State of California
THE RESOURCES AGENCY
Department of Water Resources

BULLETIN No. 136

NORTH COASTAL AREA INVESTIGATION

APPENDIX C
FISH AND WILDLIFE

By
Department of Fish and Game
Water Projects Branch
Contract Services Section

APRIL 1965

1. King salmon jumping at Burnt Ranch Falls, Trinity River.

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FOREWORD

The report on the North Coastal Area Investigation consists of Bulletin No. 136, four separately bound appendixes, and three separately bound office reports. The appendixes cover the subjects of watershed management in the Eel River Basin, recreation, fish and wildlife, and engineering geology. The office reports cover alternative plans for development, designs and cost estimates, and hydrology.

The North Coastal area of California contains a wealth of economically and aesthetically valuable fish and wildlife resources. Construction of water developments on the North Coastal streams, as discussed in Bulletin No. 136, would present difficult problems in connection with the preservation of fish life, especially anadromous fishes.

This appendix, entitled "Fish and Wildlife", Appendix C to Bulletin No. 136, was prepared by the Department of Fish and Game on the basis of investigations which were carried out under various interagency agreements with the Department of Water Resources.

The appendix presents information in two categories: (1) estimates of the present fish and wildlife populations in each hydrographic unit of the North Coastal area; (2) estimates of the measures which would be required to preserve, and possibly enhance, the fish and wildlife resources affected by the construction of the major water conservation projects described in Bulletin No. 136.

Some of the measures discussed in this appendix would be costly and would greatly affect the operation and water yield of the planned reservoirs. In those cases where the firm water yield of the projects would be significantly decreased, the annual unit cost of the exportable water to the user would be increased. It is emphasized that the estimates presented herein are based on reconnaissance-level studies, and they do not constitute formal specific recommendations. Determination of the actual measures which would be necessary for a given project will be made in the course of the comprehensive and detailed studies associated with formulation of individual projects.

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F CALIFORNIA—RESOURCES AGENCY WILLIAM E. WARNE, Director

RTMENT OF WATER RESOURCES
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ENTO

March 10, 1965

Honorable Edmund G. Brown, Governor
and Members of the Legislature
of the State of California

Gentlemen:

I am pleased to transmit herewith an appendix to Bulletin No. 136, "North Coastal Area Investigation", entitled Appendix C, "Fish and Wildlife". This report completes the preliminary fish and wildlife studies related to the investigation. These studies were carried out and the report prepared by the Department of Fish and Game under an interagency agreement with the Department of Water Resources.

As indicated in the report, the North Coastal area of California possesses a wealth of economically and aesthetically valuable fish and wildlife resources. The large scale of proposed water development in the North Coastal drainages would present very difficult problems in connection with preservation of existing fish and wildlife, especially anadromous fishes. In some cases, the problems are unprecedented because of the size and location of the dams and the export features of the projects.

The report presents preliminary estimates of the measures required to maintain fish and wildlife resources in association with the proposed developments. However, much additional work remains to more accurately inventory the fish and wildlife resources, determine streamflow releases, and develop plans for facilities to replace spawning and nursery areas blocked and inundated by the reservoirs.

Sincerely yours,

William E. Warne

Director

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The Resources Agency
DEPARTMENT OF WATER RESOURCES

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CHAPTER I. INTRODUCTION

This report completes the reconnaissance-level studies of fish and wildlife which have been conducted as part of the investigation of the North Coastal region made by the Department of Water Resources. These studies have been conducted under two individual programs: the North Coastal Area Investigation, and the Coordinated Statewide Planning Program. The North Coastal Area Investigation has been directed primarily toward planning for major water conservation projects; therefore, the purpose of the related fish and wildlife studies was to make preliminary evaluations of the effects of possible projects on the fish and wildlife resources. The Coordinated Statewide Planning Program is directed primarily toward determining basic data regarding land and water use, water supply, and estimates of future water requirements for hydrographic areas throughout the State so that water projects can be logically staged; thus, the purpose of the fish and wildlife studies conducted under this program has been to determine the water requirements necessary to preserve, and possibly enhance, these resources in the North Coastal Hydrographic Area. The results and conclusions of both of these programs are included in this report since the two investigations are closely related and the studies for each were carried on concurrently.

This chapter will briefly describe the North Coastal Area Investigation, the Coordinated Statewide Planning Program, and the related fish and wildlife investigations.

North Coastal Area Investigation

A primary mission of the Department of Water Resources is the implementation of the State Water Resources Development System. As defined in the California Water Resources Development Bond Act of 1959, popularly known as the Burns-Porter Act, this system includes the Central Valley Project, the State Water Facilities under construction, and the additional facilities that may be authorized by the Legislature or the Department of Water Resources to augment water supplies in the Delta and to meet local needs.

Need

In recognition of the necessity to specifically define major multiple-purpose projects to follow the Feather River Project (subsequently designated State Water Facilities by the Burns-Porter Act) and to establish their logical sequence of development, the Department of Water Resources initiated the North Coastal Area Investigation in July 1958. The initial reconnaissance phase of the continuing investigation will be completed with the publication of Bulletin No. 136. The Water Resources Development Bond Act, passed by the Legislature in 1959, and approved by the voters in 1960, provided added official recognition of the necessity for developing additional water supplies; and within certain limitations, the act provided for the financing of succeeding additions to the State Water Resources Development System.

The objective of the North Coastal Area Investigation is to formulate plans for the optimum development of the water resources of the region, considering all potential uses, including anticipated local and export water supply needs; enhancement of fish and wildlife resources; development of hydroelectric power and water-associated recreation potential; and protection against floods.

Scope

The first phase of the North Coastal Area Investigation has been conducted at a reconnaissance-level of intensity. The scope of the investigation is comprehensive with regard to the multiple-purpose uses of the prospective export facilities. These uses include provisions, where appropriate, for distribution of water supplies to local areas, control of floods by reservoirs, generation of hydroelectric power, fisheries enhancement, and development of recreation potential.

The program for the investigation covered all aspects of development, control, and conveyance of water. Studies ranged from cursory examination of alternatives to semidetailed analysis of project units and features. The investigation included field work and office studies within the following categories: watershed management, hydrology and meteorology, geology, surveys and topographic mapping, land and water use, water quality, economics, property appraisal, and fisheries and recreation evaluation. Operation studies to determine conservation yield, hydroelectric power capability, flood control potential, and other factors for prospective multiple-purpose reservoirs and export systems were conducted by both conventional and electronic machine computing methods. The intensity of design studies and cost estimates ranged from reconnaissance to reasonably detailed analysis. Based on these studies, the more favorable major projects have been selected for more intensive studies.

Selected Projects

The long-range development plans within the North Coastal and west side Sacramento Valley areas which are recommended in Bulletin No. 136 for more intensive studies are listed below in the order of development recommended at this time.

- Paskenta-Newville Project
- Upper Eel River Development
- Trinity River Developments
  - Trinity Diversion Project
  - South Fork Trinity Project
  - Mad-Van Duzen Project
- Greater Berryessa Project
- Lower Eel River Development
- Klamath River Project

These plans are shown on Plate 1.

Future Investigations

With the publication of Bulletin No. 136, the first phase reconnaissance investigation in the North Coastal area was completed. Beginning in July 1964, departmental efforts in this area have been confined primarily to two planning programs. The first program is an advance planning investigation of the Upper Eel River Development. The objective of the investigation is the final formulation of a project to meet the requirements for additional facilities of the State Water Resources Development System. This feasibility-level investigation will be culminated by a report on specific features of the initial project.

The second study will be a continuation of the area-wide investigation of the remainder of the North Coastal area. This investigation will be of an intermediate level of intensity. It will be directed toward the more detailed identification of future projects within the Trinity, Mad, Van Duzen, Lower Eel, and Klamath River Basins. The objective of this study will be to further define the second and later-staged developments recommended in Bulletin No. 136, in anticipation of future feasibility-level studies.

Coordinated Statewide Planning Program

The Coordinated Statewide Planning Program is conducted under the basic authorization contained in Section 232 of the California Water Code, wherein;

> "....the Department is authorized and directed to conduct investigations and hearings and to prepare findings therefrom and to report thereon to the Legislature at the earliest possible date with respect to the following matters:
>
> (a) The boundaries of the respective watersheds of the State and the quantities of water originating therein;
>
> (b) The quantities of water reasonably required for ultimate beneficial use in the respective watersheds;
>
> (c) The quantities of water, if any, available for export from the respective watersheds;
>
> (d) The areas which can be served by the water available for export from each watershed; and
>
> (e) The present uses of water within each watershed together with the apparent claim of water right attaching thereto, excluding individual uses of water involving diversions of small quantities which, in the judgment of the Director of Water Resources, are insufficient in the aggregate to materially affect the quantitative determinations included in the report.
>
> "Before adopting any findings which are reported to the Legislature, the department shall hold public hearings after reasonable notice, at which all interested persons may be heard."

(Added by Statutes of 1956 (Executive Session), Chapter 61; amended by Statues of 1959, Chapter 2025.)

Compilation of this information is the responsibility of the Department of Water Resources. To accomplish this, the department divided the State into major hydrographic areas, and, within each, into hydrographic units generally comprising watersheds of individual rivers. Further division into subunits was made, usually along watersheds of tributary streams.

The department is compiling basic data on water and land use, land classification, streamflows, ground water and water quality for these hydrographic units. This activity has been concentrated in the northern part of the State, since this is the area from which large amounts of surplus water will be exported. It is of fundamental importance to have information concerning the amounts of water which can be made available for export from this area without depriving those areas of water necessary for economic development, recreational use and preservation of fish and wildlife resources.

The above described activity constitutes part of the first phase of the total program. It has been reported in the Bulletin No. 94 series for the following hydrographic units in the North Coastal area: Trinity River, Eel River, Russian River, Mad River, Redwood Creek, Mendocino Coast, Klamath River, Shasta-Scott River, and Smith River.

The second phase of the program consists of a systematic evaluation by significant drainage basins of the amounts and qualities of surface and underground water resources, estimates of timed future economic demands for water, and an appraisal of the resultant future water surpluses or deficiencies for each study area. These studies will be reported in the Bulletin No. 142 series. The first of these, No. 142-1.1, published concurrently with Bulletin No. 136, covers the hydrographic units of the southern portion of the North Coastal area. The southern portion includes the Trinity River, Eel River, Russian River, Mad River-Redwood Creek, and the Mendocino Coast.

The third and final phase of the investigation will utilize the results of the first two phases, not only for the study area of Bulletin No. 142-1.1, but for all other areas of the State where similar investigations have been conducted, and will recommend specific projects together with their dates and sequence of construction.

Fish and Wildlife Investigations

The North Coastal area of California is truly fortunate in having a wealth of fish and wildlife resources in a region of unique scenic beauty. These resources are a basic part of the recreation industry which is second only to lumbering in the economy of the region. The king and silver salmon populations supported by North Coastal streams also contribute significantly to the ocean commercial fishery of Northwestern California. Commercial fishing is also a basic industry of the area. Its income is exceeded only by lumbering, recreation, and agriculture.

The water developments proposed for the North Coastal area would have a tremendous effect on the fish and wildlife resources. Major developments proposed for the Eel, Trinity, Mad, Van Duzen, and Klamath Rivers would either inundate or block off a large part of the spawning and nursery areas of anadromous fish in the upper portions of these drainages. In addition, the reservoirs would inundate winter feeding areas of migratory deer and other game animals. It is apparent that any plan for major water development in the North Coastal area must include provisions for protection of the fish and wildlife resources, and this can be done only after thorough evaluation of these resources.

Authorization for Studies

The Davis-Dolwig Act (Chapter 10, Part 3, Division Six, Water Code) declares that recreation and the enhancement of fish and wildlife resources are among the purposes of water projects constructed by the State itself or by the State in cooperation with the United States. This act and various policies and procedures prescribed by the California Legislature direct the Department of Water Resources to give full consideration to the preservation and enhancement of fish and wildlife in all project planning investigations that are part of The California Water Plan.

The fish and wildlife investigations leading to this report were carried out under various Interagency Agreements between the Department of Water Resources and the Department of Fish and Game. The report was prepared by the Contract Services Section, Water Projects Branch, Department of Fish and Game under Interagency Agreement No. 252851 with the Department of Water Resources. This report completes the first phase of the reconnaissance-level investigations on fish and wildlife in the North Coastal area which would be affected by the planned water projects.

Scope

The fish and wildlife studies were conducted at a reconnaissance-level. Emphasis was placed on review of available literature and evaluation of data previously collected. Field work was relatively limited.

Due to the reconnaissance nature of the studies, the estimates of fish and wildlife populations and streamflow requirements presented in this report should be considered preliminary and subject to revision as more intensive studies are conducted.

Objectives

As described previously, the fish and wildlife studies in the North Coastal area were conducted under two individual programs. The objectives of the studies under each program were as follows:

Coordinated Statewide Planning Program

1. To describe and inventory the fish and wildlife resources in the North Coastal Hydrographic Area.

2. To estimate minimum streamflows required at each hydrographic subunit boundary to maintain existing fish and wildlife at their historical average abundance.

3. To estimate enhancement flows for streams that possess a potential for increased production of economically important fish and wildlife.

North Coastal Area Investigation

1. To make preliminary evaluations of the effects of possible projects on fish and wildlife.

2. To make preliminary recommendations for measures which would be required to preserve fish and wildlife in connection with project construction and operation; and where losses would be unavoidable, to recommend measures required for mitigation or compensation.

3. To make preliminary recommendations for measures which could

enhance fish and wildlife resources in connection with specific projects, where it is anticipated that enhancement would be feasible.

4. To delineate fish and wildlife problems that will require further investigation when the plans for water development are studied at a higher level of intensity.

Conclusions

1. The North Coastal area contains a wealth of fish and wildlife resources that require protection to meet present and future human demands for economic development, recreational use, and aesthetic enjoyment.

2. Water projects proposed for the North Coastal area will have a major impact on the fish and wildlife resources which are important to the economy of the area. It is state policy that these resources be preserved and enhanced.

3. For the earlier staged projects, fish and wildlife could probably be preserved with conventional techniques. Projects proposed for the lower Eel and Klamath Rivers pose problems of far greater complexity. Preservation of fish and wildlife with these projects may require development of entirely new techniques, and in some respects may not be possible.

4. This report presents a preliminary evaluation of the effects of the proposed water projects and suggests measures for preservation and enhancement of the affected fish and wildlife resources. However, our present knowledge of these resources and the probable effects of the projects is far from complete, and further study will be necessary before final recommendations can be made for the protection of the fish and wildlife resources of the North Coastal area.

Recommendations

Preliminary estimates of the measures required for fish and wildlife maintenance, compensation, and enhancement in connection with specific projects are presented in this report. These measures should be considered in the advance planning program for the Upper Eel River Development and the continuing North Coastal Area Investigation. In addition, the effects of the proposed projects on fish and wildlife should be given more intensive study during the course of these investigations. Specific problems requiring further study are outlined in Chapter XVI. The general recommendations are summarized below:

1. A more precise inventory of the fish and wildlife resources affected by the proposed developments should be obtained.

2. Adequate streamflow releases to support fish and wildlife below all proposed projects should be more accurately determined.

3. Detailed water quality studies of the streams affected by the proposed developments should be initiated.

4. Planning for suitable artificial propagation facilities to replace lost spawning and nursery areas of anadromous fish should be initiated.

5. Fishery enhancement possibilities suggested in this report should be given further study to determine the feasibility of the proposed measures.

6. Comprehensive wildlife studies are needed for each of the proposed water projects to more accurately evaluate wildlife losses, to select mitigation sites for these losses, and to evaluate enhancement possibilities and determine benefits.

7. The proposed projects would create new reservoir fisheries; however, since each proposed project would destroy many miles of inland sport fishing, consideration should be given to acquiring stream areas below the dams, and improving public access if necessary, to mitigate the loss of stream fishing within the reservoir basins.

8. A study should be initiated to determine the feasibility of improving the fisheries of small coastal streams by construction of streamflow maintenance dams.

Organization of Report

The first three chapters of this report provide a general introduction to the North Coastal Area Investigation and the Coordinated Statewi Planning Program, describe the assumptions and methods of analysis utilized in the fish and wildlife studies, and present a description of the fish and wildlife resources of the North Coastal area. Following this background information, Chapter IV discusses generally fishery problems associated with water project developments and the various measures required to preser and enhance fish and wildlife.

The principal findings of the fish and wildlife studies are presented in Chapters V through XV. Each of these chapters covers the studies for a hydrographic unit, usually corresponding to the drainage boundaries of a major watershed. The first part of each chapter includes a general description of the hydrographic unit and its fish and wildlife resources, followed by a description of the hydrographic subunits and estimates of the streamflows required to preserve, and where feasible, enhance fish and wildlife in each. The second part of each of these chapters is devoted to a discussion of the effects of proposed water projects on fish and wildlife resources. This includes a description of possible projects in the hydrographic unit and their effects on fish and wildlife, estimates of streamflo and other measures required to preserve, and where possible, enhance the fisheries, and estimates of the measures required to compensate for losses of wildlife habitat.

The final chapter of the report outlines the fish and wildlife studies which will be needed as parts of the Upper Eel River Advance Planning Program and the continuing North Coastal Area Investigation.

Related Reports and Investigations

Middle Fork Eel River Investigation (Department of Fish and Game)

The major part of the basic fisheries data required for preliminary evaluation of the anticipated Middle Fork Eel River developments was obtained in field studies conducted in 1959 and 1960. These studies were carried out by Fish and Game personnel of the Contract Services Section in accordance with an Interagency Agreement with the Department of Water Resources, as an integral part of the North Coastal Area Investigation. These studies included fish population sampling, trapping of downstream migrants, recording of stream temperatures, streamflow and spawning gravel measurements, stream surveys, review of available literature, and discussions with personnel of various agencies. The results were presented in an office report entitled, "The Effects of the Spencer-Franciscan, Jarbow and Dos Rios Alternative Projects on the Fisheries of the Middle Fork Eel River." Because this study is so pertinent to the present report, a brief summary of the information obtained is given in Chapter V.

Klamath River Investigation (Department of Water Resources)

An appendix to Bulletin No. 83, "Klamath River Basin Investigation," discussed fish, game, and recreation in the Klamath River basin. This appendix, was published in May 1960 and presented information on the fish and wildlife resources in the basin, their importance and water requirements, and recreational use of the Klamath River drainage.

Northwestern California Investigation (U. S. Department of the Interior)

In 1960 the U. S. Department of the Interior published the report "Natural Resources of Northwestern California." The U. S. Fish and Wildlif Service, River Basin Studies, prepared an appendix to this report entitled, "A Preliminary Survey of Fish and Wildlife Resources." The purposes of the appendix were to review existing information on fish and wildlife resources; to summarize recent investigations; and to make a general analysis of the needs of fish and wildlife resources in relation to proposed and potential development of the area.

The appendix presented the results of studies conducted by the Service between 1955-1959. These investigations were devoted primarily to the Eel River but included the Trinity and Klamath Rivers; and to a lesser extent, the Smith, Mad, and Mattole Rivers, and several smaller streams. The investigations included population estimates of anadromous fish in the Eel River, derived from tag and recovery work, downstream migrant studies, spawning gravel studies, temperature data collection, and estimates of the sport and commercial fisheries.

Much of the information obtained in these studies and presented in the U. S. Fish and Wildlife Service report was used in the preparation of this report.

Shasta Valley Investigation (Department of Water Resources)

Fish and wildlife were discussed in relation to water development plans in the Shasta Valley in an appendix to Bulletin No. 87, "Preliminary Report, Shasta Valley Investigation," which was released in July 1961. The appendix was based on data obtained from a literature review, field surveys of the Shasta River, and interviews with local people.

Branscomb Investigation (Department of Water Resources)

The effects of the proposed Branscomb Project on the fishery resources of the South Fork Eel River were evaluated in an appendix to Bulletin No. 92, "Branscomb Project Investigation," which was published in June 1962. This report was based primarily on brief field studies by the Department of Fish and Game and review of available literature.

CHAPTER II. METHODS AND PROCEDURES

Much of the information contained in this report is based on an extensive review of literature pertaining to fish and wildlife in the North Coastal area of California. Previous reports prepared by the Department of Fish and Game, Contract Services Section and the U. S. Fish and Wildlife Service were used extensively. Existing data and unpublished reports from the files of the Department of Fish and Game and the U. S. Fish and Wildlife Service were obtained and evaluated. This literature review supplemented the field studies conducted on the Middle Fork Eel River by Smith and Elwell (1961), and the wildlife surveys conducted by the Department of Fish and Game in the various possible reservoir sites.

This chapter explains the methods and assumptions inherent in the studies leading to the preparation of this report.

Fishery Studies

The estimates of anadromous fish populations and their distribution in North Coastal streams were based on dam and weir counts, where available. Unpublished spawning survey data from Department of Fish and Game and U. S. Fish and Wildlife Service files were also used. Many of the streams of the North Coast have never been studied adequately to obtain accurate estimates of the anadromous fish populations. This is particularly true of the lower Klamath, South Fork Trinity, Van Duzen, Smith, and Russian Rivers. Adequate estimates are entirely lacking for all of the smaller coastal streams.

Estimates of the numbers of silver salmon and steelhead for all of the North Coastal rivers are crude since the spawning migration of these species occurs during the winter months when streamflows are high and the inaccessibility of many areas makes surveys difficult or impossible. In many cases it was necessary to rely on estimates made by personnel of the Department of Fish and Game or U. S. Fish and Wildlife Service, and estimates from fragmentary data.

Due to the inadequacy of these methods, the estimates presented in this report are preliminary and indicate only the general magnitude of the anadromous fish runs. These estimates should be refined by more intensive studies during the advance planning program for the Upper Eel River Development and the continuing North Coastal Area Investigation. No attemp was made to estimate the relative abundance of resident fish species in the drainages under investigation. However, the presence of these species was indicated when it was important in relation to the proposed developments.

The fishery maintenance flows given in this report were estimated using the method described later in this chapter under "Water Requirement Studies." However, the streamflows listed for several specific projects ar different from those indicated in the water requirement sections due to spe circumstances associated with the particular projects. The fishery mainten flows are intended to preserve the fishery resources historically using the river downstream from the proposed projects. It is assumed that hatcheries or other artificial propagation facilities would compensate for losses of upstream spawning and nursery areas.

These artificial propagation facilities would be designed to maintain historical average runs of king salmon, silver salmon and steelhead. The size of these anadromous fish runs has varied greatly from year to year, depending on numerous natural and man-made conditions.

Recent studies by the Department of Fish and Game (Hallock and others, 1961, and unpublished data of the Marine Resources Branch) have show that about a 2 percent return of adults can be expected from plants of yearling silver salmon and steelhead. Therefore, in determining the size of artificial propagation facilities, it was assumed that only enough yearlings would be raised and planted so that a 2 percent return would result in the average annual run of adult fish.

However, young fall-run king salmon normally migrate to the ocean soon after hatching and therefore, king salmon should be maintained by plants of advanced fry and fingerlings. The spawning runs of king salmon would be expected to fluctuate as they have historically, and thus it would be necessary to accommodate eggs taken from the peak runs in order to maintain the average abundance of king salmon. Counts of king salmon at several stations maintained by the Department of Fish and Game in the North Coastal area (Tables 1 and 2), indicate that the peak runs may vary from $1\frac{1}{2}$ to $4\frac{1}{2}$ times the average historical runs. In this report it is assumed that the peak king salmon runs are $2\frac{1}{2}$ times the average runs, and artificial propagation facilities are sized for the eggs expected from this number of adult fish.

The enhancement flows listed in this report are estimates of the flows required to maximize usable salmon spawning gravel in the various river sections. It was assumed that one-half of the spawning flow would be adequate for egg incubation and downstream migration of the juvenile salmon. This assumption ignores the possible need for large flows to initiate downstream migration as discussed in Chapter IV. Adequate studies have not been made to determine the flows necessary to provide enhanced summer flows. The problem of providing satisfactory water temperatures for salmonids during the summer months must be considered in future studies.

Streamflow releases during the summer must be adequate to provide suitable water temperatures since the juvenile salmon and steelhead migrate downstream throughout most of the summer in some areas. Studies of downstream migrant king salmon in Mill Creek by the Department of Fish and Game (unpublished), and on Deer Creek by Needham and others (1943), indicate that young salmon are in the Sacramento River tributaries at least through July. Similarly, studies on the Eel River by Shapovalov (1940), the Mad River by Bailey (1951), and the Trinity River by Moffett and Smith (1950), indicate that salmon and steelhead migrate downstream through July and even early August.

The estimates of increased anadromous fish production from improve streamflows below specific projects includes only fall-run king salmon enhan ment. No consideration was given to possible increased production of silver salmon or steelhead, or to the possibility of developing runs of winter-run king salmon.

The spawning seasons of winter and fall king salmon do not overlap therefore, the same spawning areas could be used by both runs without conflic Thus, if it were possible to establish runs of both winter and fall king saln the benefits would double. Presently, sport fishing for salmon in the Sacramento River is believed to be supported primarily by winter king salmon. Therefore, increased production of winter-run salmon would be highly desirabl

The numerous assumptions required to estimate potential increased king salmon production from enhanced flows are listed in the footnotes on Plate 2. Estimates of the square feet of usable spawning gravel came from various sources. Smith and Elwell (1961) presented data for the Middle Fork Eel River. Unpublished data from the Department of Fish and Game and the U. S. Fish and Wildlife Service provided estimates for the main Eel River, South Fork Trinity River, and Stony Creek. Measurements of usable king salmo spawning gravel at various streamflows made by the U. S. Geological Survey for an unpublished report by Rantz (MS) provided data for the Mad, Van Duzen, and South Fork Eel Rivers, as well as Outlet and Tenmile Creeks. Unpublished data obtained by Smith and Van Woert (MS) provided estimates for the Cottonwood Creek drainage. Fisk (1959) surveyed salmon spawning gravel in Thomes Creek and obtained the necessary data for that drainage.

If adequate flows and suitable temperatures are present during the proper months, adult salmon will enter the streams to spawn, and ultimately establish a run of approximately the proportions estimated. However, reliance on a natural process cannot be expected to produce immediate results. Therefore, an initial program of stocking would be desired.

Fingerling salmon would be released in the spawning area during the last two years of construction and the first two years following completion of the projects. This would assure the establishment of the run with the return of the first adult spawners the second year after completion of the projects.

A return of about one half of one percent of stocked fingerlings as adult spawning salmon can be anticipated. Therefore, to establish the desired run in the shortest possible time would require the release of 200 fingerling salmon annually for every returning fish.

It should be emphasized that losses from certain projects must be completely compensated before there can be net enhancement of anadromous fish resources. Therefore, it might be possible to enhance the salmon runs in one stream to compensate for losses in another; however, net fishery benefits would not result.

In addition to streamflow releases, certain stream improvement work would probably be necessary to obtain the full enhancement potential.

For example, improved access over natural and artificial barriers would be necessary in some cases. All significant diversions should be screened to protect migrating fish. Consolidation of divergent stream channels and improvement of spawning areas by creating semi-natural spawning channels through the introduction of spawning-sized gravel would be desirable in several drainages.

Determination of benefits from possible increased production of silver salmon and steelhead will require further evaluation. These species spend one or more years in freshwater before migrating to the ocean. Thus, in order to obtain silver salmon and steelhead enhancement, adequate summer flows and water temperatures would be required to provide improved nursery areas for these species.

Wildlife Studies

Attention during this study was focused on principal wildlife game species which are found in the North Coast study area. No attempts were made to estimate wildlife and/or wildlife densities except in the proposed reservoir sites being studied. Reconnaissance surveys were conducted in proposed project sites to estimate days-of-use or population densities for the following game species: black-tailed deer, California quail, mountain quail, sooty grouse, brush rabbit, black-tailed jackrabbit, and gray squirrel

Furbearers and predators will be discussed briefly in the report, but no surveys were made to evaluate project effects on this resource. Species, numbers, and sign were recorded in field notes incidental to other surveys conducted. Other wildlife, game and non-game species, were recorded as observed by field personnel.

Wildlife surveys reported herein were conducted on a reconnaissance level for one year (1963) only. Survey results are an estimate of wildlife use and/or population, and should not be considered an accurate account of wildlife using proposed reservoir sites. Additional studies are necessary to accurately evaluate wildlife use in these proposed sites and necessary measures required for the preservation of these wildlife species. The purpose of the reconnaissance surveys is to obtain basic data on wildlife species using the proposed reservoirs to assist the biologist in formulating a realistic management plan. All wildlife surveys were conducted in the proposed reservoir sites below the normal pool elevation by experienced field personnel. Loss of wildlife habitat due to construction borrows, road construction, recreation facilities, and administration facilities were not appraised for wildlife losses at this time. These losses should be calculated and measures taken for their mitigation as additional engineering data becomes available.

Deer use, expressed as deer days-of-use, is estimated by the mil-acre pellet count procedure in each of the proposed reservoir sites. A deer day-of-use is the amount of range use equivalent to that ordinarily required by one deer on the range for one day. This does not indicate the number of animals using a reservoir site, but indicates the number of days an unknown number of animals use the reservoir site. Because the longevity of pellet groups is not known and both resident and migratory deer use many of the proposed sites, it is difficult to determine the number of actual animals completely dependent on the reservoir site, without a more intensive study. Thus, the deer use in a reservoir site is more appropriately referred to as deer days-of-use. This same measure of use is also used in deer use projections in mitigation areas.

Other wildlife species which were studied in the proposed reservoir sites were surveyed by using a variation of the King transect technique.

Mitigation can best be done by increasing the carrying capacity of wildlife habitat in areas adjacent to the reservoir site.

Several species of wildlife will be displaced by the proposed water projects; however, in the case of these reservoirs, the species involved will all benefit when the lands chosen for deer mitigation are properly developed and managed. Initial wildlife mitigation developments will consist of creating additional carrying capacity of lands which can best be developed for this adjacent to the reservoir sites whenever possible. This can be effected by restoration, conversion, or establishment of forage plants beneficial to the displaced wildlife. Controlled burning, mechanical, manual, and chemical brush manipulation, as well as cultivation, fertilization, and reseeding, may be necessary to accomplish this objective. Annual general maintenance and periodic extensive treatment will be necessary to keep the developed areas producing optimum carrying capacity.

Water Requirement Studies

The objectives of the water requirement studies were to provide estimates of the streamflows required at each hydrographic subunit boundary for maintenance and enhancement of existing fish and wildlife resources in the subunit. In addition, these estimates were the basis for setting streamflow releases to support fishlife below the proposed water projects described in this report.

The selection of a valid method of determining streamflows necessary for maintenance or enhancement of fish and wildlife populations over a large geographical area is controlled by many factors, not the least of which is the available time within which answers must be provided. Ideally, field measurements should be made for a number of representative stations on each stream involved over a several-year period, and should cover all life history phases of the species concerned. Such a study, of course, would require much time and manpower.

In the present study, both time and manpower were extremely limited, being confined to the services of one man, and occasionally two, over a span of somewhat less than a year and a half. Under these limitations, an office method had to be quickly developed that would provide reasonable estimates of streamflow requirements, useable for water requirement investigations and operational studies on proposed projects at a reconnaissance level, but which would not be the final word on fish and wildlife requirements.

After much trial and error with a number of different procedures, a method suggested by staff hydrologist Jack Hannaford was finally adopted for determining spawning flows for the majority of the streams covered in this report. Spawning flows are among the most critical flows encountered by anadromous salmonid fish during their freshwater existence, and are the flows studied most often in setting flow requirements for these fish relative to water projects.

The procedure developed can be termed the flow duration curve method. Simply stated, this approach utilizes mean monthly flow data during spawning months over a representative period of years, in conjunction with a field-measured spawning flow for the stream involved. At least one such field-measured flow is required per drainage (hydrographic unit) to set fishlife flows in this or hydrologically and geologically similar drainages.

The method can be described most clearly by listing the steps required to arrive at the final spawning flow figure:

1. Construct a flow duration curve for a representative period of years for each of the spawning months on probability scale x 3 cycle logarithm paper (see Figure 1). Denote Q in cubic feet per second along the ordinate, and the percentage of total years that mean monthly flow is less than that shown at any point on curve, along the abscissa.

2. Introduce a field-measured fish maintenance spawning flow (flow required to maintain present average run) onto the individual flow duration curves from the point on the ordinate representing the appropriate flow (Figure 1).

3. Read off the percentage probability figures (probable percentage of total years that the mean spawning flow would prevail) for individual months along the abscissa.

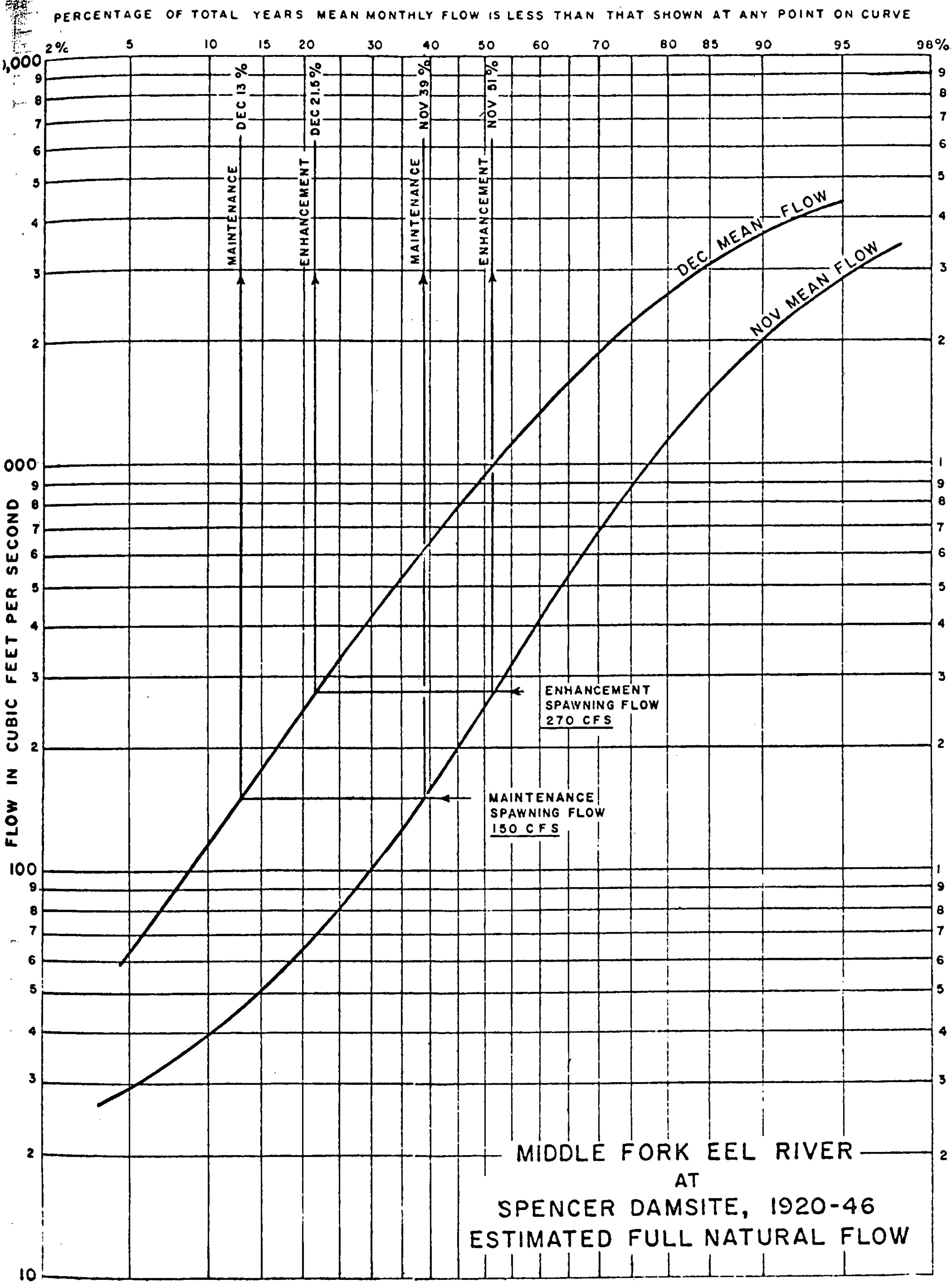
4. Introduce the percentage probability figures derived from step 3 to the abscissa of the graph of flow duration curves for any other stream in the same or similar drainages where mean monthly flows for similar time periods have been determined (Figure 2).

5. Read off the estimated maintenance spawning flows for each month involved.

6. Average the flows thus derived. This figure is the estimated maintenance spawning flow for the particular stream.

7. Follow the same procedure to determine an enhancement (optimum) spawning flow.

Following spawning, the next phase in the freshwater life of anadromous fish is the period of egg incubation. This period extends from



TYPICAL FLOW DURATION CURVES USED TO DETERMINE PROBABILITY PERCENTAGES FROM FIELD MEASURED SPAWNING FLOWS

FIGURE 1

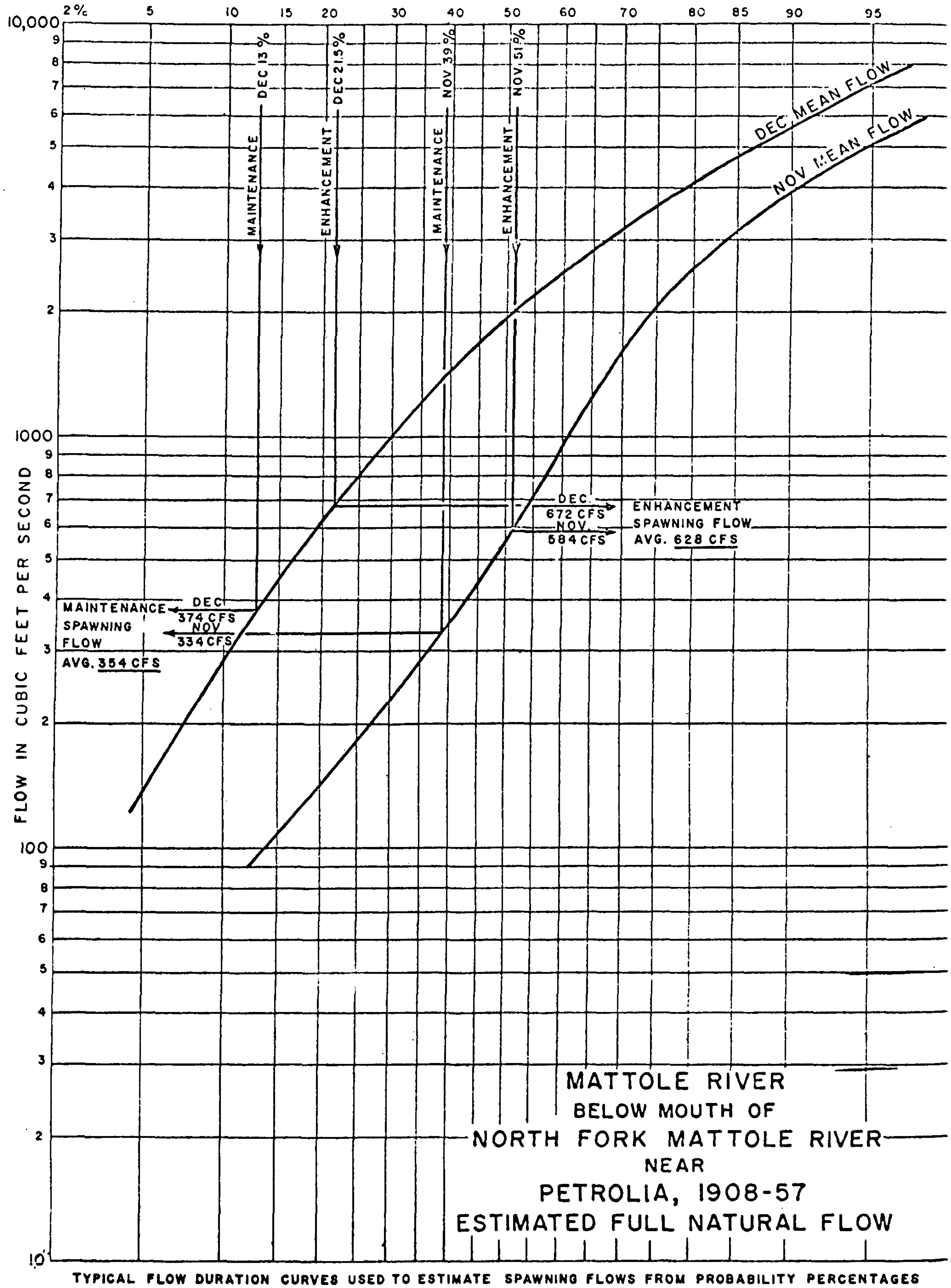

MATTOLE RIVER
BELOW MOUTH OF
NORTH FORK MATTOLE RIVER
NEAR
PETROLIA, 1908-57
ESTIMATED FULL NATURAL FLOW
FLOW IN CUBIC FEET PER SECOND
DEC. MEAN FLOW
NOV MEAN FLOW
MAINTENANCE DEC 13%
ENHANCEMENT DEC 21.5%
MAINTENANCE NOV 39%
ENHANCEMENT NOV 51%
DEC. 672 CFS
NOV. 584 CFS
ENHANCEMENT SPAWNING FLOW AVG. 628 CFS
DEC 374 CFS
NOV 334 CFS
MAINTENANCE SPAWNING FLOW AVG. 354 CFS
TYPICAL FLOW DURATION CURVES USED TO ESTIMATE SPAWNING FLOWS FROM PROBABILITY PERCENTAGES

FIGURE 2

a few weeks to several months, depending on water temperatures. Salmon and steelhead eggs normally incubate during winter and spring, a time of high streamflow. The eggs require considerable water flow for proper aeration. In this investigation it was assumed that spawning flows would be adequate and desirable for egg incubation, and thus were extended through this period.

The next activity of salmon and steelhead in fresh water is downstream migration of juvenile fish en route to the ocean. This takes place in the spring and early summer. One-half of the spawning and egg incubation flow was thought to be adequate for downstream migration.

King salmon migrate to sea within a few months after hatching; however, silver salmon and steelhead remain in the streams over one summer and steelhead sometimes over two summers. Streamflows required to support existing average populations were thought to be mean flows that prevail during the summer and early fall period. Therefore, summer carryover flows were derived by simply averaging long-term mean monthly discharges or flow estimates during this period.

In most instances it is believed that survival of juvenile fish and, in a few streams, summer-run adults, could be increased by larger than natural summer carryover flows. More wetted stream perimeter would mean more shelter, space, and flood organism production. Cold water released downstream would result in more summer habitat for an undefined distance below the point of release. Since it would take intensive field studies to establish optimum summer flows, no attempt was made to determine these flows.

Field-measured spawning flows came from several sources. Smith and Elwell (1961) measured a range of spawning flows for the Middle Fork

Eel River. These flows were used as a basis for estimating spawning flows in the Eel River and the Smith River hydrographic units, which were considered to have similar fall runoff patterns. Spawning flows were also measured at nine different stations, seven in the Eel River drainage and two in the Mad River drainage, by the United States Geological Survey during a joint study with the Department of Fish and Game in 1962 and 1963. These data were used as a basis for estimating spawning flows in the streams measured in this study in preference to the use of the data obtained by Smith and Elwell.

Spawning flows measured by Smith (unpublished data, 1960) on the South Fork Trinity River, and substantiating field data for the North Fork, Canyon Creek and Brown's Creek, tributaries of the Trinity River, obtained under the direction of the writer in 1963, were used as a basis for spawning flow determination in the Trinity River and Shasta-Scott hydrographic units, and for the Salmon River, part of the Klamath River hydrographic unit.

An equation developed by S. E. Rantz of the U. S. Geological Survey as a result of the cooperative investigation with the Department of Fish and Game provides an easy field method for determination of optimum spawning flows. The procedure remains to be field-tested through intensive comparative studies; however, it was believed to be an adequate approach for determining spawning flows in the Mendocino Coast hydrographic unit and on tributaries of the Russian River, in lieu of any other field-measured flows.

Flows recommended for the main stem of the Russian River are simply flows stipulated in an agreement between the Department of Fish and Game and the Sonoma and Mendocino County Flood Control and Water Conservation Districts in the 1959 hearings before the State Water Rights Board. Similarly, flows determined for the Klamath River are based on an agreement executed in 1959 between the department and the California-Oregon Power Company relative to streamflow releases below the company's Iron Gate Dam.

Finally, in the Lost River-Butte Valley hydrographic unit, recommended streamflows are based on a review of available flow records and advice of regional Department of Fish and Game personnel. This area is unique compared to the remainder of the North Coastal area, since its streams drain internally and contain no anadromous fish. Instead, existing fish populations are composed of resident rainbow and brown trout and warm-water fish. Setting of flows for fishlife, therefore, did not lend itself to the approach used in the remainder of the area covered in this report.

The reference point for flows determined for sustenance or enhancement of fishlife relative to the Coordinated Statewide Planning portions of this report is, in all cases but one, the downstream boundary line of each hydrographic subunit. These subunits are designated in the narrative and the flows are listed in tables following the Subunit Description section of each chapter. In the Lost River-Butte Valley hydrographic unit, most streams do not reach the subunit lines, or have summer flows inadequate in volume or temperature to sustain game fish. In these subunits alternative reference points are indicated.

In all hydrographic units and subunits described, flows recommended for fishlife are also considered adequate to sustain wildlife.

CHAPTER III. FISH AND WILDLIFE RESOURCES

Northwestern California possesses a wealth of economically and aesthetically valuable fish and wildlife resources. These resources are mainstays of the area's recreation service industry, which is second only to lumbering in economic value. The Klamath, Trinity, Eel, Smith and Russian River systems are widely recognized for the salmon and steelhead angling they provide. The fish produced in these and other North Coastal streams also contribute substantially to sport and commercial salmon fisheries in the ocean. The North Coastal area likewise supports a wide variety of wildlife species. Deer abound in much of the area, and provide excellent public hunting where access is available.

The purpose of this chapter is to provide a general description of the fish and wildlife resources of the North Coastal area. Information on the abundance and distribution of the various fish and wildlife species and the use made of these resources will be included.

Fishery Resources

Anadromous fish are the outstanding fishery resource of the North Coastal area. Species of greatest importance, which occur in all suitable streams, are king salmon, silver salmon, and steelhead trout. Sea-run brown trout are found in the Trinity River. Sea-run cutthroat trout are also present in the extreme northern drainages. Other anadromous species found in North Coastal streams include American shad, sturgeon, eulachon, smelt and Pacific lamprey. These species contribute to relatively small, yet distinctive fisheries. Resident species also support important sport fisheries in several drainages, but are somewhat restricted in distribution.

Rainbow, brook and brown trout are found in the upper sections of numerous streams, and in most of the high elevation lakes. Several warmwater fishes are also common in the North Coastal area. Brown bullhead, largemouth bass, smallmouth bass, green sunfish, pumpkinseed, and bluegill are found in the lower sections of several rivers, such as the Eel and Russian, and in dredger ponds along the Klamath River. Yellow perch are also found in the Klamath River. These species are of relatively minor importance to anglers. Various species of rough fishes, such as carp, suckers, minnows and sculpins, are present in most of the waters, but are of negligible value.

The life cycles of anadromous fish are of major significance in relation to the proposed water developments in the North Coastal area. The stages of the life cycle spent in fresh water are exacting in their requirements. Anadromous fish must be able to migrate upstream from the ocean to suitable spawning gravel where adequate streamflow, temperature and water quality must prevail during the spawning and egg incubation periods. Although most young king salmon migrate downstream to the ocean soon after hatching, juvenile silver salmon and steelhead may remain in freshwater for one or more years before migrating to the ocean, and thus require suitable habitat throughout the year.

While millions of juvenile salmonids migrate downstream to the ocean, only a relatively small number return to spawn. Before leaving freshwater many young fish succumb to predators and natural or artificial hazards such as drying streams, water diversions, and pollution. As the fish grow in the ocean they are subjected to intense commercial and sport fisheries. These fisheries affect king and silver salmon much more than steelhead. The commercial fishery takes roughly two-thirds of the adult king salmon population, while the ocean and river sport fisheries account for about

9 percent. Although less affected by the ocean fisheries, steelhead are the objective of famous river sport fisheries. Thus, the spawning escapement of these species is comprised of those fish which have successfully negotiated these various hazards and returned to their native streams to spawn.

King salmon are found in major streams such as the Smith, Klamath, Trinity, Mad, Eel, and Van Duzen Rivers, as well as several smaller rivers and tributaries. They enter these streams as maturing adults during the late summer or fall, and spawn between October and December. Spring and summer-run king salmon enter suitable rivers during the spring and early summer and spend several months in the cool waters of upstream areas before spawning in the fall.

Selection of the spawning sites and preparation of the redds is accomplished by the females. After the eggs are deposited and fertilized, the female also covers them with gravel. All Pacific salmon die following completion of spawning. The eggs usually hatch in 50 to 60 days depending on water temperatures and the young salmon begin their journey to the ocean shortly after emerging from the gravel. After about four years in the ocean (a range of two to six years is common) the fish return to the streams of their origin to spawn and die.

The life history of silver salmon is slightly different than that of king salmon. Silver salmon usually enter the streams later than kings, often after fall rains increase streamflows, and spawn between November and January. After hatching juvenile silver salmon spend about one year in freshwater before entering the ocean and usually return to spawn at three years of age. Some precocious male silvers return at two years of age.

For the most part, silver salmon prefer smaller streams than king salmon, although there is some overlap of territory. Silver salmon are abundant in the smaller streams of Mendocino County where king salmon are virtually absent.

Steelhead trout are present in all suitable streams of the North Coastal area and are easily the most abundant of the three important anadromous species. Steelhead enter freshwater during the late fall or early winter, and spawn during the winter or spring months. Young steelhead spend from one to three years in freshwater before migrating to the ocean. They return to spawn after one or two years in the ocean, but do not necessarily die after spawning. Steelhead may return to salt water, and then spawn again a year or two later, although many succumb to the rigors of migration and spawning and the number that spawns more than once is small. The life history of this species is much more variable than that of the salmon.

Counts of salmon and steelhead at several stations maintained by the Department of Fish and Game in Northwestern California are given in Tables 1 and 2.

Sport Fishery

Both king and silver salmon sustain an important sport fishery in ocean waters. This sport fishery extends along the entire Northern California coast, but is concentrated near San Francisco Bay, Fort Bragg, Humboldt Bay and Trinidad Head. Most anglers fish from private boats; however, the number of anglers using licensed party boats has increased greatly in recent years. The U. S. Fish and Wildlife Service (1960) estimated the total sport catch of king salmon in Northwestern California during 1956 at over 44,000 fish. Of this total, about 30,000 were caught in streams and

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TABLE 1. SALMON AND STEELHEAD COUNTS - NORTH COASTAL AREA, CALIFORNIA

Year	Mad River (Sweasy Dam)			South Fork of Eel River (Benbow Dam)			Eel River (Van Arsdale Dam)	
	King salmon	Silver salmon	Steel-head	King salmon	Silver salmon	Steel-head	King salmon	Steel-head
1933 1/	-	-	-	-	-	-	-	3,247
1934	-	-	-	-	-	-	-	2,255
1935	-	-	-	-	-	-	-	6,310
1936	-	-	-	-	-	-	-	6,861
1937	-	-	-	-	-	-	-	3,413
1938	1,273	498	3,110	6,051	7,370	12,995	-	4,786
1939	1,257	725	3,118	3,424	8,629	14,476	-	3,889
1940	1,293	73	5,706	14,691	11,073	18,308	-	2,225
1941	3,139	308	4,583	21,011	13,694	17,356	-	-
1942	1,676	378	6,650	10,612	15,037	25,032	-	-
1943	1,236	259	4,921	7,264	13,030	23,445	-	-
1944	-	-	-	13,966	18,309	20,172	-	9,528
1945	-	-	-	12,488	16,731	13,626	-	5,054
1946	1,181	415	5,106	16,024	14,109	19,005	917	4,409
1947	717 2/	510	3,582	13,160	25,289	18,225	994	178
1948	672	515	3,139	16,312	12,872	13,963	-	2,433
1949	484	512	4,074	3,803	7,495	13,715	-	-
1950	1,505	147	4,430	14,357	12,050	15,138	55	1,091
1951	1,519	414	5,543	12,476	11,441	13,774	-	5,444
1952	401	72	5,613	7,256	3,711	19,488	-	2,197
1953	847	91	2,943	7,948	3,052	15,405	-	2,590
1954	409	59	2,390	5,367	5,952	13,609	-	6,131
1955	390	2	148	3,974	5,977	10,065	5	3,719
1956	129	21	2,717	1,530	5,717	12,333	-	4,109
1957	494	11	1,957	3,050	5,433	7,910	2	5,151
1958	478	3	1,780	1,472	3,344	11,984	-	3,335
1959	19	541	1,376	473	2,119	8,367	-	2,206
1960	55	244	1,343	2,665	3,184	6,370	-	1,130
1961	40	710	1,985	2,046	8,479	14,374	-	1,693
1962	238	3,580	1,708	3,688	10,031	8,303	9	2,030
1963								
1964								
1965								
1966								
1967								

1/ 1933 refers to counting year 1933-34, etc.

2/ Does not include an estimated 250 fish that passed the dam before counting started.

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TABLE 2. SALMON AND STEELHEAD COUNTS - NORTH COASTAL AREA, CALIFORNIA

Year	Trinity River (Lewiston)			Klamath River (Klamathon Racks)	Shasta River
	King salmon	Silver salmon	Steel-head	King salmon	King salmon
1925 1/	-	-	-	10,420	-
1926	-	-	-	9,387	-
1927	-	-	-	-	-
1928	-	-	-	-	-
1929	-	-	-	4,031	-
1930	-	-	-	2,392	19,338
1931	-	-	-	12,611	81,844
1932	-	-	-	13,740	34,689
1933	-	-	-	-	11,570
1934	-	-	-	10,340	48,668
1935	-	-	-	14,051	74,537
1936	-	-	-	10,398	46,115
1937	-	-	-	33,144	33,255
1938	-	-	-	16,340	9,090 2/
1939	-	-	-	-	28,167
1940	-	-	-	14,965	55,155
1941	-	-	-	11,204	13,252
1942	195 7/	-	-	13,038	11,425
1943	-	-	-	-	10,022
1944	9,925 7/	-	-	-	11,498
1945	7,510 7/	-	-	-	18,191
1946	274 7/	-	-	-	7,590
1947	-	-	-	-	341
1948	-	-	-	5,821	37
1949	-	-	-	11,504	193
1950	-	-	-	21,584	248
1951	-	-	-	17,857	2,024
1952	-	-	-	6,591	1,666
1953	-	-	-	6,267	1,605
1954	-	-	-	2,042	2,625
1955	-	-	-	14,946	1,817
1956	-	-	-	6,770	-
1957	-	-	-	2,436	2,234 3/
1958	3,524	616	2,835	1,950	6,089
1959	7,277	119	2,095	3,568	9,875
1960	7,466	208	3,547	6,363	10,698
1961	5,397	355	3,243	2,930 4/	8,764
1962	9,451	16	1,687	1,339 6/	14,898 5/
1963					
1964					

1/ 1925 refers to counting year 1925-26, etc.
2/ Counting station moved seven miles upstream from original location. This may account for some of the decrease in the counts.
3/ Counting station moved back to original location near mouth.
4/ Racks not fish tight. Approx. 6,000 additional fish estimated to have passed upstream.
5/ Racks not fish tight for one week.
6/ Counting station moved upstream from Klamathon racks to Iron Gate Dam.
7/ Incomplete Fish and Wildlife Service weir counts.

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about 14,000 in ocean waters. The estimated sport catch of silver salmon was 18,000 fish; of which about 16,000 were caught in the ocean and 2,000 in freshwater.

There is also an important fishery for salmon in the rivers during the fall and winter months. During the king salmon runs, anglers concentrate in the estuary and lower riffle areas of the Klamath, Smith, and Eel Rivers. Anglers follow the runs upstream as the fish move to the spawning beds. Although sizeable runs of silver salmon ascend the streams, relatively few are caught by anglers. The short duration of the run and the high, turbid streamflows which are normally present, result in a relatively small catch of silver salmon.

A run of small steelhead accompanies the fall run of king salmon. As these "half-pounders" enter the rivers in late summer and early fall, fishermen congregate at accessible points along the main streams. The fishery for this run in the Klamath River is outstanding. The fishery for larger winter-run steelhead develops as the fish enter the rivers in increasing numbers during the winter months.

There are a large number of streams and natural lakes which offer excellent trout fishing in the headwaters of the major streams in the North Coastal area. The Marble Mountains, Trinity Alps, Trinity Divide, and Yolla Bolly Wilderness Areas are all noted for their fine fishing. Eastern brook trout and resident rainbow trout predominate in these higher lakes and streams, although brown trout are also present in many waters.

Anglers also take many juvenile steelhead and salmon from the lower rivers and tributaries. Juvenile steelhead are virtually indistinguishable from resident rainbow trout and many anglers confuse young salmon with trout. Coastal cutthroat trout, another anadromous species, are found in the lower tributary streams of the Smith, Klamath, Mad, and Eel Rivers. When taken in freshwater, the young of all of these species, anadromous or resident, are considered trout in this report.

Commercial Fishery

Commercial fishing is a basic industry of Northwestern California. The income received by the commercial fishing industry is about equal to that derived from agriculture and is exceeded only by the lumbering industry, and the tourist and recreational trade. The seven fishing ports receiving most of the fish landings along the North Coastal area are Crescent City, Trinidad Head, Eureka, Fields Landing, Shelter Cove, Point Arena, and Fort Bragg.

Commercial salmon landings in these ports during the 1947-1960 period are shown in Table 3. Although the salmon landings made up only about 9 percent of the total percentage of commercial fish landings in the Eureka Region ports during this period, they provided nearly 29 percent of the income to fishermen.

King salmon comprise about 90 percent of the commercial salmon catch off the California coast. In the North Coastal area, however, they are less predominant in the catch. For example, silver salmon accounted for nearly 30 percent of the total weight of salmon landings in Eureka Region ports during 1952 (Marine Fisheries Branch, 1954).

The relative contribution of streams of the North Coastal area to the ocean salmon fishery has not been clearly determined. The results of several tagging studies suggest that while Northwestern California streams may contribute slightly to the commercial fisheries of Oregon and Washington,

TABLE 3
Commercial Salmon Landings, 1947-60,
Eureka Region Ports 1/

YEAR	EUREKA WEIGHT 2/	EUREKA VALUE	FORT BRAGG WEIGHT	FORT BRAGG VALUE	FIELDS LANDING WEIGHT	FIELDS LANDING VALUE	CRESCENT CITY WEIGHT	CRESCENT CITY VALUE	POINT ARENA WEIGHT	POINT ARENA VALUE	SHELTER COVE WEIGHT	SHELTER COVE VALUE	TRINIDAD WEIGHT	TRINIDAD VALUE	ANNUAL TOTAL WEIGHT	ANNUAL TOTAL VALUE
1947	1,673,151	$355,545	1,475,776	$313,602	172,270	$36,607	1,153,916	$245,207	748,260	$159,005	549,154	$116,695	95,515	$20,297	5,868,042	$1,246,958
1948	976,003	264,497	1,315,465	356,491	203,190	55,064	733,744	198,844	368,006	99,730	364,083	98,666	71,450	19,363	4,031,941	$1,092,655
1949	902,352	214,218	883,300	209,707	45,956	10,910	465,499	110,510	88,526	21,016	178,321	42,333	37,436	8,887	2,601,390	$ 617,581
1950	435,473	102,467	810,274	190,657	---	---	819,450	192,817	50,910	11,979	42,891	10,092	56,654	13,331	2,215,652	$ 521,343
1951	703,705	182,752	707,179	183,654	29,184	7,579	412,494	107,125	---	---	103,247	26,813	22,340	5,918	1,978,149	$ 513,841
1952	526,471	126,458	1,024,536	246,094	---	---	877,206	210,705	39,918	9,588	---	---	15,734	3,779	2,483,865	$ 596,624
1953	689,042	167,851	1,610,661	392,357	178,527	43,489	380,922	92,793	54,525	13,282	---	---	26,172	6,375	2,939,849	$ 719,147
1954	1,057,322	321,955	1,674,622	509,922	210,089	63,972	814,077	247,886	119,588	36,415	27,886	8,491	25,324	7,711	3,928,908	$1,196,352
1955	1,772,344	619,322	1,884,487	661,154	73,197	25,356	985,831	342,227	64,546	22,860	---	---	29,201	9,906	4,809,606	$1,680,825
1956	2,400,142	849,824	2,506,058	883,444	---	---	1,212,460	429,418	87,493	30,977	82,273	27,115	---	---	6,288,426	$2,220,778
1957	1,045,642	347,107	1,264,098	417,916	---	---	939,256	305,611	36,068	12,054	---	---	34,912	9,981	3,319,976	$1,092,669
1958	440,632	195,025	963,192	426,318	---	---	165,808	74,257	16,328	7,227	---	---	16,389	7,356	1,602,349	$ 710,183
1959	812,155	329,677	734,392	296,691	---	---	286,119	115,807	---	---	---	---	---	---	1,832,666	$ 742,175
1960	917,859	496,470	664,076	359,197	---	---	759,943	411,079	---	---	---	---	87,932	48,237	2,429,809	$1,314,983
Average	1,025,164	$326,655	1,251,294	$389,086	65,172	$17,356	714,766	$220,306	119,583	$ 30,295	96,275	$ 23,586	37,076	$11,510	3,309,331	$1,018,794

1/ Taken from California Department of Fish and Game Fish Bulletins No. 74, 80, 86, 89, 95, 102, 105, 108, 111 and 117.

2/ Weight in pounds.

their major contribution is to relatively nearby waters. Most of the California catch of king salmon is produced in the Sacramento River, although fish produced in the streams of the North Coastal area provide an important part of the catch in the Eureka region. Coastal streams of Oregon apparently produce most of the silver salmon landed along the northern coast of California.

Wildlife Resources

As agriculture, industry, and urbanization change in our rapidly altering civilization, so must our wildlife. As a result, wildlife management becomes more and more complex. Thus, close cooperation between interested agencies is necessary to preserve, maintain, and increase our wildlife resources. In this day and age when more of our leisure time is being utilize in outdoor activities, wildlife is a more important facet in our lives.

To avoid lengthy written descriptions of the ranges for various game species, maps are included in this report for the reader's convenience. The following discussions of wildlife species will be grouped into four categories: (1) big game, (2) upland game, (3) waterfowl, and (4) furbearers and predators. Although not mentioned in the above categories, nongame specie are an important part of our wildlife resource. Many species are a principal source of food for predators, and are of importance to many interested groups of people who enjoy wildlife for its aesthetic values.

Big Game

There are approximately 56,500,000 acres of deer range in Californi occupied by an estimated 1,123,000 animals. The coast ranges collectively support nearly half the deer in the State. The average estimated deer densit for the State is 13 deer per square mile of range. The central coastal ranges support the highest deer population with an average of 19 per square mile. Deer densities are greatly affected by the human uses placed on the land. A summer population of deer in the North Coast study area varies from 1 animal per square mile to over 20 animals per square mile.

The columbian black-tailed deer (Odocoileus hemionus columbianus) is by far the most abundant and important big game species found in the area under study (Figure 3). Both resident and migratory deer herd are found in the North Coast area. In general the resident deer herds are found at lower elevation below the influence of deep snow. Some local movement does occur by resident deer because of seasonal variations in diet and weather conditions. Migratory deer inhabit areas at higher elevations during the summer and move to lower elevations during the winter because of weather conditions (Plate 3). Often these deer will move down in elevation into their winter ranges just far enough below the snow line to obtain suitable browse, and the reverse of this in the spring. Resident and migratory deer ranges often overlap during the winter period.

Migratory deer are the rule for the North Coast area north of Clear Lake, Lake County, east of the main Eel River, and east of the redwood belt along the coast north of Humboldt Bay to the eastern slopes of the Coast Range. Migration patterns consist mainly of dropping from higher areas to lower elevations. Exceptions are the Devil's Garden deer herd wintering around Clear Lake, Modoc County, and the Trinity Alps deer herd migrating some distances to various locations along the Trinity River (Plate 3).

For the most part, the deer winter ranges are limited to the stream-side areas. Any reduction in the carrying capacity of winter ranges by proposed water development projects will present serious forage problems for both migratory and resident deer.

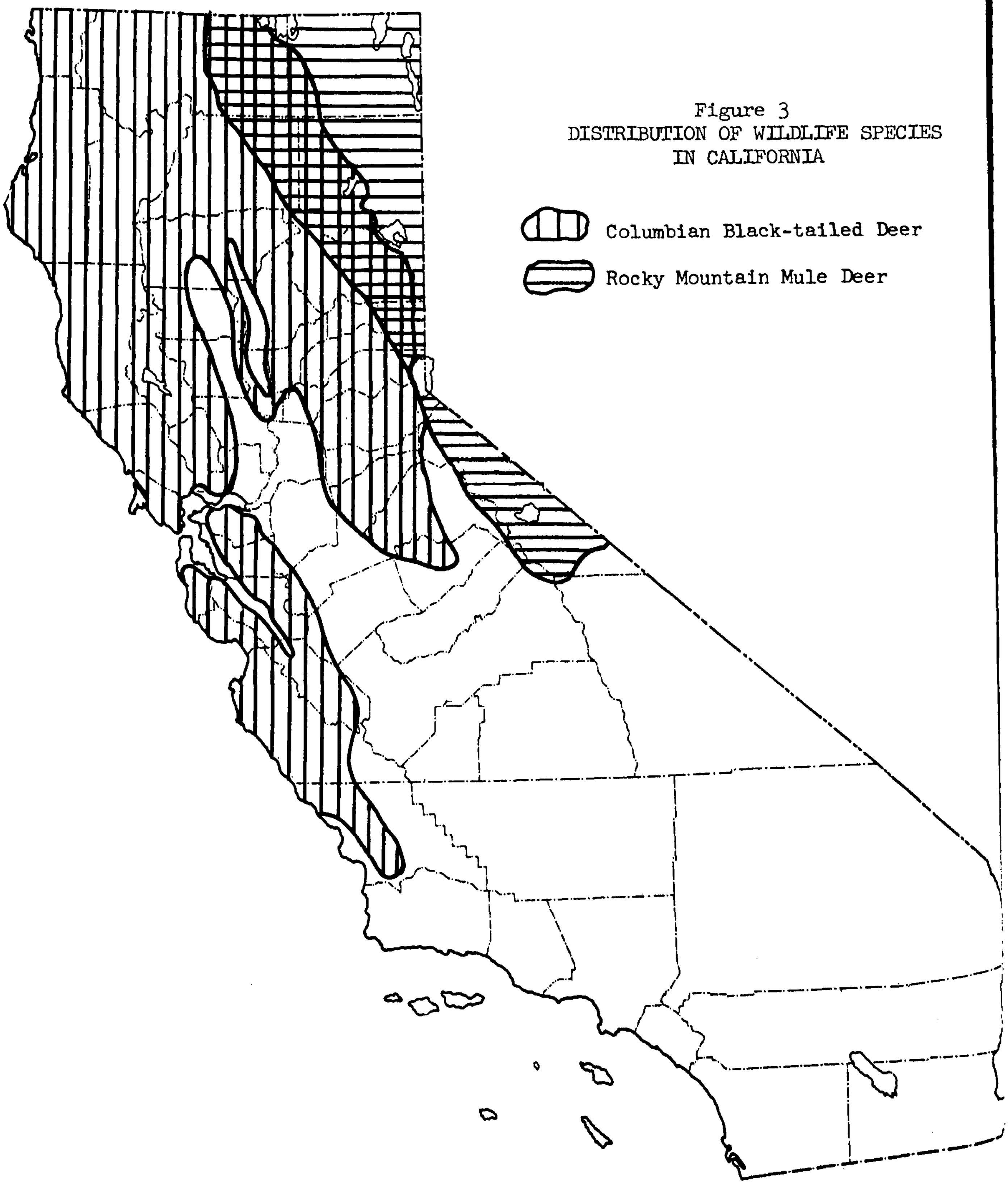


Figure 3
DISTRIBUTION OF WILDLIFE SPECIES
IN CALIFORNIA
Columbian Black-tailed Deer
Rocky Mountain Mule Deer

The subspecies of deer rated third in abundance in the State is the Rocky Mountain mule deer (Odocoileus hemionus hemionus). Their distribution in respect to the North Coast study is limited to the Lost River-Butte Valley Hydrographic Unit (Figure 3). Because of their range, none of the proposed projects in this study will adversely affect this important big game species. This is the most commonly known race found throughout the western United States, and is migratory where it occurs in California.

Table 4 indicates the number of animals reported taken during the 1962 season in the counties of interest in the North Coast area.

In California the five leading counties with the highest deer kill for 1962 were: Humboldt (4,094), Mendocino (4,002), Siskiyou (3,270), Shasta (2,339), and Tehama (2,339).

Deer cause heavy depredation in many local areas on orchards, field crops, landscaping, gardens, etc. Table 5 gives the number of permittees issued permits to take deer to alleviate deer depredation, number of deer reported taken, and the type of deer damage.

Two races of black bear are found in the North Coast study area: the northwestern black bear (Euarctos americanus altifrontalis) and the Sierra Nevada black bear (Euarctos americanus californiensis) (Figure 4). Bear have a limited territory and are usually associated with timber and brush areas throughout the study area. Bear population densities are not thought to be greater than one per township in the average bear range.

Table 6 provides information on bear taken during the regular 1962-63 bear season.

The five leading counties with the highest bear kill in the State during 1962-63 season were: Siskiyou (87), Shasta (85), Trinity (75), Plumas (57), and Butte (57).

TABLE 4

Regular Season Buck Deer Kill
Reported from Deer Tag Returns - 1962
North Coast Study Area
(Archery Tags Included)

County	1962	1957-1961 Avg.
Del Norte	197	148
Glenn	986	772
Humboldt	4,094	3,805
Lake	1,720	1,661
Mendocino	4,002	4,053
Modoc	1,324	3,793
Napa	1,191	1,140
Shasta	2,339	2,880
Siskiyou	3,270	4,513
Sonoma	1,742	1,364
Tehama	2,339	3,222
Trinity	1,923	1,677
Subtotal	25,127	29,028
Statewide Totals	54,909	68,412
Estimated Deer Tag Sales	410,000	407,739

TABLE 5

Deer Taken on Depredation Permits
North Coast Study Area
1962

County	No. of Permittees	No. of Deer Taken	Crop or Property Damage
Del Norte	1	0	Pasturage
Glenn	6	7	Orchard, field crops
Humboldt	15	24	Garden, orchards, field crops
Lake	41	80	Landscaping, orchards, field crops
Mendocino	76	75	Landscaping, orchards, field crops
Modoc	1	4	Haystack
Napa	92	325	Landscaping, orchards, field and truck crops
Shasta	4	23	Gardens, orchards, field crops
Siskiyou	2	10	Alfalfa, gardens
Sonoma	114	201	Landscaping, orchards, field and truck crops
Tehama	10	25	Orchards, alfalfa
Trinity	0	0	
Subtotal	362	774	
Statewide Total	821	1,827	

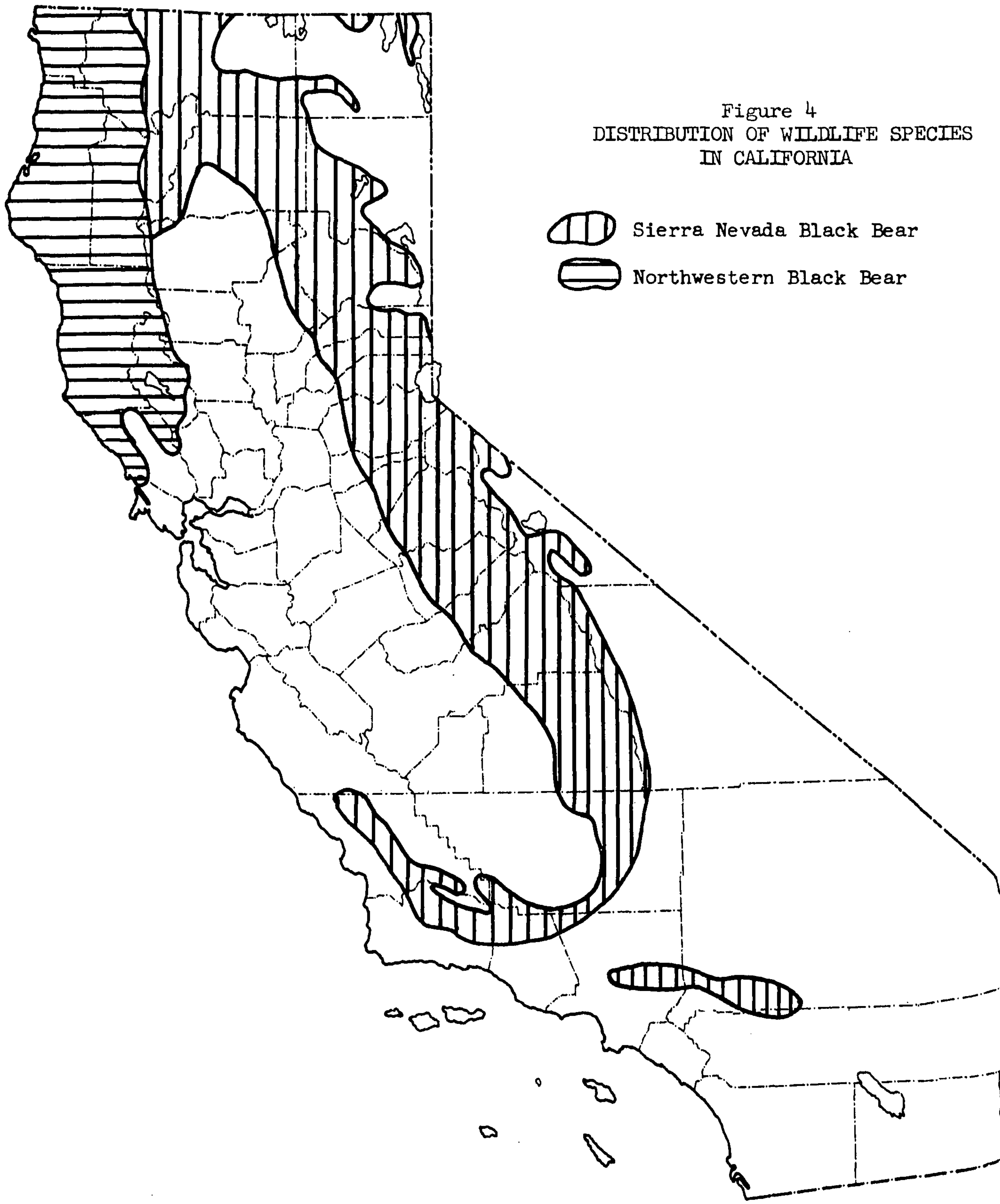


Figure 4
DISTRIBUTION OF WILDLIFE SPECIES
IN CALIFORNIA

Sierra Nevada Black Bear

Northwestern Black Bear

TABLE 6

California Regular Season Bear Kill
North Coast Study Area
1961-62 and 1962-63 Seasons

County of Kill	1962-63	1961-62
Del Norte	10	11
Glenn	11	12
Humboldt	37	83
Lake	6	1
Mendocino	12	22
Modoc	1	1
Napa	--	--
Shasta	85	129
Siskiyou	87	44
Sonoma	--	--
Tehama	22	40
Trinity	75	60
Subtotal	346	403
Statewide Total	594	841

Table 7 indicates losses of crop and property by bear depredation in the study area. In some areas bear at times will feed on the inner bark of trees, thus causing damage to second growth timber. The permittee in Humboldt County is having such a problem.

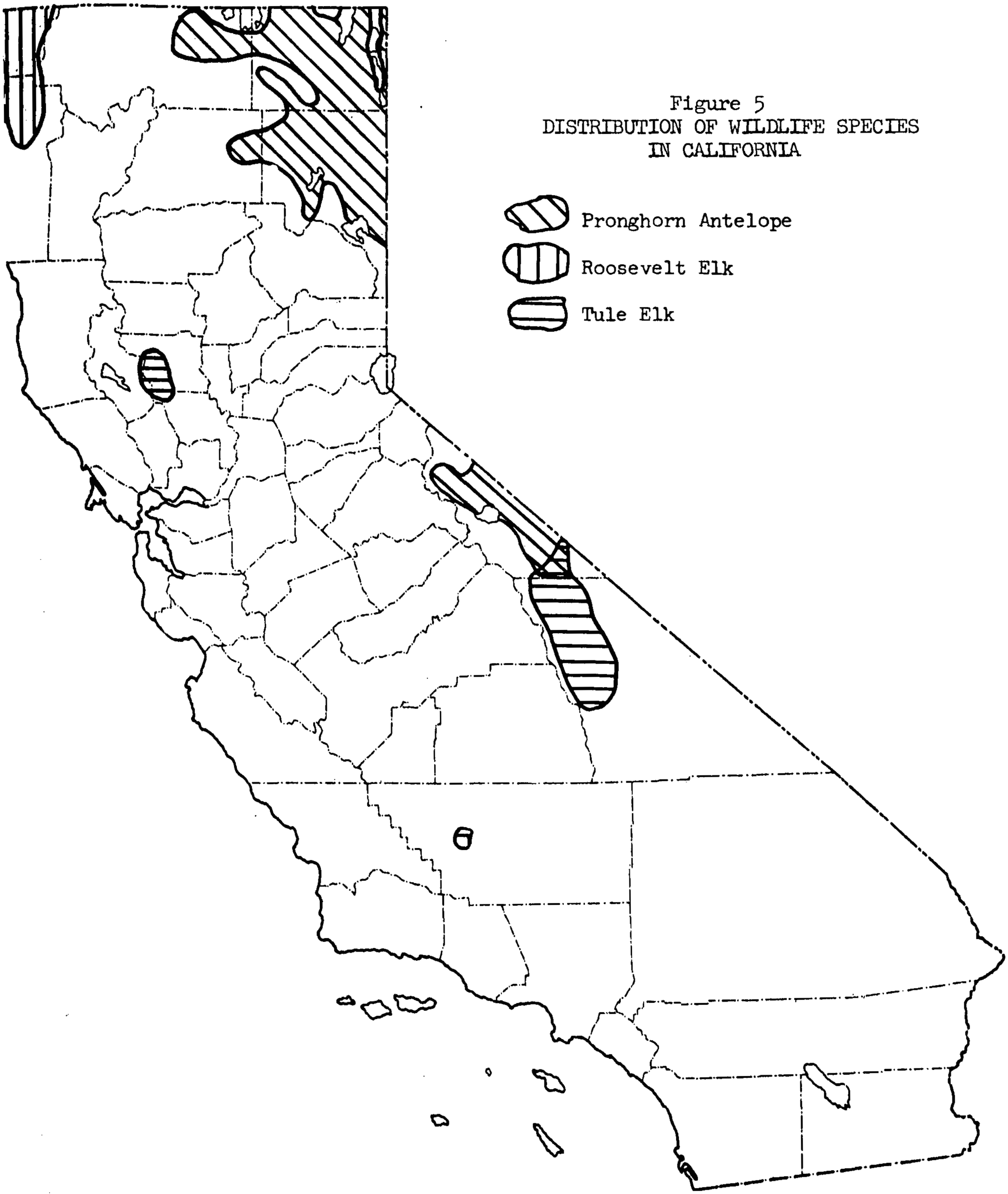
TABLE 7

Bear Killed on Depredation Permits
1962
North Coast Study Area

County	No. of Permittees	No. of Bear Taken	Crop or Property Damage
Del Norte	1	0	Pigs
Glenn	0	0	
Humboldt	1	20	Young timber
Lake	0	0	
Mendocino	0	0	
Modoc	0	0	
Napa	0	0	
Shasta	2	0	Bees, fruit trees
Siskiyou	7	3	Camps, orchard, poultry, bees, building, livestock
Sonoma	0	0	
Tehama	0	0	
Trinity	3	1	Orchard, camps, pipelines
Subtotal	14	24	
Statewide Total	30	31	

Of the three races of elk in California, the Roosevelt elk (*Cervus canadensis roosevelti*) and tule elk (*Cervus canadensis mannodes*) are found in the North Coast study area (Figure 5). The former range of the Roosevelt elk included the coastal area from San Francisco Bay to Vancouver Island in the north. However, this race has been reduced in numbers and range by the advancement of civilization. Portions of Del Norte

Figure 5
DISTRIBUTION OF WILDLIFE SPECIES
IN CALIFORNIA



and northern Humboldt Counties are all that remain of their former range in California. This race is both resident and migratory, depending on winter weather conditions. The Prairie Creek State Park in Humboldt County is the location of an elk herd which can usually be seen from the highway.

The tule elk is but a remnant of the former numbers found in the valleys and foothills of California. A small herd is located in the Cache Creek area of Lake and Colusa Counties. This race is the smallest of the species and is often referred to as the dwarf elk.

The pronghorn antelope (Antilocapra americana americana) distribution is limited to the Lost River-Butte Valley Hydrographic Unit portion of this study area (Figure 5). Small bands are counted each year in this unit in Siskiyou and Modoc Counties. A total of 2,618 animals were recorded in 1964 for northeastern California.

There is no annual season on elk and antelope in California. When populations increase to a point where they are over extending their range, the Fish and Game Commission, after a public hearing, may allow a number of animals to be harvested. A total of 70 Roosevelt elk were taken from the herd near Orick, Humboldt County in 1963. The last special antelope hunt in California was 1959 when 120 animals were taken.

Upland Game

California quail (Laphortyx californicus) is the most common upland game species in the North Coast study area (Figure 6). The California quail and the mourning dove are the two most widely distributed upland game birds in the State. This species is usually found in most of the available quail habitat in the study area.

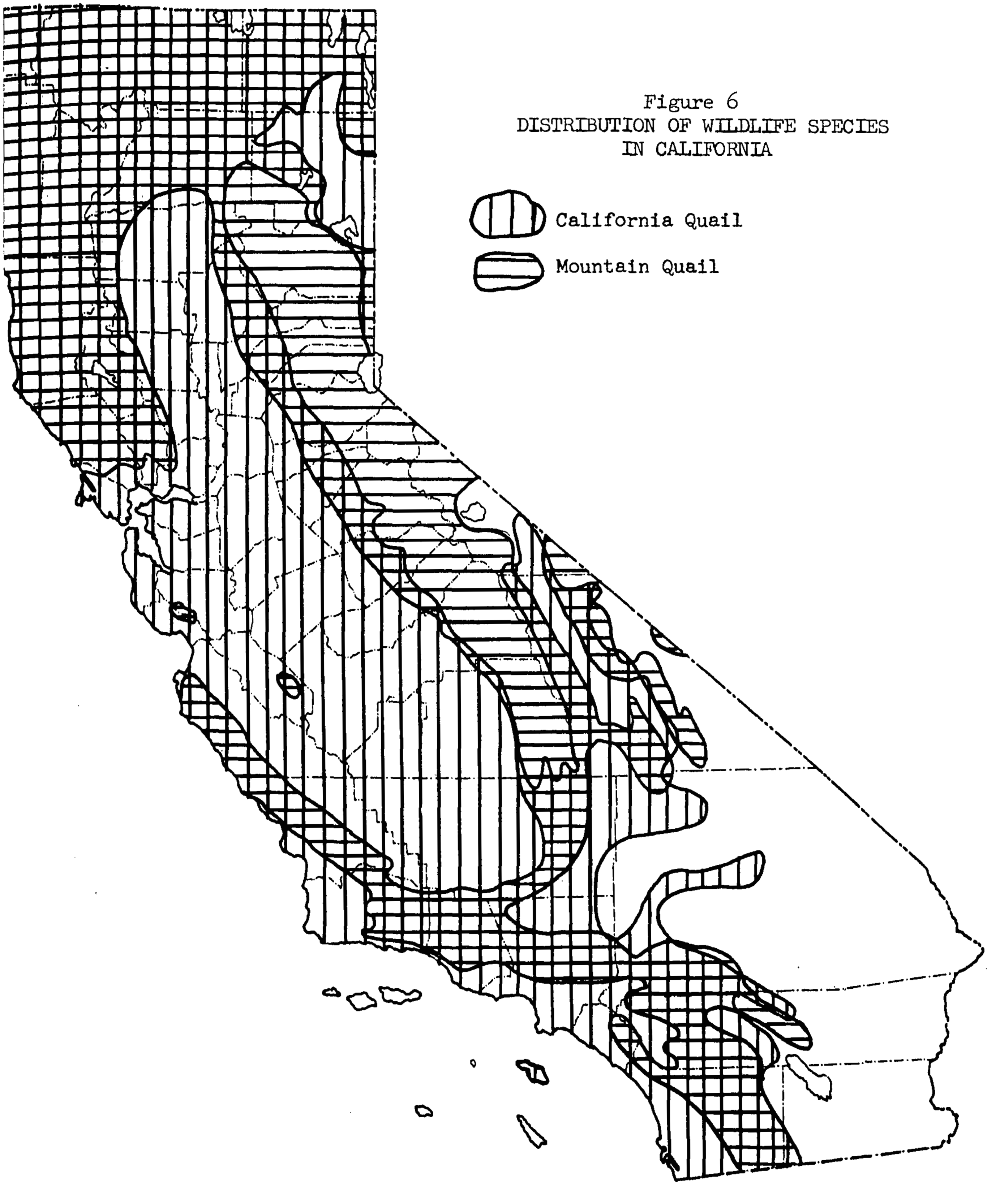


Figure 6
DISTRIBUTION OF WILDLIFE SPECIES
IN CALIFORNIA

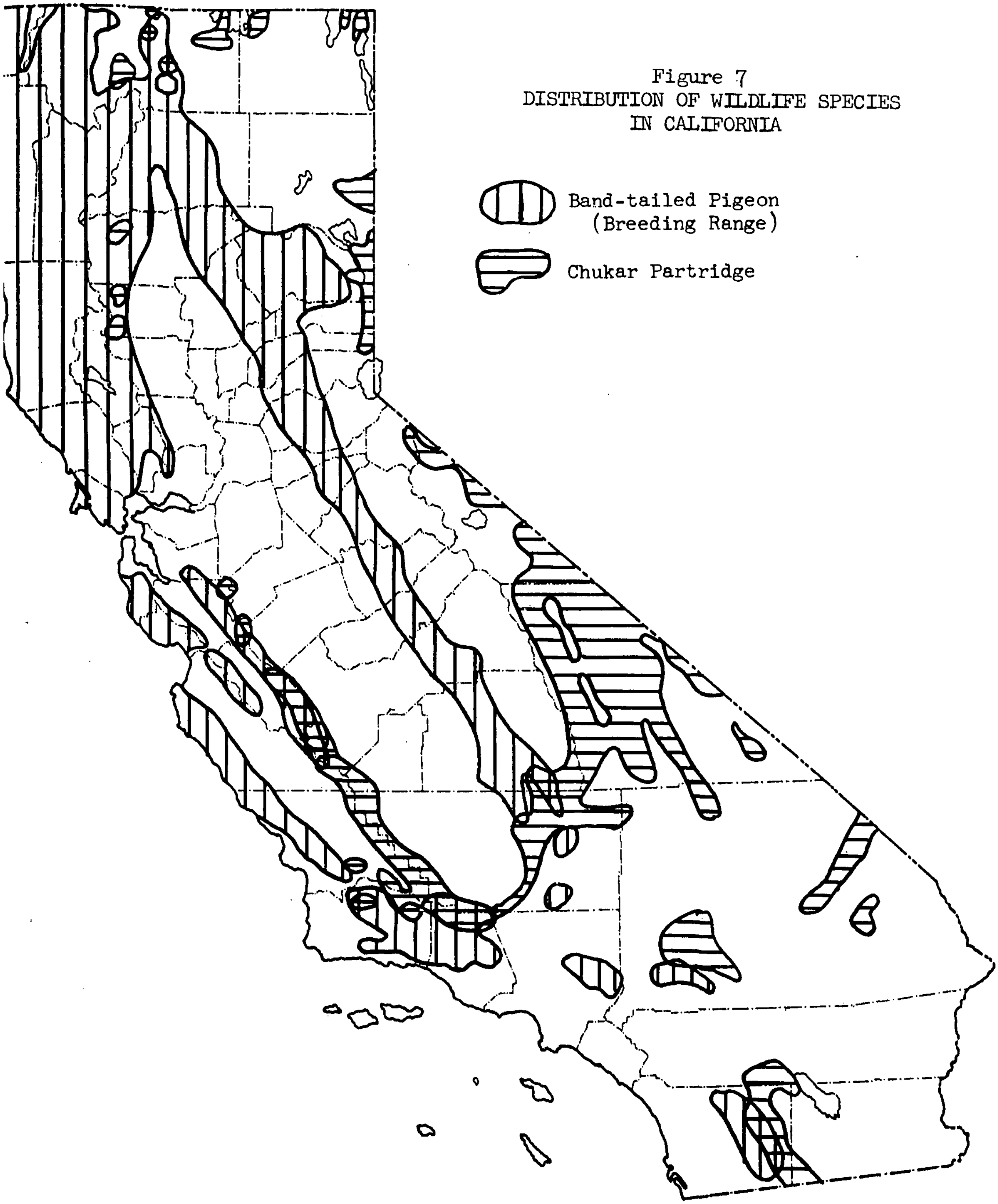
The mountain quail (Oreortyx picta) range often overlap with the California quail range (Figure 6). The mountain quail prefers higher elevations and rougher terrain. Their numbers are seldom as great as other quail. This species has a vertical migration from higher elevations to lower elevations during the winter. Winter cover is often a controlling factor on their population densities.

These popular game birds, the quail in general, are rated second in total numbers of birds taken and rated third in total number of hunters participating in the State. Based on replies to the 1962 Department of Fish and Game hunter survey, a total of 2,147,800 quail were taken. Precipitation in the winter of 1961-62, which relieved drought conditions, also improved forage and contributed to higher quail populations in most of the State. This is pointed out also by an increased quail take of 29 percent over 1961, average seasonal bag increased from 10.8 birds to 12.1, and the increase of 15 percent in the number of quail hunters taking to the field.

The mourning dove (Zenaidura macroura) nest in every county of the State, indicating its wide distribution. Dove are less common in coniferous forest areas of the study area and will often migrate to more suitable climate during the winter. More dove are taken and more hunters pursue this highly prized upland game bird than any other species, indicating the importance this bird is as a game species. The dove bag reported in 1962 (4,864,300) registered a 24 percent increase over 1961. The average seasonal bag rose to 21.8 birds per hunter from 19.4 in 1961. Favorable weather holding the birds in better areas was thought to add birds to the bag. The North Coast area is seldom in the top ten counties for doves bagged.

Band-tailed pigeon (Columba fasciata) nest in the transition life zone and are widely distributed throughout this study area as the breeding

Figure 7
DISTRIBUTION OF WILDLIFE SPECIES
IN CALIFORNIA



distribution map indicates (Figure 7). After the breeding season these birds become nomadic and move in bands from one feeding area to another. The California pigeon population is augmented by birds from Oregon, Washington and British Columbia. Population densities are as a rule light during the breeding season and may migrate from these breeding areas in the winter to historical concentration areas because of available food, salt lick, etc. Of the reported 44,800 pigeon hunters in the State, an average of 7.5 birds per hunter were taken in 1962. Sonoma County is the most important of the North Coast counties in pigeon hunting and is rated ninth in the State.

Oregon sooty grouse (Dendragapus fuliginosus) are found at higher elevations in the drainages of the North Coast study area. The Oregon ruffed grouse (Bonasa umbellus) inhabit the dense evergreen, maple and alder streamside forests of the extreme northwestern California. These two species (Figure 6) produce, in the hunter's bag, a total of 2,100 birds for the State Hunting pressure is light and often birds are taken while hunters are hunting other game.

Sage grouse (Centrocercus urophasianus) are associated with big sagebrush (Artemisia tridentata) in the Great Basin sagebrush type country, and limited in distribution in this study area to Siskiyou and Modoc Counties in the eastern portion of the Lost River-Butte Valley Hydrographic Unit (Figure 8). There was no hunting season for sage grouse (sage hen) for 1961-62; however, the season was reopened this year (1963). Hunting success was good.

A good example of a successful exotic upland game bird introduction in the State, is the ring-necked pheasant (Phasianus calchicus). With the advent of land use changes in the valley to cultivated seed crops the pheasa

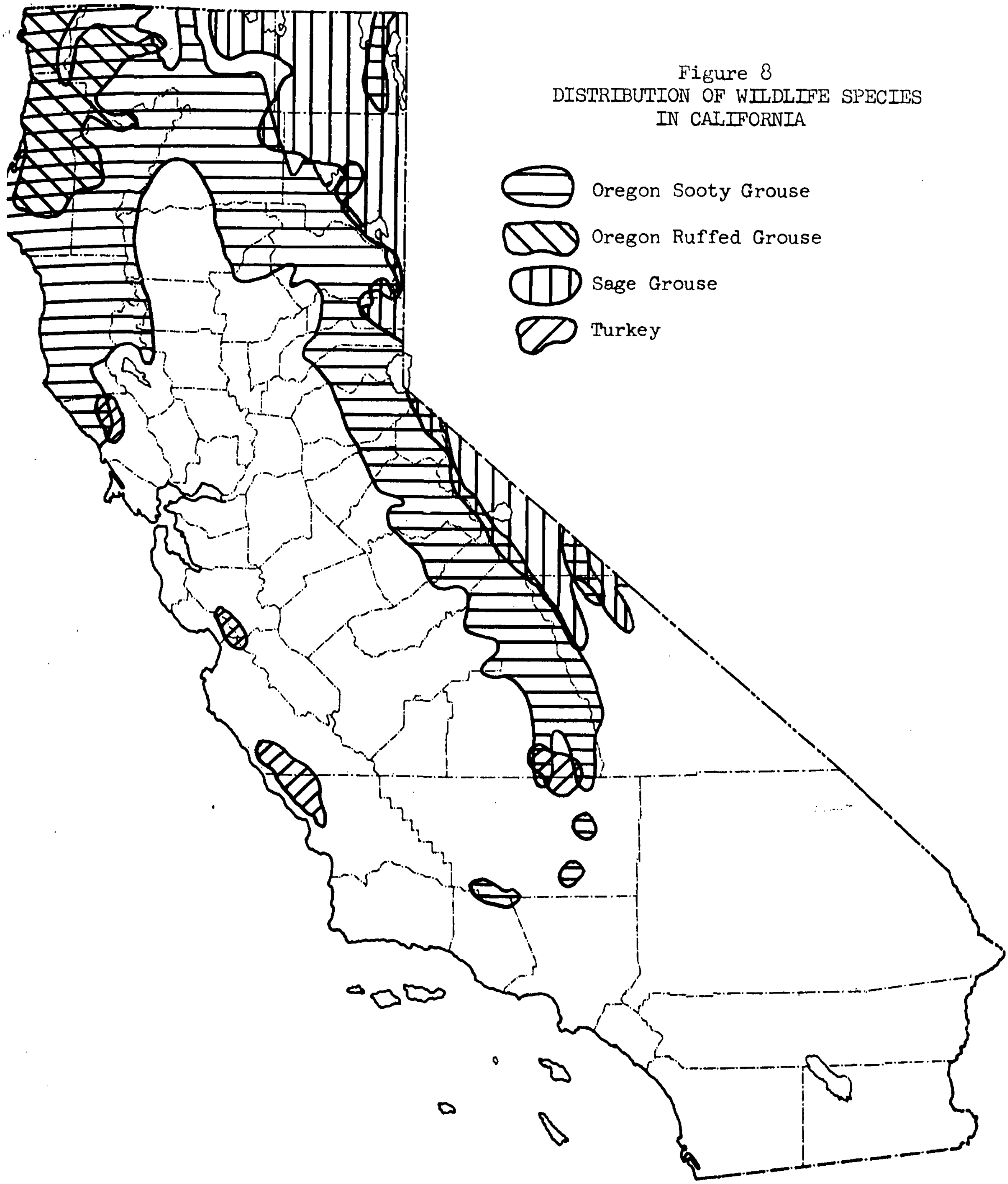


Figure 8
DISTRIBUTION OF WILDLIFE SPECIES
IN CALIFORNIA

numbers increased. Pheasants were well established in California by 1920. The most important pheasant area today is in the great Central Valley; however, the Tule Lake and Lower Klamath area have high population densities (Figure 9). Other areas in the North Coast produce limited numbers of these colorful birds.

The Indian chukar partridge (Alectoris graeca), an exotic upland game species introduced into the State from India in 1932, is becoming a very popular game species since the first open season in 1954. This species is found in the more arid, rocky, mountainous areas in the Tule Lake-Lower Klamath Lake area in Siskiyou and Modoc Counties, western side of Shasta Valley in Siskiyou County, and elsewhere in the study area in smaller numbers. Other species of this red-legged partridge group are being introduced at various locations in the State by the Department of Fish and Game. The 1962 seasonal increase in chukar hunters in the field is an indication of its increased popularity. A reported 18,800 hunters represents a 45 percent increase over 1961. The estimated number of birds bagged in 1962 was 52,500.

The turkey (Meleagris gallopavo) is an introduced species which is not native to California. They are established only in Sonoma County in the North Coast study area (Figure 8).

The Nuttall's cottontail (Sylvilagus nuttallii) is found in the northeastern or Great Basin portion of the State (Figure 10). The more common Audubon's cottontail (Sylvilagus audubonii) is not found in the North Coast study area (Figure 10). Large numbers of these upland game species are taken each year by quail hunters. About 537,100 animals were taken by hunters in 1962.

The black-tailed jackrabbit (Lepus californicus) is the most abundant and more widely distributed of the jackrabbits and snowshoe rabbit group in the State (Figure 11). This species is well known to everyone and little

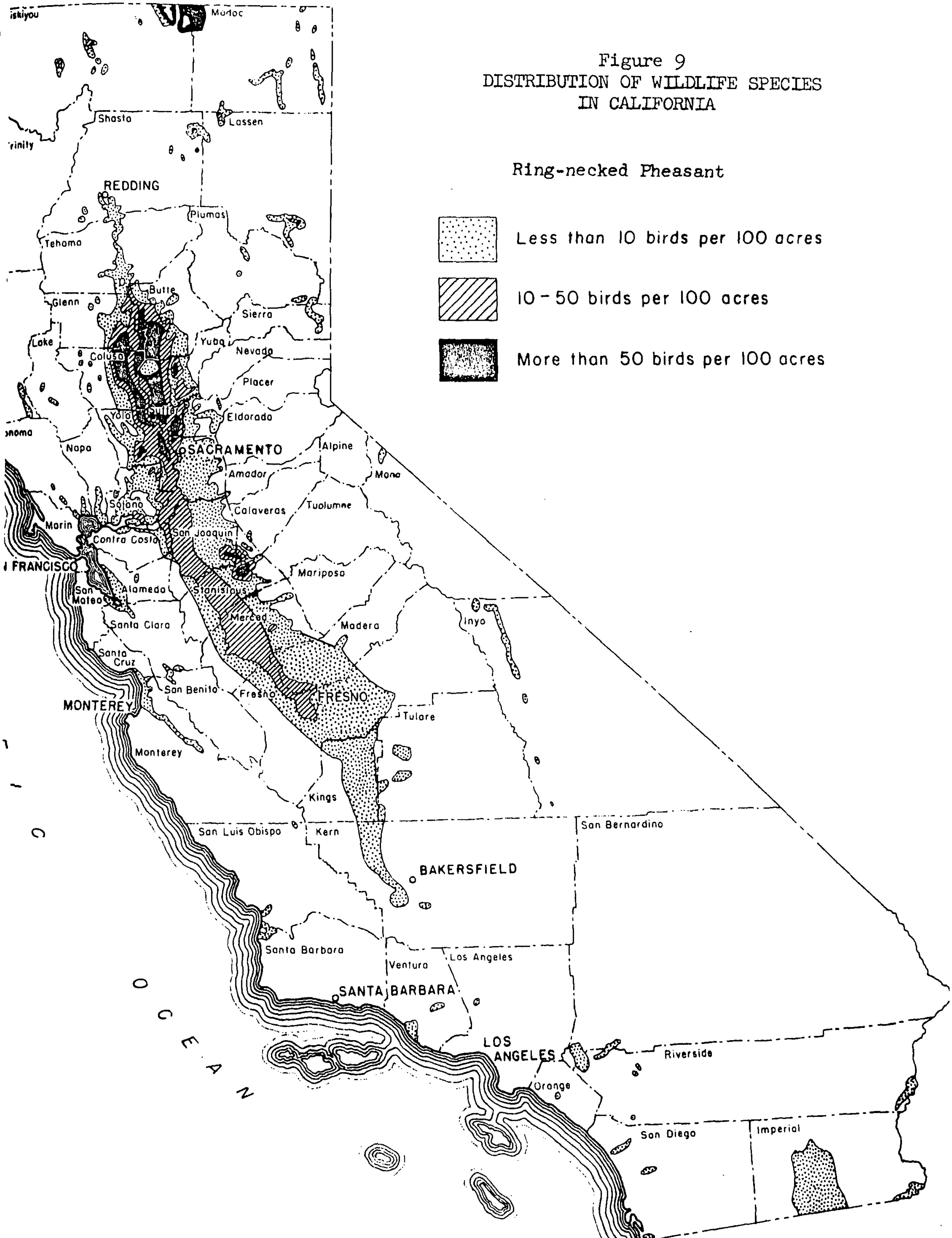


Figure 9
DISTRIBUTION OF WILDLIFE SPECIES
IN CALIFORNIA

Ring-necked Pheasant

Less than 10 birds per 100 acres

10 - 50 birds per 100 acres

More than 50 birds per 100 acres

Figure 10
DISTRIBUTION OF WILDLIFE SPECIES
IN CALIFORNIA

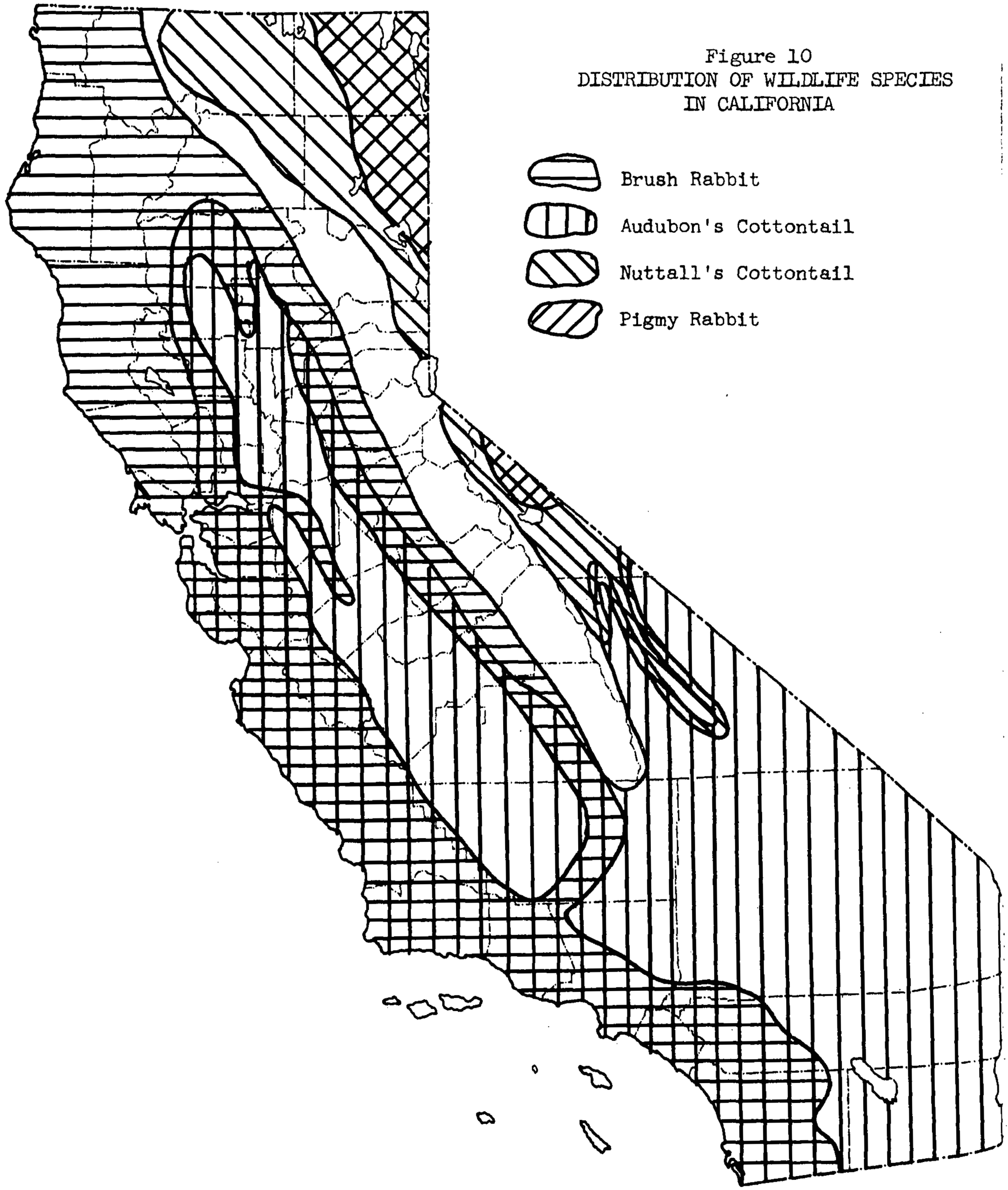
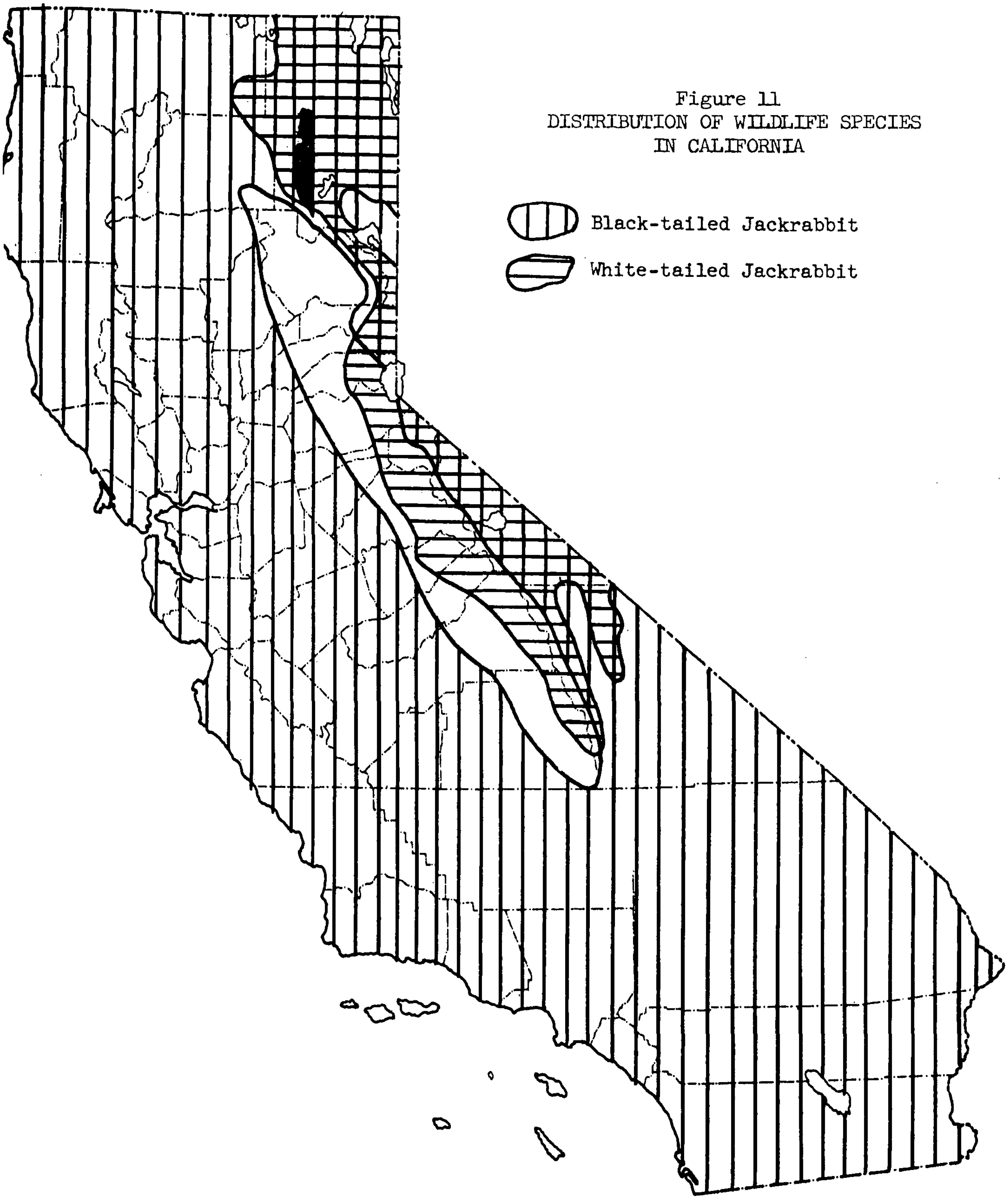


Figure 11
DISTRIBUTION OF WILDLIFE SPECIES
IN CALIFORNIA



need be said concerning it. It is heavily hunted for sport and meat in California. The reported bag in the State was estimated at 1,553,400 animals.

The white-tailed jackrabbit (Lepus townsendii) is the largest of the rabbit family in the United States. They are found only in the extreme eastern portion of the Lost River-Butte Valley Hydrographic Unit in limited numbers (Figure 11).

The snowshoe rabbit (Lepus washingtonii) inhabits the higher brush thickets of manzanita, chinquapin, snow brush, and streamside thickets (Figure 12). This species is seldom taken in any numbers and is not very common anywhere in California.

The western gray squirrel (Sciurus griseus) are regularly hunted by ardent squirrel hunters. They are generally associated with digger pine-blue oak and yellow pine-black oak habitat in California. Although widely distributed throughout the State, population densities are not considered very high throughout its range (Figure 12).

The little known Douglas squirrel (Tamiasciurus douglasii), often left out as a game species, is found throughout the North Coast study area (Figure 12). This species, however, does not contribute much to the sportsmen bag, but is of great interest to people enjoying outdoor recreation in general.

Waterfowl

The Pacific Flyway, most important of the four major flyways on the North American Continent, supports a winter waterfowl population of 9 to 12 million ducks, geese and swans. Approximately 57 percent of the flyway waterfowl population winter in California. By waterfowl migration studies, wildlife biologists have determined that 80 percent of the waterfowl wintering

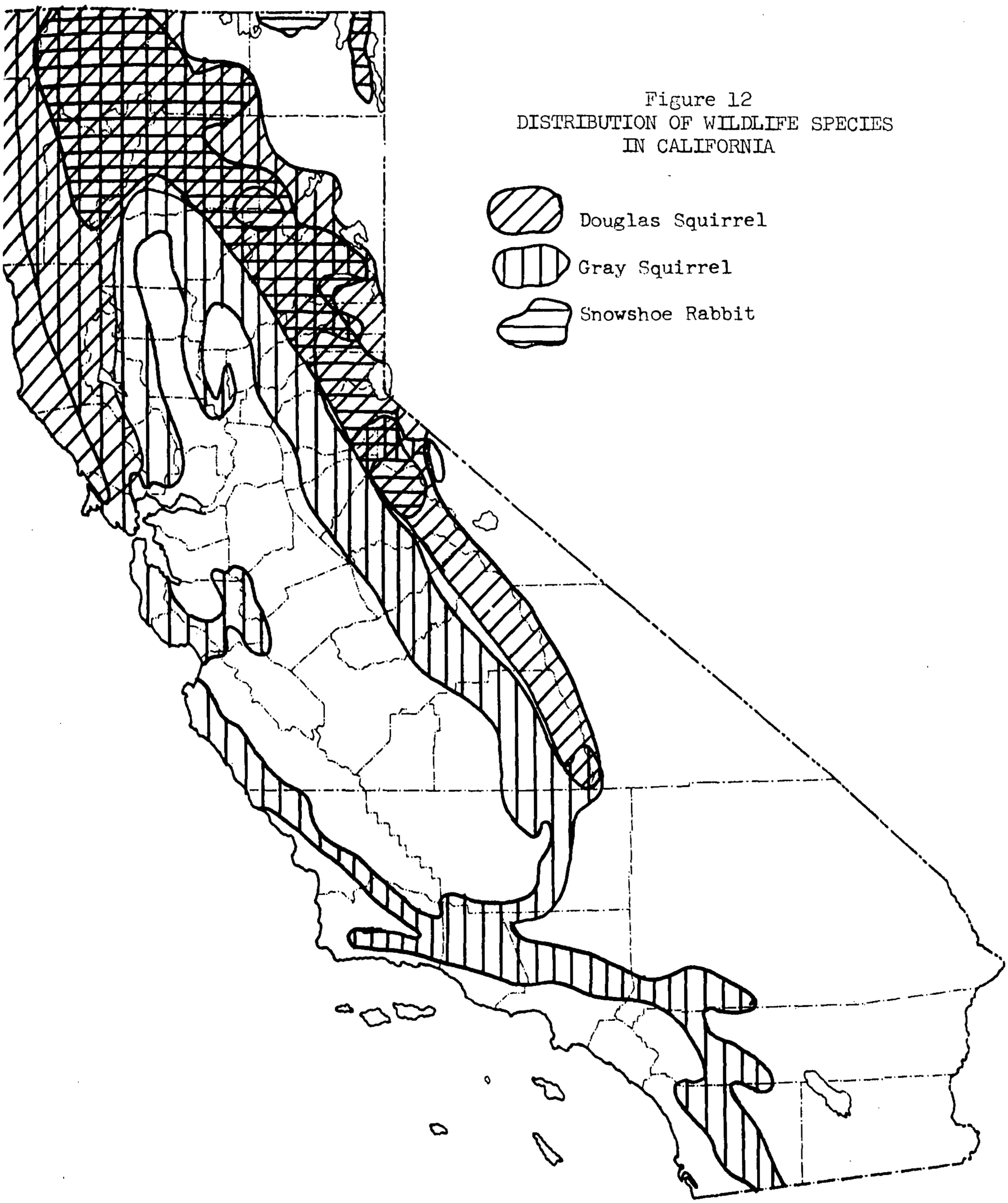


Figure 12
DISTRIBUTION OF WILDLIFE SPECIES
IN CALIFORNIA

Douglas Squirrel

Gray Squirrel

Snowshoe Rabbit

in California funnel into the north and northeastern corner of the State through Tule Lake and Lower Klamath National Wildlife Refuges. Here millions of waterfowl stop on their annual southward migration and remain until climatic conditions force them on farther south.

The shrinkage of waterfowl habitat in California creates a concentration of waterfowl upon agricultural crops. The breeding grounds for waterfowl using the Pacific Flyway and wintering in California has been influenced less from man's interference than the breeding grounds of other major flyways. Because of this California plays a more important part in the life cycle of waterfowl as a wintering grounds than as a breeding grounds. Figure 13 points out the importance California plays in the tremendous movement of waterfowl. In addition to the Tule Lake-Lower Klamath Lake area, the coastal migration route is used by many waterfowl species wintering in the coastal bays and estuaries. The Tule Lake-Lower Klamath Lake area is used the year round, supporting 75,000 young birds each year; however, the primary importance of the refuges in this area is to delay migratory birds from going into the Central Valley too early, causing crop depredation. Waterfowl start moving into this area on their southward migration late in July. Population estimates are: 175,000 in late July, 1,000,000 by the last of August, 2,500,000 in late September, 4,000,000 in October, and about 1,500,000 in late November as birds move south.

Species of waterfowl nesting in limited numbers in the North Coast study area excluding the Lost River-Butte Valley Hydrographic Unit are mallards (Anas platyrhynchos), wood ducks (Aix sponsa), and common mergansers (Mergus merganser). The numbers of waterfowl species observed in the 1962-63 Department of Fish and Game annual winter waterfowl inventory are found in Table 8 for counties of interest in the study area.

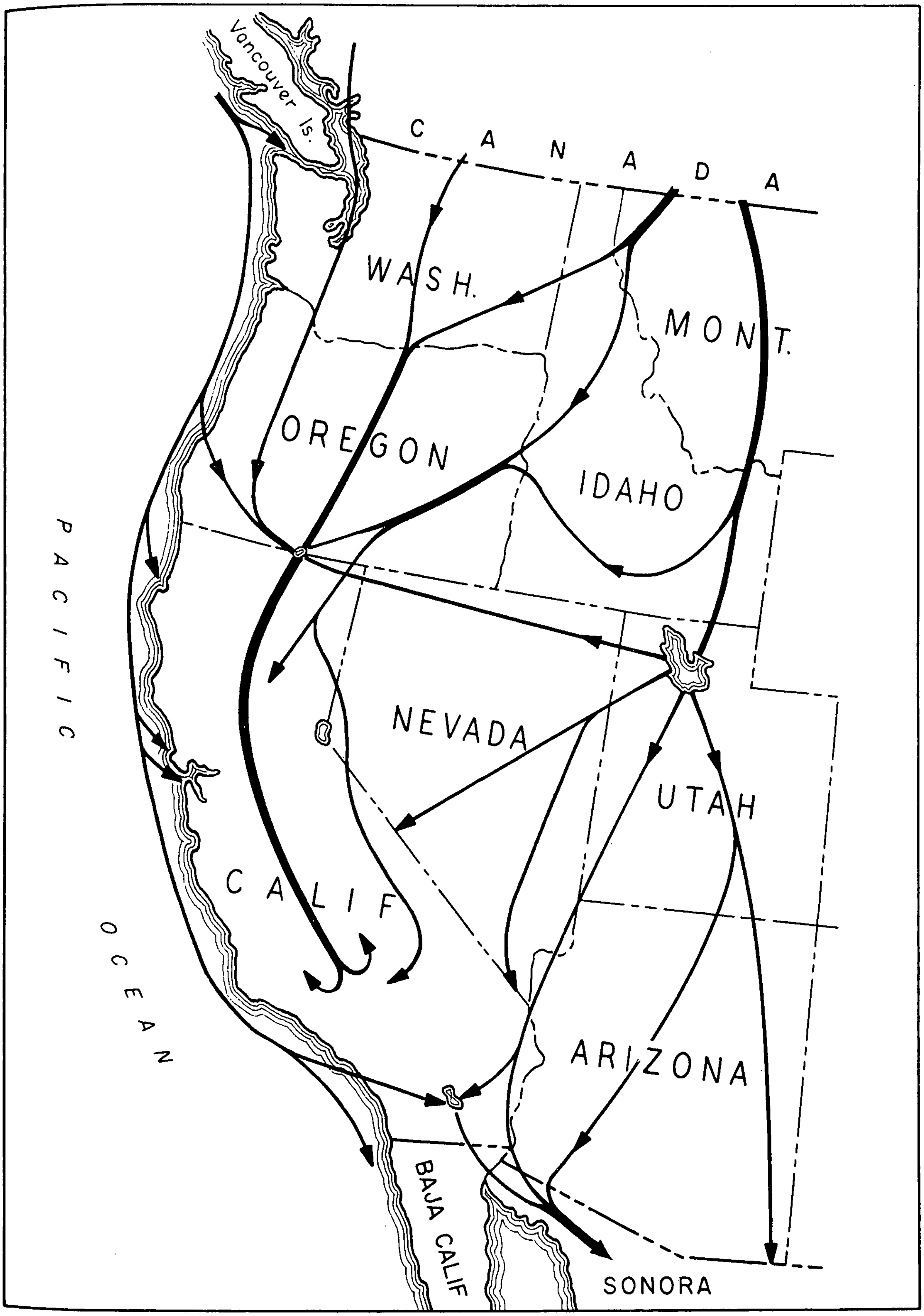


FIG. 13 PACIFIC FLYWAY, SHOWING PRINCIPAL FALL MIGRATION ROUTES

TABLE 8

Winter Inventory of Waterfowl in Counties of Interest,
North Coast Study Area - 12/26/62 and 1/3/63

Species	Del Norte	Humboldt	Modoc	Siskiyou	Sonoma	Trinity	Sub-Total	State Total
Mallard	185	1,145	10,585	104,750	50	20	116,735	513,587
Gadwall			60	20,250			20,310	78,130
Baldpate	255	11,250	1,370	16,150	12		29,037	795,685
Green-winged teal	60	100	40	2,880	40		3,120	235,746
Cinnamon teal				2			2	4,837
Shoveller	35	30		19,600			19,665	219,286
Pintail	80	9,005	6,600	103,450	500		119,635	1,438,968
Wood duck				30	150	2	182	1,083
Redhead	30	25		1,350			1,405	3,610
Canvasback	480	175		1,840		4	2,499	86,226
Scaup	285	1,906		5,400	120		7,711	212,471
Ringneck				605			605	1,471
Golden-eye			35	270	50		355	7,399
Bufflehead	460	70		225	100		855	5,300
Ruddy	665	51		820	25		1,561	135,134
Merganser	220	10	12	225	20	12	499	1,640
Scoter		2,527			75		2,602	29,033
Unidentified		455	880	2,000			3,335	17,269
TOTAL DUCKS	2,755	26,749	19,582	279,847	1,142	38	330,113	3,786,875
Snow goose			474	20,250			20,724	457,629
White-front			1	16,550			16,551	127,536
Canada goose	74		9,235	5,650			14,959	35,401
Lesser Canada goose			3,175	400			3,575	8,621
Cackling goose			14,837	4,300			19,137	232,320
TOTAL GEESE	74	0	27,722	47,150	0	0	74,946	861,507
Black brant		500			2		502	2,888
Coot	820	1,549		8,300	425		11,094	371,432
Whistling swan	311	164	3,780	3,959			8,214	21,820
GRAND TOTAL	3,960	28,962	51,084	339,256	1,569	38	424,869	5,044,522

This table must not be construed to be the total numbers of waterfowl which use the areas listed. This represents only the birds in these counties on that date. These birds are mobile and populations fluctuate rapidly during the winter. Over 390,000 birds are recorded for Siskiyou and Modoc Counties; however, 80 percent of the Pacific Flyway, funnel through this area, considerably more than recorded here.

Furbearers and Predators

The reported fur catch of 585 licensed trappers in California for the 1962-63 trapping season was 71,724 pelts and estimated at a value of $90,740. Muskrat lead all other furbearers in the number of pelts taken and in revenue received for the skins taken in the State. Table 9 indicates the number of animals reported taken during the 1962-63 trapping season for those counties of interest in the North Coast study area.

TABLE 9
Number of Animals Reported Taken by
Licensed Fur Trappers - 1962-63
by Species and County of Reported Catch in
in North Coast Study Area

Reported County of Catch	Badger	Beaver	*1 Bobcat	*2 Coyote	Grey Fox	House Cat	Mink	Muskrat	Nutria	Opossum	Raccoon	Ringtail Cat	Spotted Skunk	Striped Skunk	Weasel	Total	Mt. Lion*
Del Norte		6					2	163			1		2	1		175	2
Glenn	1	95	19	1	8		3	4,397		7	70	8	1	11		4,621	
Humboldt		14	22	4	22		14		3		198	7	12	34		330	3
Lake			12	3	18		75				41	3	8	36		196	2
Mendocino					3		27				95	4	2	1		132	2
Modoc	5	56	20	2			40	1,084			17	1	5	2		1,232	1
Napa					14		3	32			47		10	18	4	128	
Shasta		69	52	124	19		11	5,744		10	47	20	1	26		6,123	4
Siskiyou		122	44	29	11		134	11,310			69		5	10		11,734	11
Sonoma	5							2			7			3		17	
Tehama		51	1	1	2	1	8	260		4	51	7		2		388	1
Trinity	—	14	19	8	20	—	38	—	—	1	24	17	3	10	—	154	4
Sub-Total	11	427	189	172	117	1	355	22,992	3	22	667	67	49	154	4	25,230	30
Statewide Total	22	1,606	295	401	275	26	1,086	66,068	4	174	1,247	86	71	346	17	71,724	114
Statewide Avg. Price	.95	7.58	2.75	2.51	.87	.49	7.92	.98	.25	.50	1.99	1.61	.96	.97	.24		

* Bounty not included by state or county; ♂ $50.00, ♀ $60.00 Mendocino - $10.00 Glenn - $50.00 Siskiyou - ♂ $50.00, ♀ $60.00
*1 Bounty not included by county; $5.00 Humboldt - $5.00 Shasta - $5.00 Tehama - $5.00 Trinity.
*2 Bounty not included by county; $10.00 Shasta - $10.00 Tehama - $10.00 Trinity.

CHAPTER IV. GENERAL DISCUSSION

The dams, reservoirs and conveyance facilities proposed for the export of surplus water from the North Coastal area would have profound effects on the fish and wildlife resources of the region, particularly the anadromous fishes. If these resources are to be protected and maintained, appropriate measures must be taken to mitigate and compensate for the effects of these projects. Measures are described in following chapters for maintenance and enhancement of fish and wildlife with regard to specific projects. This chapter will discuss some of the general effects of water project development on fish and wildlife, and will describe mitigatory and compensatory measures which could apply to the proposed developments.

Streamflow Releases

Curtis (1959) found that when the volume of flow in a river is reduced, the wetted perimeter and depth are reduced at a rate somewhat less than the change in volume. However, the mean velocity of the water shows a much greater percentage reduction. Studies of the relationship between bottom-dwelling organisms and water velocity have shown that a significant reduction in velocity changes the population composition of bottom organisms quantitatively and qualitatively, and thus indirectly affects fish populations. Reduction of velocity also changes the habitat which may cause a modification of the fish species present, both in locality and in numbers of various species. Likewise, reduction of velocity affects spawning and egg incubation. Chambers and others (1955) found that salmon and steelhead prefer velocities of one to three feet-per-second over suitable gravel for spawning. Reduction of velocity over spawning riffles below this level can significantly alter the amount of suitable spawning area.

Silver (1960) held steelhead and king salmon embryos from fertilization to hatching at various concentrations of dissolved oxygen and at known water current velocities. Reduced levels of dissolved oxygen or velocity caused delays in hatching, and the fry produced at the low levels were smaller in length than those reared at higher levels of dissolved oxygen or water velocity. Abnormal or very small fry from embryos reared at very low oxygen concentrations probably cannot be expected to survive under natural conditions.

Similarly, Coble (1961) found a positive correlation between the apparent velocity of ground water and embryonic survival of steelhead trout, and between the dissolved oxygen levels of the intra-gravel water and survival. The apparent velocities and dissolved oxygen concentrations were closely related in the intra-gravel water and the effects of these factors could not be separated.

Despite these various adverse effects, in some cases fish production in stream areas below a dam can be substantially improved over natural conditions. Releases from a reservoir may be used to augment low summer flows. Winter floods which are often destructive to fish are usually contained within the reservoir. By scheduling releases to meet the requirements of downstream fisheries, optimum conditions can often be provided.

Thus, streamflow releases from water projects should be carefully determined to provide suitable conditions for fishlife in downstream areas. Water requirements vary with different types of fisheries. Warmwater and coldwater species usually require a constant flow throughout the year. Anadromous species need large flows to provide suitable depths and velocities during their migration, spawning, and incubation periods, while lesser flows are usually sufficient during the remainder of the year. Adequate water temperatures must also be provided.

The water requirements for wildlife can best be expressed in gallons rather than cubic feet per second as in water releases for fish. This need for water is as important to sustain a wildlife population as it is for fish. The quantities of water necessary are small, but must be scattered over wildlife ranges in proper relation to the basic food and cover requirements. Free water requirements are greater in the more arid areas.

Estimates of the water requirements for fish and wildlife presented in this report are intended to maintain the existing populations at their average historical levels. Where appropriate, enhancement flows are also listed.

The construction of large impoundments in the North Coastal area may result in sediment problems similar to those recently encountered in the joint operation of Lake Pillsbury on the Upper Eel River and Lake Mendocino on the Russian River. The Pacific Gas and Electric Company releases water down the Eel River from Lake Pillsbury for diversion at Van Arsdale Reservoir into the Russian River basin. This water is stored in Lake Mendocino for eventual release down the Russian River.

Since the construction of Coyote Valley Dam (Lake Mendocino) there has been an apparent increase in the turbidity of the Russian River during the winter months. This has had an adverse effect on the salmon and steelhead fishing in the river. This turbidity problem is apparently due to the small size of some of the suspended sediments in runoff from these drainages. These sediments are of such fine composition that they do not completely precipitate even after lengthy retention in the reservoirs. Then later releases (from low level outlets at Lake Mendocino) color the river downstream at a time when it would otherwise be clear. A similar situation has been observed at

Ruth Reservoir on the Mad River. It is possible that many of the projects proposed for the North Coastal area will export turbid water to the Sacramento Valley. If so, this turbid water could have adverse effects on fisheries and other resources. This problem should be evaluated and the possible effects of the export of turbid water assessed as part of the planning process in the formulation of the North Coastal area projects.

Multiple Level Outlets

Change in water velocity also affects water temperatures and thus indirectly affects fish. When water velocity is reduced it requires significantly longer time for water to flow over a particular section of river, thus exposing it to the sun for a longer period of time. When longer exposure is coupled with a smaller volume of water, the heating potential of the sun exerts a much greater effect and water temperatures are much higher.

Water temperature requirements of incubating eggs and salmon and steelhead fry are somewhat critical. Taking into consideration both mortality and growth rate, Seymour (1956) found that the optimum temperature was about 52°F for king salmon eggs and fry and about 58°F for fingerlings.

Studies by Olsen and Foster (1957) and Combs and Burrows (1957) indicated upper and lower threshold temperatures for successful egg incubation. However, more recent studies by Hinze (1959) and Rice (1960) have indicated somewhat different results. In general, it appears that optimum development of king salmon eggs occurs at about 50 to 55°F. Further research is needed to determine if individual strains of salmon in various rivers have different temperature requirements.

The large reservoirs proposed for the North Coastal area would normally be thermally stratified during the summer months. The surface layers of these reservoirs would be well above water temperatures suitable for normal development of salmon and steelhead eggs and fry during the summer and early fall. King salmon in particular would likely find unsuitable water conditions below these reservoirs during the spawning season. Under preproject conditions, the water temperature of salmon spawning streams drops quickly with the onset of cooler fall temperatures and conditions are adequate early in the spawning season. The large reservoirs, however, would remain warm for some time before gradually cooling, prior to the fall overturn.

In order to provide suitable spawning and incubation conditions for anadromous fish below these dams, it will often be necessary to make the fishery release from relatively low levels in the reservoir where cool water is available. Since most of the proposed reservoirs would cut off extensive spawning and nursery areas formerly used by salmon and steelhead, suitable temperature conditions below the dams and in the artificial propagation facilities should be provided as compensation for these lost areas. Multiple level outlets in the proposed dams would allow water of nearly any desired temperature to be released and thus would provide the best possible temperature conditions below the dams.

Multiple level outlets may also have some value in reducing the turbidity of downstream fishery releases. As mentioned previously, many of the projects proposed for the North Coastal area may store turbid water for extended periods of time. The turbid water entering the reservoirs during the winter is more dense and tends to stratify in the lower levels of the reservoir. Therefore, during the winter and spring months the fisheries release could be made from the relatively clear upper levels of the reservoir.

Attraction and Flushing Flows

The possible need for large flows to initiate upstream migration of adult salmon and steelhead and downstream migration of juvenile fish is so far largely undocumented. However, there is ample evidence that uncontrolled spring runoff insures rapid downstream movement of salmon fingerlings. This is probably beneficial since studies have shown that fish grow faster and attain a larger size at maturity if there is only a short period of stream residence. In addition, losses in irrigation diversions and from predation are minimized by high flows. Fyke net studies at Mossdale on the San Joaquin River, at Hood on the Sacramento and at Gridley on the Feather River have demonstrated that peak movements of juvenile salmon occur when peak flows start to recede. It is also known from experience on the Tuolumne River that fingerlings may not migrate at extremely low flows even though it is physically possible for them to do so (Warner, 1962).

This fragmentary information suggests that we may want to reserve an unknown amount of water to release in large quantities for short periods to initiate upstream and downstream migration. However, at this time we are unable to positively determine either the need or amount of water required.

Reduced flows below dams may also cause compaction of gravel and accumulation of silt. It may prove necessary to make occasional large releases of water to loosen gravels and wash away silt carried into the river by tributaries. Since Trinity Dam was constructed there has been an accumulation of silt in the Trinity River channel. This condition will probably be aggravated in the future by the absence of large flows to wash the silt downstream. The long-term effects of this condition on composition, compaction and permeability of spawning gravels should be investigated.

Streamflow Fluctuation

Although it may be necessary to provide occasional large releases below dams to attract upstream migrants, initiate downstream migration, or wash out silt and loosen compacted gravels, frequent violent fluctuations in flow would be detrimental to the downstream fishery resources.

Severe freshets or violent stream fluctuations should be distinguished from adequate streamflows, which are beneficial to virtually all phases of the freshwater life history of salmonids. Adequate flows are required to provide sufficient water for upstream migration and to maintain suitable water velocities and oxygen supply for successful spawning and egg incubation. In addition, substantial flows during the downstream migration period of the fry increase turbidity and protection from predators, lessen the chance of the small fish being swept into irrigation intakes, dilute pollutants, and provide suitable temperature and oxygen conditions in the stream.

However, severe fluctuations in streamflow such as might be caused by power dams, reduce fish production and survival. Fish and food organisms may be isolated in pools and stranded by dropping water levels, while high flows destroy food by abrasion and displacement. High rates of flucutation intensify these effects. Similarly, fluctuations in streamflow endanger the spawning success of all stream fish by stranding the eggs at low flows and scouring eggs from the redds at high flows.

Gangmark and Broad (1956) found a close correlation between freshets and heavy losses of king salmon eggs planted in Mill Creek, California. An experiment during 1953-54 involved placing eggs in Mill Creek and planting a similar group in a controlled flow channel. Main stream losses were heavy and in sharp contrast to a good survival rate in the control channel.

Gangmark and Bakkala (1960) concluded that production of king salmon in the Sacramento River system is limited by a series of factors resulting from the unstable streamflow found in the area. Among these are direct losses of spawn caused by erosion of eggs from the stream gravel. Fifty percent of planted egg samples observed were washed out and lost in this manner during six years of tests. Indirect losses of eggs result from deposition of silt and sand in salmon redds. This deposition reduces seepage rate and leads to poor delivery of oxygen to incubating eggs, low dissolved oxygen levels from humus decomposition, and poor cleansing of metabolic waste products. Indirect losses also result from a critical shortage of suitable spawning gravel due to gravel being eroded from the normal streamflow channel by floods. The effects of flooding were eliminated in a controlled-flow stream channel at Mill Creek. During the incubation period, erosion and reduced seepage rate were the most critical of the factor investigated that might affect the survival of spawn.

Studies on the Klamath River below Copco revealed that fluctuations were responsible for significant losses of small salmon, in addition to the destruction of resident fish and invertebrate fauna. Fluctuations on the Mokelumne River rendered a major portion of the suitable salmon spawning gravels unusable. Daily flows below the power operation of Pardee Dam ranged from 50 to 700 cfs, which often exposed redds at the low flows.

Thus, permissible rates of streamflow fluctuation should be determined below each power facility proposed for construction in the North Coasta area. These rates of change should protect the streambed from erosion, protect human life and property, and protect fish and wildlife resources in downstream areas.

Channel Improvement

Some of the major projects proposed for the North Coastal river basins will eliminate many miles of sport fishing area, in addition to large amounts of spawning and nursery area for anadromous fish. Although hatcheries and other artificial propagation facilities can largely replace the spawning and nursery areas, it is difficult to compensate for lost stream fishing. A partial answer to this problem could be to acquire sections of river bed and bordering lands below the major projects and develop them into semi-natural spawning and nursery areas. These areas would have high value for public angling and other recreational use, and would provide mitigation for lost stream fishing areas above the dams. With channel improvement, and even without in some cases, the stream sections below the dams will become important spawning and nursery areas with streamflow releases of adequate temperature and quality. These areas should be protected from gravel removal, siltation and other deleterious practices which would lower their value for fishery production.

Smith and Elwell (1961) recommend improvement of the Middle Fork Eel River channel by removing the bottom material in the low flow channel, which now consists mainly of sand and cobbles, and replacing it with graded spawning gravel. Studies conducted during 1960 indicated that satisfactory spawning velocities could be obtained at a flow of 100 cfs, although very little gravel was available for spawning at that reduced flow. Under natural conditions spawning gravel in the lower reaches of the Middle Fork Eel River is deposited in large bars above the low flow channel.

With channel improvement, Smith and Elwell found the spawning area available for salmon at a flow of 100 cfs would rise from an estimated

40,000 square feet per mile of stream to about 240,000 square feet. Under normal conditions only 80,000 square feet of gravel per mile of stream was available at 300 cfs.

This idea seems to have considerable merit and could be applied in many areas of the North Coast where the stream channel gradient and contour is such that moderate flow releases would provide suitable water velocities. In some areas the slope of the stream bottom may require grading or construction of drop structures to improve water velocities. The water supply should be regulated to provide water of adequate temperature and quality and to avoid damaging floods.

Regulated streamflow releases would tend to keep the stream bottom reasonably stable, in contrast to natural conditions, where the streambed is scoured out each year by floods. Some spill would be expected from the projects proposed for the North Coastal area during years of exceptionally high runoff; however, the frequency and magnitude of spill would probably not be great enough to displace the imported spawning gravel.

Although improved spawning conditions and optimum streamflow might be adequate to enhance king salmon runs, silver salmon and steelhead would require suitable nursery areas also, since these species spend a year or more in fresh water. In some streams adequate cover would be naturally present, however, in others the natural pools could be dredged to greater depth to provide better protection for the fish. Streamflow releases of adequate temperature would be required throughout the year for production of these species.

Artificial Spawning Channels

An artificial spawning channel can be defined as a man-made spawning area similar to a natural stream spawning area. In the channel, however, the gravel has been graded to specific sizes and washed to remove fine material such as mud, clay, and sand. The channel bottom has been graded to proper slope and provided with regulated flow of water. Optimum conditions for spawning are thus provided by adjusting the depth, and velocity of this water over the selected gravel.

The primary function of man-made spawning channels is to increase production of salmon and steelhead fry. All five species of Pacific salmon have reproduced successfully in artificial spawning channels. Salmon are allowed to spawn naturally in the gravel of most spawning channels, however, in some instances artificially fertilized eggs are reared to the eyed stage and then planted in the gravel. It is anticipated that artificial spawning channels can produce large numbers of young salmon, and that salmon fry spawned and hatched naturally and allowed to emerge from the gravel and migrate to the ocean in a normal manner will be stronger than hatchery-reared fish, thus giving them a better chance of survival in later stages of their life cycle.

The first major spawning channel was constructed in British Columbia at Jones Creek in 1954. McNary Channel and Baker Beach in Washington were operational in 1957; other completed projects were not in production until 1959 or later. Thus, there has not yet been sufficient time to evaluate the potential of these spawning channels.

However, at Jones Creek adult pink salmon spawned successfully, their eggs hatched, and the resulting fry migrated out of the channel, to return as adult spawners and complete the cycle. The number of returning adult pink salmon increased from 400 in 1955 to 2,600 in 1959, and more than 5,000 in 1961. Egg-to-fry survival has been as high as 63 percent. In the McNary Channel, the highest egg-to-fry survival of king salmon has been only about 26 percent, presumably because of high water temperatures during most of the spawning season.

According to Menchen (1962), the major problems considered at controlled-flow spawning grounds have been:

1. Silting of spawning riffles where a proper filter system is lacking.

2. Serious loss of water where bottom and banks of the channel are not made water-tight.

3. High water temperatures as at McNary Channel where most of the fish have been spawning in water 60°F or warmer.

4. Adult salmon bruising themselves at improperly built inlet and outlet drop structures.

5. Spawning fish being disturbed by people walking along the banks of the spawning channel. Tree growth along the Jones Creek Channel and a solid wooden fence along sections of the Robertson Creek Channel in British Columbia have solved this problem.

The manpower requirements to operate a spawning channel are small. One man can operate two or three neighboring channels even when the salmon are spawning if this is his only responsibility. The biologist's duties would consist primarily of regulating the water flow; controlling the number of spawners entering each section of the channel; preventing poaching, and general maintenance.

If a spawning channel is properly constructed, maintenance involves only grading the gravel of the bottom and sides each year. This is done after the downstream migrants have left. Additional maintenance is required at channels where silt is a problem. The silt must be washed from the gravel when the gravel becomes compacted or when permeability decreases below that required for optimum egg and sac fry development. At Jones Creek, silt is removed once each year by raking the gravel while water is flowing through the channel; about every five years the gravel is removed and fine materials are screened out.

Freshwater Rearing Ponds

Man-made spawning channels may be sufficient to increase production of fall-run king salmon which spend a limited amount of time in freshwater after emergence from the gravel. However, for species such as silver salmon, spring or summer king salmon, and steelhead trout which remain in freshwater up to a year or more after emergence from the gravel, the spawning channel may be only a partial answer to increasing production. A productive spawning channel without associated freshwater rearing facilities would be of no practical value for these latter species.

Attempts have been made to create or improve natural rearing areas for salmon and steelhead. The Washington Department of Fisheries and the Fish and Game Commissions of Oregon are pioneers in this work. Since 1960, these agencies have been studying modified natural lakes and man-made impoundments for the rearing of salmon and steelhead. Primary emphasis has been placed on silver salmon, although fall king salmon are also being studied. The Oregon Game Commission has devoted much of its attention to steelhead trout.

Basically, these investigations have consisted of releasing a known number of fry into a lake or pond and counting the smolts migrating downstream the following spring. In man-made impoundments, provision has been made for draining the lake in some cases. Most of the ponds are less than 100 acres in surface area, although studies are being carried out by the Washington Department of Fisheries at Lake Merwin, which is a reservoir of about 4,000 surface acres.

The results of these studies have been extremely variable to date. Between 0.6 and 89.0 percent of the young silver salmon introduced into 27 controlled "natural" rearing areas in Washington were counted out as downstream migrants. At Lake Merwin, the estimated survival of silver salmon was one to 2.2 percent. Atkinson (1963) reported survivals of less than 10 percent to nearly 40 percent in three natural lakes and one pond studied by the Oregon Fish Commission. Atkinson also reported an 8.8 percent survival of steelhead recorded by the Oregon Game Commission from an artificial lake in the Umpqua River drainage. Substantial work remains before these "natural" rearing areas can be relied on to produce downstream migrant salmon and steelhead in satisfactory numbers.

Fish Screens

All major diversions associated with the proposed projects in the North Coastal area should be adequately screened to prevent loss of fishlife and transfer of undesirable species from one body of water to another. In particular, diversion canals such as the Geyserville Diversion Canal (Chapter VII) will require satisfactory screening to prevent loss of downstream migrant salmon and steelhead.

A great deal of experience has been gained in recent years through studies by the federal government on methods of screening large diversions. Bates and others (1960) evaluated 10 years of operating at the louver screen and fish collecting facility at the Central Valley Diversion at Tracy, Californ

Personnel of the Delta Fish and Wildlife Protection Study, a cooperative investigation of the California Department of Fish and Game and Department of Water Resources, are studying various plans to screen proposed diversions from the lower Sacramento River. This and other investigations should provide satisfactory methods of screening which may be applicable to the large diversions associated with the North Coastal area developments.

Fishways and Ladders

Collins and others (1962) discussed the results of several years of study of the ability of salmonids to ascend fishways. In the course of the experiments, six king salmon, four sockeye salmon, and four steelhead were permitted to ascend 1,000 feet in the experimental "endless" fishways. One sockeye salmon was allowed to climb the fishway for over 5 days, and ascended 6,648 feet before the test was discontinued. Collins concluded that, in general, well designed fishways present no problem to adult salmon and steelhead.

As a result of this and other studies conducted in recent years considerable experience and knowledge of upstream passage facilities has been gained and is available to fishery biologists and planning engineers. Thus, fishways can be designed for most conventional dams with substantial confidence that they will function satisfactorily. Assuming successful passage of adult fish over a dam and through the reservoir and equally safe passage of the young fish downstream through the reservoir into the tailwaters of the dam, provision of passage facilities would generally be a less expensive means of preservation of the anadromous fish runs than artificial spawning facilities. Successful passage of downstream migrant salmonids past a dam could probably be engineered provided the young fish could be concentrated immediately above the dam. The real problem in retaining use of upstream spawning grounds, therefore, lies in providing transportation of juvenile fish downstream through the reservoir and to the dam. This problem has not yet been satisfactorily solved. Smith (1963) reported on a recent study supported by the Department of Water Resources and the Bureau of Commercial Fisheries, U. S. Fish and Wildlife Service, and conducted by the Department of Fish and Game. This investigation was aimed at determining the movement and behavior of planted fingerling king salmon in Shasta Reservoi California. A complete evaluation of the habits of juvenile king salmon in this reservoir was impossible due to premature termination of the study. However, preliminary data indicate that the young fish planted during the study have taken up at least a temporary residence in the reservoir and have shown no inclination to leave.

Thus, at this time it appears impractical to provide access for anadromous fish over the dams proposed for construction in the North Coastal area even if substantial spawning areas exist upstream. Instead it would be necessary to provide more expensive artificial propagation facilities belo the damsites. This could consist of conventional fish hatcheries, or possibl improved natural channels or artificial spawning channels. However, further evaluation must be made of the latter two possibilities before they can be recommended as a positive solution.

In the case of relatively small dams such as the Geyserville Divers Dam proposed for the Russian River (Chapter VII), the situation is much different. River-run projects of this type are a relatively minor problem for downstream migrants to negotiate provided the diversions are adequately screened. Fish ladders of a conventional design should be constructed to provide access for anadromous fish over such barriers.

Interim Fish Protection Facilities

During construction of the dams proposed for the North Coastal area, upstream migration of salmon and steelhead would be halted by the high water velocities in the diversion tunnels. Therefore, it would be necessary to construct facilities to trap adult upstream migrants. These fish would then be transported above the damsite where they could spawn naturally. The diversion tunnels should be constructed so that downstream migrant salmon and steelhead and spawned-out adult steelhead could negotiate them without harm. In some cases, the trapping facilities would be temporary structures; however, in other cases they would remain as a permanent part of the artificial propagation facilities to be constructed at the completion of the project.

Wherever possible, hatcheries or other artificial propagation facilities should be provided to maintain salmon and steelhead when the diversion tunnels around the damsite are closed and juvenile fish can no longer migrate downstream. If fish facilities are not complete at this time, adult fish must spawn in a restricted area below the dam for one or more years until the facilities are completed and severe reduction of the runs may occur. As development of the North Coast proceeds and several hatcheries are constructed, it may be possible to maintain runs blocked by projects under construction in the previously constructed facilities for one or two years. These hatcheries will be designed to accommodate peak runs of fish and the average runs are, of course, much smaller; thus, in any given year hatching and rearing space may be available.

Appropriate measures should be taken to prevent siltation and other pollution damage in the streambed downstream from construction sites. In most cases areas downstream from the proposed projects are important spawning areas for anadromous fish. Following completion of the projects these areas will be the major remaining salmon spawning areas. Steelhead and silver salmon must also use these areas as nursery grounds, in many cases.

CHAPTER V. EEL RIVER HYDROGRAPHIC UNIT

General Description

The Eel River Hydrographic Unit consists primarily of the Eel River drainage, with the addition of the small coastal basins of the Bear, Mattole, and Elk Rivers, plus numerous minor drainages adjacent to these rivers. The Eel River drainage covers almost 3,700 square miles, located in Humboldt, Mendocino, Trinity, and Lake Counties. The main stem flows almost straight for over 100 miles in a northwest direction, entering the Pacific Ocean about 15 miles south of Eureka.

The topography is generally subdued in the upper elevations, being composed of long rather even ridges, with no imposing peaks. The canyon bottoms and adjacent slopes are usually steep and rugged, being composed of highly erodible, folded sedimentary formations. The elevation ranges from sea level at the mouth to 7,500 feet in the headwaters of the Middle Fork Eel River. For the most part, however, the elevation of the headwaters of major tributaries ranges from 2,000 to 4,000 feet.

The headwaters of major tributaries and all lesser tributaries throughout their lengths flow through steep V-shaped canyons, with a few exceptions. Flood plains begin to appear in the mid or lower sections of major tributaries and progressively widen on the main stem to extensive gravel bars as the river approaches the coast.

The main river and major tributaries are of moderate gradient throughout most of their length, and are steep only in their extreme headwaters. Smaller tributaries are steeper, and many follow short, tortuous routes to the main streams. Main streams are exposed in their middle and lower portions.

Flood plains limit growth of streamside vegetation. Headwaters and smaller tributaries, however, are well shaded by alder, willow, maple, and conifers, and often by steep-sided canyons.

Spawning gravel for salmon and steelhead trout is scattered throughout the drainage. Extensive riffles composed of gravel suitable for king salmon spawning are located in various sections of the main river, the lower half of the Middle Fork, and the upper half of the South Fork. Small pockets of spawning gravel occur throughout the remainder of these streams, and, with few exceptions, are accessible to spawning fish. In addition, good spawning gravel for king salmon is available in several of the larger tributaries, especially in the middle and upper parts of the drainage. Smaller gravel suitable for steelhead and silver salmon spawning is available in most of the smaller tributaries.

Moderate amounts of sand and silt are present on the stream bottom throughout the drainage, especially in parts of the watershed subject to extensive logging, roadbuilding or grazing activity.

Most of the precipitation in this hydrographic unit falls in the form of rain, concentrated in the months of November through April. Runoff is rapid and there is a wide variation between winter and summer flows. Most of the drainage is characterized by hot, dry summers. Coastal summer fog cools air and water temperatures in the lower 20 or 30 miles of the basin.

Conifers dominate the vegetative cover in the basin; redwoods in the coastal fog belt, and Douglas fir and yellow pine in the remainder, with some red fir scattered along the high ridges. Considerable areas of oak-grassland and brush are found on the dry south slopes of the middle and upper parts of the watershed.

The Bear, Mattole and Elk River drainages, located adjacent to the Eel River, comprise most of the remainder of the Eel River Hydrographic Unit. These are short coastal streams similar to the larger tributaries in the lower basin of the Eel, but markedly different from the upper Eel drainage. The watersheds of these short coastal streams are heavily timbered and are subject to high annual rainfall. In fact, the highest rainfall in the State has been measured in the Mattole Basin near Honeydew.

Like the Eel, the runoff of these streams fluctuates greatly between summer and winter, which is reflected in streambed physiography. Headwaters are in steep V-shaped canyons, with little or no flood plain, while mid and lower sections have a gentle to moderate gradient with relatively wide flood plains. Spawning gravels for steelhead and salmon are extensive in mid and lower sections.

Coastal fog keeps summer air and water temperatures cool in the lower half of the Elk River and in the lower quarter of the Bear and Mattole Rivers. Air and water temperatures are high upstream from these areas.

In the subunit description section of this chapter topography and fish habitat are described only if they vary from general descriptions in this introductory section. Subsequent chapters describing hydrographic units and subunits will follow the same general pattern.

Geographical boundaries of the hydrographic unit and subunits are shown on Plate 4, entitled "Hydrographic Units and Subunits in the North Coastal Hydrographic Area."

All quantitative data on fishery resources and flow requirements are shown in Table 10 at the end of the subunit description section.

Fish and Wildlife Resources

The Eel River is the largest and most important drainage within the Eel River Hydrographic Unit. The unit also contains several smaller drainages, which have important fish and wildlife resources. The resources of all of these basins will be described in the following section.

Fishery Resources

Eel River

The Eel River provides habitat for substantial populations of important fish and wildlife species within its drainage basin of 3,700 square miles. It is one of California's most important anadromous fish streams; ranking second in silver salmon and steelhead trout production, and third in king salmon production.

An estimate was made of the average annual spawning escapement based on the annual counts of salmon and steelhead passing over Benbow Dam on the South Fork Eel River, and escapement estimates made by the U. S. Fish and Wildlife Service for the entire river between 1955-59. From these data, the average annual spawning escapement of king salmon during the 25-year period from 1938-62 was estimated at approximately 69,000 fish with the peak run for a single year estimated at 177,000 fish. During the same period the average run of silver salmon was about 30,000 with a range from 6,500 to 78,000 fish. The spawning escapement of steelhead averaged 115,000 and ranged from 50,000 to 196,000 fish. Table 10 presents estimates of the available spawning escapement of the various species and the estimated flow requirements necessary to maintain these resources for each subunit of the Eel River Hydrographic Unit.

King salmon begin their journey from the ocean in late summer, reaching the riffles downstream from Fernbridge in late August. During September they lie in the lower pools and estuary waiting for streamflows to increase sufficiently to allow migration upstream. Some of the early arrivals are ready to spawn upon entrance into the Eel River and probably spawn in the lower main Eel and Van Duzen Rivers. These fish are often delayed in their migration by lack of flow over shallow riffles.

A large part of the natural flow of the upper Eel River is diverted from Van Arsdale Reservoir to the East Fork Russian River by the Pacific Gas and Electric Company. This water is used for power generation and irrigation within the Russian River basin. During the dry season this diversion of water creates very unfavorable conditions for fish in the Eel River from Van Arsdale Reservoir to the confluence of the Middle Fork at Dos Rios. During the late summer the effects are noticeable all the way to the mouth of the Eel.

The peak of the king salmon migration in the lower river occurs in October and early November. Fall rains are the principal factor governing time and distribution of the spawning migration. During dry years most of the spawning is confined to the major tributaries. This often results in low survival of the eggs since redds in the main streams are more vulnerable to destruction from floods than those widely distributed throughout the tributaries. During years of normal flow, tributaries in the upper portion of the system are heavily used. Spawning begins in late October, reaches a peak in November, and continues through at least December.

The silver salmon run in the Eel River system is short in duration.

The migration begins in mid-October, reaches a peak in November and dwindles through December. Silver salmon usually move into the river on high flows following the first major winter storms, and most of the run may pass upstream within a week. Spawning is predominantly confined to the South Fork Eel River and the smaller tributaries of the lower main Eel and Van Duzen Rivers. Surveys by the U. S. Fish and Wildlife Service (1960) indicated that 35 to 40 percent of the silver salmon spawned above Benbow Dam on the South Fork. Silver salmon are not known to migrate in the main Eel River above the confluence of the North Fork.

Steelhead trout enter the river in varying numbers throughout the year. A small spring run enters during April and May and migrates to the upper reaches of the Van Duzen and the Middle Fork. Like the Klamath River, the Eel receives a significant run of small steelhead in late summer or early fall. Summer and early fall migrations are often impeded by low water conditions. Large numbers of steelhead congregate in the pools near tidewater until improved flows allow them to move upstream. The run usually peaks during December and January in the lower river.

Steelhead spawn in most of the smaller tributaries throughout the drainage. They are easily the most widespread and most abundant of the three anadromous species. Most of the steelhead spawn during the period February through April, however, the spring run fish lie in the cool water of the upper Van Duzen and Middle Fork through the summer, and apparently spawn in the late fall or early winter, somewhat ahead of the winter-run fish.

A shad population of unknown size is present in the Eel River. Adult shad spawn in the lower 40 to 50 miles of the main river. The sturgeon population of the river is now negligible. At one time the species supported an important sport fishery as far upstream as Rio Dell. In recent years, only an occasional green sturgeon has been reported in the lowermost part of the river.

The Eel River supports the second largest sport fishery in Northwestern California, exceeded only by the Klamath-Trinity River System. Fishing for king salmon and steelhead is at its best during the fall and early winter. During the winter months the high, turbid flows may make fishing unprofitable for long periods. The Middle Fork and Van Duzen Rivers provide a fine summer and early fall fishery for spring run steelhead.

Salmon are usually taken from the lower river by boat fishermen beginning in late August. As the run moves upstream, a considerable bank fishery develops concurrently with the "half-pounder" steelhead fishery. In general, this fishery develops at the mouth and moves upstream beginning during early October in the estuary and continuing through December in upper areas near the confluence of the Middle Fork, and near Covelo on the Middle Fork Eel River. Most of the angling for early-run steelhead is concentrated in the tidewater area. The winter steelhead fishery nearly coincides with the November peak of the king salmon run in the lower river, and catches during this period commonly include both species. Silver salmon are occasionally taken during November and December in the South Fork and lower main Eel River.

The South Fork Eel River receives most of the angling pressure in the drainage. Anglers concentrate at numerous access points along the stream up to Benbow Dam. Fishing pressure is reduced upstream from the dam. The mainstem receives angling pressure mainly along the lower 30 miles and upstream from the confluence of the Middle Fork. Much of the area above the confluence of the South Fork is inaccessible during the winter. The Middle Fork Eel

River is also lightly fished during the winter due to limited access. Anglers concentrate near the mouth and in the vicinity of the Eel River Ranger Station. The Van Duzen River receives only light to moderate angling pressure for salmon and steelhead. This low effort is apparently directly related to the relatively small run of fish in this tributary.

According to angler-use surveys conducted by the U. S. Fish and Wildlife Service (1960), the Eel River sport fishery provided over 80,000 angler-days annually during 1956 and 1957. Trout (mostly juvenile steelhead) fishing provided 45,000 angler-days, salmon fishing 7,000 days, and steelhead about 28,000 days. Average catch was 68,000 trout, 3,500 salmon, and nearly 14,000 steelhead per year. Thus, the sport fishery in the Eel River took about 16 percent of the chinook salmon run and 13 percent of the steelhead run during those years.

Middle Fork Eel River

Basic fishery data required for evaluation of the proposed Middle Fork Eel River developments were obtained in field studies conducted by Smith and Elwell (1961) in 1959 and 1960. The studies included fish population sampling, trapping of downstream migrants, recording of stream temperatures, streamflow and spawning gravel measurements, stream surveys, review of available literature and discussions with personnel of various agencies. The results were presented in an office report entitled, "The Effects of the Spencer-Franciscan, Jarbow and Dos Rios Alternative Projects on the Fisheries of the Middle Fork Eel River." Since this information is pertinent to this report a brief summary follows.

Fish Populations. Two species of anadromous fish, king salmon and steelhead trout, constitute the major fishery of the Middle Fork Eel River. However, populations of resident rainbow trout, green sunfish, brown bullhead, suckers, and sticklebacks are also present in the drainage.

Only a fall-run of king salmon occurs in the Middle Fork Eel River. In years of ample streamflows, the spawning run of these fish generally first appears in the drainage during mid-October, peaks during the first part of November, and tapers off into December. Spawning takes place in the main river channel and in certain tributaries at least as far upstream as the confluence of Black Butte River. Stream surveys indicated that lower sections of Mill, Short, Williams and Elk Creeks are the important king salmon spawning tributaries.

The Middle Fork Eel River is one of a few streams in the State that supports a run of spring or "summer" steelhead. The spawning run of these fish usually occurs between the latter part of April and the middle of July. The earliest that they have been observed in the vicinty of the Eel River Ranger Station is April 20. Normally, the bulk of the run has passed the Eel River Ranger Station by the latter part of June. The latest they have been observed passing this point is July 10. These fish, ranging from 3 to 13 pounds in weight, remain in the deeper pools of the Middle Fork Eel River above its confluence with Black Butte River.

By the first of July, streamflows are usually down to levels where the fish are extremely vulnerable to angling in the large holes above the Eel River Ranger Station. The cold water from snowmelt in the upper drainage enables these fish to remain in good condition throughout the summer. They apparently spawn in the late fall or early winter, somewhat ahead of the steelhead in the regular winter-run.

The first winter-run steelhead generally appear above Etsel Flat during the latter part of October with a heavy run occurring about mid-December, depending on streamflow. These fish reportedly appear at Asa Bean Falls during December and January and spawn in this area during February and March. They have been observed spawning on riffles in the main channel in the vicinity of Traveler's Home (4 miles above Eel River Ranger Station) during the middle of March. Steelhead spawn in virtually all of the tributaries of the Middle Fork upstream at least to Haynes Delight (T26N, R11W, Section 35) which was the upstream limit of the stream surveys.

Downstream Migration Studies. The timing of downstream migration of juvenile salmon and steelhead was studied using standard riffle fyke nets during May through September 1959. Migration of young salmon and steelhead was already well under way when trapping studies were initiated in the spring of 1959. Periodically, from June 10 to September 26, 1959, the entire river was blocked off at Etsel Flat and the total numbers of downstream migrants were obtained by means of a net and live box.

The data indicate that migration of salmon commences sometime prior to May 18, the first day of trapping, and terminated about the latter part of June or the first part of July.

As with the salmon, the downstream migration of young steelhead evidently commenced prior to May 18, 1959. Young steelhead were taken in the trap during the trapping period from May 18 through September 26, 1959. For all practical purposes, the bulk of the migration occurred prior to the end of July or the first of August. There was practically no downstream movement of these fish from the first of August through the end of September. A resumption in downstream migration was noted after the first fall rains on September 18-20 when streamflows increased and water temperature dropped sharply.

Temperature Studies. American Recording Thermometers were used to record water temperatures at selected stations in the Middle Fork Eel River during May to October 1959. The data showed water temperatures during the summer high enough to constitute a thermal block to migratory juvenile salmonids. Summer steelhead distribution and migration is largely determined by temperatures. The lower reaches of the river and all of the small tributary streams have summer water temperatures that are lethal to salmonids. For this reason, during the summer and early fall there is almost a complete absence of salmonids in the 25-mile section of stream from the Eel River Ranger Station to the mouth of the Middle Fork Eel River. From the end of July until the middle of September rough fish populations are predominate in the river below the Osborne Guard Station.

Spawning Area Assessment. Although it may prove necessary to maintain the bulk of the king salmon run through artificial propagation facilities following construction of the Middle Fork Projects, there is a possibility that the run could be maintained through increased utilization of the spawning riffles in the lower section of the drainage. This could be achieved by providing stable flow releases below the dam and replacement of poor quality gravel in riffle areas with graded spawning gravel. If the Dos Rios project is constructed little possibility of natural propagation of the salmon and steelhead runs would remain since the dam would be located only 3 miles upstream from the mouth of the Middle Fork.

In order to determine the amount of spawning gravel that would be available below Spencer Dam at various water flows, a spawning gravel survey was initiated in May 1959, and completed in October 1960. Since it was impossible to survey the entire 25 miles of river between the proposed damsite and the mouth of the Middle Fork Eel River, several stations that were believed typical of the lower river were established in a one-mile section of stream below the proposed damsite. Subsequent surveys confirmed that these stations were representative of areas in the lower river.

Depth and velocity measurements were taken at 5-foot intervals across the stream channel at each station. Velocity measurements were made at a point 0.3-foot from the stream bottom, which is the approximate position of a salmon while spawning. Determinations of gravel quality were completed during the period of lowest summer flows when receding waters had exposed the gravel. Standards developed by the Department of Fish and Game in previous studies were used to determine suitable gravel water depth, and velocity for successful salmon spawning.

The measurements showed the amount of available spawning gravel increased from 14,000 square feet of suitable gravel per mile at a flow of 20 cfs to 80,000 square feet at a flow of 270 cfs. Unfortunately, it was necessary to terminate the study before a sufficient number of measurements could be made in the higher flow range. Therefore, it was impossible to conclusively determine the optimum flow required to provide the maximum amount of spawning gravel for king salmon under natural conditions. It was concluded from visual observations and interpolation of the data that a flow of 300 cfs would provide approximately 80,000 square feet of usable gravel per mile, which would provide the maximum utilization of suitable spawning gravel below Spencer Dam. High water velocities would reduce the amount of area available at flows greater than 300 cfs.

During the 1960 season, it was found that satisfactory spawning velocities could be obtained at a flow of 100 cfs, but at that reduced flow very little gravel was available for spawning. Under natural conditions spawning gravel in the lower reaches of the Middle Fork Eel River is deposited in large bars above the low flow channel. In order for much of this gravel to be utilized by spawning salmon the flow must be greater than 200 cfs. If the poor quality gravel in the low flow channel were replaced with graded spawning gravel, the spawning area available at a flow of 100 cfs would rise from an estimated 40,000 square feet per mile of stream to about 240,000 square feet. Under normal conditions only 80,000 square feet of gravel per mile is available at 300 cfs.

Mattole River

The Mattole River supports populations of king and silver salmon, and steelhead trout. The U. S. Fish and Wildlife Service estimated that king salmon runs presently number about 5,000 and silver salmon about 2,000. Annual runs of about 12,000 steelhead were also estimated. Steelhead support a popular winter fishery. The timing of spawning migrations of anadromous fish in the Mattole River is comparable to that of the Eel River.

The Mattole River is accessible to king salmon for about 45 miles, according to U. S. Fish and Wildlife Service surveys. A restricted channel, forming a low fall near Thorn, is at least a partial barrier to anadromous fish, and probably constitutes the upstream limit for king salmon. Silver salmon and steelhead ascend the river several miles above this area during periods of good flow. King salmon spawn mostly in the main river, however, several tributaries, notably the North Fork, Honeydew, and Bear Creeks, provide suitable spawning areas. Silver salmon and steelhead spawn mostly in the smaller tributaries throughout the drainage.

The gradient of lower areas of the river is moderate and the stream meanders extensively. Intensive logging began in the Mattole River drainage about 1952. Since that time, siltation has increased. Debris from logging operations has blocked many miles of formerly accessible spawning habitat in the tributaries. It is believed that these conditions have led to a significant reduction in the size of the anadromous fish runs in the last ten years.

Prior to 1954, the Mattole River had an exceptionally good winter steelhead trout fishery. The fishery has deteriorated seriously since then. Most of the catch of king salmon is made during November, although an occasional fish is taken in the estuary as early as October. Steelhead and an occasional silver salmon are taken whenever water conditions are favorable. U. S. Fish and Wildlife Service surveys during the 1956-57 and 1957-58 seasons indicated that an average 4,300 angler-days were spent on the river, resulting in a catch of 400 salmon, 700 steelhead, and about 8,000 juvenile steelhead trout.

Bear River

The Bear River likewise supports a good run of steelhead. U. S. Fish and Wildlife Service surveys indicated the river was suitable for silver salmon although none were observed. Spawning habitat appeared unsuitable for king salmon. Department of Fish and Game records indicate the river does support runs of all three species of anadromous fish, however, the runs of king and silver salmon probably are small.

According to the U. S. Fish and Wildlife Service, Bear River is accessible to steelhead trout for about 15 miles below a large log jam which forms a complete barrier. Increased logging activity in recent years has had an adverse effect on this drainage. A large percentage of silt and other fine material in the gravel lowers its value for spawning. The gradient of the stream near the mouth is low and riffles are broad and shallow. The stream divides and meanders considerably in the lower reaches. The Bear River has an estimated run of 1,000 king salmon, 2,500 silver salmon, and 6,000 steelhead.

Eureka Plain

The Eureka Plain subunit contains several small streams which support populations of anadromous fish. These streams include: Jacoby, Freshwater and Salmon Creeks, and the Elk River, all of which flow into Humboldt Bay. These streams provide spawning habitat for good runs of steelhead and small runs of silver and king salmon. Logging and various forms of watershed abuse has had a highly detrimental effect on these streams. Spawning gravel in many riffles has been covered by heavy deposits of silt. Log jams and other barriers have made considerable lengths of stream inaccessible to salmon and steelhead.

Collectively, these small streams provide a significant amount of sport fishing. Salmon and steelhead fishing are relatively unimportant, and emphasis is placed on the trout fishery, which consists of juvenile steelhead trout and cutthroat trout. Based on Department of Fish and Game spawning surveys and data published by the U. S. Fish and Wildlife Service (1960), these streams are estimated collectively to have runs of 2,000 king salmon, 4,000 silver salmon, and 10,000 steelhead.

Wildlife Resources

The principal wildlife game species, in order of their probable importance in this hydrographic unit, are as follows: black-tailed deer, waterfowl, California quail, black bear, band-tailed pigeon and mountain quail. Proposed water development projects under study are thought to significantly affect only deer and quail. Waterfowl use is principally limited to the bays, river deltas, and estuaries along the coast; especially Humboldt Bay and the Eel River Delta.

Subunit Descriptions

1. Lake Pillsbury Subunit. The most notable feature of this subunit is Lake Pillsbury, a hydroelectric storage impoundment owned and operated by the Pacific Gas and Electric Company. The reservoir is located on the upper main Eel River at about the midpoint of this subunit. Scott Dam, which impounds the reservoir, is an absolute barrier to upstream fish passage. At the lower boundary of the subunit Cape Horn Dam (Van Arsdale Reservoir), the diversion structure for water stored in Lake Pillsbury, diverts the major part of the flow of the Eel River much of the year into the East Fork Russian River. A fish ladder is provided at Cape Horn Dam to allow fish to ascend the remaining 12 miles to the base of Scott Dam.

This subunit is characterized by steep heavily timbered slopes, which are presently being intensively logged.

2. Willis Ridge Subunit. This subunit lies downstream from the Lake Pillsbury subunit and encompasses the main Eel River plus one main tributary, Tomki Creek. The subunit is characterized by steep V-shaped canyons. The streambed is mainly bedrock and boulders, with spawning gravel only in scattered pockets.

2. Main Eel River below Hearst. Streamflow about 30 cfs.
July 5, 1960

3. Main Eel River above Outlet Creek. Streamflow about 30 cfs.
July 6, 1960

3. Outlet Creek Subunit. The major stream of this subunit, Outlet Creek, heads in Little Lake Valley near the town of Willits. Outlet Creek, which is fed primarily by seepage from the valley, does not flow continuously during the summer due to heavy agricultural use. The middle part of the stream flows through a U-shaped valley which contains extensive gravel bars along the creek. The lower one-third of the stream steepens and flows through a V-shaped canyon before entering the Eel River at the lower end of the subunit. Good spawning gravels for both king salmon and steelhead are found in this creek, especially in the upper two-thirds of the drainage.

4. Wilderness Subunit. The extreme headwaters of the Middle Fork Eel River comprise this subunit. Headwater streams originate in the western part of the Yolla Bolly Wilderness area at an elevation of about 7,500 feet. The headwaters of the Middle Fork flow through steep V-shaped canyons heavily timbered with Douglas fir, interspersed with yellow pine and small stands of red fir along the ridges. This is the only subunit of the Eel River Hydrographic Unit that receives a large portion of its annual precipitation in the form of snow.

Steep "roughs" prevent king salmon from progressing more than a few miles into this subunit. However, steelhead ascend at least the lower two-thirds of this subunit in the main stream. Most tributaries enter the Middle Fork via a falls near their mouths, so they are inaccessible to anadromous fish.

5. Black Butte Subunit. Black Butte River is the major stream in this subunit. It heads in western Glenn County at an elevation of about 6,000 feet. The stream is typical of those in the upper Eel River drainage. Spawning gravels in the lower one-quarter of the river are used by king salmon.

4. Middle Fork Eel River near Etsel Crossing.
Streamflow about 75 cfs. July 7, 1960

5. Kekawaka Creek near confluence with main Eel River.
Typical steelhead and silver salmon spawning tributary.
April 4, 1964

6. Round Valley Subunit. This subunit includes Williams and Mill Creeks, which are major tributaries of the Middle Fork Eel River. It is bordered on its upstream edge by the Wilderness and Black Butte River subunits. The most imposing feature of this subunit is Round Valley, which is a large agricultural valley lying just west of the Middle Fork. Williams and Mill Creeks contain extensive spawning gravels that are heavily used by king salmon. The lower portions of these streams dry up in early summer due to low rainfall and heavy agricultural use of water in the area.

7. Etsel Subunit. This subunit includes the Middle Fork Eel River from the Wilderness and Black Butte subunits to the mouth and lies just southeast of Round Valley subunit. It includes Elk and Thatcher Creeks, major tributaries entering the river from the southeast. The section of the Middle Fork within the subunit has a slight gradient and flows in a shallow U-shaped valley with extensive flood plains along the stream. Excellent king salmon spawning gravels are located in the upper half of the subunit.

8. Bell Springs Subunit. This subunit encompasses the main Eel River, which flows through a steep, V-shaped canyon. Extensive flood plains are found along the river below the mouth of the North Fork and in the Alderpoint area. Considerable amounts of king salmon spawning gravel are found in these areas. In the remainder of the subunit, the stream channel is mainly boulders and bedrock, with only scattered pockets of usable spawning gravel.

9. North Fork Subunit. This subunit encompasses the North Fork Eel River. Its watershed is typical of the middle and upper portions of the Eel River drainage, and the streamflows through a steep V-shaped canyon

6. Confluence of North Fork Eel River with main Eel River.
August 18, 1960

for most of its length. Although there are pockets of good salmon spawning gravels scattered throughout much of the river, king salmon are only able to use those in the lower mile and one-half of the stream due to an inaccessible barrier at the upper end of that reach. However, steelhead are able to ascend a considerable distance above this point on high winter flows and find spawning gravel to their liking throughout much of the drainage.

10. Sequoia Subunit. This subunit is similar to Bell Springs subunit and encompasses the main Eel River immediately downstream from the latter subunit. There is, however, more king salmon spawning gravel per mile of stream as the river's flood plains become more extensive, especially in the lower half of the subunit.

11. Laytonville Subunit. This subunit contains the headwaters of the South Fork Eel River and includes its main tributary, Tenmile Creek, which enters the river immediately above the lower subunit boundary. Watersheds in this subunit are moderately steep and V-shaped, except for a small agricultural valley along the South Fork which contains the town of Branscomb, and scattered flats along the upper two-thirds of Tenmile Creek.

Although the two streams are small, good quantities of spawning gravel suitable for king salmon are present, and extensive use is made of them. In addition, considerable use is made of these streams by silver salmon and steelhead.

12. Lake Benbow Subunit. This subunit contains the major portion of the South Fork Eel River. The upper half of the stream flows through a steep, V-shaped canyon where the streambed is composed mainly of bedrock,

boulders, and rubble. In the lower half of the subunit, the stream flattens out and develops a flood plain containing extensive spawning riffles suitable for king and silver salmon and steelhead. In addition, there are a number of tributaries suitable for these species.

In general, the South Fork Eel River flows through an area of higher precipitation and denser vegetation than do other forks of the river. The climate is ideal for redwood, which is the dominant conifer.

13. Humboldt Redwoods Subunit. This subunit encompasses the lower portion of the South Fork Eel River. The characteristics of this subunit are similar to those of the Lake Benbow Subunit, except that the redwood forest becomes more dense. There is an extensive flood plain along the river and considerable spawning gravels suitable for king salmon are present. In addition, king salmon use the gravels in several tributaries.

14. Larabee Creek Subunit. This subunit is similar to other subunits in the immediate area. Precipitation is fairly heavy and the stream flows throughout the year.

15. Van Duzen River Subunit. This subunit lies in an area of high precipitation which is drained by the Van Duzen River and its main tributary, the South Fork. The entire drainage has high winter and spring flows; however, the summer flows subside to a low level, because there is little snowfall in the drainage and spring seepage is limited. Extensive flood plains containing considerable amounts of spawning gravel suitable for king salmon, silver salmon, and steelhead are present. The upper reaches of the stream are confined in long, shallow, U-shaped troughs which deepen into V-shaped canyons. In the lower portions the canyon widens before the stream enters the Eel River. High rainfall and summer fog make the middle and lower watershed ideal for dense stands of redwoods.

16. Yager Creek Subunit. Yager Creek, a major tributary, enters the Van Duzen River from the north a short distance above its mouth. The stream has a high but greatly fluctuating runoff. Persistant summer fog encourages redwoods to form the dominant tree cover. Some king salmon spawning gravel is available in lower Yager Creek, while silver salmon spawning gravel is extensive in the middle and upper areas. Steelhead spawning gravel is found throughout the stream.

17. Lower Eel Subunit. This subunit contains the lower main Eel River from the mouth of the South Fork downstream. Between the mouth of the South Fork and the town of Scotia, which is the midpoint of the subunit, the V-shaped canyon widens until it becomes a U-shaped valley that progressively widens into a coastal plain near Fortuna.

Although there are extensive riffles of suitable gravel, very little of this area is utilized for spawning by king salmon. The fish apparently prefer to go further upstream. The limited spawning that occurs takes place near the town of Fortuna.

18. Eureka Plain Subunit. This subunit encompasses the Eureka Plain adjacent to Humboldt Bay. The major drainage in the subunit is Elk River. Lesser drainages are Freshwater and Jacoby Creeks. The lower reaches of these drainages cross the Eureka Plain and have a gentle gradient. The upper portions steepen into heavily forested, V-shaped canyons. Steelhead and silver salmon are the predominant fish species and only a few king salmon are found in these streams.

19. Cape Mendocino Subunit. The two main drainages included in this subunit are the Bear and Mattole Rivers. These drainages are described in the introductory section of this chapter. It is sufficient to note here

EEL RIVER HYDROGRAPHIC UNIT
ESTIMATED FISHERY RESOURCES AND FLOW REQUIREMENTS

Subunit	Fishery Resources			Required Flows (CFS)					
				Maintenance			Enhancement		
	King Salmon	Silver Salmon	Steel-head	Oct 16 to Apr 30	May 1 to Jun 30	Jul 1 to Oct 15	Oct 1 to Apr 30	May 1 to Jun 30	Jul 1 to Sep 30
Lake Pillsbury 1/	3,500 2/	0	4,000	60	30	20	110	55	4/
Willis Ridge 1/	8,000	0	11,000	250	125	40	375	190	4/
Outlet Creek	8,000	0	6,000	120	60	9	200	100	4/
Wilderness	2,000	0	8,000	100	50	25	180	90	4/
Black Butte River	1,500	0	8,000	150	75	7	225	115	4/
Round Valley									
Williams Creek	1,500	0	1,000	40	20	3	75	40	4/
Mill Creek	2,000	0	1,500	40	20	0	75	40	4/
Etsel	6,000	0	4,500	180 3/	150	45	350	175	4/
Bell Springs 1/	3,000	3,000	6,000	600 3/	300	100	1,100	550	4/
North Fork	500	0	4,500	100 3/	50	15	200	100	4/
Sequoia 1/	3,500	1,500	9,000	650 3/	325	120	1,200	600	4/
Laytonville	4,000	8,000	6,000	170 3/	85	10	370	185	4/
Lake Benbow	10,000	4,000	17,000	300 3/	150	45	600	300	4/
Humboldt Redwoods	8,000	500	8,000	400 3/	200	60	800	400	4/
Larabee Creek	500	1,000	2,000	130 3/	65	9	250	125	4/
Van Duzen River	3,000	1,000	7,000	1,000 3/	500	35	1,500	750	4/
Yager Creek	1,000	3,000	4,500	150 3/	75	10	300	150	4/
Lower Eel River 1/	6,000	8,000	7,000	2,200 3/	1,100	215	4,000	2,000	4/
Eureka Plain	2,000	4,000	10,000	--	--	--	--	--	--
Cape Mendocino									
Bear River	1,000	2,500	6,000	120 3/	60	25	225	110	4/
Mattole River	5,000	2,000	12,000	375 3/	190	70	650	325	4/

1/ All fish maintenance and enhancement flows on main Eel River are based on full natural flow rather than present impaired flows.

2/ Includes anticipated increase of 3,000 king salmon following relicensing of F.P.C. 77 (Scott Dam).

3/ Fish maintenance flow for fall spawning period begins October 1 rather than October 16. End of summer period changes accordingly.

4/ Summer enhancement flows are unknown pending further evaluation of the influence of high water temperatures.

that the Mattole River was formerly one of the better king salmon, steelhead, and silver salmon producers of the entire coast. Since 1950, excessive logging operations have taken place in the drainage, which has severely damaged the stream, primarily from siltation. The stream is still considered to have the potential to again be the major fish producer that it was historically if improved logging and land management principles are followed.

Proposed Water Developments

Both the Mattole and Bear Rivers have been studied for water projects oriented toward recreation and fisheries enhancement. Comments made in Chapter XI with regard to fisheries enhancement developments also apply here. These streams would require substantial additional study in order to adequately inventory the resources, determine the best methods for increasing production, and evaluate potential benefits.

At this time, no water developments have been proposed for the small streams in the Eureka Plain subunit.

A project for conserving and diverting surplus flows of the Middle Fork Eel River has been selected as the initial major North Coastal development. This project, designated the Upper Eel River Development, was authorized for construction by the Director of the Department of Water Resources in March 1964. The primary purpose of the development will be to augment water supplies in the Sacramento-San Joaquin Delta, but it will also provide local water service, recreation, power generation and flood control.

Upper Eel River Development

The Upper Eel River Development would include water conservation features on the Middle Fork Eel River and associated conveyance facilities in either of two alternative diversion routes to the Sacramento Valley. One of the routes could involve a pumped diversion to English Ridge Reservoir on the upper main Eel River, with subsequent gravity diversion via Clear Lake, Putah Creek, and Lake Berryessa. The other route would be via gravity diversion through a long tunnel to the Glenn Reservoir Complex in Glenn and Tehama Counties. In this discussion, these alternative plans are designated the Glenn Diversion Project and the Clear Lake Diversion Project. Selection of the diversion route and final determination of specific project features will be made during the Advance Planning Program for the Upper Eel River Development, which began in July 1964.

Description of the Eel River conservation features which could be included in the Upper Eel River Development and their effects on fish and wildlife follows. Discussion of the effects of the Clear Lake diversion route on fish and wildlife resources is contained in Chapter VI -- Putah-Cache Creeks Hydrographic Unit. Discussion of the Glenn Reservoir Complex is included in Chapter XI -- Sacramento Valley West Hydrographic Unit.

Spencer-Franciscan Reservoir

Project Description. Spencer Dam and Reservoir could be the only conservation feature on the Middle Fork Eel River as part of the Glenn Diversion Project, or the upstream reservoir in the Clear Lake Diversion Project. The latter plan would also include a dam at the Dos Rios site about 2 miles upstream from the mouth of the Middle Fork.

As part of the Clear Lake Diversion Project, Spencer Reservoir would have a capacity of 850,000 acre-feet at a normal pool elevation of 1,710 feet. It would be formed by construction of two dams: (1) a 385-foot high rockfill dam at the Spencer site on the Middle Fork Eel River, and (2) a 335-foot high earthfill dam at the Franciscan site on Short Creek, a tributary to the Middle Fork.

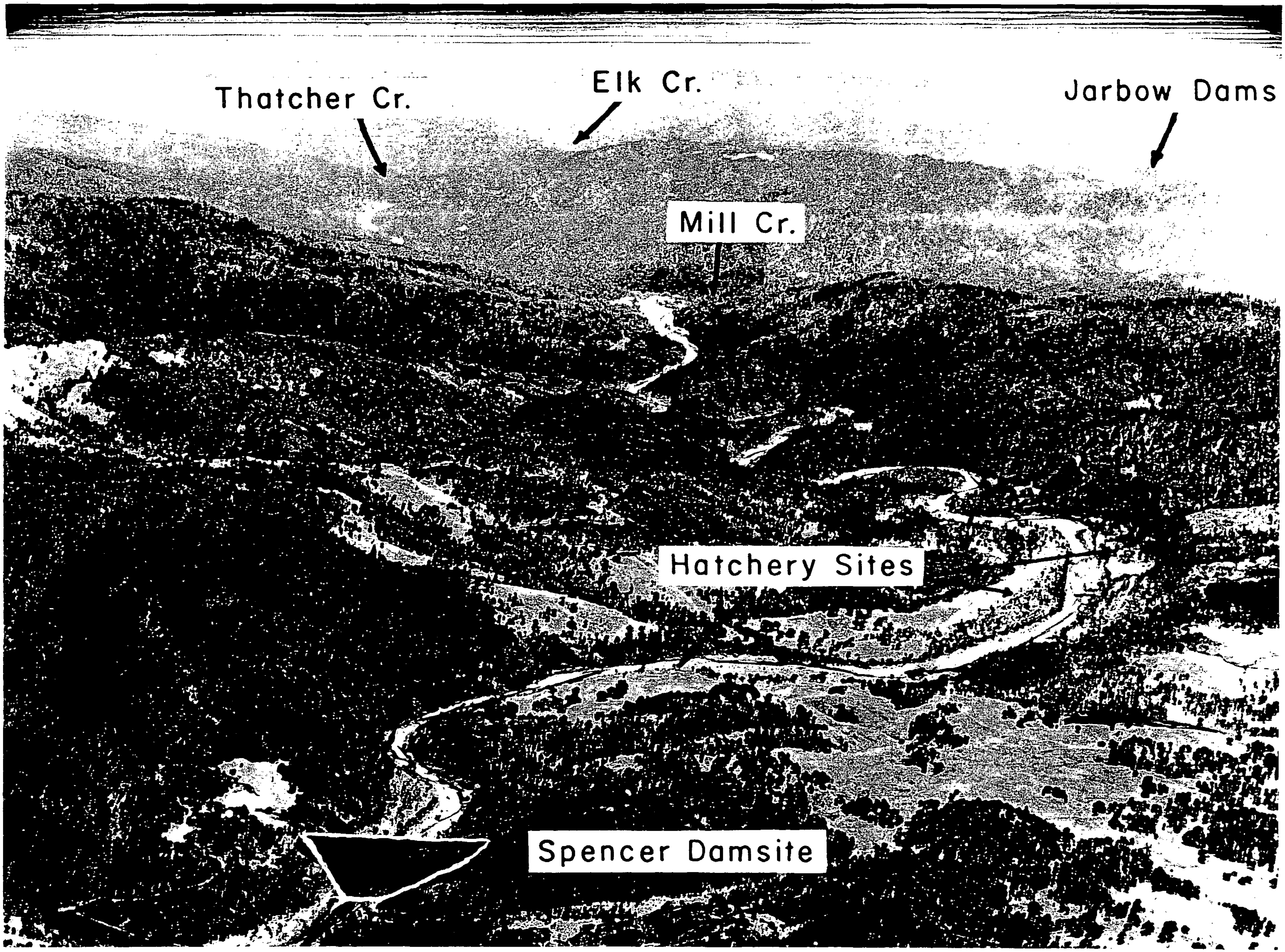
Under the alternative plan, surplus runoff from the Middle Fork Eel River would be conserved in a 530,000 acre-foot Spencer Reservoir. This reservoir would be impounded by a 330-foot high dam at the Spencer site on the Middle Fork and a 280-foot high Franciscan Dam on Short Creek. From Spencer Reservoir the conserved water would be diverted through a 10-foot diameter, 20.1-mile long tunnel to Thomes Creek, a tributary of the Sacramento River. There, the water would be reregulated in Paskenta-Newville Reservoir, the first stage element of the Glenn Reservoir Complex.

Effects of Project on Fishery Resources. Spencer Dam and Reservoir would block off and inundate the spawning and nursery area historically used by 9,000 king salmon and 17,500 steelhead. It would eliminate the only section of river now suitable for year-round nursery area, and would block off the sections suitable for maintenance of the spring-run steelhead.

POSSIBLE PHYSICAL FEATURES OF
UPPER EEL RIVER DEVELOPMENT

Dam and reservoir	Spencer	Dos Rios	Jarbow 1/	English Ridge
Streams	Middle Fork Eel Short Creek	Middle Fork Eel	Middle Fork Eel	Main Eel River
Damsite Locations	T22N,R12W, S 1 T23N, R12W, S 28	T21N,R13W, S 4	T21N,R12W, S 4	T19N,R12W, S 6
Streambed Elevations (feet, MSL)	1,345 1,395	916	1,060	1,180
Height of Dams (feet)	385 335	430	290	535
Type of Dams	Rockfill Earthfill	Rockfill	Earthfill	Earth and rockfill
Normal Pool Elevation (feet, MSL)	1,710	1,325	1,325	1,695
Minimum Pool Elevation (feet, MSL)	1,537	1,275	1,275	1,475
Reservoir Surface Area (acres)	6,600	6,500	4,200	11,500
Reservoir Storage Capacity (acre-feet)	850,000	560,000	250,000	1,800,000
Firm Annual Yield (acre-feet)	500,000	100,000 2/	50,000 2/	340,000 3/
Estimated Capital Cost 4/	$53,000,000	$25,000,000	$25,000,000	$80,000,000

1/ Alternative development to Dos Rios Reservoir.
2/ Impaired by Spencer-Franciscan Reservoir.
3/ Impaired by Lake Pillsbury.
4/ Construction of dam and reservoir only; does not include cost of associated conveyance facilities.



7. Downstream view from Spencer damsite, Middle Fork Eel River.

All of the king salmon spawning area above the dam would be inundated, although some steelhead spawning and nursery area would remain. However, the cost of trapping and transporting adult steelhead upstream, plus the uncertainties of getting the downstream migrants safely down through the reservoir, make transporting adult fish above the reservoir infeasible. Under these circumstances, the most practical and economical way the steelhead run could be maintained is by a combination of artificial propagation and improved conditions for natural reproduction below the dam.

Spencer Reservoir would probably not support a good game fish population, nor would it be particularly attractive to anglers. The warm climate of the basin would result in high surface temperatures in the reservoir during the summer months. These temperatures, together with the expected deficiency of dissolved oxygen in the deeper levels of the reservoir, would probably result in conditions unsuitable for trout during the summer and early fall. Excessive surface fluctuation would probably limit the establishment of a good warm-water fishery, although there would be some spawning area available.

<u>Fishery Maintenance</u>. The following measures would be required to maintain the anadromous fish populations in the Middle Fork Eel River:

1. The stream channel from immediately below Spencer Dam to the mouth of Mill Creek should be improved to provide maximum spawning area for king salmon and steelhead. By removing the bottom material in the low-flow channel, which now consists mainly of sand and cobbles, and replacing it with graded spawning gravel, a flow of 150 cfs could produce more spawning area than a flow of 300 cfs under natural conditions. If such stream channel

improvements are not made, then a larger fishery maintenance flow would be required and hatchery construction and yearly maintenance costs would be increased.

2. With this channel improvement, the following fisheries maintenance flows, measured directly above the confluence of Mill Creek, should be released from Spencer Dam:

Period	Flow Release
October 16 to February 28	150 cfs
March 1 to June 30	150 cfs
July 1 to October 15	40 cfs

Without channel improvement the following fishery maintenance flow would be required:

Period	Flow Release
October 16 to February 28	225 cfs
March 1 to June 30	150 cfs
July 1 to October 15	40 cfs

3. The feasibility of an artificial spawning channel in Short Creek should be investigated. Also, an adequate fish maintenance flow from the Franciscan Dam will have to be determined. The size of this flow will depend on the feasibility of constructing an artificial spawning channel.

4. Fish trapping facilities should be installed below Spencer Dam during the construction period. Fish taken at the trap would be trucked around the construction area and released upstream. These facilities should be part of the hatchery to be constructed upon completion of the project.

5. Temporary fish trapping facilities should be installed in Short Creek below Franciscan Dam during the construction period. Fish taken at the trap would be trucked around the dam for release upstream to spawn. Free passage of downstream migrants would be required during the construction period.

6. Multiple level outlet works should be incorporated in Spencer and Franciscan Dams.

Fishery Compensation. Adequate artificial propagation facilities would be required to compensate for the loss of spawning areas above the dams. As indicated previously, there are two possibilities:

(a) The 7 miles of stream between Spencer Dam and the mouth of Mill Creek would be improved with graded gravel as described by Smith and Elwell (1961), and a spawning channel would be constructed on Short Creek. A hatchery with a capacity of 875,000 steelhead yearlings would also be required.

(b) Without channel improvement, a hatchery would be constructed with a capacity of 40,000,000 king salmon eggs and 875,000 steelhead yearlings.

Fishery Enhancement. The following measures could potentially enhance the fishery of the Middle Fork Eel River:

1. The flow release from Spencer Dam could be increased to 300 cfs during the spawning period October 1 to February 28, which would provide the maximum amount of spawning gravel for king salmon in the unimproved channel. Preliminary estimates indicate this flow could potentially increase the spawning run of king salmon by about 17,000 fish. This evaluation assumes that the flows released during the remainder of the year are also optimum, with regard to volume and temperature; however, these flows have not been determined at this time.

2. The feasibility of releasing water from Franciscan Reservoir down Mill Creek during the summer months to create additional steelhead nursery area should be studied. This would essentially involve temperature evaluation and measurement of the stream at various flows to determine the required release.

3. The feasibility of constructing a reservoir in Eden Valley to provide adequate additional water for salmon migration should be studied and the economic justification determined.

Effects of Project on Wildlife Resources. The proposed Spencer-Franciscan Reservoir on the Middle Fork of the Eel River, would have a surface area of 6,600 acres. Principal land uses in the reservoir site are livestock grazing, recreation, and logging. Estimates of wildlife losses based on reconnaissance surveys are:

Black-tailed deer days-of-use	113,300
California quail*	1,500
Mountain quail*	700
Mourning dove	1,000
Band-tailed pigeon	700
Gray squirrel	25

*Quail populations estimated for fall population.

Wildlife Compensation. The measures required to develop and maintain wildlife habitat for 113,300 additional deer days-of-use on winter ranges below the 3,000 foot elevation are as follows:

Land: Approximately 2,340 acres of public land and purchase of 1,160 acres of private land.

Development: Browse and timber conversion, and browseways on 1,850 acres.

Maintenance:	Annual operation and maintenance of program at project cost.
Facilities:	Administration facilities and program manager (would include administration of Spencer-Franciscan, Jarbow or Dos Rios, and English Ridge wildlife compensation areas).

Dos Rios Reservoir

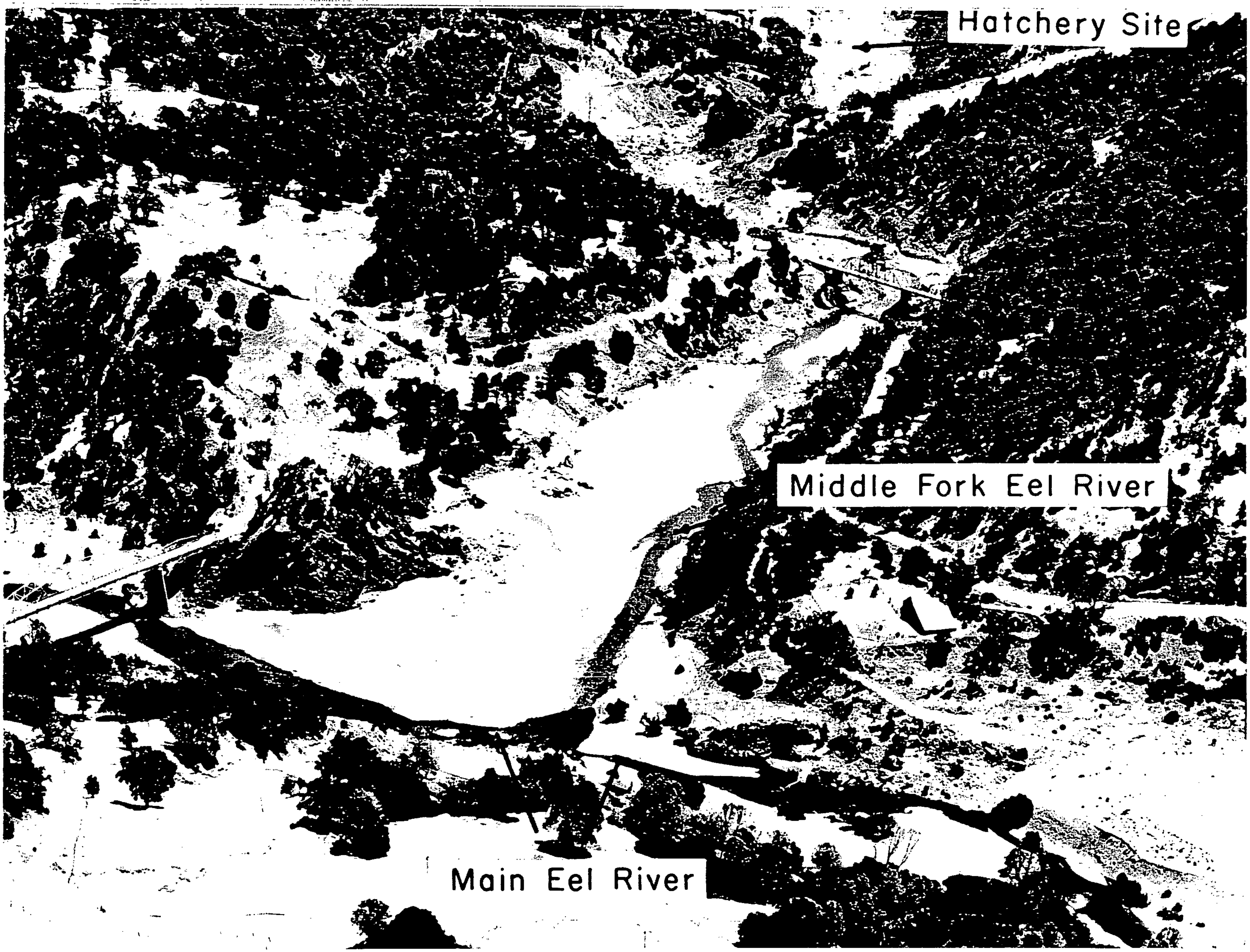
Project Description. Dos Rios Reservoir would be formed by construction of a 430-foot high rockfill dam and would have a capacity of about 560,000 acre-feet at a water surface elevation of 1,325 feet. Water could be pumped to the proposed English Ridge Reservoir via the 7-mile long Elk Creek Tunnel.

Effects of Project on Fishery Resources. Of the projects proposed for the Middle Fork Eel River, the Dos Rios Dam would have the most serious effect on anadromous fish. All steelhead spawning tributaries would be cut off and the king salmon would be denied access to all but 3 miles of the poorest spawning area. Under these circumstances, the only way steelhead and salmon runs could be maintained would be by artificial propagation.

A fishery similar to that predicted for Spencer-Franciscan Reservour would probably develop in Dos Rios Reservoir since similar conditions could be expected.

Fishery Maintenance. The following measures would be required to maintain the anadromous fish populations of the Middle Fork Eel River:

1. The following streamflow releases should be made from Dos Rios Dam:



8. Confluence of Middle Fork Eel River with the main Eel River.
July 31, 1959

Period	Flow Release
October 16 to February 28	150 cfs
March 1 to June 30	150 cfs
July 1 to October 15	45 cfs

2. Fish trapping facilities should be installed below Dos Rios Dam during the construction period. The facilities would be built as part of the hatchery that would be required upon completion of the project.

3. A multiple level outlet works should be incorporated in Dos Rios Dam.

Fishery Compensation. Construction of the Dos Rios Project would require artificial propagation facilities to maintain average runs of about 13,000 king salmon and 23,000 steelhead. This could be accomplished by a hatchery with a capacity of 58.5 million king salmon eggs and 1.2 million steelhead yearlings.

Fishery Enhancement. It is probable that the flows in the main Eel River below Dos Rios could be improved by fishery enhancement releases from Dos Rios Dam. For example, an earlier and improved spawning flow could be provided. Streamflows during the remainder of the year could probably also be improved. This possibility would require additional study to determine the amount of fishery enhancement which would result.

Effects of Project on Wildlife Resources. The proposed Dos Rios Reservoir on the Middle Fork of the Eel River, would have a surface area of 6,500 acres. Principal land uses in the reservoir site are livestock grazing, recreation, and logging. Estimated wildlife losses based on reconnaissance surveys are:

Black-tailed deer days-of-use	91,000
California quail*	2,900
Mountain quail*	150
Mourning dove	450
Band-tailed pigeon	250
Gray squirrel	70

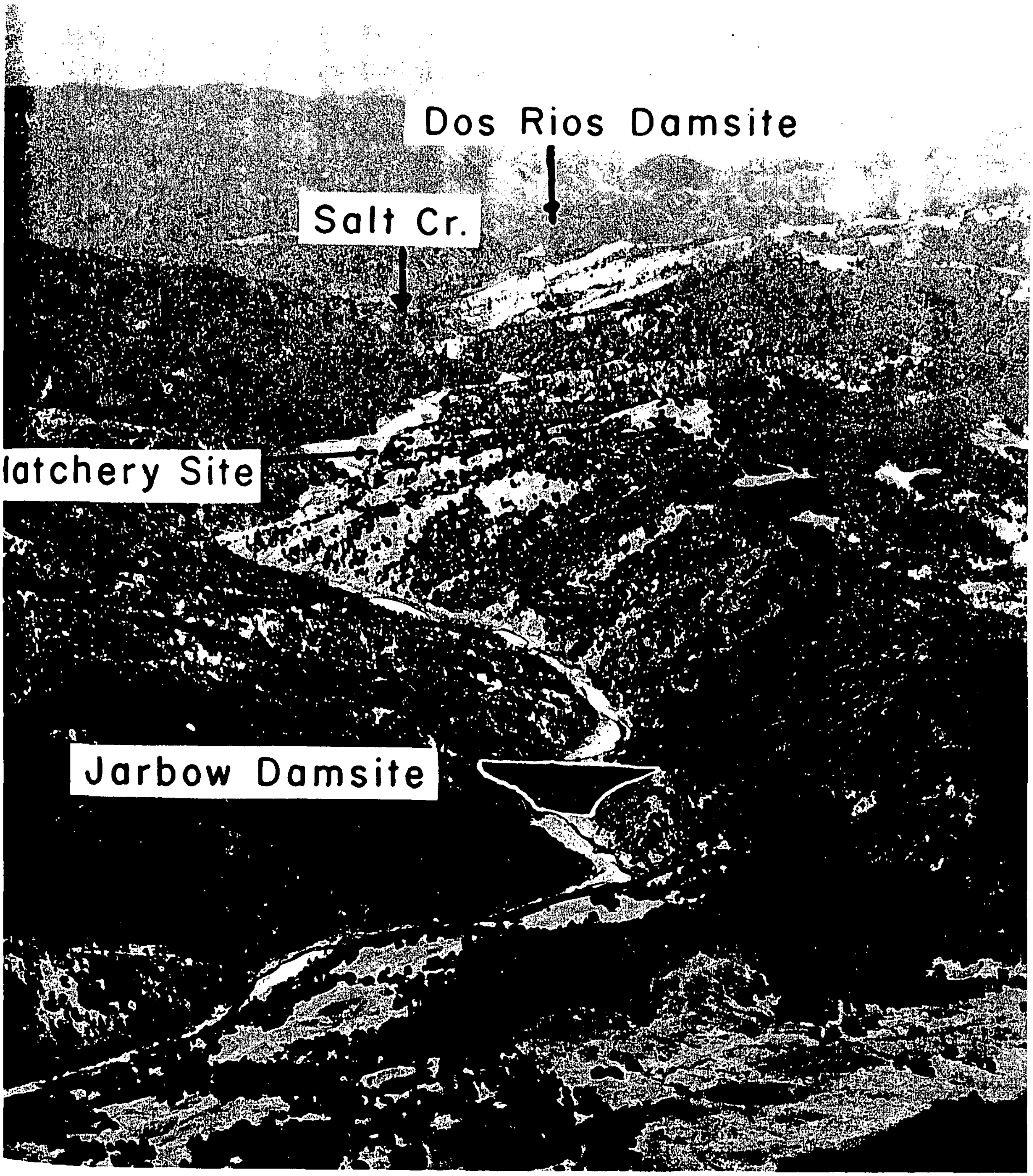
*Quail populations estimated for fall populations.

Wildlife Compensation. The measures required to develop and maintain wildlife habitat for 91,000 additional deer days-of-use on land adjacent to the reservoir site are as follows:

Land:	Purchase of approximately 3,000 acres of private land.
Development:	Browse and timber conversion, browseways, and browse regeneration on 1,500 acres.
Maintenance:	Annual operation and maintenance of program at project cost.
Facilities:	Administration facilities and program manager, which could be included in Spencer-Franciscan wildlife compensation area.

Jarbow Reservoir

Project Description. Jarbow Reservoir, a possible upstream alternate to Dos Rios Reservoir, would be formed by the construction of a 290-foot high earthfill dam and would have a capacity of about 250,000 acre-feet. Jarbow-Grindstone Tunnel, which would be required in the plan to divert water to the Stony Creek drainage, would be 12 feet in diameter and about 23 miles in length. The tunnel would end in Grindstone Creek, a tributary of the Stony Creek drainage. Jarbow Reservoir and Tunnel could develop about 550,000 acre-feet of water annually.



9. Downstream view from Jarbow damsite, Middle Fork Eel River.
July 31, 1959

Effects of Project on Fishery Resources. The construction of Jarbow Reservoir would block off all but 10 miles of the Middle Fork Eel River Drainage to runs of salmon and steelhead. Of the tributaries remaining below the Jarbow damsite, only Salt Creek is known to support a run of anadromous fish. This run is of minor importance. An average annual run of 13,000 king salmon and 23,000 steelhead would have to be maintained by artificial propagation facilities below Jarbow Dam.

Jarbow Reservoir would have similar conditions as were predicted for the Spencer-Franciscan Reservoir and a similar fishery could be expected to develop.

Fishery Maintenance. The following measures would be required to maintain the anadromous fish populations of the Middle Fork Eel River:

1. The stream channel between Jarbow Dam and the mouth of Salt Creek should be improved as described for Spencer Dam to provide maximum spawning conditions for king salmon and steelhead.

2. The following flow releases should be made from Jarbow Dam:

Schedule 1.
(with channel improvement)

Period	Flow Release
October 16 to February 28	150 cfs
March 1 to June 30	150 cfs
July 1 to October 15	45 cfs

Schedule 2.
(without channel improvement)

Period	Flow Release
October 16 to February 28	150 cfs
March 1 to June 30	150 cfs
July 1 to October 15	45 cfs

3. Fish trapping facilities should be provided below Jarbow during the construction stage. These facilities would be part of the hatchery that will be constructed upon completion of the project.

4. A multiple level outlet works should be incorporated in Jarbow Dam.

Fishery Compensation. The artificial propagation facilities would be considerably more extensive than those required for the Spencer-Franciscan Project. Again, there are two possibilities, depending on whether or not the stream channel below the dam is improved.

(a) With channel improvement of the 5 miles of river between the dam and the mouth of Salt Creek, a hatchery with a capacity of 29 million king salmon eggs and 1.2 million steelhead yearlings would be required.

(b) Without channel improvement, a hatchery would be required to maintain the entire anadromous fish run. It would have a capacity of 58.5 million king salmon eggs and 1.2 million steelhead yearlings.

Fishery Enhancement. Although little suitable habitat would remain in the Middle Fork below Jarbow Reservoir, enhancement flow releases from the dam could improve conditions for anadromous fish in the main Eel River below Dos Rios. For example, an earlier and improved spawning season flow could be provided. Streamflows during other seasons of the year could probably also be improved. However, at this time it is not possible to determine the resulting fishery enhancement. This possibility should be given additional study.

Effects of Project on Wildlife Resources. The proposed Jarbow Reservoir on the Middle Fork of the Eel River, would have a surface area of 4,200 acres. Principal land uses in the area are livestock grazing, recreation, and logging. Estimated wildlife losses based on reconnaissance surveys made in September 1963 are:

Black-tailed deer days-of-use	58,800
California quail	1,900
Mountain quail	100
Mourning dove	300
Band-tailed pigeon	175
Gray squirrel	50

Wildlife Compensation. The measures required to develop and maintain wildlife habitat for 58,800 additional deer days-of-use on adjacent ranges are as follows:

Land:	Purchase of approximately 2,000 acres of private land.
Development:	Browse and timber conversion, browseways, and browse regeneration on 1,050 acres.
Maintenance:	Annual operation and maintenance of program at project cost.
Facilities:	Administration facilities and program manager, which could be included in the Spencer-Franciscan wildlife compensation area.

English Ridge Reservoir

Project Description. The English Ridge Project could consist of a 535-foot high earth- and rockfill dam on the upper main Eel River and a dual diversion system to Clear Lake and the Russian River Basin. The latter diversion route would be via a powerhouse to the East Branch Russian River and Lake Mendocino. The Clear Lake diversion would be routed through Garrett Tunnel and down Middle Creek to Clear Lake, through the Soda Creek Tunnel into Soda and Putah Creeks and ultimately into the existing or an enlarged Lake Berryessa.

Effects of Project on Fishery Resources. The English Ridge Project would cut off the important salmon and steelhead spawning areas in the upper main Eel River and Tomki Creek. Assuming improved flows in the main Eel River below Van Arsdale Reservoir following relicensing of FPC-77 (Scott Dam) in 1972, it is estimated that 10,000 king salmon and 14,000 steelhead would have to be maintained by artificial propagation facilities. The historical population under present conditions is estimated at 7,000 king salmon and 14,000 steelhead.

The English Ridge Reservoir may fluctuate only moderately in any one year and it might be possible to establish a fair warm-water fishery. The reservoir would lie in a relatively steep, narrow canyon which would limit fish production as well as angler use. The warm climate of the area will result in high surface temperatures in the reservoir during the summer months.

Fishery Maintenance. The following recommendations are made:

1. The following fishery maintenance flow release would be required to maintain the existing anadromous fishery resource below the English Ridge Dam:

Period	Flow Release
October 16 to February 28	200 cfs
March 1 to June 30	125 cfs
July 1 to October 15	125 cfs

These flows would create trout habitat below the dam to replace that lost by inundation of the stream in the reservoir basin.

2. Multiple level outlet works should be incorporated into English Ridge Dam to provide adequate downstream water temperatures.

Fishery Compensation. A complete salmon and steelhead hatchery or an addition to the Middle Fork hatchery facilities would be required to compensate for the loss of the important spawning and nursery areas cut off and inundated by the English Ridge Project. Since it is not known if a suitable hatchery site exists near the English Ridge damsite, it was assumed that an addition to the Middle Fork hatchery would be made. Fish trapping facilities and an egg taking station would be constructed below the English Ridge damsite and the Middle Fork hatchery would be expanded to accommodate an additional 45 million king salmon eggs and 700,000 steelhead yearlings.

Fishery Enhancement. The following measures could potentially enhance the fishery of the Eel River:

1. The streamflow release from English Ridge Dam could be increased to 350 cfs during the spawning period, October 1 to February 28. This would provide an earlier and improved spawning season flow. A preliminary evaluation of this enhanced flow indicates that it could potentially increase the average spawning run by 27,000 king salmon. This estimate assumes flows for other periods of the year and water temperatures throughout the year would also be optimum. Further study would be required to determine these optimum flows, to evaluate water temperatures, and to determine benefits.

2. The U. S. Bureau of Reclamation has considered a diversion from English Ridge Reservoir to the headwaters of Outlet Creek near Little Lake Valley for irrigation purposes. This diversion system could be continued along Long Valley Creek and into Tenmile Creek near Laytonville and the South Fork Eel River at about elevation 1,900 feet. Supplemental streamflow releases could be made down each of these streams, improving

conditions for anadromous fish, and resulting in substantial fishery benefits. Streamflow regimes that could be maintained and the estimated potential benefits are shown in Table 12. These flows and benefits are preliminary estimates based on the assumptions that optimum flows would be maintained during the remainder of the year, and that water temperature and quality would be adequate.

Effects of Project on Wildlife Resources. The proposed English Ridge Reservoir site will be located on the upper main Eel River. With a storage capacity of 1.8 million acre-feet, it would have a surface area of 11,500 acres. Principal land uses in the area are logging, livestock grazing, and recreation (hunting, fishing, and camping). Estimates of wildlife losses based on reconnaissance surveys are:

Black-tailed deer days-of-use	345,600
California quail*	5,050
Mountain quail*	950
Mourning dove	1,250
Gray squirrel	125

*Quail population estimated for fall population.

Brush rabbit and jack rabbit were found in the area, but no census was made.

Wildlife Compensation. The measures required to develop and maintain wildlife habitat for 345,600 additional deer days-of-use on land adjacent to English Ridge Reservoir are as follows:

Land: Approximately 5,000 acres of public land and purchase of 3,000 acres of private land.

Development: Browse and timber conversion, browse regeneration, and browseways on 4,000 acres.

TABLE 12

PRELIMINARY FISHERY ENHANCEMENT FLOWS
AND ESTIMATED BENEFITS FOR DIVERSION
FROM ENGLISH RIDGE PROJECT
INTO EEL RIVER TRIBUTARIES

Stream	Streamflow Required 1/			Potential Net Increased Spawning Salmon	Potential Net Increased Total Production 5/
	Oct. 1 to Apr. 30	May 1 to June 30	July 1 to Sept 30		
Outlet Creek 2/	200 cfs	100 cfs	Unknown	2,000	9,000
Long Valley Creek	Unknown	Unknown	Unknown	Unknown	Unknown
Tenmile Creek 3/	160 cfs	80 cfs	Unknown	6,000	23,000
South Fork Eel River 4/	185 cfs	90 cfs	Unknown	87,000	348,000
Totals	545 cfs	370 cfs		95,000	380,000

1/ Natural streamflow should be supplemented so that the flows listed are maintained.
2/ Flow measured at Outlet Creek guage, near Longvale.
3/ Flow measured at Tenmile Creek guage, near Laytonville.
4/ Flow measured at South Fork Eel River guage, near Branscomb.
5/ Net Increased Total Production includes the potential spawning run, commercial catch and sport catch, less the historical average total production of adult salmon.

Maintenance: Annual operation and maintenance of program at project cost.

Facilities: Administration facilities and program manager, which could be included in Spencer-Franciscan wildlife compensation area.

Lower Eel River Development

Sequoia, Willow Creek, Bell Springs, and Woodman Reservoirs

Project Descriptions. Future development of the lower Eel River may include construction of a 610-foot rockfill dam at the Sequoia site on the lower main Eel River approximately 10 miles upstream from its confluence with the South Fork. Water developed by the Sequoia Reservoir would be pumped upstream into one of the three alternative reservoirs constructed at the Willow Creek, Bell Springs, or Woodman sites. Possible physical features of these projects are listed in Tables 13 and 14. The water could then be conveyed either by gravity through the Middle Fork Eel Diversion Project to the Sacramento Valley or by pumping into the English Ridge Reservoir for subsequent diversion to Clear Lake or the Russian River Basin. Preliminary studies indicate that Bell Springs and Sequoia Reservoirs would be the most favorable projects to develop this additional new yield.

Effects of Projects on Fishery Resources. The Sequoia Reservoir would be the most downstream feature of the Lower Eel River Project. Since construction of these downstream projects will involve relocating the Northwestern Pacific Railroad at a cost of about $130 million, it is unlikely that the upper projects would be developed without Sequoia Dam. Therefore, only the effects of Sequoia Dam on anadromous fish were consiered.

A dam at the Sequoia site would block anadromous fish runs from all of the important spawning and nursery areas in the Eel River drainage except the South Fork and Van Duzen Rivers. Artificial propagation facilities to maintain an average run of approximately 38,000 king salmon, 4,000 silver salmon and 62,000 steelhead would be required, assuming the increase in the run of king salmon anticipated following favorable relicensing of FPC-77 in 1972. The historical spawning run of king salmon above this point numbers about 35,000 fish.

10. Sequoia damsite, lower main Eel River.
June 1958

TABLE 13

POSSIBLE PHYSICAL FEATURES OF SEQUOIA AND MINA UNITS OF LOWER EEL RIVER PROJECT

Dam and reservoir	Sequoia	Mina
Stream	Eel River	North Fork Eel River
Damsite Location	T2S,R4E, S 6	T5S, R8E, S 28 and 34
Streambed Elevation (feet, MSL)	140	1,275
Height of Dam (feet)	610	475
Type of Dam	Rockfill	Earthfill
Normal Pool Elevation (feet, MSL)	740	1,680
Minimum Pool Elevation (feet, MSL)	650	1,525
Reservoir Surface Area (acres)	24,000	1,800
Reservoir Storage Capacity (acre-feet)	5,400,000	300,000
Firm Annual Yield (acre-feet)	600,000 1/	200,000
Estimated Capital Cost 2/	$170,000,000	$58,000,000

1/ Impaired by Bell Springs, Dos Rios, and English Ridge Reservoirs.

2/ Construction of dam and reservoir only; does not include cost of associated conveyance facilities or cost of railroad relocation.

TABLE 14

POSSIBLE PHYSICAL FEATURES OF ALTERNATIVE
WILLOW CREEK, BELL SPRINGS AND WOODMAN UNITS OF
LOWER EEL RIVER PROJECT

Dam and reservoir	Willow Creek	Bell Springs	Woodman
Stream	Eel River	Eel River	Eel River
Damsite Location	T5S,R6E, S 26	T24N,R14W, S 19	T22N,R14W, S 13 and 14
Streambed Elevation (feet, MSL)	520	650	820
Height of Dam (feet)	325	490	500
Type of Dam	Concrete Gravity	Rockfill	Concrete Gravity
Normal Pool Elevation (feet, MSL)	835	1,130	1,300
Minimum Pool Elevation (feet, MSL)	835	925	1,000
Reservoir Surface Area (acres)	3,500	8,200	14,000
Reservoir Storage Capacity (acre-feet)	400,000	1,350,000	2,040,000
Firm Annual Yield (acre-feet)	0 1/	400,000 2/	300,000 2/
Estimated Capital Cost 3/	$79,000,000 4/	$101,000,000	$162,000,000

1/ Impaired by Woodman, Dos Rios, and English Ridge Reservoirs.

2/ Impaired by Dos Rios and English Ridge Reservoirs.

3/ Construction of dam and reservoir only; does not include cost of associated conveyance facilities or railroad relocation cost.

4/ Estimated by U. S. Bureau of Reclamation.

Approximately 100 miles of salmon and steelhead sport fishing area along the upper main Eel and the Middle Fork Eel Rivers would also be lost.

Sequoia Reservoir would be located in a narrow steep-walled canyon. The annual fluctuation and lack of extensive shallow areas would greatly limit fish production. In addition, the steep sides and relative inaccessibility would limit angler use. A poor warm-water fishery could be expected to develop.

The alternative Bell Springs, Willow Creek, and Woodman Reservoirs would be similar in configuration to Sequoia Reservoir, except that they would probably not fluctuate to such an extent since water from Sequoia would be pumped into them for diversion to English Ridge Reservoir. However, fish production would be limited by the relative lack of shallow food-producing areas.

Fishery Maintenance. The following measures would be required to maintain the salmon and steelhead resource of the lower Eel River:

1. The following fishery maintenance flows should be released from Sequoia Dam:

Period	Flow Release
October 1 to April 30	650 cfs
May 1 to June 30	325 cfs
July 1 to September 30	120 cfs

2. Fish trapping facilities should be constructed below Sequoia Dam during the construction period. Fish taken at the trap would be trucked around the construction area of Sequoia and the upstream project, which would probably be constructed concurrently, and released. Free

passage of downstream migrants would be required during the construction period. These facilities would be part of the hatchery to be constructed below Sequoia Dam upon completion of the project.

3. Multiple level outlet works should be incorporated into Sequoia Dam so that downstream releases will be of suitable temperature for salmon and steelhead utilizing the lower river.

Fishery Compensation. Compensation for the loss of the Eel River salmon and steelhead resources caused by the construction of Woodman, Willow Creek or Bell Springs, and Sequoia Dams and Reservoirs could be provided by the following measures:

1. Artificial propagation facilities sufficient to accommodate the eggs obtained from peak runs of salmon and steelhead blocked by the Sequoia Dam should be constructed immediately below the dam if an adequate site can be located. The total capacity of artificial propagation facilities to maintain the anadromous fish runs blocked by the Sequoia Dam would be 170 million king salmon eggs, 200,000 silver salmon yearlings, and 3.1 million steelhead yearlings. The capacity of the previously constructed Middle Fork Hatchery is included in this total. As the various projects are presently sized, the upstream artificial propagation facilities would be flooded out by the proposed downstream developments. The excellent hatchery site at Etsel Flat below Spencer Dam would be flooded out by Dos Rios or Jarbow Reservoir (Normal Pool Elevation 1,325 feet) and the hatchery sites below Dos Rios or Jarbow Dams, as well as the egg-taking facilities at English Ridge, would be flooded by the proposed Bell Springs Reservoir (Normal Pool Elevation 1,125 feet). Therefore, a complete new artificial propagation facility would be required below Sequoia Dam. However, some of the equipment at the upstream facilities might be salvaged.

2. The diversion of water into Larabee Creek from Sequoia Reservoir to improve conditions for salmon and steelhead should be investigated. The possibility of diverting water from Bell Springs Reservoir into the headwaters of Tenmile Creek and the South Fork Eel River, as described previously, should also be considered. If optimum flows and temperatures could be provided and production of these streams increased so that they could provide more angler-days of fishing each year, this might partially compensate for the loss of fishing area above the Sequoia damsite.

Fishery Enhancement. The following measures could potentially increase the anadromous fish runs in the lower Eel River:

1. The streamflow release from Sequoia Dam could be enhanced as follows:

Period	Flow Release
October 1 to April 30	1,200 cfs
May 1 to June 30	600 cfs
July 1 to September 30	250 cfs

We are unable to determine the enhancement resulting from this release schedule at this time.

2. Since Sequoia Dam is the lowermost proposed development in the Eel River drainage, the possibility of enlarging the hatchery to raise more steelhead and silver salmon yearlings as a means of enhancing the fishery should be considered.

3. The possibility of constructing artificial spawning channels below Sequoia Dam as a means of increasing the size of the salmon runs should also be investigated.

Effects of Projects on Wildlife Resources. The proposed Sequoia Reservoir would have a surface area of about 24,000 acres. The entire length of the reservoir basin is occupied by a resident deer herd. Except for a strip of cut-over redwood forest on the south side of the river from the damsite south to Brock Creek, this site is composed of typical coastal glades interspersed with stands of fir and oak on the north slopes. Preferred deer browse is absent, in fact, very little browse of any kind is available. In the past the reservoir site was extensively used for sheep winter range. At the present time there is a trend to shift from sheep to cattle, with an accompanying increase in deer numbers.

Estimates of wildlife losses based on reconnaissance surveys are as follows:

Black-tailed deer days-of-use	666,700
California quail*	4,000
Mountain quail*	5,500
Mourning dove	750
Gray squirrel	140
Sooty grouse	110

*Quail population estimated for post-nesting season.

Each of the possible alternative upstream projects in the Lower Eel River Development would have somewhat different effects on wildlife. The effects of each of these possible reservoirs is discussed below.

The proposed Willow Creek Reservoir would have a surface area of 3,500 acres. Land use conditions in this reservoir site are similar to those in the Sequoia Reservoir site. Wildlife populations were thought to be comparable to those existing in the Mina Reservoir site, based on field observations. No wildlife surveys were made because of poor road conditions and insufficient time to make a reconnaissance survey.

Wildlife losses estimated from comparable wildlife losses on the Mina Reservoir are as follows:

Black-tailed deer days-of-use	54,600
California quail*	60
Mountain quail*	60
Gray squirrel	40
Sooty grouse	20

*Quail population estimated for pre-nesting season.

The Bell Springs Reservoir would be located on the main Eel River upstream from the Sequoia and Willow Creek Reservoir sites, and would have a surface area of 8,200 acres. At this time it is considered the most favorable upstream alternative project in association with Sequoia Reservoir. Principal land use in the area is livestock grazing, logging, and recreation. Estimated wildlife losses in the Bell Springs Reservoir site based on reconnaissance surveys made in the nearby Sequoia and Dos Rios Reservoir sites are as follows:

Black-tailed deer days-of-use	150,000
California quail*	3,400
Mountain quail*	1,200
Gray squirrel	300
Sooty grouse	30

*Quail population estimated for post-nesting season.

Woodman Reservoir, an alternative to Bell Springs Reservoir, would be located on the main Eel River below the Middle Fork, and would have a surface area of 14,000 acres. Estimated wildlife losses in the reservoir site based on wildlife projections of data from the Bell Springs Reservoir site are as follows:

Black-tailed deer days-of-use	270,000
California quail*	6,000
Mountain quail*	2,000
Gray squirrel	500
Sooty grouse	50

*Quail population estimated for post-nesting season.

Wildlife Compensation. From a management and development standpoint, land selected for wildlife compensation should be in one block rather than in long narrow strips along the reservoir edge. The area selected for wildlife compensation associated with the Sequoia Reservoir is located from Blocksburg south to Dobbyn Creek, and extends from the reservoir edge northward to the Six Rivers National Forest boundary. This area is well-balanced deer range with many open south and east slopes. At the present time a large part of this range is occupied by sheep throughout the year. Removal of the sheep would provide additional carrying capacity for deer without any habitat development.

Measures required to develop and maintain an additional 666,700 deer days-of-use on adjacent rangeland to compensate for losses associated with Sequoia Reservoir would be as follows:

Land: Purchase of approximately 14,000 acres of private land.

Development: Browse propagation, irrigated pastures, and browse regeneration of 12,000 acres. Construction of access roads, fence to control livestock grazing, and quail habitat development.

Maintenance: Annual operation and maintenance of program at project cost.

Facilities: Administration facilities and a program manager, which would include administration of Willow Creek, Bell Springs or Woodman wildlife compensation area.

Measures required to develop and maintain wildlife habitat for 54,600 additional deer days-of-use to compensate for losses in the Willow Creek reservoir site are as follows:

Land: Purchase of approximately 2,000 acres of private land.

Development: Browse propagation, browse regeneration, grassland conversion to brush, and quail habitat development on 1,600 acres.

Maintenance: Annual operation and maintenance of program at project cost.

Facilities: Included under Sequoia Reservoir compensation measures.

Measures required to develop and maintain wildlife habitat for 150,000 additional deer days-of-use to compensate for losses in the Bell Springs Reservoir site are as follows:

Land: Purchase of approximately 5,000 acres of private land.

Development: Brush and timber conversion, browse propagation on 3,000 acres. Construction of access roads, fence to control livestock grazing, and quail habitat development.

Maintenance: Annual operation and maintenance of program at project cost.

Facilities: Included under Sequoia Reservoir compensation measures.

Measures required to develop and maintain wildlife habitat for 270,000 additional deer days-of-use to compensate for losses in the Woodman Reservoir site are as follows:

Land: Purchase of approximately 9,000 acres of private land.

Development: Brush and timber conversion, browse propagation on 5,400 acres. Construction of access roads, fence to control livestock grazing, and quail habitat development.

Maintenance: Annual operation and maintenance of program at project cost.

Facilities: Included under Sequoia Reservoir compensation measures.

Mina Reservoir

Project Description. The potential new water yield of the North Fork Eel River could be developed in either of two ways. The runoff could be captured in the proposed Sequoia Reservoir and pumped upstream through Bell Springs Reservoir into Dos Rios Reservoir. Under the alternative plan, Mina Reservoir and a gravity tunnel into Spencer-Franciscan Reservoir would be constructed. From Spencer-Franciscan Reservoir, the water could be released to the Glenn Reservoir Complex, or pumped into English Ridge Reservoir. If constructed, Mina Reservoir would probably be formed by an earthfill dam across the North Fork just below the confluence of Hulls Creek.

Effects of Project on Fishery Resources. The North Fork Eel River has only a small run of king salmon; probably numbering less than 500 fish. King salmon are apparently unable to migrate upstream past Akerly Falls, located just below the confluence of Azbill Creek. Steelhead are able to pass over this barrier at higher flows and migrate well into the upper drainage. They have been reported in Hulls Creek just above the proposed damsite and in the upper North Fork at least as far as the Shannon Butte area.

A dam at the upper Mina site would block off most of the steelhead spawning area and all of the suitable nursery area. Water temperatures in the lower North Fork reach 80°F. during the summer months. It is estimated that artificial propagation facilities to maintain an average run of 4,500 steelhead would be required if Mina Reservoir is constructed.

Mina Reservoir would be typical of other reservoirs in the Eel River Basin. Summer water temperatures would be high. The reservoir would be steep-sided and would fluctuate over 100 feet each year. These factors would probably result in a poor warm-water fishery.

Fishery Maintenance. The following measures would be required to maintain salmon and steelhead in the North Fork Eel River.

1. The following fishery maintenance flows should be released from Mina Reservoir:

Period	Flow Release
October 16 to April 30	80 cfs
May 1 to June 30	40 cfs
July 1 to October 15	10 cfs

2. Multiple level outlet works should be incorporated into Mina Dam.

Fishery Compensation. Artificial propagation facilities to accommodate 225,000 yearling steelhead trout would be required as compensation for the loss of spawning and nursery area caused by the construction of Mina Reservoir. A fish trap and egg-taking station would be required below Mina Reservoir; however, the incubation and rearing facilities might be elsewhere. This capacity could be added to the Middle Fork Eel River facilities.

Fishery Enhancement. Since there is limited available spawning area for both king salmon and steelhead below the Mina site, no fishery enhancement flow is recommended. It is possible some fishery enhancement benefits could be realized by improving flows in the main Eel River, assuming no downstream developments; however, this possibility requires further study.

Effects of Project on Wildlife Resources. Mina Reservoir would be located on the North Fork of the Eel River. With a gross capacity of

300,000 acre-feet, it would have a surface area of 1,800 acres. Land use is similar to that of the south end of Sequoia Reservoir, and wildlife populations are similar, except migratory deer herds are involved. Wildlife losses in the reservoir site are estimated as follows:

Black-tailed deer days-of-use	28,100
California quail*	30
Mountain quail*	30
Gray squirrel	20
Sooty grouse	10

*Quail population estimated for pre-nesting season.

Wildlife Compensation. The measures required to develop and maintain wildlife habitat for 28,100 additional deer days-of-use on land adjacent to the reservoir site are as follows:

Land: Approximately 800 acres of public land and purchase of 200 acres of private land:

Development: Grass land conversion to brush, browseways, browse propagation, and quail habitat development on 800 acres of land.

Maintenance: Annual operation and maintenance of program at project cost.

Facilities: Administration facilities and program manager, which could be included in the Sequoia Reservoir wildlife compensation area.

Van Duzen River Projects

The Van Duzen River projects would constitute part of the third stage of development within the Trinity River Division. Features of this third stage would include Larabee Valley (or alternate Base Line Reservoir) and Eaton Reservoirs in the Van Duzen River Basin; Anderson Ford Diversion Dam, plus an enlarged Ruth Reservoir on the upper Mad River, and Butler

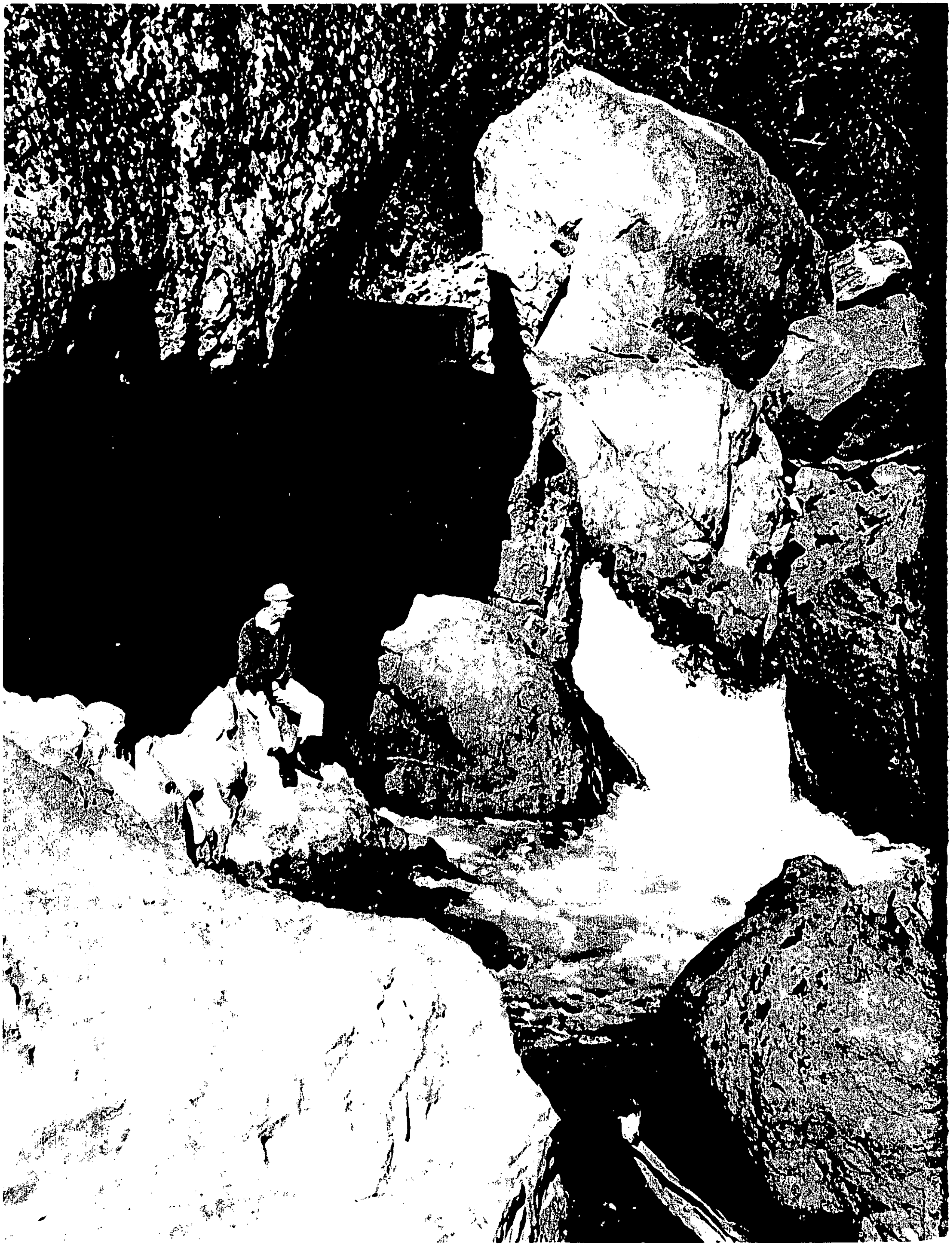
TABLE 15

POSSIBLE PHYSICAL FEATURES OF
VAN DUZEN RIVER PROJECTS

Dam and reservoir	Larabee Valley	Base Line 1/	Eaton
Stream	South Fork Van Duzen River	South Fork Van Duzen River	Van Duzen River
Damsite Location	T1N,R5E, S 18 HB&M	T1N,R5E, S 33 HB&M	T1N,R5E, S 5 and 8 HB&M
Streambed Elevation (feet, MSL)	2,260	2,500	2,320
Height of Dam (feet)	452	190	381
Type of Dam	Earthfill	Earthfill	Earthfill
Normal Pool Elevation (feet, MSL)	2,686	2,670	2,676
Minimum Pool Elevation (feet, MSL)	2,408	2,600	2,400
Reservoir Surface Area (acres)	4,050	720	4,050
Reservoir Storage Capacity (acre-feet)	568,000	46,000	635,000
Firm Annual Yield (acre-feet)	130,000	--	230,000
Estimated Capital Cost 2/	$37,300,000	$5,000,000	$26,200,000

1/ Alternative development to Larabee Valley Reservoir which would provide 73,000 AF/annum fishery release thus eliminating fishery release from Larabee Valley Dam.

2/ Construction of dam and reservoir only; does not include cost of associated conveyance facilities.



11. Eaton Roughs, Van Duzen River near Bridgeville.
Division of Beaches and Parks Photograph

Valley Reservoir on the lower Mad River. Surplus flows of the Mad and Van Duzen Rivers, developed by these reservoirs, would be diverted through a tunnel and powerplant into Eltapom Reservoir on the South Fork Trinity for subsequent diversion to the Sacramento Valley.

Larabee Valley Reservoir

Project Description. Larabee Valley Reservoir would be formed by a 452-foot high earthfill dam across the South Fork Van Duzen River just above its confluence with the Van Duzen River. Water developed by the reservoir would be diverted through Van Duzen Pipeline to Eaton Reservoir on the upper Van Duzen River for export to the Mad River Basin.

Effects of Project on Fishery Resources. Salmon are unable to reach the upper Van Duzen River drainage because of natural barriers near the "Eaton Roughs," several miles below the proposed damsite. Eaton Roughs are also a partial barrier to steelhead during most years and probably a complete block at times.

Steelhead which ascend the Van Duzen River to the Eaton Roughs area and rest in the deep pools there during the summer probably are no different from those taken during the summer in pools in the upper portion of the Middle Fork Eel River. They are apparently true spring-run fish which enter the lower river in April or May, migrate to upper areas, and spend the summer in deep pools, and then spawn in late fall or early winter.

It is estimated that an average of about 2,000 steelhead spawn annually in the South Fork Van Duzen River.

Since more than one-fifth of the storage capacity of Larabee Valley Reservoir would be diverted each year, the reservoir would fluctuate severely. This would limit the fishery production. The reservoir would probably support a trout fishery similar to that of Ruth Reservoir on the Mad River. Stream water temperatures are somewhat higher in the Van Duzen than in the Mad River; however, it is anticipated that there would be adequate cool water in Larabee Valley Reservoir to support trout.

Fishery Maintenance. The following flow releases from the Larabee Valley Reservoir would be required to maintain fishery resources in the lower South Fork and Van Duzen Rivers:

Period	Flow Release
October 1 to February 28	60 cfs
March 1 to June 30	40 cfs
July 1 to September 30	10 cfs

Multiple level outlet works should be incorporated into Larabee Valley Dam to provide streamflow releases of suitable temperatures for salmonids.

Fishery Compensation. Artificial propagation facilities to accommodate 100,000 steelhead yearlings would be required below Larabee Valley Dam to compensate for the loss of steelhead spawning and nursery area above the damsite. These facilities might be constructed below the dam or could be added to the Middle Fork Eel River or Mad River Hatcheries.

Fishery Enhancement. Substantial fishery benefits would result if supplemental streamflow releases could be made from the Van Duzen River Projects. These releases should provide the following flows measured at the U. S. Geological Survey Gauge near Bridgeville:

Period	Flow Release
October 1 to April 30	1,000 cfs
May 1 to June 30	500 cfs
July 1 to September 30	Unknown

These flows would provide improved spawning and incubation conditions for a potential average spawning run of about 100,000 king salmon. This preliminary estimate assumes optimum flows would be provided during the remainder of the year and that water temperatures would be satisfactory.

Effects of Project on Wildlife Resources. The Larabee Valley Reservoir on the South Fork Van Duzen River would have a surface area of about 4,050 surface acres. Resident deer live in the proposed reservoir site year round. During winter and spring, deer that summer in the high mountain ranges nearby come down and share the lower elevation forage with the resident deer.

Based on reconnaissance surveys, estimated wildlife losses that would be caused by the construction of Larabee Valley Reservoir are as follows:

Black-tailed deer days-of-use	117,800
California quail*	40
Gray squirrel	20
Sooty grouse	30
Jackrabbit	10

*Quail population estimated for pre-nesting season.

Wildlife Compensation. Measures required for developing and maintaining wildlife habitat for 117,800 deer days-of-use on the winter range are as follows:

Land: Approximately 1,300 acres of public land and purchase of 1,300 acres of private land.

Development: Grassland conversion to brush, browseways, browse propagation, browse regeneration, and quail habitat development on 2,300 acres.

Maintenance: Annual operation and maintenance of program at project cost.

Facilities: Administration facilities and program manager, which could include administration of Eaton, Butler Valley, Anderson Ford, and enlarged Ruth Reservoir wildlife compensation areas.

Eaton Reservoir

Project Description. Eaton Reservoir would be created by construction of a 381-foot high earthfill dam on the upper Van Duzen a short distance above its confluence with the South Fork. The project would develop about 230,000 acre-feet of water annually. This water, plus about 130,000 acre-feet diverted from the Larabee Valley Project, would be transported through the Mad Tunnel into Anderson Ford Reservoir in the Mad River Basin, Eltapom Reservoir on the South Fork Trinity and Helena Reservoir on the Trinity River for eventual export to the Sacramento Valley. In the event that the alternate Baseline Reservoir is constructed, the entire yield of Eaton Reservoir would be available for diversion out of the basin, since the fish maintenance release would come from Baseline Reservoir.

Effects of Project on Fishery Resources. Eaton Reservoir would lie above the point of upstream migration of anadromous fish in the Van Duzen River drainage. Therefore, only resident fish would be affected provided adequate downstream flow releases are made.

Eaton Reservoir would be a very long, narrow and deep body of water subject to severe fluctuation, since over one-fourth of its volume would be diverted annually. The reservoir could be expected to support a trout fishery similar to Ruth Reservoir on the Mad River. Due to a relatively steep shoreline, angler use will be limited much as it is at Ruth.

Fishery Maintenance. The following fishery maintenance flow releases should be made from Eaton Reservoir for maintenance of anadromous and resident fish in the lower Van Duzen River:

Period	Flow Release
October 1 to February 28	90 cfs
March 1 to June 30	60 cfs
July 1 to September 30	10 cfs

Multiple level outlets should be incorporated into Eaton Dam to provide streamflow releases of suitable temperatures for salmonids.

In the event that Baseline Reservoir is constructed on the South Fork Van Duzen River, the fisheries maintenance release would come from it and the above release schedule could be eliminated.

Fishery Enhancement. As discussed for the alternate projects proposed for the South Fork Van Duzen, substantial opportunity for fishery enhancement exists in the lower Van Duzen River. Supplemental flows necessary to accomplish this could come from any or a combination of the projects proposed for the upper Van Duzen drainage.

Effects of Project on Wildlife Resources. Eaton Reservoir would be constructed on the Van Duzen River above the confluence of the South Fork. It would have a surface area of 4,500 acres of the same general terrain and cover characteristics as Larabee Valley Reservoir. Resident deer live in the proposed reservoir site year round. During winter and spring, deer that summer in the high mountain ranges nearby move down to lower elevations and share the forage with the resident deer.

Estimated wildlife losses associated with construction of Eaton Reservoir are as follows:

Black-tailed deer days-of-use	105,500
Mountain quail*	20
Gray squirrel	10
Jackrabbit	40
Brushrabbit	10

*Quail population estimated for pre-nesting season.

Wildlife Compensation. Measures required for developing and maintaining wildlife habitat for 105,500 deer days-of-use on the winter range are as follows:

Land:	Approximately 1,200 acres of public land and purchase of 1,200 acres of private land.
Development:	Grassland conversion to brush, browseways, browse propagation, browse regeneration and quail habitat development on 2,200 acres.
Maintenance:	Annual maintenance of program included in project cost.
Facilities:	Administration facilities and program manager, which could be included in Larabee Valley wildlife compensation area.

Baseline Reservoir

Project Description. Baseline Reservoir would be constructed as an alternate to the Larabee Valley Reservoir. It would be formed by a 190-foot high earthfill dam on the South Fork Van Duzen River about 5 miles above its confluence with the upper Van Duzen River. The reservoir would have a gross capacity of about 46,000 acre-feet at a normal pool elevation of 2,670 feet.

Effects of Project on Fishery Resources. Baseline Reservoir would function as a fisheries maintenance and recreation reservoir. It would provide a streamflow release large enough so that the fish maintenance release from Eaton Reservoir on the upper Van Duzen River could be eliminated. This would dry up about 1½ miles of stream below Eaton Reservoir; however, this would be compensated for by improved flows in about 5 miles of the South Fork from Baseline Dam to the confluence with the Van Duzen.

Only a relatively small run of steelhead reaches the South Fork Van Duzen River because of natural barriers near the "Eaton Roughs," as stated previously. Artificial propagation facilities to maintain about 2,000 steelhead would be required.

Baseline Reservoir would probably support a trout fishery comparable to that of Ruth Reservoir on the Mad River. The reservoir would have a large annual fluctuation, however, which would greatly limit its fish production potential.

Fishery Maintenance. The following flow release schedule would be required below Baseline Reservoir to maintain fishery resources in the lower South Fork and Van Duzen Rivers:

Period	Flow Release
October 1 to February 28	150 cfs
March 1 to June 30	100 cfs
July 1 to September 30	20 cfs

Multiple level outlet works should be incorporated into Baseline Dam to provide releases of suitable temperature for salmonids.

Fishery Compensation. Artificial propagation facilities as described for Larabee Valley Reservoir would be required.

Fishery Enhancement. If adequate storage could be provided in Baseline Reservoir to provide supplemental flows in the lower Van Duzen River as discussed under "Fishery Enhancement" for the Larabee Project, similar enhancement benefits could be realized.

Effects of Project on Wildlife Resources. The proposed Baseline Reservoir on the South Fork of the Van Duzen River with a surface area of 720 acres, is an alternate to the Larabee Valley Reservoir. Resident and migratory deer use this reservoir site as in the Larabee Valley Reservoir downstream from this site. Wildlife losses based on reconnaissance surveys are as follows:

Black-tailed deer days-of-use	22,500
California quail*	8
Gray squirrel	4
Sooty grouse	6
Jackrabbit	2

*Quail population estimated for pre-nesting season.

Wildlife Compensation. The measures required to develop and maintain wildlife habitat for 22,500 additional deer days-of-use on winter ranges adjacent to the reservoir site are as follows:

Land:	Approximately 500 acres of public land and purchase of 500 acres of private land.
Development:	Grassland conversion to brush, browseways, browse propagation, browse regeneration, and quail habitat development on 900 acres of land.
Maintenance:	Annual operation and maintenance of program at project cost.
Facilities:	Administration facilities and program manager, which could include administration of Eaton, Butler Valley, Anderson Ford, and enlarged Ruth wildlife compensation areas.

CHAPTER VI. PUTAH-CACHE CREEKS HYDROGRAPHIC UNIT

General Description

The Putah-Cache Creeks Hydrographic Unit encompasses the drainages of Putah and Cache Creeks including Lake Berryessa and Clear Lake. Putah Creek arises in lower Lake County near Middletown and flows about 80 miles in a southeasterly direction. It empties into the Yolo Bypass and does not reach the Sacramento River. The stream is dry below the town of Winters for several months of the year because the entire flow is diverted for irrigation or is lost through evaporation. Cache Creek is the outlet of Clear Lake, and flows in a southeasterly direction toward the Yolo Bypass. Like Putah Creek, it does not reach the Sacramento River. Lower reaches of the streams are dry from July to November.

Fishery Resources

The Putah-Cache Creeks Hydrographic Unit contains several bodies of water supporting valuable fishery resources. The most important of these are Clear Lake, Lake Berryessa, and Putah Creek. The fishery resources of each of these waters are briefly discussed below.

Clear Lake

In historical times, when the waters of the lake lived up to its name, the sport fishery of Clear Lake was composed chiefly of rainbow trout and Sacramento perch, both of which apparently existed in enormous numbers. Steelhead ascended Cache Creek, passed through the lake and spawned in the tributaries. Squawfish were also enormously abundant and apparently enjoyed considerable popularity as a food and sport fish. Today, squawfish are practically extinct. Sacramento perch are now scarce, trout almost nonexistent, and steelhead blocked by the dam at the outlet of Clear Lake, and by alterations in the lower reaches of Cache Creek.

In recent years Clear Lake has supported one of the more important and productive warmwater fisheries in Northern California. Largemouth bass, black crappie, white crappie, bluegill, Sacramento perch, white catfish and brown bullhead dominate the catch.

Putah Creek

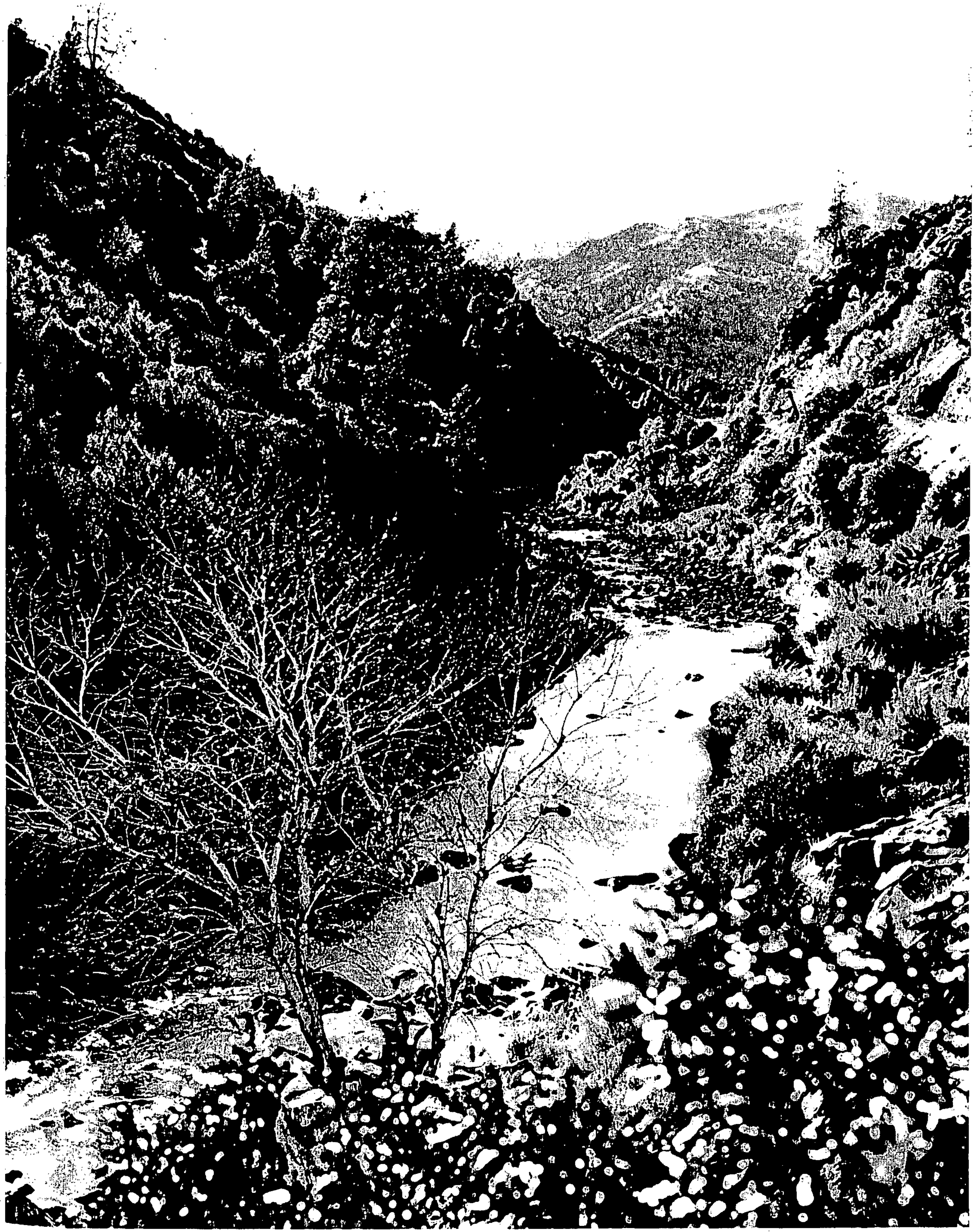
Upper Putah Creek supports a good smallmouth bass population although angler use is only moderate due to limited access. The stream is very rich in aquatic organisms; however, low summer flows presently limit fish production.

Lake Berryessa

Lake Berryessa also supports a fine warmwater fishery and is one of the most heavily used reservoirs in Northern California, drawing visitors from both the San Francisco and Sacramento areas. Largemouth bass, crappie, bluegill, white catfish, and brown bullhead, along with an occasional trout are most commonly taken by anglers.

Lower Putah Creek

Putah Creek below Lake Berryessa, although not actually within the boundaries of the hydrographic unit, would also be affected by the Clear Lake Diversion Project. A fine trout fishery has developed in the 8-mile section between Monticello Dam and the diversion into the Putah South Canal. The stream below this diversion is of no value to fishlife at present due to inadequate flows.



12. Cache Creek below confluence of North Fork.
November 7, 1958

Cache Creek

Cache Creek sustains minor fisheries for smallmouth bass and white catfish. Limited numbers of other warmwater game fishes, and several species of rough fish are also found in the drainage but are of limited importance.

Rainbow trout are present in the headwaters of the North Fork of Cache Creek and its tributaries where suitable water temperatures and year-long flows exist.

The production of game fish is limited by the large amounts of sediment carried by Cache Creek, and the low flows present during the fall months. The drainage also has many mineralized springs, which may further degrade the productivity of the stream.

Wildlife Resources

Black-tailed deer, California quail, mourning dove, waterfowl, mountain quail, and brush rabbit are the important game species, in order of their importance, found in this hydrographic unit. Large numbers of resident deer are located in the project development sites. Some areas of dense deer populations, exceeding 20 deer per section occur in this unit. Clear Lake and Lake Berryessa are used by limited numbers of waterfowl.

Subunit Description

The Coordinated Statewide Planning Program has not yet included the Putah-Cache Creeks Hydrographic Unit; therefore, estimates of streamflow requirements and descriptions of the hydrographic subunits are not presented in this report.

Proposed Water Developments

The physical features of the Clear Lake Diversion Project were described previously in Chapter V. The proposed diversion route will be discussed briefly below. Water developed in the Eel River Basin could be diverted from English Ridge Reservoir through Garrett Tunnel into Middle Creek which flows into Clear Lake. After passing through Clear Lake, the water would be diverted from upper Cache Creek through a 2-mile long tunnel into Soda Creek. It would then flow down Soda Creek through two small power reservoirs into upper Putah Creek and Lake Berryessa. Water developed in the Eel River basin and exported through the Clear Lake Diversion to Lake Berryessa would eventually be released down Putah Creek to the Sacramento River.

The possibility of a pumped-storage operation at an enlarged Lake Berryessa for both water conservation and power generation appears promising solely as a further development of the Sacramento River, and is even more promising with imports from the Eel River.

Effects of Project on Fishery Resources. The diversion of water from the Eel River Basin through the Clear Lake Diversion System would have profound effects on the stream channels and bodies of water involved. The effects of this conveyance system on Clear Lake and Putah Creek are the most important. As mentioned previously, Clear Lake has a productive warmwater fishery. It is heavily used for angling and recreation. The conveyance of large volumes of water through Clear Lake could result in major physical and chemical changes in the lake's characteristics. Without detailed study of Clear Lake, it is impossible to say what changes would result. However, the changes would probably be detrimental to the present warmwater fishery for several reasons. Conveyance of large volumes of cool water through Clear Lake could reduce the water temperature enough to lower basic productivity, and might flush out enough nutrients and aquatic organisms from the lake to lower fish productivity. It is possible that water temperatures might be lowered enough to make the lake more suitable for trout. This could result in management problems associated with developing a natural trout spawning area or the need for a hatchery stocking program to maintain the trout fishery.

Significant changes in the turbidity of Clear Lake could result from importation of Eel River water. Releases of water from Lake Mendocino into the Russian River have resulted in an increase in the turbidity of the river. Investigation of the problem has disclosed that this is the result of storage of Eel River water in Lake Mendocino for later release into the Russian River. Apparently, suspended sediments from the Eel River are of such fine composition that they do not completely precipitate even after lengthy retention in a reservoir. Then later releases color the river downstream at a time when it would normally be clear. If similar conditions occurred in water diverted from the Eel River to Clear Lake the results would not be popular with fisheries and recreational interests.

The smallmouth bass population of upper Putah Creek would probably be greatly reduced as a result of very high conveyance flows, assuming Lake Berryessa is not enlarged. With enlargement of Lake Berryessa, the entire section affected by the diversion route would be inundated.

Effects of Project on Wildlife Resources. No adverse effects to wildlife is foreseen at the present time. However, as more complete engineering data becomes available, a review of these plans are necessary to evaluate the effects of the project on the wildlife resources. Phases of the project which may cause a detriment to wildlife are: (1) incoming flows to Clear Lake coming down Middle Creek, (2) channelization at south end of Clear Lake to the Soda Creek tunnel, and (3) aquatic vegetation changes which may occur in Clear Lake.

Stienhart and Jerusalem Reservoirs

Project Descriptions. Stienhart and Jerusalem Reservoirs would be formed by construction of two dams on Soda Creek, a small intermittent tributary to Putah Creek. Approximately 400 feet of power head could be developed by these projects. The surface elevation of these reservoirs would remain relatively constant, which could result in development of fair warmwater fisheries.

Effects of Projects on Fishery Resources. Soda Creek does not contain a significant fish population, therefore, there would be no fishery detriments associated with these projects. As mentioned above, some enhancement could result from the possible development of fisheries in these reservoirs, although the high rate of water exchange would probably limit fish production.

Effects of Projects on Wildlife Resources. The proposed Stienhart Reservoir site would be located on Soda Creek, and would have a surface area of 850 acres. Principal land uses in the reservoir site are recreation and limited livestock grazing. The area has had limited mining activities in the past. Wildlife losses based on reconnaissance surveys made October 1963, are:

Black-tailed deer days-of-use	13,600
California quail	5
Mountain quail	60
Mourning dove	30
Band-tailed pigeon	40
Gray squirrel	10

TABLE 16

POSSIBLE PHYSICAL FEATURES OF
GREATER BERRYESSA PROJECT

Dam and reservoir	Stienhart	Jerusalem	Enlarged Berryessa
Stream	Soda Creek	Soda Creek	Putah Creek
Damsite Location	T12N, R6W, S 27	T11N, R6W, S 14	T8N, R2W, S 28
Streambed Elevation (feet, MSL)	1,045	900	185
Height of Dam (feet)	275	160	600
Type of Dam	Earthfill	Rockfill	Earth and Rockfill
Normal Pool Elevation (feet, MSL)	1,300	1,045	760
Minimum Pool Elevation (feet, MSL)	1,295	1,045	530
Reservoir Surface Area (acres)	850	750	65,000
Reservoir Storage Capacity (acre-feet)	80,000	46,000	14,000,000
Firm Annual Yield (acre-feet)	0	0	1,600,000
Estimated Capital Cost 1/	$8,000,000	$5,000,000	$130,000,000

1/ Construction of dam and reservoir only; does not include cost of associated conveyance facilities.

The proposed Jerusalem Reservoir would be located on Soda Creek immediately below the Stienhart Reservoir and would have a surface area of 750 acres. Principal land uses in the reservoir area are recreation and limited livestock grazing. The area has had some mining activities in the past. Wildlife losses based on reconnaissance surveys made October 1963, are:

Black-tailed deer days-of-use	11,250
California quail	150
Mourning dove	70

Wildlife Compensation. Measures required to develop and maintain wildlife habitat for a combined total of 24,850 deer days-of-use on land adjacent to the Stienhart and Jerusalem Reservoir sites are as follows:

Land:	Purchase of approximately 760 acres of private land and 40 acres of public land.
Development:	Quail habitat development, range conversion, and browseways on 400 acres.
Maintenance:	Annual operation and maintenance of program at project cost.
Facilities:	Administration facilities and program manager, which could be included in the Greater Lake Berryessa wildlife compensation area.

Greater Lake Berryessa

Project Description. Considerable water conservation and power benefits could be realized by operation of an enlarged Lake Berryessa in coordination with imports from the Eel River and the Central Valley reservoir system. Through a direct connection with the lower Sacramento River, it would be possible to conserve excess flows by pumping them into the enlarged lake. These flows, together with imported water from the Eel River, would then be released to the Delta during periods of deficient flow. It would also be possible to install reversible pumping units at the dam for generation of hydroelectric power. Reconnaissance studies indicate that significant quantities of dependable hydroelectric power could be generatec by means of a pumped storage operation of an enlarged Lake Berryessa.

Preliminary studies indicate that Lake Berryessa should be enlarg to a gross capacity of 14 million acre-feet, although it is possible to dev a 16 million acre-foot reservoir at the site. The reservoir would be forme by a 600-foot high earth- and rockfill dam downstream from the existing Monticello concrete arch dam.

Effects of Project on Fishery Resources. The enlargement of Lake Berryessa would inundate the fine existing smallmouth bass fishery in upper Putah Creek. However, this fishery would also be largely destroyed by the of the Putah Creek channel for conveyance of Eel River water to Lake Berrye:

Existing conditions for fishlife in Lake Berryessa could be impro by the greatly expanded shoreline and normal water surface area of about 63,000 acres. Depending on operational plans, the enlarged reservoir might fluctuate considerably less than the present lake, or it could fluctuate as much as 220 feet annually. Such a severe fluctuation would be a detrime: to the fishery, the amount depending on time of year and rate of drawdown.

Fishery Maintenance. The feasibility of constructing a saddle da on the Pope Valley arm of enlarged Lake Berryessa should be investigated. This could create a separate and relatively stable body of water which woul probably be high in fish production. This would help mitigate the detrimen caused by severe fluctuations of the enlarged reservoir.

Fishery Compensation. The streamflow in Cache Creek should be improved to compensate for the loss of smallmouth bass production in upper Putah Creek. Cache Creek now sustains a small population of smallmouth bass which is limited by low flows. Therefore, it is recommended that a minimum flow of roughly 50 cfs be released down Cache Creek from the Clear Lake Water Company Dam. This would improve fishing in about 80 miles of stream.

Fishery Enhancement. The possibility of establishing a run of king salmon in Cache Creek should be investigated. There is a large amount of gravel suitable for salmon spawning in both the main stream and North Fork. However, the streamflow regime of lower Cache Creek is very undesirable due to reregulation for agricultural purposes.

If the Clear Lake Diversion Route is chosen for the Upper Eel River Development, large quantities of water would be diverted into Clear Lake from the Eel River Basin. With adequate streamflow releases down Cache Creek from Clear Lake to provide suitable migration, spawning and nursery conditions, it is possible that a run of salmon could be established by stocking king salmon fingerlings for several years.

Since Cache Creek now empties into a settling basin and the Yolo Bypass during flood periods, it would be necessary to dredge a permanent channel to the Sacramento River to allow salmon to enter the stream. Fish ladders would also be required at the Capay and Moore Diversion Dams. However, this enhancement proposal would have the major advantage that the water released would not be lost, but could be recovered in the Delta.

Further study would be required to evaluate water quality and temperatures, and to determine the streamflows necessary to provide suitable conditions for king salmon.

Effects of Project on Wildlife Resources. The proposed enlarged Berryessa Reservoir would have a surface area of 65,000 acres, 44,300 acres greater than the existing Berryessa Reservoir. Principal land uses on the reservoir site area are recreation and livestock grazing. Wildlife losses based on reconnaissance surveys are:

Black-tailed deer days-of-use	1,713,000
California quail*	18,000
Mourning dove	12,800
Ring-necked pheasant	800
Gray squirrel	80
Jackrabbit	700
Waterfowl (ducks 1,700; geese 650)	2,350

*Quail population estimated for fall population.

Wildlife Compensation. The measures required to develop and maintain wildlife habitat for 1,713,000 additional deer days-of-use on adjacent ranges are as follows:

Land:	Approximately 11,000 acres of public land and purchase of approximately 8,000 acres of private land.
Development:	Browseways, browse regeneration, browse conversion, and quail habitat development on 9,000 acres of land.
Maintenance:	Annual operation and maintenance of program at project cost.
Facilities:	Administration facilities and program manager, which could include administration of Stienhart, Jerusalem and Knight's Valley wildlife compensation areas.

CHAPTER VII. RUSSIAN RIVER HYDROGRAPHIC UNIT

General Description

The Russian River Hydrographic Unit consists primarily of the Russian River drainage, with the addition of the small coastal basins of Salmon, Stemple, and Walker Creeks at the southern end of the unit.

The Russian River drainage encompasses about 1,500 square miles and flows from central Mendocino County into Sonoma County to enter the Pacific Ocean approximately 60 miles north of San Francisco. The river basin is essentially in the form of a large trough about 60 miles long and 15 miles wide, with its long axis generally following a north-south direction. Near Healdsburg the river makes a marked turn and flows roughly southwest until it enters the ocean approximately 30 miles downstream.

The drainage is typical central coast range, composed of short, relatively steep tributaries, well timbered in the upper reaches and covered with brush and oak-grassland in the lower reaches. Small agricultural valleys border the lower one to 5 miles of these streams.

A chain of agricultural valleys border the Russian River from the headwaters of its east and west forks to a point west of Santa Rosa where the river enters the so-called "gorge" section. In its lower 20 miles the river canyon is V-shaped and heavily timbered with redwood and Douglas Fir. The river meanders over a gentle gradient and its extensive riffles contain considerable spawning gravel. It finally enters a well-developed estuary about 5 miles from its mouth.

Drainage divides are generally at an elevation of about 2,000 feet above sea level on the western boundary of the basin and 2,500 to 3,000 feet along the eastern boundary.

Air temperatures at Cloverdale ranged from a high of 106°F. to a low of 28°F. during the year 1958. During this year, the mean temperature was 64°F., which was almost equal to long-term average temperature.

Precipitation ranges from an average of over 60 inches per year just north of Cazadero to an average of under 30 inches per year a short distance south of Santa Rosa.

The agricultural valleys along the main river and the lower ends of the tributaries are all highly cultivated. The vegetative cover of the foothills bordering the agricultural valleys is primarily oak-grassland, with considerable amounts of brush on the dry south and west facing slopes. Conifers are predominant in the higher elevations and in the lower, more heavily watered part of the drainage. Redwood is the most common conifer in the lower part of the drainage and Douglas fir predominates in the upper areas.

Due to a gentle gradient, averaging only 9 feet per mile in the 110-mile length of the river, stream velocities are generally moderate. The stream is typically a series of long-sluggish pools separated by short riffles. Only for short sections such as the East Fork between Highway 20 and Potter Valley, and the main river near Squaw Rock, do velocities become rapid.

The stream bottom typically alternates between sand and silt bottomed pools, and gravel and cobblestone riffles throughout most of the river. Suitable gravel for steelhead, and king and silver salmon spawning is scattered throughout. Considerable amounts of silt are interspersed in the gravel; however, much of this washes out during spawning activities. Most of the tributary streams provide excellent conditions for steelhead spawning. Good silver salmon spawning areas are found in tributaries to the lower "gorge" section of the drainage.

A unique feature of the river's flow regime is the considerable quantity of water that is imported from the Eel River drainage. This water is diverted by Van Arsdale Dam on the Eel River about 20 miles northeast of the City of Ukiah, and drops through a penstock into Potter Valley Powerhouse, which is owned by the Pacific Gas and Electric Company. Over the 40-year period, 1923-1962, an average of about 220 cubic feet per second has been diverted in this manner, with an average of about 160,000 acre-feet annually. This imported water makes up most of the flow in the Russian River between June and October. Without this supplemental water the river would often be nearly dry in this period.

Although the river flows through a number of small towns, and there is considerable agricultural development in the valleys adjacent to it, water quality is generally good.

The portion of the Russian River Hydrographic Unit outside the Russian River drainage consists primarily of three small drainages; Salmon, Stemple, and Walker Creeks. These are short coastal streams in the southern tip of the unit. The streams head in steep, heavily forested V-shaped canyons, which open into valley plains near the midpoint of the drainages. Walker Creek is a good steelhead and silver salmon stream containing considerable amounts of spawning gravel. Salmon and Stemple Creeks are also used by these species, however, favorable fish habitat is more limited.

Geographical boundaries of the hydrographic unit and subunits are shown on Plate 4, entitled "Hydrographic Units and Subunits in the North Coastal Hydrographic Area."

All quantitative data on fish resources and subunit flow requirements are shown in Table 17 at the end of the Subunit Descriptions section.

Fishery Resources

Despite its importance as a sport fishing stream, relatively little is known about the fishery of the Russian River. Steelhead are the most important species in the river and are distributed throughout all the tributaries of appreciable size. The average annual spawning run of steelhead is estimated at about 50,000 fish. Silver salmon utilize the main river and lower tributaries up to the vicinity of Dry Creek. The spawning run of silver salmon is estimated at 5,000 fish. Significant runs of striped bass and shad also occur in the lower river and pink salmon are occasionally reported. A run of king salmon has built up in recent years as a result of improved flows following the construction of Coyote Reservoir, and plants by the Department of Fish and Game totaling about 2½ million king salmon fingerlings and 500,000 eyed eggs. The spawning run of king salmon was estimated at about 1,000 fish in 1961. This run is expected to increase to at least 2,000 fish annually by 1971. King salmon have been observed in the main river as far upstream as the confluence with the East Fork.

Among the resident species, rainbow trout are the most important and the most frequent in angler's creels. Many of these fish are actually juvenile steelhead. Largemouth and smallmouth bass are taken in appreciable numbers from the main river. White catfish, green sunfish, bluegill and brown bullhead also enter the sport fishery, but are of relatively minor importance. Several species of rough fish are common throughout the drainage

King salmon begin to show up in the sport catch near Jenner at the mouth of the Russian River during the middle of July and the first part of August. By the middle of August, salmon are moving over Hatcher's Dam on the lower Russian River near Guerneville. They reach Healdsburg in good numbers by mid-September, when the peak of the run apparently occurs. By the end of October much of the spawning is completed. King salmon spawn so early in the Russian River that concern has been expressed over the survival of the eggs. Temperatures in the Russian River during September and October average in the high 60's which is thought to be too high for successful reproduction. The department is attempting to establish a run which will enter the river later in the year.

Steelhead grilse, or "half-pounders" enter the river early in July or on the first series of high tides. Anglers report the vast majority of steelhead grilse are females, in contrast to salmon where the reverse is true. A few mature steelhead appear in the Russian River as early as September and are frequently taken by the anglers in tide water between Duncan Mills and Monte Rio. Some are also taken below Duncan Mills in the Lone Pine area. The peak of the steelhead run occurs following the first heavy rains of winter during December or January, and continuing into February. There are fairly large runs of steelhead in March that are considered equal to the February run. Migration runs occur until the middle of April depending on rainfall.

Pink salmon have been observed to run from late August to October and to migrate as far upstream as Monte Rio. They spawn in the main river and have been observed spawning in the Duncan Mills and Monte Rio areas. Pink salmon runs seem to be larger during odd years than during even years, a phenomenon which has been observed elsewhere.

Spawning migrations of shad generally occur between the first of March and July. The peak of the run occurs during May. Shad are taken by fly fishermen during the day and are easily dip-netted at night. They are caught in fair numbers as far upstream as Healdsburg. The weight of shad taken by anglers ranges from one pound up to five or six pounds, but rarely is one taken weighing over five pounds. Shad spawn primarily in the main Russian River. They migrate upstream at night and like to remain in slow water with a smooth sand or silt bottom during the day. The young shad are found in the lower reaches of Austin Creek, and Monte Rio riffles and on nearly all the riffles in the lower reaches of the Russian River.

The Russian River is well known for its sport fishery, although little data is available to support this reputation. During the 1954-55 steelhead season, an estimate of total angler use and catch was made by Wildlife Protection Officers of the Department of Fish and Game. This census, conducted during December 1954, indicated that 15,300 angler-days resulted in a catch of 8,370 steelhead (0.55 steelhead per angler-day). Scattered reports during January and February 1955 suggested even heavier use and higher catch for these months. Scattered census data for other seasons indicates angling use and catch of similar magnitude. Little is known about the king and silver salmon fishery of the Russian River.

Wildlife Resources

This unit includes a higher resident black-tailed deer population than is average for the State. Other important game species are: California quail, waterfowl, band-tailed pigeon, and mountain quail. Waterfowl use the coastal areas in general, especially Bodega and Tomales Bays.

Subunit Descriptions

1. Coyote Valley Subunit. This subunit is composed of the headwaters of the East Fork Russian River, and includes Potter Valley, a small agricultural valley. As described previously, large quantities of

water are imported into the subunit from the Eel River via the Potter Valley Powerhouse.

Potter Valley is an oval-shaped basin about 5 miles long with its axis in a north-south direction. It is rimmed by moderately high, timbered ridges. Anadromous fish are blocked from the spawning gravels in the East Fork by Coyote Valley Dam, which is located at the lower subunit boundary line.

2. <u>Forsythe Creek Subunit</u>. This subunit encompasses the headwaters of the main Russian River, and a major tributary, Forsythe Creek. The basin is similar to that of the Coyote Valley Subunit. The river and the lower part of Forsythe Creek flow through small agricultural valleys, bordered by rolling, uncultivated land with oak-grassland and brush associations and bounded by moderately high, timbered ridges. The streams in the subunit are dry at their mouths in late summer. Their gradients are low in the valleys and steep in the extreme headwaters. Steelhead can ascend almost to extreme headwaters, and find good quantities of spawning gravel in these streams.

3. <u>Upper Russian Subunit</u>. This subunit encompasses the main river and its tributaries from the vicinity of Hopland to Coyote Valley Dam. This portion of the stream fits the general description given in the introductory section of this chapter.

4. <u>Sulfur Creek Subunit</u>. This small subunit is composed of the Big Sulfur Creek drainage. The stream flows in a westerly direction and enters the river from the east near Cloverdale. It is one of the better steelhead streams of the Russian River drainage, and has considerable permanent cool water in the headwaters that supports a good population of resident rainbow trout. This is the only stream tributary to the river that rarely dries at its mouth.

5. Middle Russian Subunit. This subunit includes the middle section of the river from the vicinity of Hopland to Healdsburg. The river and its watershed in this subunit are similar in character to the general description given earlier.

6. Dry Creek Subunit. Dry Creek is a major tributary of the Russian River, both in square miles of drainage area, and in number of miles of stream suitable to anadromous fish. The lower half of the stream flows through a narrow agricultural valley and has a gentle gradient. Extensive spawning riffles are present. Only in the extreme headwaters does the gradient become steep, so that steelhead have access almost throughout this drainage. The surrounding watershed is typical of the entire river and has been adequately described in the General Description section.

7. Mark West Subunit. This small subunit is drained by Mark West Creek, a short stream fed by cool springs in its headwaters. The stream is heavily utilized by steelhead, and the cool, permanent flow in the headwaters sustains a good trout population. Spawning gravel is present throughout most of the drainage.

8. Santa Rosa Subunit. This subunit is drained by Santa Rosa Creek, which enters the Laguna de Santa Rosa a short distance west of the City of Santa Rosa. Although the stream is relatively small, it has good steelhead spawning gravel scattered throughout, and is heavily used by this species.

9. Laguna Subunit. This small subunit is drained by Laguna de Santa Rosa above the junction of Laguna de Santa Rosa with Santa Rosa Creek. This stream drains through an agricultural valley most of its length and is of gentle gradient. Spawning gravel is limited and the drainage has been dredged for flood control purposes, therefore, it has little potential use by anadromous fish.

10. Austin Creek Subunit. This subunit is drained by the East and West Forks of Austin Creek. The drainage is heavily forested with redwood and Douglas fir. This is one of the few streams that flow year-round. It has limited exposure to the sun in the heavily-shaded, V-shaped canyons that form the drainage. This creek is an excellent steelhead and silver salmon stream, reflecting the good water and shade conditions that are present. The gradient is moderately steep in the headwaters, and moderate to gentle in the lower half of the drainage.

11. Lower Russian Subunit. This subunit includes the remainder of the Russian River, from the City of Healdsburg to the mouth. The upper one-third of the stream in this subunit flows through the Santa Rosa Plain, an area of small agricultural valleys. The stream then enters the so-called "gorge" section and follows a westward course, entering the Pacific Ocean through a well-developed estuary. The river is bordered by heavily-forested, moderately steep slopes, and has an extensive flood plain with considerable spawning gravel in the riffles. Several good silver salmon streams enter the river from the south in the "gorge" section. These streams are short and relatively steep, and surrounding slopes are heavily forested with redwood and Douglas fir.

12. Walker Creek Subunit. This subunit is composed of the Walker Creek drainage. It is a small stream containing adequate amounts of gravel to sustain good runs of silver salmon and steelhead. The headwaters are moderately timbered with redwood and Douglas fir, and the lower parts of the stream flow through rather open, exposed agricultural valleys and grazing lands. The gradient is moderate in the headwaters and gentle in the lower half of the basin.

TABLE 17

RUSSIAN RIVER HYDROGRAPHIC UNIT
ESTIMATED FISHERY RESOURCES AND FLOW REQUIREMENTS

Subunit	Fishery Resources			Required Flows (CFS)			
				Maintenance		Enhancement	
	King Salmon	Silver Salmon	Steel-head	Nov. 1-May 31	June 1-Oct. 31	Nov. 1-May 31	June 1-Oct. 31
Coyote Valley	0	0	0	90	145	1/	1/
Forsythe Creek	0	0	3,500	60	5	130	1/
Upper Russian	1,000	500	12,000	150 2/	150 2/	2/	2/
Sulfur Creek	0	0	4,000	50	8	140	1/
Middle Russian	1,000	0	7,000	150 2/	150 2/	2/	2/
Dry Creek	0	500	8,000	130	20	250	1/
Mark West	0	500	2,500	100	25	200	1/
Santa Rosa	0	0	2,500	30	7	60	1/
Laguna	0	0	0	30	8	70	1/
Austin Creek	0	2,000	4,000	45	12	100	1/
Lower Russian	0	1,500	6,500	125 2/	125 2/	2/	2/
Walker Creek	0	200	2,500	30	7	60	1/
Bodega	0	300	3,000				
Salmon Creek				15	3	30	1/
Estero Americano				15	4	30	1/
Estero de San Antonio				20	5	40	1/

1/ Enhancement flows not determined.

2/ Flows set by agreement between Department of Fish and Game and Sonoma and Mendocino County Flood Control and Water Conservation Districts.

13. Bodega Subunit. The only streams of consequence draining this subunit are Salmon and Stemple Creeks. These streams have steep gradients in their heavily-forested headwaters and then flow through agricultural valleys and open grazing areas in the lower halves of their courses. In these lower portions fair amounts of spawning gravel are available to support small runs of silver salmon and steelhead.

Proposed Water Developments

Knights Valley Reservoir

Project Description. The Knights Valley Project is the major development within the Russian River Basin to be recommended for further consideration. The storage feature of this project would be a multiple purpose reservoir formed by the construction of dams on Maacama and Franz Creeks about 3 miles from their confluence with the Russian River. A diversion dam would be constructed on the Russian River near Asti, which would divert water into a canal (Geyserville Diversion Canal) terminating at the reservoir. Water diverted from the Russian River would be pumped from the canal into the reservoir. Water could be exported from Knights Valley Reservoir into the Napa River drainage through the proposed Calistoga Tunnel.

The purposes of the Knights Valley Project would be to conserve, regulate, and divert new water supplies derived from Maacama Creek and the Russian River, and to provide additional flood control and recreation benefits within the Russian River Basin. Through the pumped storage operation, the reservoir could also provide off-stream regulation and storage of surplus flows from the Russian River. Because a development at this site has attractive internal staging possibilities in connection with water conservation, Knights Valley Reservoir is a key unit in early development plans being formulated by both the U. S. Corps of Engineers and the U. S. Bureau of Reclamation.

TABLE 18

POSSIBLE PHYSICAL FEATURES OF
RUSSIAN RIVER PROJECTS

Dam and reservoir	Knights Valley	Enlarged Coyote
Streams	Franz and Maacama	East Branch Russian
Damsite Locations	T9N, R8W, S 23 T9N, R8W, S 9	T16W, R12W, S 34
Streambed Elevations (feet, MSL)	265 215	634
Height of Dams (feet)	195 245	190
Type of Dams	Earthfill Earthfill	Earthfill
Normal Pool Elevation (feet, MSL)	445	806
Minimum Pool Elevation (feet, MSL)	350	670
Reservoir Surface Area (acres)	4,300	2,400
Reservoir Storage Capacity (acre-feet)	280,000	77,000 1/
Firm Annual Yield (acre-feet)	50,000	75,000
Estimated Capital Cost 2/	$20,000,000	$6,000,000

1/ In addition to existing capacity of 122,500 acre-feet.

The optimum size and timing of construction for the proposed Knights Valley Project would depend upon many factors, including the rate of demand build-up for new water supplies in the North Bay counties service areas, and the staging of other proposed projects which could serve these areas. These other projects are the State's authorized North Bay Aqueduct, Warm Springs Dam and Reservoir on Dry Creek, enlargement of Lake Mendocino on the East Fork of the Russian River, and English Ridge Dam and Reservoir on the main Eel River.

Effects of Project on Fishery Resources. Significant numbers of steelhead trout and king salmon would be affected by the proposed Geyserville diversion dam on the Russian River. Roughly half of the steelhead and 80 percent of the king salmon normally migrate to spawning and nursery areas above the damsite. A fishway would be necessary to provide passage for salmon and steelhead over the dam. Adequate downstream releases would be required at all times. An effective fish screen would also be needed at the intake of the Geyserville Diversion Canal to prevent loss of downstream migrants into the diversion system.

Franz and Maacama Creeks are relatively small streams which unite and enter the Russian River near Healdsburg. Both streams and their tributaries have had good runs of steelhead and possibly a few silver salmon in the past. Local residents feel these runs have dwindled during the past five years. In general, the drainage provides excellent spawning for anadromous species; however, the nursery area is limited due to low summer flows. The lower two or three miles are normally dry during the summer months. A few resident trout are probably present in the headwaters of the tributaries.

Maacama Creek and its tributaries are closed to winter steelhead fishing, as are all of the other tributaries of the Russian River. The stream is open for summer trout fishing, but most of the land bordering it is private and posted. Opening day angler surveys by the Department of Fish and Game between 1953 and 1959 have estimated an average of 80 anglers fishing Maacama Creek along Highway 128 with a catch of nearly three trout per angler. Most of the fish taken are undoubtedly young steelhead.

The construction of Knights Valley Reservoir and its forebay would cutoff all but about 2 miles of steelhead spawning area. All of the limited nursery area lies above the damsites. An estimated average run of 3,000 adult steelhead spawn in Maacama and Franz Creeks above the damsites.

It is difficult to evaluate the fishery that would develop in the reservoir until operational plans are more firm, however, it would not compensate for the loss of steelhead spawning and nursery areas.

Fishery Maintenance. The following measures would be required to maintain the anadromous fish populations in Maacama Creek and the lower Russian River:

1. A minimum flow of 150 cfs in the Russian River below the East and West Forks was established by agreement between the Department of Fish and Game and the Sonoma and Mendocino County Flood Control and Water Conservation Districts. This flow results in considerable enhancement of the river during the summer and fall months and is considered compensation for lost spawning and nursery area in the East Fork caused by construction of the Coyote Valley Dam. During the winter and spring months this flow, plus natural accretion from the tributaries below this point, provides satisfactory spawning conditions for salmon and steelhead. As additional water projects are constructed in the upper Russian River basin, the natural accretion to the river will decrease. The required fishery releases from

these as yet undefined projects should be allowed to flow undiminished past the proposed Geyserville Diversion Dam in addition to the present 150 cfs flow in order to maintain suitable conditions for fishlife in the lower Russian River.

2. A fishway over the diversion dam would be required to allow salmon and steelhead to reach upstream spawning and nursery areas. Facilities for counting upstream migrants could be included in the fishway to permit enumeration of the runs.

3. An adequate fish screen would be required at the intake of the Geyserville Diversion Canal to prevent loss of downstream migrants into the diversion system.

4. The following fishery maintenance flows should be released into Maacama and Franz Creeks to maintain the salmon and steelhead runs utilizing lower sections of the drainage and the Russian River.

	Flow Release	
Period	Maacama Creek	Franz Creek
November 1 to May 31	50 cfs	10 cfs
June 1 to October 31	5 cfs	1 cfs

5. The reservoir should be equipped with multiple level outlets to maintain adequate water temperatures in downstream areas.

Fishery Compensation. Enlargement of the proposed federal Dry Creek Hatchery or a separate facility would be required to accommodate steelhead that would be blocked from spawning and nursery areas above Knights Valley Reservoir. An upstream migrant barrier, fishway, and holding pond would be required on Maacama Creek to take adult steelhead which would normally migrate above the damsite. The eggs taken would be incubated and reared in either the Dry Creek Hatchery or a facility below Knights Valley Reservoir.

The yearling steelhead would be released into Maacama and Franz Creeks. The estimated capacity of these facilities would be 150,000 yearling steelhead.

Fishery Enhancement. The fishery release from dams on Maacama and Franz Creeks could be enhanced as follows:

Period	Flow Release Maacama Creek	Franz Creek
November 1 to May 31	90 cfs	20 cfs
June 1 to October 31	Unknown	Unknown

Supplemental releases from the proposed Calistoga Tunnel into streams tributary to the Napa River could benefit steelhead and resident trout, if the water is of suitable quality and temperature. We have insufficient data at this time to evaluate the benefits associated with any of these enhancement flows.

Effects of Project on Wildlife Resources. The proposed Knight's Valley Reservoir will be located on Maacana and Franz Creeks, and would have a surface area of 4,300 acres. Principal land uses of the reservoir site are agriculture, livestock grazing, and recreation. Wildlife losses estimated from reconnaissance surveys are:

Black-tailed deer days-of-use	157,600
California quail	1,500
Gray squirrel	60

Wildlife Compensation. The measures required to develop and maintain wildlife habitat for 157,600 additional deer days-of-use on land adjacent to the reservoir site are as follows:

Land: Approximately 800 acres of public land and purchase of 2,000 acres of private land.

Development: Browseways, browse propagation, quail habitat development, and fencing to control grazing.

Maintenance: Annual operation and maintenance of program at project cost.

Facilities: Administration facilities and program manager, which could be included in the enlarged Lake Berryessa wildlife compensation area.

Enlarged Coyote Reservoir

Project Description. Preliminary consideration has been given to possible enlargement of Coyote Valley Dam on the East Fork of the Russian River. This flood control and water conservation structure was built by the U. S. Army Corps of Engineers under contract with the Sonoma and Mendocino Counties Flood Control and Water Conservation Districts. Coyote Valley Dam is an earthfill dam, 160 feet high and impounds a reservoir with a gross capacity of about 122,500 acre-feet. The dam could be raised to a height of about 190 feet which would increase the gross capacity of the reservoir by 77,000 acre-feet. This would provide additional water storage for use in the Russian River Basin and the North Bay area, plus flood control benefits.

Effects of Project on Fishery Resources. Approximately 32 miles of good spawning and some nursery area were lost by the construction of Coyote Valley Dam in 1958. The loss of this area was mitigated by the release of enough water below the dam to maintain the following minimum flows in the Russian River: 25 cfs in the East Fork below Coyote Valley Dam; 150 cfs at the confluence of the East and West Forks; and 125 cfs at Guerneville. This was a substantial enhancement of the summer flow in the main Russian River which formerly had a very low summer flow in the vicinity of Guerneville.

It was anticipated that this release would substantially improve the water temperatures in the upper Russian River, however, scattered field measurements have indicated that the water warms to pre-project levels in 4 or 5 miles. In addition, by September the water temperature throughout the reservoir is in excess of 67°F., resulting in a streamflow release which quickly warms to near lethal temperatures for salmonids.

A limnological survey of Lake Mendocino by Day (1961) indicated that by releasing large quantities of water from the bottom of the reservoir throughout the summer all of the water less than 67°F. is gone from the reservoir by September. If a variable outlet were installed in the proposed reservoir, the level of the release could be regulated so that maximum use could be made of the cold water in the bottom of the reservoir. Coupled with increased reservoir capacity and a greater volume of cool water this could enhance conditions for fishlife in the upper Russian River. However, further study is required to determine the optimum volume and temperature of the release to achieve maximum enhancement.

In general, enlargement of Coyote Valley Dam and Reservoir will cause no detriments to the fishery of the Russian River and may provide opportunities for enhancement. The limnological study conducted at Lake Mendocino during 1959 and reported by Day (1961) indicated that the main body of the reservoir was unsuitable for trout for two or three months during the summer; however, conditions remained suitable throughout the season in a limited area near the inlet and in the upper East Branch of the Russian River. Therefore, it was concluded that a limited trout fishery will probably continue to exist in the reservoir when conditions are adequate in the spring and fall, but that largemouth bass and other warmwater fishes will probably predominate in the main body of the reservoir in the future because conditions are more suitable for these species. With enlargement of the reservoir and a larger inflow of water of lower temperature, conditions will probably become more suitable for trout. Therefore, with enlargement of the reservoir it is expected that the trout fishery will increase, providing some enhancement to the fishery.

Fishery Maintenance. As stated previously, there is an existing agreement establishing minimum flows in the Russian River. These flows are: 25 cfs in the East Fork below Coyote Valley Dam; 150 cfs at the confluence of the East and West Forks; and 125 cfs at Guerneville. With an enlarged Coyote Valley Dam, these would continue to be the required minimum flows.

Fishery Enhancement. A multiple level outlet works should be installed in the proposed enlarged Coyote Valley Dam. As mentioned previously, some enhancement of the upper Russian River would probably result depending on the volume of cool water available and the size of the releases made from the reservoir. Further study is required to determine the optimum volume and temperature of the release to achieve maximum enhancement, and the associated benefits.

Effects of Project on Wildlife Resources. No effort was spent on the proposed Coyote Reservoir on the East Fork Russian River. An increase of 444 acres from the present surface area of 1,956 acres is expected; however, the effects on wildlife should be very minor. Therefore, no wildlife compensation is claimed.

CHAPTER VIII. TRINITY RIVER HYDROGRAPHIC UNIT

General Description

The Trinity River Hydrographic Unit encompasses the Trinity River drainage. The unit covers almost 3,000 square miles of Trinity and Humboldt Counties. The river heads in the lofty Trinity Alps at more than 9,000 feet elevation and flows south to a point near Weaverville, where it turns west, and eventually north near its mouth. It enters the Klamath River at an elevation of less than 300 feet.

The river flows through heavily forested, mountainous terrain, throughout the majority of its course. The major exceptions are the extensive flats along the middle part of the main river and in the Hyampom Valley of the South Fork, the major tributary of the river. Most of the ridges separating the canyons range between 4,000 and 6,000 feet above sea level.

Precipitation in this unit is divided between heavy snow in the headwaters and along the higher ridges, and moderately heavy rains, about 50 inches annually, in the canyons at the lower elevations. Runoff is heavy during the winter from rainfall and during the spring from melting snow. Summer flows are also sustained at relatively good levels by snowmelt. Summer air temperatures are warm in the canyon bottoms and cool above 4,000 feet. The drainage is too far inland to be affected by summer fog, except on rare occasions.

The dominant vegetative type is conifers, primarily Douglas fir, with lesser amounts of white and red fir, and yellow and sugar pine. Lodgepole pine is common at the higher elevations. The dry south and west-facing slopes at lower elevations have some brush and oak-grassland cover.

The main river and major tributaries have a moderate gradient throughout most of their lengths, except in the areas of extensive gravel flats and valleys where the gradient is slight. All stream courses are steep in their extreme headwaters.

All of the larger streams are open and exposed in their middle and lower portions. Flood plains or steep, rocky stream borders limit growth of streamside vegetation. Headwaters and smaller tributaries, however, are well-shaded by the steep canyons in which they are located, as well as by alders and conifers.

Spawning gravel for king salmon is primarily confined to the upper half of the main river and valleys and gravel flats along the South Fork. Gravel is scattered throughout the latter drainage, but is concentrated in Hyampom Valley. Steelhead and silver salmon spawning gravel is scattered throughout the entire drainage; however, most spawning occurs in the tributaries, rather than in the main streams.

Mining activity and improper logging practices in the drainage contribute to sand and sediment deposits which lower the value of these spawning areas. Reduced winter flows in the main Trinity River, due to Trinity Dam, have reduced the flushing of these sediments downstream.

Geographical boundaries of the hydrographic unit and subunits are shown on Plate 4, entitled "Hydrographic Units and Subunits in the North Coastal Hydrographic Area."

All quantitative data on fishery resources and flow requirements are shown in Table 19 at the end of the Subunit Description section.

Fishery Resources

The Trinity River is the largest and most important spawning tributary of the Klamath River, which ranks first in California silver salmon and steelhead production and second in king salmon production. In addition to salmon and steelhead, the Trinity River system also supports runs of American shad, and substantial numbers of resident brown and rainbow trout.

King salmon are the most important of the anadromous fish in the drainage. Adult king salmon migrate up the Trinity River in three seasonal groups; spring, summer and fall. The spring migration reaches Lewiston during June and July; the summer migration during August and September; and the fall migration during October and November. Since construction of Trinity and Lewiston Dams, the spring run seems to be diminishing and the summer run reaches Lewiston later in the fall so that it is becoming indistinguishable from the fall run. The South Fork of the Trinity River also has both spring and fall runs of king salmon each year.

During October 1963 Department of Fish and Game personnel surveyed the South Fork Trinity River from the East Fork downstream to a point 10 miles below Forest Glen. In this section a total of 787 salmon, and 432 redds were counted. The peak of spawning was believed to have been over. Based on these observations, the 1963 spring-run of king salmon was estimated to be about 7,000 to 10,000 fish.

Gravel of suitable quality for salmon and steelhead spawning is comparatively scarce in the Trinity River downstream from the mouth of the North Fork, due to steep gradient, deep pools, and a boulder-strewn bottom. Relatively few king salmon spawn in this section of the Trinity; however, king salmon are known to spawn in the Hoopa Valley just upstream from the confluence of the Trinity with the Klamath River. Most of the king salmon migrating into the Trinity River above the South Fork spawn in the 40 miles of river between the North Fork and Lewiston and in several tributaries. About half of the natural spawning area in the upper Trinity River was cut off by the construction of Trinity and Lewiston Dams. Of the remaining half, about 90 percent lies above the North Fork.

The Department of Fish and Game estimated the spawning escapement of king salmon in the Trinity River above the North Fork at about 37,000 fish in 1955, 55,000 in 1956 and 82,000 in 1963. The 1956 and 1963 runs were considered above average for this river.

Silver salmon enter the Trinity River starting in September and spawning occurs from November to January. Little information is available regarding the distribution of silver salmon in the drainage; however, it is thought the South Fork Trinity River receives the heaviest use. Silver salmon enter most of the lower Trinity River tributaries to spawn.

Steelhead, like silver salmon, spawn mainly in the tributaries. Steelhead enter the river in the late fall and winter and spawn between February and June when virtually all tributaries have adequate flows. Major steelhead spawning tributaries are Rush, Indian, Reading, Browns, Canyon, and Hayfork Creeks and the North and South Forks of the Trinity River.

Sturgeon and shad also migrate up the Trinity River at least to Willow Creek, and perhaps as far as Gray's Falls above Hawkins Bar.

Resident rainbow trout are distributed throughout the drainage. Brown trout are also well distributed but are fewer in number and are generally absent from the upper reaches of the river and its tributaries.

spawning migrations of brown trout occur in the Lewiston area but the size of the runs is small. Populations of eastern brook trout occur in colder waters of the upper reaches of the drainage.

An estimate was made of the total average annual spawning escapement of salmon and steelhead in the Trinity River drainage based on counts of the U. S. Fish and Wildlife Service at the Lewiston Weir (1942-46), counts at Lewiston Fish Trapping Facilities (1958-62), and recent salmon spawning surveys made by the California Department of Fish and Game. From these data, the average annual spawning escapement of fall-run king salmon is estimated at 57,000 fish. In addition there are about 9,000 spring-run king salmon in the drainage. The average number of silver salmon is estimated at about 7,500 fish and the average spawning run of steelhead at about 140,000 fish.

The Trinity River has been a fishing grounds for generations of Indian tribes. The Indians constructed fish weirs of logs, poles, and brush across the river each summer and speared or netted the upstream migrant salmon and steelhead. Some of these weirs, such as those constructed by the Hoopa Indians on the lower Trinity, remained in the stream as virtually impassable barriers until the first rains of autumn increased river flows sufficiently to wash them away. However, the Indians seemed to realize that some of the fish must reach the spawning grounds to maintain the runs and installed gates in the weirs to allow part of the migrating salmon to pass upstream. Other weirs were removed by the Indians after an exact number of days in place in accordance with strict ritual and procedures. In modern times, most of the fish weirs have disappeared. However, the Indians still seine, spear and gill net salmon and steelhead on the Hoopa Reservation.

13. Typical catch of steelhead from Trinity River.
U. S. Bureau of Reclamation Photograph

Recent estimates by the Department of Fish and Game indicate that as many as 15,000 king salmon are taken annually by the Indian fishery.

Creel census data reported by the U. S. Fish and Wildlife Service (1960) indicated that the Trinity River annually supported about 5,000 angler-days for salmon, 13,000 angler-days for steelhead and nearly 20,000 angler-days for trout (mostly juvenile steelhead and salmon) during the 1956-58 period. This effort resulted in a total annual catch of 2,600 salmon, 9,000 steelhead and nearly 43,000 trout. These estimates are considered minimal. Anglers also fish for sturgeon in the Trinity, especially at the mouth of Tish Tang-A-Tang Creek.

Wildlife Resources

Game species found throughout this hydrographic unit in significant numbers are: black-tailed deer, California quail, black bear, mountain quail, band-tailed pigeon, sooty grouse, and grey squirrel. The proposed water development projects will affect significant numbers of migratory deer by inundation of their winter ranges.

Subunit Descriptions

1. Trinity Reservoir Subunit. This subunit contains the headwaters of the main Trinity River among some of the highest peaks of the drainage. The river and its tributaries head in a number of alpine lakes. Stream gradients are steep in the headwaters, becoming moderate where the tributaries combine with the main river. The Trinity River has a slight gradient at the lower end of the subunit.

The recently constructed Trinity and Lewiston Reservoirs inundate over half of the river and considerable portions of the lower ends of

1[illegible] Trout fishing on Stuart Fork, tributary to Trinity Reservoir.

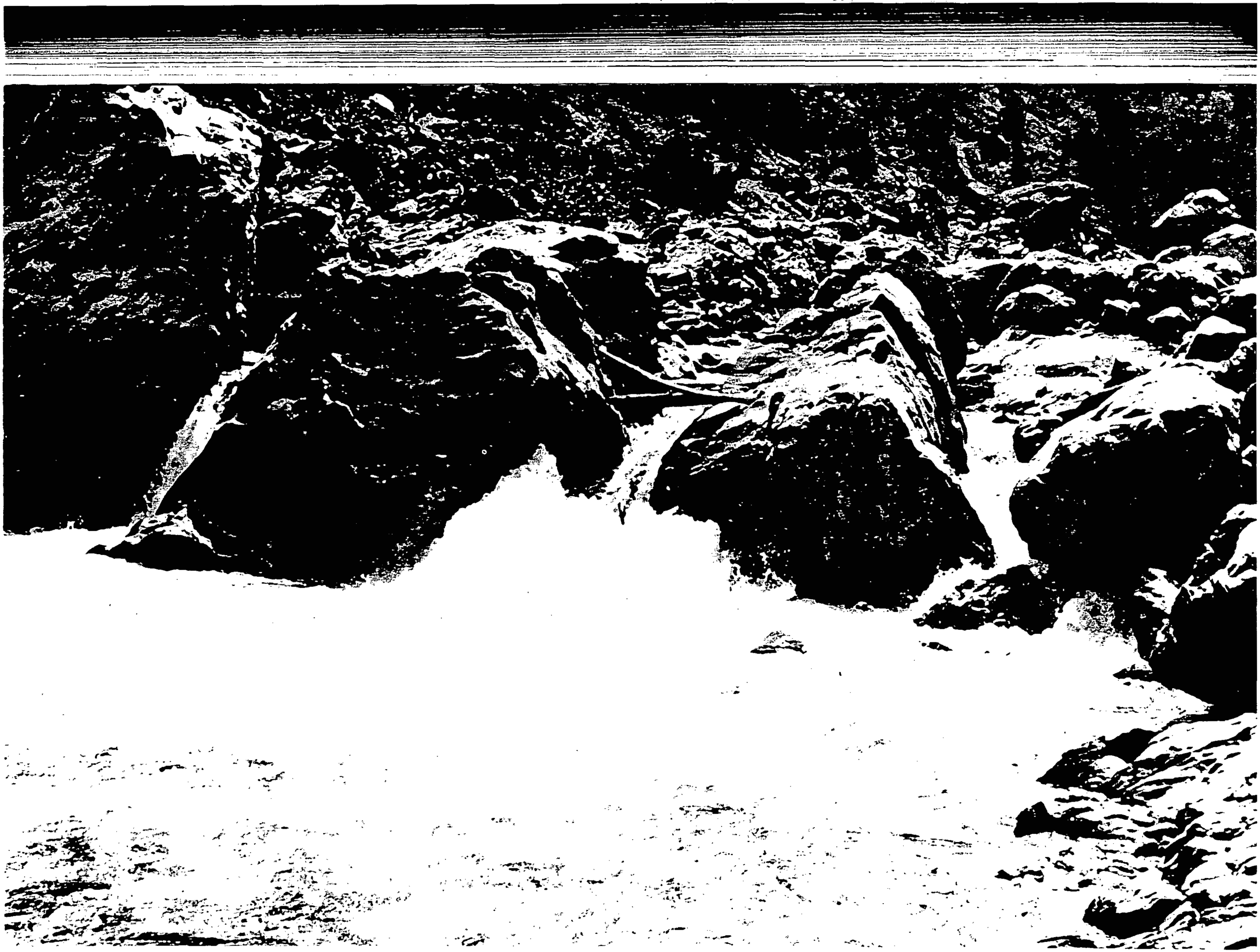
tributaries in the subunit. These reservoirs were constructed by the U. S. Bureau of Reclamation for the purpose of exporting water to the adjacent upper Sacramento River drainage and for power generation. Although fish flow releases have been set below Lewiston Dam, through agreement between the Bureau and the California Department of Fish and Game, there is evidence they are too low and revised flows are listed in Table 19.

Prior to impoundment, considerable king salmon spawning took place above Lewiston Dam. No provision was made to provide upstream access for spawning fish at this structure, since the reservoir backs water almost to Trinity Dam. To replace spawning and nursery areas above these two dams, the Bureau provided a large fish hatchery immediately below Lewiston Dam.

2. Middle Trinity Subunit. This subunit includes the main river from Lewiston Dam to the mouth of Browns Creek and includes several important tributaries; Browns, Reading, Indian, Grass Valley, and Rush Creeks. The river has a slight gradient and contains extensive gravel riffles, where a large percentage of the king salmon run spawns. The tributaries mentioned are important steelhead and salmon spawning streams, and it is possible that even heavier spawning will take place in these streams in the future due to blockage of the runs by Lewiston Dam.

3. Weaver Creek Subunit. This subunit is composed of the Weaver Creek drainage, a small tributary entering the river from the north. The stream, though of small size, is utilized for spawning by steelhead and small numbers of king salmon.

4. Helena Subunit. The Trinity River in this subunit is very similar to the section in the Middle Trinity Subunit, having a slight gradient and extensive gravel riffles. It has been estimated that about 10 percent



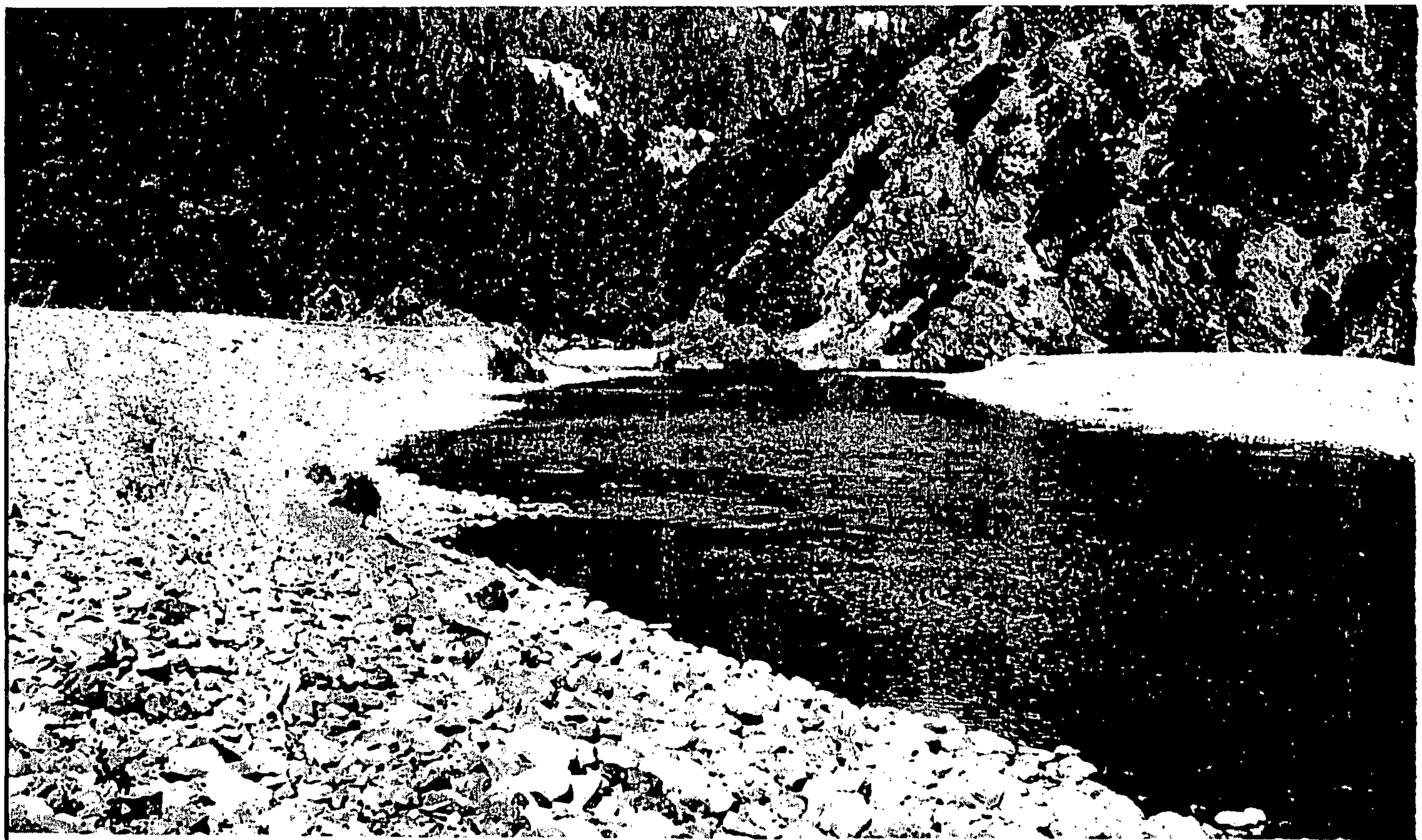
15. Burnt Ranch Falls, Trinity River.

of the king salmon reaching the lower end of the subunit spawn in this section of the river. The most important tributaries of this subunit are the North Fork Trinity River and Canyon Creek. King salmon migrate an unknown distance up the North Fork and were observed 2 miles up the East Fork of the North Fork in 1963. Steelhead ascend at least to Rattlesnake Creek, about 21 miles up the North Fork. King salmon spawned in the lower 6 miles of Canyon Creek in 1963, and steelhead migrate at least 11 miles up this stream.

5. Burnt Ranch Subunit. In this subunit the gradient of the Trinity River steepens, and gravel riffles give way to deep pools lined by bedrock and boulders with little spawning gravel. There is a natural rock obstruction in the river near Burnt Ranch which delays migrating salmon at certain flows.

6. New River Subunit. This subunit contains the New River drainage, one of the more important tributaries of the Trinity River. King salmon spawning gravel is concentrated near the town of Denny, with limited suitable gravel elsewhere in the drainage. Steelhead spawning gravel is abundant throughout the drainage. Spring-run king salmon and steelhead migrate considerable distances above Denny. Steelhead have been reported in the vicinity of Virgin Creek, about 12 miles above Denny. The East Fork of New River is also reported to have runs of steelhead.

7. Upper South Fork Subunit. This subunit includes the upper half of the South Fork Trinity River, the most important tributary of the Trinity River. The headwaters are steep; however, most of the stream has a slight to moderate gradient and contains considerable salmon and steelhead spawning gravel. In addition to use by fall-run king salmon, this subunit is the principal spawning area for spring-run king salmon in the South Fork drainage.



16. Eltapom damsite, South Fork Trinity River below Hyampom. Streamflow about 80 cfs. August 10, 1960

17. South Fork Trinity River near Salyer. Streamflow about 135 cfs. August 11, 1960

8. Hayfork Valley Subunit. This subunit includes the upper half of Hayfork Creek, the major tributary of the South Fork Trinity River. The headwaters of Hayfork Creek have a steep gradient, which rapidly becomes slight as the stream reaches Hayfork Valley near the lower end of the subunit. Steelhead and small numbers of king salmon spawn in Hayfork Valley up to a barrier a short distance above the town of Hayfork. A fish ladder will be constructed by the Department of Fish and Game in 1964, which will provide access to several more miles of stream for steelhead spawning.

9. Hayfork Creek Subunit. This subunit includes the lower half of Hayfork Creek to its confluence with the South Fork Trinity River. Hayfork Creek has a moderately steep gradient, with salmon and steelhead spawning gravel available in scattered pockets in the stream and its tributaries.

10. Hyampom Subunit. This small subunit includes a short stretch of the South Fork Trinity River in Hyampom Valley. The stream is of slight gradient and contains extensive gravel bars that provide excellent spawning areas for king salmon.

11. Lower South Fork Subunit. This subunit includes the lower portion of the South Fork Trinity River to its confluence with the Trinity River. The river has a moderate gradient and flows through a steep V-shaped canyon, with considerable bedrock and boulders. There are scattered pockets of king salmon spawning gravel throughout this section. Tributary streams provide spawning areas for steelhead and silver salmon.

12. Willow Creek Subunit. This small subunit lies immediately below the confluence of the Trinity River with the South Fork. The gradient is moderate and the river is in a steep-sided V-shaped canyon. The river bottom is predominately bedrock and boulders with deep pools and lacks

spawning gravel except in the lower 2 miles of the subunit where the gradient is less and there are scattered pockets of king salmon spawning gravel.

13. Hoopa Subunit. This subunit contains the lower main Trinity River, which flows through the Hoopa Indian Reservation, where the stream has a slight gradient and contains excellent king salmon spawning gravel. Below the reservation the stream flows through a deep canyon where the stream-bed is composed mainly of bedrock and rubble, and lacks suitable spawning gra-

TABLE 19

TRINITY RIVER HYDROGRAPHIC UNIT
ESTIMATED FISHERY RESOURCES AND FLOW REQUIREMENTS

	Fishery Resources			Required Flows (CFS)		
				Maintenance		Enhancement
Subunit	King Salmon	Silver Salmon	Steel-head	October to July	August September	Year Long
Trinity Reservoir	13,000	500	5,000	325	190	450
Middle Trinity	29,000	1,000	15,000	400	225	600
Weaver Creek	0	200	5,000	10	3	25
Helena	4,000	1,000	15,000	500	300	700
Burnt Ranch	1,000	500	10,000	700	425	1,000
New River	1,000	500	15,000	100	60	140
Upper South Fork	7,000	1,000	20,000	70	40	140
Hayfork Valley	500	500	10,000	40	30	80
Hayfork Creek	1,500	1,000	15,000	60	40	110
Hyampom	3,000	500	5,000	120	80	250
Lower South Fork	2,000	500	10,000	190	110	375
Willow Creek	500	300	5,000	1,100	550	1,600
Hoopa	3,500	500	10,000	1,200	600	1,700

Proposed Water Developments

The additional facilities of the State Water Plan proposed to follow the Upper Eel River Development are located in the upper Trinity River and adjacent basins. There are three projects in this area which are susceptible to staged construction. They would produce a total new water yield of 1,800,000 acre-feet in approximately equal increments. These projects are the Trinity Diversion Project, South Fork Trinity Project, and Mad-Van Duzen Project.

The water diverted from the upper Trinity River and adjacent basin developments could be routed through the recently constructed Whiskeytown Reservoir on Clear Creek into the Sacramento Valley. Current planning contemplates use of this route until the lower Trinity and Klamath River Projects are constructed, at which time the proposed West Side Conveyance System to an enlarged Glenn Reservoir Complex would be constructed. The West Side Conveyance System would consist of a series of interconnected reservoirs, formed by dams and cuts on the upper reaches of Cottonwood, Red Bank, and Elder Creeks, which would regulate the local runoff of these water courses, and provide conveyance to the Glenn Reservoir Complex. The Glenn Reservoir Complex would provide storage for the water imported from the Trinity-Klamath Projects.

Trinity Diversion Project

Helena Reservoir

Project Description. The Trinity Diversion Project would include the construction of Helena Dam to form a 2.8 million acre-foot reservoir. Helena Reservoir would extend upstream to the existing Lewiston Dam and

TABLE 20

POSSIBLE PHYSICAL FEATURES OF UPPER TRINITY RIVER
AND SOUTH FORK TRINITY RIVER PROJECTS

Dam and reservoir	Helena	Eltapom	Burnt Ranch	Beartooth
Stream	Trinity River	South Fork Trinity River	Trinity River	New River
Damsite Location	T34N, R12W, S 36 MDB&M	T3N, R6E, S 4 HB&M	T5N, R6E, S 13 HB&M	T6N, R7E, S 7 and 18 HB&M
Streambed Elevation (feet, MSL)	1,285	1,190	870	1,210
Height of Dam (feet)	585	350	590	285
Type of Dam	Rockfill	Earth and Rockfill	Rockfill	Earthfill
Normal Pool Elevation (feet, MSL)	1,840	1,522	1,437	1,475
Minimum Pool Elevation (feet, MSL)	1,650	1,330	1,285	1,320
Reservoir Surface Area (acres)	15,700	4,600	5,300	390
Reservoir Storage Capacity (acre-feet)	2,860,000	730,000	980,000	36,000
Firm Annual Yield (acre-feet)	600,000 1/	400,000	80,000 2/	120,000
Estimated Capital Cost 3/	$84,000,000	$55,000,000	$71,000,000	$14,000,000

1/ Impaired by Trinity and Lewiston Reservoirs.

2/ Impaired by Helena, Trinity and Lewiston Reservoirs.

3/ Construction of dam and reservoir only; does not include cost of associated conveyance facilities.

would develop an annual new water yield of about 600,000 acre-feet of water. This water would be diverted to the Sacramento River Basin by means of an 11.5-mile long Clear Creek Tunnel No. 2, which would extend from Helena Reservoir to Clear Creek above Whiskeytown Reservoir. This tunnel would be sized to provide capacity for the succeeding South Fork Trinity and Mad-Van Duzen Projects. From Whiskeytown Reservoir the water would be conveyed through the federal Spring Creek Tunnel and Powerplant for generation of secondary energy.

A possible alternative diversion route would be from Helena Reservoir to the West Side Conveyance System through the Cottonwood Creek Tunnel. At present the main justification for the alternative route is the necessity for conveyance of flows from later developments on the lower Trinity and Klamath Rivers to the Glenn Reservoir Complex for reregulation compatible with needs in the Central Valley Basin. However, considerable fisheries and other local water-associated benefits could be attributed to the West Side Conveyance System. Possible fishery enhancement benefits are discussed in Chapter XI.

Effects of Project on Fishery Resources. Spawning escapement surveys conducted by the Department of Fish and Game indicated that about 37,000 fall-run king salmon used the spawning areas above the Helena dam-site in 1955. In 1956, the run was estimated at 55,000 salmon. When Trinity and Lewiston Dams were subsequently constructed, a hatchery was constructed to handle the fish blocked. The hatchery was designed for maximum runs of 35,000 king salmon, 10,000 steelhead, and 5,000 silver salmon. Trinity and Lewiston Dams cut off about 50 percent of the natural king salmon spawning area in the main Trinity River above the South Fork. Helena Reservoir would block and inundate about 90 percent of the remaining spawning area, leaving only 5 percent of the historical salmon spawning grounds in the main Trinity River above the South Fork.

Silver salmon and steelhead would be cut off from major spawning areas in Indian, Reading, Browns, and Canyon Creeks, and the North Fork Trinity River. Sport fishing for anadromous fish would be eliminated along the 40 miles of river between the Helena damsite and Lewiston Dam. While the loss of spawning and nursery areas can possibly be mitigated by hatcher and improved flows below the projects, the loss of fishing area cannot be replaced.

Artificial propagation facilities would be required below Helena Dam to maintain an estimated average run of 46,000 king salmon, 2,700 silve salmon and 40,000 steelhead.

Helena Reservoir would probably not support an outstanding fisher The watershed is not particularly fertile. Average annual reservoir drawd would be approximately 40 feet; an average daily fluctuation of about 2 inc This would limit natural spawning success of warmwater fish. The reservo would probably support a fair initial fish population for two to four years after which there would be a severe decline in fish production. There woul probably be a band of cold water with adequate oxygen to support trout or kokanee salmon. Canyon Creek and North Fork Trinity River would provide spawning areas for these species. However, to provide satisfactory fishin supplemental planting of trout would no doubt be necessary. This would be an expensive proposition in a reservoir of this size and the source of fun for such a stocking program are uncertain.

<u>Fishery Maintenance</u>. Preliminary estimates of the measures requ to support salmon and steelhead in the Trinity River are:

1. The following fishery maintenance flows should be released from Helena Dam:

Period	Flow Release
October 1 to July 31	500 cfs
August 1 to September 30	300 cfs

2. Multiple level outlet works should be incorporated into Helena Dam.

3. Fish trapping facilities should be installed below Helena Dam during the construction period. Fish taken at the trap would be trucked around the construction area and released upstream. These facilities would be part of the hatchery to be constructed upon completion of the project.

Fishery Compensation. Artificial propagation facilities sufficient to accommodate the eggs obtained from estimated peak runs of about 115,000 king salmon blocked by the Helena Dam would be required. Facilities should also be provided to produce enough yearling silver salmon and steelhead to maintain average historical runs. The total capacity of these facilities would be about 124 million king salmon eggs, 135,000 silver salmon yearlings and 2 million steelhead yearlings.

Fishery Enhancement. The following measures should be considered:

1. The fishery release from Helena Dam could be increased to a 700 cfs year-round flow. This rough estimate of the enhancement flow should be evaluated by field studies. Such a release would increase the fish production potential of the lower Trinity River to an unknown degree.

2. Northern units of the West Side Conveyance System could be constructed and water diverted from the Trinity River could be released down Cottonwood Creek, resulting in considerable fishery benefits. These fishery enhancement possibilities are discussed in Chapter XI.

Effects of Project on Wildlife Resources. The Trinity River drainage supports a major deer herd. The deer summer in the high mountains that encircles the watershed, and winter at low elevations in a narrow strip along the main river and larger tributaries. The summer range is about five times the size of the wintering area. In all, five water storage reservoirs (Horse Linto, Beartooth, Ironside Mountain, Burnt Ranch and Helena) with a combined total of approximately 34,000 surface acres are proposed for this watershed. All the reservoir sites will fall completely within the boundary of the deer winter range. Reconnaissance surveys indicate that if these reservoirs are constructed, approximately 1,090,400 deer days-of-use will be destroyed by inundation.

Seventeen thousand acres of deer winter range has already been destroyed by the Trinity and Lewiston Reservoirs. No compensation for carrying capacity destroyed by these two reservoirs has been received to date. However, negotiations for compensation are underway.

In selecting areas for compensation for the Trinity and Lewiston Reservoirs, the very best areas for habitat development in the entire Trinity River drainage were chosen. Eleven hundred of these acres will be flooded if the 15,700-acre Helena Reservoir is constructed. There is not enough suitable public land on which to create the additional 790,700 deer days-of-u in conjunction with the habitat development recommended for the Trinity and Lewiston Reservoirs. Even with intensive development of all suitable public lands regardless of their location in the winter range, some private lands will have to be acquired. Due to the development of poorer soil sites and mitigation for game losses other than deer, the cost of habitat development and maintenance will be significantly higher than for Trinity and Lewiston Reservoirs.

Complete compensation for wildlife losses should be made. Construction of the proposed reservoirs in conjunction with the Trinity and Lewiston units will not only destroy valuable wildlife habitat, but will inundate practically all of the level and arable land as well as preclude mining along and in the stream channels. The major economy in Trinity County is wildlife and recreation. The best use of the remaining wildlands would be propagation of forests and wildlife. If compensation is not allowed, then the use of the large understocked summer deer range cannot be utilized.

Controlled water flows from the Lewiston Reservoir has permitted considerable riparian growth (willow and alders) as well as considerable herbage (legumes, grasses, and forbs) to become established on the sand bars and along the river course. These areas will be flooded by the construction of the Helena Reservoir. No benefits are anticipated from controlled flows further downstream. Wildlife survey transects were run through these areas, including the mining tailings, and the data is incorporated with the upland game surveys. Total surface acres were used in computing wildlife habitat for Helena Reservoir.

In addition to the wildlife habitat losses, the large numbers of deer that summer in the Chaparral Mountain, Monument Peak-Hayfork Divide area, and cross over and winter north of the Trinity River can be expected to perish, since their migration route will be blocked by Helena Reservoir.

Wildlife losses estimated from reconnaissance surveys are as follows:

Black-tailed deer days-of-use	790,700
California quail*	850
Mountain quail*	300
Gray squirrel	350
Sooty grouse	40
Jackrabbit	60
Wood duck	20

* Quail population estimated for pre-nesting season.

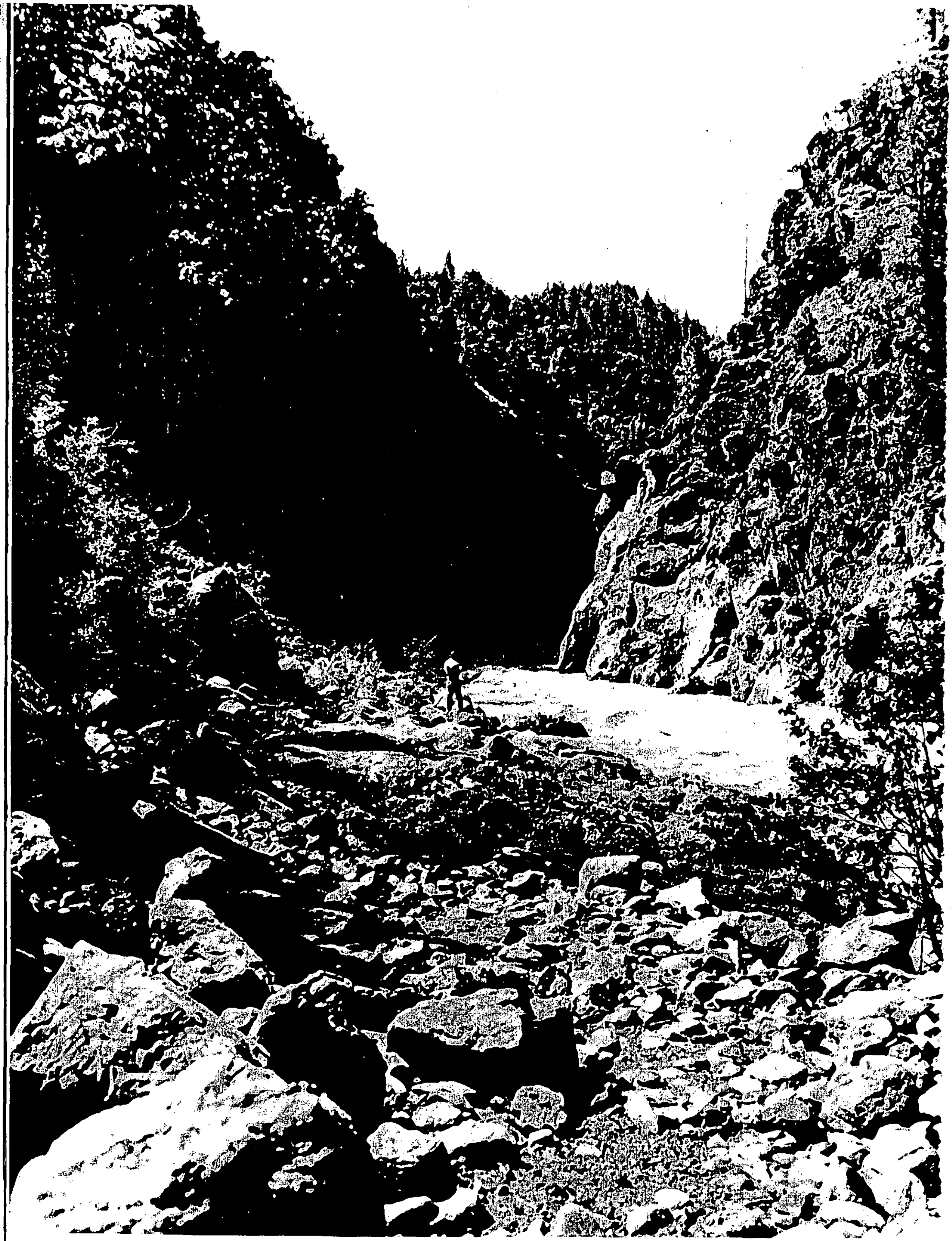
Wildlife Compensation. The measures required to develop and maintain wildlife habitat for 790,700 additional deer days-of-use on winter ranges near the reservoir site are as follows:

Land:	Approximately 13,500 acres of public land and purchase of 1,500 acres of private land.
Development:	Brush and timber conversion, browseways, browse propagation, browse regeneration, and quail habitat development on 13,000 acres of land.
Maintenance:	Annual operation and maintenance of program at project cost.
Facilities:	Administration facilities and program manager.

South Fork Trinity Project

There are two alternatives for the second stage development in the upper Trinity River Basin. The original plan proposed a 645-foot-high dam on the South Fork Trinity River near Hyampom. However, recent geological studies have indicated that a high Eltapom Dam might not be desirable due to the high cost of developing the site. The plan now being given primary consideration would include a 350-foot-high Eltapom Dam downstream from the original damsite. A dam and reservoir on the main Trinity River below Helena at the

18. Upstream view from Eltapom damsite, South Fork Trinity River.
August 18, 1960



19. Burnt Ranch damsite, Trinity River.
June 1958

Burnt Ranch site would be needed. Beartooth Reservoir on the New River near Denny might also be included in this plan. Brief descriptions of these alternatives follow:

Eltapom, Burnt Ranch and Beartooth Reservoirs

Project Descriptions. The second stage development in the upper Trinity River Basin could include a 350-foot-high Eltapom Dam on the South Fork Trinity River, which would create a reservoir with a gross storage capacity of 730,000 acre-feet. Water would be diverted from Eltapom Reservoir through a tunnel to Burnt Ranch Reservoir, which would be created by a 590-foot-high dam across the main Trinity River near the town of Burnt Ranch. Additional new water could be obtained by construction of Beartooth Dam on the New River near Denny and a tunnel to Burnt Ranch Reservoir. Burnt Ranch and Beartooth Reservoirs would have a combined gross storage of about a million acre-feet and a firm annual yield of 200,000 acre-feet of water.

Water developed from Eltapom, Burnt Ranch and Beartooth Reservoirs would be pumped upstream into Helena Reservoir, for subsequent diversion to the Sacramento River Basin via the Clear Creek Tunnel No. 2. The Eltapom-Burnt Ranch Tunnel would be sized to provide capacity for the subsequent Mad-Van Duzen Projects. The water developed from the second stage, together with the yield from the first stage project, could be routed from Whiskeytown Reservoir via Clear Creek through a series of reservoirs and powerplants, or through the West Side Conveyance System as discussed previously.

An alternative plan for second stage development of the upper Trinity River Basin would include only a 645-foot-high dam and reservoir on the South Fork Trinity River near Hyampom. This would create a large

TABLE 21

POSSIBLE PHYSICAL FEATURES OF ALTERNATIVE
SECOND STAGE TRINITY RIVER PROJECT

Dam and Reservoir	Eltapom
Stream	South Fork Trinity River
Damsite Location	T3N, R6E, S 3, 9 and 10 HB&M
Streambed Elevation (feet, MSL)	1,210
Height of Dam (feet)	650
Type of Dam	Earth and Rockfill
Normal Pool Elevation (feet, MSL)	1,840
Minimum Pool Elevation (feet, MSL)	1,670
Reservoir Surface Area (acres)	11,100
Reservoir Storage Capacity (acre-feet)	3,200,000
Firm Annual Yield (acre-feet)	600,000
Estimated Capital Cost	$177,000,000 1/

1/ Construction of dam and reservoir only; does not include cost of associated conveyance facilities.

reservoir with a gross capacity of 3.1 million acre-feet, which would develop an annual yield of about 600,000 acre-feet. Water would be diverted from Eltapom Reservoir via a 13-mile long Eltapom-Helena Tunnel to Helena Reservoir, with subsequent diversion to the Sacramento River Basin via the Clear Creek Tunnel No. 2 as described previously. The Eltapom-Helena Tunnel would be sized to provide capacity for the subsequent Mad-Van Duzen Projects.

Effects of Projects on Fishery Resources. Limited information is available on the numbers and distribution of anadromous fish utilizing the South Fork Trinity River. Current information indicates that all of the spring-run king salmon and most of the fall-run king salmon, silver salmon and steelhead use the area above the proposed damsite. According to the U. S. Fish and Wildlife Service (1960) only about 15 percent of the king salmon spawning in the South Fork use the area below the Eltapom damsite.

Artificial propagation facilities to maintain an estimated average run of 7,000 spring-run king salmon, 5,000 fall-run king salmon, 2,500 silver salmon and 45,000 steelhead would be required below the Eltapom damsite.

Burnt Ranch Reservoir would inundate most of the natural king salmon spawning area in the main Trinity River below the Helena damsite. Only the limited spawning area in the Hoopa Valley would remain. In addition, silver salmon and steelhead spawning and nursery areas in several small tributaries would be lost.

Beartooth Dam and Reservoir would inundate and block access to the majority of the suitable spawning and nursery areas in the New River.

Artificial propagation facilities previously constructed below Helena Dam would be moved below Burnt Ranch Reservoir and enlarged to maintain the anadromous fish runs normally spawning above Burnt Ranch and Beartooth Reservoirs. It is estimated that facilities to accommodate average annual runs of 47,500 king salmon, 3,500 silver salmon and 60,000 steelhead would be required.

The comments made on the probable reservoir fishery in Helena Reservoir also apply generally to Eltapom, Burnt Ranch and Beartooth Reservoirs. The conditions that would exist would probably permit only limited warmwater and coldwater fisheries. Hayfork Creek and the upper South Fork Trinity River would provide suitable spawning for coldwater species in Eltapom Reservoir; however, supplemental planting would be necessary. Eltapom Reservoir would fluctuate about 80 feet annually which would severely limit natural spawning of warmwater species. Burnt Ranch would be a narrow, steep-sided reservoir which would fluctuate over 30 feet annually. It would have very limited natural spawning for both cold and warmwater fishes. Beartooth would be a much smaller reservoir, with an average annual fluctuation of about 30 feet. Coldwater species would find good spawning in the upper reaches of New River; however, supplemental stocking would probably still be necessary.

Fishery Maintenance. Preliminary evaluation of the South Fork Trinity Project indicates the following measures would be required:

1. The following fishery maintenance flows should be released from Eltapom Dam to support the salmon and steelhead utilizing the lower South Fork Trinity River:

Period	Flow Release
October 1 to July 31	120 cfs
August 1 to September 30	80 cfs

2. The following fishery maintenance flows should be released from Burnt Ranch Dam to support the salmon and steelhead utilizing the lower Trinity River:

Period	Flow Release
October 1 to July 31	550 cfs
August 1 to September 30	300 cfs

3. The following fishery maintenance flows should be released from Beartooth Dam to support salmon and steelhead utilizing the lower New River:

Period	Flow Release
October 1 to July 31	80 cfs
August 1 to September 30	50 cfs

4. Multiple level outlet works should be incorporated into Eltapom, Burnt Ranch and Beartooth Dams.

5. Fish trapping facilities should be installed below Eltapom and Burnt Ranch Dams during the construction period. Fish taken in the traps would be trucked around the construction areas and released upstream. These facilities would become part of the hatcheries to be constructed upon completion of the projects.

Fishery Compensation. Artificial propagation facilities to accommodate the eggs obtained from estimated peak runs of about 30,000 king salmon blocked by Eltapom Dam should be constructed below the damsite. Facilities should also be provided to produce enough yearling silver salmon and steelhead to maintain estimated annual runs. The total capacity of these facilities would be about 32 million king salmon eggs, 125,000 silver salmon yearlings and 2.25 million steelhead yearlings.

Artificial propagation facilities would also be required below Burnt Ranch Dam, if a suitable site is available, to accommodate the eggs obtained from peak runs of king salmon blocked by Burnt Ranch and Beartooth Reservoirs. The size of these runs could reach 120,000 king salmon. Facilities to produce enough yearling silver salmon and steelhead to maintain historical average runs should also be provided. The combined capacity of these facilities would be about 128 million king salmon eggs, 175,000 silver salmon yearlings, and 3 million steelhead yearlings.

Fishery Enhancement. The following measures should be considered:

1. The streamflow release from Eltapom Dam could be increased to a yearlong flow of 250 cfs. This would provide optimum velocity and depth over the maximum amount of potential spawning gravel in the lower South Fork Trinity River, and would greatly enhance conditions for fishlife. Assuming that temperatures would be suitable for anadromous fish throughout the year, this release could potentially result in an increase of about 24,000 spawning king salmon.

2. The fishery releases from Burnt Ranch and Beartooth Reservoirs could be enhanced to yearlong flows of 1,000 cfs and 140 cfs, respectively. These flows would improve conditions for fishlife in the stream sections affected.

3. Diversion of water from the second stage developments in the upper Trinity River Basin to the Central Valley could provide justification for construction of additional units of the West Side Conveyance System.

Water released down the West Side Tributaries to the Sacramento River could have considerable fishery benefits. These enhancement possibilities are discussed in Chapter XI.

Effects of Projects on Wildlife Resources. The proposed Eltapom Reservoir would be located on the South Fork Trinity River and would inundate the town of Hyampom and Hyampom Valley. It would have a surface area of 4,600 acres. Estimated wildlife losses based on reconnaissance surveys are as follows:

Black-tailed deer days-of-use	162,000
California quail*	600
Mountain quail*	30
Mourning dove	40
Band-tailed pigeon	300
Gray squirrel	200
Sooty grouse	50
Jackrabbit	20

*Quail population estimated for pre-nesting season.

The proposed Burnt Ranch Reservoir would be located on the main Trinity River and would have a surface area of 5,300 acres. Principal land use in the area is recreation, logging, and mining. Nine hundred acres of the area to be inundated by the proposed reservoir is not considered game habitat, and no wildlife losses were claimed for this area. Estimated wildlife losses based on reconnaissance surveys are as follows:

Black-tailed deer days-of-use	180,000
Mountain quail*	80
Gray squirrel	80

*Quail population estimated for pre-nesting season.

The proposed Beartooth Reservoir would be located on New River, a tributary to the Trinity River, and would have a surface area of 390 acres. Estimated wildlife losses based on reconnaissance surveys are as follows:

Black-tailed deer days-of-use	9,600
California quail*	60
Mountain quail*	20
Gray squirrel	10

*Quail population estimated post-nesting season.

Wildlife Compensation. Measures required to develop and maintain wildlife habitat for 162,000 additional deer days-of-use on ranges adjacent to the Eltapom Reservoir site are as follows:

Land: Approximately 2,500 acres of public land and purchase of 200 acres of private land.

Development: Browse propagation, browseways, browse regeneration, and quail habitat development on 2,500 acres.

Maintenance: Annual operation and maintenance of program at project cost.

Facilities: Administration facilities and program manager, which could include administration of the Burnt Ranch and Beartooth wildlife compensation areas.

The construction of Burnt Ranch Reservoir would require the following measures to develop and maintain wildlife habitat for 180,000 additional deer days-of-use:

Land: Approximately 2,000 acres of public land and purchase of 300 acres of private land.

Development: Brush and timber conversion, browseways, browse propagation, browse regeneration, and quail habitat development on 2,000 acres.

Maintenance: Annual operation and maintenance of program at project cost.

Facilities: Administration facilities and program manager which could be included in Eltapom wildlife compensation area.

Measures required to develop and maintain wildlife habitat for 9,600 additional deer days-of-use on winter ranges adjacent to the Beartooth Reservoir site are as follows:

Land:	Approximately 200 acres of public land.
Development:	Brush and timber conversion, browseways, browse propagation, browse regeneration, and quail habitat development on 175 acres.
Maintenance:	Annual operation and maintenance of program at project cost.
Facilities:	Administration facilities and program manager which could be included in Eltapom wildlife compensation area.

Lower Trinity River Developments

The need for development of the lower Trinity River depends primarily on staging of Klamath River projects. Studies of possible alternative plans for development of the lower Trinity and Klamath Rivers have not been made in as great detail as those for the probable earlier-staged projects. However, these preliminary studies have indicated that one of the possible plans for Klamath River development would require the future construction of Humboldt Reservoir on the lower Klamath, along with Burnt Ranch and Ironside Mountain Reservoirs, and pumping plants on the lower Trinity River, for conveyance of the new water yield into Helena Reservoir. Subsequently, this water would be diverted to the upper Sacramento Valley, possibly through the West Side Conveyance System and the Glenn Reservoir Complex.

Alternative development of the Klamath River would probably include several reservoirs on the upper Klamath River with a diversion to a reservoir at the Horse Linto site on the lower Trinity River. In this plan, water developed from the Klamath River would be pumped from Horse Linto Reservoir successively into Ironside Mountain, Burnt Ranch and Helena

TABLE 22

POSSIBLE PHYSICAL FEATURES OF ALTERNATIVE
LOWER TRINITY-KLAMATH RIVER PROJECTS

Dam and reservoir	Ironside Mountain	Horse Linto 1/
Stream	Trinity River	Trinity River
Damsite Location	T6N, R6E, S 35 HB&M	T7N, R6E, S 5 HB&M
Streambed Elevation (feet, MSL)	660	325
Height of Dam (feet)	230	530
Type of Dam	Concrete Gravity	Concrete Gravity
Normal Pool Elevation (feet, MSL)	870	850
Minimum Pool Elevation (feet, MSL)	870	660
Reservoir Surface Area (acres)	160	12,000
Reservoir Storage Capacity (acre-feet)	15,000	2,600,000
Firm Annual Yield (acre-feet)	0	1,100,000 2/
Estimated Capital Cost 3/	$11,000,000	$88,000,000

1/ Alternative development in association with unspecified upper Klamath River developments to Humboldt Reservoir.

2/ Impaired by full development of the Trinity River, including Helena, Burnt Ranch, and Ironside Mountain Reservoirs, but with no development of the South Fork Trinity River.

3/ Construction of dam and reservoir only; does not include cost of associated conveyance facilities.

Reservoirs, with eventual diversion to the Sacramento Valley as described previously.

Ironside Mountain and Horse Linto Reservoirs

Project Descriptions. In either plan to develop the lower Trinity-Klamath Basin a reservoir at the Ironside Mountain site is necessary; however, since it develops no new yield, Ironside Mountain Reservoir would not be built without additional downstream development. Ironside Mountain Reservoir would function solely in the transportation of water up the Trinity River for eventual export from the basin. It would be formed by a 230-foot high dam and would have a gross storage of about 15,000 acre-feet.

The alternative development of the lower Trinity-Klamath Basin would probably require a reservoir at the Horse Linto site. This reservoir would be formed by a 530-foot high dam and would have a gross capacity of about 2.6 million acre-feet.

Effect of Projects on Fishery Resources. The effects of possible development at the Humboldt site on the anadromous fish of the Klamath River will be discussed in Chapter X -- Klamath River Hydrographic Unit. Under the alternative plan, Horse Linto would complete development of the lower Trinity River and would block anadromous fish historically migrating above that point. Only the limited salmon spawning area in the Hoopa Indian Reservation would remain below this project. Sturgeon and shad would also be blocked by Horse Linto Dam. Both species migrate upstream at least to Willow Creek.

Artificial propagation facilities to maintain average annual runs of 70,000 king salmon, 7,500 silver salmon and about 130,000 steelhead would be required below Horse Linto Dam.

Fishery Maintenance. Preliminary estimates of the measures required to support salmon and steelhead in the lower Trinity River are:

1. The following fishery maintenance flows should be released from a dam constructed at the Horse Linto site:

Period	Flow Release
October 1 to July 31	1,100 cfs
August 1 to September 30	550 cfs

2. Multiple level outlet works should be installed in Horse Linto Dam to provide downstream releases of suitable temperature for fishlife.

3. Fish trapping facilities should be constructed below Horse Linto Dam during the construction period. Fish taken at the trap would be trucked around the construction area and released upstream. These facilities would become part of the hatchery to be constructed upon completion of the project.

Fishery Compensation. Artificial propagation facilities adequate to accommodate the eggs taken from peak runs of about 175,000 king salmon blocked by Horse Linto Dam should be constructed below the damsite. Facilities to produce enough yearling silver salmon and steelhead to maintain historical average runs of these species would also be required. The total capacity of these facilities would be about 190 million king salmon eggs, 375,000 silver salmon yearlings and 6.5 million steelhead yearlings.

Fishery Enhancement. The following measures should be considered:

1. While little is known about streamflow conditions for fishlife in the lower Trinity River, a yearlong fishery release of 1,600 cfs would probably enhance the lower river. Further study would be required to determine the enhancement provided by this flow.

2. As discussed previously, diversion of Trinity River water through the West Side Conveyance System could provide substantial fishery enhancement in the West Side Tributaries to the Sacramento River. These enhancement possibilities are discussed in Chapter XI.

Effects of Projects on Wildlife Resources. The proposed Ironside Mountain Reservoir, located on the lower Trinity River, would have a surface area of 160 acres. Because of the reservoir's small size, and the terrain in which the reservoir is located, no wildlife compensation is being claimed.

The proposed Horse Linto Reservoir would be located on the lower Trinity River and would have a surface area of 12,000 acres. Wildlife losses based on reconnaissance surveys are as follows:

Black-tailed deer days-of-use	180,800
California quail*	1,240
Mountain quail*	320
Mourning dove	100
Gray squirrel	200

*Quail population estimated post-nesting season.

Wildlife Compensation. The measures required to develop and maintain wildlife habitat for 180,800 additional deer days-of-use on winter ranges adjacent to the Horse Linto Reservoir site are as follows:

Land: Approximately 4,000 acres of public land:

Development: Brush and timber conversion, browseways, browse propagation, browse regeneration, and quail habitat development on 3,400 acres of land.

Maintenance: Annual operation and maintenance of program at project cost.

Facilities: Administration facilities and program manager, which could be included in the Helena wildlife compensation area.

CHAPTER IX. MAD RIVER-REDWOOD CREEK HYDROGRAPHIC UNIT

General Description

The Mad River-Redwood Creek Hydrographic Unit contains the Mad River drainage plus the smaller coastal basins of Redwood Creek, Maple Creek, and Little River. The Mad River heads at about 5,000 feet elevation in southwestern Trinity County. It flows in a northwesterly direction through a narrow trough that gradually expands as it approaches the coast, before the stream enters the ocean about 10 miles north of Eureka. The drainage includes nearly 500 square miles.

Long, straight, rather even-shaped ridges form the divide of this drainage. There are no imposing peaks. The canyon bottoms and adjacent slopes are usually steep and rugged. The tops of the ridges vary from about 3,000 to 5,000 feet elevation.

The upper one-third of the river flows through a graveled course of slight gradient. There are considerable amounts of small gravel suitable for steelhead and silver salmon; however, barriers about half-way up the stream block these fish at most flows. The middle one-third of the river has a moderate gradient and is characterized by deep pools and numerous small falls and cascades. The streambed is composed largely of boulders, bedrock, and rubble. Spawning gravel is very scarce in this section. The lower one-third of the stream has a slight gradient and is characterized by long, graveled riffles. Much of this reach is suitable for king salmon spawning.

The major tributaries of the Mad River are the North Fork, which enters the river about 10 miles above the mouth, and Pilot Creek which enters from the north side near the mid-point of the drainage. Most tributaries are small and intermittent.

Most of the precipitation in this unit falls in the form of rain concentrated in the months of November through April. Runoff is rapid and there is wide variation between winter and summer flows. The summer climate is warm in all but the lower 10 miles or so of stream. The latter area is subject to the cooling effect of coastal fog.

Conifers are the dominant tree type in the drainage. These are mainly Douglas fir with lesser amounts of redwood. Redwood are found most frequently in coastal areas of the drainage. Roughly two percent of the basin is in agricultural lands on the coastal plain near the mouth.

Streams in the drainage are fairly well shaded by trees and shrubs, the general steepness of the canyon, and the trend of the stream courses.

Moderate to heavy amounts of silt are found on the stream bottom, however, apparently this does not materially injure the spawned eggs. Many of these fines are washed away by fall rains and during spawning activity.

One of the major features of the drainage is Sweasey Dam and Reservoir, located about 17 miles above the mouth. This old structure serves as a source of domestic and municipal water for the Eureka area. A fish ladder located at the dam provides access for salmon and steelhead to the mid-part of the drainage where the previously mentioned barriers are located. Ruth Dam and Reservoir dominates the upper third of the drainage. No fish access facilities are required at Ruth Dam, because of natural fish barriers downstream.

The Redwood Creek drainage is the second largest and most important stream system in the Mad River Hydrographic Unit. In some respects, it resembles the Mad River drainage. Its general topography is very similar, and like the Mad River, it flows in a northwesterly direction, but it is only about one-half the length of the Mad River. Redwood Creek has a moderate gradient throughout, and steelhead and silver salmon can ascend almost to the headwaters. There are no major water developments in the Redwood Creek basin.

The only remaining drainages in the hydrographic unit are Maple Creek, which drains the Big Lagoon subunit, and Little River. These short coastal drainages differ from the Mad River drainage in that they are completely under the influence of coastal summer fog. Consequently, water temperatures stay considerably lower than they do in the portions of Mad River above the fog belt. Most of the gravels in these streams are much smaller than are those in the Mad River, consequently, these streams are better suited for steelhead and silver salmon spawning than they are for king salmon.

Georgraphical boundaries of the hydrographic unit and subunits are shown on Plate 4, entitled "Hydrographic Units and Subunits of the North Coastal Hydrographic Area." All quantitative data on fish resources and flow requirements are shown in Table 23.

Fishery Resources

The Mad River Hydrographic Unit contains two large streams, the Mad River and Redwood Creek, plus three smaller streams, Little River, Maple and McDonald Creeks. These streams support good runs of silver salmon and steelhead. Mad River, Redwood Creek, and Little River also have runs of king salmon. A brief description of these basins and their fish and wildlife resources follows.

Mad River

The Mad River is a major producer of fish. It supports runs of anadromous salmon and steelhead, and resident trout are present in upstream areas. King salmon, silver salmon, and steelhead trout constitute the most important fisheries of the river. The coastal cutthroat trout, another anadromous species, is present in limited numbers, but is not of major importance. Resident rainbow trout are found in the Mad River above Sweasey Dam and in the upper reaches of most of the tributaries.

King salmon enter the river from the ocean usually after the first substantial fall rains. A sand bar closes the mouth of the stream during the low flow period in most years, and increased flows must break open the bar to allow fish to enter the stream. During years when the mouth of the river is not closed, king salmon may enter as early as August, but are often blocked by intermittent sections of stream only a few miles above the mouth. There is a large tidal estuary about 3 miles in length at the mouth of the river which serves as an important resting area for salmon and steelhead which have entered the river but are not ready or unable to migrate upstream.

Silver salmon and steelhead do not enter the Mad River in large numbers until streamflows have risen to substantial levels. The run of silver salmon usually peaks about a month after the peak of the king salmon run. The steelhead migration continues well into the spring months, with most of the spawning taking place in late winter or early spring. Since silver salmon and steelhead are in the stream during months of greatest rainfall, weather and streamflow conditions are often poor resulting in fewer fishable days for these species than for king salmon.

King salmon are subject to sport fishing from the time they enter the stream until they complete spawning in late December. Generally, mild weather and moderate streamflows during this time enables anglers to take fairly large numbers of them.

The U. S. Fish and Wildlife Service (1960) estimated that the Mad River presently receives about 7,600 angler-days of fishing annually, of which 3,800 are for trout, 1,000 for salmon, and 2,800 for steelhead. An estimated 12,400 trout, 200 salmon, and 1,100 steelhead are caught. These estimates are believed to be very conservative. Data for the 1956-57 season indicated that approximately 6,300 angler-days were expended fishing for salmon and steelhead on the Mad River with a catch of over 2,200 fish.

Spawning gravel surveys by the U. S. Fish and Wildlife Service (1960) and Humboldt State College (Ridenhour and others,1961) indicated that the major spawning areas for king salmon occur in the lower Mad River up to Sweasey Dam and in the North Fork and Canon Creek. It was estimated that a minimum of 2,500 king salmon redds could be accommodated by the gravels in the lower Mad River and its tributaries. Excellent spawning gravel exists between Sweasey Dam and Blue Slide Creek about 15 miles upstream, and about 2,000 pairs of salmon would be able to spawn without difficulty. Relatively few good spawning areas were observed between Blue Slide Creek and the upstream limit of migration near the mouth of Wilson Creek. There was sufficient gravel for only about 100 redds in this area. These estimates of spawning gravel capacity were all relative and should not be considered as absolute numbers of fish required to fully utilize the available spawning gravel.

Approximately 24 miles above Sweasey Dam is a 2-mile long section of roughs, beginning near the confluence of Wilson Creek. These roughs consist of large boulders which block much of the channel, with a 25-foot fall at the head of the section. This fall, about one-half mile below the mouth of Bug Creek is the upstream limit for anadromous fish migration.

Black Dog, Maple and Boulder Creeks provide spawning areas for anadromous fish migrating above Sweasey Dam; however, the relative amount is not known.

During two recent years, 1952 and 1954, the Department of Fish and Game conducted tagging and recovery programs to estimate the size of the king salmon runs. In 1952, when 401 king salmon passed over Sweasey Dam, it was estimated that 5,120 king salmon spawned downstream from the dam, and that 800 were taken by anglers in the river below the dam. In 1954, when 403 kings passed Sweasey Dam an estimated 3,300 fish spawned downstream from the dam, and the catch by anglers was estimated at 240 fish.

Counts made by the Department of Fish and Game at Sweasey Dam have shown that the run of king salmon spawning above the dam has gradually dwindled from a peak of 3,139 in 1941 to only 19 fish in 1959. This small number of fish may be the result of the severe floods in December 1955, which undoubtedly adversely affected eggs spawned that year. It is anticipated that the run will gradually build up to its former magnitude. The counts made by the department at Sweasey Dam since 1938 are a good indication of the numbers of fish spawning above the dam, but do not reflect the numbers of fish using downstream areas. Most of the king and silver salmon spawning in the Mad River use areas downstream from Sweasey Dam. The bulk of the steelhead run, however, probably spawns upstream from the dam.

Based on Sweasey Dam counts, spawning surveys by the Department of Fish and Game, and sport fishing data collected by the U. S. Fish and Wildlife Service, it is estimated that the historical average number of king salmon spawning in the Mad River is about 10,000 fish. It is also estimated that there are average runs of about 2,500 silver salmon and

6,000 steelhead. The Department of Fish and Game has stocked large numbers of silver salmon yearlings in the river since 1957 in an attempt to build up the run of this species. As a result the returns of silver salmon migrating above Sweasey has risen sharply the past few years. It remains to be seen whether the run will maintain itself when the stocking program is terminated.

Redwood Creek

Redwood Creek flows through a relatively long and narrow basin of about 280 square miles in Humboldt County. It has few tributaries, with Prairie Creek the best known and most important. Nursery habitat for silver salmon and steelhead is limited throughout the drainage by low summer flows. Sand bars often close the mouth which blocks the upstream migration of anadromous fish until the first fall rains. Spawning gravel is generally small to medium in size throughout the drainage and is interspersed with large amounts of fine sediments.

Redwood Creek supports fair runs of king and silver salmon, and a good run of steelhead. The fall run of king salmon was estimated at 5,000 fish by the U. S. Fish and Wildlife Service (1960). There is probably no spring run. The peak of the fall king salmon run occurs in late October and early November. Spawning takes place from November to January.

The silver salmon run in Redwood Creek is estimated at about 2,000 fish. They enter the stream about the same time as the king salmon; however, spawning is somewhat later and continues into February. Silver salmon spawn primarily in the headwaters of the tributaries.

A run of about 10,000 steelhead spawns in Redwood Creek. Like silver salmon, they spawn mostly in the headwaters of the smaller tributaries. The peak of the spawning occurs in March.

Redwood Creek also has a good run of anadromous cutthroat trout. The bulk of these fish spawn in Prairie Creek during the early spring. Resident cutthroat and rainbow trout also inhabit upper areas of the Redwood Creek basin.

Little River

Little River once supported a small commercial king salmon fishery, however, apparently over-fishing largely destroyed the run. Now, only a small number of king salmon spawn in the river, although it is still an important silver salmon spawning stream. Steelhead trout and sea-run cutthroat trout also enter the river to spawn in the winter and early spring. According to U. S. Fish and Wildlife Service surveys, about 8 miles of the Little River is accessible to salmon runs. Usable spawning riffles, composed primarily of small gravel, are found generally in the middle reaches of the main stream and its tributaries.

Based on limited data, it is estimated that Little River has runs of about 900 king salmon, 1,500 silver salmon and 4,000 steelhead.

Tributaries to Big Lagoon Subunit

Maple Creek, a tributary of Big Lagoon, and McDonald Creek, a tributary of Stone Lagoon, have small runs of silver salmon and steelhead trout. It is estimated these runs total about 1,500 silver salmon and 4,000 steelhead. Resident and anadromous cutthroat trout are also present in moderate numbers.

Wildlife Resources

This area along with most hydrographic units in the North Coast have high black-tailed deer densities. Among the many game species present in the unit, the following, in addition to deer, are the more important: California quail, mountain quail, black bear, brush rabbit, waterfowl, sooty grouse, and gray squirrel. Both migratory and resident deer are found in this unit and are hunted quite heavily. Quail and brush rabbit are taken by hunters in moderate numbers where these species occur.

Subunit Descriptions

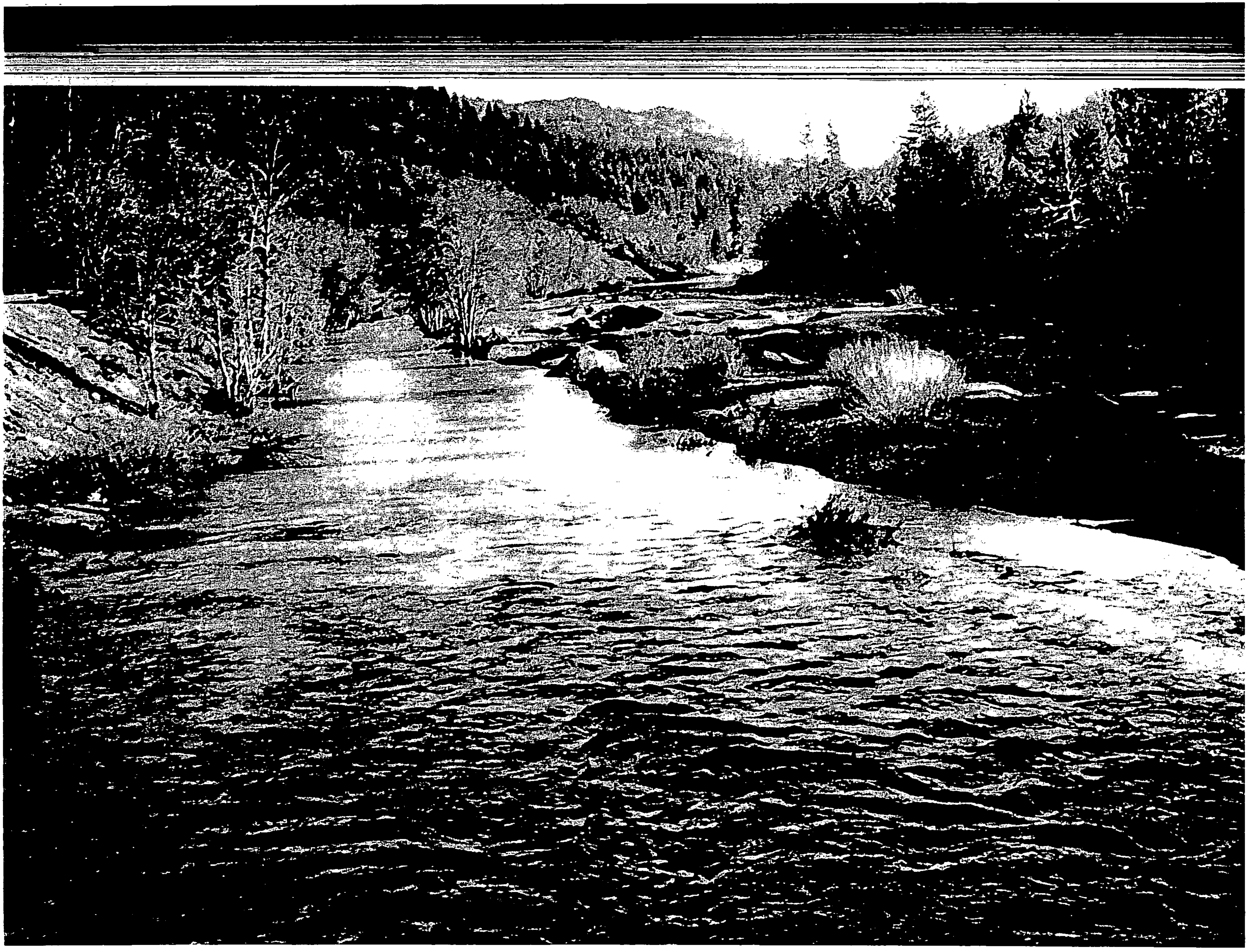
1. Ruth Subunit. This subunit is composed of the upper one-third of the Mad River drainage. The river canyon is very narrow in this section and the short, steep tributaries follow tortuous courses to the river. The major man-made feature of this subunit is Ruth Dam, located about 10 miles above the lower boundary of the subunit.

2. Butler Valley Subunit. This subunit includes most of the remainder of the river's course. The canyon widens from a constriction at the upper end of the subunit to the maximum width found anywhere in the drainage by the time it reaches the lower end of the subunit. Sweasey Dam is located near the lower end of the subunit and most king salmon spawning in the subunit occurs below that structure.

3. North Fork Subunit. This subunit encompasses the drainage of the North Fork Mad River. The extreme headwaters are steep, but as the stream enters the main canyon of the Mad River it widens and the streambed contains considerable amounts of gravel suitable for king salmon spawning.

4. Blue Lake Subunit. This subunit includes the remainder of the Mad River from a point just above the mouth of the North Fork to the ocean. Extensive spawning beds are found in the wide stream channel of the lower river.

5. Little River Subunit. This short coastal drainage heads in a steep, V-shaped canyon which quickly widens as it enters the coastal plain.



In the coastal plain considerable amounts of gravel suitable for spawning by king and silver salmon and steelhead are found, except in the lowermost reaches of the stream. The stream gradient is moderate in the middle and lower sections. The climate in the subunit is cool throughout the summer due to the influence of coastal fog.

6. Snow Camp Subunit. This is the uppermost subunit on Redwood Creek. The gradient in this portion of the stream is moderate to steep and spawning gravel for king salmon is limited. The spawning gravel is of small size and restricted to pockets, except in the extreme headwaters of this section. These gravels are usable by steelhead and silver salmon.

7. Beaver Subunit. This subunit encompasses the middle section of Redwood Creek. The canyon is narrow in this section, however, due to larger flows, the stream does spread out somewhat, and gravel becomes more extensive. The gravel is larger than that found further upstream and becomes suitable for king salmon. Considerable amounts of sand and silt are found in this and lower parts of the stream, no doubt as a result of poor logging practices within the watershed.

8. Orick Subunit. This is the lowermost subunit of the Redwood Creek drainage. The gradient flattens out somewhat and the stream comes under the influence of coastal fog, which results in the lowering of summer air temperatures. The major triburary of this section is Prairie Creek, which enters the stream from the north a short distance above the mouth. Gravel size increases somewhat in this lower section and is suitable for king salmon spawning.

9. Big Lagoon Subunit. The only drainage of importance in this subunit is Maple Creek, which enters Big Lagoon at its southern end. The stream is rather steep in its extreme headwaters; however, lower areas cross

the coastal plain where the gradient is slight. The proximity of Maple Creek to the coast puts it under the influence of coastal fog and summer water temperatures are cool as a consequence. The Maple Creek drainage contains relatively small gravel and is only suitable for steelhead and silver salmon spawning.

TABLE 23

MAD RIVER-REDWOOD CREEK HYDROGRAPHIC UNIT
ESTIMATED FISHERY RESOURCES AND FLOW REQUIREMENTS

Subunit	Fishery Resources			Required Flows (CFS) Maintenance			Required Flows (CFS) Enhancement		
	King Salmon	Silver Salmon	Steel-head	Oct 16-Apr 30	May 1-Jun 30	Jul 1-Oct 15	Oct 1-Apr 30	May 1-Jun 30	Jul 1-Sep 3
Ruth	0	0	0	120	60	5	275	140	Unknc
Butler Valley	5,600	500	4,000	650	325	40	1,400	700	Unknc
North Fork	700	100	500	100	50	5	200	100	Unknc
Blue Lake	3,700	1,900	1,500	900	450	50	1,800	900	Unknc
Little River	900	1,500	4,000	110	55	8	200	100	Unknc
Snow Camp	1,000	600	3,000	200	100	18	300	150	Unknc
Beaver	2,000	800	4,000	600	300	40	900	450	Unknc
Orick	2,000	600	3,000	900	450	60	1,400	700	Unknc
Big Lagoon	0	1,500	4,000	180	90	14	375	190	Unknc

Proposed Water Developments

Mad-Van Duzen Project

This project would constitute the third stage of development withir the Trinity River Division. Features would include Larabee Valley and Eaton Reservoirs in the Van Duzen River Basin, which have been previously discusse

TABLE 24

POSSIBLE PHYSICAL FEATURES OF
MAD RIVER PROJECTS

Dam and reservoir	Butler Valley	Anderson Ford	Enlarged Ruth
Stream	Mad River	Mad River	Mad River
Damsite Location	T5N, R2E, S 36 HB&M	T2N, R5E, S 16 HB&M	T1S, R7E, S 19 HB&M
Streambed Elevation (feet, MSL)	307	2,077	2,540
Height of Dam (feet)	193	372	277
Type of Dam	Earthfill	Earthfill	Earthfill
Normal Pool Elevation (feet, MSL)	460	2,415	2,787
Minimum Pool Elevation (feet, MSL)	387	2,350	2,601
Reservoir Surface Area (acres)	1,360	1,380	5,420
Reservoir Storage Capacity (acre-feet)	75,000	160,000	480,000
Firm Annual Yield (acre-feet)	144,000 1/	60,000 2/	180,000
Estimated Capital Cost 3/	$13,000,000	$29,500,000	$12,800,000

1/ Yield at Essex Pumping Plant.

2/ Combined export yield of Enlarged Ruth, Anderson Ford, Eaton, and Larabee Valley Reservoirs would be 600,000 acre-feet per year.

3/ Construction of dam and reservoir only; does not include cost of associated conveyance facilities.

in Chapter V - Eel River Hydrographic Unit. The project would also include an enlargement of Ruth Reservoir; Anderson Ford Diversion Dam; and a reservoir at the Butler Valley site, all in the Mad River Basin. These projects would provide additional export water, municipal and industrial water supply for the Eureka-Arcata area, and stream maintenance releases for the lower Mad River.

Surplus flows of the Mad and Van Duzen Rivers, developed by these reservoirs, would be diverted through a tunnel and powerplant into Eltapom Reservoir on the South Fork Trinity River for subsequent diversion to the Sacramento Valley. The Mad-Van Duzen Project would add another 600,000 acre-feet of new yield to the system at an estimated capital cost of $219 million.

Enlarged Ruth Reservoir

Project Description. Ruth Reservoir is a recently constructed facility of the Humboldt County Water District which provides the Eureka-Arcata area water supply. Ruth Dam is a 150-foot high earthfill structure which impounds a reservoir of 51,800 acre-feet of water. The enlarged Ruth Reservoir would be formed by raising the dam to a height of 277 feet, which would back a reservoir with a capacity of 480,000 acre-feet and a surface area of 5,420 acres.

Effects of Project on Fishery Resources. Anadromous fish have never been able to reach the Ruth damsite due to natural barriers in the river downstream, therefore, the existing reservoir as well as the proposed enlargement affect only resident species. Since its construction, Ruth Reservoir has supported a fine trout fishery, due to heavy stocking with fingerling trout by the Department of Fish and Game and the initial fertility present in most new impoundments. This high level of production will not continue after the initial fertility of the basin is exhausted. Fish production can be expected to drop sharply and then stabilize at some relatively low level. Enlargement of the reservoir would, of course, cause fish production to spurt upward for a few years. The enlarged reservoir could be expected to support a trout fishery similar to that in the existing reservoir.

Fishery Maintenance. The following fishery maintenance flow should be released from enlarged Ruth Dam to support resident trout in downstream areas of the Mad River:

Period	Flow Release
October 16 to April 30	120 cfs
May 1 to June 30	60 cfs
July 1 to October 16	5 cfs

The streamflow release from Ruth Dam should be made from a low level in the reservoir so that water temperatures suitable for trout can be maintained as far downstream as possible.

Effects of Project on Wildlife Resources. The enlarged Ruth Reservoir would have a surface area of 5,420 acres. The reservoir basin presently supports small herds of resident and migratory deer. The best wintering areas are on the south and east slopes of mountains north of the river. There is a shortage of browse on the winter range and the deer depend heavily on grass and herbs found in glades during winter and spring. Estimated wildlife losses based on reconnaissance surveys conducted in the enlarged Ruth Reservoir site are as follows:

Black-tailed deer days-of-use	154,800
California quail*	150
Mountain quail*	120
Band-tailed pigeon	20
Gray squirrel	100
Sooty grouse	20
Jackrabbit	20

*Quail population estimated for pre-nesting season.

Wildlife Compensation. The measures required to develop and maintain wildlife habitat for 154,800 additional deer days-of-use on winter range adjacent to the enlarged Ruth Reservoir are as follows:

Land: Approximately 1,800 acres of public land and purchase of 1,800 acres of private land.

Development: Browseways, browse propagation, browse regeneration and quail habitat development on 2,500 acres. Construction of 20 miles of fence to control livestock grazing.

Maintenance: Annual operation and maintenance of program at project cost.

Facilities: Administration facilities and a program manager, which could be included in the Larabee Valley wildlife compensation area.

Anderson Ford Diversion Dam

Project Description. Anderson Ford Diversion Dam would be formed by a 372-foot high earthfill dam across the Mad River just below the confluence of Pilot Creek. The reservoir would have a storage capacity of about 160,000 acre-feet and would capture local runoff as well as divert water released from Ruth Reservoir and imported from the Van Duzen River Projects into South Fork Tunnel which would terminate in Eltapom Reservoir on the South Fork Trinity River.

Effects of Project on Fishery Resources. Anderson Ford Diversion Dam would also lie above the point of upstream migration of anadromous fish and would therefore affect only resident species. The reservoir would be a long, narrow body of water which would probably support a fair trout fishery. The trout population would find spawning areas in the Mad River between Ruth Dam and the upper end of Anderson Ford Reservoir and in upper Pilot Creek; however, the trout fishery would depend on heavy supplemental planting of fingerling or catchable trout. Due to the relative steepness of the reservoir, and rapid turnover of the water, it would not be particularly fertile, and it is doubtful that a really good fishery would develop.

Fishery Maintenance. The following fishery maintenance flow should be released from Anderson Ford Diversion Dam to maintain salmon, steelhead and resident trout populations in the lower Mad River:

Period	Flow Releases
October 16 to April 30	250 cfs
May 1 to June 30	125 cfs
July 1 to October 16	15 cfs

The streamflow release from Anderson Ford Dam should be made from a low level in the reservoir so that temperatures suitable for salmonids can be maintained as far downstream as possible.

Fishery Enhancement. The streamflow release from Anderson Ford Diversion Dam could probably be enhanced to support a larger fish population below the reservoir; however, the optimum flow release schedule is not known at this time.

Effects of Project on Wildlife Resources. The proposed Anderson Ford Reservoir would have a surface area of 1,380 acres. The reservoir site has the same general terrain characteristics and ground cover types as the Ruth Reservoir basin. It also supports small herds of resident and migratory deer. Estimated wildlife losses based on reconnaissance surveys conducted in the reservoir site are as follows:

Black-tailed deer days-of-use	35,600
California quail*	30
Mountain quail*	20
Band-tailed pigeon	5
Gray squirrel	20
Sooty grouse	25
Jackrabbit	5

*Quail population estimated for pre-nesting season.

Wildlife Compensation. The measures required to develop and maintai wildlife habitat for 35,600 additional deer days-of-use on winter ranges adja-cent to Anderson Ford Reservoir are as follows:

Land: Approximately 400 acres of public land and purchase of 400 acres of private land.

Development: Browseways, browse propagation, browse regeneration, and quail habitat development on approximately 600 acres.

Maintenance: Annual operation and maintenance of program at project cost.

Facilities: Administration facilities and a program manager, which could be included in the Larabee Valley wildlife compen-sation area.

Butler Valley Reservoir

Project Description. Butler Valley Reservoir would be formed by a 193-foot high earthfill dam across the Mad River several miles upstream from the existing Sweasey Dam. It would have a capacity of about 75,000 acre-feet and would serve as the domestic and industrial water supply for the Eureka-Arcata area.

Effects of Project on Fishery Resources. Butler Valley Reservoir would lie below the upstream limit to anadromous fish migration. Most of the salmon and steelhead migrating over Sweasey Dam normally spawn above the Butler Valley damsite. Therefore, artificial propagation facilities to accommodate the eggs taken from average runs of 800 king salmon, 300 silver salmon, and 3,500 steelhead, would be required below the dam.

The reservoir would probably support a trout fishery which would have to be maintained by planting fingerling or catchable trout. Due to its relative proximity to the Eureka-Arcata area, Butler Valley Reservoir would probably receive heavy angler-use.

Fishery Maintenance. The following fishery release should be made from Butler Valley Dam to maintain salmon and steelhead utilizing downstream areas of the Mad River:

Period	Flow Release
October 16 to April 30	550 cfs
May 1 to June 30	280 cfs
July 1 to October 15	35 cfs

Multiple level outlet works should be incorporated into Butler Valley Dam to provide water of suitable temperature for salmon and steelhead.

During the construction period of Butler Valley Dam, salmon and steelhead migrating over Sweasey Dam should be trapped and trucked around the construction site and released. Free passage for downstream migrants would be necessary during the entire construction period.

Fishery Compensation. Artificial propagation facilities should be provided below Butler Valley Dam to accommodate eggs taken from peak runs of king salmon, silver salmon and steelhead. The capacity of these facilities should be about 3.25 million king salmon eggs, 15,000 silver salmon yearlings, and 175,000 steelhead yearlings.

As an alternative to the above plan, improvement of downstream areas of the Mad River might be undertaken to increase production of anadromous fish below the damsite. The streamflow release from Butler Valley Reservoir could be enhanced to increase production of king salmon in the lower river. Sweasey Dam, no longer needed as a domestic water supply, could be razed, thus improving access to the fine salmon spawning area between Sweasey Reservoir and the Butler Valley damsite. Fish ladders could be constructed over natural barriers on Canyon Creek and the North Fork Mad River, which would open up many miles of spawning and nursery area to silver salmon and steelhead. The cost of these measures could be much less than the capital cost and annual operation costs of the proposed hatchery. These two alternative plans should be given further study to determine which has the most merit.

Fishery Enhancement. The suitable salmon spawning gravel in the lower Mad River could be maximized by increasing the fishery maintenance release from Butler Valley Dam to supplement the natural flow and maintain the following flows at the U. S. Geological Survey Stream Gage near Arcata:

Period	Flow Release
October 1 to April 30	1,400 cfs
May 1 to June 30	700 cfs
July 1 to September 30	Unknown

Assuming that optimum flows could be determined and released during the remainder of the year and that water temperatures would be suitable for salmonids, this supplemental release would provide the potential for an incre of 57,000 fish in the average annual spawning run of king salmon.

Effects of Project on Wildlife Resources. The proposed 1,360 acre Butler Valley Reservoir is located on Mad River near the logging community of Maple Creek. The proposed reservoir site encompasses Butler Valley and cleared farming areas and pastures that lie upstream from the valley. The open land is surrounded by and interspersed with logged-over redwood forests. The edge around the cleared area is productive game habitat. Wildlife losses based on reconnaissance surveys are as follows:

Black-tailed deer days-of-use	25,300
California quail*	475
Mountain quail*	150
Mourning dove	10
Band-tailed pigeon	20
Gray squirrel	10
Sooty grouse	20
Brushrabbit	30

*Quail population estimated for pre-nesting season.

Wildlife Compensation. With the flooding of the major open areas in the reservoir basin, the creation of additional game habitat in the immediate vicinity of the project would be a costly undertaking of doubtful success. Wildlife losses should therefore be mitigated upstream in conjunction with the Anderson Ford or enlarged Ruth Reservoir projects. The measures required to develop and maintain wildlife habitat for 25,300 additional deer days-of-use as compensation for losses in the Butler Valley Reservoir site are as follows:

Land: Approximately 300 acres of public land and purchase of 300 acres of private land.

Development: Browseways, browse propagation, browse regeneration, and quail habitat development on approximately 400 acres.

Maintenance: Annual operation and maintenance of program at project cost.

Facilities: Administration facilities and a program manager, which could be included in the Larabee Valley wildlife compensation area.

CHAPTER X. KLAMATH RIVER HYDROGRAPHIC UNIT

General Description

The Klamath River Hydrographic Unit consists of the Klamath River drainage plus the lower ends of the Salmon and the Scott Rivers. This unit covers only the portion of the Klamath River drainage within the State of California. This is the largest drainage in Northern California and covers almost 8,000 square miles.

The portion of the river to be described in this report heads in Copco Lake, a hydroelectric project owned by the California-Oregon Power Company. From this reservoir the river flows in a generally west-southwest direction for over 200 miles and enters the Pacific Ocean 32 miles south of the California-Oregon boundary. Major tributaries are the Shasta, Scott, Salmon, and Trinity Rivers, all of which are described in other chapters in this report.

The Copco Lake basin is in semi-arid volcanic country dotted with volcanic buttes and mesas. The vegetation is very sparse and consists primarily of juniper, black and white oaks, sage brush, and various grasses. Below Copco Lake the river flows in a western direction and enters a steep-walled, V-shaped canyon below Hornbrook. The vegetation undergoes a transition from juniper and sagebrush to Douglas fir and yellow pine. The canyon becomes progressively steeper as it flows westward and the coniferous tree cover becomes more dense. Only Seiad Valley and scattered small flats break up the V-shaped topography of the canyon. Near Happy Camp the river turns and flows southwest through a gorge toward its confluence with the Trinity River. This is the deepest and most precipitous part of the canyon. Below the mouth of the Trinity, the Klamath River flows in a northwestern direction to its mouth.

Most of the main river has a moderate gradient, except for the section below the mouth of the Trinity River, which has a slight gradient. Gradients of lower sections of major tributaries are moderate also, becoming steep only in the extreme headwaters. Tributaries draining the Marble and Salmon-Scott Mountains, and the Trinity Alps head in rocky, alpine regions.

The river is perennially discolored due to microscopic plants and animals. The presence of these organisms attest to the generally fertile nature of the water and watershed.

Although much of the precipitation in this hydrographic unit falls as rain during the months of October through April, snowmelt contributes a considerable part of the river's flow, especially during the spring and summer. This results from snowfall in the high Marble, Salmon-Scott, and Trinity Alps, and Siskiyou Mountains which drain into the middle of the basin from the south. The summer streamflow is also maintained by numerous springs in the volcanic formations in the eastern part of the basin.

The streamflow of the Klamath River frequently exceeds 10,000 cubic feet per second for a considerable period of time between November and June. Summer flows at the mouth of the Klamath are sustained at approximately 3,000 to 4,000 cubic feet per second. The Klamath River's relatively stable streamflow differs markedly from the runoff of most other drainages in the North Coastal area. The streamflow of these rivers fluctuates greatly between winter and summer because virtually all of their precipitation is rain and they lack large springs to sustain summer flows.

In California, the Klamath River's flow is controlled considerably by Copco and Iron Gate Dams. Iron Gate Dam smooths out the violent flucutations in the outflow from Copco Dam. Additional control of runoff is provided by storage in Upper Klamath Lake in Oregon.

The climate of the eastern part of the hydrographic unit is semi-arid, with annual precipitation averaging only 12 inches. Precipitation increases toward the coast, reaching 40 to 100 inches in the lower part of the drainage. The basin is characterized by hot, dry summers, although fog cools the coastal areas. Water temperatures in the lower part of the drainage are suitable for salmon and steelhead throughout the summer. In the middle and upper sections of the river water temperatures approach 80°F and become lethal to fingerling salmon and steelhead during the summer.

Douglas fir is the dominant conifer, although there is considerable yellow pine in the eastern portion of the drainage. Scattered alders and conifers provide some shade along the stream except in the extensive flood plains along the lower part of the river. Agriculture in the drainage is centered in the irrigated valley portions of the headwater volcanic plateaus. Some of this land has been reclaimed by drainage of shallow lakes and swamps.

Geographical boundaries of hydrographic units and subunits are shown on Plate 4, entitled "Hydrographic Units and Subunits of the North Coastal Hydrographic Area."

All quantitative data on fish resources and flow requirements are shown in Table 26 at the end of the Subunit Description section.

Fishery Resources

The Klamath River is the most important producer of silver salmon and steelhead in California, and compares favorably with the Sacramento River system in king salmon production. Adult king salmon enter the Klamath River from the ocean in two well defined runs, one in spring and another in fall. The spring run begins in late March, reaches a peak in May, and diminishes almost to the vanishing point by the end of June. In recent years this run has been very small, but Snyder (1931) cited evidence that about 1850, and even later, the spring run was the most abundant. The fall run usually begins entering the Klamath estuary about the first of July. It increases gradually during the month, reaches a peak in August, declines steadily during September and is virtually completed by the beginning of winter. The general pattern of salmon and steelhead migration, spawning and incubation periods in the Klamath River and its tributaries is illustrated in Figure 14.

The principal salmon spawning areas in the main Klamath River are located in the 13 miles from the mouth of the Shasta River to the upstream limit of migration at Iron Gate Dam. Spawning in the river below the confluence with the Shasta River is scattered and somewhat limited. The larger tributaries, including the Trinity, Salmon, Scott, and Shasta Rivers, as well as many excellent smaller tributaries, such as Blue, Clear, Elk, Indian, Beaver, Wooley and Grider Creeks, contain important spawning beds heavily utilized by salmon and steelhead.

The spring salmon migration in the Klamath River system was once very great, but due to greatly increased diversion for irrigation, and other factors, it has now become very reduced. Studies during the 1920's indicated salmon runs of the Klamath River system as a whole were diminishing, and that further investigation was needed to find ways to remedy this situation. Counts of upstream migrant king salmon began at Klamathon Racks on the

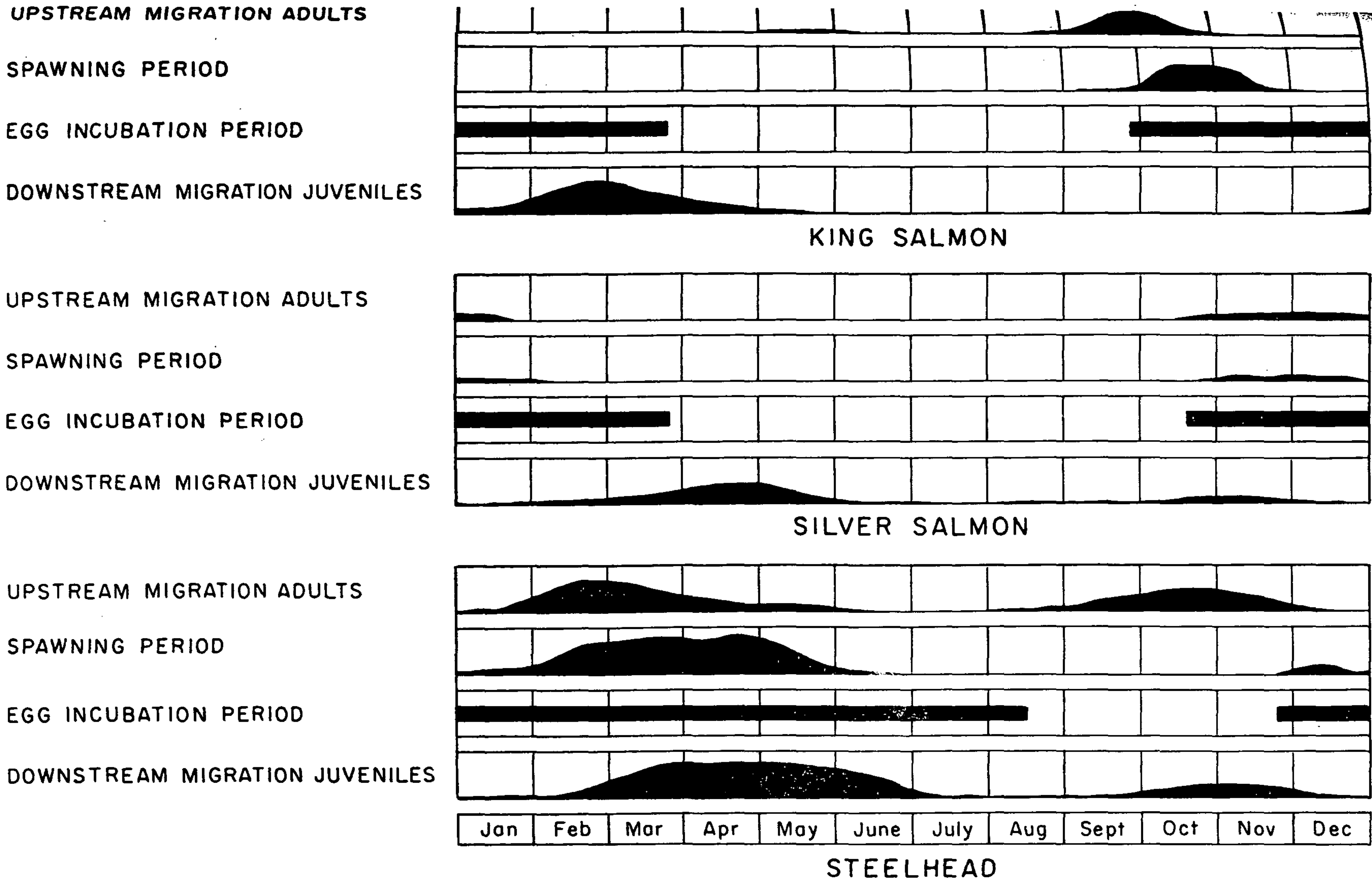


Figure 14. GENERAL PATTERN OF SALMON AND STEELHEAD MIGRATION, SPAWNING, AND INCUBATION PERIODS
KLAMATH RIVER AND TRIBUTARIES, SISKIYOU COUNTY

upper Klamath River in 1925. Five years later a counting rack was also installed on Shasta River near its confluence with the Klamath River.

The average annual number of king salmon reaching Klamathon Racks during the 31 years in which counts have been made between 1925-62 is about 10,000. The bulk of the king salmon utilizing areas upstream from Klamathon usually spawn from October 1 through the early part of November, and the seaward migration of young salmon begins the latter part of December and continues into early April. Table 2 gives the counts of adult king salmon at Klamathon Racks from 1925 through 1962.

Very little is known concerning the size of the silver salmon runs in the Klamath River. Recently, however, the Department of Fish and Game has accumulated considerable evidence which shows that silver salmon are more abundant than has been generally supposed. Silvers spawn in most tributaries to the Klamath, from those near the mouth, such as High Prairie, Hunter, Turwar, and Blue Creeks, to Bogus Creek just below Iron Gate Dam. They utilize many smaller streams not used by king salmon. No attempt has been made to get a complete count of silver salmon at Klamathon or Shasta Racks but those that pass through the gates during the king salmon run are counted. It is estimated that an average run of about 1,000 silver salmon spawn above Klamathon annually. About the same number spawn in the Shasta River, and the Scott River has a run of about 2,000 silver salmon.

Steelhead utilize practically all tributaries of the Klamath and are easily the most widespread of the anadromous fishes in the drainage. They enter the Klamath River during all months of the year, although there are usually considered to be two major runs; the spring run and the fall-winter run. The spring run fish enter the river in April and May, move up to the headwater areas and spawn early in the following spring. The fall-winter run is actually composed of two waves of fish. In the early fall large numbers of "half-pounders" enter the river. These are fish which have usually spent less than one year in the ocean before returning to fresh water, and range from 10 to 20 inches in length.

Following the "half-pounders," another wave of progressively larger fish enters the river. The peak of this run occurs in late December and January; however, fish continue to arrive at the spawning grounds through the winter into early spring, when they spawn. The major portion of the steelhead run at Klamathon and Shasta Racks comes after November 15 and usually after the counting racks have been removed for the season, so no complete counts are available. However, based on partial counts and observations, it is estimated that about 8,000 steelhead spawn above Klamathon annually. Approximately 6,000 steelhead are estimated to spawn in the Shasta River each year.

The U. S. Fish and Wildlife Service conducted field studies in 1958 to determine the size and distribution of king salmon runs. These studies consisted of a tag and recovery operation, an aerial redd count on several of the major tributaries, and surveys of spawning gravel in the important tributaries. Unfortunately, relatively few fish were tagged and recoveries were very scarce. Therefore the estimate of the total run derived from this study lacks statistical validity. However, it is the only available estimate of a total run of king salmon in the Klamath River. As a result of the tagging program, it was estimated that 42,500 king salmon comprised the escapement above Ah Pah Creek. The aerial redd survey of the same area yielded an estimate of 38,750 fish. The average of these estimates, about 41,000 king salmon, was accepted as a reasonable figure for the king salmon escapement above Ah Pah Creek in the fall run. The late fall run of king salmon that spawns in the tributaries downstream from the Trinity River totaled an estimated 4,000 fish, therefore the total spawning escapement for the Klamath River during 1958-59 was estimated at about 45,000 fish. This was considered an unusually small run.

Based on this estimate and counts by the California Department of Fish and Game at Klamathon Racks on the Upper Klamath River (1925-62) and at Shasta Racks on the Shasta River (1930-62), the historical average annual spawning escapement of king salmon in the Klamath River system is probably at least 175,000 fish.

The U. S. Fish and Wildlife Service has (1960) estimated the number of silver salmon that spawn in the Klamath River at approximately 20,000; however, there is very little data to support any specific figure. Based on creel census data and comparisons with information obtained from the Eel River studies made by the Fish and Wildlife Service between 1955-59, the estimate of silver salmon could be as high as 70,000 fish.

The steelhead trout population, including "half-pounders" was estimated by the U. S. Fish and Wildlife Service at approximately 400,000 fish. This estimate was based on creel census data and comparisons with information obtained from the Eel River studies between 1955-59. Again, there is only fragmentary data on which to base an estimate. Estimates based on creel census data indicate the steelhead run in the Klamath River could very well range between 300,000 and 750,000 fish.

During the fall and winter sea-run cutthroat trout are taken in varying numbers from several of the lower tributaries to the Klamath River.

DeWitt (1954) reported that runs of anadromous cutthroat are found in Panther, Hunter, Turwar, Ah Pah and Tectah Creeks.

Other species of anadromous fish found in the Klamath River include sturgeon, which are known to migrate up the Klamath as far as Ishi Pishi Falls, a short distance above the confluence with the Salmon River. These fish migrate through the lower river in the spring and are found near Orleans where they support a sport fishery of increasing importance.

Eulachon or candle fish are most familiar to the Indian residents in the vicinity of Pecwan. These fish migrate into fresh water in March and April. Little is known of the area used by these fish for spawning, but it is believed that they use the lower reaches of the system. Like salmon, eulachon die after spawning. Their importance in the Klamath River is based in the Indian dip-net fishery they support.

Increasing numbers of shad have been observed in the Klamath River in recent years; however, the extent of their range of migration is not well defined. The first observations of these fish in the vicinity of the Salmon River confluence were reported by local residents in 1957. Shad move up the river in the spring to await suitable water temperatures before spawning.

The Klamath River supports the most important sport fishery in California on the basis of angler-use and total catch. The early season "half-pounder" steelhead fishery is widely known throughout the United States.

Steelhead fishing occurs from July into the early spring with the peak of angling effort in October and November. Fishing for early-run steelhead begins in the riffles just above tidewater and gradually extends upstream with the run. Highest fishing pressure occurs in the lower riffle areas below the Trinity River confluence. Less than 12 percent of the early fall steelhead fishermen of the lower river are local residents, a fact which is of great importance to the local recreation industry. A large portion are from Southern California, more than 600 miles away. Most of the fishing during the winter is along the accessible upper main Klamath River above the Scott River confluence and on the Trinity River from Willow Creek upstream to Lewiston.

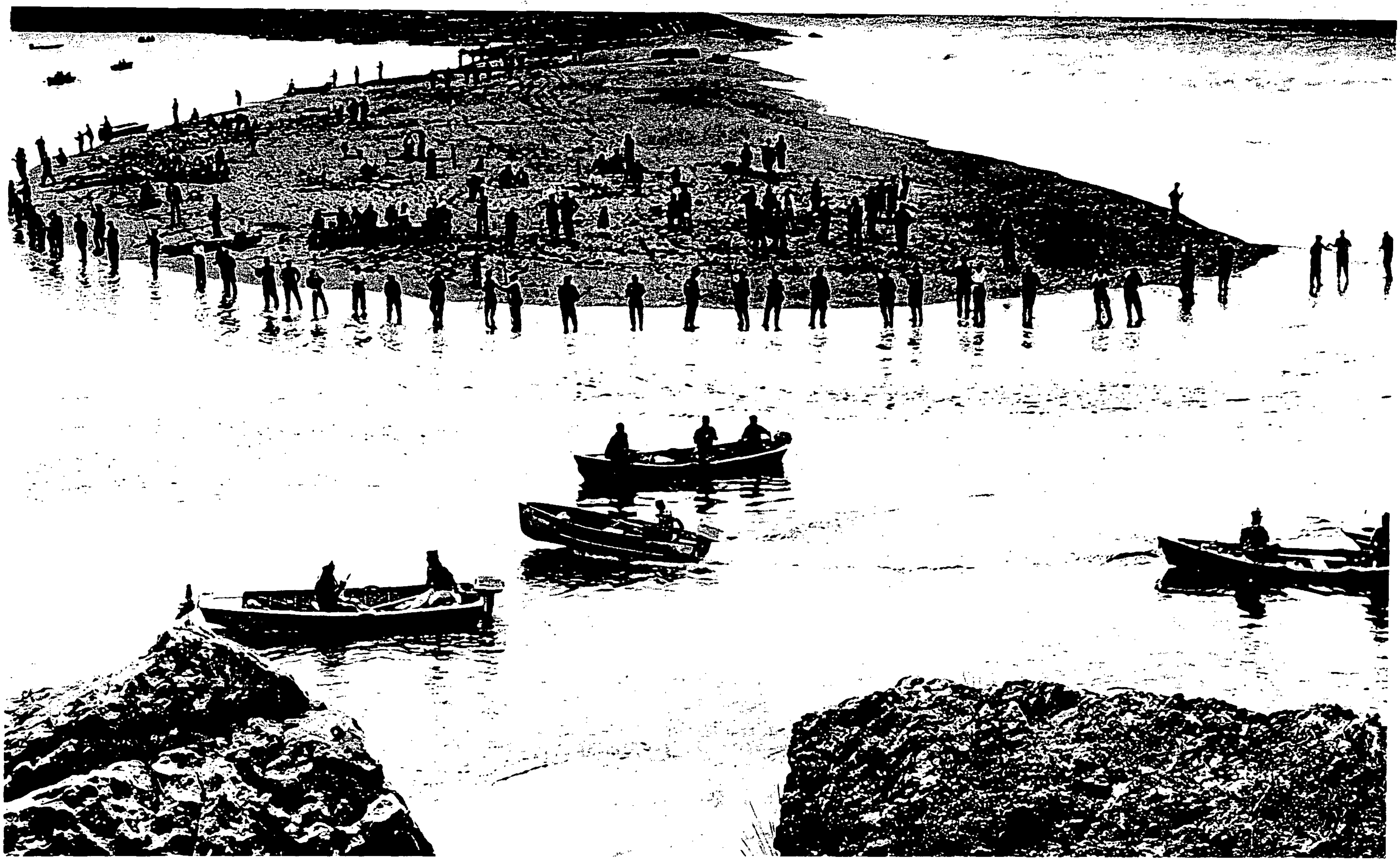
The Klamath River salmon fishery begins during the summer as a boat fishery at the mouth of the stream. This fishing begins in July and reaches a peak in August. Soon after boat fishing starts near the mouth, salmon fishing develops upstream as the run moves toward the spawning areas. Angling effort reaches a climax in October in the upper reaches of the Klamath and Trinity Rivers. The majority of the salmon sport catch consists of king salmon but the proportion of silver salmon increases rapidly toward the end of the run in late September.

The Department of Fish and Game made estimates of total angler use and catch in the Klamath River estuary sport fishery for several years. These surveys extended from the mouth upstream to the Highway 101 bridge. Data from these surveys is presented below.

TABLE 25

ESTIMATED ANGLER USE AND SPORT CATCH
IN KLAMATH RIVER ESTUARY

Year	Stream Section	Angler-Days	King Salmon	Silver Salmon	Steel-head
1951	Mouth to 101 Bridge	25,500	4,400	1,200	900
1952		No estimate			
1953		No estimate			
1954	Mouth to 101 Bridge	38,000	11,000	4,000	-
1955	Mouth to 101 Bridge	33,500	10,400	100	-
1963	Mouth to 101 Bridge	44,400	30,300	1,800	500



21. Salmon fishing at the mouth of the Klamath River. September 1963.
Eureka Newspapers Photograph

During 1956 and 1957, the U. S. Fish and Wildlife Service censused the sport fishery of the river from the mouth upstream to Pecwan Creek. The Service estimated an average of 26,700 angler-days during each of these years, with a catch of 14,200 king salmon and 21,600 steelhead.

A good trout fishery is also found throughout most of the Klamath Basin. In streams accessible to anadromous fish, this is mainly supported by juvenile steelhead trout; however, resident rainbow trout and moderate numbers of brown trout are found in the headwaters and the Trinity River drainage. Alpine streams and lakes provide excellent fishing for eastern brook, rainbow and brown trout. The California Department of Fish and Game maintains a planting program for many of the lakes.

Based on creel census conducted during 1956 and 1957, the U. S. Fish and Wildlife Service estimated that the Klamath-Trinity River fishery supported over 160,900 angler-days annually of which over 51,400 were for trout, 39,700 for salmon, and 69,800 for steelhead trout. Over 80 percent of the angler-days expended on steelhead were for early-run "half-pounders." The estimated average catch was 21,100 salmon, 58,200 steelhead and 104,000 trout. These estimates are considered very conservative.

Wildlife Resources

This unit has high wildlife values. Again black-tailed deer are the most important game species. This area is hunted heavily during the deer season each year. Other important game species of the unit are: California quail, mountain quail, black bear, band-tailed pigeon, gray squirrel, sooty grouse and Oregon ruffed grouse. Migratory deer are in greatest abundance east of the redwood belt.

Subunit Descriptions

1. Copco Lake Subunit. The California-Oregon border forms the upstream boundary of this subunit. From the border, the river flows a few miles and enters Copco Reservoir. This reservoir was formed by damming the lower end of a small valley at an elevation of 2,600 feet. The river gradient steepens near the lower end of the subunit for a short distance and enters Iron Gate Reservoir. The surrounding watershed is semi-arid terrain characterized by small volcanic buttes. Vegetative covering is sparse and consists of juniper, oak, sage brush, and grass. Willow, poplars, alders, and oaks border the stream side and provide a fair amount of shade.

2. Hornbrook Subunit. A prominent feature of this subunit is Iron Gate Dam, which regulates power releases from Copco Dam. The river below Iron Gate flows through a V-shaped canyon with small flats scattered along the stream channel. The river has a moderate gradient, dropping about 18 feet per mile, and is characterized by a series of riffles. Fair shade is provided by willows, poplars, alders, and oaks along the stream. The watershed is arid and volcanic, and surrounding slopes are precipitous basalt plateaus. Vegetative cover is sparse, mostly junipers, oaks, sage-brush, and grasses. The climate is semi-arid, with a mean precipitation of only 12 inches annually.

3. Beaver Creek Subunit. The river continues to flow through a V-shaped canyon with many small flats scattered along the river bottom. The watershed is very mountainous and the vegetative cover begins a transition from semi-arid to woodland cover, consisting of Douglas fir, yellow pine and scattered black and white oaks. The stream has a moderate gradient,

about 13 feet per mile, and is characterized by numerous riffles. The transition from semi-arid cover to a woodland association reflects an increase in mean annual precipitation to about 30 inches of rainfall.

4. Seiad Valley Subunit. The river flows through a V-shaped canyon with small flats along much of the streambed in this subunit. The watershed is very mountainous and is bordered by high, rocky mountains to the south. Precipitation increases to an average of 40 inches annually. The stream has a moderate gradient of 13 feet per mile. Vegetative cover becomes denser, dominated by Douglas fir with some yellow pine, oaks, and madrone.

5. Happy Camp Subunit. There is little change in the appearance of the watershed in this subunit from that which prevails upstream. Major tributaries in this subunit are Indian Creek and Thompson Creek, both entering the river from the north.

6. Somesbar Subunit. In this subunit the V-shaped canyon becomes deep and precipitous and flows through what is known as the "gorge." There are occasional small flats along the river and downstream a flood plain begins to develop. The steep slopes are densely covered with conifers. Elk, Independence, and Ukonom Creeks are major tributaries which drain alpine country containing many natural lakes in the western part of the Marble Mountains. Clear and Dillon Creeks are also large tributaries and flow southerly out of the Siskiyou Mountains to join the river. The gradient steepens and the river becomes turbulent 1 mile above the mouth of the Salmon River near Ishi Pishi Falls. In this area, the river drops 100 feet in about a quarter of a mile.

7. Weitchpec Subunit. This subunit includes the main stem of the Klamath River from the town of Somesbar to the mouth of the Trinity River. The stream continues to flow through a steep V-shaped canyon; however, its gradient again becomes moderate. There is a wide flood plain near the town of Orleans but the river narrows again downstream.

8. Klamath Glen Subunit. This subunit includes the lower Klamath River from the mouth of the Trinity River downstream to the ocean. The river flows through a canyon that gradually widens to include a flood plain the remainder of the way to the mouth, although the canyon walls on either side remain steep. The stream gradient throughout this subunit is slight, averaging only 4 feet per mile. The watershed is mountainous and heavily wooded.

9. Scott Bar Subunit. The Scott Bar Subunit includes lower Scott River which enters the Klamath River about 10 miles upstream from the town of Seiad Valley. Like the Klamath, this section of Scott River has a moderate gradient and flows through a V-shaped canyon, with small flats near its mouth. It drains the rugged Marble and Salmon Mountains to the south. Kelsey and Canyon Creeks are major tributaries draining several alpine lakes nestled among rocky peaks in the Marble Mountains. The other major tributary to lower Scott River is Mill Creek, which enters the river from the east side a short distance above the confluence with the Klamath.

10. Cecilville Subunit. This subunit contains the headwaters of the South Fork of the Salmon River. The stream flows in a V-shaped canyon, with occasional small flats near the towns of Cecilville and Summerville. The extreme headwaters are steep and originate in alpine

lakes among high peaks in the Salmon Mountains and Trinity Alps. Except for the rocky peaks in the headwaters, the drainage is heavily forested.

11. Salmon River Subunit. This subunit includes the lower Salmon River below the Cecilville subunit. The river flows through a steep V-shaped canyon, with small flats along much of the stream channel. In the upper part of the subunit the river gradient is slight, becoming moderate in the lower part of the subunit. The major tributaries to this part of the Salmon River are Wooley Creek, flowing from the north, and Nordheimer Creek, which enters the river from the south.

12. Sawyers Bar Subunit. This subunit is composed of the North Fork of the Salmon River, which joins the South Fork at the town of Forks of Salmon. The river in this subunit has a moderate gradient, except near the town of Sawyers Bar, where a stretch of river about 3 miles long has only a slight gradient. This subunit drains the southeast side of the Marble Mountains, an area of many alpine lakes among high rocky peaks. The entire area is very mountainous and heavily forested, except for the rocky peaks.

13. Wooley Creek Subunit. Wooley Creek is a major tributary of the Salmon River, entering the river a few miles above its mouth from the northeast. This creek has a steep gradient in its headwaters in the Marble Mountains. The gradient becomes moderate in the mid and lower part of the basin. Most of the stream flows through a steep-sided V-shaped canyon. Surrounding slopes are heavily timbered, except for the rocky areas in the extreme headwaters. Wooley Creek has runs of steelhead and spring-run king salmon.

TABLE 26

KLAMATH RIVER HYDROGRAPHIC UNIT
ESTIMATED FISHERY RESOURCES AND FLOW REQUIREMENTS

Subunit	Fishery Resources: King Salmon	Fishery Resources: Silver Salmon	Fishery Resources: Steelhead	Required Flows (CFS) 1/ Maintenance: Sept. 1-Apr. 30	Maintenance: May 1-May 31	Maintenance: June 1-July 31	Maintenance: Aug. 1-Aug. 31
Klamath River							
Copco Lake	1,000	200	1,000	1,300 3/	1,000 3/	700 3/	1,000 3/
Hornbrook	11,000	1,000	9,000	1,500	1,200	800	1,000
Beaver Creek	7,500	800	25,000	1,500	1,200	900	1,100
Seiad Valley	6,500	700	19,000	1,600	1,300	1,600	1,200
Applegate	2/	2/	2/	2/	2/	2/	2/
Happy Camp	7,500	800	23,000	1,700	1,400	1,700	1,200
Somesbar	15,000	1,600	42,000	2,300	2,000	3,000	1,800
Weitchpec	7,500	900	23,000	2,500	2,200	3,500	2,200
Klamath Glen	8,000	1,000	27,000	3,500	3,200	5,000	3,000
				Yearlong			
Scott River							
Scott Bar	2,500	300	6,000	120			
Salmon River							
Cecilville	6,000	900	22,000	140			
Salmon River	3,000	300	7,000	350			
Sawyers Bar	4,000	500	9,000	90			
Wooley Creek	2,000	300	7,000	70			

1/ Possible enhancement flows not determined at this time.

2/ Fishery resources and maintenance flows not determined at this time.

3/ Flows set by agreement between Department of Fish and Game and California-Oregon Power Company.

TABLE 27

POSSIBLE PHYSICAL FEATURES OF
KLAMATH RIVER DEVELOPMENT

Dam and reservoir	Humboldt
Stream	Klamath River
Damsite Location	T12N, R2E, S 10 HB&M
Streambed Elevation (feet, MSL)	30
Height of Dam (feet)	740
Type of Dam	Earthfill
Normal Pool Elevation (feet, MSL)	765
Minimum Pool Elevation (feet, MSL)	600
Reservoir Surface Area (acres)	56,000
Reservoir Storage Capacity (acre-feet)	14,800,000
Firm Annual Yield (acre-feet)	6,000,000 1/
Estimated Capital Cost 2/	$607,000,000

1/ Impaired by Trinity River developments.

2/ Construction of dam and reservoir only; does not include cost of associated conveyance facilities.

Proposed Water Developments

Following development of the projects described in previous chapters, sources of additional new surface water supplies to meet increasing demands within the State could come from the Klamath River Basin, including the lower Trinity River. Faced with a rapidly rising demand curve and the uncertainty that other sources of water will be available when the need arises, the State has made very preliminary studies of several alternative plans for development of the lower Trinity and Klamath Rivers.

These preliminary studies have indicated that one of the possible favorable plans for Klamath River development would include construction of a very large reservoir near the mouth of that river, and two reservoirs and pumping plants on the lower Trinity River for conveyance of the new water yield into Helena Reservoir of the Trinity Diversion Project. Subsequently, this new water supply would be diverted to the upper Sacramento Valley, possibly via Cottonwood Creek and the West Side Conveyance System to the Glenn Reservoir Complex.

Humboldt Reservoir

Project Description. Humboldt Reservoir, the primary conservation feature on the lower Klamath River, with a gross storage capacity of 15 million acre-feet, could conserve and make available for upstream diversion about 6 million acre-feet of water annually. This new water supply would be pumped successively into Ironside Mountain, Burnt Ranch and Helena Reservoirs. The diversion out of the basin from Helena Reservoir would be achieved via gravity flow tunnel to Cottonwood Creek, a western tributary of the Sacramento River. From there the water would flow via the West Side Conveyance System to the Glenn Reservoir Complex. The Rancheria unit of the reservoir complex could be added at that time. The estimated capital cost of the Klamath River Project, including associated conveyance, diversion, and reregulation features is about $1.6 billion.

Effects of Project on Fishery Resources. The construction of Humboldt Dam about 12.5 miles upstream from the mouth of the Klamath River, and its afterbay just above the town of Klamath, would completely block the anadromous fish of the basin from their historical spawning and nursery grounds. It might be possible to maintain the salmon and steelhead runs in very large and expensive artificial propagation facilities, thus avoiding damage to the commercial and ocean sport fisheries; however, the river sport fishery would be completely eliminated. This would include virtually the entire steelhead catch. At this time no way is known to mitigate the loss of this fishery. In addition, there appears to be no suitable site for the immense artificial propagation facilities that would be required.

It has been suggested that a number of streamflow maintenance dams be constructed on smaller coastal streams in order to build up the runs of anadromous fish in these basins as partial compensation for the loss of the Klamath River fishery. However, as discussed in Chapter XII, no evaluation has yet been made of the value of streamflow maintenance structures in increasing the size of runs. This is an untried method of fishery preservation which would require prior development, testing and confirmation.

Department of Water Resources engineers have suggested the following plan as a possibility for partial compensation for the loss of the Klamath River fishery. Water could be piped from Humboldt Dam into upper Prairie Creek in the Redwood Creek drainage. A large hatchery would be constructed on the large flats along lower Redwood and Prairie Creeks.

A streamflow maintenance dam would be constructed in upper Redwood Creek to enhance summer flows in the lower creek. It might also be possible to connect Big Lagoon, Stone Lagoon and Freshwater Lagoon with the estuary of Redwood Creek and use them for saltwater rearing ponds. The intent of these measures would be to greatly increase the runs of salmon and steelhead in Redwood Creek to partially compensate for losses in the Klamath River Basin.

Unfortunately, this rather bold plan assumes a much greater state of technology than is presently possessed in fisheries propagation and management. The plan would involve transferring runs of fish from one drainage to another or allowing one run to die out and building another up elsewhere. It assumes that streamflow maintenance dams have real value to anadromous fish; a concept which has not yet been evaluated. Furthermore, the above plan envisions a type of "fish-farming" currently being studied in Washington and Oregon with mixed results. At best this program would probably mitigate only a relatively small part of the tremendous fishery losses which would occur in the Klamath River if the Humboldt Project is constructed.

In general, while the above plan and all other mitigation possibilities should be considered, it is obvious that a great deal of additional study will be required. At this time no way is known to compensate for the loss of the anadromous fish resources in the event that Humboldt Reservoir is constructed. Before the Klamath River is developed, especially by a dam at the Humboldt Reservoir site, extensive studies should be made of all possible alternative sources of water.

Effects of Project on Wildlife Resources. The proposed Humboldt Reservoir would have a surface area of approximately 56,000 surface acres. Reconnaissance surveys indicated the following wildlife will be lost:

Black-tailed deer days-of-use	611,200
California quail*	2,640
Mountain quail*	960
Mourning dove	100
Gray squirrel	980
Sooty grouse	70
Ruffed grouse	240

*Quail population estimated pre-nesting season.

Wildlife Compensation. For such a large area, small wildlife populations exist. Two factors contribute to the small number of animals; (1) a large part of the area is covered by dense forests, and (2) a large part of the proposed reservoir is within the boundary of the Hoopa Indian Reservation where hunting is permitted year round. Although the wildlife losses should be compensated, it does not seem logical to attempt mitigation in the immediate vicinity of the proposed reservoir site. It is best to move upstream and develop the necessary winter deer carrying capacity in the Trinity or Salmon River drainages so advantage could be taken of the understocked Salmon-Trinity Alps deer summer range. At this time the exact location of development has not been determined.

The measures required to develop and maintain wildlife habitat for an additional 611,200 deer days-of-use on winter ranges in the Trinity or Salmon River drainages are as follows:

Land: Approximately 11,000 acres of public land.

Development: Browseways, browse propagation, browse regeneration, and quail habitat development on 8,400 acres of land.

Maintenance: Annual operation and maintenance of program at project cost.

Facilities: Administrative facilities and program manager.

CHAPTER XI. SACRAMENTO VALLEY WEST HYDROGRAPHIC UNIT

General Description

This hydrographic unit roughly includes the western mountain and foothill areas tributary to the Sacramento River between Shasta Dam and the city of Chico. The major streams in this group include Clear, Cottonwood, Red Bank, Elder, Thomes and Stony Creeks. Except for Clear Creek, these are historically intermittent streams having limited value to fishlife. The fishery resources of each of these streams will be briefly described below.

Fishery Resources

Clear Creek

Clear Creek originates in a rough mountainous area of Shasta County between the Sacramento and Trinity River drainages. It flows south for about 25 miles, then turns southeast and ultimately joins the Sacramento River about 7 miles downstream from Redding. In upper areas, Clear Creek supports a trout population. Prior to construction of Whiskeytown Dam, no significant resident trout fishery existed in lower Clear Creek. Streamflows were seasonally undependable and high water temperatures prevented survival of salmonids during the summer. Squawfish, carp, and suckers were the predominant resident fish species. It remains to be seen if changes in flow and temperature following completion of Whiskeytown Dam will modify this population structure.

It has generally been accepted that Clear Creek has a fine potential as a salmon and steelhead spawning stream. Hanson and others (1940) surveyed Clear Creek to determine its real and potential value as a salmon spawning stream. They estimated that spawning area was available for 3,316 female salmon from the mouth of Clear Creek to a point 14.5 miles upstream. Since the ratio of males to females in the upper Sacramento River system is about 1.5 to 1, this means that about 8,300 salmon could be accommodated in this section. Later, Moffett and others (1947) concluded that a run of 9,960 king salmon could be accommodated downstream from the Whiskeytown damsite at a flow of 100 cfs.

In spite of this potential, runs of salmon in recent years have been relatively small. Spawning fish have been limited primarily by inadequate flows and the McCormick-Saeltzer Dam located about 5 miles upstream from the mouth of Clear Creek. This 12-foot high structure diverts water for local irrigation purposes. A fish ladder has been constructed in a tunnel around the dam; however, to date salmon and steelhead have not been observed above the dam. The Department of Fish and Game modified the structure recently, and presumably it will be usable in the future.

Estimates of the number of salmon spawning in Clear Creek below McCormick-Saeltzer Dam were made by the Department of Fish and Game during 7 years of the 1953-62 period. These estimates indicate that an average of about 2,000 fall-run king salmon spawned the lower 5 miles of Clear Creek. Under historical flow conditions and with adequate fish passage around McCormick-Saeltzer Dam, an average annual run of 4,500 fall-run king salmon would probably have been maintained in Clear Creek.

The size of the steelhead run in Clear Creek is unknown. There is exceptional steelhead fishing at times in the Sacramento River near the mouth of Clear Creek. Presumably some of the fish taken here are part of the Clear Creek run.

The U. S. Bureau of Reclamation is considering the following fishery release from Whiskeytown Reservoir:

Period	Flow Release Normal Year	Flow Release Dry Year
January 1 to October 31	50 cfs	30 cfs
November 1 to December 31	100 cfs	70 cfs

With these flows, water temperature and quality will probably be adequate to provide very favorable conditions for salmon and steelhead in the 16.5 miles of stream below the dam. The minimum flow is expected to assure the development of a good trout fishery in Clear Creek between Whiskeytown Dam and McCormick-Saeltzer Dam, a distance of about 11.5 miles.

Production of fall-run king salmon is expected to be substantially enhanced by the above streamflow release. The U. S. Fish and Wildlife Service has estimated that an average of 14,000 spawning king salmon (5,000 above McCormick-Saeltzer Dam and 9,000 below) will be supported in the creek with these flows. This is an increase of 9,500 spawning fish over the estimated historical run. It is assumed that about 20 years will be required to build the run up to 14,000 salmon, without supplemental planting of king salmon fingerling.

Additional fishery benefits could result from the proposed streamflow release. For example, it might be possible to establish spring-run king salmon in Clear Creek with the project flows. However, the spawning periods of spring and fall king salmon overlap and the two races tend to compete so that there would probably not be a net gain in fish production. It is possible that spring run salmon might be preferred over fall-run fish since their numbers are greatly depleted in the Sacramento Valley and because they provide more inland sport fishing.

Winter-run king salmon could probably also be established in Clear Creek if minimum flows were maintained downstream from McCormick-Saeltzer Dam. Theoretically, a run of winter-run salmon as large as, and in addition to, the fall-run of king salmon could be established. The spawning seasons of winter and fall king salmon do not overlap; therefore, the same spawning areas could be used by both runs without conflict. Presently, sport fishing for salmon in the Sacramento River is believed to be maintained primarily by winter-run king salmon.

Year-long minimum flows below McCormick-Saeltzer Dam would also increase steelhead trout production. Good spawning and nursery areas for this species are present upstream from the Igo stream gage. Without provision of summer flows in lower Clear Creek, migration of adult steelhead is restricted to the winter months. Although steelhead migrate up the Sacramento River during most months of the year, the peak migration usually occurs in late September. Juvenile steelhead would have to remain in Clear Creek for at least one year and migrate downstream during the fall, winter or spring months. Downstream migration would have to be completed by the end of May.

Some steelhead trout will probably be produced in Clear Creek under the present conditions despite the restricted flow in its lower reaches; however, the run could be greatly enhanced by minimum flows during the summer months below McCormick-Saeltzer Dam.

Cottonwood Creek

Cottonwood Creek rises on the eastern slopes of the Coast Range within the Middle Eel-Yolla Bolly Wilderness Area and the Trinity National Forest. There are three main tributaries, the North, Middle and South Forks, which drain an area of 930 square miles. These tributaries unite and flow into the Sacramento River approximately 5 miles south of the town of Cottonwood

22. Cottonwood Creek near Highway 99 bridge. Streamflow about 300 cfs.
May 17, 1961

Lower areas of Cottonwood Creek contain large amounts of gravel suitable for salmon and steelhead spawning, but the streambed is characteristically dry during the early fall months.

Historically, Cottonwood Creek has had a very small fall run of king salmon due to the typical low streamflows during the early fall months. During years of early rainfall a few salmon enter the stream and spawn in the lower 4 to 6 miles of the main stream. In recent years this run has averaged between 350 and 6,000 fish, with an average of about 1,800 salmon. A remnant population of spring-run king salmon spawn in the upper drainage but the number of fish is limited by low summer flows in the headwater sections.

An unknown number of steelhead also spawn in the drainage. Steelhead are limited by the low summer flows in upstream nursery areas. A few resident rainbow and brown trout are found throughout the headwaters of the drainage.

Redbank and Elder Creeks

Redbank and Elder Creeks are small, intermittent streams which rise in the Coast Range in eastern Tehama County and join the Sacramento River just south of Red Bluff. Neither stream has significant value for fishlife at present due to inadequate streamflow during the summer and fall months. Potential spawning gravel for anadromous fish is scarce throughout both streams.

Thomes Creek

Thomes Creek heads in the Coast Range along the Tehama County line and flows in an easterly direction through the southern portion of the county, joining the Sacramento River near the town of Tehama. The stream is usually dry or intermittent below the U. S. Geological Survey stream gage near Paskenta

23. Thomes Creek near Henleyville. Streamflow about 200 cfs at Paskenta Gage.
March 2, 1961

during the summer months and until the first heavy fall rains occur. Due to its wide streambed and gentle gradient, the stream tends to split into more than one channel throughout much of the section below Paskenta.

Several species of fish are present in the stream. Sacramento western sucker, Sacramento squawfish, Sacramento western roach, Pacific speckled dace, green sunfish and carp are the most abundant species. Rainbow and brown trout are present in the headwaters. During the early part of the trout season they are caught as far downstream as Paskenta. Depending on adequate flows, adult king salmon spawn in Thomes Creek. Spawning fall-run salmon were observed only once between 1957-1962, when heavy rains occurred in October 1957, and the discharge at Paskenta reached 2,610 cfs. Murphy (1946) reported finding spring-run king salmon above Paskenta, and two spring-run salmon were observed by department personnel near Henleyville in 1961.

Stony Creek

Stony Creek is a tributary of the Sacramento River south of Hamilton City. Its headwater tributaries originate on the eastern slope of the Coast Range at elevations up to 7,000 feet. From this origin the tributary streams have cut deep, rugged canyons through the eastern foothills of the Coast Range before flowing across the relatively level benchland along the edge of the Central Valley. Below the recently constructed Black Butte Reservoir, Stony Creek meanders across the Sacramento Valley floor in a southeastern direction for about 26 miles to its confluence with the Sacramento River south of Hamilton City.

Fall-run king salmon have been reported to enter Stony Creek in wet years, although none were observed during spawning surveys conducted in recent years by the Department of Fish and Game. The U. S. Fish and Wildlif

Service has estimated that there are average runs of 400 king salmon annually. Steelhead no doubt also spawned in the drainage at one time. However, Stony Creek has been regulated by East Park Reservoir since 1910, and by Stony Gorge Reservoir since 1928, which together impound over 100,000 acre-feet of water annually. Black Butte Reservoir, completed in 1961, further regulates the flow in lower Stony Creek. During the summer, releases are made down the stream channel to meet irrigation demands.

The North Diversion Dam of the Orland Project diverts most of the flow of Stony Creek about 5 miles below Black Butte Reservoir. During the irrigation season, any remaining flow is added to the water in the Central Irrigation Canal. The Central Canal has a maximum flow of about 2,500 second-feet which is pumped from the Sacramento River. A temporary gravel dam about 10 feet high and 500 feet long is erected each year about 18 miles downstream from the North Diversion Dam and about 3 miles upstream from the mouth to carry the flow of the canal across the bed of Stony Creek. As a result of these diversions, the lower 21 miles of Stony Creek have little or no value to resident fish.

Sacramento River

Although not part of the Sacramento Valley West Hydrographic Unit, the Sacramento River would be affected by water diverted through the west side tributaries of the unit. Therefore a brief discussion of the fishery resources of the river is appropriate.

The upper Sacramento River and its tributaries support one of the largest runs of king salmon in California. Fish produced there provide the bulk of the California commercial salmon catch, and contribute to the catch in Oregon and Washington. In addition, there is an important sport fishery in California's coastal waters and in the river itself. A sizeable steelhead population also migrates up the Sacramento River to spawning areas in the upper river and tributaries.

Prior to construction of Shasta Dam, summer flows in the lower Sacramento River were small and water temperatures were above the lethal level for salmon and trout. Most of the king salmon spawned above the Shasta damsite and the areas near Redding were relatively lightly used. Steelhead were rare in the upper Sacramento drainage. Operation of the Central Valley Project has maintained continuous large volumes of cold water in the river and has resulted in greatly increased salmon and steelhead production in the areas below Shasta Dam.

In recent years it has become apparent that there are three distinct races of king salmon in the upper Sacramento River Basin: fall, winter and spring-run fish. The fall-run is by far the largest. Estimates of the numbers of adult fall-run king salmon spawning in the upper Sacramento River main stem between 1950 and 1962 range from 73,000 to 408,000 with an average of 204,000 salmon. From 1946 to 1956, estimates of spring-run salmon have ranged from 9,000 to 33,000 with an average of 19,000. No estimates of the abundance of winter-run fish are available; however, the run has built up remarkably in recent years and may be approaching fall-run in abundance (Slater, 1963).

Hallock and others (1961) estimated that the steelhead run in the upper Sacramento River averaged about 20,500 fish during the period 1953-1959. Most of these fish spawn above Iron Canyon.

Wildlife Resources

Some major black-tailed deer winter ranges lie within this hydrographic unit on the east slope of the Coast Range. Included also is a large resident herd at lower elevations. California quail are hunted quite heavily and the counties involved support a large percent of the annual hunting pressure. Other important game species are: mountain quail, mourning dove, band-tailed pigeon, gray squirrel, and brush rabbits.

Subunit Descriptions

The Coordinated Statewide Planning program has not yet included the Sacramento Valley West Hydrographic Unit; therefore, estimates of streamflow requirements and descriptions of the hydrographic subunits are not presented in this report.

Proposed Water Developments

Surplus waters diverted from the upper Trinity River developments could be routed to the Sacramento River Basin through the 11.5-mile long Clear Creek Tunnel No. 2 which would extend from Helena Reservoir to Clear Creek above Whiskeytown Reservoir. Capacity would be provided in this tunnel for water diverted from the three upper Trinity River projects. From Whiskeytown Reservoir, the water would be conveyed down Clear Creek through a series of reservoirs and powerplants to the Sacramento River.

The water from the Trinity River developments alternatively could be diverted to the Sacramento Valley via the West Side Conveyance System and the Glenn Reservoir Complex. Portions of the Glenn Reservoir Complex might be previously constructed, justified on the basis of development of local runoff; however, the primary value of the full storage potential of the complex would be for reregulation of imported water.

Major salmon enhancement could be achieved by conveyance of Trinity-Klamath water via the West Side Conveyance System with planned discharges for streamflow augmentation into Sacramento River tributaries. West side tributary streams which have enhancement potential are Cottonwood, Elder, Redbank, Thomes, and Stony Creeks. Development of these tributaries for increased salmon and steelhead production, without major detriment to the main Sacramento River, could be an important part of the overall plan of compensating for losses in other areas and enhancing conditions for these species in connection with the State Water Plan. Water released down the tributaries for fishery enhancement could be recaptured in the Delta for export to southern service areas. Therefore, if the proposed fishery releases could be integrated into the operational plan they could provide fishery enhancement without significant loss of water to the system.

Clear Creek Projects

Project Descriptions. Development of Clear Creek for conveyance of Trinity River water to the upper Sacramento River would include Towerhouse Reservoir above the existing Whiskeytown Reservoir, and Kanaka, Saeltzer, and Girvan Reservoirs on lower Clear Creek for power generation. Physical features of these reservoirs are described in Table 28.

Effects of Projects on Fishery Resources. Conditions for salmon and steelhead in Clear Creek are expected to improve in future years over those existing historically, with improved flows from Whiskeytown Reservoir. Construction of the several projects proposed for Clear Creek would completely destroy the great potential this stream has as a spawning and nursery area for anadromous fish.

TABLE 28

POSSIBLE PHYSICAL FEATURES OF
CLEAR CREEK PROJECTS

Dam and reservoir	Towerhouse	Kanaka	Saeltzer	Girvan
Stream	Clear Creek	Clear Creek	Clear Creek	Clear Creek
Damsite Location	T32N,R7W, S 6 MDB&M	8 miles upstream from Igo-Redding Road	T31N,R6W, S 31 MDB&M	T31N,R5W, S 26 MDB&M
Streambed Elevation (feet, MSL)	1,220	700	553	440
Height of Dam (feet)	365	270	170	80
Type of Dam	Earthfill	Earthfill	Earthfill	Earthfill
Normal Pool Elevation (feet, MSL)	1,565	950	700	500
Minimum Pool Elevation (feet, MSL)	1,558	950	700	500
Reservoir Surface Area (acres)	2,760	400	1,150	750
Reservoir Storage Capacity (acre-feet)	362,000	29,000	83,500	18,000
Firm Annual Yield (acre-feet)	0	0	0	0
Estimated Capital Cost 1/	$37,000,000	$4,300,000	$11,700,000	$6,500,000

1/ Construction of dam and reservoir only; does not include cost of associated conveyance facilities.

The method of conveying water from the Trinity-Klamath River projects is an important factor since it will affect the upper Sacramento River, which is probably the most important king salmon spawning area in the world.

Unlike many California streams, the Sacramento River may presently have near optimum temperature and flows for salmon spawning. Addition of large volumes of new water could result in significant reduction of king salmon spawning areas due to increased velocity and depth, which would make some presently used spawning areas unsuitable. The quality of water, with regard to temperature and subtle chemical changes would be another factor requiring careful evaluation.

On the other hand, the addition of good quality water to the Sacramento River above Keswick Dam could be beneficial by further diluting toxic mining wastes originating in the Spring Creek drainage.

The reservoirs proposed for Clear Creek do have some fishery potential. All of the reservoirs would have relatively constant water surface levels; however, since they would serve for conveyance and power generation, the rate of water exchange would be high. This would limit fish production. The exception is Towerhouse, which would have a relatively low rate of water exchange since the inlet is located near the outlet. Both coldwater and warmwater fisheries could probably be developed at Towerhouse Reservoir. The relatively constant water level and moderate rate of water exchange would allow adequate production of food production and spawning for warmwater species. Upper Clear Creek would provide spawning areas for coldwater species. Suitable water temperatures would probably be available for both groups. Conversely, Kanaka, Saeltzer and Girvan

Reservoirs would probably only support a limited catchable trout fishery or a poor warmwater fishery due to their high rate of water exchange.

Fishery Maintenance. The following recommendations are made:

1. Minimum fishery maintenance flows and permissable rate of change of the power releases should be determined to protect the valuable fishery resources on the upper Sacramento River.

2. An evaluation should be made of the probable temperature and quality of water to be conveyed through the Clear Creek projects and released from Girvan Reservoir into the Sacramento River to insure that possible deleterious effects are anticipated and prevented.

Fishery Compensation. Artificial propagation facilities would be required to support the runs of king salmon and steelhead utilizing Clear Creek as a spawning and nursery area. These runs are expected to increase in future years due to enhanced streamflow conditions provided by Whiskeytown Dam. The size of these runs should be accurately determined prior to development of lower Clear Creek and artificial propagation facilities of appropriate size provided.

Fishery Enhancement. Consideration should be given to the possibility of diverting additional water into the Sacramento River above Keswick Dam to further dilute the toxic mining wastes originating in the Spring Creek drainage. The optimum release schedule should be determined.

Effects of Projects on Wildlife Resources. The Clear Creek drainage is small but is one of the most productive hunting areas in California. The 1962 deer tag returns show 244 legal bucks taken in this watershed. This is over 10 percent of the total Shasta County kill. Bear tag returns for 1962 show 20 bear taken in this area which represents more than 2 percent of the total take in the State.

The four reservoirs proposed for Clear Creek have a combined area of 5,060 acres. Kanaka, Saeltzer, and Girvan Reservoirs would lie downstream from the existing Whiskeytown Reservoir, and Towerhouse Reservoir would lie immediately upstream. These proposed reservoirs would affect resident and migratory deer herds, upland game populations, excellent nesting sites for wood ducks along Clear Creek, and a valuable mineral spring located in the Towerhouse Reservoir site which is used extensively by band-tailed pigeon. Wildlife losses indicated by reconnaissance surveys are:

	Towerhouse	Kanaka	Saeltzer	Girvan	Totals
Black-tailed deer days-of-use	100,000	500	12,700	2,200	115,400
California quail*	400		130	350	880
Mountain quail*	130				130
Mourning dove	10		10	5	25
Band-tailed pigeon	200				200
Gray squirrel	10		30	20	60
Jackrabbit	10				10
Wood duck	75		20		95

*Quail populations estimated pre-nesting season.

Wildlife Compensation. The three downstream projects would inundate inferior wildlife habitat. Development and maintenance of marginal wildlife habitat surrounding these reservoirs would be expensive. The proximity of suburban development with attendant encroachment on wildlife habitat would make perpetuation of the wildlife populations difficult, if not impossible. In contrast, the proposed Towerhouse Reservoir site not only has significant wildlife values, but adjacent terrain and cover types are amenable to habitat development.

Compensation is requested by the department in the Towerhouse area for the combined wildlife losses in the four proposed Clear Creek reservoirs. This would amount to: (1) deer carrying capacity equal to that destroyed by flooding (115,400 deer days-of-use) to be created and maintained by the project developer, (2) adequate developments on lands acquired for deer ranges to mitigate small game losses, (3) constructing, installing, and maintaining 55 wood duck nesting boxes, (4) replacing flooded mineral spring used extensively by band-tailed pigeon with an artificial mineral watering device.

The measures required to accomplish this compensation are as follows:

Land: Approximately 1,000 acres of public land and purchase of 700 acres of private land.

Development: Restoration and establishment of forage species, browse-ways and upland game habitat developments on 1,200 acres of land. Development to start with construction of reservoir and be completed within three years.

Maintenance: Annual operation and maintenance of program at project cost.

Facilities: Administration facilities and program manager.

West Side Conveyance System

Project Description. The West Side Conveyance System would consist of a series of interconnected reservoirs, formed by dams and cuts on the upper reaches of Cottonwood, Redbank, Elder and Thomes Creek, which would completely regulate the local runoff of these streams.

There would be numerous local water-associated benefits attributable to the West Side Conveyance System. However, the main justification for these projects appears to be the necessity for conveyance of the water diverted from the Trinity-Klamath developments to the Glenn Reservoir Complex, for re-regulation compatible with needs in the Central Valley Basin.

Effects of Projects on Fishery Resources. The present fishery value of the west side tributaries of the Sacramento River is low due primarily to lack of flows during the summer and fall months. However, with adequate streamflow releases from the projects proposed as part of the West Side Conveyance System, their potential for salmon and steelhead production is high. The potential of each of these streams is described below.

Cottonwood Creek. The Middle Fork, South Fork and Main Cottonwood Creek have over 56 miles of potential spawning and nursery areas, limited by inadequate streamflows. In 1960, Smith and Van Woert (MS) measured the available spawning gravel at various flows in all of the major tributaries of Cottonwood Creek. From these data it is possible to estimate the potential salmon production in the drainage with specific streamflow releases.

Streamflow releases could be made down the major tributaries of Cottonwood Creek from the proposed reservoirs on the West Side Conveyance System. These reservoirs are Fiddlers, Pentacola, Cold Fork, and McCartney Reservoirs. Proposed flow releases are presented in Table 29. This release schedule could result in a potential average spawning run of 47,000 king salmon, including the average historical run. These estimates assume the water released down Cottonwood Creek would be of adequate quality and temperature to support salmonids.

TABLE 29

RECOMMENDED RELEASE SCHEDULE FROM
WEST SIDE CONVEYANCE SYSTEM FOR KING SALMON
ENHANCEMENT IN COTTONWOOD CREEK DRAINAGE

Period	Fiddler's Reservoir	Pentacola Reservoir	Cold Fork Diversion	McCartney Reservoir
Oct. 1 - Oct. 15	150 cfs	50 cfs	25 cfs	125 cfs
Oct. 16 - Dec. 15	200 cfs	100 cfs	50 cfs	150 cfs
Dec. 16 - Dec. 31	150 cfs	50 cfs	25 cfs	125 cfs
Jan. 1 - June 30	100 cfs	50 cfs	25 cfs	75 cfs
July 1 - Sept. 30	150 cfs	10 cfs	10 cfs	50 cfs
Acre-feet	97,500	37,080	18,540	62,400

Redbank and Elder Creeks. These streams have little potential for salmon production in their natural state due to limited suitable spawning gravel. However, graded spawning-sized gravel could be imported and semi-natural spawning channels created in both streambeds. The proposed Schoenfield and Bluedoor Reservoirs on Redbank Creek, and Galatin Reservoir on Elder Creek would probably provide adequate flood control to prevent loss of this gravel. The streamflow releases required to provide suitable depths and velocities would probably be about 50 to 100 cfs in each stream. This proposal has not been studied adequately to estimate costs or possible benefits but appears worth further investigation.

Effects of Projects on Wildlife Resources. The proposed West Side Conveyance System will extend from Cottonwood Creek to Thomes Creek and will contain 16 water storage reservoirs with a total area of 16,210 surface acres. Time did not permit a reconnaissance survey of the proposed reservoir sites. Information for estimating wildlife losses was taken from data compiled in the Upper Sacramento River Study conducted in 1963. The proposed tributary reservoirs in the Upper Sacramento River Study are located in the same general area and follow the approximate contour level as the proposed Westside Conveyance System.

Estimated wildlife losses are 348,000 deer days-of-use, with less significant numbers of California quail, mountain quail, and gray squirrels.

Wildlife Compensation. The measures required to develop and maintain wildlife habitat for 348,000 additional deer days-of-use are as follows:

Land:	Purchase of approximately 7,000 acres of private land.
Development:	Browseways, browse propagation, browse regeneration, and quail habitat development on 6,000 acres of land.
Maintenance:	Annual operation and maintenance of program at project cost.
Facilities:	Administration facilities and program manager.

Paskenta-Newville Project

Project Description. The Glenn Reservoir Complex would consist of three adjacent developments; Paskenta, Newville, and Rancheria Reservoirs. Although the primary value of the full storage potential of the complex would be for reregulation of imported water, portions of the complex could be justified on the basis of development of local runoff. Thus, routing of the Middle Fork Eel River water via Clear Lake would not prevent early construction of certain elements of the complex.

Paskenta-Newville Reservoir, the two northern elements of the complex, could be built at an early date as a conservation project for development of flows in Thomes and North Fork Stony Creeks. Storage at Paskenta-Newville Reservoir represents one of the most favorable remaining water storage projects in the Central Valley, and also provides opportunity for substantial fishery enhancement. A 1.2 million acre-foot Paskenta-Newville Reservoir, when operated in coordination with the Central Valley

TABLE 30

POSSIBLE PHYSICAL FEATURES OF
GLENN RESERVOIR COMPLEX

Dam and reservoir	Newville	Paskenta	Rancheria
Stream	North Fork Stony Creek	Thomes Creek	Stony Creek
Damsite Location	T22N,R6E, S 3 MDB&M	T23N,R6W, S 6 MDB&M	T21N,R6W, S 14 MDB&M
Streambed Elevation (feet, MSL)	600	790	580
Height of Dam (feet)	370	180	390
Type of Dam	Earthfill	Earthfill	Earthfill
Normal Pool Elevation (feet, MSL)	950 1/	950 1/	950
Minimum Pool Elevation (feet, MSL)	610	840	650
Reservoir Surface Area (acres)	16,500 1/	-	28,000
Reservoir Storage Capacity (acre-feet)	2,600,000 1/	-	3,500,000
Firm Annual Yield (acre-feet)	180,000 1/	-	170,000 2/
Estimated Capital Cost 3/	$60,000,000 1/	-	$78,000,000

1/ Combined Newville and Paskenta Reservoirs.

2/ Impaired by East Park Reservoir.

3/ Construction of dam and reservoir only; does not include cost of associated conveyance facilities.

reservoir system, could develop a total annual yield of 200,000 acre-feet. Portions of this new water supply would be available for consumptive use in the West Side Sacramento Valley service areas, for fisheries enhancement, and for export to the Sacramento-San Joaquin Delta.

The West Side Conveyance System and the Rancheria compartment of the Glenn Reservoir Complex could be added concurrent with construction of the Trinity-Klamath River projects to provide reregulation of Trinity-Klamath water compatible with needs in the Central Valley Basin.

Effects of Project on Fishery Resources. Although both Thomes and Stony Creeks contain gravels suitable for anadromous fish spawning, present runs are of little consequence due to insufficient streamflow during the time spawning fish would use them. With adequate streamflow releases from the storage facilities of the proposed Glenn Reservoir Complex, it is likely substantial runs of salmon can be established in lower Thomes and Stony Creeks. The potential of these streams is discussed below.

Thomes Creek. Historically, both state and federal fishery biologists have recognized the outstanding potential of Thomes Creek for salmon production. The gravel of Thomes Creek is generally suitable for king salmon spawning along the entire 30 miles from the Sacramento River to Paskenta. However, the wide streambed in the lower 15 miles separates into two or more shallow channels in numerous areas, which prevents use of the entire section as a potential spawning area.

Under these conditions, only the upper 15 miles of this reach has potential for salmon production. Therefore, in determining the potential salmon production of Thomes Creek only the upper 15 miles below Paskenta Dam was evaluated. Through stream improvement it is possible that the effective length of the usable stream section could be extended.

The Thomes Creek drainage contains large amounts of fine silt and colloidal clays which may also lower the potential of the gravel. These materials enter the stream during periods of runoff and fill the interstices of the gravel. It is possible that these materials will gradually wash out of the gravel with a constant release of relatively siltless water from the proposed Paskenta Reservoir.

Fisk (1959) conducted a spawning gravel survey of Thomes Creek which related usable gravel to various flow conditions. He found that a flow of about 215 cfs at Paskenta gage would be about optimum for spawning salmon. Using the data obtained by Fisk it was determined that with the proposed streamflow release presented in Table 31, Thomes Creek could support a potential average spawning run of 14,000 king salmon.

TABLE 31

RECOMMENDED RELEASE SCHEDULE FROM PASKENTA RESERVOIR FOR KING SALMON ENHANCEMENT IN THOMES CREEK

Period	Flow	Acre-feet
October 1 - 15	150 cfs	4,500
October 16 - December 15	200 cfs	24,400
December 16 - 31	150 cfs	4,800
January 1 - June 30	100 cfs	36,200
July 1 - September 30	50 cfs	9,200
TOTAL		79,100

Stony Creek. The U. S. Fish and Wildlife Service conducted a brief office study to determine the potential of Stony Creek for salmon production. Aerial photos were used to estimate the pool to riffle ratio.

Using various hydraulic formulae and limited field measurements it was determined that a spawning flow of about 500 cfs would be optimum. The service recommended a year-long flow of 400 cfs to enhance king salmon spawning in Stony Creek below Black Butte Reservoir. At this flow they estimated there would be about 1,800,000 square feet of usable spawning gravel in the 26 miles of Stony Creek below the reservoir. A potential average spawning run of about 26,000 king salmon could be maintained at this flow.

The Stony Creek basin has large amounts of fine silt and colloidal clays similar to that in Thomes Creek, which may reduce this potential. In addition, the Central Canal crossing of Stony Creek should be siphoned under the streambed to provide access for king salmon into upstream areas and to protect juvenile salmon during their downstream migration, if the full potential is to be reached.

Effects of Project on Wildlife Resources. The proposed water development projects in the Glenn Reservoir Complex are: Paskenta on Thomes Creek, Newville on North Fork Stony Creek, and Rancheria on Stony Creek. The combined surface area of these three reservoirs is 44,500 acres. The Department of Fish and Game has reviewed the Paskenta Reservoir project when the Tehama County Flood Control and Water Conservation District submitted their formal application for a Davis-Grunsky grant. The department has submitted wildlife compensation recommendations. These measures include the purchase and/or reservation of 700 acres for wildlife with management at an initial capital outlay of $38,000 and the annual operation and maintenance cost of $1,300. No wildlife surveys were made in the Newville and Rancheria portions of the Glenn Reservoir Complex. However, observations made by the Department of Fish and Game indicate a good population of

California quail exists in the riparian vegetation along approximately 18 miles of creek bottom in these reservoir sites. The measures required to mitigate these losses are not known at this time. Migratory deer occasionally reach the west side of the reservoir sites when severe winter conditions exist in the inner Coast Range. The proposed reservoirs are not expected to affect this population significantly. Some resident deer also use the reservoir basins. However, this use is not of major proportions. Mourning dove use the reservoir sites for feeding and a limited amount of nesting, but the projects are not expected to affect population numbers. The proposed Glenn Reservoir Complex could provide a large resting area from which waterfowl could move to adjacent areas to feed. Therefore, waterfowl benefits may be assigned to this project, but further study is required to evaluate this possibility and other potential downstream enhancement features.

CHAPTER XII. MENDOCINO COAST HYDROGRAPHIC UNIT

General Description

The Mendocino Coast Hydrographic Unit is composed of short coastal drainages from the extreme southern tip of Humboldt County, south through Mendocino County to the mouth of the Russian River in Sonoma County. This area is a long, narrow strip about 120 miles long and averaging 20 miles wide. In a north to south order, the streams in this area under investigation are: Tenmile, Noyo, Big, Albion, Navarro, Garcia, and Gualala Rivers.

The topography of this region is entirely mountainous, composed of long, even ridges with steep V-shaped canyons, and no imposing peaks. The area is heavily forested with conifers, except for a narrow, grassy plain along the coast. Elevations range from sea level to approximately 2,000 feet, with a few peaks up to 3,000 feet.

Virtually all precipitation is in the form of rain. Runoff is rapid and there is a wide variation in winter and summer flow. With few exceptions, the mouths of all streams at the ocean are closed during summer and early fall by sand bars.

The lower few miles of the streams in the coastal fog belt remain cool during the summer. The remainder of the drainages are moderately warm in climate and stream temperatures are somewhat higher, though usually not critical to fish life.

Dominant vegetation in this unit is conifers, primarily redwoods near the coast and in the stream bottoms and Douglas fir in the interior or along the ridges. On the dry south and west slopes in the headwaters there is considerable oak-grassland and brush. There is moderate to heavy streamside growth of alders and willows throughout the drainages. This, plus steep, heavily timbered canyons, keep most streams cool. There are a few open agricultural valleys where the irrigation-diminished flows warm to a point critical to fish life.

There have been adverse logging practices in many of the drainages, resulting in the streams being strewn with logging debris and the deposition of considerable amounts of silt harmful to fish life.

Geographical boundaries of hydrographic units and subunits are shown on Plate 4, entitled "Hydrographic Units and Subunits of the North Coastal Hydrographic Area."

All quantitative data on fish resources and flow requirements are shown in Table 32 at the end of the Subunit Description section.

Fishery Resources

The principal sport fishes of the Mendocino Coast Hydrographic Unit are steelhead and silver salmon. King salmon are occasionally reported, but none of the streams supports a run of any importance. The department has attempted to establish a run of king salmon in both Big River and Noyo River, but so far has met with little success. Pink salmon have been known to appear in several of the streams, but this is a rare occurrence. They were last recorded as being taken from the Garcia and the Tenmile Rivers in 1937. Resident rainbow trout are found in the headwaters of all of these streams above barriers which block the anadromous steelhead.

Silver salmon and steelhead enter the Mendocino coastal streams on their spawning migration some time during November or December, depending upon streamflow conditions. Spawning takes place from November to March. The majority of the juvenile fish move downstream to the ocean between March and June of each year.

The major importance of these streams is to the sport fishery. Fishing for steelhead and silver salmon occurs mainly during the winter salmon and steelhead season, from November through February. The salmon usually supply most of the catch during the early part of the season, with the main steelhead runs occurring later and providing fishing through the end of the season. Summer fishing is not permitted on many of these streams in order to provide protected nursery areas for the young fish prior to their migration to the ocean. The majority of the ocean salmon fishing along the Mendocino Coast takes place during the summer and fall. Silver salmon are also taken at sea in the commercial fishery. Relatively few of the fish taken in the sport and commercial fishery are produced in the Mendocino coastal streams.

Little information is available regarding the numbers of salmon and steelhead utilizing the streams in the Mendocino Coast Hydrographic Unit. Estimates given are, for the most part, based on creel census data and comparisons with nearby streams. These estimates are very rough, and only serve to indicate the relative magnitude of the runs. Much additional work remains before we will have a reasonably accurate inventory of the fishery resources of these streams.

Gualala River

The winter steelhead fishery of the Gualala River was censused by the Department of Fish and Game during two seasons. In January and February 1954, an estimated 2,800 angler-days resulted in a catch of about 1,700 steelhead.

Much of the drainage is closed to fishing during the summer trout season in order to protect the juvenile steelhead and silver salmon. However, Rockpile Creek, Buckeye Creek, the Wheatfield Fork, and the South Fork above Valley Crossing, and tributaries of these four streams, are open to trout fishing with artificial flies only.

Based on creel census data and comparison with nearby coastal streams it is estimated that the average annual run of steelhead into the Gualala River totals about 10,000 fish. The average annual run of silver salmon is probably about 2,000 fish.

Garcia River

Creel censuses conducted by the Department of Fish and Game during the 1954-55 winter steelhead and salmon season, indicated that about 1,700 angler-days were spent on the Garcia River and 700 steelhead taken. Based on these meager data the annual run of steelhead is estimated at about 5,000 fish. The river has an estimated annual run of 2,000 silver salmon.

Navarro River

Based on limited creel census data and consideration of data from fish rescue work conducted in the Navarro River drainage by the Department of Fish and Game, the estimated annual run of steelhead trout is about 10,000 fish. The annual run of silver salmon probably averages about 3,000 fish.

Big River

Big River supports a fine winter steelhead fishery. Creel census data collected by the department during January 1955 indicated that about 800 angler-days were expended resulting in a catch of 450 steelhead. Based on this data it is estimated that the river has a run of about 6,000 steelhead annually. The average run of silver salmon is estimated at about 2,000 fish.

Noyo River

A total of 4,900 silver salmon were taken during the 1963-64 season at the Noyo River Egg Taking Station by the Department of Fish and Game. This was probably an exceptional run of silver salmon, and based on limited data it is estimated that the Noyo River drainage has average runs of about 4,000 steelhead and 2,000 silver salmon.

Albion River

The size of the anadromous fish populations in this drainage is unknown; however, based on a comparison with nearby streams, it is estimated that there are runs of about 1,500 steelhead and 1,000 silver salmon.

Tenmile River

Very little information is available regarding the fishery resources of Tenmile River; however, based on comparison with nearby streams, it is estimated that it supports annual runs of about 5,000 steelhead and 2,000 silver salmon.

Wildlife Resources

High resident black-tailed deer populations exist in this unit. Some of the highest deer densities in the State occur in this area. Private land restricts the general public from most of this area, but there are many hunting clubs. California quail is an important upland game species to this area. The mountain quail, band-tailed pigeon, brush rabbits, and sooty grouse are also found in this unit.

Subunit Descriptions

1. Gualala River Subunit. The Gualala River drainage encompasses nearly 300 square miles of mountainous area. The river has three main branches; the North, Wheatfield, and South Forks. There are also two large tributaries; Rockpile and Buckeye Creeks. These streams, with the exception of the North Fork, normally have permanent flows. The Gualala River is characterized by its wide channel containing an abundance of gravel, particularly from the ocean upstream along the South Fork to its junction with the Wheatfield Fork. The mouth of the Gualala is usually closed by sand bars for several months each year. The lagoon is rather wide and shallow, extending about a mile upstream from the mouth. The river is somewhat unique in that it heads only about 3 miles from the coast and flows in a northwestern direction through a trough that parallels the coast for about 25 miles before it turns toward the ocean and flows the remaining 2 miles to its mouth.

The Gualala River has the highest runoff of any river in the hydrographic unit. Consequently, it has the best developed flood plain and extensive spawning gravels in its lower portion.

This drainage has had the most logging damage of any stream in the hydrographic unit. There are numerous log jams, especially in the headwaters, and tremendous quantities of silt that have washed down from the highly erodable hillsides where logging has taken place. In spite of this damage, the Gualala River is still considered one of the better steelhead streams of the unit.

2. Point Arena Subunit. The major drainage in the Point Arena Subunit is the Garcia River which drains 115 square miles of predominately

mountainous area. This drainage heads about 20 miles from the coast and flows in a generally western direction. It has one main tributary, the North Fork, which joins the main stem about 8 miles above the mouth. The drainage is characterized by extremely precipitous slopes and heavy vegetation. There is a small lagoon at the mouth which normally remains open to the ocean.

The Garcia River contains good steelhead and silver salmon spawning gravels in its lower 16 miles; however, in the upstream reaches near Mill and Pardaloe Creeks gravel is scarce and the streambed has much exposed bedrock. This upper section flows in a deep, narrow canyon for most of its length. There is a falls about 25 miles above the mouth which is reported to block most upstream migrant salmon and steelhead.

To the north of the Garcia River lie the smaller drainages of Alder, Elk, and Greenwood Creeks, respectively, progressing northward. These streams are all about the same size, with drainages about 15 miles long.

3. Navarro River Subunit. The Navarro River drains 315 square miles of predominantly mountainous, redwood forested area in southern Mendocino County. The stream ranks with the Gualala as a steelhead and silver salmon producer. It has a lengthy tidal lagoon, extending about 5 miles upstream from the mouth. The mouth of the stream is closed by sand bars during most of the summer low flow period.

Extensive spawning areas are found in most of the tributaries, especially in the upper reaches of the North Fork, Indian Creek, Anderson Creek and Rancheria Creek. Most of the tributaries become very low or intermittent during the late summer months, often resulting in streamflow and water temperature conditions that are critical to fish life.

4. Fort Bragg Subunit. This subunit contains two major drainages, Noyo River and Big River, and a smaller drainage, the Albion River. The two larger streams have excellent populations of steelhead and silver salmon. There was considerable logging damage to these streams in the past; however, stream clearance work recently completed by the Department of Fish and Game has removed logging debris from the stream channels and provided access throughout the drainages for anadromous fish.

Noyo River. The Noyo River drains about 110 square miles of mountainous area. The river has two main tributaries, the North and South Forks. Most of the tributaries of the drainage have permanent flow. The mouth of the Noyo River is kept open continuously by rock jetties protecting a boat harbor located in the river's lagoon. Numerous commercial fishing boats fish out of Noyo Harbor and an expanding salmon sport fishery exists in the ocean near the mouth of the river. Although the river contributes to these fisheries, most of the catch comes from other river systems, especially the Sacramento River.

Big River. The Big River drainage contains about 130 square miles of mountainous area. The river has several tributaries, of which the North Fork and the South Fork are the largest. Most of the tributaries have permanent flow, although the South Fork usually becomes very low. The mouth of Big River is continuously open and has an excellent 6-mile long lagoon. The streambed is rather wide and the flow sluggish throughout much of the lower part of the drainage. The better spawning areas are mainly upstream from the confluence of Two Log Creek.

Albion River. The Albion River drains a relatively small basin of about 40 square miles. Sections of the river become intermittent during the summer months, and the lagoon is closed except for short periods of heavy runoff during the winter.

5. Rockport Subunit. The major stream in this subunit, Tenmile River, drains an area of 130 square miles and is characterized by three main branches, the North, Middle, and South Forks. The mouth of the river is usually blocked by a sand bar from late summer until December. A small, shallow lagoon is present.

The only other stream of consequence is Usal Creek, which lies at the northern end of the subunit. Although rather small, this is a good steelhead and silver salmon stream. It heads only about 5 miles from the coast and flows southward parallel to the coast before turning sharply toward the ocean a short distance above its mouth.

TABLE 32

MENDOCINO COAST HYDROGRAPHIC UNIT
ESTIMATED FISHERY RESOURCES AND FLOW REQUIREMENTS

Subunit	Fishery Resources			Required Flows (CFS)			
				Maintenance			Enhancement 1/
	King Salmon	Silver Salmon	Steelhead	Nov 1-Apr 30	May 1-Jun 30	Jul 1-Oct 31	Oct 1-May 31
Gualala River	0	2,000	10,000	300	150	35	550
Point Arena							
Garcia River	0	2,000	5,000	45	25	8	90
Navarro River	0	3,000	10,000	130	70	20	250
Fort Bragg							
Big River	0	2,000	6,000	100	50	20	190
Noyo River	0	2,000	4,000	60	30	11	110
Albion River	0	1,000	1,500	40	20	8	80
Rockport							
Tenmile River	0	2,000	5,000	60	30	12	130

1/ Enhancement flows for June 1 to September 30 period not determined.

Fishery Enhancement Potential

Reconnaissance studies to date have indicated that the major justification for water projects on the smaller coastal streams would be dependent principally on benefits from fisheries enhancement and recreation. Therefore, current studies have been directed toward the selection of the more favorable fisheries enhancement projects in each basin.

It has been generally assumed that the proposed streamflow maintenance dams on coastal basin streams would benefit the anadromous fisheries of those streams. The proposed dams would improve summer flows and provide a permanent flow through many sections which become intermittent under natural conditions. This would result in increased food production and cover, leading to increased production of fish. A continuous flow of water could reduce summer water temperatures to some extent. The proposed reservoirs would store water during the winter months. This would reduce the flood flows, especially immediately below the dams, and reduce damage to redds caused by flood flows churning up the gravel and destroying the eggs.

On the negative side, the proposed dams would block and inundate some stream sections now used for spawning and nursery areas. Although these areas are relatively small, they are for the most part heavily used.

In order to show net fishery benefits for the projects, the areas below the dams must be improved enough so that they can produce many more fish than are presently being produced in the upstream areas.

There are some serious problems in evaluating the anticipated benefits from these proposed fishery enhancement projects. There is little doubt that maintaining permanent flows in streams which naturally become intermittent would increase fish production to some extent; however, the real question is whether water temperatures suitable for salmonids could be maintained for any distance below the project. If not, then conditions would be improved primarily for rough fish.

Each proposed project must be evaluated carefully to determine the number of miles of stream that would be improved for salmonids and the amount of increased production that could be expected. A basic inventory of the existing resources would be necessary. Likewise, the loss of spawning and nursery area above the damsite must be evaluated. Consideration should be given to the effects of the improved flows on rough fish populations, which compete with the anadromous fish for living space.

The necessity for detailed field studies of fishery enhancement potential in North Coastal streams cannot be emphasized too strongly. Any other approach will likely lead us to the same situation confronting us on the South Fork of the Eel River, where the fishery benefits of the proposed Branscomb Project are uncertain.

CHAPTER XIII. SHASTA-SCOTT VALLEY HYDROGRAPHIC UNIT

General Description

The Shasta-Scott Valley Hydrographic Unit consists of the entire Shasta River drainage and all of the Scott River drainage except for the lower 20 miles of the river and associated tributaries.

Both the Shasta and Scott Rivers flow generally in a northern direction and are tributaries of the Klamath River. The Shasta River drains the 9,000 feet high Scott Mountains to the south and southwest and the even higher Cascade Mountains, dominated by Mount Shasta, to the east and southeast. The Scott River drains the 8,000 feet high Salmon Mountains and the western slopes of the Scott Mountains.

Terrain in the hydrographic unit is ruggedly mountainous, except for rather extensive agricultural areas in the Shasta and Scott Valleys. Many of the streams in the western part of the unit head in alpine country interspersed with small natural lakes. The terrain of the eastern part of the unit is volcanic and gives rise to numerous springs. The headwaters of the tributary streams flow through steep V-shaped canyons before entering the agricultural valleys and joining the main rivers. After flowing through the valleys, the Shasta and Scott Rivers both enter short gorge sections before joining the Klamath River.

Precipitation occurs mainly during the months of November through April. It is mostly in the form of rain in the valleys and snow at the higher elevations. Snow is almost perennial on the higher north slopes. Snowmelt plus numerous springs in the volcanic terrain result in substantial flows in the upper portions of most streams. For example, Big Springs contributes over 100 cfs continuously to the Shasta River above the town of Grenada. However, since irrigation is heavy in the agricultural valleys, the lower parts of many streams become intermittent by late summer.

There is a wide range of vegetative types in the two drainages. The watershed of the Scott River is dominated by conifers, except on the low hills and in Scott valley. The low hills are covered with brush and the valley is developed for agriculture. The Shasta River basin lies further inland with less precipitation and the watershed is dominated by a sagebrush-juniper-grassland association. Only on the north slopes and in the higher elevations are conifers the dominant vegetation. Much of the eastern part of the Shasta River drainage is flat or rolling country interspersed with many small volcanic buttes. Here, sagebrush and juniper are the predominate cover.

The streams in the hydrographic unit are well shaded in their upper extremities by alders and conifers, and often by steep-sided canyon walls. As the streams approach the large agricultural valleys, however, they become more exposed and shade is limited.

Geographical boundaries of hydrographic units and subunits are shown on Plate 4, entitled "Hydrographic Units and Subunits of the North Coastal Hydrographic Area."

All quantitative data on fish resources and flow requirements are shown in Table 33 at the end of the Subunit Description section.

Fishery Resources

Shasta River

Since irrigation districts were formed in Shasta Valley in 1924, initiating large scale irrigation, water from the several tributaries and from the main Shasta River has been used extensively for agricultural and domestic purposes. This practice, no doubt, has contributed to the startling decline of salmon and steelhead runs in the Shasta River. Runs of both spring and fall-run king salmon were very large in the past, for even in 1931, when the Shasta was considered to be in poor shape, 81,000 king salmon were counted through the rack located near the mouth of the stream.

This fish counting rack was built on the Shasta River near its confluence with the Klamath River in 1930 by the California Division of Fish and Game. It was moved upstream 7 miles in 1938, and an unknown number of salmon spawned in the river below, until 1957 when the rack was moved back to its original location. Between 1938-46 it was estimated that about one-third of the total Shasta River run of king salmon spawned in the 7-mile gorge section of the river below the counting rack. Between 1947-56 an estimated average 2,000 salmon spawned below the racks. Since the rack was moved back to its original location essentially the entire run has been counted. Table 2 shows the actual fish counts on the Shasta River from 1930 to 1962. If these counts are corrected as indicated above, the totals will probably be reasonably close to the true figure for the entire Shasta River. During the period 1930-62 the average annual run of king salmon in the Shasta River was about 21,000 fish. The count for 1963 was nearly 32,000 king salmon, evidence the runs may be building back up to their historical abundance after several years of very low counts.

Historically, spring-run fish entered the Shasta River during May and June, spent the summer in the river under ideal conditions provided by the cool, steady flow of Big Springs, and spawned in the fall following the first rains. This run has now been virtually eliminated by the warm, low flows resulting from heavy upstream diversion. The fall-run salmon now sustain the fishery.

Fall-run king salmon enter the Shasta River in early September and begin spawning shortly thereafter. Most of the spawning is completed by the middle of November. The salmon fry emerge from the gravel prior to February and begin their downstream migration to the ocean. The peak of the downstream migration is reached during February or March.

The areas used by king salmon for spawning include the lower 8 miles of river from the mouth upstream to Montague, and about 3 miles of excellent gravel in the river near its confluence with Big Spring. Several miles of intermittent gravel and riffle areas are also available both above and below the town of Grenada. The slow meandering section of the river in the valley is generally poor or unusable for spawning. The streambed from Big Springs up to Dwinnell Reservoir contains good spawning gravel, but lacks adequate flows. In all, about one-half of the 35 miles of river between the mouth and Dwinnell Reservoir are presently used by king salmon for spawning.

Accurate counts of steelhead utilizing the Shasta River are not available because the racks are removed due to high water by the time the bulk of the fish enter the river in January and February. The run probably varies between about 3,000 and 8,000 fish, with an average of about 6,000 steelhead. In 1948-49, a year of small runs in the upper Klamath Basin, it was not necessary to remove the racks and nearly 4,000 steelhead were counted.

There are two runs of adult steelhead into the Shasta River; a fall-run and a winter-run. The winter-run is probably larger than the fall-run. The fall-run fish enter the Shasta River between September and November each year. The winter-run occurs between January and April. Steelhead spawn from early January through April and the fry are usually out of the gravel by the end of May. Unlike king salmon, the small steelhead remain in fresh water for a year or more before migrating to the ocean.

Steelhead spawn in the gorge section of the Shasta River, the section of river below Big Springs, and the section of Big Springs between the Shasta River and the lake at the head of the springs. Some steelhead use the gravel in the main river above its confluence with Big Springs and Parks Creek when flows are adequate.

Silver salmon runs in the Shasta River probably average about 1,000 fish each a year. They enter the river from October through January and spawn during the same period. Silver salmon have similar spawning requirements to steelhead and often utilize the same areas. Some of the young silver salmon also remain in the river for a year before moving downstream to the ocean.

Resident rainbow and brown trout populations exist in the river from the town of Grenada upstream to Dwinnell Reservoir. The river above the reservoir also supports populations of resident trout. The Little Shasta River and several other tributaries have populations of brown and rainbow trout. Catfish are found in the slower, meandering sections of the Shasta River, providing some angling for local residents.

The gorge section of the river is fished heavily during May each year. Opening day creel censuses have been conducted each year since 1948 and show an average of about 350 anglers. From 1953 through 1956, the number of opening day anglers increased to an estimated 500 to 600 fishermen. Early season angling is excellent for juvenile steelhead which average about 7 to 8 inches in length. The opening day catch varies from year to year, but has averaged 8 to 13 fish per angler in recent years.

Angler use diminishes from the opening day peak to negligible proportions by the end of May, at which time most of the young steelhead have moved out of the river. In addition to providing angling during the spring, salmon and steelhead originating in the Shasta River contribute to sport fishing in the ocean and in the lower Klamath River.

Scott River

The Scott River drains an area of about 800 square miles, which varies in topography from the rugged 9,000-foot high Scott Mountains, to the relatively level Scott Valley near its confluence with the Klamath River. King and silver salmon and steelhead trout spawn in the Scott River, although relatively little is known about their numbers and distribution. The timing of the runs is somewhat later than those of the Shasta River.

Fall-run king salmon enter the stream in late September and October. The peak of spawning occurs in November, and spawning extends into December. A spring-run of unknown proportions formerly existed in Scott River, but this run has disappeared in recent years. Silver salmon spawn in the Scott River between October and January. Fall-run steelhead enter the Scott River between September and November, with the winter-run fish entering between January and April. The peak of the spawning period is in March and April, but spawning extends into May. Resident rainbow and brown trout are also present throughout most of the river.

Based on very fragmentary data the historical king salmon run in the Scott River is estimated at about 10,000 fish. There is also an estimated run of 2,000 silver salmon and 20,000 to 40,000 steelhead.

Wildlife Resources

Migratory black-tailed deer are the most important wildlife species in this unit. This area supports high hunting pressures on deer and California quail. Other important game species in the unit are: band-tailed pigeon, brush rabbit, mountain quail, and black-tailed jackrabbit.

Subunit Descriptions

1. Eddy Creek Subunit. This subunit is composed of the headwaters of Eddy and Dale Creeks. These streams flow through steep, V-shaped canyons, Eddy Creek heading at about 6,500 feet and Dale Creek heading at about 8,000 feet in several small alpine lakes. The streams have populations of rainbow, brown, and eastern brook trout. In this area there is a moderate covering of conifers, giving way to sagebrush and juniper at the lower end of the subunit where the streams enter Shasta Valley.

2. Weed Subunit. This subunit consists of lower Eddy and Dale Creeks where they flow into Shasta Valley, plus about 7 miles of the Shasta River above Dwinnell Reservoir. In this subunit the river flows through Shasta Valley. Surrounding slopes are sparsely covered with timber and a considerable amount of sagebrush. Many small volcanic buttes are interspersed through the valley and the surrounding watershed.

3. Stewart Springs Subunit. This subunit includes the headwaters of Parks Creek from its origin to Shasta Valley, about one-third of the stream. This stream heads in alpine lakes on the east side of China Mountain, which rises to an elevation of 8,500 feet. The stream follows a steep, V-shaped canyon down to Shasta Valley. The surrounding slopes are covered by a moderate stand of conifers, giving way to sagebrush and junipers as the stream breaks out into the valley at the lower end of the subunit.

4. Parks Creek Subunit. This subunit includes the lower two-thirds of Parks Creek from the point where it breaks out into Shasta Valley to its confluence with the Shasta River below Dwinnell Reservoir. The stream is open and exposed through the valley, where the landscape is dotted with many volcanic buttes. The stream gradient is slight. Springs in the upper part of the subunit augment the flow, which is heavily diverted for irrigation downstream.

5. Dwinnell Reservoir Subunit. This is a large subunit that contains Dwinnell Reservoir in its southwestern corner. A section of the Shasta River from about 3 miles above Dwinnell Reservoir to about 8 miles below the reservoir is also included in the subunit. The streamflow is greatly augmented near the lower end of the subunit by a constant flow of over 100 cfs from Big Springs. The river and reservoir are located within

Shasta Valley, an area well developed for agriculture. The surrounding slopes are covered with sagebrush, grass, and scattered junipers.

6. Willow Creek Subunit. This subunit contains the upper one-quarter of Willow Creek. The stream heads at an elevation of about 5,000 feet and flows down a steep gradient in a northeasterly direction before entering Shasta Valley in the Grenada Subunit. The canyon in the extreme headwaters is V-shaped, and covered with a moderate stand of conifers, giving way to sagebrush and junipers at the lower end of the subunit.

7. Grenada Subunit. This subunit contains the lower three-quarters of Willow Creek and several miles of the Shasta River. The stream flows through Shasta Valley in this area and is open and exposed. Surrounding slopes are covered with sagebrush and scattered juniper.

8. Grass Lake Subunit. This is an unimportant subunit as far as fishlife is concerned. The only thing of prominence in this unit is Grass Lake, a large marsh along U. S. Highway 97, some 20 miles northeast of the town of Weed. The watershed in this subunit is moderately steep and sparsely covered with timber and sagebrush and interspersed with many small volcanic buttes.

9. Ball Mountain Subunit. This subunit is composed of the headwaters of the Little Shasta River. The stream heads on Ball Mountain at an elevation of about 7,800 feet in a moderately steep, V-shaped canyon.

10. Little Shasta Subunit. This subunit contains the remaining two-thirds of the Little Shasta River from the lower end of Ball Mountain Subunit to the mouth of the stream plus several miles of the Shasta River. The river flows through Shasta Valley, an irrigated agricultural area where the stream gradient is slight. Due to heavy irrigation, the stream goes dry during the summer from the town of Little Shasta to the mouth.

11. Yreka Creek Subunit. This subunit contains the Yreka Creek drainage including its major tributary, Greenhorn Creek, and the lower 5 miles of the Shasta River. Yreka Creek has a moderate gradient in its headwaters, but assumes a slight gradient through the town of Yreka and down to its mouth. Dredger tailings are located along the lower end of the creek. The stream flows through an agricultural area in the vicinity of Yreka.

12. East Fork Subunit. This subunit is composed of the drainage of the East Fork of the Scott River. The stream heads in a shallow, V-shaped canyon in several alpine lakes in the Scott Mountains. The stream canyon widens before joining the South Fork of the Scott River in Scott Valley at the lower end of the subunit. In this section the stream is largely diverted for irrigation. There is a moderate covering of conifers on the upper slopes of the drainage, and the land in the valley is developed for agriculture. The stream has a moderate gradient in its headwaters and a slight gradient at its lower end.

13. South Fork Subunit. The South Fork of the Scott River heads at about 7,800 feet in several alpine lakes. The stream makes steep descent and then assumes a slight gradient at its lower end. In the lower area it flows through a V-shaped canyon. Except in the alpine headwaters there is a moderately heavy covering of timber on the slopes. The other streams in this subunit, Sugar and French Creeks, parallel the South Fork and enter Scott River 2 and 8 miles, respectively, downstream from the mouth of the South Fork. They head in alpine lakes in the Salmon Mountains at an elevation of about 8,000 feet and follow steep, V-shaped canyons until they reach the lower end of the subunit where they enter Scott Valley.

14. Callahan Subunit. This subunit includes the upper part of the main Scott River in Scott Valley. This section of the river flows through an irrigated valley, and becomes intermittent during the summer due to diversions. Downstream from the confluence of the South and East Forks, the river flows through about 5 miles of dredger tailings. The subunit also includes the lower section of French Creek in Scott Valley. A moderate stand of timber covers the upper parts of the surrounding slopes, and there is considerable brush in lower areas of the subunit.

15. Kidder Creek Subunit. This subunit includes Kidder, Patterson, and Etna Creeks, from their headwaters to their entrance into Scott Valley. These streams head in alpine lakes in rocky terrain in the Salmon Mountains at an elevation of about 7,500 feet. In their headwaters, the streams follow steep, V-shaped canyons, which gradually widen and assume moderate gradients just before they enter Scott Valley.

16. Etna Subunit. This subunit includes the Scott River in Scott Valley. The stream is sluggish and heavily diverted for irrigation in the summertime. It has limited spawning areas due to sand and silt from past placer mining operations covering streambed gravels. This subunit also includes the lower sections of Etna, Patterson, and Kidder Creeks, from their entrance into Scott Valley to their mouths. This part of Scott Valley is open and exposed with little vegetation along the stream banks. There is brush on the lower southern and western slopes surrounding the valley, and upper slopes in the watershed are covered with a moderate stand of conifers.

17. Moffett Creek Subunit. This subunit includes the upper three-quarters of Moffett Creek. The extreme headwaters have a steep

gradient and the remainder of the stream down to Scott Valley flows through a V-shaped canyon of moderate gradient. Moderate stands of timber cover the high ridges and north slopes with sagebrush on the lower slopes.

18. McAdam Creek Subunit. This subunit includes the McAdam Creek drainage and the lower one-quarter of Moffett Creek. The upper half of McAdam Creek flows through a steep, V-shaped canyon, while the lower half flattens out as it enters Scott Valley and becomes sluggish. There are some dredger tailings along the lower part of this stream. The lower part of Moffett Creek as it enters Scott Valley is similar. Both streams are borderline habitat for resident trout and steelhead. The watershed in this subunit consists of moderate stands of conifers in the headwaters of McAdam Creek, giving way to scattered sagebrush and small stands of conifers on the lower slopes.

19. Shackleford Creek Subunit. This subunit includes the upper two-thirds of Shackleford Creek. It heads in alpine lakes amid rocky peaks at an elevation of about 8,300 feet. The stream follows a steep, V-shaped canyon in its extreme headwaters and gradually decreases in gradient as it approaches the lower end of the subunit. The surrounding slopes are well timbered and there are considerable numbers of alders along the stream. Shackleford Creek is an excellent trout stream.

20. Lower Scott Valley Subunit. This subunit includes Scott River in Lower Scott Valley down to the point where it leaves the hydrographic unit and enters the steeper gorge section of the river. In this part of the valley, the streamflow is sluggish and becomes low and warm in the summertime due to irrigation diversions. The subunit also contains the lower end of Shackleford Creek which becomes intermittent in the valley. Indian Creek

TABLE 33

SHASTA-SCOTT VALLEY HYDROGRAPHIC UNIT
ESTIMATED FISHERY RESOURCES AND FLOW REQUIREMENTS

Subunit	Stream	Fishery Resources: King Salmon	Fishery Resources: Silver Salmon	Fishery Resources: Steelhead	Required Flows (CFS)1/ Maintenance: Sept. 1-June 30	Required Flows (CFS)1/ Maintenance: July 1-Aug. 31
Shasta River						
Eddy Creek	Eddy Creek	0	0	0	2	1
	Dale Creek	0	0	0	3	1
Weed	Shasta River	0	0	0	10	4
Stewart Springs	Parks Creek	0	0	0	4	2
Parks Creek	Parks Creek	0	100	500	8	4
Dwinnell Reservoir	Shasta River	5,000	300	2,000	60	20
Willow Creek	Willow Creek	0	0	0	0.5	0.5
Grenada	Shasta River	3,000	100	500	80	25
Grass Lake		0	0	0	0	0
Ball Mountain	Little Shasta River	0	0	0	7	3
Little Shasta	Shasta River	5,000	100	500	110	40
Yreka Creek	Shasta River	7,000	400	2,500	130	50
Scott River					Yearlong	
East Fork	East Fork Scott	0	300	6,000	20	
South Fork	South Fork Scott	0	300	6,000	12	
	Sugar Creek	-	-	-	8	
	French Creek	-	-	-	7	
Callahan	Scott River	2,500	200	4,000	50	
Kidder Creek	Etna Creek	0	200	4,000	15	
	Patterson Creek	0	100	2,000	8	
	Kidder Creek	0	100	2,000	9	
Etna	Scott River	1,000	300	6,000	85	
Moffett Creek	Moffett Creek	0	0	0	3	
McAdam Creek	McAdam Creek	0	0	0	5	
Shackleford Creek	Shackleford Creek	0	100	2,000	15	
Lower Scott Valley	Scott River	4,000	100	2,000	110	

1/ Possible enhancement flows not determined at this time.

flows into the river from the north side of the valley near the upper part of the subunit. The upper half of this stream flows through a steep, V-shaped canyon, and the lower half becomes sluggish after it enters Scott Valley. Some dredger tailings are found along the lower part of the stream.

Proposed Water Developments

Bulletin No. 136 does not recommend specific developments for the Shasta-Scott Valley Hydrographic Unit. However, several projects have been previously proposed. These were described in Department of Water Resources Bulletin No. 87, "Preliminary Report - Shasta Valley Investigation," published in 1961. The effects of these projects on fish and wildlife were evaluated in an appendix entitled, "Preliminary Report on Fish and Wildlife in Relation to Plans for Water Development in Shasta Valley," and no additional comments will be made here. If projects in the Shasta Valley are given further consideration, their effects on the fish and wildlife resources of the area should likewise be given additional study.

CHAPTER XIV. SMITH RIVER HYDROGRAPHIC UNIT

General Description

The Smith River Hydrographic Unit consists of the Smith River, with the addition of a few small coastal drainages. The Smith River basin covers 720 square miles, almost all of it in California, in the extreme northwestern corner of the State. It is bounded on the east by the Del Norte-Siskiyou County line.

The Smith River drainage is composed of rugged mountainous terrain ranging from sea level to 6,500 feet in elevation. Most of the main ridges of the basin vary in height from 3,000 to 5,000 feet. Although the drainage covers a considerable area, it heads only about 30 miles from the coast.

With a few exceptions in the lower part of the drainage, most of the streams in the system flow through steep, V-shaped canyons. The main river develops a large flood plain in its lower 20 miles. Agricultural development is confined to a coastal plain that lies mainly south of the mouth of the river.

Because of the relatively low altitude of the drainage, most precipitation falls in the form of rain, and snow is largely confined to the slopes above 4,000 feet. As is typical of the north coast, most of this precipitation falls in the months of November through April except for a drizzle that commonly falls as coastal fog in the lower part of the drainage during the summer months.

The watershed is well timbered and numerous springs are located in the headwaters, therefore, the stream has a good, dependable flow. At the mouth, the river has a minimum mean monthly flow of about 300 cubic feet per second, therefore, salmon and steelhead are able to enter the river at all times.

Because the drainage is well forested and quite stable, the stream clears rapidly after storms. The fertility of the stream is relatively low. Conifers are the dominant vegetation in the basin, Douglas fir in the headwaters and middle sections, and redwoods in the coastal portion.

The major tributaries of the Smith River, which include the North, South and Middle Forks, flow through deep rocky canyons. The major streams are open and somewhat exposed in their lower reaches. However, the upper sections of most tributaries are well shaded by alders, willows, conifers, and often by steep-sided canyon walls. Usable spawning gravel is not abundant in these tributaries although numerous large, deep pools provide excellent cover and resting habitat for adult salmon and steelhead. Gravel in the scattered spawning riffles is predominantly large and interspersed with boulders. The lower main Smith River has broad flat riffles consisting primarily of small and medium gravel. Above the confluence of Mill Creek, the streambed is composed primarily of bedrock and riffle areas are scarce.

Geographical boundaries of hydrographic units and subunits are shown on Plate 4, entitled "Hydrographic Units and Subunits of the North Coastal Hydrographic Area."

All quantitative data on fish resources and flow requirements are shown in Table 34 at the end of the Subunit Description section.

Fishery Resources

Smith River

Prior to the turn of the century, the Smith River supported a local commercial salmon fishery and cannery. As many as 7,000 cases of king salmon and 3,000 cases of silver salmon were packed annually early in the century. Today, the river still supports important runs of salmon, steelhead and cutthroat trout.

Population estimates were made by the U. S. Fish and Wildlife Service (1960) based on creel census data, spawning ground surveys and comparisons with the Eel River where detailed studies were made between 1955-59.

The fall run of king salmon was estimated at about 15,000 fish, although the once important spring run has diminished to a fragment of its former numbers. Fall-run king salmon enter the river beginning in mid-September, with the peak of the upstream migration in October. Spawning occurs through November and December in all major tributaries.

Silver salmon enter the Smith River in November and December on their spawning migration. Spawning occurs from November through January. An average annual run of about 5,000 silver salmon is thought to occur in the river.

Salmon spawning is concentrated in the lower main Smith River and is scattered throughout the three major forks. Rowdy and Mill Creeks are important spawning tributaries in the lower part of the drainage. Spawning surveys by the Department of Fish and Game have indicated that Mill Creek supports runs of 3,000 king salmon and 400 silver salmon, as well as substantial numbers of steelhead and cutthroat trout.

The Smith River supports an estimated run of about 30,000 steelhead. The peak spawning migration occurs during the winter months, although some steelhead migrate up the river in all months of the year.

The Smith River is the most important sea-run cutthroat trout stream in California. Virtually all sections of the river and its tributaries are known to contain cutthroat. Runs of anadromous cutthroat trout occur in September or October, usually after the first rains. Very good catches of sea-run fish are made in tidewater areas of the Smith, especially in the fall, winter, and early spring, but occasionally also in the summer. Spawning apparently occurs over a relatively long period, probably from January to April. Cutthroat trout spawn throughout the drainage in small tributaries often inaccessible to other anadromous species. Few scientific studies have been made of this species in California and no estimates of its abundance are available.

Sport fishing in the Smith River is similar to that of most other major Northwest California streams with one important exception. A high, clear flow usually occurs during all seasons and periods of turbid flow are short. Anglers are attracted to the Smith River from other California and Oregon coastal streams where turbid flows usually prevail for long periods during the winter salmon and steelhead seasons.

Fishing for king salmon begins near the mouth of the Smith River as early as mid-August and extends through December. Most of the angling during October and November occurs in the estuary. As the run moves upstream, angling is distributed along the main stream until the run declines in December. During the latter part of the salmon run, steelhead, and silver salmon contribute to the catch.

Steelhead fishing is best from November through February, with the peak during mid-winter. Steelhead angling is concentrated along the main Smith River and Middle Fork upstream to the confluence of Patrick Creek. The lower South Fork and North Fork are less heavily used.

The estuary fishery for king salmon is predominantly a boat fishery, while in upstream areas bank anglers predominate. The Department of Fish and Game surveyed the Smith River boat fishery during the 1955 salmon season. This survey extended from July through November. About one-third of the anglers were interviewed at several boat landings. Based on the census data, and a daily tally of boats, it was estimated that about 12,800 man-days of fishing resulted in a total catch of 4,340 king and 60 silver salmon. It took the average angler 2.9 days to catch one salmon.

The U. S. Fish and Wildlife Service (1960) estimated that the Smith River drainage provided an average of 44,100 angler days during the 1956 and 1957 seasons, of which 22,900 days were for trout, 8,700 for salmon and 12,500 for steelhead. The average catch was estimated to be about 32,400 trout, 3,400 salmon and 4,400 steelhead. This appears to be a very conservative estimate of angler-use.

Wilson Creek

Wilson Creek is included in the Smith River Hydrographic Unit although it is a separate drainage emptying into the Pacific Ocean about 5 miles north of the Klamath River. The stream has a moderate gradient in the lower areas and fair amounts of spawning size gravel are present in the streambed.

Little information is available on the fishery of Wilson Creek. Spawning surveys conducted by the Department of Fish and Game in 1953 and

1954 revealed that king and silver salmon spawn in the drainage. Steelhead and anadromous cutthroat trout are also present in good numbers. Based on limited data it is estimated that about 200 king salmon, 500 silver salmon and 1,000 steelhead and cutthroat trout spawn annually in the Wilson Creek basin.

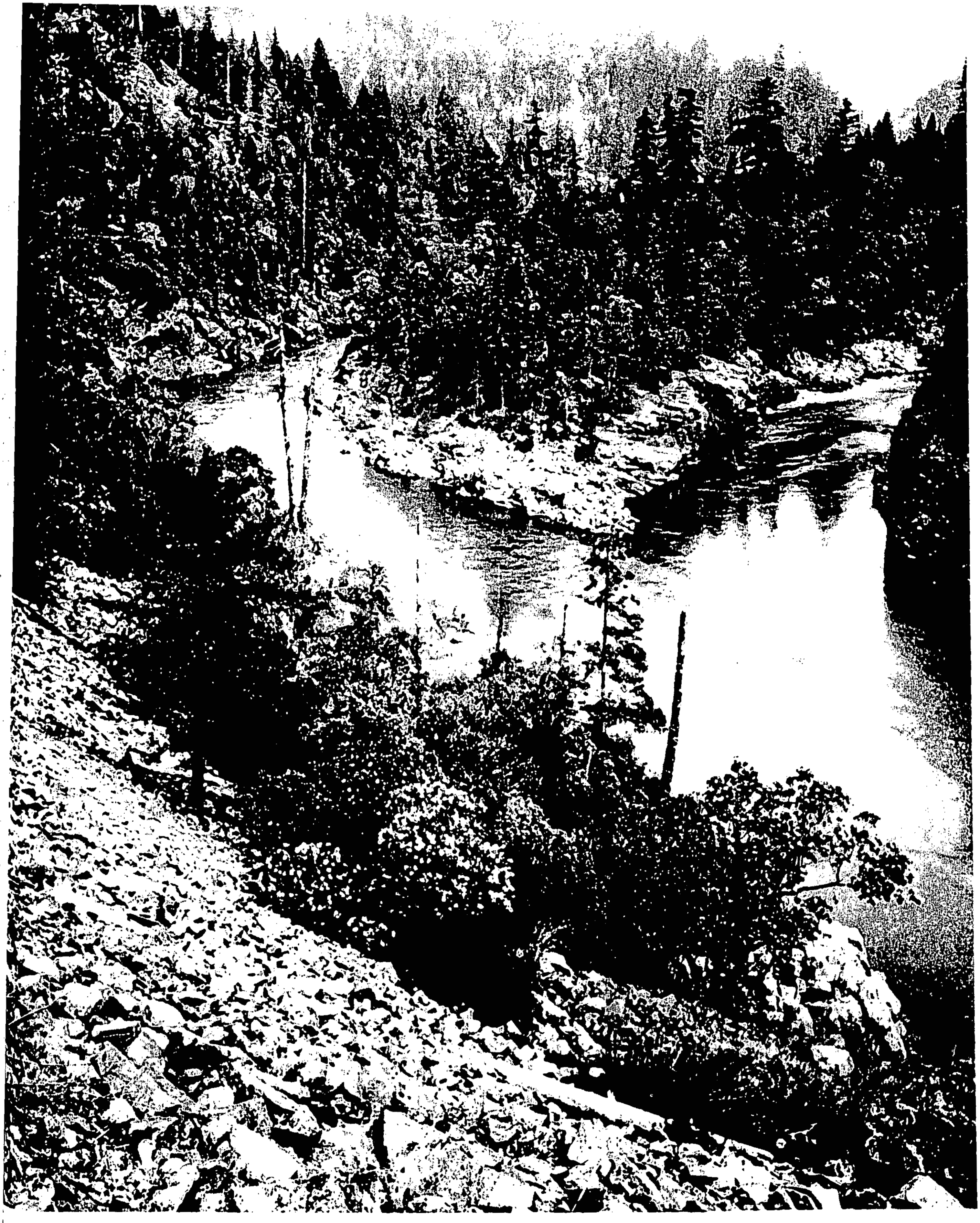
Wildlife Resources

Black-tailed deer are probably the most important game species in this hydrographic unit. Heavy hunting pressures are expended on deer in this area. Both resident and migratory deer are present. Migratory deer are found east of the redwood belt. Roosevelt elk range includes nearly the entire unit. Other game species of importance found in the area are: California quail, brush rabbit, Oregon ruffed grouse, sooty grouse, and mountain quail.

Subunit Descriptions

1. North Fork Subunit. This subunit is composed of the North Fork of the Smith River plus its major tributary, Diamond Creek. Both of these streams head in Oregon, and then combine to flow down a steep-sided, V-shaped canyon to join the Middle Fork at the town of Gasquet. Ridges bounding this drainage rise to between 2,500 and 3,500 feet. Good spawning gravel exists in the North Fork drainage, mainly concentrated in the middle part of the drainage. It has been estimated by the U. S. Fish and Wildlife Service that 11 percent of the king salmon spawning gravel in the Smith River drainage lies in the North Fork.

2. Middle Fork Subunit. The Middle Fork Smith River heads on the Del Norte-Siskiyou County line at an elevation of about 5,000 feet.



24. Confluence of Middle and South Forks of Smith River.
Division of Beaches and Parks Photograph

Initially it flows to the northwest through a steep, V-shaped canyon, and then turns to the southwest for the remainder of its course to join the South Fork about 25 miles upstream from the ocean. The gradient of the Middle Fork is moderate, except in the headwaters area where it is steep.

Patrick Creek, the major tributary of the Middle Fork, heads near the Oregon line and flows southward through a terrain similar to that of the Middle Fork. The Siskiyou Fork joins the Middle Fork from the southeast, and also has terrain similar to that of the Middle Fork. The Middle Fork and South Fork join at the lower end of the subunit.

There is some gravel suitable for king salmon spawning in the upper part of the drainage. It has been estimated by the Fish and Wildlife Service that 8 percent of the spawning gravel within the Smith River drainage lies in the Middle Fork.

3. South Fork Subunit. This subunit is composed primarily of the South Fork of the Smith River. The river heads at 6,400 feet on the west side of Bear Mountain near the Del Norte-Siskiyou County line. It flows south for 10 miles before turning northwest to join the Middle Fork 7 miles east of Crescent City. The stream follows a steep, V-shaped canyon throughout, with a few small flats in the lower 5 miles. The gradient is steep in the extreme headwaters and moderate in the remainder, except for the lower 5 miles where the gradient is slight. The watershed is heavily timbered. The coastal fog affects only the lower section of the stream.

Good king salmon spawning gravel is found in the middle portion of this stream. It has been estimated by the Fish and Wildlife Service that 8 percent of all the king salmon spawning gravel in the Smith River drainage is found in the South Fork.

4. Mill Creek Subunit. This subunit includes Mill Creek, a small drainage entering the main stem of the Smith River from the south a short distance downstream from the confluence of the Middle and South Forks. Mill Creek flows in a northern direction through a steep, V-shaped canyon. The gradient is steep in the extreme headwaters and moderate in the remainder.

5. Rowdy Creek Subunit. Rowdy Creek is a major drainage in this subunit, heading just over the Oregon border and flowing in a southwesterly direction to join the main river on the coastal plain about 5 miles above the mouth. The stream follows a steep, V-shaped canyon throughout. The watershed is heavily timbered and lies primarily in the fog belt. The stream is an important spawning tributary, particularly for steelhead and silver salmon.

6. Smith River Plain Subunit. This subunit includes the lower 20 miles of the main stem of the Smith River from the mouth of the South Fork to the ocean. The gradient is slight, and there are small flats along the U-shaped canyon in the upper half of the subunit. When the river reaches the coastal plain in the lower half of the subunit, an extensive flood plain develops.

The remainder of this subunit consists mainly of the flat coastal plain in which the most prominent feature is Lake Earl, a large coastal lagoon. Other small lagoons are found in this area, as well as a few short, steep drainages in the southern portion of the subunit.

7. Wilson Creek Subunit. This subunit consists of the Wilson Creek drainage, a small coastal stream heading at an elevation of 2,000 feet about 10 miles southeast of Crescent City and 5 miles inland from the coast. The stream follows a steep, V-shaped canyon. Its gradient is steep in the

upper one-third, moderate in the middle one-third, and slight in the lower one-third. The stream lies in an area influenced by summer fog, therefore stream temperatures are low. In addition, the drainage is heavily timbered and good shade vegetation is found along the stream.

8. Illinois River Subunit. This drainage lies just north of the Smith River drainage, heading 9 miles inside California and flowing north into Oregon to join the Rogue River. The portion in California flows through a steep, V-shaped canyon and has a steep gradient throughout. The slopes are heavily timbered.

9. Winchuck River Subunit. This subunit includes only the South Fork of the Winchuck River, the remainder of the drainage lying in the State of Oregon. The mouth of the river is just north of the California-Oregon line.

The drainage occupies the extreme northwest corner of the subunit, with about 5 miles of the South Fork in California. It joins the main river just across the state line.

The stream heads at an elevation of about 1,500 feet and follows a steep, V-shaped canyon which becomes U-shaped about 2 miles before reaching the state line. In the latter portion, flats are found along the stream. The gradient is steep in the extreme headwaters, moderate for a short distance, and then slight in the U-shaped section.

TABLE 34

SMITH RIVER HYDROGRAPHIC UNIT
ESTIMATED FISHERY RESOURCES AND FLOW REQUIREMENTS

Subunit	Fishery Resources: King Salmon	Fishery Resources: Silver Salmon	Fishery Resources: Steelhead	Required Flows (CFS) Maintenance 1/: Oct. 1- May 31	Required Flows (CFS) Maintenance 1/: June 1- Sept. 30
North Fork	3,000	1,000	6,500	600	130
Middle Fork	2,000	1,000	6,000	2,000	500
South Fork	3,000	2,000	12,000	1,100	275
Mill Creek	2,000	400	2,000	100	12
Rowdy Creek Plain	1,000	500	1,500	100	12
Smith River Plain	4,000	100	2,000	2,400	650
Wilson Creek	200	500	1,000	50	10
Illinois River	Unknown	Unknown	Unknown	Unknown	Unknown
Winchuck River	Unknown	Unknown	Unknown	Unknown	Unknown

1/ Possible enhancement flows not determined at this time.

Proposed Water Developments

There are no significant water developments within the Smith River drainage except for a small power diversion dam on Patrick Creek near its confluence with the Middle Fork. Studies by the Department of Water Resources of possible developments have been very preliminary to date. Therefore, no comments on the effects of possible water developments on the fish and wildlife resources of the basin are appropriate at this time.

CHAPTER XV. LOST RIVER-BUTTE VALLEY HYDROGRAPHIC UNIT

General Description

The Lost River-Butte Valley Hydrographic Unit lies in the north-central and eastern part of the State along the Oregon line in portions of Modoc and Siskiyou Counties. It is composed of seven subunits and covers 3,000 square miles. The region is one of large plateaus surrounded by lava beds and volcanic buttes. The few drainages in the area are self-contained, and little water leaves the subunit except for irrigation return water and flood flows that eventually reach the Klamath River to the north and west.

The area ranges in elevation from 4,000 feet in the Tule Lake Basin to over 8,000 feet at the top of Haight Mountain on the south side of Butte Valley.

The only drainages of significance in the unit are Butte and Antelope Creeks in the southwest corner of the unit, and Lost River which heads in Clear Lake Reservoir and flows into Tule Lake.

The few streams in the unit have steep to moderate gradients in their extreme headwaters and quickly flow down onto rolling or flat ground where the gradient lessens considerably. Headwater reaches have permanent flow and, without exception, the lower ends of the streams dry up or sink into marshy areas. The streams flow through moderate to shallow V-shaped canyons in their headwaters and spread into wide, sluggish streams when they reach the flats below.

For the most part there is little spawning gravel in the streams of this unit. The stream bottoms are mainly bedrock, volcanic rubble, sand, and silt. The only gravel of consequence is in the upper reaches of Butte and Antelope Creeks.

Precipitation in this unit falls in the form of both rain and snow, concentrated in the months of November through April. The area is semi-arid and therefore precipitation is light. Because of the high altitude, much of the winter precipitation is in the form of snow. Runoff is rapid due to the lack of vegetation and open exposure. Springs large enough to result in permanent streamflow are found only in the southwestern part of the unit, where streams head in high volcanic mountains on the northeast side of Mount Shasta. These streams form marshes or sink into the ground when they reach the porous volcanic flats surrounding the mountain.

The dominant vegetative types of the unit are sagebrush and grass, with scattered junipers. Some larger coniferous timber is found in the headwaters of Butte and Antelope Creeks. Except for the headwaters of Butte and Antelope Creeks, the streams are open and exposed to the sun. Due to this exposure and high summer air temperatures, the lower sections of all of the streams become very warm.

Geographical boundaries of the hydrographic units and subunits are shown on Plate 4, entitled "Hydrographic Units and Subunits of the North Coastal Hydrographic Area."

All quantitative data on flow requirements are shown in Table 35 at the end of the Subunit Description section.

Fishery Resources

Butte and Antelope Creeks are by far the best fish streams in the hydrographic unit, containing excellent resident populations of brown and rainbow trout in their upper portions. Ikes, Harris and Muskgrave Creeks, tributary to Meiss Lake in the northwest corner of the unit, are minor trout streams. Catfish, white crappie, and pumpkinseed sunfish are found in Lost River below Clear Lake Reservoir.

Wildlife Resources

The Lost River-Butte Valley Hydrographic Unit is a key area for waterfowl using the Pacific Flyway. The Lower Klamath and Tule Lakes are historical concentration points for waterfowl migrating to and from the great wintering areas in the Central Valley of California. Large numbers of waterfowl nest in the unit as well.

This unit also contains the important Devil's Garden winter range for the Rocky Mountain mule deer. This range is located in the Clear Lake area of Modoc County and is used by deer that summer in Oregon and winter in California. Many migratory black-tailed deer also use this winter range.

Other game species of importance in this area are: ring-necked pheasant, sage grouse, antelope, cottontail, chukar partridge, and black-tailed jackrabbit.

Subunit Descriptions

1. Willow Creek Subunit. The major part of the Willow Creek drainage, which drains the Willow Creek subunit, is made up of the North Fork Willow Creek and Boles Creek, which join a few miles from Clear Lake Reservoir. The combined flow is then known as Willow Creek and enters the eastern end of the reservoir. The two streams are intermittent and are located in typical volcanic terrain. Their streambeds are composed of bedrock, sand, and silt, with very little gravel.

The North Fork of Willow Creek heads on the Oregon line and flows roughly in a southwestern direction. Boles Creek heads in the south central part of the subunit and flows generally north before joining the North Fork to form Willow Creek. Its headwaters receive water diverted through a ditch from Fletcher Creek and Reservoir "F", which lie to the east and southeast, respectively.

Outside of the immediate stream drainages described, the terrain is volcanic, with a number of small marshes and irrigation reservoirs concentrated mainly in the eastern and southern parts of the subunit. Few gamefish are present in these waters; the predominate species are suckers, lampreys, dace and tui chubs. Trout are stocked in Janes Reservoir and Reservoir "F".

2. Clear Lake Subunit. The dominant feature of this subunit is a semi-natural reservoir, Clear Lake, which lies in the northern part of the area. This reservoir is the source of Lost River, which leaves the northeaster corner of the reservoir and flows northwestward into Oregon before making a large loop and returning to California some 15 miles west of the point where it left the State.

Lost River is the only stream of consequence in this subunit, and contains catfish, white crappie, and pumpkinseed sunfish. It flows through an incised canyon bordered on both sides by volcanic plateaus about 150 feet high. An intermittent tributary, Rock Creek, enters Lost River from the east.

The only other stream in the subunit is Mowitz Creek, which heads in the southeastern corner of the subunit and flows northerly to enter Clear Lake Reservoir at its southeastern corner. This intermittent stream has a slight gradient and is almost worthless for fishlife.

3. Tule Lake Subunit. Tule Lake lies in the northwest part of the subunit and forms the terminus of the Lost River. This lake is a large semi-natural sump and marsh. There is a large flat around the eastern and southern part of the lake, otherwise the terrain is composed of many lava beds and buttes. The area is sparsely covered with grass, sagebrush and juniper.

4. Mount Dome Subunit. The prominent feature of this subunit is Lower Klamath Lake which is an important waterfowl refuge. The only drainage in the subunit is Willow Creek, which lies southwest of Lower Klamath Lake. The stream is shallow, sluggish, intermittent, and of no significance to fishlife. The general terrain of this subunit is similar to that described for the Tule Lake Subunit.

5. Antelope Creek Subunit. The only drainage in this subunit is Antelope Creek, which heads at an elevation of 7,000 feet near the southwest corner of the subunit on the northern slopes of Dry Creek Peak. The stream flows north for 15 miles to disappear in the Antelope Sink on the south side of Cedar Mountain. Antelope Creek has a good, permanent flow in its upper part, but becomes intermittent and usually drys up completely in its lower part during the summer. There is a good population of brown and rainbow trout sustained by natural reproduction in the upper 10 miles. The Department of Fish and Game also plants catchable rainbow trout in this portion of the stream.

The surrounding terrain is high, volcanic country, with many volcanic buttes and ridges encompassing the upper end of Butte Valley at the northern end of the subunit.

6. Butte Creek Subunit. This subunit lies in the southwestern corner of the hydrographic unit and is composed of the Butte Creek drainage. The stream heads in Hart Meadow at an elevation of 6,000 feet, a few miles northeast of Mount Shasta. It then follows a slight gradient through long, narrow valleys down to Butte Valley where it flows northward and sinks into the ground just south of the town of Macdoel.

There are some coniferous timber and alders along the headwaters of the stream. As Butte Creek enters the upper end of Butte Valley, however, large vegetation becomes very scarce, and vegetation is mainly grass, sagebrush, and scattered junipers. The lower end of the Butte Valley is heavily irrigated for production of alfalfa and potatoes, and for cattle grazing.

Good self-sustaining populations of brown and rainbow trout exist in the upper section of the stream, and catchable rainbow trout are also stocked by the Department of Fish and Game.

7. Butte Valley Subunit. This subunit is in the northwestern corner of the hydrographic unit. The only prominent feature of this subunit is Meiss Lake, a large natural sink in the west central part of the subunit. The terrain of the subunit is typical of this hydrographic unit, being composed of volcanic ridges and buttes that surround the valley and rise to elevations of 6,000 to 8,000 feet.

The only permanent stream drainages found in this subunit are three small tributaries entering the southwest corner of Meiss Lake; Ikes, Harris, and Muskgrave Creeks. Small populations of trout are found in these streams.

Proposed Water Developments

Studies of possible water developments in the Lost River - Butte Valley Hydrographic Unit by the Department of Water Resources have so far been very preliminary. Since it was not among the purposes of Bulletin No. 136 to report on these studies, comments on the effects of these possible developments on fish and wildlife are not appropriate in this report.

TABLE 35

Lost River-Butte Valley Hydrographic Unit Fishery Resources and Flow Requirements

Subunit	Stream	Fish Resources 1/	Required Maintenance Flow: Reference Point	Required Maintenance Flow: Streamflow (CFS)
Willow Creek	North Fork Willow Creek	Rough fish only (suckers, dace, lampreys, and tue chubs).	T47N, R8E, S 13	5 cfs yearlong
	Boles Creek		T47N, R8E, S 13	4 cfs yearlong
Clear Lake	Mowitz Creek	None	T46N, R8E, S 21	0.5 cfs or natural flow, whichever is less. 2/
	Lost River	Catfish, white crappie and pumpkinseed sunfish.	T48N, R7E, S 20	25 cfs yearlong.
	---	Unknown	Clear Lake	3/
Tule Lake	---	Unknown	Tule Lake	3/
Mount Dome	Lower Klamath Lake	Unknown	Lower Klamath Lake	3/
	Willow Creek	None	T46N, R2E, S 4	0.5 cfs or natural flow, whichever is less. 2/
Antelope Creek	Antelope Creek	Excellent self-sustaining populations of resident brown and rainbow trout in permanent water. Catchable rainbow trout are also stocked.	T43N, R1W, S 25	45 cfs May 1- Oct 31 10 cfs or natural flow, whichever is less-Nov 1-April 30

(Cont.)

TABLE 35

Lost River-Butte Valley Hydrographic Unit Fishery Resources and Flow Requirements (Continued)

Subunit	Stream	Fish Resources 1/	Required Maintenance Flow	
			Reference Point	Streamflow (CFS)
Butte Creek	Butte Creek	Excellent self-sustaining population of resident brown and rainbow trout in permanent headwater. Catchable rainbow trout are also stocked.	T44N, R2W, S 23	50 cfs May 1- Oct 31 15 cfs or natural flow, whichever is less-Nov 1 - April 30
Butte Valley	---	Minor trout populations in small tributaries of Meiss Lake.	Meiss Lake	3/

1/ Relative number of fish in these populations is unknown.
2/ For wildlife maintenance only.
3/ Present mean lake level should be maintained to preserve waterfowl habitat.

CHAPTER XVI. FUTURE FISH AND WILDLIFE STUDIES

With the initiation of the advance planning program for the Upper Eel River Development in July 1964, the Department of Water Resources commenced feasibility-level studies of additional conservation and conveyance facilities of the State Water Resources Development System. These additional facilities, designated the Upper Eel River Development, will include dams and reservoirs on the Middle Fork Eel River. They may also include associated transbasin diversion features to convey the developed water supplies to local service areas and to English Ridge Reservoir on the upper main Eel River, with subsequent diversion via Clear Lake, Soda Creek, Putah Creek, and Lake Berryessa to the Sacramento-San Joaquin Delta. Concurrently, more intensive studies will be made of the alternative diversion route via a gravity-flow tunnel to Thomes Creek, and of possible elements of the Glenn Reservoir Complex. The advance planning program for the Upper Eel River Development and associated features is scheduled for completion in June 1968.

Studies of an intermediate intensity will be conducted as part of the continuing North Coastal Area Investigation of projects anticipated for later staging. These studies would be directed toward more detailed identification of future projects within the Trinity, Klamath, Mad, Van Duzen, Russian, and lower Eel River basins. It is anticipated that feasibility-level studies of the subsequent additional facilities, such as the Trinity Diversion Project, would follow.

Reconnaissance level estimates of the effects of the proposed North Coastal area water projects on fish and wildlife, and recommendations for preservation and enhancement of these resources are presented in this report. This preliminary evaluation of these projects is based primarily on review of existing literature, and data obtained from relatively limited previous field studies. There are a number of important areas where our knowledge of the fish and wildlife resources of the North Coastal region remains meager. Intensive field studies of these fish and wildlife problems should begin with the initiation of the Upper Eel River Advance Planning Program.

In addition, field studies should be conducted to complete basic inventories of the fish and wildlife resources affected by the projects proposed for the Trinity, Klamath, Mad, Van Duzen, Russian, and lower Eel River basins. Specific areas where further work is needed are outlined below.

Upper Eel River Advance Planning Program

1. A better estimate of the size of the anadromous fish runs and their distribution in relation to the Upper Eel River Development should be obtained. The U. S. Fish and Wildlife Service (1960) tagged salmon and steelhead in the lower Eel River each year 1955-59 and estimated the total spawning escapement in the drainage from the ratio of tagged to untagged carcasses recovered in the spawning grounds. Due to inadequate manpower and the immense size of the Eel River drainage, many problems were encountered in this study and the estimates obtained are not precise.

An estimate of the spawning populations of king salmon and steelhead in relation to the Upper Eel River Development could be obtained by tagging fish below the confluence of the Middle Fork and recovery of salmon carcasses in the upper main Eel River and Middle Fork. Although more restricted than the U. S. Fish and Wildlife Service investigation, this would be a difficult task due to the size of the drainage, and the poor access into much of the area during the late fall months. Substantial amounts of manpower would be required.

Enumeration of steelhead presents an even more difficult problem, since they migrate during the winter and spring months when streamflows are high and access into the area is at its worst. It is possible that steelhead could be estimated by weirs on several important tributaries correlated with fyke-net studies of downstream migrants the following spring and summer. This method would require repetition for several years and substantial manpower, but appears to offer some promise.

In view of the difficulties involved in estimating populations of anadromous fish, some consideration should be given to the possibility of constructing concrete fish barriers, similar to the structure built by the Bureau of Reclamation below its Lewiston Dam on the Trinity River. Permanent barriers of this type could be constructed near the mouth of the Middle Fork and below the proposed English Ridge project on the main Eel River. The Upper Eel River Development was authorized for construction by the State in March 1964. As soon as the damsite locations are firm, concrete barriers with fish ladders and counting facilities could be constructed to allow enumeration of anadromous fish passing upstream. Such installations would allow several years of counts prior to construction of the proposed projects.

Although relatively expensive to construct, permanent weirs would have the major advantages of allowing enumeration of virtually all of the salmon and steelhead passing above the damsites, and would save the majority of the funds budgeted for the population studies described above. Since it will be necessary to provide fish barriers to allow transport of anadromous fish above the project areas during the construction period, the capital cost of the fish barriers will be an eventual project cost. Thus, simply constructing the fish barriers earlier than would otherwise be necessary could provide a method of enumerating anadromous fish populations with much greater accuracy, and with substantial financial savings to the project in the long run.

2. The streamflow releases required for spawning, egg incubation and nursery areas should be determined for the Middle Fork and upper main Eel River. Smith and Elwell (1961) measured the flow required for optimum spawning flow in the Middle Fork. A similar study would be required on the main Eel River below the English Ridge damsite. The desirable egg incubation flows could be determined by measuring dissolved oxygen in the intragravel water, permeability of the gravel, and seepage rate of the intragravel water using standpipe techniques. Adequate nursery flows could be determined by measurement of fish habitat at various flows.

3. The streamflow required to allow anadromous fish to easily migrate up the main Eel River should be determined by observations during the migration season. This flow, measured on the main Eel River at Dos Rios, would be the required migration flow.

4. A detailed water temperature prediction study should be made for the Spencer-Franciscan, Dos Rios, and English Ridge projects. This would require collection of basic data on precipitation, air and water temperatures, wind velocity, and solar radiation in the reservoir sites. An expansion of the current weather data collection program of the Department of Water Resources' Northern Branch would be needed to obtain this data.

5. Basic water quality data should be collected to enable a prediction of turbidity in the proposed reservoirs and to determine the probable effects of this turbidity on the reservoir fishery, hatchery operation, and the downstream fisheries.

6. An investigation of possible hatchery locations, sizing and evaluation of the predicted water supplies should be initiated for each of the proposed projects.

7. The feasibility of constructing an artificial spawning channel in Short Creek should be investigated. Depending on the results of this study, the required fisheries maintenance flow from the Franciscan Dam should be determined. This work can be accomplished by field reconnaissance of the area to determine what would be required and cost estimates by DWR engineers. The required spawning, egg incubation and nursery flows would have to be measured as described above.

8. The feasibility of releasing water from the Franciscan Dam down Mill Creek during the summer months to create a steelhead nursery area should be investigated. This would require a temperature evaluation and measurements of Mill Creek to determine the streamflow required to provide adequate nursery area.

9. The feasibility of constructing a reservoir in Eden Valley to provide water for salmon migration in the Middle Fork should be investigated. This would require field reconnaissance and cost estimates by DWR engineers.

10. A fyke-net study to determine the timing and numbers of downstream migrants should be conducted at least one or two years on the Middle Fork and upper main Eel River. This would provide an indirect measure of spawning use by adults and would also establish the timing of the migration and the conditions under which it occurs. These data could be used to determine the period of the spring and summer flows.

11. Stream surveys should be conducted of Elk, Thatcher, Tomki, and Outlet Creeks and their tributaries and other important tributaries to the Middle Fork and upper main Eel River.

12. The possibility of making a diversion from English Ridge or Bell Springs Reservoirs to the headwaters of Outlet Creek and the South Fork Eel River should be investigated. Streamflow releases required for optimum spawning, egg incubation and nursery areas in Outlet, Long Valley, and Tenmile Creeks, and the South Fork Eel River should be determined.

13. Better estimates of the wildlife values in the proposed project sites are needed. A study of the areas suitable for wildlife mitigation should be undertaken to formulate a management plan. Investigation of wildlife enhancement possibilities should be continued.

North Coastal Area Investigation

1. Studies to estimate the adult anadromous fish populations and their distribution should be initiated. Adequate estimates have already been made for the Trinity River above the South Fork and the Mad River. However, little is known about the anadromous fish populations in the other basins under study. Determining the size of these runs is a large job and the work should be started during the intermediate level investigation since adequate time will probably not be available during the feasibility level study to accomplish all the work required.

2. Studies to determine the streamflow releases required for optimum spawning, egg incubation and nursery area below the various projects should be begun. These studies should be initiated during the intermediate level investigation since information on flows required for fisheries is needed by DWR engineers early in their studies. Also the large number of

projects to be studied indicates adequate time may not be available during the feasibility level investigation to make all the field studies necessary.

3. Fyke-net studies to determine the timing and magnitude of the downstream migrant runs in relation to the proposed developments should be initiated. As indicated above, there are a large number of rivers to study, therefore work should be initiated during the intermediate level investigation.

4. Water temperature studies should be initiated on the upper Trinity River to determine the rate of warming of streamflow releases from major dams. Water temperature studies will probably be required on the other North Coastal drainages; however, this can be accomplished during the feasibility investigation.

5. Stream surveys should be made of all important tributaries of the Trinity, Russian, Mad, Van Duzen, lower Eel and Klamath Rivers. Many of these streams have already been surveyed by Region 1 of the Department of Fish and Game.

6. A more comprehensive wildlife study is needed for each of the proposed water projects to more accurately evaluate wildlife losses which will occur, to select mitigation sites for these losses, and to evaluate enhancement possibilities and determine benefits.

Sacramento Valley Investigations

1. An investigation should be initiated to evaluate the effects of imported Eel River water on Middle Creek, Clear Lake, Soda Creek, Putah Creek, Lake Berryessa, and lower Putah Creek.

2. Studies should be conducted to more accurately determine optimum spawning, egg incubation and nursery flows in connection with

enhancement of Clear, Cottonwood, Elder, Redbank, Stony and Cache Creeks. Optimum egg incubation and nursery flows should also be determined for Thomes Creek. Optimum spawning flows in Thomes Creek was measured by Fisk (1959).

3. A more comprehensive wildlife study is needed on the two possible routes for importing Eel River water to the Sacramento Valley. A plan for mitigation of wildlife losses should be developed. Wildlife enhancement possibilities should be explored, especially at Clear Lake and the Glenn Reservoir Complex.

General Investigations

1. A long-range study should be initiated to determine the value of streamflow maintenance dams to anadromous fish. An evaluation of controlled and enhanced flows in terms of number of additional fish produced should be made.

2. A method should be developed for determining maintenance flows from the spawning gravel versus streamflow studies. There is a need to clearly define what is maintenance and what is enhancement. It is possible that the optimum spawning flow as determined by spawning gravel studies is the necessary maintenance flow although we have usually considered maintenance as something less.

3. The possible need for large flows to stimulate and initiate upstream and downstream migration of anadromous fish should be investigated.

4. The possible need for large flushing flows to wash away silt and loosen compacted gravel should be investigated.

5. An evaluation should be made of the effects of streambed gravel movement below a dam without replacement.

6. The possibility of "fish farming" with natural and artificial rearing areas in a manner similar to experimental work conducted by Oregon and Washington during the past several years should be investigated. This might be one method of partial compensation required for the large projects proposed for the Lower Eel and Klamath Rivers. The study should include completely artificial ponds and natural coastal lagoons.

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