	0	
	4	4	1			4	6	3	
	5	6	0			5	6	1	
2	1	18	1	10.8	2	1	8	0	8.6
	2	8	1			2	6	2	
	3	12	1			3	12	1	
	4	6	1			4	8	0	
	5	6	0			5	6	0	
3	1	5	1	5.2	3	1	3	0	5.8
	2	6	0			2	5	0	
	3	10	1			3	8	2	
	4	1	0			4	4	1	
	5	2	0			5	4	2	
4	1	2	0	2.4	4	1	4	0	3.6
	2	0	0			2	4	1	
	3	2	0			3	2	2	
	4	2	1			4	1	1	
	5	4	1			5	2	1	
	Sum	136	15			Sum	125	27	

Age Specific Length

Trout in the lower 32 km of the North Fork are generally larger than upper river trout of the same age. There was no overlap of the 95% confidence intervals for the mean lengths of the first four age classes of lower and upper river rainbow trout (Fig. 8). This difference may be caused by a downstream movement of larger trout, different growth rates of trout in the two general areas of river, or to some combination of both. The different growth rate hypothesis is supported by the fact that water temperatures in the lower river are warmer (Fig. 3) and trout fry emerged two weeks earlier in the lower river. The similarity of lengths of age class VI rainbow trout may be due to upstream migration of some older trout from the lower river, underestimating the age of older trout from the upper river, or an ultimate length of rainbow trout in the North Fork related to food availability.

A comparison of age specific lengths of rainbow and cutthroat trout collected from the river above km 32 indicated that rainbow trout from age II and older are larger than cutthroat trout (Fig. 8). Delayed maturation of rainbow trout may account for this difference but does not rule out the possibility of interspecific competition as a factor in growth rate differences. Observations of the two species' distribution within pools showed that rainbow trout (regardless of size) in the upper river are concentrated in the larger pools and generally

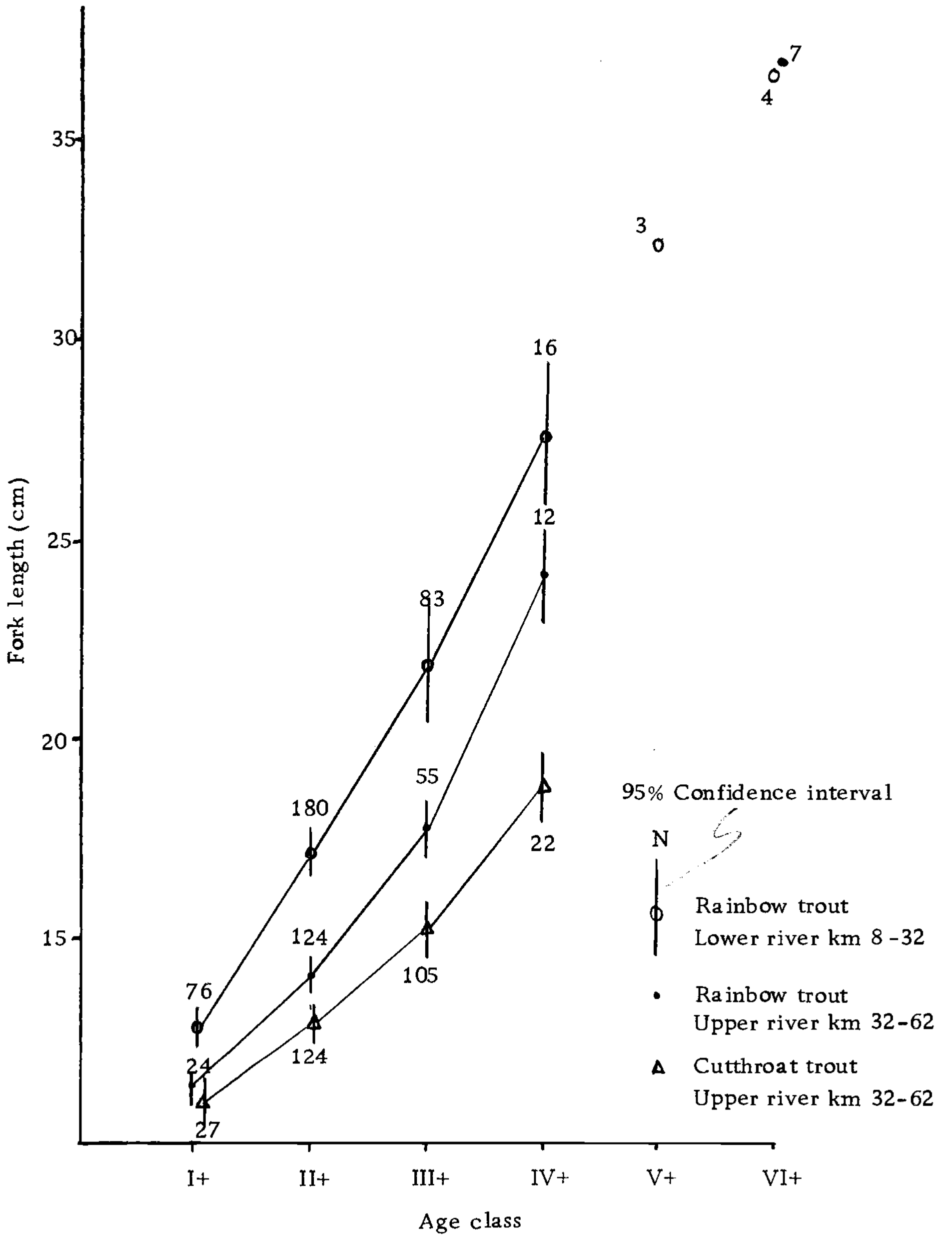

Figure 8. Age specific lengths of rainbow and cutthroat trout in the North Fork. Samples were taken in 1975 and 1976.

occupied feeding stations at the heads of pools and adjacent to swift current lines in pools. Cutthroat trout, on the other hand, typically occupied shallower riffles, pockets between pools, slower current areas of pools, and backwater eddies.

The lower river is primarily populated by rainbow trout which attain legal size (15 cm) at about age II. The upper river is primarily populated by cutthroat trout which attain legal size at about age III.

Age of Maturity

Cutthroat trout in the North Fork mature at a younger age than rainbow trout. While 92% of the male cutthroat trout sampled were mature at age III and all were mature over that age, only 67% of age III male rainbow trout were mature and some age class IV, V, and VI fish were not mature (Figs. 9 and 10). Female cutthroat trout also matured at a younger age than female rainbow trout. None of the female rainbow trout sampled were mature at age II, 2% were mature at age III, and only 50% were mature at age IV (Fig. 11). In contrast, 19% of female cutthroat trout sampled were mature at age II, 86% were mature at age III, and 90% were mature at age IV (Fig. 12).

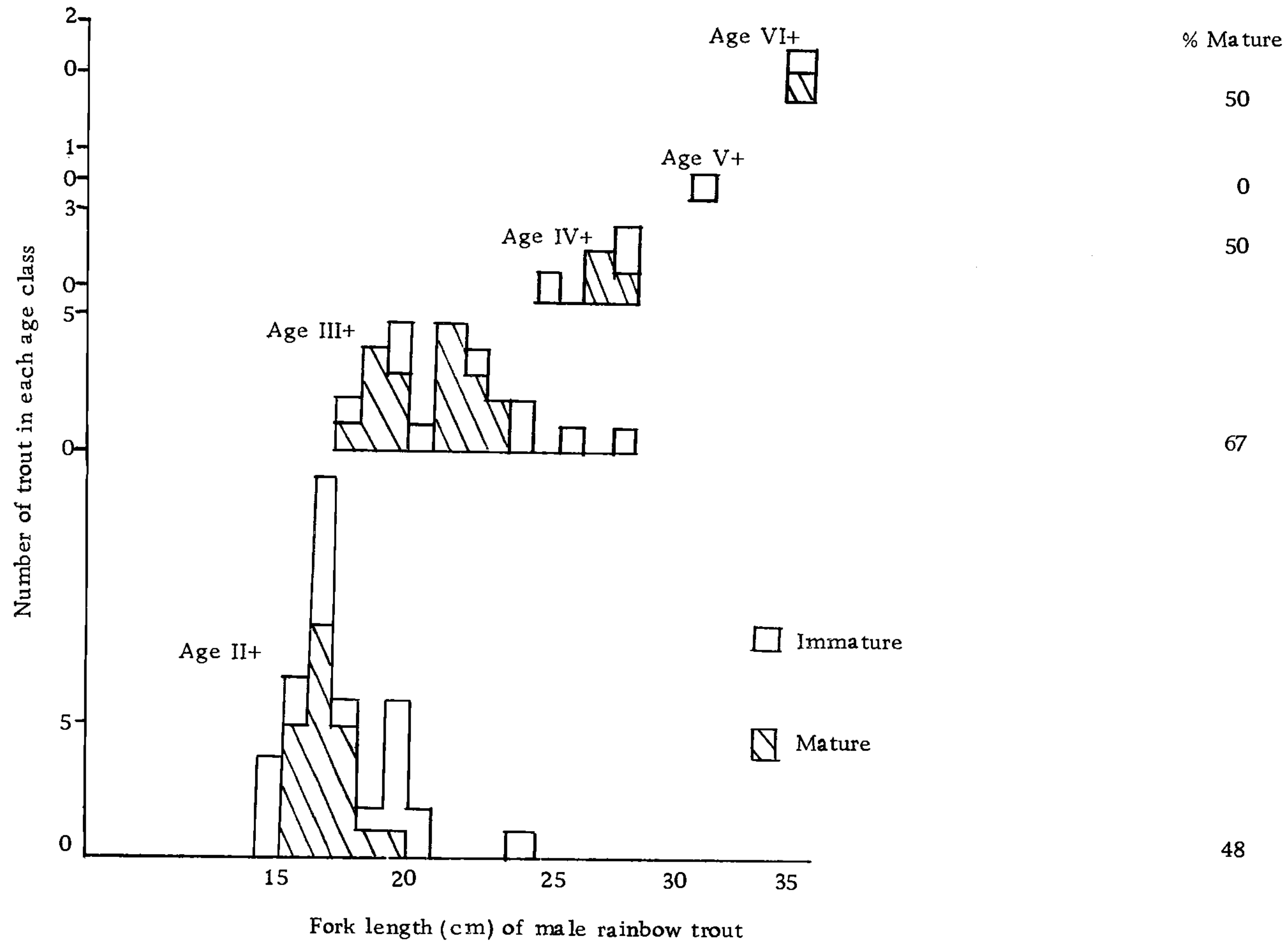

Figure 9. Length and age of maturity of male rainbow trout in the North Fork.

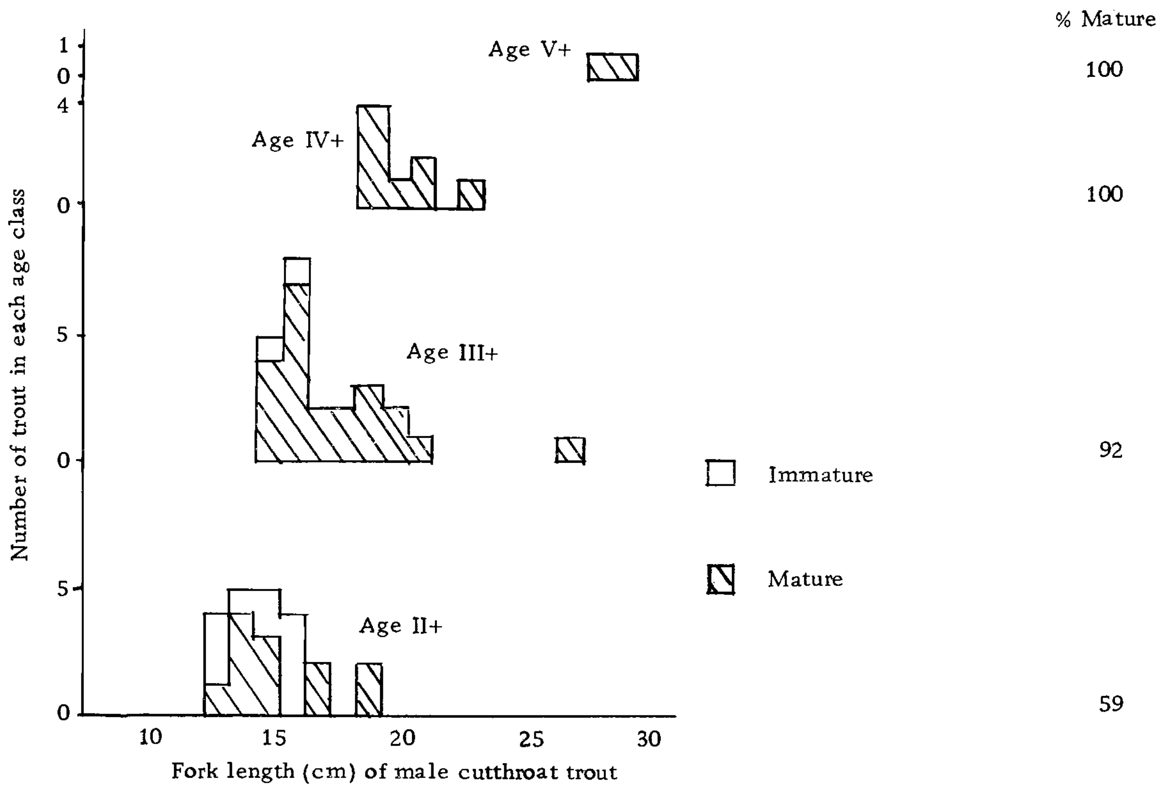

Figure 10. Length and age of maturity of male cutthroat trout in the North Fork.

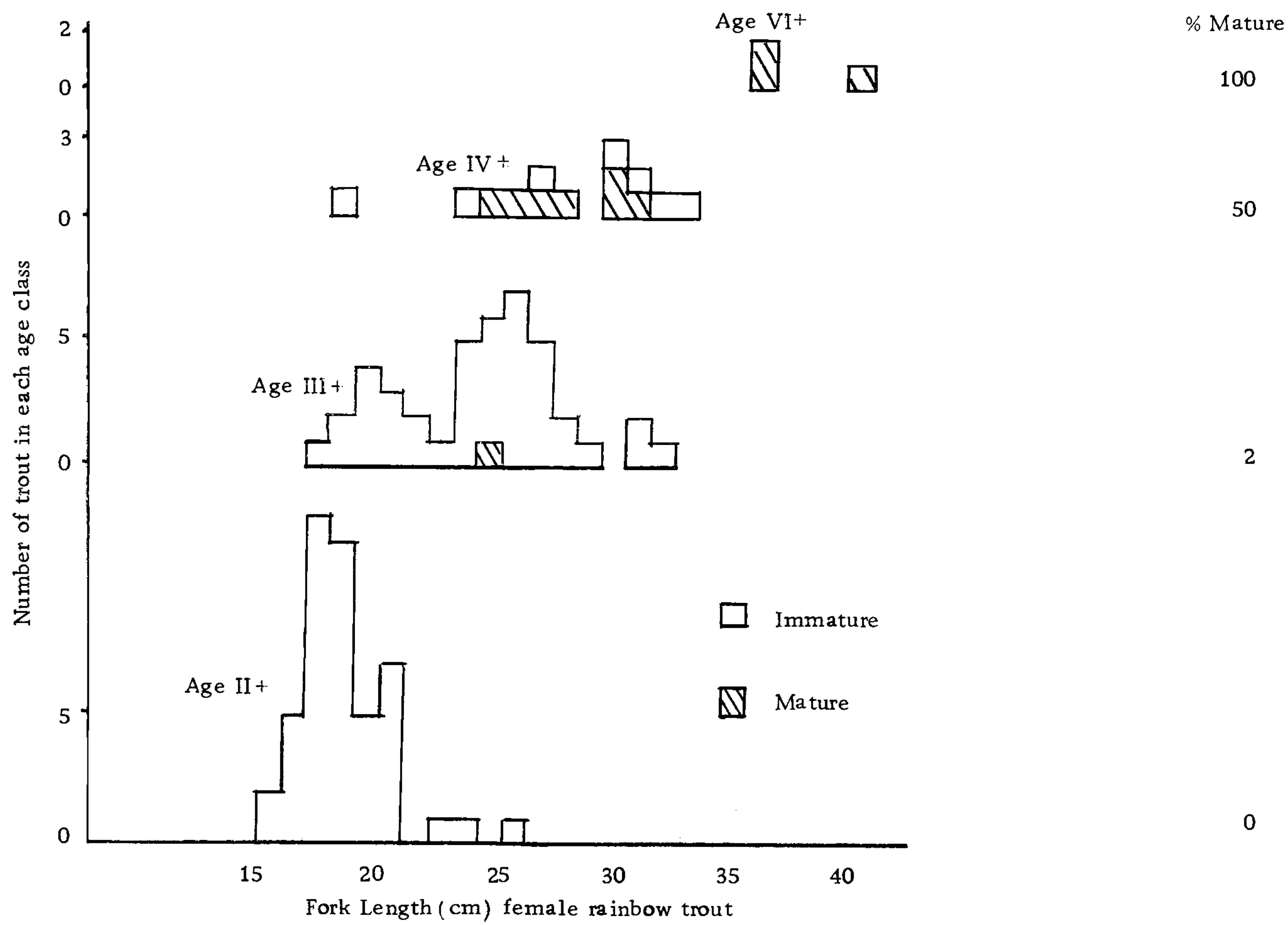

Figure 11. Length and age of maturity of female rainbow trout in the North Fork.

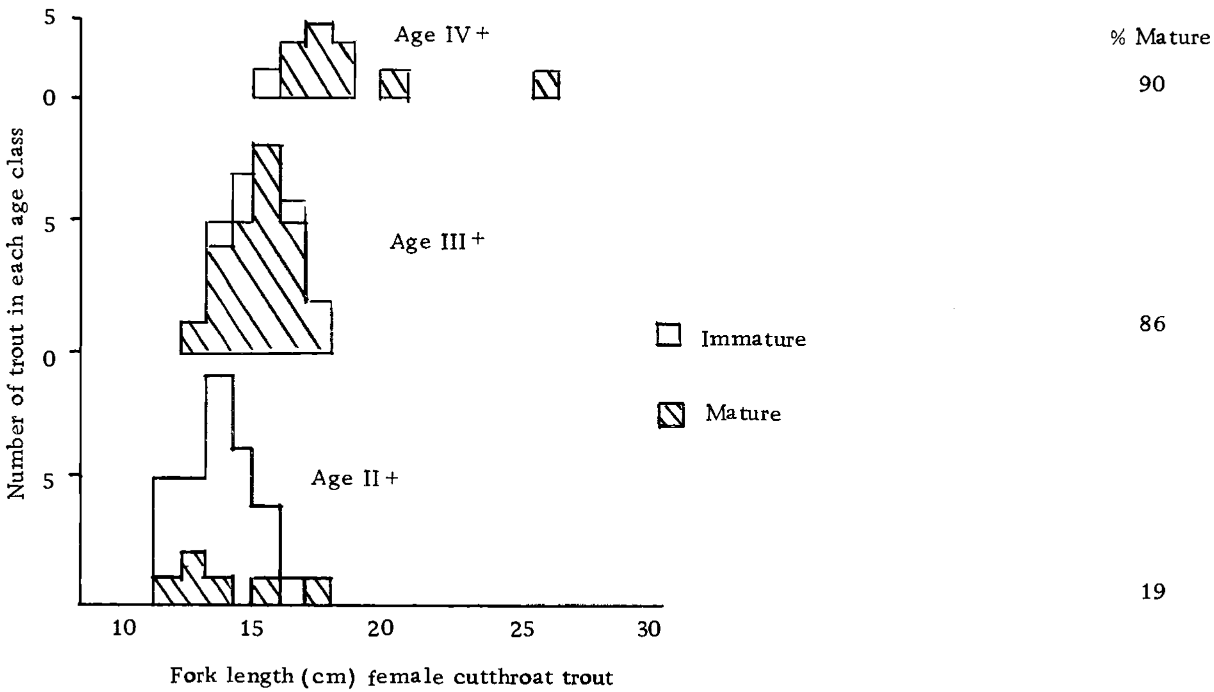

Figure 12. Length and age of maturity of female cutthroat trout in the North Fork.

DISCUSSION

The major problem in this study is the same problem that faces many fishery managers: how can one determine if a particular fish population is declining? Once managers are cognizant of population trends (stability, increasing, decreasing) they can initiate programs designed to regulate harvest and protect the population's reproductive capacity.

There are a large number of streams that resist effective sampling by shocking, seining, and trapping methods to determine population densities. Many of these streams are ideal subjects for visual underwater sampling of fish populations. There are, of course, difficulties with visual surveys such as size determination, multiple counts of the same fish, fish that are not detected and the occasional need to approximate the number of trout observed (Northcote and Wilkie, 1963). On the whole, however, visual survey of trout in moderate sized, low turbidity streams is a promising technique that can provide quantitative information where none was previously available. Surveys can be made in a standardized manner in the same locations from year to year to monitor trends in fish populations. Once an observer is trained, counts often can be made more quickly than other sample methods would permit, and with far less disturbance to the fish.

Catch-rates on the North Fork in 1976 were within stated limits for an acceptable sport fishery. These trout populations can continue to support an acceptable harvest at similar levels of effort if the assumptions made concerning the results of these fish counts are valid. The average number of legal size trout counted per pool in each section was nearly equal in the two years. The difference of less than 10% in the number of small legal trout counted in the second year may be attributable to observer error, but the increase in the number of large legal trout is probably not a simple error in counting. There were almost twice as many rainbow trout in the five and six year old size range in 1976 as there were in 1975.

Changes in population abundance are not necessarily related only to the level of angling exploitation. Temporary population changes can be caused by periodic environmental conditions that affect survival in some years or year classes. Sustained population changes could occur if the general quality of the watershed is altered. Assuming that the environment of the populations on the North Fork has remained stable in recent years, and that trout movement was random in the North Fork in relation to study pools in 1976, fish counts suggest that the trout populations are not declining in general, and the abundance of older age-classes may be increasing. If we also assume that the harvest in 1975 was equivalent to the harvest in 1976, the North Fork should be able to continue to support a similar fishery in the future.

Angling pressure is likely to increase on the North Fork in the near future; the highway is being widened and paved, and the stream is gaining notoriety as a wild trout stream. If population levels become depressed in the future, special regulations can be applied to reduce the impact of angling mortality on the population. More restrictive regulations applied to a depressed population will yield very low catch rates, but may allow the population to regain much of its former abundance and thereby support an attractive landing rate of trout, most of which would need to be released.

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