Management plans ~~[illegible]~~ 863

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HIGH MOUNTAIN LAKE SEMINAR

IDAHO DEPARTMENT OF FISH AND GAME

January 15, 1976

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TABLE OF CONTENTS

INTRODUCTION

A seminar dealing with management of high mountain lakes was included as a portion of Idaho's Annual Fishery Biologists' and Fish Hatchery Superintendents' Conference for 1976.

The intention of the seminar was to review present mountain lake management in Idaho and in other states with the end result being better mountain lake management in the future. This report was compiled from the seminar presentations and related material to be utilized by regional managers as an aid in their management program.

The main speaker at the seminar was Pat Marcuson (District Biologist for the Montana Fish and Game Department). Marcuson has surveyed over 1,000 high lakes in Montana and presented a slide presentation on his techniques and management philosophy. Marcuson's presentation was excellent but since there was no written text, it will not be covered in this report.

Each of Idaho's Regional Fishery Biologists and Managers answered a questionnaire relating to their present management of high lakes. That material was summarized at the meeting and is included in this report.

A general look at Idaho's alpine lakes (including stocking procedures) by Stacy Gebhards have been included for completeness.

Idaho is on the threshold of establishing a statewide policy plan for fish. At present this plan is in a preliminary draft stage. The portion of that plan that covers mountain lakes is included in this report.

The Chiefs of Fisheries in six adjacent western states were asked to supply information relative to their management of high lakes in their state. This information is also summarized.

Washington Department of Game has probably undertaken and reported on more high lake surveys than any other western state. As an aid to Idaho's management biologists, we have abstracted portions of reports by biologists James L. Cummins, James M. Johnston and Ken Williams.

Dr. William Platts was scheduled to speak at the mountain lake seminar but was unable to attend because of another pressing engagement. However, Dr. Platts has supplied an abstract from his current report on mountain lakes.

The State of California has had many problems with management of high lakes in national parks and wilderness areas administered by the Federal Government. To round out this report we have included a paper dealing with this problem in California.

Finally, the seminar ended with a summary of a few suggestions on future mountain lake management in Idaho.

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Fishery Research Supervisor

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PRESENT HIGH LAKE MANAGEMENT IN IDAHO

At the present time the Regional Fishery Manager has the option of managing high lakes in his region in any manner he wishes within broad restraints. In an effort to determine techniques and management that are being applied in Idaho, a questionnaire was completed by each Regional Fishery Manager (six regions and two subregions). The results of that questionnaire and pertinent discussion are listed in this section.

1. How many high mountain lakes in your region (or subregion)?

Region	High Lakes
1	94
2	256
3	110
3A	400
4	47
5	1
6	46
6A	682
Total	1,636

2. The number of mountain lakes with each of the following species:

Species	Number of Lakes
Cutthroat	699
Rainbow	427
Brook	198
Grayling	26
Golden	20
Dolly Varden	2
Westslope Cutthroat	1
Mixed*	117
Barren	176
Total	1,636

* Breakdown of lakes stocked with mixed species.

Species	Number of Lakes
CT - RB	77
CT - GT	15
CT - EB	10
RB - EB	8
RB - GR	2
EB - DV	2
DV - W.S. CT	1
CT - GR	1
CT - RB - GR	1
Total	117

3. What percent of your lakes do you have a physical survey for (size, depth, spawning area, etc.)?

Percent Surveyed	Occurrence
0	1
<10	1
10-25	3
50	1
>90	1

4. Do you stock high lakes in your region personally? Do hatchery personnel? Other (specify)?

Hatchery Personnel Only	Combined Hatchery Personnel Major Effort	Combined Fishery Manager Major Effort
3	3	2

5. If you do not personally stock high mountain lakes but designate this to hatchery personnel, do you (1) have a conference with them each year and outline their program detail? or (2) expect them to follow the catalog with little or no contact from you each year?

Annual Conference	3
Catalog Only	4
Combination	1

6. How do you determine which species each lake should contain?

The bulk of the managers indicated that they normally stocked the same species in each high lake that is historically contained. However, each listed the species availability a large constraint in their program. All managers were in favor of providing some variety of species in their program. Cutthroat was generally the most desired species for use in high lakes.

7. What stocking rate do you utilize for high mountain lakes?

Stocking Rate	Occurrence
140/SA	1
150/SA	1
300-500/SA	1
500/SA	2
5,000/SA	1
1/2-1 lb./Lake	2

8. How often do you stock high lakes and does accessibility and/or use play a role?

Stocking Frequency*	Occurrence
2 Years	2
2-3 Years	1
3 Years	3
3-5 Years	1

* In most cases some lakes are stocked annually if access and pressure dictates.

9. List the estimated percentage of your lakes that you stock by each of the following methods:

	Region							
	1	2	3	3A	4	5	6	6A
Fixed wing aircraft	-	99%	95%	80%	-	-	-	-
Helicopter	33%	1%	5%	5%	95%	-	70%	80%
Horse	17%	-	-	5%	2.5%	100%	15%	10%
Backpack	47%	-	-	5%	2.5%	-	15%	5%
Trail bike	3%	-	-	5%	-	-	-	5%

10. How many high mountain lakes do you normally visit in a given year?

Lake Visits Each Year	Occurrence
0	1
<2	1
2-5	1
5-8	1
10	2
10-20	1

11. Do you thoroughly survey and record data on the lakes that you see?

All responses were affirmative.

12. Which of the following items do you collect at the lakes that you visit?

Item	Occurrence
Species	7
Age and Growth	4
Depth-Surface Acres	6
Water Quality	2
Basin Characteristics	4
Inlet, Outlet Spawning	7
Access, Forage, Camping	5
Photos	6
Other	
Use	1
Food Organisms	1

13. Do you receive very much information on high lakes from (1) CO's? 6 Yes - 2 No, (2) USFS? 4 Yes - 4 No, (3) Anglers? 5 Yes - 3 No, (4) Others? 1 Yes (I & E and Hatchery Personnel) - 7 No.

14. Do you need research help with surveys, etc. for your high mountain lakes?

6 Yes - 2 No - Region 5 with one lake and Region 4 with a relatively small number of lakes were the no answers. Region 1 indicated that although research assistance was needed, it was not a high priority item.

15. Do you have a fairly accurate estimation of the magnitude of the fishing pressure at each of your high lakes? 0 Yes, 75-99% of them? 0 Yes, 50-74%? 1 Yes, 25-49%? 0 Yes, 10-24%? 1 Yes, <10%? 3 Yes, 0%? 3 Yes.

16. Do any of your high mountain lakes have special regulations?

Special regulations are found on high lakes only in Region 2.

If so, list them and state the reason for and success of these regulations.

Fish Lake (Cedars) - August 1-November 30. Short season is an effort to protect native outlet spawning cutthroat. -- Region 2 rates this regulation a success.

Doe Lake (Selway) - Brook trout bag and possession limit is 50 fish. The liberal limits are an effort to reduce brook trout numbers and, therefore, increase size. As yet, the success of the regulation has not been determined.

Lizard Lakes #1 and #2 - Brook trout bag and possession limit is 50 fish. Reasons for and success of this regulation is identical to that for Doe Lake.

Steep Lake (Cedars) - August 1-November 30, bag and possession limit is 3 trout. This is a relatively accessible lake with golden trout. The regulation is an attempt to maintain the golden trout population and is termed successful.

17. Do you favor continued publication of the high mountain lakes booklet? A separate booklet for each region? No high mountain lake publication?

Continue in Present Form	5*
Separate Regional Booklets	1
Discontinue	2

* One of these five was a tentative yes, but had some reservations about continuing the booklet in its present form.

This item sparked more comment than any other item on the questionnaire. It was pointed out that when the booklet was initiated there was a need to encourage use in back country areas. The group agreed that there was no longer a need to encourage added pressure on this resource. To the contrary, most felt that many lakes are overused and use should be cut back if we hope to maintain the quality environment around these lakes as well as a quality fishery. Most of those that suggested continuing the booklet voiced a change in thought after having time to reflect on the issue. Most agreed that we should answer individual angler questions but not advertise the lakes.

18. Are high mountain lakes a high priority item in your region?

Four of the seven regions with high mountain lakes listed them as a high priority item. The other three listed high lakes as important but not a high priority. These three felt that their highest priority was for lowland lakes and streams that were heavily utilized and whose habitat was in danger. They also felt that generally the habitat in high lakes is stable, few contain populations not supported by hatchery stocks (no endangered populations), and that we can now and probably will always be able (through regulations and stocking) to maintain good fishing.

ALPINE LAKES

by Stacy Gebhards

Idaho was glaciated intermittently over the past 3 million years, with the Ice Age terminating about 10,000 years ago. Today's high elevation alpine lakes mark the final resting place of huge ice blocks which carved basins in the rock and built up moraines or levees at the outer edge which perform as a natural dam. Typically these lakes are at elevations over 5,000 feet and may be called by such technical names as alpine lakes, glacier lakes, cirque lakes, montane lakes, or tarns. Probably no one really knows how many mountain lakes there are in the State of Idaho. Through the years, the Department of Fish and Game has stocked fish in over 1,700. Hundreds of others too small or shallow to stock with fish are not even shown on Forest Service maps.

Anyone experienced at fishing alpine lakes soon recognizes that there is a great deal of variance in fish size or productivity between drainages and even individual lakes within the same drainage. Productivity of these lakes is a function of the geology, elevation, exposure, morphometry, and depth. One of the first principles you learn in limnology is that the biomass of plants and animals produced in a food chain is linked initially to the nutrients or minerals dissolved in the waters. Seawater, which is abundantly rich in minerals, is highly productive. In contrast is the almost non-mineralized waters which drain from granitic rocks and soil. A large portion of our alpine lakes lie within the Idaho Batholith which is predominately granite. The composition of granite is chiefly feldspar and quartz with small amounts of mica and hornblende, all of which are insoluble and chemically very stable. Lakes which are found in sedimentary rock formations (ancient sea or lake deposits) are much more productive. Here we find phosphate, carbonate, and sulphate rock constituents which are more readily soluble than granite and are leached into the drainage waters.

In a given drainage system, the water chemistry and productivity will change as the water flows down from the upper elevations. Comparison of lakes in Colorado with 4,300 feet elevational difference showed sharp increases in total organic matter, nitrates, calcium, phosphate, and pH in the lower elevation lakes compared to high elevation waters. Artificial fertilization of alpine lakes has been attempted, but without much success. The volume and rapid exchange of water through a lake system precludes application of fertilizers as a practical management technique.

Abundance or volume of plankton organisms, can be directly correlated with the water chemistry and mineral content. Even so, the numbers of plankton fauna in alpine lakes are comparatively small. Phytoplankton are chiefly diatoms rather than green algae. Zooplankton include cladocerans (or water fleas) and copepods. Several species of copepods are endemic to alpine lakes and take on brilliant colorations of scarlet, orange, or purple. These carotenoid or red pigments in the water fleas and copepods are absorbed in the muscle tissue of the fish and are an indicator of the fish's diet in the lake. Freshwater shrimp will also impart the deep red flesh colorations and are found in some alpine lakes.

Another important food item are the aquatic insects of the lake, particularly the case-bearing caddis fly larvae which inhabit the shallow water areas. These are utilized both during the larval stage and after the adult emerges above water. Mosquitoes and aquatic midges are a major grocery item in alpine lake fish diets. Midge larvae live in the soft bottom mud of the lake and are somewhat secluded from predation at this time. However, during emergence they must wriggle their way to the surface and are then easy prey for the fish.

We have seen that the water chemistry and general productivity of water tends to improve as it moves down drainage. Theoretically, then, fishing should improve as we move down off the mountain . . . but this is not always the case, because there are other factors which influence productivity and the fishery. One of these is the physical shape of the lake basin. Steep, rocky shorelines afford poor living quarters for midge larvae and other aquatic insects. Shallow lake basins with mud bottoms and shoreline vegetation provide excellent habitat for midges, caddis flies, shrimp, and other aquatic insects. Water temperatures are also warmer which accelerates total food production and the net result is bigger fish. Lakes which adjoin heavy timber at times receive significant quantities of terrestrial or forest insects which are utilized by the fish as these insects fall into the lake.

Elevation or altitude influences productivity and the fishery in several ways. The most obvious is water temperature and length of growing season between high elevation lakes which may still be ice-covered the third week in July while lower elevation lakes are ice-free six weeks earlier. Likewise, a lake on a north exposure will be ice-covered much longer. A lake which is not ice-free until mid-July probably freezes again in mid-October which means a total growing season of only 3 months or less in a year. Length of time a lake is ice-covered will vary from year to year, depending upon weather conditions and snowpack.

Dissolved oxygen is the principal limiting factor in an alpine lake fishery. The higher the altitude, the less oxygen the water can hold at saturation. A lake at sea level will contain 11 ppm dissolved oxygen at saturation while one at 10,000 feet will contain around 7 ppm. Optimum levels of dissolved oxygen for trout are about 5 ppm. Below this, the fish are under stress and losses will occur as levels reach 2.5 to 3.0 ppm. The margin of safety in a high elevation lake, sealed under the ice and snow for 9 months is indeed slim. Fish survival will be closely tied to the volume of water in the lake and the total oxygen demand during the ice period.

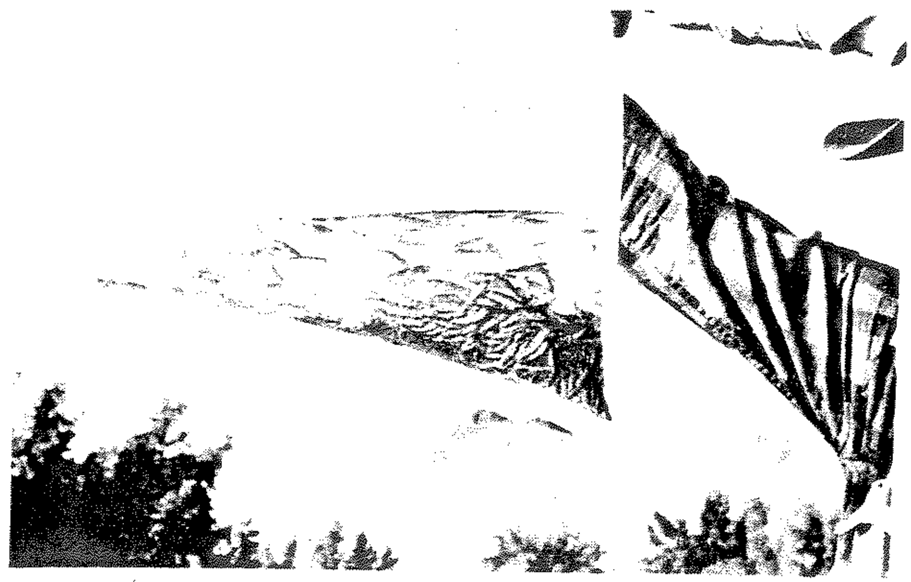
There is a point in time in the geological aging of an alpine lake, before it turns into a meadow, when it will no longer support fish. Ironically, the lake becomes progressively richer over a period of hundreds of years as it becomes more shallow. While the lake increases in biological productivity, which means more plankton, more insects, more vegetation, faster growing fish--the oxygen demand also increases and the safety margin for fish survival diminishes.

During the winter ice and snow cover, the organic materials, the vegetation, produced during the summer growing season are decomposing and using up the dissolved oxygen. Fish and other living organisms also drain the oxygen supply. If oxygen demand eventually exceeds the supply, the fish die. Every summer, almost without fail, we receive reports of mountain lakes having been dynamited and all the fish killed. In nearly every instance these are lakes in which the dissolved oxygen ran out before the ice thawed. In some lakes it will occur every year; others may support fish for many years and then suddenly winterkill due to unusual weather conditions. The rigors of 8 or 9 months under ice and limited food supply places severe stress on fish and they often will not recover. It is not uncommon to observe numbers of large adult fish debilitated, covered with fungus patches, and dying off during the summer.

With few exceptions, nearly all of the alpine lakes originally were barren of fish. Only in those lakes, such as Fish Lake in the upper Clearwater, which had adequate stream access, did a native population become established. Cutthroat for our mountain lake stocking originates from spawn taken at Henrys Lake. Rainbow are spring spawning stocks purchased from out-of-state. Cutthroat and rainbow dominate our mountain lake fish plantings. In the early days, brook trout were planted extensively throughout the Sawtooth Mountains. These fish were an unfortunate choice in most instances because of their tendency to overpopulate and develop stunted populations. Brook trout adapt readily to stream or shoreline spawning situations whereas the other trout species must have spawning streams entering or leaving the lake. California golden have been stocked in only a limited number of lakes, primarily because of difficulty in obtaining a reliable source of eggs. Most of our goldens come from wild stock in Wyoming and they are only able to fill our requests every 2 or 3 years. Since 1968 we have stocked 34 lakes with grayling, also supplied from Wyoming. As yet we do not know if any of these populations are self-sustaining. Grayling are stream spawners and spawn shortly after the ice goes off.

Planting fish from a truck is a relatively simple procedure when you can drive to the water's edge. Transporting live fish to a lake on top of a mountain at 10,000 feet elevation, 15 or 20 miles from the nearest road presents a little different problem. The old stand-by for fish hauling was the 10-gallon milk can. Each can when iced down could carry about one pound of small trout. Although this method proved to be quite serviceable, there were several disadvantages. When filled, each can weighed 110 pounds, making an extremely heavy pack load of 220 pounds to be carried by pack horse or mule. The tinkling of the ice in the cans or ice water sloshing on the back of a nervous pack animal often produces some rather explosive results. Many a trail and mountain side have been liberally stocked with fish. On long trips, rising water temperatures and oxygen depletion would often result in heavy mortality or complete loss of the fish. An improvement over the milk can was the canvas fish bag, which carried about the same amount of fish and water. . . but it too was plagued with the same problems of excessive weight, temperature control, and oxygen depletion.

Instead of using 10 gallons of water weighing 83 pounds to transport one pound of fish, we now haul 18 ounces of fish in three quarts of water weighing only 6 pounds. This is accomplished with a 3-gallon capacity, double plastic bag inflated with oxygen. One bag will carry up to 4,000 fish, depending upon their size. The bags are manufactured for the dairy industry, and are used as milk dispensers. Two 3-gallon bags are contained in a pack box which is lined with one inch sheet styrofoam. Six to eight pounds of crushed ice placed around the outside of the bags will hold water temperatures below 45°F. for 12 hours and below 38°F. for six hours, even with the boxes exposed to direct sunlight and hot summer temperatures. Three boxes can be easily packed on one horse, making a total of 24,000 fish that can be carried on a single animal. Quite often this is enough fish to stock 6 lakes. If the going gets too rough, the bags can be hand carried or put in a backpack for the final leg of the trip.



Planting of fish from the air is really nothing new. One of the first attempts at dropping fish from a plane was made in north Idaho in 1919. Many agencies experimented with aerial fish planting prior to World War II and by 1950 had worked out a number of successful techniques. One system used in Idaho was to carry the fish in milk cans in a large plane (the old Ford Tri Motor), and then pour the contents out the door of the plane while passing over the lake. Usually the man with the least amount of seniority got to do the pouring.

We also adapted the plastic bag transport to aerial fish stocking. Up to 30 bags can be carried in a small plane and as many lakes stocked on a single flight. The fish are released from the plane by pouring them into a hopper and pulling the plug while passing over the lake. Studies have shown that small fish can withstand a freefall up to 800 feet without harm . . . providing they land in the lake. We have a cost-share agreement with the U. S. Forest Service, utilizing helicopters which they have on contract during the fire season. Here again, we use the plastic bags to transport fish. Except for those which have self-sustaining populations, we try to schedule lakes for stocking at least once in 3 years. The number of alpine lakes stocked each year varies between 150 to 200 and about 40 percent of these are planted by helicopter.

Fishing pressure on Idaho high lakes increases each year. Much of this has been stimulated by our publication on mountain lakes which provides maps and information on some 600 lakes. Over 100,000 copies of this booklet have been distributed in recent years. Personally, I feel we have reached a saturation point at many of our wilderness lakes and instead of spoon-feeding details to fishermen on how to find these lakes we should be burning our maps and discouraging the Forest Service from maintaining high trail standards to alpine lakes.

Techniques in maintaining good fishing in mountain lakes have come a long way since the days of mules and milk cans. Yet we have still much to learn about the ecology, chemistry, and physical features of alpine lakes and their inter-relationships. Proportionately, when you consider the total number of fishermen statewide, the interest and use of mountain lake fisheries is small, but it has increased tremendously in the past 10 years. Mountain lakes have, and will continue, to be a challenge to man, beast, and machine.

PRELIMINARY

STATEWIDE POLICY PLAN

FOR

MOUNTAIN LAKES

IN

IDAHO

RESIDENT TROUT MAJOR PROGRAM -- MOUNTAIN LAKES

There are six species or races of fish included in the mountain lakes resident trout major program. These include; rainbow trout, Yellowstone cutthroat trout, Westslope cutthroat trout, brook trout, California golden trout, Dolly Varden trout and grayling.

Some of these fish are found in all geographical areas of Idaho. Habitat is restricted to high elevation lakes. Present and projected habitat is shown in the table below. High mountain lake habitat is contained almost exclusively within lands controlled by the federal government. _______percent of Idaho resident and nonresident anglers express a preference for this fishery. Approximately _______ fisherman days are spent in high mountain lake angling. This amounts to _______ percent of total fisherman days effort in the State.

PROBLEMS AND STRATEGIES

Problems -- Shallow, productive lakes are subject to periodic winterkill of fish.

Strategies -- Develop programs of mountain lakes inventory to collect data on physical features, fish populations and fish survival.

Problems -- High angler use on some lakes has reduced fishing quality (size and numbers of fish) and caused environmental damage to trails, adjacent alpine meadows and lake shorelines. Use of trail machines and 4-wheel drive vehicles and domestic livestock grazing and vegetation trampling and timber cutting conflict with aesthetic values of mountain lake settings.

Strategies -- Suppress publication of maps, articles and information on specific lakes to reduce "people" impact and maintain aesthetic and fishing quality. Maintain close liaison with the U.S.F.S. and recommend guidelines to control angler use, livestock grazing, off-road vehicles, trail development and timber practices in mountain lake areas.

Problems -- Basic knowledge of mountain lake ecology is generally lacking.

Strategies -- Conduct, sponsor and encourage research on mountain lake ecology.

Problems -- Better data are needed to determine optimum stocking rates (fish/surface acre) and stocking frequencies on individual lakes.

Strategies -- Conduct research to determine optimum stocking rates and frequency as related to lake productivity.

Problems -- Overpopulation of stunted brook trout or other fish species preclude establishment of a preferred fishery in some lakes.

Strategies -- Employ chemical rehabilitation (partial or complete) of lakes containing stunted or undesirable fish populations.

Problems -- Better management data are needed regarding fishermen distribution, harvest and catch rates.

Strategies -- Develop programs for data collection on fishermen distribution, harvest and catch rates.

Problems -- There is a lack of expression by fishermen as to species preference in mountain lakes.

Strategies -- Conduct opinion surveys to determine angler species preferences.

POLICIES

1. Lakes which "winterkill" with a frequency greater than once in four years will not be stocked.

2. Lakes requiring maintenance stocking will be planted at least once in three years.

3. The Department of Fish and Game will not publish maps, articles or detailed information on specific lakes or lake basins.

4. Brook, brown, Dolly Varden and mackinaw trout will not be stocked in mountain lakes.

5. A diversity of suitable species will be maintained in the development of stocking programs.

HIGH LAKE MANAGEMENT IN SURROUNDING STATES

The Chiefs of Fisheries in six western states were asked to supply information relative to their management of high lakes in their state. This information is summarized in this section.

CALIFORNIA

I. California has 3,316 high lakes in the Sierra Nevada and Klamath mountains.

   A. Approximately 75% of the lakes are in the National Park or wilderness area and subject to federal management policies.

      1. About 1,558 lakes are within the four major National Parks and they are not allowed to utilize aerial stocking (Policy - return parks to natural condition).

      2. Some 1,200 lakes are in wilderness areas but may be aerially stocked with limitations.

II. Stocking

   A. Rate = 100-200/SA.

   B. Frequency = 1-4 years.

   C. Size = $\bar{x}$ = 15-20/oz. or 240-300/lb.

   D. Species = 40-60% rainbow (remainder brk, ct, gldn, brown).

   E. Mostly fixed wing.

III. Philosophy

   A. Provide quality angling experience in keeping with the high aesthetic quality in which they are found.

   B. Provide variety.

IV. Use Study

   A. Approximately 60% of users did not fish. The remaining 40% included fishing tackle but only 6% cited fishing as the primary motive for their visit with 34% giving fishing as a secondary reason.

   B. About 94% would have made the trip without fishing but did indicate that fishing was an important value.

MONTANA

I. High lakes are important but are not given a high priority.

II. No state policy -- management is left to the individual biologist.

III. Stocking

A. Rate - variable.

B. Frequency - 3 years.

C. Species - Yellowstone cutthroat.

D. Most with fixed wing - some helicopter.

IV. Regulations

A. Year-round.

B. 10 fish or 10 pounds.

C. Brook lakes - bonus 10 pounds.

V. Mountain Lakes Booklet

A. No statewide booklet.

B. Very rough booklet for various groups of lakes in cooperations with USFS.

VI. Use

A. USFS furnishes some information on pressure from their trail sign-in program.

B. Value of this information is not known.

VII. Philosophy

A. They are trying to get away from stocking as much as possible.

1. Self-sustaining populations where possible.

2. May be brook in other situations.

NEVADA

I. Only 30 high lakes of which about 20 are considered fishable.

II. Very low emphasis and will probably continue in this vein.

III. Stocking

A. Rate = about 1,500/lake (100-300/SA).

B. Frequency - 4-5 years.

C. Species

1. Brook - occur in most lakes.

2. Rainbow - stock in overpopulated lakes (they feel rainbow can compete favorably with overabundant brook trout populations).

IV. Publicity

A. Angler guide for Elko County with special section on mountain lakes.

B. Angler use in the high lakes is increasing each year and the past practice of furnishing information to outdoor writers for articles in national magazines is no longer necessary, if it ever was.

Department files should be closed as a reference source of information for these writers.

OREGON

I. Approximately 700 high lakes.

II. High lakes are a vital part of the state's fisheries programs but do not receive their share of attention.

III. Stocking

- A. Rate - 150/SA.
- B. Frequency - Annually (450-500), Biennially (remainder).
- C. Species
  1. Most with brook.
  2. Rainbow in lakes with better growing conditions.
  3. Cutthroat used experimentally - no supply.
  4. Golden did not work out well.

IV. Additional emphasis in these areas

- A. Annual stocking, especially in marginal lakes.
- B. Definite management objective by lake or lake group.
- C. Classify lake productiveness by:
  1. Elevation
  2. Depth
  3. TDS
  4. Conductivity
- D. Annual update of color aerial photos for stocking.
- E. Expand use of high lake creel cards.
- F. Try to find a successful inland cutthroat.
- G. Try to budget district biologist's work load to allow additional time to high lake management.

WASHINGTON

I. Habitat

A. Lake types

1. Cirque Lakes

a. Seldom larger than 20 SA or 40 feet.

b. Elevation = $\bar{x}$ 6,300 feet; r = 3,500-7,600 feet.

c. Source = surface runoff and snow melt within the cirque basin.

d. Ice free period = $\bar{x}$ 3.75 months (3rd week June - 2nd week October).

e. Somewhat protected from sun and wind.

f. Optimum trout temperature (55° F) may occur during 1 or 2 months.

g. Water chemistry generally acidic or neutral

2. Paternoster Lakes

a. Larger, deeper lakes.

b. Elevation = $\bar{x}$ - 3,000 feet.

c. Source = larger watersheds than small basins.

d. Ice free period $\bar{x}$ = 5.5 months (early to mid-May - 4th week in October).

e. Less protected from sun and wind.

f. Optimum trout temperature (55° F) may occur during 3 months.

g. Water chemistry generally neutral or basic.

II. Stocking

A. Rate -

1. Cirque Lake - 100/SA.

2. Paternoster Lake - 150-200/SA.

B. Frequency - 3-5 years (depends upon natural reproduction and exploitation).

C. Species

1. Cutthroat is preferred species in Cirque Lakes.

    a. Better growers (condition) - (lakes where cutthroat and rainbow co-exist show this).

    b. Aesthetic qualities.

    c. Cutthroat mature at 3 and 4 (Rb at 2 or -3) and thus have from 1-2 more years to grow before they experience the rigors of spawning.

    d. The early timing of cutthroat spawning is a valuable adaptive feature to the short alpine growing season.

2. Rainbow is preferred species in Paternoster Lakes.

    a. The richer environment is better suited to rainbow.

    b. Their later spawning is not such a factor in lakes with a longer growing season.

3. Brook - not recommended for stocking in Cirque Lakes.

    a. Ability to reproduce naturally at excessive rates.

    b. Pure mass of brook flesh causes other species to do poorly when in combination.

4. Dolly Varden

    a. Do not grow as rapidly as rainbow and are not as abundant.

    b. They provide a variety that is welcomed by anglers.

    c. Harder to catch and may escape the fishery and reach trophy size.

D. Helicopter

E. Size - smaller than 300/lb. when dropped from fixed wing (larger fry suffer greater mortality).

F. Consistency

1. Too many people utilized who don't know the country well enough and stock wrong lakes.

2. Fixed wing drops have higher mortality and therefore more fish than needed packaged to compensate.

   Favorable conditions = overstocked; unfavorable conditions - understocked.

3. Helicopter stocking assures consistency.

G. Deadline

1. August 15 deadline should be imposed since early September seems to be the time when alpine environments begin to deteriorate biologically.

III. Regulations

A. Present

1. Limit = 12 fish.

2. Minimum size = 6 inches.

B. Proposed (where natural reproduction is low or nonexistent).

1. Limit = 3-5 fish.

2. Minimum size = 8 inches.

3. Packing out fish prohibited.

IV. Mortality

A. Natural mortality to Age III is 10%/year.

B. Natural mortality at sexual maturity (III or IV) increases to 25%/year.

V. Food

A. Midges are the basic summer diet in most high lakes.

B. Gammarus (scuds) are important where found.

1. Scuds have significant populations only in lakes that have at least 30 ppm total alkalinity and 18 ppm total hardness.

2. One of few food organisms that remain abundant after September 1 (enables fish to enter the winter with greater energy reserves).

3. Cirque lakes are generally too acidic for scuds.

4. Paternoster lakes generally provide water quality and vegetation for concealment.

5. High priority to introduce scuds into lakes that are suitable.

VI. Philosophy

A. Recreationists in high lakes seek first the recreational experience and fishing is a secondary consideration.

B. Recreation aspects rather than production is goal. (Aesthetics and quality out weigh sheer numbers).

C. Anglers prefer $>$12" fish (contacts and cards).

D. In lakes with infrequent visits (less than 50/year).

1. Manage for maximum size.

2. Stock less frequently and with species that does not reproduce at a high rate.

E. One age class grows better than several in the lake at the same time.

VII. Lake Inventories

A. Photos

1. Aerial from USFS.

2. Slides and/or black and white (camera).

B. Estimated volume of tributaries ($<$5 cfs).

C. Maximum depth - calibrated line and rubber boat (17#)

D. $\bar{x}$ depth - visual observation, morphology, and several soundings.

E. Water transparency (Secchi disc).

F. Temperature (thermometer) avoid inlet areas.

G. Water Qualtiy - pH, DO, total alkalinity, total hardness (Hach set).

H. Aquatic plants, invertebrates, fish.

1. Abundance

2. Species composition

3. Distribution

I. Fish

1. Growth

2. Age composition

3. Feeding habits

J. Fish Collection

1. Sport gear

2. Gill net

a. 100' x 5' with 5-20' panels (½"-3/4"-1"-1¼"-1½").

b. 60' x 5' with 4-15' panels (3/4"-1"-1¼"-1½").

c. Small mesh end to shoreline and perpindicular to shoreline.

K. Collections

1. Scales

2. Otoliths

3. Stomachs (sample jars with formalin)

WASHINGTON STATE GAME DEPARTMENT
HIGH MOUNTAIN LAKE MANAGEMENT GUIDELINES1/

In general, the productivity of a lake is affected by: (1) geological conditions (relating to the chemistry and topography of the soil); (2) water chemistry, which is related to geological conditions; (3) climate (sunshine, precipitation, and inlet and outlet flows); (4) geographic location (altitude); (5) morphometry, as evidenced by depth, form of bowl, and proportions of deep and shallow water; (6) size, a small lake, other things equal, being more productive in proportion to volume than a large one; and (7) condition of maturity (eutrophication) (Cummins 1973).

The small, rockbound lakes among the steep cliffs at the head of glacial valleys are called cirque lakes and represent the most common type of high lake. Cirque lakes are often enclosed on 3 sides, forming spectacular amphitheaters that block direct sunlight exposure to lake surface for large portions of the day and protect the lake surface from strong, unidirectional wind currents. These lakes are seldom larger than 20 surface acres or exceed 40 feet in depth. They range in elevation from 7,600 feet (Libby Lake) to 3,500 feet (Round Lake), and average approximately 6,300 feet in elevation. Surface runoff of melting snow within the cirque basin itself is the primary source of water for these lakes. Many of the cirque basins have thinly developed soils which support subalpine conifer trees and understory, while others are completely rockbound and snowbound (Williams 1972).

Paternoster lakes differ from cirque lakes in that they are larger, deeper, have much larger watersheds, are much less protected from sunlight and wind currents, have significantly longer ice free periods, support more highly developed soils and denser stands of vegetation, and average about 3,000 feet lower in elevation.

The paternoster lakes normally lose their ice cover in early to mid-May depending on the snowpack depth and meteorlogical conditions. The average opening date of all lakes classified as alpine lakes was the 3rd week in June. The average ice-up date for alpine and paternoster lakes studied in 1972 was the second week and fourth week in October, respectively. Thus, ice free periods of 3.75 and 5.5 months occur in alpine and paternoster lakes. With an average ice free period of 8.0 months (mid-March to mid-November), the average lowland lake growing season exceeds that of the alpine and paternoster lakes by 4.25 and 3.5 months, respectively.

Optimum temperatures for salmonid fishes has been found by many researchers to approximate 55° F. Optimum temperatures in alpine lakes may occur for some sheltered, high elevation cirque lakes during 1 or 2 months out of the year and for 3 months for some of the paternoster lakes.

The hydrogen ion concentration of true alpine lakes varied from slightly over 6.0 to 7.5 and averaged 6.5 (Figure 33). The pH values of the paternoster lakes varied from slightly less than 7.0 and 8.0 and averaged 7.5.

1/ This portion of this report consists of material abstracted from reports by Washington State Game Department biologists James L. Cummins, James M. Johnston and Ken Williams.

It is interesting to note that while lowland lakes achieve maximum productivity by recycling essential nutrients to the surface water during the spring and fall "turnover", alpine lakes achieve maximum productivity by never "turning over". If alpine lakes underwent complete mixing, the loss of nutrients from the lake during the spring runoof, when the water mass would be undergoing maximum flushing due to the heavy runoff, would far outweigh benefits accrued by distributing the critical nutrients near the surface (Williams 1972).

Angler Preference

Examination of High Lake Fishing Report cards and personal communication with high lakes anglers has convinced me that high lake fishermen generally prefer large size to large numbers of fish. The high lake fisherman's dream is to fish a remote lake that supports lunker fish. Quality not quantity should be the goal in all but the most heavily fished lakes (Cummins 1973).

The average and above average high lake fisherman has come to the conclusion that it just isn't satisfying to hike 4 to 8 hours into a remote lake and then be rewarded with a catch of many small fish, most of which are under 8 inches in length. As a rule he voices his distain for these small fish and proclaims his preference for a few trout greater than 12 inches in length. Unlike his counterpart who fishes the lowland lakes, and has a primary goal of numbers, the backpacker would prefer to sacrifice numbers for increased size. He is seeking the remoteness of the high country with the hope of getting away from the crowds and the dream that his next sojourn will take him to that lake where the big ones grow.

There is a very practical side to the aesthetics of this desire for larger size fish. If the angler catches a limit of small fish, what is he to do with them -- he can rarely consume them all during his short stay and he knows from experience that they will hardly be fit to eat by the time he packs them out. If he releases the fish back into the lake the stunting problem will just be prolonged (Johnston 1973).

Stocking Formula

High lake populations generally fall into three categories: (1) self-sustaining populations that need no maintenance plants, (2) populations that spawn successfully but occasional plants are necessary, (3) fish populations that do not spawn successfully and consist entirely of planted fish.

Lakes that support only planted cutthroat or rainbow can be managed either to produce maximum numbers or maximum pounds of fish. It is evident that a management goal is necessary before stocking procedures can be formulated (Cummins 1973).

A stocking formula has at least 5 facets: (1) stocking rate (number of fish per surface acre), (2) stocking frequency in years, (3) type of fish planted, (4) size of fish planted (number of fish per pound), and (5) the time of planting (Williams 1972).

Stocking Rates

Throughout the management recommendation sections of this report I have recommended that stocking rates not exceed 100 fish per surface acre. With a few exceptions, I seriously doubt that most oligotrophic lakes would be overstocked at that rate, assuming that natural reproduction is nil. Having higher carrying capacities, the stocking rate recommended for the paternoster lakes should be increased to 150 or 200 fish per surface acre.

Actually the stocking rate in terms of surface acres is misleading in that it implies that the fry distribute themselves over the surface of a lake. The fact is that trout fry remain in close association with the upper littoral until they attain sub-legal size (4 or 5 inches). Thus a shallow 10-acre lake may be understocked with fry at 100 per surface acre, whereas a deep 10-acre lake may approach overstocking. Note that the converse is true with adult carrying capacities, however. In those cases where some natural reproduction is taking place but supplemental plants deemed necessary, I usually did not recommend altering the stocking rate but merely to reduce the stocking frequency (Williams 1972).

Examination of planting levels and growth rates clearly show that fish size can be controlled by manipulating planting rates. The relative productivity of each lake must be determined to derive at the best stocking formula. Although I have recommended that stocking rates not exceed 100 fish per surface acre, realistically planting levels should probably range from about 50 to almost 200 fish per acre depending on productivity capabilities of individual lakes. Comparison of planting records and fish growth and abundance indicate that the general stocking formula of (100 fish/acre) provides an excellent fishery for quality fish. Lakes planted in excess of 200 fish/acre do not appear to provide a better fishery (numbers of fish caught) but fish are small compared to lightly planted lakes (Cummins 1973).

Stocking Frequency

Recommended stocking frequencies range from three to five years depending on the extent of natural reproduction and exploitation rates. Stocking frequencies must be increased when harvest rates increase, but must never exceed the length of time to produce legal sized fish. This usually requires two years. Since fry remain in the shallow littoral regions until they attain legal or sub-legal (4-5") size severe competition will result if fish are planted frequently. Also, competition between several age classes results in decreased growth rates and condition of larger fish. For example, the net energy gained from 15 midge pupae by a five-inch fish is much greater than the energy gain by a 14-inch fish. Small fish have an advantage over large fish when the food supply is limited (Cummins 1973).

Type of Fish Planted

In discussing the merits of each trout species in the true alpine environment, the reader probably has already concluded from previous discussions that the cutthroat is the best adapted species. The superiority is manifested by condition and aesthetic qualities rather than growth in length in many cases. However, in those lakes where cutthroat and rainbow co-exist and samples of both species were obtained (Lower Crater and Middle Oval Lakes), the cutthroat grew faster, were more robust, and their appearance more aesthetically pleasing than their rainbow peers.

How the two species compare in the most impoverished alpine environments is clearly illustrated by the growth rates and conditions of cutthroat in Cutthroat Lake and rainbow in Scheelite Lake. The predominant age class in both lakes was age -6. The rainbow average 8.1 inches in length, 2.2 inches more than the cutthroat (5.9 inches), but the rainbow were extremely emaciated and near starvation. The smaller cutthroat, on the other hand, were in fair to good condition.

Moreover, the ability of brook trout to reproduce naturally at excessive rates and to expand their distrbution rapidly make the inclusion of this species into the alpine fishery program a risky one and one that cannot be recommended for the alpine lakes in the Okanogan National Forest.

The relatively rich, mid-elevation paternoster lakes are much better suited for rainbow. In these lakes the condition and aesthetics of rainbow are commensurate with their growth in length, which exceeds legal length by the end of the first summer and trophy size (15 inches) in 5 years.

The paternoster lakes (except Big Hidden Lake) are also the natural home of Dolly Varden. These fish don't grow quite as rapidly as rainbow and they are not as abundant (Black Lake excepted), but the variety they provide to the creel is well received by anglers. Only in Black Lake are Dolly Varden numbers sufficient to support a viable fishery. Because of their nocturnal, piscivorous feeding habits, many fish escape the fishery and reach several pounds in weight, particularly Black Lake. Some anglers fish exclusively and unconventionally for these trophies.

These data show that rainbow, cutthroat, brook trout in alpine environments are opportunistic feeders, having no reservation about taking their food from the bottom, surface or pelagic areas. Dolly Varden, on the other hand, seemed to restrict their feeding to the substrate, although some juveniles consumed surface organisms. The slow growth of this species is probably partially due to their exacting feeding habits.

Certainly one of the most beneficial adaptation to severe alpine environment is late maturation. Rainbow mature at age 2 or more commonly age -3, and the cutthroat at ages 3 and 4. Thus, cutthroat have from 1 to 2 more years to grow before they experience the rigors of spawning.

The traumas of spawning cannot be overemphasized and the severity is accentuated in alpine waters. With such short growing seasons, alpine trout can ill-afford to cease feeding for 2 or 3 weeks to spawn. Not only do they cease feeding, they also expend more energy than normal by the physical act of digging the nest and protecting it. Furthermore, the energy incorporated in gonadal tissue could have been used in somatic tissue for body growth instead. Egg retention from the incomplete extrusion of eggs during spawning and subsequent reabsorption is a stressful and even fatal (to females) aftermath to spawning.

Species which are ill-adapted to the austere alpine environment show their inferiority most dramatically during spawning by the degree to which they suffer and the length of recovery time. The rainbow seem particularly troubled by spawning. They spawn later than cutthroat, which bisects their growing season so that at a time when they should be feeding heavily they cease feeding and engage in spawing. The early timing of cutthroat spawning is a valuable adaptive feature to the short alpine growing season. By spawning soon after ice-out they take advantage of the lull in the appearance of aquatic invertebrates immediately after ice-out and re-enter the lake when food is more abundant. When Middle Oval Lake was sampled on August 14, the cutthroat had completed spawning and were feeding heavily in the lake. Most rainbow were still on their redds and the few that were not feeding. While taking cutthroat eggs at Twin Lakes, cutthroat were observed feeding heavily prior to and immediately after their eggs and sperm had been removed. While still in holding pens and groggy from anaesthesia, any split eggs were immediately consumed. Conversely, rainbow seem to lose their appetites during spawning in alpine environments.

A large percentage of rainbow females retained the bulk of their eggs, which compounds and prolongs their stress. I don't recall ever having seen a spawned-out cutthroat with retained eggs (Williams 1972).

Aesthetically the cutthroat is a superior fish. They become brilliantly colored, particularly the males, in contrast to the dark coloration of sexually mature rainbow males. On hook and line the lethargic struggle of spawning or spent rainbow cannot match that of cutthroat at their weakest condition. Post-spawning recovery rates are very rapid for cutthroat, and it is difficult to tell externally whether or not a fish has spawned. Rainbows remain dark, gaunt, and sluggish for most of the summer before they recover to a bright silvery condition and display some semblance of their fighting qualities for which they are renowned in lowland lakes. The speed of their recovery seems to depend on the fertility of the lake. For example, Quartz Lake rainbow achieve better condition much earlier in the summer than those which inhabit Upper and Middle Oval Lakes. In the most oligotrophic lakes, rainbow never fully recover from the trauma of spawning.

Size of Fish

The size of fry planted in alpine waters is paramount, and an area that can be improved over past practices. A policy of not releasing fish until they weigh a minimum of 300 fish per pound is recommended. Fish at this size seem better able to cope with the rigors of the alpine environment than smaller fry. Also, the length of time required to produce legal size fish can be cut one year by planting advanced fry.

Time of Stocking

Fish should be planted between July 15 and August 15 depending on meteorological conditions which effect a lake's thermal properties. Surface temperatures should not be less than 10°F below the maximum temperature but should not exceed 65°F in the case of homothermal lakes. Food production usually peaks between July 15 and August 15. The August 15 deadline will allow fish a two or three week period to adjust before food production decreases in early to mid-September.

Early September seems to be the time when alpine environments begin to deteriorate biologically, and water temperatures drop almost 3° F per week. An August 15 stocking deadline should be imposed. This gives the fry a 2- to 3-week period in which conditions are favorable for adjustment and survival (Williams 1972).

Planting Methods

Unquestionably the single most important technique in high lakes management and one that virtually assures consistency is the use of helicopters to stock alpine lakes.

A final recommendation concerning helicopter plants is that planting shall not take place in the absence of a person who is intimately familiar with the lake or lakes to be planted. This may seem trite, but a consistent program requires that a group of fish designated for a particular lake reach that lake.

When planting with fixed wing craft, more fish were packaged for release than a given lake could actually support in anticipation of some mortality during the freefall. Thus, under favorable conditions the lake was overstocked and understocked during unfavorable ones, with mortalities ranging from 0 to 100 percent. This certainly is not conducive to important goals of consistency (Williams 1972).

Johnston (1972-1973) and Williams (1972) have stressed the point that use of helicopters to stock high lakes assures consistency. There is little chance of significant mortality if helicopters are used to plant fish. When planting with fixed wing aircraft, it is probable that many fish do not enter the lake, and that there is some mortality associated with the freefall. This is not consistent management (Cummins 1973).

Natural Mortality

Based on my own observations of natural mortalities in the high lakes on the Olympic National Forest, I have concluded that natural mortalities from planting to age III average approximately 10 percent per year. At sexual maturity (age III or IV), natural mortalities increase to about 25 percent per year (Johnston 1973).

Regulation Considerations

Despite their dissimilarities, high lake and lowland lakes are under the same management program. Alpine lakes are small and biologically unproductive and their annual production of fish biomass are mere factions of those produced by lowland lakes, yet a limit of 12 fish is permissable in both types of lakes. A given alpine lake may yield excellent catches for 10 fishermen per year and be fished out by 30 fishermen. Low numbers of alpine lake recreationists and insufficient enforcement personnel in the past made it impractical to develop a high lake management plan drastically independent from the lowland lake management plan. Inadequacies in the program will manifest themselves as angling pressures mount. Some inadequacies are beginning to turn up and more are sure to follow.

Although the minimum size limit is 6 inches, the unwritten quality standard that we strive for in the Okanogan County lowland lakes is to produce 9 to 10 inch age -1 fish, the fishery is based almost entirely on age -1 fish, as the percentage of fish that survive the fishery is extremely low in most cases. By necessity high lake fisheries are based on several age classes of fish, since the time required to produce a 9-inch fish takes several years in many instances. With liberal limits and increasing pressure, larger, older fish will be removed. The end result will be that as soon as the fish reach legal size they will be harvested. So the paramount difference between the two environments is the low lakes can produce aesthetically acceptable fish <u>between</u> seasons whereas the high lakes require several years. Now back to the question of quality. Are 6-inch fish acceptable and should our program stress production? I say no for the reason that alpine clientel have different motives and attitudes about fishing than their typical low lake counterpart. These recreationists seek the ultimate outdoor recreational experience, and fishing in a majority of cases is a secondary facet of their trip. To them fishing is recreation, and aesthetics and quality outweigh sheer numbers. What does an angler do with a legal limit of 12 fish? He certainly can't eat that many nor can he pack them out. He may share them with the non-fishermen in his party, but is this practice fair to subsequent anglers whose angling quality is diminished? I feel that the recreation concept of fishery management should be the guideline for our high lakes program rather than strictly production. The catch limit should not exceed the number of fish that the average adult would normally consume (3 to 5 fish), and all fish should be utilized in the high country. Packing fish out should be stricly prohibited. These regulations would maintain good fishing for longer periods of time under higher fishing pressure and fish in the creel would be larger (Williams 1972).

Utilization of *Gammarus*

The circum-neutral pH and moderate carbonate contents of the paternoster lakes appear to be ideal for *Gammarus*. The only alpine lakes to contain scuds (Beaver, Middle Oval, Quartz, and Tiffany) had pH values that approached neutrality or were basic and had the highest carbonate contents. The majority of alpine lakes are probably too acidic and have too little carbonate to support scuds. Cover is another limiting factor because they are thigmotactic and react negatively to light. Consequently, they remain hidden in vegetation and under and between debris and rocks during the day.

Scuds are one of the few food organisms which remain abundant after September 1. In essence, lakes with scuds have longer growing seasons, enabling the fish to enter the winter with far greater energy reserves than fish in lakes which have little food available in the fall. This is critical for sexually mature fish which use these reserves for the development of reproductive tissue as well as to sustain themselves while they lie under the winter ice. Obviously, the condition of a fish after ice-out and spawning is governed in large part by its condition the preceding fall, and those lakes containing scuds produce the highest quality alpine trout (Williams 1972).

Data Collection Assistance

I doubt that there is a fishery biologist in the State that would not give just about anything to spend each summer in the alpine lakes gathering fishery data. However, because of other pressing responsibilities, personnel shortages and budgetary limitations, not to mention the great number of high lakes (Wolcott lists 1,567 lakes lying about 2500 feet elevation in Western Washington alone), it has been impossible for Game Department biologists to visit each lake. For several years now these biologists have depended upon the return of High Lake Fishing Report cards for management data.

Although the information contained on the High Lake Fishing Report card is resulting in formulation of some management decisions, the cards function is limited. At best they provide sketchy information about the fishery in a particular lake, and this information is probably not without bias. Successful anglers have more of a tendency to report information than their unsuccessful counterparts (Carline 1972). Additionally it is not uncommon to receive conflicting reports (no fish vs. lots of fish) and to have long period of time between reports. The report cards also do not provide enough space to record all the desirable information, nor are the fishermen trained to observe or collect more technical information.

For the aforementioned reasons, now appears the time to initiate an <u>additional</u> reporting form and procedure, that can be distributed to select groups or individuals, and is designed to provide usable biological information that will aid the fishery biologist in making sound management decisions.

In content the new form must be self-explanatory and require little, if any, additional training for successful application in the field.

It is recommended that such a form be distributed to the following groups or individuals:

- Trailblazers
- Washington High Lakers
- U. S. Forest Service District Rangers
- Selected Game Department personnel other than biologists
- Selected individuals that frequently send in High Lake Fishing Report cards.

It would be wise to designate to these people the names of specific lakes that information is desired from, and then encourage them to seek out other lakes if they have the time and inclination.

A recommended format for this new reporting form is found on the following pages.

Look for ice marks on rocks along the shoreline of the lake and any other indications of lake level fluctuation. Estimate how many feet the lake level drops each summer. This determination should be made in August if possible.

____

Are there any aquatic plants growing in the lake or sedge grasses along the shoreline of the lake? ______________ How extensive is this plant growth (in square feet) ______________________________

Now focus your eyes between the surface and the bottom of the lake, near shore, where the depth is at least 2 feet. Do you see any small red organisms suspended in the water column? __________These are red copepods which are a little larger than a pencil dot (•) and move in short one-eight inch spurts.
Remarks ______________________________

Using a 1-foot square piece of window screen, go to the shallows of the lake where either sedge grass protrudes into the water or where rubble less than 3" in diameter is found. Stir up the area with your hand or foot and before the debris cloud settles, run the screen through the disturbed area and lift out to examine. Look for the presence of freshwater shrimp. See drawing.

Drawing

Shrimp

Remarks ______________________________

____

____

____

Collect one glass pint-jar of the lake water at the outlet end of the lake. Lable the bottle with the name of the lake, Sect., Town. and Range, and the date. Deliver this water sample within 15 days to the Game Department's Regional Fish Biologist that has management responsibility for the lake sampled (See Game Dept's Fishing Regulations pamphlet for the Regional Office address).

How long a hike was it to this lake from the nearest road?
Miles______________________ Hours______________________

How many fishermen would you estimate fish this lake each year? You can get a rough idea by talking to the U.S. Forest Service's local District Ranger (or his Resource Staff) and ask him how many people visit the lake each year. Divide his estimate by 4 to arrive at an estimate of fishermen. Remarks______________

____

Take a picture of the lake from a high angle and attach print, negative, or slide to this report.

----------Data End-----------

Deliver this form, when complete, to the Regional Fish Biologist responsible for the management of the lake along with the afore mentioned water sample, or mail the form to:

Fisheries Management Division
Department of Game
600 N. Capitol Way
Olympia, Washington 98501

Did you observe any fish in the lake smaller than 6 inches?______________
If so, were there any fry along the shoreline or other indications that the fish are naturally spawning? The fry would be most likely seen in August or September.______________

If natural spawning occurs in the lake, a tributary, or the outlet, and you have personal knowledge of the location, make a rough sketch below of the spawning site in relation to the lake and include the following estimates:

Average stream width (ft)______________

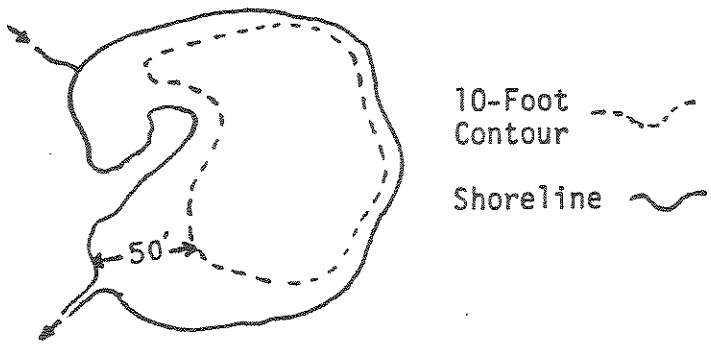
Average stream depth (ft)______________

Percent of the stream bottom covered with 1-inch or less diameter rocks in the spawning area______________%

Drawing

Make a rough drawing of the lake and sketch in the 10-foot contour line showing the extent of the shallows. Record your estimation of distance in feet of the farest point this contour line extends into the lake. Refer to the example below.

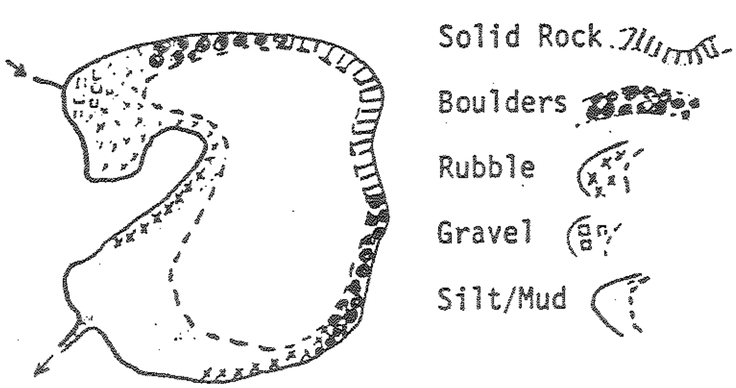
Example



Drawing

Between the shoreline and the 10-foot contour, note the makeup of the lake's bottom, i.e., solid rock, larger than 10" diameter boulders, irregular shaped rubble, rounded gravel, silt and/or mud. This information can be illustrated on another lake drawing. See example.

Example



Drawing

High Lake Data Collection Form

Lake____________________ Location: Sect.______ Town.______ Range______

Date of survey____________________ County____________________

Name, phone number, and organization of data collector____________________

____

Stocking record if known:

Month/Year	Species	Number	Size	Hatchery Source

Species of fish now in lake____________________

If more than one species, which one dominates?____________________

If fishing, what did you use: flies, worms, eggs, flatfish or lures?____________

____

Record your catch data in the following table, plus data collected from any other anglers you could check. You are Angler #1.

Angler	Total Fish RB	Total Fish CT	Total Fish EB	Time Fished (Nearest 1/2 Hr.)		Sizes of Fish (Nearest 1/4 Inch)
#1					RB	
					CT	
					EB	
#2					RB	
					CT	
					EB	
#3					RB	
					CT	
					EB	

(Note: Attach supplemental sheet if more than 3 anglers checked)

Stomach contents of fish (particularly look for red mass of copepods and/or freshwater shrimp____________________

What is the flesh color of rainbow or cutthroat trout if they are found in the lake: pink or white? Place an (X) in appropriate space.

Rainbow <12" P	Rainbow <12" W	Rainbow >12" P	Rainbow >12" W	Cutthroat <12" P	Cutthroat <12" W	Cutthroat >12" P	Cutthroat >12" W

Note:
(> = greater than)
(< = less than)

Do you consider the fish to be fat, skinny, or of average weight for their length?
Rainbow________________ Cutthroat________________ Brooks____________

Was there an accumulation of fat along the intestines or stomach of the fish?
Remarks____

Did you find any parasites (tapeworms, cysts, etc.) in the fish?

Literature Cited

Cummins, James L. 1973. High lake survey report, Gifford Pinchot and Snoqualine National Forests. Unpublished report. Washington State Game Department. 178 pp.

Johnston, James M. 1973. High lake survey report, Olympic National Forest, Part II. Unpublished Report. Washington State Game Department. 362 pp.

Williams, Ken. 1972. High lake survey report, Okanogan County. Unpublished report. Washington State Game Department. 233 pp.

TYPICAL SURVEY OF A HIGH LAKE IN WASHINGTON

(From High Lake Survey Report, Olympic National Forest, Part II. Washington State Game Department report by James M. Johnston. Published in 1973).

Lake Bear County Mason Elevation 2500'

Legal description: Section 29 Township 24N Range 4W WRIA 16

Drainage Jefferson Cr. - Jefferson Lakes - L. Elk Lk. - Hamma Hamma R.

General exposure N & S Adjacent land owner U.S.F.S.

Date(s) of survey and inventory 7/7/73

FIGURE 2

Photograph of the lake and remarks

Bear Lake, looking west, with approximately two-thirds of the lake in the photograph. The man is standing on the alluvial fan of inlet.

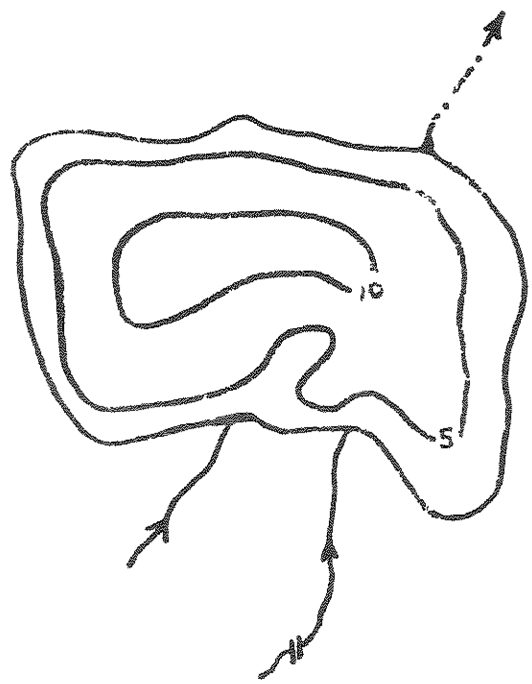
Refer to Figure 3 for aerial photograph of the lake.
Refer to Figure 4 for depth contour map of the lake.

BEAR LAKE

Mason County
T24N-R4W-S29
Aerial Scale 1:15,480
Flight Line 34, ETI-9-138
September 1, 1969

N

FIGURE 3



BEAR LAKE

0.4 Surface Acre
Scale 1 inch = 66 feet

N

FIGURE 4

Lake Physical Data

Surface area at mean high water (acres) 0.4

Average annual water level fluctuation (feet) 4

Depth measurements for mean high water (feet): Maximum 10 Mean 6

Length of shoreline at mean high water (feet) 561

Percent of the lake's mean water level surface area under which the depth is less than 20 feet" (%) 100 Area (acres) 0.4

Percent of the lake's mean water level surface area under which the depth is less than 10 feet" (%) 85 Area (acres) 0.34

Percent bottom composition of the lake shoreward of the 10-foot contour line. Determination made at mean water level:

Bedrock	(solid rock outcrop)	1
Boulders	(rocks greater than 10 inches in diameter)	1
Rubble	(broken rock of variable size but less than 10 inches in diameter)	1
Gravel	(mixture of rounded coarse material of various sizes larger than sand)	5
Sand	(particles ranging from 0.06 mm to 2.0 mm; feels rough between fingers)	2
Silt	(particles ranging from 0.004 mm to 0.059 mm; feels greasy between fingers)	80
Detritus	(dead, large sized organic matter, including sticks and leaves, that cover the bottom)	10

Inlets: Total number 2 Number with continuous summer flow 1

Area of inlet (s) drainage basin (acres) 250

Dimensions of each permanent inlet and associated flow as measured 10 feet upstream from confluence with lake:

Width (feet) 3.5

Average depth (inches) 3

Flow (cfs) 0.25

Dimensions and composition of alluvial fan at the mouth of each permanent inlet:

Width (feet) 15

Distance extending into the lake (feet) 30

Substrate composition Gravel & Sand

Lake Physical Data (continued)

Inlets (continued): Remarks The permanent inlet (labeled #1) has a small falls 150 ft. upstream from lake, which limits further fish access.

Outlet: Width (feet) Unk. Average depth (inches) Unk. Flow (cfs) Unk.

Gradient (drop in feet for first 100 feet of horizontal distance) 15

Remarks The outlet of the lake goes underground during the summer months.

Refer to Table 1 and Figure 5 for temperature data.
Refer to Table 2 for water chemistry data.

TABLE 1. - Bear Lake water temperatures on July 7, 1973.

Depth (ft)	Temperature (^oF)
0	61.0
2	60.0
5	55.5
10	50.5

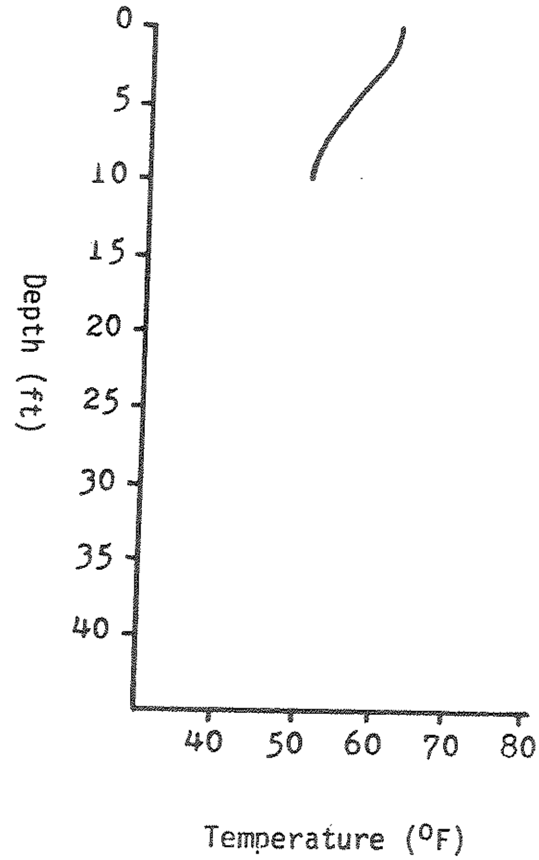


FIGURE 5. - Temperature profile of Bear Lake on July 7, 1973.

TABLE 2. - The chemical characteristics of Bear Lake on July 7, 1973.

Constituent	mg/l (ppm)
Oxygen, dissolved	9.0
pH value	7.5
Alkalinity, total	15.0
Alkalinity, bicarbonate (HCO_3)	15.0
Chloride (Cl)	2.5
Copper (Cu)	0.05
Hardness, total	15.0
Hardness, calcium ($CaCO_3$)	5.0
Hardness, magnesium	10.0
Nitrogen, nitrite + nitrate	0.0
Phosphate, ortho (PO_4)	2.5
Silica (Si)	1.0

Biological Data

Aquatic vegetation (excluding phytoplankton) and sedge abundance:

Type	Common or Latin Identification	Area Covered (sq. ft.)
Floating	None	--
Emergent	None	--
Submergent	None	--

Sedge comments: Only scattered patches around lake's perimeter.

Atypical presence or absence, abundance or scarcity of potential fish food invertebrates or vertebrates:

The relative abundance of aquatic invertebrates in Bear Lake appears average, when compared against abundance in lakes that are known not to be overstocked with fish.

Fish species present in the lake and comments on their respective abundance: Tokul Creek cutthroat are present in Bear Lake. The total population numbers less than 150 fish.

Age classes and lengths of fish samples collected:

Species	Age Class	Sample Number	Size Range (inch)	Mean Fork Length (inch)
T.Cr. Cutthroat	I	6	4.25 - 5.50	4.75
	II	3	6.50 - 7.50	6.75
	III	3	7.50 - 9.00	8.50
	IV	2	9.50 & 10.75	10.12
	VII	3	12.50 - 14.50	13.50

Note: the above data indicates that the cutthroat planted in 1966 began naturally reproducing at age III.

Biological Data (continued)

Stocking record for the lake:

		Number Planted	Number/ Surface Acre	Number/ Pound	Source
6/65	T.Cr. Cutthroat	1,028	Equivalent to 2570/acre	376	Shelton
7/66	T.Cr. Cutthroat	1,036	Equivalent to 2590/acre	259	Shelton

Note: The air plant made in 1965 is believed to have missed entering the lake. It would also be my guess that, judging from the population in the lake today, that a good part of the 1966 plant missed entry also.

Natural spawning (remarks on existing or potential spawning habitat and location, which species are spawning and with what degree of success):

This is the second high lake surveyed to date that contains a population of Tokul Creek cutthroat which find the environment suitable for natural reproduction. Most of the spawning is taking place at the mouth of the permanent inlet and on the alluvial fan. The success of the spawning is adequate to keep pace with natural and fishing mortalities, but not so successful as to result in stunting.

Fish pathology (were any lesions indicative of bacterial or viral infections, or endo- or ecto-parasites found associated with the fish sampled?):

None.

FIGURE 6

Photograph of fish sample and remarks

Tokul Creek cutthroat taken from Bear Lake. Fish are displayed from left to right in order of descending age classes: Ages VII, IV, III, II, and I respectively.

Fish stomach contents with the organisms listed in order of their decreasing volume within the stomach:

Caddisfly larvae and midge pupae.

Fish physiology:

Fat deposit in the viscera Moderate deposits

Flesh color (by species):

Species T.Cr. Cutts	Species N.A.	Species N.A.
Fish < 12" White	Fish < 12" --	Fish < 12" --
Fish > 12" White	Fish > 12" --	Fish > 12" --

Index of Condition: $C = \frac{10{,}000 \times \text{Wt. in lbs.}}{\text{Length}^3 \text{ in inches}}$

Species	Length	C
T.Cr. Cutts	14.5 "	2.6
T.Cr. Cutts	10.75 "	3.0
T.Cr. Cutts	8.50 "	3.1

Additional biological remarks:

It is my belief that the cutthroat can spawn in this lake because, (1) the alluvial fan, on which most spawning takes place, does not become completely exposed during the egg incubation period, (2) the gravels that compose the fan are a good size for spawning fish and not compacted with sediments and silt, (3) the inlet which formed the fan is permanent and does not go underground prior to entry into the lake.

Factors Influencing the Fishery

Hiking distance to the closest road ¼ mile (15 min. hike)

Future logging or road construction plans if known None planned at this time in the immediate vicinity of the lake

Present fishing pressure 10 anglers/year

Names of other managed lakes within a two-mile radius Goober Lake, Ellinor Lake, and Upper Jefferson Lake

Angler Reports

High Lake Fishing Report cards on record:

Month/Year	Species	Number Caught	Average Size	Remarks
		None received		

Future Management

Bear Lake has an Environment Parameter Index of 45, which corresponds with a sustainable production capability of 9.5 lbs/acre/year. This indicates that no more than 95 fish should be planted in this half-acre lake if quality trout are desired.

Since natural reproduction is maintaining the trout population at a level above the capability of producing quality sized fish in three or even four years, Bear Lake should not be planted.

GEOMORPHIC AND OTHER PHYSICAL CONDITIONS AFFECTING FISH POPULATIONS IN HIGH MOUNTAIN LAKES

by Dr. William S. Platts

The high mountain lakes of five mountain systems of two Rocky Mountain provinces were studied and compared, in order to explore the relationships between the geomorphic and other physical factors and the success or failure of these lakes as fish habitats. In describing the study area, similarities and differences between the physical factors and fish biology of the mountain systems were defined. The defined heterogeneity would suggest that any relationships disclosed by the study would have general applicability by relating plural fish communities to a general geomorphic type or other general physical constant.

The high mountain lake basin formation type, the determinant of many essential parameters, was selected as the basin geomorphic feature to be studied for a correlation between a geomorphic type and the success or failure of the lakes as salmonid habitats. Five types of lake basin formation types were characterized, evaluated and compared: the cirque, the rock dam, the moraine, the landslide and the avalanche (Table 5).

A high positive correlation between the basin formation types and elevation intervals exists, and, in general, the distinguishing physical characteristics of the lake basin formation types are also a function of the elevation to a remarkable degree. Thus the average and maximum water depth, the water level fluctuation, and the coarse shoal bed material decline with a decrease in elevation and in the order of cirque, rock dam, moraine, landslide and avalanche, whereas the percent shoal area increases with a decline of elevation. The anomaly in this rule is the rock dam, and the reason for the deviation in this case is assumed to be insufficient sample size.

The chemistry of the lake basin formation types is also correlated, either positively or negatively, with the elevation in the same order - cirque, rock dam, moraine, landslide and avalanche. Thus alkalinity and hardness increase with a decrease in elevation, and pH and dissolved oxygen decrease. No such function is found in the case of CO_2, however, since in CO_2 both the moraine and the landslide type tend to be high (Table 5).

Fish species compositions among the lake basin formation types are widely divergent. This divergence is attributable primarily to fish management, which by initiating this divergence masks the relative effectiveness of the lake basin formation types upon fish productivity, since it appears that certain species of fish are better adapted to the high mountain lake environment than others. Comparison of four species of salmonids showed the golden trout excelling in physical condition the cutthroat, brook and rainbow, the cutthroat next in rank, the brook following the cutthroat and the rainbow trout at a much lower level of physical condition than the other three.

Comparison of the physical condition of the four salmonids within each lake basin formation type constructs a series from the most thriving to the most impoverished, which ranks the types thus: landslide, cirque, rock dam,

Table 5. A summary of the distinguishing physical characteristics of the high mountain lake basin formation types, the characteristics ranked quantitatively (1 to 5).

Characteristic	Cirque	Rock Dam	Moraine	Landslide	Avalanche
Average Elevation (feet)	(1) 10,986	(2) 9,550	(3) 9,190	(4) 7,706	(5) 7,504
Average Water Depth (feet)	(1) 25	(5) 5	(2) 10	(4) 6	(3) 7
Water Level Fluctuation (Stable=4)	(2) 3.77	(4) 4.00	(1) 3.27	(4) 4.00	(3) 3.80
Shoal Area (% of Total Area)	(5) 51	(2) 87	(4) 83	(3) 84	(1) 92
Shoal Bed Material (% Coarse)	(1) 52	(3) 17	(2) 34	(5) 5	(4) 14
Alkalinity (ppm)	(4) 20	(5) 8	(3) 36	(1) 119	(2) 86
pH	(1) 7.4	(2) 7.5	(3) 8.2	(3) 8.2	(4) 8.6
Hardness ppm	(4) 25	(4) 25	(3) 46	(1) 110	(2) 85
D.O. (ppm)	(1) 10.0	(1) 10.0	(2) 9.1	(4) 8.7	(3) 9.0
CO_2 (ppm)	(3) 3	(3) 3	(2) 5	(1) 7.5	(3) 3

moraine and avalanche. If, however, compensation is made for differences in fish species composition and species adaptability, a different series is constructed, in which the moraine is shifted from 4th rank to first. A comparison between the two series shows that differences is species adaptability seems to be operative in the comparison between types, but that there are also differences that can be only explained as those initiated by a relationship between the lake basin formation type and the physical condition of the fish inhabitants of the type. A reversion to the correlation of certain physical properties at certain quantitative levels with particular lake basin formation types elucidates the rationale for such a relationship.

The excellence in fish physical condition within the landslide lake basin formation type is accepted as partial explanation of the high fecundity in the lakes formed by this type. On the other hand, the cirque lake basin formation type was placed at an adventitious disadvantage in such a comparison by completely lacking brook char within its fish population.

TROUT MANAGEMENT IN THE CALIFORNIA BACK COUNTRY[1/]

By

E. C. Fullerton, Director
California Department of Fish and Game

Let me begin by expressing strong agreement with many of the concepts and policies presented by the two federal panel members concerning protection of wilderness values. Certainly we in the California Department of Fish and Game can support the broad objectives of quality and naturalness in wilderness area management. The present emphasis placed by the National Park Service and U. S. Forest Service on perpetuation of natural aquatic ecosystems deserves the invitation, "welcome to the club". State fish and wildlife agencies have been resisting adverse influences on aquatic ecosystems for decades. With my usual lack of modesty, I'll even go so far to say we were leaders in the environmental movement in this country. Accordingly, many state wildlife agencies have been consistently strong advocates of establishing wilderness areas.

Mr. Griswold is right in indicating that points of difference among state and federal agencies on wilderness fishery management are not as great as points of agreement. But a few conflicts do exist and they have recently become significant. They must be resolved rather quickly. Otherwise, a long and productive climate of federal-state cooperation will be in substantial jeopardy.

To help put California's views on today's subject in perspective, let me describe briefly the resources at stake. The Sierra Nevada and Cascade mountains in our state are endowed with 3,316 lakes capable of supporting trout. Our four "natural category" national parks contain 1,558 of these lakes and

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1/ Presented as part of a panel discussion on Management of Wilderness Water at a joint meeting of the International Association of Game, Fish and Conservation Commissioners and the American Fisheries Society, Las Vegas, Nevada, September 10, 1975.

1,028 are in 12 official wilderness areas. Thus, about 75% of a major type of natural aquatic ecosystem in the state is now subject to federal management policies. Virtually all of the remaining mountain lakes occur in national forests and many of these are in wilderness study areas that may eventually be subject to management constraints.

Thousands of miles of magnificent streams exist in our parks and wilderness areas, but no appreciable conflicts in management approaches for these waters have surfaced.

All of these mountain lakes and streams provide over a million days of quality fishing each year.

To the best of our knowledge, all of California's high mountain lakes were barren of fish when first visited by European man. Now, incredibly, a handful of people would evidently prefer to see them all return to a fishless state. That feeling is evidently shared by some federal personnel.

I wonder what the early-day explorers of our mountain wilderness, who exerted great personal effort to establish fish populations in those lovely, but barren waters, long before parks and wilderness were ever considered, might think about some of the concepts being talked about today. Even the Sierra Club was deeply involved in those pioneer fish stocking efforts.

Some back country California lakes are still barren; many lakes possess sufficient spawning habitat for good natural reproduction and provide satisfactory trout angling without stocking. But a sizeable number of lakes lack adequate spawning habitat and must be planted periodically to offer any angling opportunity to the ever-increasing number of backpackers. It is these lakes that are primarily affected by a few unrealistic philosophies and policies recently promulgated by the federal managing agencies.

Fish stocking as a management tool can take many forms. At present, in alifornia's back country lakes, it mostly involves aerial plants of small ingerling rainbow and golden trout about every two or three years in some, ut not all lakes that would otherwise be barren. In the two or three years equired for these fish to reach catchable size, they become indistinguishable rom naturally-produced trout. We're not talking about the put-and-take stock- ng of catchable-sized fish in waters with high angler use; we're not talking bout stocking to achieve maximum sustained yields; and we're not talking about tocking every wilderness lake. What we are basically talking about is providing high quality, traditional fishing experience with species that are indigenous o California's mountain country. It is difficult for us to envision how such anagement could be considered inconsistent with true wilderness or natural ark values.

Whether they know it or not, the federal panel members today have advanced hilosophies which, if fully implemented, would greatly reduce the state's bility to go on managing fisheries that most wilderness users are satisfied ith. Perhaps these philosophies are appropriate for some regions of the nation, ut we do not believe they're right for California or other western states. The epartment of the Interior tells us that it's their policy to restore the natural category" parks to the condition that prevailed when first viewed by hite men. Strictly applied in California, this means cessation of fish stock- ng. Carried out fully, this could mean complete eradication of trout in our ark lakes, since all lakes were originally barren.

The basis for this policy, we are told, was the 1963 Leopold report, which esulted from intense controversy over management of big game in national parks.

The Leopold report doesn't mention fish or aquatic ecosystems. It clearly and unmistakably deals solely with wildlife, primarily ungulates. However, Interior has applied, without qualification, the report's policy recommendations to aquatic resources. We strongly disagree with this application of the policy and have requested a variance for California in order to maintain fishing as a traditional use in natural category parks, as expressed in the original federal park act. The Park Act specifically says that recreation is one of the purposes for establishing national parks.

Another issue spotlighted today by both federal speakers is aerial stocking. California long ago dispensed with the inefficient, uneconomical, environmentally unsound horseback approach in favor of aircraft. We stock between 900 and 1,000 high elevation lakes every year and we do it in less than 70 hours flying time. An individual wilderness lake is exposed to a few seconds of a low flying plane every two or three years. Can you imagine the army of pack stock and horsemen that would be required to do the same job? Visualize the impact those pack trains would have on wilderness values. We believe aerial stocking intrudes much less on those values than primitive transport, irrespective of the great differences in costs and effectiveness.

The federal panelists have talked specifically of other concepts that warrant discussion. My allotted 10 minutes doesn't allow for comments on all areas of disagreement. But one basic concept advanced by the Forest Service cannot go unchallenged. The philosophy that fish stocking must be used as a tool for managing areas for wilderness values and cannot be done for the sole purpose of providing fishing opportunities is unacceptable to California and every other western state if it means reducing or terminating stocking. This philosophy is probably the "whole enchilada" in relation to differences on isheries management in wilderness areas. It is probably the root of all our onflicts over specifics.

Without going into a long dissertation on the subject, let me simply say hat the philosophy is grossly discriminatory against anglers and, more importantly, : is based on an erroneous view of the relation between fishing and human use 1 the wilderness. The concept is unfairly discriminatory because it singles it one user group as a means of controlling overuse. If overuse is a problem, id it definitely is in some areas, we believe that controls should be applied › all user groups, not just people who consider fishing to be an important ictor in the quality of their wilderness experience. A permit system would lequately control use without reducing the quality of the experience for many :ople. Locating campsites away from lake shores is another alternative that iould be considered to reduce detrimental impact on environmental values.

A study by our Department, in cooperation with the El Dorado National Forest, i the Desolation Wilderness Area revealed that 60% of users did not fish. The :maining 40% included fishing tackle in their equipment, but only 6% cited shing as the primary motive for their visit, while 34% gave fishing as a :condary reason for their trip. In other words, 94% of the wilderness anglers uld have probably made their trip whether fish were available or not. They d indicate, however, that fishing was an important part of the back country :perience.

Our findings generally agree with those of Hendee, Clark, and Dailey who udied angler attitudes and behavior at alpine lakes in two national forests the State of Washington. Both studies strongly suggest that reducing fisheries uld be of questionable value in controlling use generally. Increasing angling portunities to obtain better dispersal of back country users might be a better proach, but even this would be only a partial solution to the overuse problem.

In resolving the differences between the state fish and wildlife agencies and the federal land managers, I recommend we both pay more attention to the biologists, social scientists, and others who have firsthand knowledge of the relationships of natural resources and people in the back country. The kind of knowledge acquired by Mr. Marcuson is essential for formulating realistic policies on wilderness fish management. I just wish that California had the personnel available to do the comprehensive survey work he had done in the proposed Beartooth Wilderness Area.

I'm not sure that I can agree fully with my counterpart in Oregon, John McKean, who places the primary blame for our problems on Congress. I see nothing in the Park or Wilderness acts specifically contrary to state fishery management goals. The problems stem almost entirely from administrative interpretations and philosophies in my view. And I'm pretty sure that we don't want to be considered bedfellows with the livestock and mining interests. But I can wholeheartedly agree that some changes in federal policy and attitudes are necessary if a traditional recreation use is to continue in our back country.

FUTURE CONSIDERATIONS

The final portion of the seminar was devoted to listing a few possible new directions in Idaho's mountain lake program.

Selective Closures Followed by Restrictive Regulation

In situations where there are several lakes in a group or chain it might be desirable to close one of the lakes until fish reach a large size and then institute a one or two fish limit on that lake. In a group of lakes one lake might be closed and recovering, one lake with quality but restricted fishing and the remainder of the lakes with ordinary fishing.

A closure of this type did work at Hidden Lake in North Idaho and produced excellent fishing for large fish.

More Restrictive Bag Limits for High Lakes

A high mountain lake trip is enhanced by seeing and catching a few fish. The experience is magnified if the fish are large.

There is normally no need or justification for a ten fish limit in mountain lakes. A limited bag and an 8-inch limit would seem desirable.

Stocking of Exotics

Unique species of which there is a relatively limited supply (goldens, grayling, etc.) should be stocked only in self-sustaining lakes and without the presence of other species. This program would provide more continuity in the presence of these species. Limits should be conservative to maximize benefits to a greater number of anglers.

Brook Trout Lakes

Most high lakes in Idaho that are stocked with brook trout result in stunted populations.

The easiest route around these stunted populations is, of course, to eradicate the lake and restock it with another species. However, if the public desires a brook trout lake for variety, it might be desirable to try an alternate approach. Attempts might be made to partially eradicate the lake periodically or to introduce a limited number of large predator species (Dolly Varden, brown, etc.)

Gammarus Introductions

Gammarus in a very desirable food item in those lakes in which it can survive because it is available into the late fall.

In their high lake visits, biologists should make an effort to determine if *Gammarus* is present and if not if the water quality is such to support this species. A total alkalinity of 30 ppm or more and at least 18 ppm total hardness is desirable. The presence of aquatic vegetation is also necessary for strong populations of this species.