MINIMUM FLOW NEEDS

FOR

TAYLOR CREEK

LAKE TAHOE BASIN MANAGEMENT UNIT

WITH

TAYLOR CREEK KOKANEE FISHERY

by

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Prepared by

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June 1981

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PREFACE

This document was prepared in conjunction with another report, that being a hydrologic analysis of the Fallen Leaf Lake watershed, the other is a revision of the Fallen Leaf Dam Operation and Maintenance Plan. The U. S. Forest Service operates the dam for varying purposes which are sometimes in conflict with each other. The sum of these documents will allow the Forest Service to operate the dam in an efficient and consistant manner in order to maximize the benefits associated with both Fallen Leaf Lake and Taylor Creek, within the constraints imposed by man and nature.

This report serves as input to the hydrologic analysis. The Analysis identifies the water available, and, with the results presented here, an operating plan is developed that will be used to manage the reservoir. The Operations and Maintenance Plan is basically a field document describing the dam and its appurtenances and the reservoir target levels for each release period.

INTRODUCTION

Taylor Creek is a tributary to Lake Tahoe and is located near the southern apex of the lake. It is the outlet to Fallen Leaf Lake (actually a reservoir), and the flow in the creek is controlled by the dam on the lake. The creek is approximately 1.5 miles long. Average width is between 15 and 30 feet. Bottom material ranges from cobbles and rocks at the upper ends to fine sands at the mouth.

The U. Forest Service Visitor Center is located adjacent to Taylor Creek. The facilities include a nature trail that provides information on aquatic ecology and a stream profile chamber. The chamber consists of a manmade channel and pond adjacent to the creek and is supported by a direct diversion of water from it. The Visitor Center is open from the spring until the fall and attracts approximately 75,000 visitors yearly.

The Forest Service has controlled the flows in Taylor Creek since approximately 1951. The present dam was constructed in 1934 by Anita Baldwin. An older dam exists about 600 feet upstream from the present structure which restricts flow out of the lake below gage heights of about 2.8 feet.

Objective

The Forest Service manages the dam primarily for two purposes:

1) To comply with the stipulations as set forth in the Memorandum of Understanding between the Fallen Leaf Lake Protection Association and the Forest Service (1972).

2) To sustain the Kokanee fishery in Taylor Creek and provide for other instream uses.

Beyond these purposes the lake is further managed to provide those lake levels desired by the Association. However, this use is not strictly compatible with providing for instream flows and in the past there have been cases where the values associated with the instream flows in Taylor Creek have suffered because of management directed toward providing lake levels desired by the homeowners. Of course, the opposite has also occurred.

The objective of this report is to identify those instream flows necessary to sustain the beneficial uses associated with Taylor Creek. This will provide the data necessary to attempt to resolve the conflicting uses and provide for better management of the lake.

The benefits derived from instream flows are generally a function of those flows e.g., increasing flows during the Kokanee spawning run increases the spawning habitat, which increases the number of resultant fry, and thence the fishery in total. Therefore, use of the term mimimum in this study should be qualified. Given the functional relationship, it is possible to identify a minimum flow adequate to allow propagation of a species, to sustain its present level, or to maximize its numbers.

For the purposes of this study, two levels of flow for those uses associated with species maintenance will be identified; that required to insure only the survival of the populations associated with the creek, and that flow needed to sustain the population at its present numbers. The latter implies that this level of flow will not create a long term downward trend in the population.

INSTREAM FLOW USES

Esthetic & Recreational

A certain amount of flow is needed to retain the esthetic and recreational values associated with the creek. The creek and associated riparian areas attracts such activities as hiking, biking, picnicing, nature study, cross country skiiing, and fishing. The proximity of Taylor Creek to the Fallen Leaf Campground, the Visitor Center, the bike trail, the Morraine trail and the cross country ski trail creates substantial amounts of the above listed uses within the Taylor Creek stream environment zone. The total number of people using these facilities is approximately 194,000 each year. The heaviest use occurs during the summer season but there is substantial use all year long.

Esthetic and recreational values increase in proportion to the flow probably up to bankfull stage. Past this point the stream is viewed more as threat to ones safety and the attraction diminishes. While flows for esthetic and recreational values cannot be absolutely quantified it is presumed that there needs to be sufficient flow for the creek to be viewed as an active body of water supporting vigorous and diverse aquatic and riparian ecosystems. it is assumed that a flow of 15 to 20 cfs is needed to fully achieve this perception.

Operation of Forest Service Stream Profile Chamber

The stream profile chamber is a major attraction at the Visitor Center, especially so during the Kokanee spawning run. A constant supply of water is needed to circulate through the profile chamber to provide aerated water which supports fish and other aquatic life. This circulation of water also keeps water temperatures as low as possible, which inhibits algae growth and insures adaquate levels of dissolved oxygen, since the amount of oxygen that can be held in water decreases as the temperature increases. A minimum of 2 cfs is needed to run the chamber. A flow of 4 cfs is desirable.

Maintenance of Bald Eagle Food Source

The Bald Eagle, an endangered species, prey on the Kokanee during and after their spawning run in Taylor Creek. The eagles are found primarily near the mouth of the creek. They reside in the basin from mid October through mid February. The Kokanee are a limiting factor as to the number of eagles that roost in the Taylor Creek area and probably limit the total number that can winter in the basin. It is Forest Service national policy under the Endangered Species Act of 1973 to protect the status of rare and endangered species (FSM 2670.11). The habitat along Taylor Creek has been proposed as essential habitat to the Regional Forester and may be classified as habitat critical to the survival of the species. Management direction on this Unit in relation to Taylor Creek is to "protect and enhance the habitat for fish..... to insure an adequate and increasing food supply for wintering eagles." (Bald Eagle Winter Management Plan for the Lake Tahoe Basin Management Unit, 1979).

In order to be consistant with the above stated management direction it is necessary to insure that the basis of the eagles food source, the Kokanee, is sustained. Improving the status of the Bald Eagle here is contingent upon increasing the average number of Kokanee that spawn in Taylor Creek each year. This, in turn, is contingent upon increasing the available spawning habitat, which is a function of the water that can be released during the fall and winter.

Aquatic Habitat Maintenance

This use is somewhat self-explanatory. In order to maintain the aquatic ecosystems and food chains in Taylor Creek there must be water in the creek. A yearlong minimum flow of at least 10 cfs would be desirable for this purpose. Beyond this minimum it is desirable to greatly increase flows during the spring runoff period in order to support endemic species which have adapted themselves to this type of flow regime.

Fisheries

Taylor Creek supports three fisheries; Rainbow Trout, Brown Trout, and Kokanee Salmon. Although each has a different life pattern they share

Certain instream flow needs:

1) Each requires sufficient flow to attract the fish to spawn and provide spawning habitat.

2) All species require sufficient flow during the incubation period to prevent eggs from exposure to freezing or desic- cation, and to provide aerated water for respiration.

3) Each species requires sufficient flow after fry have emerged to provide essential habitat and to insure aerated water at desirable temperatures.

A more detailed analysis of the flow requirements of each species follows:

Rainbow Trout

Rainbow trout spawn in the spring and are adapted to the typical un- controlled snow fed stream. This is characterized by a seasonal peak flow from snowmelt runoff in the spring followed by a steady recession during the months of June, July and into August. Low water occurs during August through September. Streamflow levels rise in October and November due to a reduction in evapotranspiration and recharge by fall rains. Flow is then steady through the winter.

Rainbow usually spawn from February through June depending on water temperature. Colder water delays the onset of spawning, (Moyle, 1976).

In Taylor Creek most spawning occurs from April to June (correspondence: California Department of Fish and Game to U.S.F.S., 1961). In order to mimic the conditions to which they are adapted flows of at least 25 cfs are needed during this period (correspondence: California Department of Fish and Game to U.S.F.S., 1961).

Incubation time is also a function of temperature with eggs hatching in 4 weeks at temperatures of 10 - 15^{0}C (Moyle, 1976). Because of lower water temperatures; the incubation period in Taylor Creek is probably 6 weeks. The fry emerge from the gravels 3 weeks later. The young Rainbow trout commonly remain in the creek for a year before migrating downstream. Sufficient flows are needed during this period to provide habitat and aerated water for the young fish. Flows of at least 10 cfs are desirable during this period.

Brown Trout

Brown Trout are fall spawners and usually spawn in Taylor Creek in October and November. For the temperatures encountered in Taylor Creek the eggs take 3 to 4 months to hatch (Staley, 1966). Brown Trout require flows of at least 25 cfs during the spawning period and at least 10 cfs during the incubation and emergence period. (ibid, Montgomery, 1961).

Kokanee Salmon

The Kokanee were accidently established in Lake Tahoe in 1944 when fry were released into the lake from the hatchery on the north shore (Seeley and McCannon, 1966). A run was subsequently established in Taylor Creek. The Kokanee spawn in the fall and die within a few weeks thereafter. They prefer cool water, from 42^{o} to 55^{o}F. Redds are made in gravels from 0.5 inches to 4 inches in diameter. The average redd is 20 inches by 36 inches in area. They are constructed in 3-10 inches of water with a current of less than 2.5 feet per second (Shultz, 1935).

The Kokanee in California originated from stock from British Columbia which is under a maritime climate. Fall and winter streamflow regimes under these condition are characterized by increasing flows in the fall caused by significant fall precipitation followed by steady or increasing flows throughout the winter and into the spring. It can be assumed that the Kokanee do best under the flow regime that they evolved under.

ANALYSIS OF KOKANEE FLOW REQUIREMENTS

Since providing for fall and winter flows for the Kokanee is often in conflict with the desires of the Association, it was recognized that analysis was needed to identify what factors, in terms of the fall and winter flow regime, most affect the Kokanee. Normally, such an analysis would consist of field observations coupled with a statistical analysis.

The most important factor affecting the number of progency produced from a given spawning run is the amount of available habitat. Large amounts of suitable habitat insure that redds are successfully constructed and the eggs covered without interference from females constructing redds upstream or downstream. It can be assumed that increasing flow during the spawning period increases the available habitat, thus largely eliminating the need for field observation of spawning habitat if flow data is available. However, beyond a certain point flow velocities reach a level where the fish must struggle to remain in a stationary position and eggs and milt are washed downstream rather than being deposited in the redd. Further increases cause the gravels and cobbles composing the redd to be moved, thus exposing the eggs and, again, washing them downstream. Figure 1 represents the relationship between flow and spawning habitat. This was derived by field surveys of the creek at various flows to determine the available habitat at each flow. Potential habitat had to have all of the following characteristics before it qualified as suitable habitat.

1. Bottom material had to range from 0.5 to 4 inches in diameter.

Interstitial space could not be completely filled with fine sediments.

2. Flow depth was at least 3 inches.
3. Velocity near the bottom did not exceed 2.5 feet per second.

Notice from Figure 1 that the relationship between flow and habitat is linear between flow of 7 cfs to 17 cfs. From there, to the last observation at 24 cfs, increases in flow produce continually smaller increases in habitat (the derivative of the function approaches zero). Since there are no observations past this flow level, the exact shape of the curve is not known. However, it is probably relatively flat and then actually drops back down as flow velocities start to exceed the maximum allowable for suitable habitat. From the graph it appears that the optimum flow level is 23 cfs At this flow level, habitat is near the practical maximum and will produce near the maximum number of progeny.

A statistical analysis using multiple linear regression was performed to determine what factors most affect the spawning Kokanee. The objective being to use the data to formulate reservoir release plans which will maximize Kokanee production given the constraints imposed by the limited water available for release in the fall and winter.

Date on the number of Kokanee that run up Taylor Creek each year since 1960 were provided by Russ Wickwire from the California State Department of Fish and Game. In choosing candidates for independent variables the

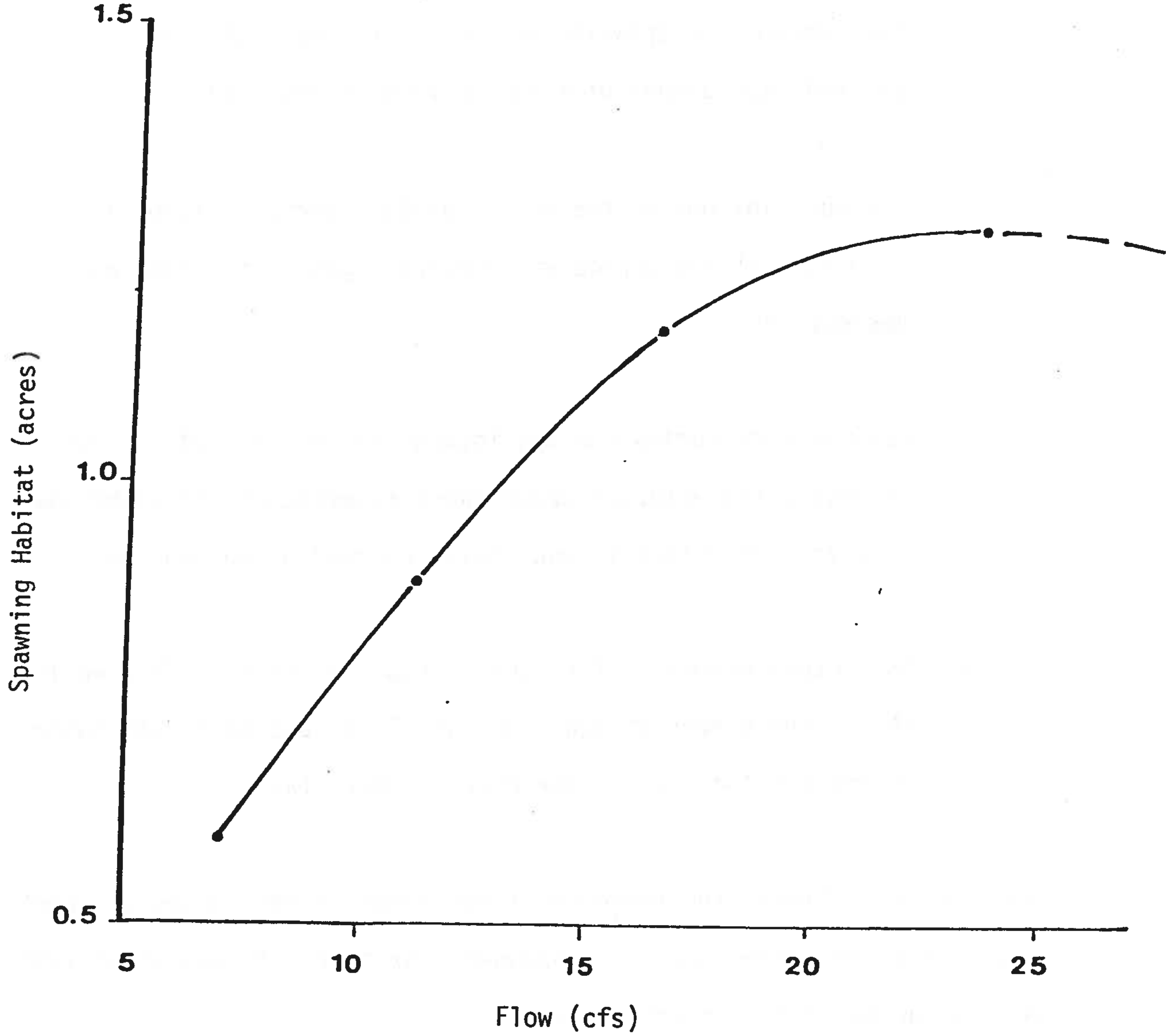

Figure 1. Relationship between spawning habitat and flow.

following general factors were identified for the reasons stated:

1) Flow during the spawning period. The amount of flow controls the amount of spawning habitat available.

2) Minimum flow during the egg incubation period. Insufficient flow during this period would expose eggs to freezing and desiccation.

3) Maximum flow during the egg incubation period. High flows of suggicient velocity would cause movement of stream bottom materials resulting in eggs being crushed or washed away.

4) The actual number of fish that run up the creek. This would affect the number of eggs that are layed and hence the number of progeny that run up the creek 3 years later.

Based on the criteria the independent variables listed in Table I were chosen to be regressed upon the dependent variable, the number of fish that ran up the creek in any given year.

The analysis regressed the number of fish spawning against the number of fish spawning in the creek three years previous and the flow conditions they encountered. Only nine years of data were available. The limiting factor in the analysis is the amount of flow data available in Taylor Creek. This is a minimal amount of data for any regression analysis,

Table 1. Independent variables used in the regression analysis

Variable Name	Definition
OCTFLOW	Average daily flow (cfs) 3 years previous to the year in question.
OCTNOV	Average daily flow (cfs) from October 1 - November 30.
OCTNOV15	Average daily flow (cfs) from October 15 - November 15.
NOV	Average daily flow (cfs) during November.
WNTERMIN	Minimum 3-day average flow during December 1 - March 31.
NOVMIN	Minimum daily flow during November.
MAXDA3	Maximum 3-day average flow during November 1 - February 28.
MAX	Maximum daily flow during November 1 - February 28.
FISH3	Number of fish spawning 3 years previously.

particularly multiple regression. The raw data is presented in Table 2.

The regression analysis was conducted using a stepwise procedure because of a large degree of correlation between variables assumed to be independent. A multiple linear regression computer program from SPSS (Statistical Package for the Social Sciences, 1970) was run on the U. S. D. A. Univac 1100 computer located in Fort Collins, Colorado.

Results

Results of the analysis indicate that by far the most important factor affecting the success of the Kokanee is the flow during October. OCTFLOW accounts for 65% of the total variance in the number of progeny resulting from fish spawning in the creek three years previous. A test of significance was made employing the null hypothesis that there is no correlation between the number of mature progeny and the Oct 5-31 flow three years previous. Using the F statistic this hypothesis was rejected at the .01 level of significance. This implies that there is only a 1% chance that the null hypothesis is indeed valid and that the observed correlation is due to mere coincidence.

The relation is a positive one, i.e. higher flows during this period produce more fish. The highest observed OCTFLOW was 25 cfs, in which 8,100 fish produced 27,000 fish (Table 2).

The ramaining variables were found to be marginally significant at

Table 2. Data used in the regression analysis.

Year	Spawners	Observations 3 years previous								
		OCTFLOW (cfs)	OCTNOV (cfs)	OCTNOV15 (cfs)	NOV (cfs)	WNTERMIN (cfs)	NOVMIN (cfs)	MAXDA3 (cfs)	MAX (cfs)	FISH3 (cfs)
1979	8,300	13	12	14	115	2	4	16	16	3,000
1978	27,000	25	32	50	38	8	21	123	146	8,100
1977	17,000	16	10	8	5	5	3	31	33	6,000
1976	3,000	10	32	104	143	24	15	685	987	5,400
1975	8,100	11	13	13	14	21	14	182	203	7,500
1974	6,000	14	11	10	8	13	6	36	39	14,000
1973	5,400	12	18	17	25	28	13	148	200	27,000
1972	7,500	5	7	8	10	10	9	675	964	31,000
1971	14,000	11	28	14	45	30	9	126	132	19,000

this time. However, this appears to be largely a result of insufficient data, and while statistical methods preclude their being called significant at this time, neither does it rule out this label when additional data becomes available. The paucity of data and the high degree of correlation within classes of variables gave some spurious initial results, with a suspiciously high R2 of 0.92. Since it had already been determined that OCTFLOW was the most important spawning flow variable an additional run was made selecting only one variable from the maximum and minimum flow classes.

This run gave an overall R Square of 0.73. Of the independent variables, only OCTFLOW was found to be significant, again at the highly significant 0.01 level. Pertinent sections of the computer printout are in Appendix A.

Discussion

The analysis revealed that probably 75% or more of the total variation in the number of fish spawning in Taylor Creek can be explained by the number of fish spawning three years previously and the flow conditions under which they spawned. This is quite high considering that, once the fry migrate into the lake, they are exposed to predation and fishing pressure, which certainly affects the total population. It also makes obvious that the fate of the Kokanee fishery in Taylor Creek is determined by how the Fallen Leaf Lake dam is operated.

Interestingly, the relationship between the number of spawners and the number they successfully reproduce is inverse, i. e. fewer fish produce more progency than do more fish. This appears to be the result of spawning females competing for limited redd space. When this occurs the females tend to destroy each others redds and eggs previously deposited are washed away.

It is likely that the effect of flood flows on the Kokanee is not a linear relationship and, while it is quite a significant factor, it will not become visible using linear regression techniques. At best, the relation may be truncated linear. Flow velocities below that required to move the gravels in which the redds are constructed will have no impact on the eggs. Flows higher than this threshold will begin to wash out the eggs.

Minimum flows during the winter do not appear to be as important a factor in incubation success as was originally hypothesized. However, this cannot be stated with any degree of assurance because of the limited amount of data, with limited variability, (only 2 observations below 8 cfs), and the mean minimum flow being 15.6 cfs which is far above the recommended minimum winter release of 10 cfs.

Prior to this analysis it was generally held that the critical spawning period was November, and that the maximum flow release should be reserved for that month. However, flow in November accounts for only 2% of the total variance in the number progeny. While the fish are indeed in the creek in November, it appears that, by far, the majority of spawning activity takes place in mid to late October. In any case, it has been conclusively shown that it is the flow level from approximately October 5-31 that has the dominate effect on the number of resulting progeny.

Recommendations

In order to maximize the production of Kokanee it is necessary to maximize the amount of suitable spawning habitat during the period the fish are actually spawning. It is also necessary to provide sufficient flows to keep eggs from being exposed to freezing or desiccation and to limit flows to below levels where eggs would be washed away. Based on the results of the statistical analysis the following flow regime should provide for the greatest number of progeny with the least amount of water released:

Release Period	Flow (cfs)
Oct 8-31	22-26
Nov 1-15	15
Nov 16-Feb 28	10
March 1-31	15

Selection of the flow periods is based on the life cycle of the Kokanee within Taylor Creek and the available flow from Fallen Leaf Lake. The flow periods and the corresponding portion of the life cycle is as follows:

October 8-31 . . . . .Spawning activity

November 1-15 . . . . .Residual spawning acitivty

November 16-30 . . . . .Egg incubation and period of very low water availability

December 1 - February 28 . . . . . . .Egg incubation

March 1-31 . . . . .Egg hatching and fry emergence.

It should be noted that, because of the inverse relationship between the number of spawners and their progeny, the amount of water released during October 8-31 should, to some degree, be a function of the number of spawners. When the number of spawning fish exceeds about 15,000 then it is critical that as high a release as possible be made so that there is sufficient habitat and a minimum of competition for redd space. During years when limited water is available and few fish run up the creek to spawn, then providing flows of only 15-20 cfs, should not have a detrimental effect.

The reasonable minimum flow needed to maintain a viable Kokanee run, which would result in a substantial cutback in their future potential numbers, at least temporarily, but would insure their survival as a population is as follows:

Release Period	Flow (cfs)
October 8-31	10
November 1-15	10
November 16-30	5
December 1-February 28	7
March 1-31	7

These flow levels are prudent and are based on existing data. Minor deviations from them will not result in an extinction of a run. However, increasingly lower flow levels convey a risk of irreparable damage to the population that nature may not be able to mend.

FLOW NEEDS BY SEASON - CONCLUSION

The following section integrates the information and data previously presented. Two levels of flow for each release period will be presented where applicable:

1) That flow necessary to sustain aquatic populations and that necessary to provide for reasonable levels of other instream uses.

2) That flow required to insure only the survival of existing aquatic populations.

These flows are presented in Table 3 and Table 4. The latter is presented with the foreknowledge that available physical storage capacity in Fallen Leaf Lake is severely limited and that often times the levels presented in Table 3, that can be considered the minimum necessary from the standpoint of good fishery and recreation management, will be unattainable. Therefore, due to the frequency of shortfall it is necessary to assign a priority to each instream flow need. The minimum flow required to fullfill higher priority needs will be committed before other uses are satisfied. The priorities are as follows:

1) Kokanee fishery and Bald Eagle habitat maintenance.

2) Maintenance of aquatic ecosystems.

3) Operation of U.S.F.S. stream profile chamber.

4) Brown Trout fishery.

5) Rainbow Trout fishery

6) Recreational and esthetics.

The summary line on Table 3 shows that flow which will satisfy all the uses shown for that release period. The summary line on Table 4 shows that flow necessary to fullfill the minimum flow requirement of the highest priority use.

The values in Table 3 are the minimum flows necessary to sustain the benefits associated with existing instream uses and to insure a vigorous, diverse aquatic ecosystem. They are the minimum prudent flows from the standpoint of good fisheries and recreation management. Every effort should be made to meet or exceed these levels. The Table 4 values are those that will insure only the survival of aquatic populations in Taylor Creek. They are the minimum prudent flows required to achieve this purpose. Operation at these levels over a number of years will, no doubt, lead to a substantial reduction of existing or potential average population levels and a proportionate reduction in the existing or potential beneficial values associated with the instream uses of Taylor Creek.

Table 3. Minimum flows by use and release period.

USE	Release Period Flows (cfs) 1	2	3	4	5	6	7	8	9
Kokanee	23	15	10	10	15	-	-	-	-
Bald Eagle	25	15	10	10	-	-	-	-	-
Aquatic Eco systems	7	7	7	7	7	10	10	10	7
Stream Profile Chamber	4	4	4	4	4	4	4	4	4
Brown Trout	25	15	10	10	10	-	-	-	-
Rainbow Trout	10	10	10	10	10	25	20	10	7
Recreation & Esthetics	10	10	10	10	10	10	10	10	10
Summary	25	15	10	10	15	25	20	10	10

Explaination

Release Period
1. Oct 8-31
2. Nov 1-15
3. Nov 16-30
4. Dec 1-Feb 28
5. Mar 1-31
6. Apr 1- July 5
7. July 6 -15
8. July 16-31
9. Aug 1-Oct 7

Table 4. Minimum flows necessary to insure survival of populations and other absolute minimum flow levels

	Release Period Flows (cfs)								
USE	1	2	3	4	5	6	7	8	9
Kokanee	10	10	5	7	7	-	-	-	-
Bald Eagle	10	10	5	7	-	-	-	-	-
Aquatic Eco-system	3	3	3	3	3	10	10	7	3-4
Stream Profile Chamber	2	2	2	2	2	2	2	2	2
Brown Trout	10	10	5	7	7	-	-	-	-
Rainbow Trout	5	5	5	7	7	10	10	7	3-4
Summary	10	10	5	7	7	10	10	7	3-4

Explaination

Release Period
1. Oct 8-31
2. Nov 1-15
3. Nov 16-30
4. Dec 1-Feb 28
5. Mar 1-31
6. Apr 1-June 30
7. July 1-15
8. July 16-31
9. Aug 1-Oct 7

REFERENCES

1. Correspondence from Robert D. Montgomery, Regional Manager, California Department of Fish and Game, to Forest Supervisor, El Dorado National Forest, February 24, 1961.

2. Memorandum of Understanding Between the Forest Service and Fallen Leaf Lake Protection Association Regarding Operation of Fallen Leaf Lake", 1972, by U.S. Forest Service and Fallen Leaf Lake Protection Association.

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4. Nie, Norman H., C. Hadlai Hull, Jean G. Jenkins and others, 1970. Statistical package for the social sciences. McGraw-Hill Inc., 675 p.

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APPENDIX A

Computer Printout of

Statistical Analysis

STATISTICAL PACKAGE FOR THE SOCIAL SCIENCES 03/02/80

FILE [illegible]

* M U L T I P L E   R E G R E S S I O N * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST 1

DEPENDENT VARIABLE.. [illegible]

VARIABLE(S) ENTERED ON STEP NUMBER 1.. OCTFLOW

MULTIPLE R	.80654	ANALYSIS OF VARIANCE	DF	SUM OF SQUARES	MEAN SQUARE	F
R SQUARE	.65051	REGRESSION	1.	291.75322	291.75322	13.02912
ADJUSTED R SQUARE	.60050	RESIDUAL	7.	156.74678	22.39240	
STANDARD ERROR	4.73206					

------------------ VARIABLES IN THE EQUATION ------------------

VARIABLE	B	BETA	STD ERROR B	F
OCTFLOW	.1111864+001	.80654	.30803	13.029
(CONSTANT)	-.3754237+001			

-------------- VARIABLES NOT IN THE EQUATION --------------

VARIABLE	BETA IN	PARTIAL	TOLERANCE	F
FISH3	.20702	.30529	.76004	.617
WNTERMIN	-.09283	-.14691	.87536	.132
MAXDA3	.06289	.08714	.67103	.046
NOVMIN	-.00283	-.00446	.87093	.000
NOV	-.14515	-.24451	.99174	.382

* *

VARIABLE(S) ENTERED ON STEP NUMBER 2.. FISH3

MULTIPLE R	.82649	ANALYSIS OF VARIANCE	DF	SUM OF SQUARES	MEAN SQUARE	F
R SQUARE	.68308	REGRESSION	2.	306.36249	153.18124	6.46618
ADJUSTED R SQUARE	.57744	RESIDUAL	6.	142.13752	23.68959	
STANDARD ERROR	4.86719					

------------------ VARIABLES IN THE EQUATION ------------------

VARIABLE	B	BETA	STD ERROR B	F
OCTFLOW	.1251667+001	.90795	.36342	11.862
FISH3	.1534573+000	.20702	.19541	.617
(CONSTANT)	-.7634814+001			

-------------- VARIABLES NOT IN THE EQUATION --------------

VARIABLE	BETA IN	PARTIAL	TOLERANCE	F
WNTERMIN	-.14934	-.24056	.82235	.307
MAXDA3	.07019	.10208	.67031	.053
NOVMIN	-.04824	-.07796	.82783	.031
NOV	-.09666	-.16181	.88810	.134

STATISTICAL PACKAGE FOR [illegible] SCIENCES 03/02/80

FILE MULTIPLE (CREATION DATE = 03/02/80) REGRESSION OF FACTORS AFFECTION KOKANEE SPAWNING RUN

VARIABLE	MEAN	STANDARD DEV	CASES
NFISH	10.7000	7.4875	9
FISH3	13.4444	10.1010	9
OCTFLOW	13.0000	5.4414	9
WNTERMIN	15.6111	10.3976	9
MAXDA3	16.6767	29.1102	9
NOVMIN	10.4111	5.8358	9
NOV	33.3333	43.4242	9

STATISTICAL PACKAGE FOR THE SOCIAL SCIENCES 03/02/80

FILE MULTIPLE (CREATION DATE = 03/02/80) REGRESSION OF FACTORS AFFECTION KOKANEE SPAWNING RUN

CORRELATION COEFFICIENTS

A VALUE OF 99.00000 IS PRINTED
IF A COEFFICIENT CANNOT BE COMPUTED.

	NFISH	FISH3	OCTFLOW	WNTERMIN	MAXDA3	NOVMIN	NOV
NFISH	1.00000	-.23775	.80654	-.36600	-.42040	.28730	-.21726
FISH3	-.23775	1.00000	-.48986	.37366	.25755	.00500	-.23614
OCTFLOW	.80654	-.48986	1.00000	-.35304	-.57356	.35927	-.09089
WNTERMIN	-.36600	.37366	-.35304	1.00000	.06904	.34885	.45815
MAXDA3	-.42040	.25755	-.57356	.06904	1.00000	.14035	.56333
NOVMIN	.28730	.00500	.35927	.34885	.14035	1.00000	.46302
NOV	-.21726	-.23614	-.09089	.45815	.56333	.46302	1.00000

FILE MULTIPLE (CREATION DATE = 03/02/80) REGRESSION OF FACTORS AFFECTION KOKANEE SPAWNING RUN

* M U L T I P L E   R E G R E S S I O N * * * * * * * * * * * * * *

VARIABLE LIST 1
REGRESSION LIST 1

DEPENDENT VARIABLE.. [illegible]

VARIABLE(S) ENTERED ON STEP NUMBER [illegible].. WNTERMIN

MULTIPLE R	.83[illegible]	ANALYSIS OF VARIANCE	DF	SUM OF SQUARES	MEAN SQUARE	F
R SQUARE	.70[illegible]	REGRESSION	3.	314.58808	104.86269	3.91536
ADJUSTED R SQUARE	.52[illegible]	RESIDUAL	5.	133.91192	26.78238	
STANDARD ERROR	5.175[illegible]					

VARIABLES IN THE EQUATION

VARIABLE	B	BETA	STD ERROR B	F
OCTFLOW	.1205619+001	.87455	.39525	9.304
FISH3	.1826923+000	.24646	.21437	.726
WNTERMIN	-.1075410+000	-.14934	.19405	.307
(CONSTANT)	-.5750406+001			

VARIABLES NOT IN THE EQUATION

VARIABLE	BETA IN	PARTIAL	TOLERANCE	F
MAXDA3	.04310	.06363	.65061	.016
NOVMIN	.03961	.05639	.60519	.013
NOV	-.01909	-.02670	.58387	.003

* *

VARIABLE(S) ENTERED ON STEP NUMBER 4.. MAXDA3

MULTIPLE R	.838[illegible]	ANALYSIS OF VARIANCE	DF	SUM OF SQUARES	MEAN SQUARE	F
R SQUARE	.702[illegible]	REGRESSION	4.	315.13023	78.78256	2.36283
ADJUSTED R SQUARE	.405[illegible]	RESIDUAL	4.	133.36977	33.34244	
STANDARD ERROR	5.774[illegible]					

VARIABLES IN THE EQUATION

VARIABLE	B	BETA	STD ERROR B	F
OCTFLOW	.1242654+001	.90142	.52805	5.538
FISH3	.1823709+000	.24603	.23920	.581
WNTERMIN	-.1027375+000	-.14267	.21977	.219
MAXDA3	.1108686-001	.04310	.08695	.016
(CONSTANT)	[illegible]			

VARIABLES NOT IN THE EQUATION

VARIABLE	BETA IN	PARTIAL	TOLERANCE	F
NOVMIN	.01767	.01879	.33637	.001
NOV	-.54026	-.25626	.06691	.211

STATISTICAL PACKAGE FOR THE SOCIAL SCIENCES 03/02/80

FILE MULTIPLE (CREATION DATE = 03/02/80) REGRESSION OF FACTORS AFFECTION KOKANEE SPAWNING RUN

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST 1

DEPENDENT VARIABLE.. NFISH

VARIABLE(S) ENTERED ON STEP NUMBER 6.. NOVMIN

MULTIPLE R	.85212
R SQUARE	.72611
ADJUSTED R SQUARE	-.09557
STANDARD ERROR	7.83710

ANALYSIS OF VARIANCE	DF	SUM OF SQUARES	MEAN SQUARE	F
REGRESSION	6.	325.65964	54.27661	.88369
RESIDUAL	2.	122.84036	61.42018	

------------------ VARIABLES IN THE EQUATION ------------------

VARIABLE	B	BETA	STD ERROR B	F
OCTFLOW	.1798265+001	1.30445	1.80171	.996
FISH3	-.7654811-001	-.10327	.70460	.012
WNTERMIN	.3118866+000	.43311	1.10275	.080
MAXDA3	.1849217+000	.71895	.45620	.164
NOV	-.1154687+000	-.66967	.27951	.171
NOVMIN	-.1575002+000	-.12276	.92758	.029
(CONSTANT)	-.1411236+002			

-------------- VARIABLES NOT IN THE EQUATION --------------

VARIABLE	BETA IN	PARTIAL	TOLERANCE	F

MAXIMUM STEP REACHED .

STATISTICS WHICH CANNOT BE COMPUTED ARE PRINTED AS ALL NINES.

STATISTICAL PACKAGE FOR THE SOCIAL SCIENCES 03/02/80

FILE MULTIPLE (CREATION [illegible] 03/02/80) [illegible]

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * * VARIABLE LIST 1
REGRESSION LIST 1

DEPENDENT VARIABLE.. NFISH

SUMMARY TABLE

VARIABLE	MULTIPLE R	R SQUARE	RSQ CHANGE	SIMPLE R	B	BETA
OCTFLOW	.80654	.65051	.65051	.80654	.1798265+001	1.30445
FISH3	.82649	.68308	.03257	-.23775	-.7654811-001	-.10327
WNTERMIN	.83751	.70142	.01834	-.36600	.3118866+000	.43311
MAXDA3	.83823	.70263	.00121	-.42040	.1849217+000	.71895
NOV	.84980	.72216	.01953	-.21726	-.1154687+000	-.66967
NOVMIN	.85212	.72611	.00395	.28730	-.1575002+000	-.12276
(CONSTANT)					-.1411236+002	

STATISTICAL PACKAGE FOR THE SOCIAL SCIENCES 03/02/80

FINISH

NORMAL END OF JOB.
11 CONTROL CARDS WERE PROCESSED.
0 ERRORS WERE DETECTED.

@BRKPT PRINT$

TERMINAL INACTIVE
>@@TERM