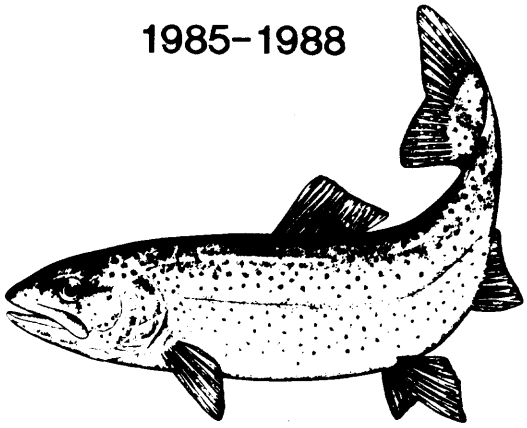
STATEWIDE FISHERIES INVESTIGATIONS

SURVEY OF AQUATIC RESOURCES

FEDERAL AID PROJECT F-7-M-31

COLORADO RIVER
LEE'S FERRY
FISH MANAGEMENT REPORT
1985-1988



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ABSTRACT

The "trophy trout" fishery that developed in the Colorado River following the closure of Glen Canyon Dam has been the source of considerable controversy in recent years. In 1978, the Arizona Game and Fish Commission reduced the bag limit from 10 fish to 4 fish. In 1980, it enacted an immediate kill regulation.

In 1984-85, the average size of fish fell drastically. Several factors probably contributed to this: there were very few 5-year and older rainbows available, as no rainbows were stocked in 1978-80; there had been a tremendous increase in angler pressure and harvest in 1982-83; and continuous high "flood" releases beginning in 1983.

In 1986, an artificials only regulation was imposed, and a constant high stocking level implemented, along with better distribution procedures. High, relatively stable releases were made from Glen Canyon Dam. This resulted in an increased catch per angler hour and increased size of fish, and a great increase in the number of fish caught and released beginning in 1987. Kamloops strain rainbow were also stocked for evaluation.

As a result of this success, pressure increased again in 1987-88 and harvest also increased, with an increasing number of smaller fish being harvested. Catch rates have remained high. There are indications that the high stocking rate may have contributed to an apparent decrease in growth rate. To date, returns on Kamloops and brook trout have not been promising.

To maintain a catch rate of 0.6-0.9 fish per angler hour, increase the average size of fish caught, and increase the catch and harvest of trophy fish, several recommendations are made. These include:

- Reduce stocking rate.
- Mark year classes for growth and return to creel evaluations.
- Evaluate Snake River cutthroat as a secondary species and continue Bel Air strain rainbows as the primary species.
- Maintain artificials only and immediate kill regulations.
- Institute a no kill slot of 16-22".
- Decrease the bag limit to 2 fish, only one of which may be larger than 22".
- Alter harvest and population structure by manipulating harvest through regulations.

INTRODUCTION

Lee's Ferry is a 15-mile tailwater fishery located below Glen Canyon Dam in northern Coconino County southwest of Page, at 111° 35' W and 37° 52' N. It is administered by the National Park Service, Glen Canyon National Recreation Area. The Colorado River at Lee's Ferry has undergone many changes since the completion of Glen Canyon Dam in 1963, including runoff/flow patterns, temperature, dissolved oxygen, sediment transport, and the aquatic food chain. Beginning in 1964 the Department began stocking rainbow trout and in 1968 introduced aquatic food organisms to take advantage of the newly created "tailwater" fishery. Trout were stocked as catchables from 1964-1976. In 1971 the amphipod Gammarus began to appear regularly in trout stomach samples. Beginning in 1976 a fingerling stocking program was initiated. In 1977 a regular creel census program (which had been discontinued in 1973) was resumed to evaluate the fishery.

By 1977, many trout over 3.5 pounds were being creeled. Lee's Ferry received public and Department attention. With sportswriters' help Lee's Ferry was "discovered". The Department did not feel the trophy fishery could sustain increased angling pressure where

fishermen could harvest a legal ten fish limit that weighed over forty pounds. Therefore a four fish bag limit was enacted in 1978.

From March 1978 to August 1980, rainbow trout were not stocked to evaluate the question of stocking versus natural reproduction. During this time approximately 250,000 brook and 60,000 cutthroat trout were stocked.

The angling public changed rapidly, with more angler days expended, more non-resident use, and a tremendous increase in the use of boats to reach areas otherwise inaccessible in the late 1970's. In 1979 the Department recommended implementing both immediate kill and artificial lure recommendations. These recommendations produced considerable controversy. Only the immediate kill regulation was implemented in 1980, as the public and the Commission did not find an artificials only regulation acceptable.

Both fishermen and the Department became concerned when the Bureau of Reclamation announced it would begin peak power production when Lake Powell filled in 1980. During 1980 and 1981, Arizona Game and Fish conducted a study to evaluate instream flows and their impact on the fishery (Persons et al. 1985).

In addition a study was conducted by Northern Arizona University in 1982 and 1983 to answer questions about fishermen's attitudes (Richards et al. 1985).

Fluctuations in water level, associated with hydroelectric "peaking power" generation, affected the Colorado River at Lee's Ferry and through Grand Canyon National Park. Primary concerns at Lee's Ferry included angler access, stranding of spawning fish and eggs, and impacts on the food base. These concerns were incorporated into the Glen Canyon Environmental Studies, administered and funded by the Bureau of Reclamation (1984-86 Phase I; Maddux et al. 1987).

Between 1980 and 1984 anglers voiced increasing concern over the "decline" of the fishery, in particular the decreasing size of the fish. During this time angling pressure increased to five times the level experienced in 1977, while the average size of rainbow trout in the creel decreased by 70%.

During 1984, a major effort was made to compile and evaluate the various data available on Lee's Ferry and to plot a course of action (Janisch 1985). The artificials only regulation was implemented on January 1, 1986, to decrease mortality on the growing percentage of fish caught and released. It also reduced fishing pressure (and harvest) and increased the average size of fish harvested. A management plan for the period January 1986 to January 1990 was prepared (Reger 1986. Appendix 1). Changes in stocking and regulations produced the desired results: a higher catch rate and an increase in

the average size of fish harvested. This has caused another increase in angling pressure and concern for future management.

CREEL SURVEY

METHODS

The boat launch at Lee's Ferry provides the only access point for boat fishermen, and affords an ideal point at which to interview large numbers of fishermen as they complete their trips. A Department creel clerk has been stationed there an average of 6 days a month during 1985-1988.

The number of fish harvested is calculated from the harvest rate (calculated from AGFD creel census data) and the number of angling hours expended (calculated from NPS use data).

Calculations are stratified by boat and shore fishermen. Boat counts (NPS data), party size and trip length (creel data) are used to calculate boat fisherman hours. Shore angler counts are treated as an average number of anglers present each daylight hour.

Harvest is not stratified by weekend-weekday, as count data (NPS) is not.

ANGLING PRESSURE

Angler use of Lee's Ferry (based on National Park Service public use data) has increased dramatically (Table 1). Reductions in pressure occurred in 1978 (four fish bag limit), 1980 (immediate kill regulation), 1984 and 1985 (reduction in size of creeled fish), and 1986 (artificials only regulation). The number of angler days has remained a good estimate of pressure, as there has been little change in the length of the angling day (boat fishermen range 6.97-7.22 hours; shore fishermen range 4.45-4.87 hours).

Angler use decreased with a decline in the catch rate, smaller fish, and high water in 1983-1985, and the change to artificials only in 1986; it has risen again to a level only exceeded by the 1982-1984 peaks.

CATCH AND HARVEST RATES

Anglers at Lee's Ferry are more successful than at most waters, with only about 20% of the anglers catching no fish. The waters in Region II with the next best success rates are Whitehorse Lake and Oak Creek. Their no-catch rates are approximately 40%. Catch rates at Lee's Ferry compare favorably with other tailwaters and with other waters in Arizona (Table 2).

Table 1. Summary of creel survey statistics from Lee's Ferry, 1977-88.

Year	NPS Angler Days	Angler Hours	Creel per Hour	Catch per Hour	Mean Length (mm)	Mean Weight (g)	Estimated Harvest	Percent Released
1977	10,613	72,202	– 0.24	n./a	398	735	17,320	n/a
1978	9,990	67,932	0.20	n./a	445	1,015	13,586	n/a
1979	22,085	150,178	0.15	n./a	431	926	22,527	n/a
1980	18,986	129,105	0.09	0.13	465	1,153	11,619	30
1981	28,784	195,731	0.14	0.22	436	957	27,402	36
1982	49,000	333,200	0.13	0.19	449	1,042	43,316	31
1983	– 52,725	– 358,530	0.15	0.27	431	926	53,780	44
1984	40,174	273,183	0.16	0.37	370	595	56,887	57
1985	19,953	139,912	0.20	0.55	370	548	42,004	64
1986	14,951	90,598	0.12	0.36	426	827	16,573	67
1987	26,395	161,286	0.16	0.65	416	770	36,876	75
1988	29,939	200,277	0.16	0.77	412	731	41,477	80

Table 2. Comparison of catch rates for various waters.

Lee's Ferry, 1986	0.36
1987	0.65
1988	0.77
Green River, Utah, 1980-84*	1.14
San Juan, N. Mex., 1984-85	0.86
Region II waters (n=7)	0.37
Region I waters (n=8)	0.48
Basic yield waters (n=5)	0.50

*Prior to artificials and slot limit regulations.

In general, catch rate has experienced a continuous increase, especially since 1986, while harvest rate has remained relatively constant (Fig. 1).

There appears to be a slight decrease in harvest rate since the implementation of the artificial only regulation in 1986. Harvest rate also seems to have leveled out since mid-1986, with less of a spawning season peak. Catch rate, on the other hand, has shown a dramatic increase since 1986, and still exhibits high points during spawning season. The percentage of fish that are caught and released has increased from 30% in 1980 to 80% in 1988 (Table 1). This confirms the need for the artificials only regulation.

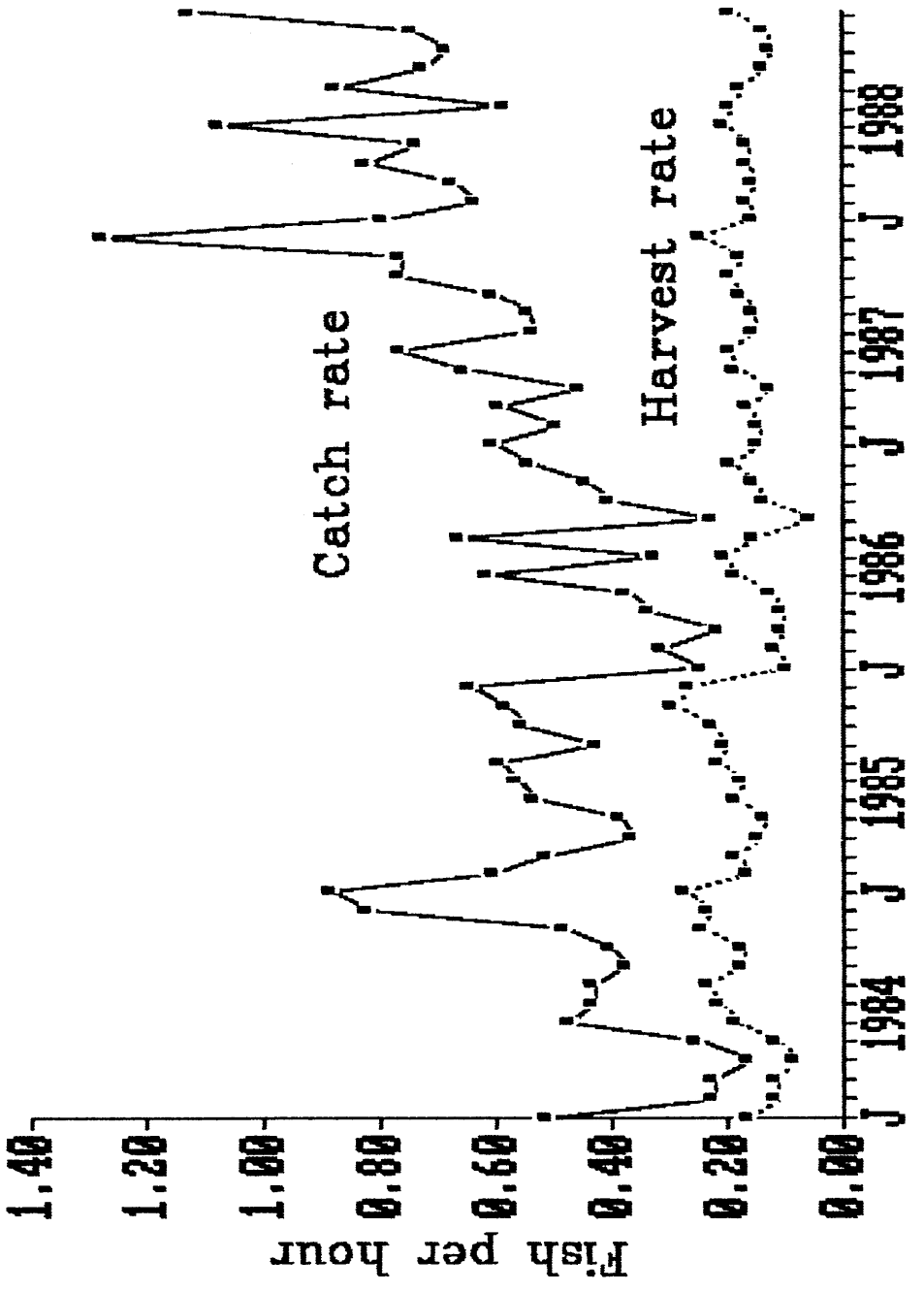

Figure 1. Average monthly catch and harvest rates at Lee's Ferry 1984–88.

SIZE OF FISH

Mean length of trout in the creel fluctuated around 17 inches (432 mm) until late 1983, then began to decline (Table 1). Mean length rose again in late 1985 - early 1986 and has stabilized at a level only slightly lower than in 1981 -1983. Mean weight of trout in the creel followed the same pattern, with larger fluctuations at greater lengths, as larger fish gain (and lose) more weight per inch (Appendices II and III).

The decrease in mean lengths and weights in the creel beginning in 1983 corresponds to both the peak in use and the beginning of continuous high "flood" discharge. Lengths and weights rose again in early 1986, which corresponds to both the implementation of the artificials only regulation and the return to "normal" discharge patterns, and probably to a change in the type of angler fishing at Lee's Ferry.

Condition factor (a length/weight or "fatness" index) has remained relatively constant other than seasonal variation. It was slightly higher in 1984 (1.04), and slightly lower in 1987 (0.97), than the overall 1984-1988 five year average (0.99).

Size distributions of fish are often more valuable in evaluating changes in a fishery than are mean sizes. Figure 2 provides the number of fish estimated to have

been harvested each year by size increment. This allows not only the percentage, but the actual harvest (area under the curve) to be visualized. This shows a larger average size, fewer small fish, and reduced harvest in 1986. Harvest increased greatly in 1987 and 1988, and included larger numbers of smaller fish.

The decline in size in 1986-1988 shows a trend alarmingly similar to that of 1982-1984, with the greater harvest being comprised increasingly of smaller fish, but without the fish over 20" of the earlier period.

The distribution of size groups harvested has changed considerably. After 1983 the contribution of fish over 25" long to the creel has virtually disappeared. Fish over 20" long made up about 25% of the harvest in 1979-1983, and less than 10% in 1985-1988. In 1984-1985, fish less than 15" accounted for approximately 50% of the harvest. This decreased to about 20% in 1986; however, the contribution to the creel of fish smaller than 15" has been increasing ever since.

SEASONAL PATTERNS

Some fairly predictable seasonal trends have developed in the fishery. Use peaks in early spring and fall (Fig. 3), corresponding to times when ambient air

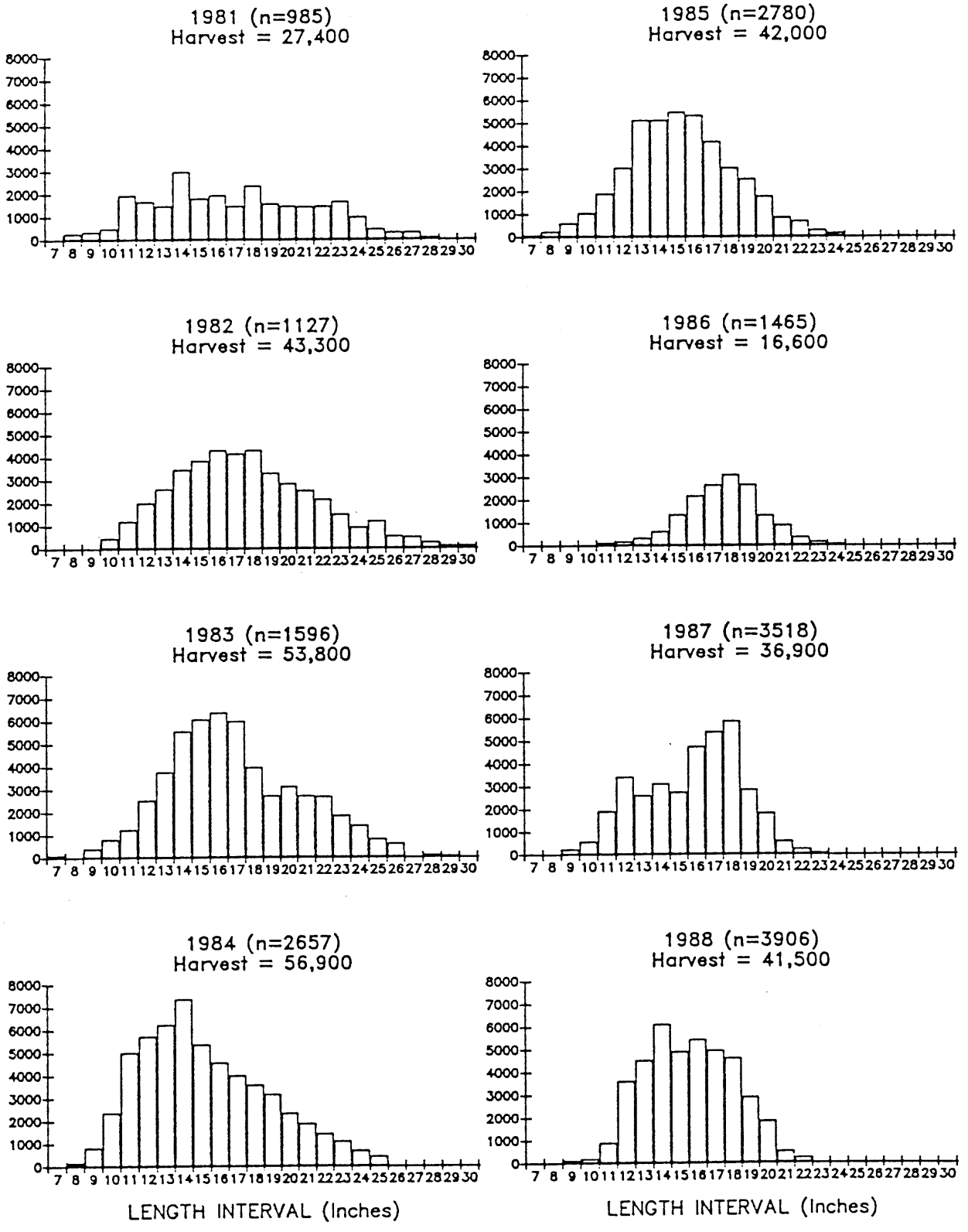

Figure 2. Harvest by year and length at Lee's Ferry 1984-88.

temperatures are less extreme and flows tend to fluctuate least (Cook 1989). Catch rates are highest in midsummer and midwinter (Fig. 4). Condition factor also follows a seasonal pattern, apparently a result of fall/winter spawning activity (Appendix IV). There may also be some relationship to flow pattern and food availability (Leibfried and Blinn 1987). Decreased condition factor and catch rate, coupled with increased use leads to increased complaints from anglers in late winter/early spring.

don't they want spawning fish?

ELECTROFISHING

While creel census provides valuable data on anglers and their harvest, it often does not present a true picture of the fish population, since certain species or sizes are selected against. Electroshocking also has sampling biases but provides another method of evaluating the fish population. As electrofishing more representatively samples most sizes of fish, it is often used to estimate growth and survival rates. Figure 5 shows length frequencies from April electrofishing samples, 1984-1988. Inspection reveals the possibility of a year class averaging 10 inches in 1985, 15 inches in 1986, and 18 inches in 1987. Another year class starts at 8 inches in 1987 and is 14 inches in 1988.

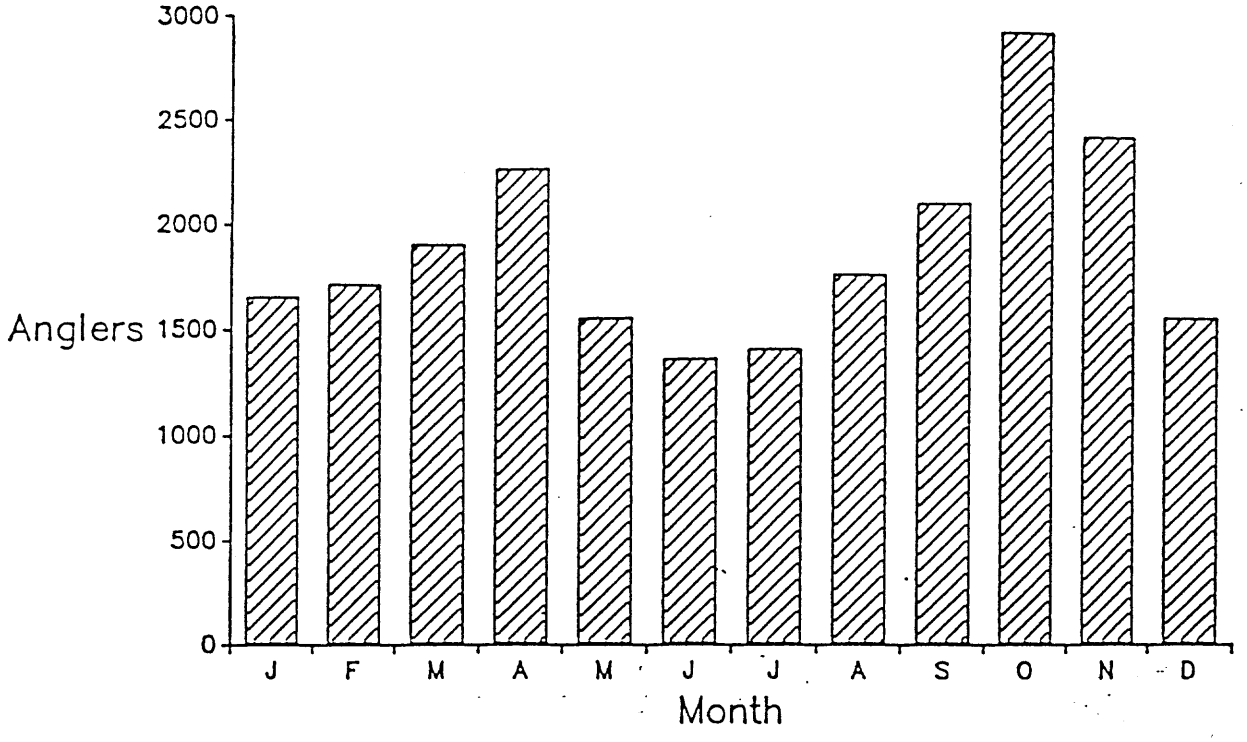

Figure 3. Monthly mean angler count at Lee's Ferry 1985-88.

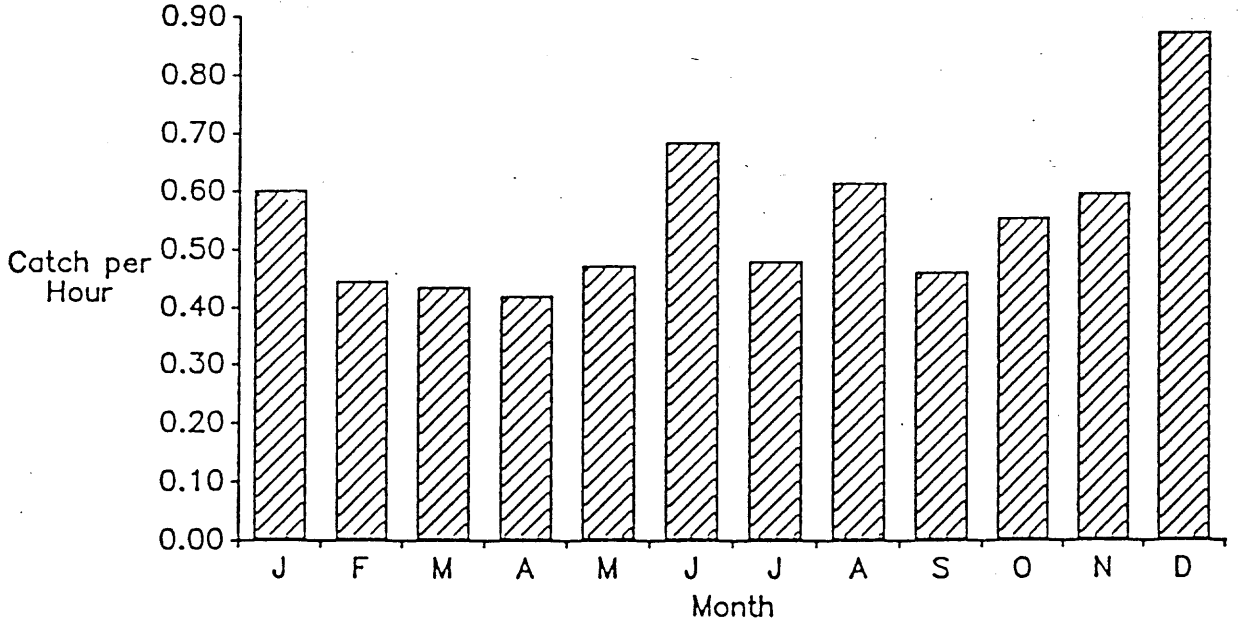

Figure 4. Monthly mean catch per angler hour at Lee's Ferry 1984-88.

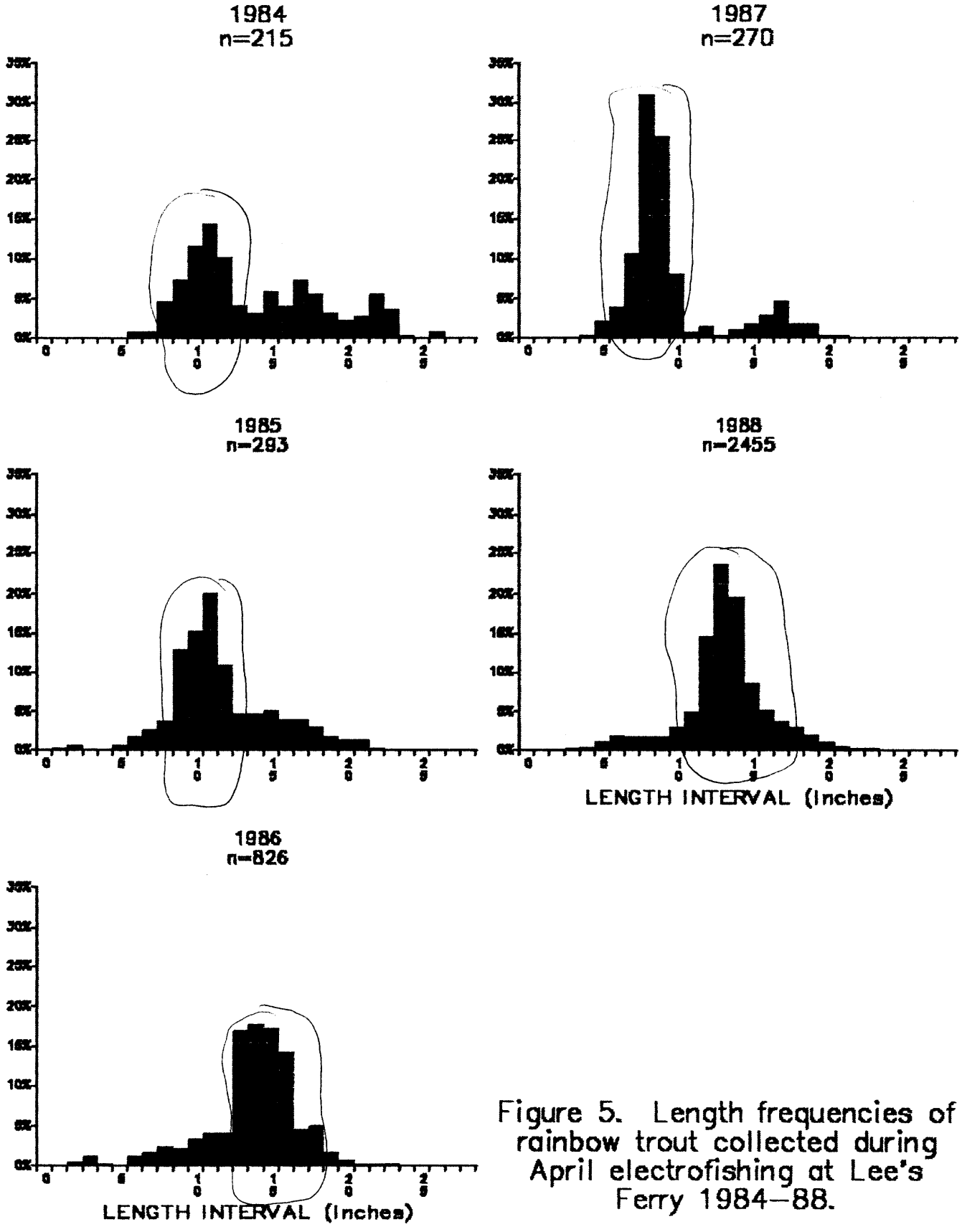

Figure 5. Length frequencies of rainbow trout collected during April electrofishing at Lee's Ferry 1984–88.

Electrofishing also samples species not frequently taken by anglers. Table 3 shows the percent species composition (and total fish sampled) by electrofishing in 1984-1988. This indicates that brook trout have been relatively stable at 5% of the population other than in 1986, and carp have been constant at 1%. The two species that change are rainbow trout and flannelmouth sucker, apparently due to large fluctuations in the flannelmouth population, which was high in 1985-1986 and very low in 1987-1988.

Table 3. Species Composition of Fish Sampled by Electrofishing at Lee's Ferry, 1984-1988.

	Percent of Sample					
Species	1984	1985	1986	1987	1988	Average
Rainbow Trout	85	78	79	94	92	86
Flannelmouth Sucker	8	16	17	1	2	9
Brook Trout	6	5	2	5	5	5
Carp	1	1	1	0	1	1
Brown Trout			*			
Bluehead Sucker		*	*		*	
Channel Catfish		*				
Striped Bass					*	
Other		*	*			
N	1459	2314	1212	663	4318	

* Less than one percent

Concern has been expressed by various groups over mortality and/or injury suffered by fish collected by electrofishing. These collections have been done under contract, and the contractors are aggressivly working to

reduce injury caused by sampling. However, some loss of individuals is to be expected when sampling fish and is part of the cost of obtaining data necessary for good management.

GROWTH

Due to fairly constant temperatures, no annulli on scales or otoliths have been detectable. Early attempts to fin clip fish were not conclusive, either because of sample size, or the apparent regeneration of fins (Janisch 1985).

Hatchery fish stocked since 1983 have been marked with oxytetracycline to evaluate the relative contribution of hatchery and natural reproduction to the fishery. However, all hatchery fish have been marked, precluding following a given year class.

Electrofishing data can be analyzed by plotting peaks of all size groups on each sample date over time. Curves drawn from left to right over time can be used to estimate the average growth of a year class. This analysis is complicated by multiple stocking dates in a year and by selective harvest of fish. Data collected by the Glen Canyon Environmental Studies is presented in this manner in Figure 6. There appear to be four fairly distinct year classes (April 1984-February 1985, October

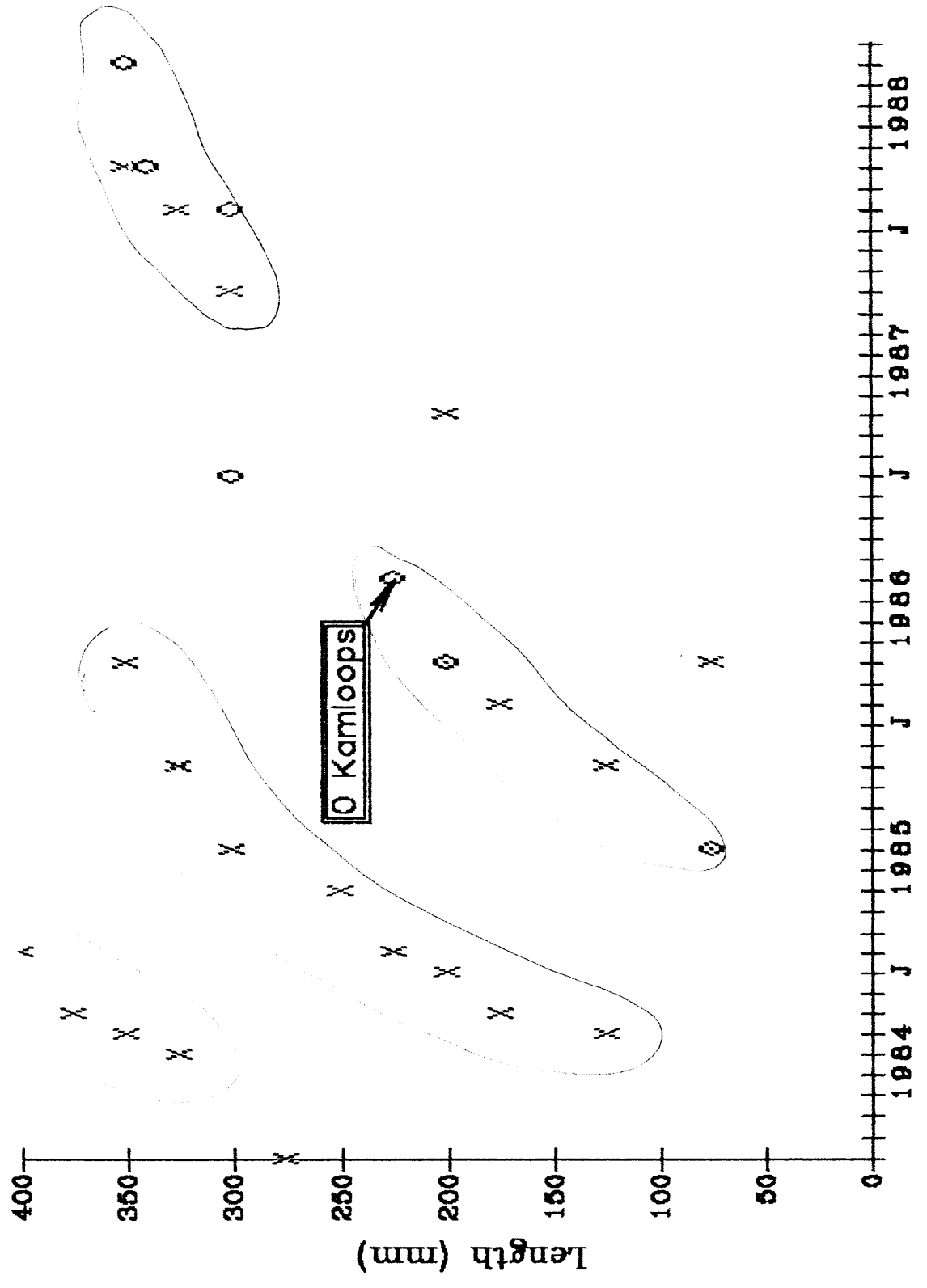

Figure 6. Electrofishing length frequency peaks at Lee's Ferry 1984–88.

1984-April 1986, July 1985-April 1986, April 1986-April 1988), excluding the data on Kamloops strain fish. All four of these year classes appear to have a growth rate of about one-half inch per month (range 0.45-0.54). This is considerably less than the estimated 1" per month (Bancroft 1980, per. comm.) or the estimated 3/4" per month (Maddux 1985, per. comm.) which would compare to the 1" per month reported for the Green River below Flaming Gorge Dam (Johnson et al. 1987).

The estimated growth rate of 1/2" per month was for fish stocked at much higher densities, under higher water conditions, and more heavily harvested than in earlier years. Food availability - due to stocking rate, changes in flows, or aging of Lake Powell (decrease in plankton and nutrients) - could have caused a decrease in growth rate. Peaks in length frequencies tend to run together at lengths over 16". It is also possible that harvest simply removes the larger fish, therefore it is difficult to estimate growth of larger fish from frequency tables.

Length at age was estimated from electrofishing and creel length frequencies (Table 4).

LAW ENFORCEMENT

The Department frequently receives complaints of

Table 4. Estimated length (inches) at age, Lee's Ferry rainbow trout.

Age	Length
I	10.0
II	14.9
III	18.5
IV	22.2
V	25.0

inadequate law enforcement at Lee's Ferry, implying that lawlessness is rampant. Data compiled in Region II, however, indicate that anglers at Lee's Ferry are in higher compliance than average. For the period 1985-1988 the rate of fishing non-compliance (citations per 100 anglers interviewed, excluding watercraft citations) was 3.4. This compares favorably to other Region II waters (Cataract Lake - 2.6, Kaibab Lake - 3.2, Perkin's Tank - 10.0, Mud Lake - 7.2, Soldiers Annex Lake - 5.3, Santa Fe Lake - 6.7, Lower Lake Mary - 6.7, City Res.- 4.8).

Special patrols on holiday weekends in 1983-1988 with marked and unmarked officers have found an average non-compliance of 4.6 (range 0.7 - 10.2). Inspection of vehicles returning through Cameron agricultural inspection in 1983-1988 totaled 370 anglers, 662 fish, and only 4 citations - all in 1987 for overlimits.

For 1987-1988 Lee's Ferry accounted for 31% of all citations in Region II: 41% of the fishing violations and

Table 5. Lee's Ferry citations, 1985-88.

Year	Total Citations	% no Lic./stamp	% With Live Fish	% Over Limit	% Using Bait
1985	210	38	24	5	N/A
1986	116	23	17	18	11
1987	172	41	11	2	24
1988	314	22	12	9	37

41% of the watercraft violations. This is an area which has less than 10% of the total acres of water and less than 15% of the angler days in the Region II, and in spite of a high compliance rate. This reflects the high level of enforcement activity at Lee's Ferry. Janisch (1985) was correct that "law enforcement is more than adequate".

SAN JUAN SHUFFLE

The practice of shuffling (dislodging bottom organisms into the current to form a chum line) has increased in popularity in recent years. This has raised a legitimate concern among anglers who find the practice offensive. The biological problems are centered on habitat destruction. Both food production and spawning bars can be severely impacted in local areas. Another problem is the increased rate of foul hooking when

fishing in a downstream chum line. Even if released, many more of these fish will die as a result of the hook wound or infection from the increased handling required to remove the hook.

This practice has been made illegal in Utah and New Mexico, but enforcement is extremely difficult. There is a concerted effort to educate the public about the consequences of this practice by angling organizations. This probably represents the most feasible solution to the problem in Arizona.

MANAGEMENT IMPLICATIONS

Objectives need to be established that satisfy public desires and maximize the unique biological potential of this fishery. "Trophy trout fisheries are rare in the American Southwest, and Lee's Ferry is regarded by many anglers to be the most highly prized. Indeed, some anglers travel across the nation to fish its waters." (Richards et al. 1985). The recreational benefit has conservatively been estimated at 5 million dollars (1982 dollars) by Richards et al. (1985).

With artificial only regulations, it appears that a catch rate of 0.6 to 0.9 fish per hour can be maintained. Harvest rate seems to have stabilized at about 0.15 fish per hour while maintaining angler

satisfaction. Angler densities are well below the maximum of 2.5 anglers/acre/week recommended for "Blue Ribbon" fisheries (Stephenson 1985), reaching only 1.0 in 1982. The real item of discussion is what constitutes a large/trophy fish? Richards et al. (1985) found that 65% of respondents felt that catching a trophy was important and Bishop et al. (1987) found that increases in the probability of catching a large fish (greater than 4 pounds) is an important attribute of a Lee's Ferry fishing experience. Richards et al. (1985) also, through several questions, ascertained that anglers at Lee's Ferry felt a trophy fish weighed seven pounds (from length-weight regressions this is a 26-27" fish at Lee's Ferry).

Lee's Ferry is biologically capable of supporting, and the public desires, a quality fishery beyond the "blue-ribbon" concept in the cold water strategic plan. Objectives are to maintain a catch rate of 0.6-0.9 fish per angler hour, maintain a harvest of 30-40 thousand fish per year, increase the number of "trophy" sized fish caught (and harvested) and thereby increase the average size of fish available to the angler.

There are a variety of tools available to managers for control of population structure and harvest of fish populations. These tools fall into three general

categories: stocking, harvest restrictions, and habitat manipulation.

STOCKING

Preliminary results of oxytetracycline marking of stocked fish (Janisch 1985) as well as analysis of year classes indicated that stocked fish contributed approximately 75% to the harvest. Final rates reported in "Effects of Varied Flow Regimes on Aquatic Resources of Glen and Grand Canyons" (Maddux et al. 1987) were 27.5% natural reproduction, or 72.5 % due to stocking under steady high flows. In recent years, large numbers of fish have been stocked (Table 6) and stocking rates have been stabilized.

Persons et. al. (1985) presented a model to estimate stocking rate at Lee's Ferry. This model was made while bait fishing was still allowed, so mortality rates may have been higher (release rates were also lower then). A harvest rate of 0.15 fish per hour (very close to the 1984-1988 average of 0.16) was used. The conclusion was to stock 111,000 fish annually to sustain 350,000 angler hours at a harvest rate of 0.15 fish per hour. By this formula it would require 85,000 fish to be stocked annually to sustain 200,000 angler hours at 0.2 fish per

Table 6. Stocking Summary for Lee's Ferry, 1978-1988.

Year	Thousands of Trout			
	Rainbow*	Brook	Cutthroat	Total
1978	50	200	60	310
1979	-	43	-	43
1980	15	40	1	56
1981	108	60	-	168
1982	50	50	-	100
1983	99	50	-	149
1984	128	-	-	128
1985	121?	50	-	171?
1986	128	40	-	168
1987	121	25	-	146
1988	150	-	-	150

*Including Kamloops: 1985 - 60, 1986 - 34, 1987 - 21, 1988 - 66.

159,000 fish per year from 1985-1988. Distribution of stockings both in time and geographically, as recommended by Gosse (1985), Persons et al. (1985), and Reger (1986), by using tanks mounted on a raft has been accomplished. Average size of fingerlings stocked has not quite been the 3" minimum recommended. We have not shifted strains, but have stocked domestic strain Bel Airs and have tried to evaluate the Kamloop strain in comparison. Kamloop fingerlings had adipose fin clips by volunteers prior to stocking in 1985-1988.

The growth rate of Kamloops has been very similar to Bel Airs (Fig. 6); however, condition factor, especially in the smaller fish, has not been as good as Bel Air rainbow and brook trout (Fig. 7). Return to creel has been poor - Kamloops were 38% of the rainbow trout stocked in 1985-1986 but were only 2% of the rainbow trout creeled in 1987-1988.

It would be possible to stock a year class of an identifiable strain (eg Albinos); however, growth and survival data obtained would apply only to that strain. Also, some strains (especially Albino) do not do as well when stocked as fingerlings. While spray pigment marking does not stay on all fish, or for the life of the fish. It could provide growth data for several years.

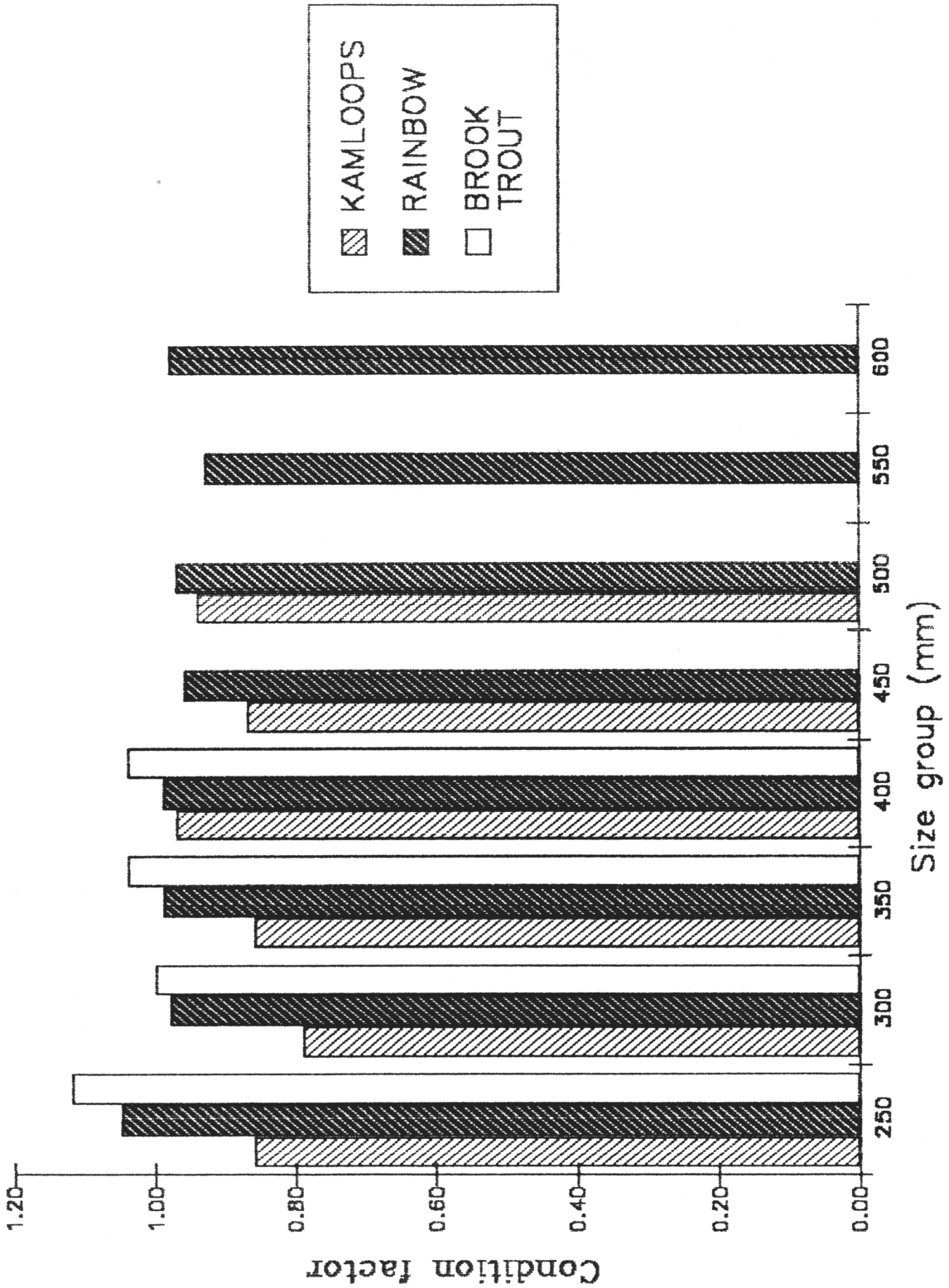

Figure 7. Mean condition factor of trout creeled at Lee's Ferry 1988.

HARVEST RESTRICTIONS

There are many types of harvest restrictions: when (seasons), how (terminal tackle), how many (bag limits), which (size limits). All have strengths and weaknesses for achieving specific objectives (an example of several, with reference to Lee's Ferry, is presented in Appendix 5 and represents one group's assessment). Several of the most often discussed options for use at Lee's Ferry are presented below.

Terminal tackle restrictions

A fair amount of interest has been expressed in further restrictions on terminal tackle. Literature on salmonid hooking mortality has been summarized by the State of Washington (Mongillo 1984), and data excerpted from that study are presented in Figure 8. Conclusions from that paper include:

> There are no differences in hooking mortality between any artificial lures or flies, with or without barbless hooks, on any salmonid species.
>
> Use of bait causes significantly higher mortality than use of artificial lures or flies. There is likely a positive relationship between temperature and hooking mortality.
>
> Fish hooked in gills, esophagus, tongue, or eye are four times more likely to die than those hooked in the jaw or mouth - bait fishing causes hook penetration in critical areas approximately 50% of the time, artificials less than 10%.
>
> There is no technical basis for requiring single barbless hooks.

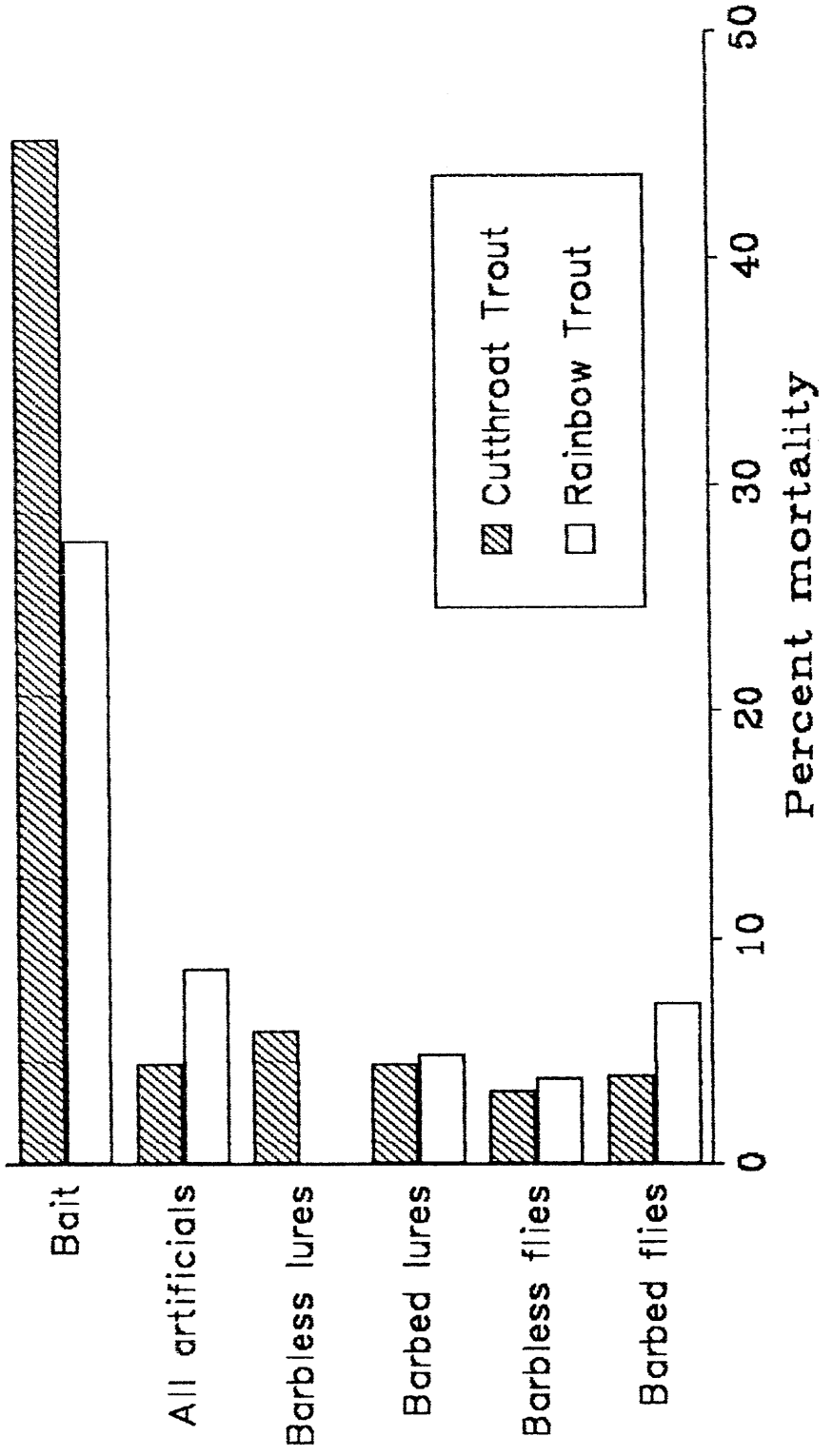

Figure 8. Hooking mortality associated with various gear and bait (Mongillo 1984).

There is firm technical basis for prohibiting the use of bait for trout fishing.

A recent study in California (Titus and Vanicek, 1988) found high temperatures greatly increased mortality, and at high temperatures single barbless hooks caused greater mortality among hook types.

Bag limits

Depending on the assumptions made in the model, a two fish bag limit could have a range of impacts on the harvest. A least impact scenario is achieved if one assumes a one day trip (i.e. bag = possession and all visits are one day each) and that all parties "pool" their bag limits. Under this scenario a two fish bag limit would impact approximately 20% of the anglers and harvest would be 81% of the present level.

A most impact scenario uses an average anglers' trip as 2.5 days (Janisch 1985, GCES 1988), assumes no "party" fishing, and assumes that no fish are consumed during the trip. It results in a two fish bag/possession limit impacting all anglers and in a reduction in harvest to 61% of present.

Neither of these scenarios accounts for unsuccessful anglers, catch and release anglers, or anglers who "save" room in the bag for a trophy fish or to legally continue catch and release fishing.

Size limits

There are three kinds of size limits: minimum, maximum, and slot limits. A minimum size is used to protect fish until they reach certain size acceptable to the majority of anglers. It is often used where pressure is high and usually results in most of the fish harvested being just over the minimum size. A maximum size protects larger fish for spawning or for a trophy catch-and-release fishery. Its value is to increase recreational use at expense of harvest.

Slot limits have been proposed as a method to increase the catch of large fish without greatly reducing the total harvest (Jensen 1981). Theoretically, the catch of "trophy" fish can be increased considerably (by 60%) while only slightly decreasing total harvest (14%) with a 15-20 inch no kill slot (Persons et al. 1985). If the trophy fish are of greater value to the angler, a slot limit maximizes the recreational value of the fishery.

HABITAT MANIPULATIONS

What proposed?

FLOWS

Glen Canyon Dam, although its primary purposes are flood control and water storage, releases water primarily

in response to needs for production of hydroelectric power. This results in low minimum flows (when water is being "conserved") and rapid changes in flows (and water level). Low levels reduce the carrying capacity of the system by reducing habitat. Persons et al. (1985) recommended a minimum flow of 8,000 cfs to maintain the fishery. Flows also affect anglers. Kelly (1986) reported that catch rate and flow rate were inversely related on the San Juan River, New Mexico. Maddux et al. (1987) reported this to be true at extreme ranges of flows at Lee's Ferry. Flows also influence the accessibility to upstream areas and boating safety.

Flow variations also have the potential for direct impacts on the population. Estimates from as high as 15 to as low as 2 thousand adult fish per year being lost by stranding - mostly during spawning season - have been made. As no good data exists on the relation of water level and/or ramping rate (changes in water releases) on stranding, all such losses are lumped with "natural mortality" and reduce the fish available for anglers. Water level fluctuations also desicate redds and kill eggs and fry. Juvenile fish are forced to move continuously in search of habitat - increasing the exposure to predation and impacting their growth potential. Some fluctuations may increase food

availability (drift), but large fluctuations could desicate or scour food producing areas.

RECOMMENDATIONS

RESEARCH

1) Impacts of various flow regimes, particularly minimum flows and ramping rates need to be evaluated. Even if no change in power production patterns occur, there may well be an average of 3.5 million more acre feet per year released (the amount formerly stored to fill Lake Powell (Cook 1989)). How this could best benefit the fishery needs to be known (by maintaining minimum flows or reducing ramping rates). In particular, flow impacts need to be assessed upon:

A) Stranding of spawning adults

B) Mortality of eggs and fry

C) Proximity of juvenile habitat at different flows

D) Angler access

E) Food resources and trout growth, including stomach samples not from the creel

2) Assess marking methods so that individual year classes can be followed and growth and mortality rates (natural and angling) documented.

3) Institute a sampling and marking program that will allow the determination of population size structure.

STOCKING

1) Reduce stocking rate to 80,000 Bel Air rainbow trout and 30,000 Snake River cutthroat per year.

2) Do not change this stocking rate until growth rates have been determined. The impact on growth rate of any future increases in stocking to meet angling pressure can then be determined.

3) Spray-pigment mark year classes so growth can be documented.

4) Continue to distribute fish throughout the reach by raft.

5) Attempt to distribute fish at different times to increase growth and survival (eg. Dec. eggs to 3" by April 1 at PSH, by June 1 at CCH).

6) Discontinue stocking Kamloops and brook trout due to poor performance, but continue to follow existing year classes. Begin evaluating Snake River cutthroats, as they have been particularly successful in achieving trophy status in the Green River (J. Johnson, pers. comm.). Mongillo's (1984) data suggest that cutthroat may survive being caught and released (Fig. 8) better

than rainbow trout. Cutthroat also have a reputation for being more susceptible to angling.

CREEL

Maintain creel efforts at present or slightly increased levels. Attempt to include more data on shore anglers in the "walk-in" area. Add, on a regular basis, carefully selected opinion questions to determine satisfaction, desirability of change, what is a trophy, etc. Attempt to gain better information on sizes of fish released.

POPULATION SURVEYS

Select three areas for annual electrofishing. Sample a minimum of two hundred fish from each area for size composition and to examine for pigment marking.

INFORMATION AND EDUCATION

Much of the controversy over programs could be alleviated if the public was aware of their purpose. Information on how to release fish would increase the survival of fish returned to the water. Knowledge of

the reason for harvest restrictions could increase voluntary compliance.

HARVEST REGULATIONS

1) Maintain artificials only and immediate kill regulations.

2) Decrease bag limit to two fish. This should maintain existing harvest and allow for some increase in pressure.

3) Institute a no-kill slot. This should increase the average size of fish caught, increase the catch and harvest of trophy fish, and maintain a high catch rate.

The harvest of smaller fish will prevent "stock-piling" and reduced growth rates. "Stock-piling" has become a problem on the Green River in Utah (Johnson, per. comm. 1989). Many anglers wish to harvest fish for consumption, and this approach is compatible with management objectives.

It is also desireable to allow the harvest of some trophy fish, as this is important to many anglers, as long as this harvest does not negatively impact the average size of fish available to be caught. In New Mexico the solution on the San Juan was to gradually increase the top of the slot - this seems to have worked well.

PROPOSED CHANGES

It is proposed that a 16-22" no-kill slot, and a reduced bag limit of two fish, only one of which may be over 22", begin January 1, 1990. The long range plan is to achieve an 18-26" no-kill slot (or even larger) as the fishery develops.

Maintain a constant stocking rate until growth rate can be determined. It is proposed that for the management segment (1990-1995) population structure and harvest be manipulated by changes in harvest regulations only. Once information on growth and mortality rates are available, stocking rate can be adjusted. This information, and continued creel data on catch rates and harvest will indicate any necessary changes in the slot or in the bag limit.

ALTERNATIVES

There are some viable, but less preferable options to the proposed changes in management.

1. A 16-22" no-kill slot only, with 3 fish allowed below and one above the slot. This might not reduce harvest, which appears to be needed even at present stocking rates. It could be a good option if the

anticipation is new regulations would cause a drastic reduction in pressure, however, this is not expected.

2. Two fish bag, 18-26" no-kill slot. This represents an immediate jump to our long range objective. It would probably underharvest small fish initially, stock-pile fish in the slot, and result in very little trophy catch or harvest. It also would not allow creel data to dictate changes or even provide data to evaluate progress. This would most likely invite considerable controversy each year over regulation changes, but without an adequate data base to make an objective recommendation.

3. A trophy tag or "open" slot, where a 2 fish bag below 17" is allowed, and a number of tags are sold for fish larger than 17". There are many variations to this theme (the west coast punch-card; punch license for each trophy tag and increase cost for additional tags, etc.). This would be difficult to administer,and the angling public is not ready for this radical an approach to trophy management.

4. Total catch and release. This would not allow for harvest, which many anglers desire. Current estimates are that a "harvest" (including extra hooking mortality) of 40,000 fish is compatible with a 0.6-0.9 catch per hour, increased average size, and increased catch and harvest of trophy fish. It is possible the

harvest could be increased if the estimate of natural mortality proves to be too high or if increased stocking can be shown not to affect growth rate.

Submitted by Scott Kogan

Approved by Joseph L. Jones, Jr.

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WORK PLAN

Plan Category	Date Submitted
Cold Water	January 1986
Submitted By	**Region**
Scott Reger	2

Title

Lee's Ferry Fish Management Plan

Total Est. Cost	Time Period Covered	Location of Work
$	From (Mo./Yr.) 1-86 To (Mo./Yr.) 1-90	Lee's Ferry

Objectives Develop and maintain a trout fishery at Lee's Ferry as "Blue Ribbon" waters by providing harvest rates of .3 fish per hour; catch rates at or above 1 fish per hour and maintain an average length for harvested fish of 18 inches.

Justification Lee's Ferry currently is the only trout fishery in Arizona that has the potential to produce trout, on the average, over 18 inches. According to the coldwater plan there are 22,000 days of "Blue Ribbon" demand we are not able to supply. Managing Lee's Ferry "Blue Ribbon" fishing will help meet part of this demand.

Procedures

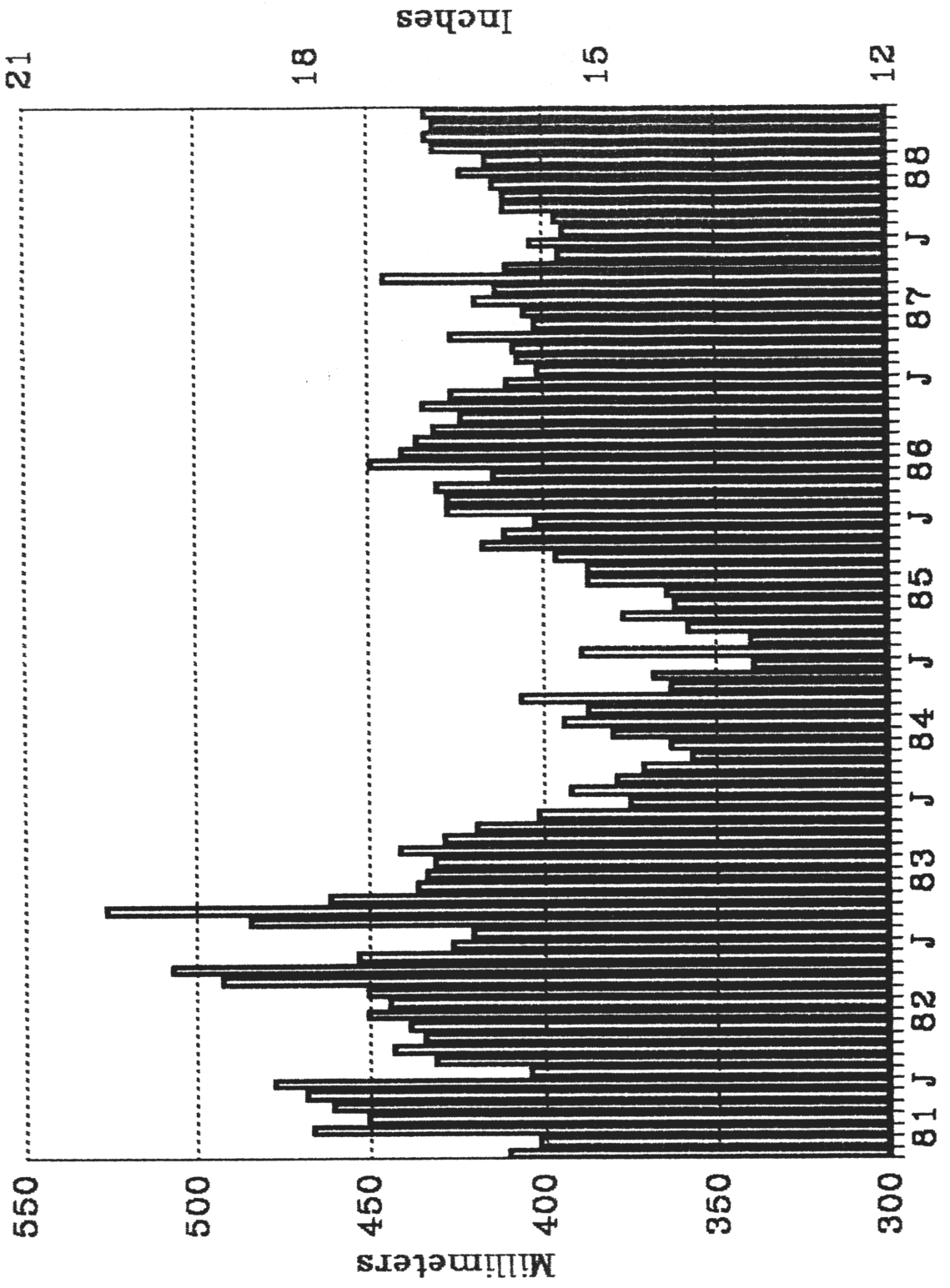
1. o Stocking: 100,000 - 150,000 3" Fingerling Rainbow trout and
   30,000 - 50,000 3" Fingerling Brook trout annually.
   - o Disperse stocking between dam and boat ramp.
   - o Stock at least 2 different times March - July to avoid year class failure due to discharge events.
   - o Evaluate growth condition and return of various strains to creel.
   - o Mark strains so they are identifiable in creel.
2. Creel:
   - o Monitor total pressure (angler days and hours)
   - o Monitor catch and harvest rates by strain.
   - o Monitor growth and return rates by strain.
   - o Evaluate impact of artificial lure regulation.
   - o Collect tags to evaluate movement and growth.
   - o Monitor size and condition of fish harvested.
3. Population Surveys
   - o Quarterly or at least twice annually evaluate biological parameters (growth, condition, size, relative numbers) of strains w/out angling bias.
   - o Occasional down river population sampling for comparison with Ferry population.
4. Food Base Studies
   - o Initiate benthos and drift sampling.
   - o Stomach samples - alternate years.
   - o Food related to flow pattern.
   - o Food related to "age" of Lake Powell.

(Over)

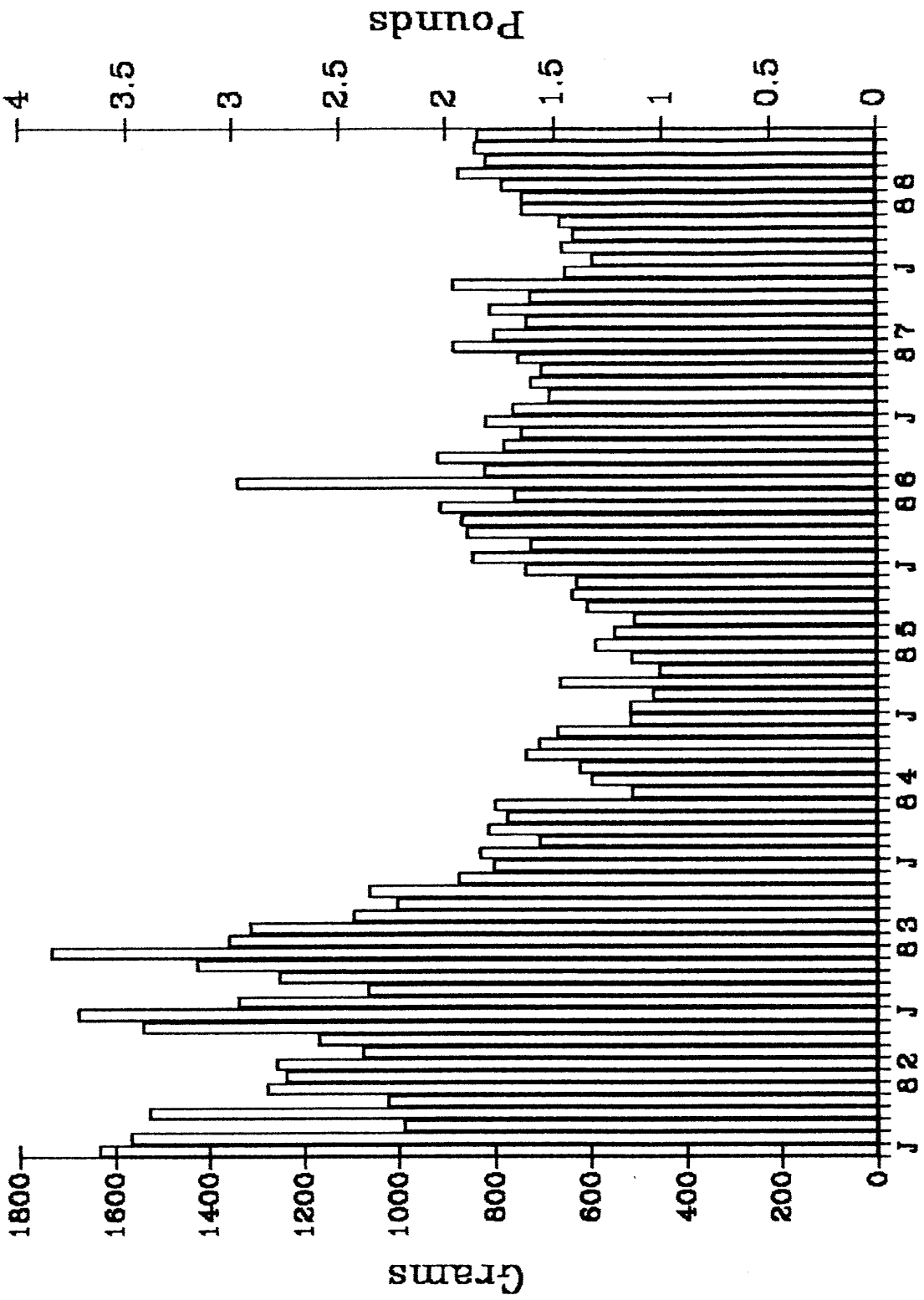
Fisheries Specialist	Branch Supervisor
Scott J. Reger	J. Jonas

Procedures Continued

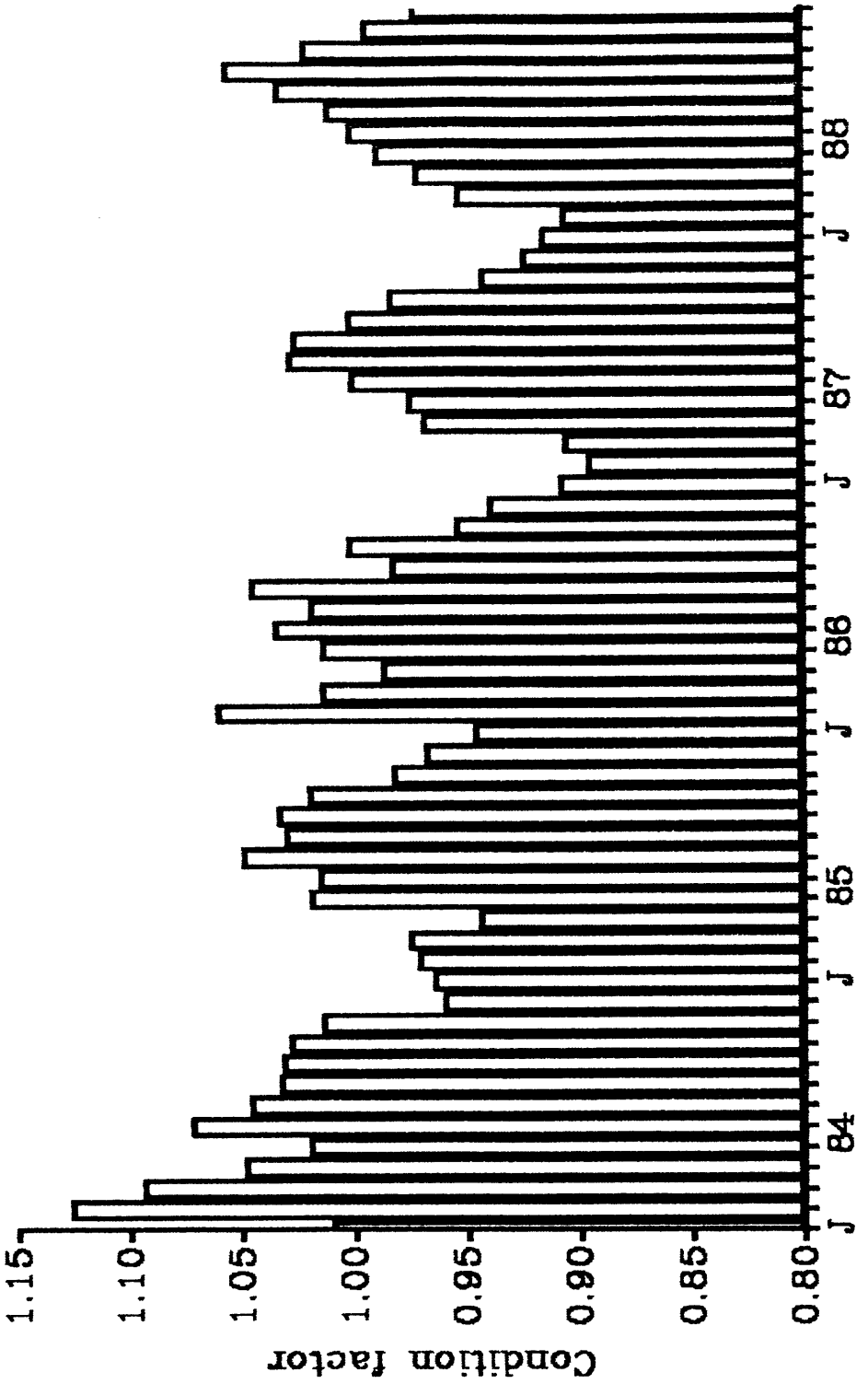
5. Aggressive Information and Education Program
   - o TV show spots.
   - o Display at visitor center at dam.
   - o Information available at marble CYN.
   - o Annual "presentation" to guides, etc., on results of studies.



Appendix II. Monthly mean lengths of rainbow trout creeled at Lee's Ferry 1981–88.



Appendix III. Monthly mean weights of rainbow trout creeled at Lee's Ferry 1982–88.



Appendix IV. Monthly mean condition factors of rainbow trout creeled at Lee's Ferry 1984–88.

SUPPLEMENT TO "THE FLYCASTER"

VOL. VII, ISSUE 3 Official Newsletter of the Northern Arizona Flycasters March, 1989

LEE'S FERRY MANAGEMENT OPTIONS

Well folks, here they are. As we discussed at the last meeting, it is time to adopt a managment plan for the Ferry that we can get behind and endorse, as a group, to the Commission in October. With the help of Scott Reger, we have compiled a list of the most acceptable options along with their strengths and weaknesses. By "acceptable", we mean from a biological and enforcable management viewpoint. One important note: the examples set forth here are for clarification purposes only: they are NOT meant to represent management options currently being considered! It is up to us as an important user group to decide which, if any, options are (1) acceptable to us as a group, and (2) that we can successfully promote to the Commissioners and the angling public. As you can see from this list, Game and Fish are doing their job; now it's time for us to do OURS.

MANAGEMENT OPTIONS

(1) STATUS QUO (four fish limit; flies & lures only)
- Strengths: it's easy; no effort required; we have more protection now than four years ago.
- Weaknesses: increased angler use may increase harvest and decrease average size of catch; large fish are currently being over-harvested.

(2) TOTAL CATCH & RELEASE
- Strengths: protects large fish (trophies) including spawners; will promote self-sustaining fishery.
- Weaknesses: protects small fish from harvest which could reduce overall growth rate (lots of little fish); angler dissatisfaction due to no harvest.

(3) TWO FISH BAG (Example: no slots or size restrictions, but angler must stop fishing when second fish is kept)
- Strengths: will reduce harvest; will maintain high catch rate.
- Weaknesses: large trout are not protected to enable them to grow into trophy classes.

(4) MAXIMUM SIZE LIMIT (two or four fish limit)
- Strengths: would reduce harvest of large fish; increase average size of catch.
- Weaknesses: no harvest of trophies, angler dissatisfaction, increased mortality due to necessity of measuring catch. (NOTE: This is the general weakness of any slot and size limit.)

(5) NO-KILL MID-SIZE SLOT (Example: two fish under 16", one over 20")
- Strengths: would protect mid-size fish (i.e. they grow "large").
- Weaknesses: harvest of large fish continues when slot-sized fish grow into legal harvest size; handling (measuring) mortality increases; stockpiling of mid-size fish could reduce growth rate. (Green River, Utah)

(6) TROPHY PERMIT (Example: two fish under 17"; 4,000 trophy tags per year at "X" dollars each [like Elk tags])

Strengths: trophies can be harvested, but bulk of large fish protected; small fish are harvested; handling mortality moderated; trophy fish can be managed on a yearly basis (i.e. more trophies harvested when biologically sound, fewer when spawning population needs protection); may generate additional revenues.

Weaknesses: costly to administer; non-resident or travelling anglers may be discriminated against.

(7) MINIMUM SIZE LIMIT (Example: two fish limit, must be 18" or over)

Strengths: maintains catch rates and harvest; angler satisfaction.

Weaknesses: doesn't protect trophy and spawning size fish; average size of catch will not improve.

(8) SEASONAL BAG LIMIT (Example: ten fish per angler per year)

Strengths: would reduce pressure; reduces harvest.

Weaknesses: law enforcement and administration difficulty; angler dissatisfaction.

(9) STRATIFIED DAILY BAG BY SIZE CLASS (Example: two fish 16" or less, one fish 16"-22"; one fish 22" plus)

Strengths: would protect size classes (large fish) while allowing for fine-tuned management; could maintain catch and harvest rates.

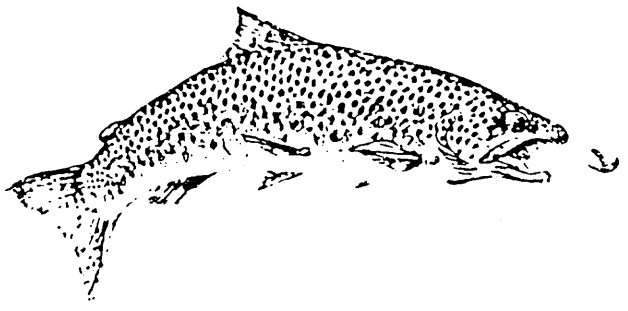
Weaknesses: lots of handling mortality; enforcement and administration problems; size classes maintained (i.e. no increase in very large fish).

(10) LIMITED ENTRY (Example: 10,000 three-day access permits per year by drawing*)

Strengths: limits pressure and harvest; may maintain catch and size rates per 1988 statistics.

Weaknesses: administration problems; angler dissatisfaction; probably would not increase size of trophy fish (would likely be equal to a "freeze" of current conditions: good fishing for 18"-20" fish, decline in trophy and spawning population).

As you can see, management of a resource is never a cut-and-dried proposition. However, it is up to us as a **potentially** influential user group to adopt **ONE** viable option, promote it to the Game and Fish, secure their cooperation, and present it to the Commissioners and other user groups. Let's do it!



Appendix VI. Hypothetical management scenario.

In theory it would be possible to maintain a sort of steady-state fish population by manipulating harvest regulations and stocking rate. In reality, many other factors influence fish population paramenters. The example provided below cannot be modified for actual use until such parameters as growth and mortality rates are available. Also, to be useful, the level of impacts of varing flow releases would need to be known. The following model is based on population parameters estimated in Persons et al 1985 and a stocking rate of 100,000 fish per year.

To reduce the controversy over regulation changes each year, specific indicators could be adopted to trigger specific regulation changes for the following year. The following harvest levels are based on the assumption that 40 of each 100 thousand fish stocked are available for harvest and the increased loss to hooking mortality anticipated with a slot limit.

Indicator	Problem	Management regulation
-estimated harvest of 1,000 fish or more above slot	top of slot not high enough-could increase size and number of "trophys"	increase top of slot
-catch per angler hour falls to 0.5 or lower	reduced population below and/or in slot	decrease bag to one fish below and one fish above slot
-average size of fish harvested below slot falls more than 1"	overharvest below slot - too few will reach slot	decrease bag to one fish below and one fish above slot
-estimated harvest of 30,000 or more below slot	overharvest below slot - too few will reach slot	decrease bag to one fish below and one fish above slot
-estimated harvest of 20,000 or less below slot	underharvest below slot - too many fish get in "stock-pile"; decrease growth and size	increase bag limit below slot