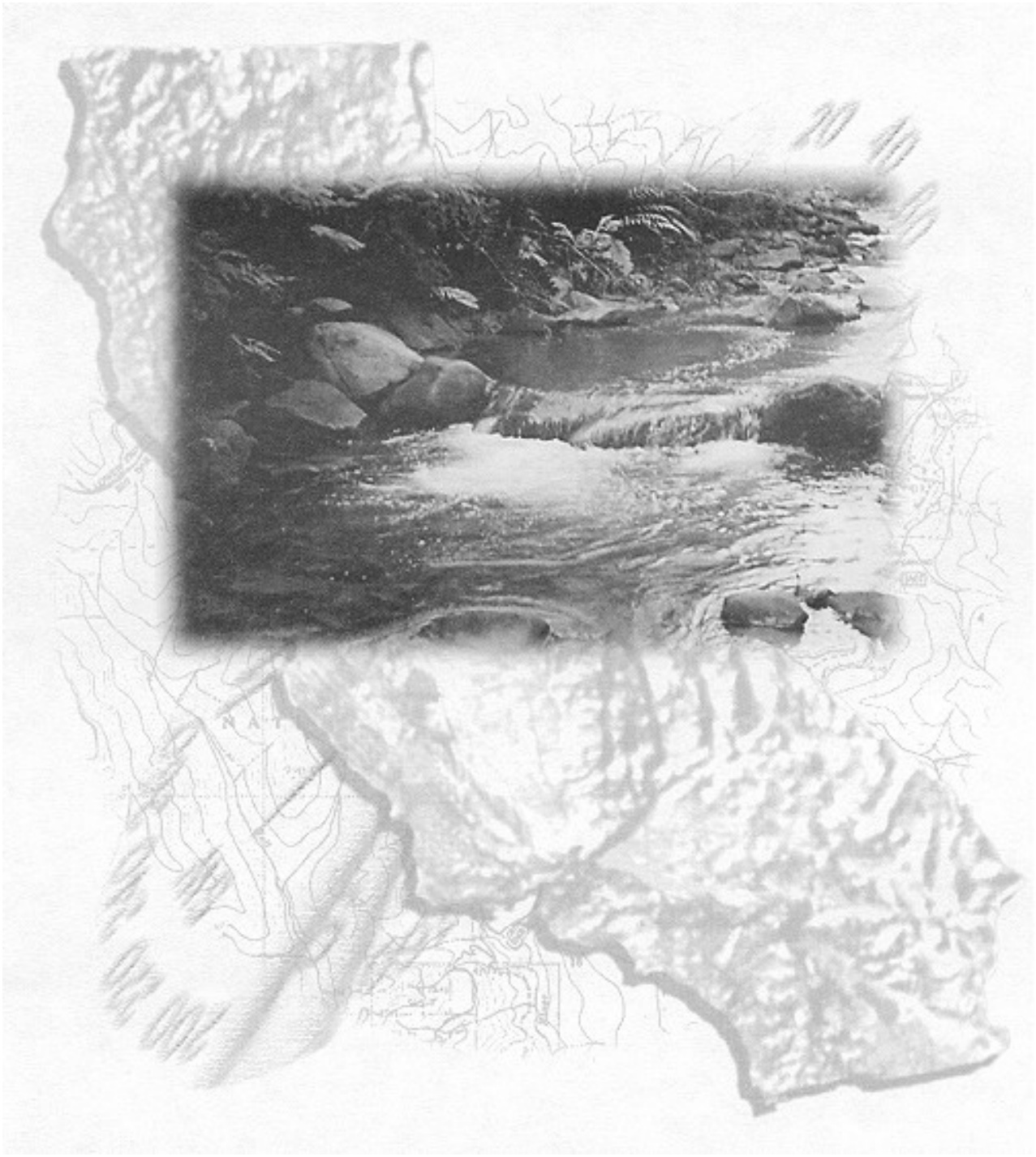
CALIFORNIA SALMONID STREAM HABITAT RESTORATION MANUAL

APPENDICES



APPENDIX A.

POLICY AND REGULATIONS FOR SALMON AND STEELHEAD RESTORATION IN CALIFORNIA

FISH AND GAME COMMISSION POLICY

Steelhead Rainbow Trout

It is the policy of the Fish and Game Commission that:

I. Steelhead rainbow trout shall be managed to protect and maintain the populations and genetic integrity of all identifiable stocks. Naturally spawned steelhead shall provide the foundation of the Department's management program.

II. Steelhead shall be rescued only when they will be returned to the stream system of origin. Rescue of juvenile steelhead shall be limited to circumstances where fish can be held until habitat conditions improve, or where immediate release can be made in understocked areas of their natal stream system.

III. Restoration and acquisition plans shall be developed and implemented to safeguard such critical habitats as estuaries, coastal lagoons, and spawning and rearing areas, and to protect or guarantee future instream flows. All steelhead streams shall be inventoried for quantity and quality of habitat, including stream flow conditions. Steelhead Restoration Card and other funding shall be directed to implement the plans.

IV. Existing steelhead trout habitat shall not be diminished further without offsetting mitigation of equal or greater long-term habitat benefits. All available steps shall be taken to prevent loss of habitat, and the Department shall oppose any development or project which will result in irreplaceable losses. Artificial production shall not be considered appropriate mitigation for loss of wild fish or their habitat.

V. Sport fishing for sea-run steelhead shall be encouraged where the Department has determined that harvest will not harm existing wild populations. Harvest of juveniles shall only be permitted where such harvest does not impair adequate returns of adults for sport fishing and spawning. Special restrictions on the harvest of wild juvenile steelhead may be necessary when a fishery includes both wild and hatchery stocks.

VI. Resident fish will not be planted or resident fisheries developed in drainages of steelhead waters, where, in the opinion of the Department, such planting or development will interfere with steelhead populations.

VII. Exceptions to this policy may be made by the Commission (a) where the stream is no longer adaptable to anadromous runs, or (b) during the mid-summer period in those individual streams considered on a water-by-water basis where there is a high demand for angling recreation, and such planting or development has been determined by the Department not to be detrimental to steelhead.

The following waters are excepted.

Nacimiento River	San Luis Obispo County
North Fork Battle Creek	Shasta County, upstream from Manton
Cow Creek	Shasta County upstream from Fern Road and Ingot
Antelope Creek	Tehama County, upstream from Ponderosa Way
Deer Creek	Tehama County, upstream from upper Deer Creek Falls
American River	Sacramento County, only in Arden Pond

Salmon

It is the policy of the Fish and Game Commission that:

I. Salmon shall be managed to protect, restore and maintain the populations and genetic integrity of all identifiable stocks. Naturally spawned salmon shall provide the foundation for the Department's management program.

II. Salmon streams shall be inventoried for quantity and quality of habitat, including instream flow requirements. Restoration plans shall identify habitats for restoration and acquisition and opportunities to protect or guarantee future instream flows. Commercial Salmon Trollers Stamp and other funding shall be directed to implement the plans.

III. Existing salmon habitat shall not be diminished further without offsetting the impacts of the lost habitat. All available steps shall be taken to prevent loss of habitat, and the Department shall oppose any development or project which will result in irreplaceable loss of fish. Artificial production shall not be considered as appropriate mitigation for loss of wild fish or their habitat.

IV. Salmon shall be rescued only when they will be returned to the stream system of origin. Rescue of juvenile salmon shall be limited to circumstances where fish can be held until habitat conditions improve, or where immediate release can be made in understocked areas of their natal stream system.

V. In coastal streams without Department hatcheries, artificial rearing shall be limited to areas where the Department determines it would be beneficial to supplement natural production to re-establish or enhance the depleted wild population. In the Sacramento, American, Feather, San Joaquin, Klamath, and Trinity river systems, hatchery production shall be used to meet established mitigation goals. At the discretion of the Department excess eggs and fish from State, Federal, or cooperative hatcheries may be used to provide additional fish for the commercial and sport fisheries.

VI. Resident fish will not be planted or resident fisheries developed in drainages of salmon waters, where, in the opinion of the Department, such planting or development will interfere with salmon populations. Exceptions to this policy may be authorized by the Commission (a) where the stream is no longer adaptable to anadromous runs, or (b) during the mid-summer period in those individual streams considered on a water-by-water basis where there is a high demand for angling recreation and such planting or development has been determined by the Department not to be detrimental to salmon.

Classification and Management System

The classification system shall be employed to define the appropriate stocks and the role of artificial production for management of each salmon and steelhead stream in California. This classification may be applied to drainages, individual streams, or segments of streams as necessary to protect discrete stocks of salmon or steelhead. Only designated appropriate stocks may be placed or artificially produced in any stream within the guidelines specified under this classification system. Exceptions to these management constraints may be allowed only under emergency conditions that substantially threaten the long-term welfare of the fishery. Exceptions may only be granted upon submission of a written request, which details the emergency conditions, by a DFG region or an Inland Fisheries Division (IFD) Assistant Chief to the Chief of IFD. The IFD Chief will review the request and make recommendations for approval or denial to the Deputy Director of Fisheries who will then approve or deny the request.

Salmon and Steelhead Stream Classification System Terms

The salmon or steelhead stocks stream management goal shall manage streams for the following appropriate stock and only those stocks may be placed in the stream (each term is progressively inclusive of the preceding terms):

a. Endemic - Only historic naturally reproducing fish originating from the same stream or tributary.

b. Naturally reproducing stocks within drainage - Naturally reproducing stocks from the drainage of which the stream is part.

c. Hatchery stocks within basin - Stocks which may include hatchery produced fish from streams within the drainage.

d. Naturally reproducing stocks from out of basin - Naturally reproducing stocks from streams outside the basin.

e. Hatchery stocks out of basin - Stocks which may include hatchery produced fish from streams outside the basin.

f. Any stock - Any stock which appears to exhibit characteristics suitable for the stream system.

Artificial production limitations shall be defined according to the following terms. The Department of Fish and Game (DFG) guidelines for cooperative fish production in California are included as Appendix B.

a. None - No artificial production or fish planting permitted. Manage for natural reproduction. Rearing habitat fully occupied by natural production in most years.

b. Supplementary - Artificial production is less desirable than natural production and is allowed only to the extent that it provides for full stocking of the stream. Artificial production shall be construed to be a temporary measure until such time as the DFG determines the stream to be fully stocked, but shall not continue beyond 5 years without formal review by the appropriate Regional Fisheries Management Supervisor and Inland Fisheries Division representative. Releases of artificially reared fish shall be distributed to minimize disruption of naturally produced salmon or steelhead.

c. Complementary - Artificial production is as important for fishery management purposes as natural production and hatchery production may be used on a permanent basis to complement natural production. The level of hatchery production shall not significantly interfere with natural reproduction and survival.

d. Hatchery - Managed principally for hatchery production with natural production protected but considered secondary.

DEPARTMENT OF FISH AND GAME FISH SCREEN POLICY

This fish screening policy is structured to comply with existing fish screening statutes, the National Environmental Policy Act (NEPA), the California Environmental Quality Act (CEQA), the Federal Endangered Species Act of 1973 (ESA), the California Endangered Species Act (CESA), and court decisions in place at the time of its adoption. All diversions shall be dealt with uniformly on a statewide basis, as outlined in this policy memorandum.

Diversions Covered By Section 6100

The Department of Fish and Game shall require the installation of fish screens under Section 6100 et seq. of the Fish and Game Code on any new diversion, or on the intake of any existing diversion that is either enlarged, relocated, or at which the season of use is changed, in salmon and steelhead (anadromous) waters of the State.

In addition, all diversions covered by this section which are located within the essential habitat of a State-CESA listed species or the critical habitat of a Federal-ESA listed species shall be screened.

Variances from these requirements shall be supported by a report, prepared by the diverter, which includes data from onsite monitoring and a review of historical entrainment and diversion data. The scope of the report and the sampling effort shall be approved by the Department of Fish and Game prior to the initiation of work.

Both approval of the scope of the report and approval of an exception to this policy shall require the concurrence of the appropriate Regional Manager, the Chief of the Inland Fisheries Division, and the Chief of the Environmental Services Division. The final exception notice shall be issued by the Deputy Director - Fisheries.

Diversions Covered By Section 5980

The Department of Fish and Game shall investigate, and where necessary, order fish screens installed on all diversions which affect fishery resources with a capacity greater than 250 cubic feet per second (cfs). Diversions in anadromous waters of the State shall be screened unless onsite sampling demonstrates otherwise.

In addition, all diversions covered by this section which are located within the essential habitat of a State CESA-listed species or the critical habitat of a Federal-ESA listed species shall be screened.

Variances from these requirements shall be supported by a report prepared by the diverter, which includes data from onsite monitoring, and a review of historical entrainment and diversion data. The scope of the report and the sampling effort shall be approved by the Department of Fish and Game prior to the initiation of work.

Both approval of the scope of the report, and approval of an exception to this policy shall require the concurrence of the appropriate Regional Manager, the Chief of the Inland Fisheries Division, and the Chief of the Environmental Services Division. The final exception notice shall be issued by the Deputy Director - Fisheries.

Diversions Covered By Section 6020

The Department of Fish and Game may consider for screening any diversion with a capacity of 250 cfs or less. Activities in this category should be assigned a lower priority than those covered by provisions of Section 5980, until all of the Department of Fish and Game obligations for both its own diversions, and for those diversions with a capacity greater than 250 cfs, have been fulfilled.

In addition, all diversions covered by this section which are located within the essential habitat of a State CESA-listed species or the critical habitat of a Federal-ESA listed species shall be screened.

Variances from these requirements shall be supported by a report, prepared by the diverter, which includes data from onsite monitoring, and a review of historical entrainment and diversion data. The scope of the report and the sampling effort shall be approved by the Department of Fish and Game, prior to the initiation of work.

Both approval of the scope of the report, and approval of an exception to this policy shall require the concurrence of the appropriate Regional Manager, the Chief of the Inland Fisheries Division, and the Chief of the Environmental Services Division. The final exception notice shall be issued by the Deputy Director - Fisheries.

NEPA And CEQA Processes

When reviewing projects, the Department of Fish and Game shall make every effort to require the installation of fish screens on all unscreened diversions where other measures cannot reasonably prevent entrainment of fish. Further, the Department of Fish and Game shall make every effort to require modernization of fish screens which do not meet our present fish screening criteria. This effort shall include the Streambed Alteration Agreement process (Section 1600 et seq. of the Fish and Game Code). Variances from the fish screening policy shall be treated as discussed above.

Fish and Wildlife Coordination Act

Under the provisions of this Federal legislation enacted in 1934, the Department of Fish and Game shall require installation of fish screens on all unscreened diversions where fish are present. Further, the Department of Fish and Game shall make every effort to require improvement of fish screens not meeting our present screening criteria. For example, opportunities are provided by the U.S. Army Corps of Engineers permit process under the Federal Rivers and Harbors and Clean Water acts.

The "General Fish Screening Criteria" shall be used as the basis for design of fish screens required under this policy. The need-to-screen criteria may be modified by the Department of Fish and Game, and it is the responsibility of the project proponent to have the most recent copy of these agreement criteria. Copies are available from either the Environmental Services Division or the In land Fisheries Division of the Department of Fish and Game.

SENATE BILL 2261
(CHAPTER 1545, Statutes of 1988)

SENATE BILL 2261, introduced by Senator Barry Keene. Salmon, Steelhead Trout, and Anadromous Fisheries Program Act) added Chapter 8 (commencing with section 6900) to Part 1 of Division 6 of the Fish and Game Code, relating to fish, making an appropriation therefore, and declaring the urgency thereof, to take effect immediately.

The people of the State of California do enact as follows:

SEC. 1. The Legislature finds that the Advisory Committee on Salmon and Steelhead Trout, reestablished by Resolution Chapter 141 of the Statues of 1983, has conducted a thorough inquiry into the decline of the naturally spawning salmon and steelhead trout resources of the state and has presented to the public its findings and recommendations for legislative and administrative actions to protect and increase those resources. As a result of the advisory committee's inquiry, findings, and recommendations, the Legislature has recommended the establishment of a salmon, steelhead trout, and anadromous fisheries program set forth in Chapter 8 (commencing with Section 6900) of Part 1 of Division 6 of the Fish and Game Code.

SEC. 2. Chapter 8 (commencing with Section 6900) is added to Part 1 of Division 6 of the Fish and Game Code, to read:

CHAPTER 8. SALMON, STEELHEAD TROUT, AND ANADROMOUS FISHERIES PROGRAM ACT

Article 1. Citation and Legislative Findings

6900. This chapter shall be known and may be cited as the Salmon, Steelhead Trout, and Anadromous Fisheries Program Act.

6901. The Legislature, for purposes of this chapter, finds as follows:

(a) According to the department, the natural production of salmon and steelhead trout in California has declined to approximately 1,000,000 adult chinook or king salmon, 100,000 coho or silver salmon, and 150,000 steelhead trout.

(b) The naturally spawning salmon and steelhead trout resources of the state have declined dramatically within the past four decades, primarily as a result of lost stream habitat on many streams in the state.

(c) Much of the loss of salmon and steelhead trout and anadromous fish in the state has occurred in the central valley.

(d) Protection of, and in increase in, the naturally spawning salmon and steelhead trout resources of the state would provide a valuable public resource to the residents, a large statewide economic benefit, and would, in addition, provide employment opportunities not otherwise available to the citizens of this state, particularly in rural areas of present underemployment.

(e) Proper salmon and steelhead trout resource management requires maintaining adequate levels of natural, as compared to hatchery, spawning and rearing.

(f) Reliance upon hatchery production of salmon and steelhead trout in California is at or near the maximum percentage that it should occupy in the mix of natural and artificial hatchery production in the state. Hatchery production may be an appropriate means of protecting and increasing salmon and steelhead in specific situations; however, when both are feasible alternatives, preference shall be given to natural production.

(g) The protection of, and increase in, the naturally spawning salmon and steelhead trout of the state must be accomplished primarily through the improvement of stream habitat.

(h) Funds provided by the Legislature since 1978 to further the protection and increase of the fisheries of the state have been administered by the Department of Fish and Game in a successful program of contracts with local government and nonprofit agencies and private groups in ways that have attracted substantial citizen effort.

(i) The Department's contract program has demonstrated that California has a large and enthusiastic corps of citizens that are eager to further the restoration of the stream and fishery resources of this state and that are willing to provide significant amounts of time and labor to that purpose.

(j) There is need for a comprehensive salmon, steelhead trout, and anadromous fisheries plan, program, and state government organization to guide the state's efforts to protect and increase the naturally spawning salmon, steelhead trout, and anadromous fishery resources of the state.

6902. The Legislature, for purposes of this chapter, declares as follows:

(a) It is the policy of the state to significantly increase the natural production of salmon and steelhead trout by the end of this century. The Department shall develop a plan and a program that strives to double the current natural production of salmon and steelhead trout resources.

(b) It is the policy of the state to recognize and encourage the participation of the public in privately and publicly funded mitigation, restoration, and enhancement programs in order to protect and increase naturally spawning salmon and steelhead trout resources.

(c) It is the policy of the state that existing natural salmon and steelhead trout habitat shall not be diminished further without offsetting the impacts of the lost habitat.

Article 2. Definitions

6910. Unless the context clearly requires a different meaning, the definitions in this article govern the construction of this chapter.

6911. "Production" means the survival of fish to adulthood as measured by the abundance of the recreational and commercial catch together with the return of fish to the state's spawning streams.

6912. "Program" means the program for protection and increasing the naturally spawning salmon and steelhead trout of the state provided for in Article 3 (commencing with Section 6920).

Article 3. Salmon, Steelhead Trout, and Anadromous Fisheries Program

6920. (a) The Department shall, with the advice of the Advisory Committee on Salmon and Steelhead Trout and the Commercial Salmon Trollers Advisory Committee, prepare and maintain a detailed and comprehensive program for the protection and increase of salmon, steelhead trout, and anadromous fisheries.

(b) The Department shall consult with every public agency whose policies or decisions may affect the goals of this program to determine if there are feasible means for those public agencies to help the Department achieve the goals of this program.

6921. The program shall identify the measures the Department will carry out to achieve the policies set fourth in Section 6902.

6922. The program shall include, but is not limited to, all of the following elements:

(a) Identification of streams where the natural production of salmon and steelhead trout can be increased primarily through the improvement of stream and stream bank conditions without effect on land ownership, land use practices, or changes in stream flow operations.

(b) Identification of streams where the natural production of salmon and steelhead trout can be increased only through the improvement of land use practices or changes in stream flow operations.

(c) Identification of streams where the protection of, and increase in, salmon and steelhead trout resources require, as a result of significant prior loss of stream habitat, the construction of artificial propagation facilities.

(d) A program element for evaluating the effectiveness of the program.

(e) Recommendations for an organizational structure, staffing, budgeting, long-term sources of funding, changes in state statutes and regulations and federal and local government policy and such other administrative and legislative actions as the Department finds to be necessary to accomplish the purposes of this chapter.

(f) Identification of measures to protect and increase the production of other anadromous fisheries consistent with policies set forth in Section 6902.

(g) Identification of alternatives to, or mitigation of, manmade factors which cause the loss of juvenile and adult fish in California's stream systems.

6923. Measures which are the responsibility of other agencies or persons, such as the repair or replacement of dysfunctional fish screens, are not eligible for funding under the program.

6924. The Department shall determine the initial elements of the program and transmit a report describing those elements to the Legislature and the Advisory Committee on Salmon and Steelhead Trout within six months of the effective date of this chapter.

SEC. 3. The Department of Fish and Game shall determine the initial elements of the salmon, steelhead trout, and anadromous fisheries program initiated pursuant to Chapter 8 (commencing with Section 6900) of Part 1 of Division 6 of the Fish and Game Code, shall coordinate existing programs, and shall implement the elements of the program. In addition to the personnel positions authorized in the Budget Act of 1988, the Department shall use moneys allocated to the salmon, steelhead trout, and anadromous fisheries program, upon appropriation by the legislature, to provide three additional personnel years for the purposes of maintaining a salmon, steelhead trout, and anadromous fisheries program. The Department shall annually submit a budget for the purpose of continuing this program.

SEC. 4. The sum of one hundred twenty-five thousand dollars ($125,000) is hereby appropriated from the Environmental License Plate Fund, and the sum of one hundred sixty-six thousand dollars ($166,000) is hereby appropriated from the Fish and Game Preservation Fund to the Department of Fish and Game to establish the salmon, steelhead trout, and anadromous fisheries program pursuant to Chapter 8 (commencing with Section 6900) of Part 1 of Division 6 of the Fish and Game Code. The Department may also utilize its allocation of funds received pursuant to Chapter 10B (commencing with Section 777) of Title 16 of the United States Code for this program.

SEC. 5. This act is an urgency statue necessary for the immediate preservation of the public peace, health, or safety within the meaning of Article IV of the Constitution and shall go into immediate effect. The facts constituting the necessity are:

The decline of naturally spawning salmon, steelhead trout, and other anadromous fish resources is occurring at such a rate that some segment of these native California fish may be threatened with extinction. In order to stop the decline and restore the fishery resource at the earliest possible time, it is necessary that this act take effect immediately.

APPENDIX B.

COOPERATIVE FISH PRODUCTION IN CALIFORNIA

Artificial fish production is accomplished through three separate administrative processes:

- State or Federal hatcheries operated for mitigation of water project damages or for fisheries enhancement.

- Aquaculture contracts for production of mitigation or fisheries enhancement fish for public harvest. Some fish such as striped bass are reared for mitigation purposes by registered aquaculturists; refer to IFD Informational Leaflet No. 34 for the laws and regulation on aquaculture.

- Cooperative fish rearing operations for production of fish to accelerate fisheries restoration or to enhance fisheries.

Each of these options for fish production can play an important role in the management and restoration of California's fisheries resources. In addition to maintaining State hatcheries, the Department of Fish and Game (DFG) strongly advocates involvement by the public sector where it is economically and operationally advantageous to the fisheries. The policies and State laws pertaining to cooperative fish rearing which permit, contract, or grant rearing of public domain fish for return to the public domain are aimed at maintenance of a strong and beneficial public involvement in fish rearing. Aquaculture is regulated under a special set of laws and regulations which permit the sale of the fish produced.

SPECIAL PURPOSE FACILITIES

A wide variety of facilities and strategies are used by DFG and its cooperators to fulfill the needs for artificial production of fish for restoration and enhancement.

Rescue Rearing

Annually, Department personnel rescue fish stranded in inhospitable conditions due to poor water quality or lack of flow. The fish are collected and then relocated to suitable waters. Occasionally, it is preferable to place rescued fish in rearing facilities where the fish are grown to a larger size and released to the wild at the time of year most likely to result in their survival. Rearing facilities for rescued fish may be used to insure the survival of a run of fish, to reintroduce fish to suitable streams, or where natural rearing conditions have temporarily been too severely degraded to maintain wild populations.

Trapping Weirs

Trapping weirs are sometimes used to trap fish for tagging, marking, measuring, transporting, or obtaining eggs for fish rearing programs. These weirs are usually fish-proof fences installed across streams to direct fish into a containment device. All fish moving upstream or downstream can be stopped at the weir and can only pass when the weir and trap are deactivated

or removed. Care must be taken to avoid harming fish during handling, and juvenile fish must be provided a hiding place in the trap to reduce predation by larger fish or by other species that have been captured.

Weirs used for counting or marking fish are sometimes kept in operation for days or even weeks to obtain the necessary number of fish to meet the purpose of the project. Fish not retained for project purposes are observed or marked and then released to continue on their way.

Weirs used for obtaining fish for relocation to another area or for obtaining eggs are normally installed for a short period of time or are periodically deactivated to allow the majority of the fish to pass unhindered. This allows the stream to retain its basic population of fish, and reduces the potential for adversely impacting production of the stream. A weir is not allowed in areas where it could cause harm to the fishery.

Ocean Net Pen Rearing

Ocean net pen rearing operations are used to rear and acclimate chinook salmon fingerlings from freshwater to salt water conditions in a protected environment where the salmon can be imprinted to the nearby bay. Ocean net pen rearing is used mainly for ocean fishery enhancement.

Ocean net pen rearing operations require suitable water quality and temperature, water depth, and minimal tidal action in the harbor or bay. Usually a plastic liner is inserted into the net pen which is filled with filtered fresh water and oxygenated. Over a period of three to six days, sea water is gradually added until the liner contains full strength sea water. The liners are then removed, as the salmon are then acclimated to the sea water. The chinook salmon are usually reared from two weeks to four months for imprinting purposes. The longer term provides protection for the chinook salmon during poor summer ocean conditions, El Nino events, and predators. The fish are released at the rearing location when they have reached a targeted size.

Rearing Ponds or Other Facilities

DFG cooperators typically produce salmon and steelhead juveniles by rearing fish in small artificial ponds. The rearing ponds require fry from an acceptable sources. Most frequently, to meet genetic stock selection requirements, the fry are from eggs taken from natal fish captured in local streams and the eggs are incubated in a hatch box, egg baskets, or in stacks of egg trays.

Rearing facilities require a reliable source of high quality water ranging in temperature from 45E to 59E Fahrenheit. All water intake structures must meet Department of Fish and Game fish proof screening and flow bypass criteria. These specifications are found within the Fish and Game Code Sections 5900 - 6100 et. seq. Required screen size is listed in a 1984 memo by Department of Fish and Game Engineers. This memo is available from the Department of Fish and Game, Environmental Services Division at DFG Regional offices.

Chinook salmon are typically reared until mid-May and are released as juveniles weighing no less than 90 fish to the pound. Coho salmon and steelhead trout require similar water conditions but should be reared for one full year. Coho salmon must be released in March, April, or May. Generally, survival for steelhead is greatest for large fish that count 2 or 3 to the pound

when they are released as one-year-old fish during the winter months. Coho that are too large at time of release will frequently return to the spawning grounds the following fall as "grilse" which are only two years old. Grilse do not contribute to the commercial fishery and seldom contribute to the sport fishery. For that reason, it is better to release coho in March, April, or May at 6 to 12 fish to the pound so they will be more likely to spend two summers growing in the ocean. Some cooperators, with expressed permission from the Department, may release fish at smaller sizes into newly restored or underseeded areas. This allows the fish to "imprint" on the area for future returns. The fish generally will stay within the area until stream flows and temperatures trigger natural migration downstream to the ocean. Usually, only one species of fish is allowed to be released in one location to prevent inordinate levels of competition for food and habitat.

GENETIC CONSIDERATIONS

Genetic considerations must be made in the selection of fish stocks for rearing or relocation programs. Live salmon and steelhead may not be taken from one stream or lake and put in a different stream without a specific permit from DFG. Generally, movement of fish will be allowed within all or part of a river system or drainage basin. This means that transportation of live fish is limited to areas that the genetic strain of fish could normally be expected to frequent on their own.

These limitations on the transportation and stocking of live fish into different rivers is to protect the general fish population. Fish from different waters could carry disease unique to their source stream. This could cause mortality among fish endemic to the receiving stream. Conversely, the transplanted stocks could lack immunity to diseases present in their new home. Introduced fish that are not genetically suited to their new home can also have long term effects on their new neighbors. If the fish interbreed, which would typically happen, then their offspring may inherit genetic traits that are not suited for survival in some part of their ocean or stream habitats. For example, stocks genetically suited to a short migration would be ill suited for locations far from the ocean. Some stocks are suited for late winter spawning; these would not do well in a location that only provided favorable spawning conditions in autumn. If some limited reproduction did occur, even with endemic stocks, their offspring would likely be poorly suited for survival.

Habitat conditions and genetic adaptations determine the long-term productivity and survival of salmon or steelhead stocks. Subtle differences in habitat, genetics, and endemic stocks must be carefully evaluated before stock transfer is carried out. Generally, relocation is restricted to intra-basin transfer, or to similar, nearby watersheds. Relocation of fish from the South Fork Eel River fall-run chinook population is confined to the South Fork Eel River and its tributaries, and to Warm Springs Hatchery on the Russian River where there are no native fall-run chinook to be impacted. Larger streams like the Sacramento River are restricted even further; fish from the lower Sacramento are used to stock the upper half of the river only in emergencies.

GENERAL INFORMATION ABOUT PUBLICLY OPERATED FISH REARING PROGRAMS

Contracts and permits that may be required:

- Before trapping or spawning any fish, all fish rearing projects must have a permit from the appropriate DFG Regional Manager.
- A National Marine Fisheries Service (NMFS) permit is required before handling any fish listed by the Federal Threatened and Endangered Species Act.
- Any lake or streambed alteration requires a written 1601-1603 agreement from the local Fish and Game Biologist or Warden.
- Certified Spawn Taker: A DFG training session must be attended by any individual actively participating in an artificial spawning (egg taking) project.
- A State Water Resources Control Board permit is required for appropriative water use.
- Water pumped from a stream requires a 1601-1603 agreement from the area Fish and Game Biologist or Warden.
- A Regional Water Quality Control Board waste discharge permit is required for any discharge.
- No payments will be made to a contractor without a fully executed contract, memorandum of understanding, or joint powers agreement. Payments will not be made for work completed before the approval date or after the closing date of the contract.
- No work will be started until all permits have been obtained, and copies mailed to the Contract Administrator. All cooperative rearing projects must conform to the California Environmental Quality Act.
- All publicly operated fish rearing facilities will be linked to restoration goals and objectives with an approved written project and management plan providing for evaluation and covering a period of five years, linked to an overall long-term watershed fishery restoration plan.

Fish Culture Practices and Site Requirements

- An adequate water supply, with a suitable emergency backup system, through the proposed period of operation must be demonstrated.

- Water temperatures between 42E and 56E Fahrenheit are required for egg incubation.

- Year round water temperatures between 45E and 59E Fahrenheit are required for rearing yearling or post-smolt salmonids.

- Water supplies must have a minimum of seven parts per million dissolved oxygen, and be free of harmful gasses and pollutants. A pH between 6.7 and 8.2 is desirable.

- Zinc, copper, lead, and cadmium are lethal to fish and eggs. Galvanized pipe may not be used for hatchery or incubator water supplies.

- Ultraviolet lighting, such as fluorescent lights, may not be used in spawning and incubation areas. UV light, especially sunlight, is detrimental to fish eggs. Incandescent lighting is recommended. Windows should be covered with black plastic to prevent sunlight from entering the room.

- Feeding must be started when swim-ups appear. The appropriate size starter mash for the species will be fed at least 10 times daily during this early feeding stage. Larger fish must also be fed daily though less often. DFG Fish Bulletin 164 should be consulted for feeding criteria in conjunction with the food chart provided by the feed supplier.

- Rearing ponds must be cleaned on a regular basis to prevent build-up of biomass and algae as a control for diseases. Biomass and algae contribute to the production of toxic gasses which is lethal to fish.

- The rearing and incubation facility must be secure from vandals and predators. The facility must be kept in a clean condition at all times.

- Frozen fish food must be kept at -10E Fahrenheit. No more than two daily feedings may be thawed at one time. No feed will be used after the lot expiration date.

- Fish screen sizes should be changed as fish grow. See DFG Fish Bulletin 164 for details.

- No treatment other than salt can be used without prior written permission from the DFG Pathology Section.

- It is DFG policy that steelhead trout and coho salmon will be raised to yearlings before release. Chinook salmon will be raised to a minimum size of 90 fish to the pound.

- If a project does not receive the eggs or fish agreed upon in the regional permit, the contract funds will be reduced using criteria established by DFG.

- Cost effectiveness will be calculated for each project based upon fish and egg inventories and total dollars spent.

SPECIFIC GUIDELINES FOR CREATION OF FIVE-YEAR FISH REARING PLAN

The following outline is a guide for the production of a five-year fish rearing plan, as required by State Fish and Game Commission Policy, for the operation of a cooperative fish rearing facility.

The purpose of the five-year fish rearing plan is to develop background information, goals, operational procedures, and monitoring plans for all existing and proposed cooperative fish rearing programs, regardless of funding sources. This plan will assist Department personnel to assess the environmental issues and suitability of existing and proposed programs. An update of the five-year management plan will be required when any major change occurs in hatchery operation, watershed condition, or new environmental issues are raised concerning the rearing facility and/or watershed. The plan is the responsibility of the project sponsors but should be developed with input from the DFG regional fishery biologist. The supervisor of the regional fisheries program will make the final decision concerning the acceptance of the management plan.

The acceptance of the five-year management plan does not guarantee five years of project operation, but it does indicate the Department's intention to provide the necessary trapping and rearing permits as long as the project adheres to the approved plan. The project sponsor is responsible for providing adequate project funding and obtaining all necessary permits.

Program Summary

Project Name:
Organization: (give name and address)
Contact Person: (give name, address and telephone)
Program Goal: (give purpose and objective(s) of program, including number of years of operation)
General Rearing Plan: (separate information for each species)
Species of fish to be reared:
Number to be reared:
Size(s) at release:
Date(s) of release:

Release site(s):
Source of eggs or fry:

Project Funding: (state how project will be funded)

Supporting and Cooperating Organizations: (give names and addresses and a contact person)

(start new page for remainder of information)

Detailed Project Description

Project Location: (mark locations on map or indicate latitude and longitude of rearing, release and trapping sites, and describe physical and legal access; describe land ownership and land use agreement)

Rearing Water Source:

Flow: (for the rearing period give range of flows expected at water source, for both primary and emergency backup)

Water rights: (describe the status of the water right)

Temperature: (give range in temperature of water source during rearing period)

Turbidity: (describe seasonal levels of turbidity and settleable solids to be expected in water source)

Dissolved oxygen: (provide any available information on dissolved oxygen levels of water source(s))

Other water quality factors: (provide any available information on chemical makeup of water at source(s))

Physical Facilities: (fully describe rearing facilities including water delivery system, water treatment system, capacity of water delivery system, type and size of rearing tanks or ponds, pond effluent treatment facilities (must meet Regional Water Quality Control Board requirements), and water discharge system - include a full set of diagrams)

Egg incubation facilities (if any): (provide same information as required for "Rearing Facilities," including diagrams)

Adult trapping and egg taking facilities (if any): (fully describe adult trapping and egg taking facilities including type of trap, holding tanks and spawning area and equipment - including full set of diagrams)

Plan of Operation:

Water system: (fully describe capacity and operation of system including water collection and delivery (for both primary and backup), water treatment (including aeration and removal of sediment and any toxicants, and treatment of effluent))

Rearing facilities: (fully describe operation of facilities including number of eggs or fry needed, pond loading rates (number of fish per gallon), feeding methods and rates, type of food, removal of wastes, treatment of disease (note: DFG approval required for use of chemicals) and recovery of fish)

Egg incubation facilities (if any): (fully describe operation of facilities including incubator loading rates, treatment of disease and recovery of fry)
Adult trapping and egg taking facilities (if any): (fully describe operation of facilities including proposed trapping schedule, selection of broodstock, method of spawning and disposition of spawned and unspawned fish)

Personnel: (list persons expected to work on project and describe qualifications of each)

Project Justification

Species Status: (Describe adult and juvenile fish population trends and status in affected stream and drainage; provide information on the affected stream's capacity for both juveniles and adults)

Project Effects:

Wild populations: (fully describe expected positive and negative effects from project on established wild populations in the affected stream and drainage, including expected genetic effects)
Other environmental effects: (describe potential effects, positive and negative, on other hatchery operations, other resources and human uses in the affected area; attach a completed environmental checklist)

Alternatives to Proposed Project: (describe alternatives to the project and their positive and negative aspects - include a "No Project" alternative)

Project Evaluation

Project History: (for established projects, provide annual records by species of adults spawned, eggs taken, number and size planted, affects on wild populations and contribution of the project's production to spawning runs and sport and commercial fisheries)

Concurrent Evaluation: (describe your plan for keeping project records on water temperature, fish mortality, growth, feed rates, fish tagging, fish trapping records, etc.)

Long Term Evaluation: (provide a plan for evaluating the long term effects of the cooperative rearing project by using techniques such as spawning surveys, migrant traps, tagging, etc.)

FISH AND GAME CODE SECTIONS

Article 1. General Provisions

6400 - Fish placing without permission is unlawful. It is unlawful to place, plant, or cause to be placed or planted, in any of the waters of this State, any live fish, any fresh or salt water animal, or any aquatic plant, whether taken without or within the State, without first submitting it for inspection to, and securing the written permission of the Department.

Article 5. Private Nonprofit Hatcheries

1170 - Permit. The Commission may issue a permit, subject to such restrictions and regulations as the Commission deems desirable, to a nonprofit organization to construct and operate an anadromous fish hatchery.

1171 - Financial capacity as prerequisite. The Commission shall not issue a permit unless it determines the nonprofit organization has the financial capability to successfully construct and operate the hatchery and will diligently and properly conduct operation authorized under the permit.

1172 - Grounds for denial of permit. No permit will be issued which may tend to deplete the natural runs of anadromous fish, result in waste or deterioration of fish, or when proposed operation is located on a stream or river below a State or Federal fish hatchery or egg taking station.

1173 - Hatchery or wild fish; status. All fish handled under authority of this article during the time they are in the hatchery or in the wild are the property of the State and when in the wild may be taken under the authority of a sport or commercial fishing license as otherwise authorized for wild fish.

1174 - Conditions. Any permit granted by the Commission pursuant to this article shall contain all of the following conditions:

(a) If after a hearing the Commission finds that the operation described in the permit and conducted pursuant to this article is not in the best public interest, the commission may alter the conditions of the permit to mitigate the adverse effects, or may cause an orderly termination of the operation under the permit. An orderly termination shall not exceed a three-year period and shall culminate in the revocation of the permit in its entirety.

(b) If the Commission finds that the operation has caused deterioration of the natural run of anadromous fish in the waters covered by the permit, it may require the permittee to return the fishery to the same conditions as was prior to issuance of the permit. If the permittee fails to take appropriate action, the Commission may direct the Department to take the action, and the permittee shall bear any cost incurred by the Department.

(c) Prior to release into State waters and at any other time deemed necessary by the Department, the fish may be examined by the Department to determine that they are not diseased or infected with any disease which, in the opinion of the Department, may be detrimental to the State fishery resources. (amended by Stats 1986 ch. 1244)

1175 - Operation responsibility. The State shall assume no responsibility for the operation of a hatchery pursuant to this article and shall not be in any manner liable for its operation. (added by Stats 1970 ch. 862)

Note: Section 2 of Chapter 862 provides: Any permit issued under this act shall be on an experimental basis until its impact on the fishery resource can be ascertained and, therefore, this act shall be applicable only to the waters of Rowdy Creek, contained within Del Norte County.

2081 - Endangered species; exceptions. Through permits or memorandums of understanding, DFG may authorize individuals, public agencies, universities, zoologic gardens, and scientific or educational institutions, to import, export, take, or possess any endangered species, threatened species, or candidate species for scientific, educational, or management purposes.

6901 - Legislative findings. The Legislature, for purposes of this chapter (Chapter 8. Salmon, Steelhead Trout, and Anadromous Fisheries Program Act), finds as follows:

(e) Proper salmon and steelhead trout resource management requires maintaining adequate levels of natural, as compared to hatchery, spawning and rearing.

(f) Reliance upon hatchery production of salmon and steelhead trout in California is at or near the maximum percentage that it should occupy in the mix of natural and artificial production in the state. Hatchery production may be an appropriate means of protecting and increasing salmon and steelhead in specific situations; however, when both are feasible alternatives, preference shall be given to natural production.

(g) The protection of, and increase in, the naturally spawning salmon and steelhead trout of the State must be accomplished primarily through the improvement of stream habitat.

ARTICLE 6. Cooperative Salmon and Steelhead Rearing Facilities

1200 - Rearing facilities; agreements. The Department is authorized to enter into agreements with counties, nonprofit groups, private persons, individually or in combination, for the management and operation of rearing facilities for salmon and steelhead. All such agreements shall be in accordance with the policies of the Commission and the criteria of the Department which govern the operation under such agreements.

The purpose for operating such facilities shall be to provide additional fishing resources and to augment the natural runs.

1201 - Financial ability; demonstration. An applicant who wishes to enter into an agreement to operate a rearing facility shall demonstrate, to the satisfaction of the Department prior to executing such agreement, such applicant's financial ability to properly operate the rearing facility. The Department shall develop and specify the means for an applicant to make such a demonstration.

1203 - Fish release in accordance with policy. The release of fish reared in facilities pursuant to this article shall be made in accordance with the policy of the Commission.

1204 - Funding. The Department shall fund the agreements provided for in Section 1200 only on a matching basis with the person or entities who enter into such agreements. Funds appropriated for the purposes of this article shall not be used to purchase equipment or for construction.

The Department shall be reimbursed from funds appropriate for the purposes of this article for administrative costs, legal costs, and supervisorial costs relating to the execution and supervision of such agreements by the Department.

1205 - Department responsibilities as to fish size, etc. according to agreement. The Department shall, subject to the limitations of appropriate egg sources and funding, make available fish of appropriate size and species to persons or entities who enter into agreements pursuant to this article.

1206 - Salmon, etc. release at point of conception. Salmon and steelhead raised pursuant to this article shall be released in streams, rivers, or waters north of Point Conception and upon release shall have unimpeded access to the sea.

15900 - Private stocking of anadromous fish (ocean ranching). A registered aquaculturist may be granted a permit by the commission, under any terms and conditions that the commission may prescribe, to release and capture anadromous fish in state waters which have been reared in an aquaculture facility. *(Effective only until 1/1/2001.)* Regulations covering this activity are contained in Section 15901 - 15908 of the Code, and Section 238.5 of Title 14.

TITLE 14 OF THE CALIFORNIA ADMINISTRATIVE CODE

238.5 - Stocking of Aquaculture Products

No person shall stock aquaculture products in this state except in accordance with the following general terms and conditions:

(h) Except for those specific areas and waters covered in Section 238.5 (c)(1) and all authorized species not listed in Section 238.5(c), no person shall stock aquatic plants and animals except as follows:

1) Each stocking of fish shall require a separate Private Stocking Permit (FG 749) issued by the department. A copy of this permit shall accompany all shipments. However, with the exception of Inyo and Mono counties, a copy of the same permit

(FG 749) may be used for additional consignments of the same species when stocked in the same water, until canceled by the Department.

2) Application for the private stocking permit shall be made to the regional manager of the DFG Region in which the fish are to be stocked. An application will be supplied to each applicant upon request.

3) No person shall stock any species of fish in any water in which the stocking of such fish is contrary to the fisheries management programs of the Department for that water or drainage, or in any water from which such fish might escape to other waters where such fish are not already present. All applicants will be advised upon request of the said departmental fisheries management programs.

4) Permittee shall notify the regional office of the department not less than 10 days in advance of stocking in order to make arrangements for inspection. Such inspection may be waived at the discretion of the Department. If, upon inspection, diseased or parasitized fish or fish of unauthorized species are found by the Department to be present, they shall be disposed of by the permittee as directed by the Department. The Department may require that the expense of any inspection made necessary by the provisions of these regulations be borne by the permittee.

FISH AND GAME COMMISSION POLICY

COOPERATIVELY OPERATED REARING PROGRAMS FOR SALMON AND STEELHEAD

I. The State's salmon and steelhead resources may be used to support cooperative rearing programs. Rearing programs may be of two types: (1) those that grow fish for use in accelerating the restoration/rehabilitation of depleted wild populations in underseeded habitat and (2) those that are dedicated solely to growing fish for harvest. The following constraints apply to both types:

A. Only those fish surplus to the needs of the Department's programs shall be utilized for such programs and allocation shall be based on past performance and the Department's evaluation of the potential of proposed new programs.

B. The suitability and acceptance or rejection of proposed programs shall be determined by the Department after reviewing a written proposal. A written project and management plan providing for evaluation and covering a period of five years must be evaluated and approved by the Department. Prior to reauthorization the Department must determine that the project is in compliance with the approved plan and continuance of the program is in the best interest of the State's fishery resources.

C. Routine care and food costs shall be the financial responsibility of the sponsoring entity. The Department shall provide technical advice and special assistance as appropriate.

D. Fish raised in these programs shall not be stocked in, or broodstock captured from, waters where the Department has determined that adverse effects to native fish populations or other aquatic species may result.

II. The bulk of the state's salmon and steelhead resources shall be produced naturally. The State's goals of maintaining and increasing natural production take precedence over the goals of cooperatively operated rearing programs.

SALMON

It is the policy of the Fish and Game Commission that:

I. Salmon shall be managed to protect, restore and maintain the populations and genetic integrity of all identifiable stocks. Naturally spawned salmon shall provide the foundation for the Department's management program.

II. Salmon streams shall be inventoried for quantity and quality of habitat, including instream flow requirements. Restoration plans shall identify habitats for restoration and acquisition and opportunities to protect or guarantee future instream flows. Commercial Salmon Trollers Stamp and other funding shall be directed to implement the plans.

III. Existing salmon habitat shall not be diminished further without offsetting the impacts of the lost habitat. All available steps shall be taken to prevent loss of habitat, and the Department shall oppose any development or project which will result in irreplaceable loss of fish. Artificial production shall not be considered as appropriate mitigation for loss of wild fish or their habitat.

IV. Salmon shall be rescued only when they will be returned to the stream system of origin. Rescue of juvenile salmon shall be limited to circumstances where fish can be held until habitat conditions improve, or where immediate release can be made in understocked areas of their natal stream system.

V. In coastal streams without Department hatcheries, artificial rearing shall be limited to areas where the Department determines it would be beneficial to supplement natural production to re-establish or enhance the depleted wild population. In the Sacramento, American, Feather, San Joaquin, Klamath, and Trinity river systems, hatchery production shall be used to meet established mitigation goals. At the discretion of the Department excess eggs and fish from State, Federal, or cooperative hatcheries may be used to provide additional fish for the commercial and sport fisheries.

VI. Resident fish will not be planted or resident fisheries developed in drainages of salmon waters, where, in the opinion of the Department, such planting or development will interfere with salmon populations. Exceptions to this policy may be authorized by the Commission (a) where the stream is no longer adaptable to anadromous runs, or (b) during the mid-summer period in those individual streams considered on a water-by-

water basis where there is a high demand for angling recreation and such planting or development has been determined by the Department not to be detrimental to salmon.

STEELHEAD RAINBOW TROUT

It is the policy of the Fish and Game Commission that:

I. Steelhead rainbow trout shall be managed to protect and maintain the populations and genetic integrity of all identifiable stocks. Naturally spawned steelhead shall provide the foundation of the Department's management program.

II. Steelhead shall be rescued only when they will be returned to the stream system of origin. Rescue of juvenile steelhead shall be limited to circumstances where fish can be held until habitat conditions improve, or where immediate release can be made in understocked areas of their natal stream system.

III. Restoration and acquisition plans shall be developed and implemented to safeguard such critical habitats such as estuaries, coastal lagoons, spawning and rearing areas, and to protect or guarantee future instream flows. All steelhead streams shall be inventoried for quantity and quality of habitat, including stream flow conditions. Steelhead Restoration Card and other funding shall be directed to implement the plans.

IV. Existing steelhead trout habitat shall not be diminished further without offsetting mitigation of equal or greater long-term habitat benefits. All available steps shall be taken to prevent loss of habitat, and the Department shall oppose any development or project which will result in irreplaceable losses. Artificial production shall not be considered appropriate mitigation for loss of wild fish or their habitat.

V. Sport fishing for sea-run steelhead shall be encouraged where the Department has determined that harvest will not harm existing wild populations. Harvest of juveniles shall only be permitted where such harvest does not impair adequate returns of adults for sport fishing and spawning. Special restrictions on the harvest of wild juvenile steelhead may be necessary when a fishery includes both wild and hatchery stocks.

VI. Resident fish will not be planted or resident fisheries developed in drainages of steelhead waters, where, in the opinion of the Department, such planting or development will interfere with steelhead populations.

VII. Exceptions to this policy may be made by the Commission (a) where the stream is no longer adaptable to anadromous runs, or (b) during the mid-summer period in those individual streams considered on a water-by-water basis where there is a high demand for angling recreation and such planting or development has been determined by the Department not to be detrimental to steelhead.

The following waters are excepted.

Nacimiento River	San Luis Obispo County
North Fork Battle Creek	Shasta County, upstream from Manton
Cow Creek	Shasta County upstream from Fern Road and Ingot
Antelope Creek	Tehama County, upstream from Ponderosa Way
Deer Creek	Tehama County, upstream from upper Deer Creek Falls
American River	Sacramento County, only in Arden Pond

TROUT

It is the policy of the Fish and Game Commission that:

I. Natural reproduction and rearing of trout will be encouraged to the greatest extent possible by protecting and improving habitat and by affording protection from disease, predators and competing fish species.

II. Populations of wild trout shall be sustained in suitable waters to provide a diversity of angling opportunities. In some waters it may be necessary to restrict angler harvest to the extent that such harvest has virtually no long-term effect on numbers and sizes of fish in the populations.

III. Artificial propagation and rearing of trout is a major Department program, but will be utilized only when necessary to augment natural production. Stocking fingerling and sub-catchable-sized trout shall take priority over planting catchable-sized trout in the hatchery stocking program when the smaller fish will maintain satisfactory fishing.

Hatchery trout shall not be stocked in waters where they may compete or hybridize with trout which are threatened, endangered or species of special concern. Exceptions may be made for stocking waters which are not part of a species recovery program.

IV. Catchable-sized trout shall be stocked only:

A. In lakes, reservoirs and streams where natural reproduction and growth are inadequate to maintain populations capable of supporting fishing; and

B. When it is reasonable to expect at least 50 percent by number or weight will be taken by anglers.

In stocking catchable-sized trout, lakes and larger streams shall have priority over smaller streams. Suitable waters with heavy fishing pressure compared to the size of planting allotments shall have priority. Trophy fish, weighing one pound or more may constitute up to 10 percent by weight of each load of catchables stocked, if they replace an equivalent poundage of catchables in the allotment for the water stocked.

V. Sub-catchable-sized trout may be stocked in lakes, reservoirs and streams where appropriate to augment trout populations in such waters, and to increase fishing opportunities and success. Fingerlings shall be stocked primarily in waters where reproduction is limiting and satisfactory angling can be supported with fingerling stocking, where the population has been destroyed, and in lakes where they will establish a new fishery or augment the existing fishery.

VI. Water companies, utility districts and other public or private agencies in control of urban lakes shall be encouraged to finance put-and-take trout fishing in such waters when suitable for such purposes. The Department shall provide technical advice and otherwise assist in the development and maintenance of such programs.

DEPARTMENT OF FISH AND GAME OPERATIONS MANUAL (POLICY)

Section 5220 - Importation of trout and salmon eggs.
Several serious fish diseases are known to be transmitted by eggs. The only treatment for some of these diseases is destruction of all infected fish. Because of the potential threat to broodstock, hatchery production, and wild fish, all trout and salmon or their eggs imported by the DFG from out-of-state will be sent to and retained at the Yountville Fish Facility until they have been certified disease-free by the Fish Disease Section. All importations of eggs must have prior written approval from the Division Chief.

Trout eggs exchanges or purchases for DFG hatcheries will be arranged by Inland Fisheries Division (IFD) subject to the following restrictions:

a. Eggs may be imported only if the egg source has been tested by competent pathologists or hatchery biologists and are free of certain diseases. (See Section 5435, DFG Operations Manual);

b. Eggs may not be purchased from so-called "egg brokers." These dealers obtain eggs from worldwide sources and it is impossible to maintain adequate checks on the condition of their eggs;

c. Live salmon and trout and their eggs may not be imported into California from Idaho.

Section 5225 - Transfer of fish or eggs. Live fish and egg transfers between DFG facilities are considered during the January meeting of the Hatchery Operations Committee (HOC) (see Section 5210). All egg transfers within, or into, DFG hatchery system must be documented using form FG 701, "Records of Eggs Shipped and Received", transfers of eggs or fish into the system shall be coordinated by IFD with the approval of Pathology and the Division Chief.

Pathology approval (use Form FG 701A "Pathology Approval to Ship Eggs or Fish") shall be obtained at least 30 days prior to any proposed transfer of eggs or fish into the DFG hatchery system (see Fish Hatchery Operations Manual for more detail).

Trout and salmon eggs to be transferred within the DFG hatchery system which were not considered in the January fish production and allocation meeting of the HOC shall be coordinated by IFD and require Directorate approval.

Egg transfers may require special treatment by pathology to prevent disease transmittal. Special labeling/marking of containers used for shipping may also be required.

Section 5240 - Cooperative rearing programs. The DFG may enter into agreements with counties, non-profit groups or private persons for management and operation of rearing facilities for salmon and steelhead (Fish and Game Code Sections 1200-1206). The Fish and Game Commission (FGC) policy supports the program, with restraints on its size and goals.

Section 5330 - Fingerling trout. Fingerling trout shall be utilized primarily to stock naturally barren waters, waters where the population has been destroyed, waters that have inadequate recruitment and lakes where fingerlings will provide an adequate fishery.

Fingerling trout shall be stocked pursuant to the approved annual regional trout allotments. Addition of any new water to the fingerling trout stocking program requires prior approval from the Division Chief.

Trout fingerlings surplus to existing allotments may be stocked in waters within reasonable distances from hatcheries where transportation costs are minimal, provided the waters have been previously planted. This is preferable to destroying such surplus fish.

Section 5335 - Sub-catchable trout. Sub-catchable trout shall be planted in waters with a potential for their growth. Sub-catchable trout shall be given priority over catchable trout when they can support all or a part of the fishery, and when expected costs of putting fish in the creek are less than that expected from catchable fish.

Sub-catchable trout shall be stocked pursuant to the approved annual regional trout allotments. Addition of any new water to the sub-catchable trout stocking program requires prior approval from the Division Chief.

Section 5340 - Catchable trout. Catchable trout shall be stocked only in heavily fished roadside lakes and streams where natural reproduction is inadequate to provide satisfactory fisheries. Exception may be made for special waters with approval of the Division Chief.

Waters shall not be stocked with catchable trout unless it is reasonable to expect that 50 percent or more of the stocked fish, by number or weight, will be taken by anglers.

Catchable trout shall be stocked pursuant to the approved annual regional trout allotments.

Addition of any new water to the catchable trout stocking program requires approval from the Division Chief.

Section 5355 - Temperature and flow criteria for catchable trout. Catchable trout shall not be stocked in streams when water temperatures reach 75^{E} Fahrenheit and it appears that such

temperatures will continue to occur regularly or when stream flows drop below 10 cubic feet per second (cfs). The exception is that suitable streams with flows between 2 and 10 cfs may be planted if water temperatures do not exceed 70^{E} Fahrenheit and other conditions are satisfactory. Stocking shall be discontinued if conditions are unsuitable because of shallow water, lack of pools, growth of algae, poor water quality, or other reasons.

Catchable trout shall not be stocked in lakes or reservoirs after surface water temperatures reach 78^{E} Fahrenheit and it appears that such temperatures will continue to occur regularly, nor after a trout die-off is attributed in whole or in part to an oxygen deficiency. Stocking shall be discontinued if algae blooms, aquatic weed growth, high turbidity, high alkalinity, or other conditions render the lake unsuitable for catchable trout or for fishing.

Catchable trout shall not be stocked in lakes or reservoirs until water temperatures reach 42^{E} Fahrenheit or higher most afternoons, or in streams until water temperatures reach 45^{E} Fahrenheit or higher most afternoons.

Catchable trout stocking may be suspended in reservoirs during periods of spill in order to avoid losses of planted fish to downstream areas where trout may not be readily available to anglers.

Section 5360 - Native anadromous salmon and trout in inland waters. Anadromous salmon or trout from sources within the state may not be stocked in inland waters without prior approval of the Deputy Director for Fisheries. This stocking may be done only if the fish are surplus to the needs of the regular stocking program.

Section 5365 - Native anadromous salmon and trout in anadromous waters. Serious problems occur in several drainages in California. To prevent the spread of these diseases, restrictions on movement of fish between drainages are necessary. It is also important to protect the genetic integrity of fish in several drainages that have been relatively unaffected by past stockings.

A policy is now being developed to address these problems. In the meantime, all movement of fish between drainages must have prior written approval of the Division Chief.

Section 5370 - Time and size of planting anadromous salmon and trout. Causal relationships have been established between survival and size of fish at release and the timing of release. Following are guidelines to be used in size of release and timing of release for chinook salmon, coho salmon, and steelhead trout from DFG hatcheries and cooperative rearing facilities.

a. **Chinook salmon.** Chinook salmon will normally be held until they reach at least 90/lb. Central Valley fall-run chinook stocks usually attain this size about May 1. Exceptions must be approved by the Division Chief.

   Chinook salmon reared to yearlings normally reach a size of 8 to 12/lb. in October and should be released before November 1st.

b. **Coho salmon and steelhead trout.** Coho salmon should range from 10 to 20/lb. and steelhead trout should be at least 10/lb. at the time of release. The time period for release of coho salmon and steelhead trout is only between March 15 and May 1 except with approval of the Division Chief.

Section 5430 - Private stocking of anadromous fish. Under authority of Section 15900 of the Fish and Game Code, the Fish and Game Commission may grant a permit to a registered aquaculturist to rear and stock anadromous fish in State waters (ocean ranching). Regulations covering this activity are contained in Section 15901-15908 of the code, and Section 235.2 of Title 14.

Permits are issued by Wildlife Protection Division after approval is given by the FGC. All stocking of fish under this permit must have advance approval of the DFG.

APPENDIX C.

HYDROLOGIC BASIN PLANNING MAPS

Hydrologic unit boundaries are displayed on a series of 12 hydrologic basin maps for California at a scale of 1 to 500,000. Each map is based upon a Hydrologic Basin Planning Area. These maps may be used for: geocoding water-related data for computer storage and retrieval, such as sampling stations, sewage treatment facilities, industrial dischargers, stream flows, and water quality and aquatic tissue monitoring data; water quantity/quality problem (pollution) identification and control; and coordinating water resource planning. The 12 hydrologic basins are:

North Coast (NC)
San Francisco Bay (SF)
Central Coast (CC)
Los Angeles (LA)
Sacramento (SB)
San Joaquin (SJ)
Tulare Lake (TL)
North Lahontan (NL)
South Lahontan (SL)
Colorado River (CR)
Santa Ana (SA)
San Diego (SD)

These basins are surface water drainage areas, with some minor adjustments and follow Regional Board boundaries and the previously defined DWR hydrologic study areas.

State Board and DWR hydrologic boundaries are now congruent at all four levels (basin, unit, area, and subarea) of the hierarchy. The numbering systems for the areas are different, but the names and areas are identical. The state hydrologic boundaries are correlated with, and allow use of, a number of State Board, Regional Board, and other State agencies' mapping systems and/or associated databases. The State Board and DWR have agreed to use different numbering (coding) systems for the hydrologic hierarchy, but the two coding systems are related and have been documented in a reference computer file.

The numbering system used in the USGS hydrologic hierarchy is different than the State systems, but has been referenced to the State numbering systems in the same computer file noted above. This correlation between coding systems allows an interchange among mapping databases at the State and Federal level.

To obtain copies of the hydrologic basin planning area maps:

Chief, Surveillance and Monitoring Unit
Division of Water Quality
State Water Resources Control Board
P.O. Box 100
Sacramento, California 95801

APPENDIX D.

AERIAL PHOTO SOURCES

One of the best initial contacts for researching aerial photography and related information is the Earth Science Information Center (ESIC), operated by the U.S. Geologic Survey (USGS). For example, ESIC=s Aerial Photography Summary Record System identifies over 130 California sources of aerial photography, public and private. In addition to the California office in Menlo Park, ESIC also maintains liaisons with the State Agencies listed below.

Another good source is the aerial photo "clearing house" for the U.S. Department of Agriculture (USDA) and the Agriculture Stabilization and Conservation Service (ASCS). The ASCS can provide photo indexes and hard copies of current and historical aerial photography, as well as information on in-progress and planned aerial photo missions by the federal agencies. Allow four to six weeks for delivery. Private sources have quicker turn-around times (some offer overnight service), but prices for typical products (9 x 9 contact prints or simple enlargements) are substantially higher than federal and state sources.

FEDERAL ESIC

USGS
Earth Science Information Center
345 Middlefield Rd.
MS 532
Menlo Park, CA 94025
(415) 329-4309

NASA Ames Research Center
Aircraft Data Facility
MS 240-12; Bldg 240, Room 219
Moffet Field, CA 94035-1000
(415) 604-6252

OTHER FEDERAL AGENCIES

U.S. Department of Agriculture
Agricultural Stabilization &
Conservation Service
Aerial Photography Field Office
P.O. Box 30010
Salt Lake City, UT 84130
(801) 975-3503

U.S. Forest Service
Region 5 Office
630 Sansome Street
San Francisco, CA 94111
(415) 705-2836

U.S. Department of Interior
Bureau of Reclamation
Mid-Pacific Region
2800 Cottage Way, Room W1324
Sacramento, CA 95825
(916) 978-5010

U.S. Environmental Protection Agency
Environmental Sciences Division
Landscape Ecology Branch
P.O. Box 93478
Las Vegas, NV 89193-3478
(702) 798-2100

U.S. Army Corps of Engineers
Regulatory Functions Branch
333 Market St. 8th Floor
San Francisco, CA 94105
(415) 977-8462

U.S. Army Corps of Engineers
Survey Branch, Sacramento District
1325 J St
Sacramento, CA 95814-2922
(916) 557-7158

U.S. Department of Interior
Bureau of Indian Affairs
Sacramento Office, Br. Of Land Operations
2800 Cottage Way, Room W2550
Sacramento, CA 95825
(916) 979-2600

U.S. Geological Survey
EROS Data Center
Sioux Falls, SD 57148
(605) 594-6151

U.S. Army Corps of Engineers
Survey Branch, Los Angeles District
645 Durfee Ave
El Monte, CA 91733
(818) 401-4009

U.S. Geological Survey
Western Mapping Center
345 Middlefield Rd
Menlo Park, CA 94025
(650) 853-8300

STATE ESIC AGENCIES

California Department of Conservation
Division of Mines and Geology
Information Office
801 K Street, MS 12-30
Sacramento, CA 95814-3532
(916) 445-1825

OTHER STATE AGENCIES

CALTRANS
Division of Highways, Photogrammetry Br.
1120 N St., MS 35
Sacramento, CA 95814
(916) 227-7680

Library, Map Collection
San Diego State University
San Diego, CA 92182-0511
(619) 594-5832
(916) 653-4881

CA Department of Water Resources
1416 9th St.
P.O. Box 942836
Sacramento, CA 94236-9257

Map and Imagery Laboratory
Davidson Library University of California Santa Barbara
Santa Barbara, CA 93106
(805) 893-2779

COUNTY AGENCIES

County assessors, planners, and public works departments often have historical aerial and other photography used for timber tax assessment or early land surveys.

PRIVATE FIRMS

A selection of firms serving California and other western states is provided below. Additionally, ESIC=s Aerial Photography Summary Record System for address and phone numbers of all organizations which contribute photo archive information.

Richard B. Davis Company
140 Rowdy Creek Rd
Smith River, CA 95567
(707) 487-6277

Pacific Aerial Surveys
8407 Edgewater Dr
Oakland, CA 94621-1403
(510) 632-2020

WAC Corporation
520 Conger Street
Eugene, OR 97402
(800) 845-8088
(541) 342-5169

Chase Jones
1500 S. W. 12th Avenue
Portland, OR 97201
(503) 228-9844

PDS
1090 Bailey Hill Rd. Suite E
Eugene, OR 97402
(541) 343-8877

Aerial Data Systems
990 Klamath Lane, Suite 18
Yuba City, CA 95993-8962
(530) 673-1430

Aerial Photomapping Services
2929 Larkin Ave.
Clovis, CA 93612
(209) 291-0147

I. K. Curtis Services, Inc.
2901 Empire Avenue
Burbank, CA 91504
(818) 842-5127

APPENDIX E.

LIST OF CALIFORNIA FISH SPECIES

The California Department of Fish and Game uses the following standardized abbreviations for aquatic species found in California.

Variety	Abbreviation
Lamprey	LP
White sturgeon	WST
Green sturgeon	GST
American shad	AS
Threadfin shad	TFS
Freshwater smelt	FS
Delta smelt	DS
Mountain whitefish	WF
Salmon	
Pink salmon	PINK
Chum salmon	CHUM
Coho salmon	COHO
Chinook salmon	CHIN
Sockeye salmon	SOCK
Kokanee salmon	KOK
Trout	
Brown trout	BN
Cutthroat trout	CT
Coast cutthroat trout	CT-C
Lahontan cutthroat trout	CT-L
Paiute cutthroat trout	CT-P
Rainbow trout	RT
Steelhead rainbow trout	SH
Coleman stock	RT-C
Kamloops rainbow trout	RT-K
Junction Kamloops stock	RT-KJ
Hot Creek stock	RT-H
Mt. Shasta stock	RT-S
Mt. Whitney stock	RT-W
Pit River stock	RT-P
Eagle Lake trout	ELT

Variety	Abbreviation
Golden trout	GT
Little Kern golden stock	GT-LK
South Fork Kern golden trout	GT-SF
Chars	
Brook trout	EB
San Joaquin stock	EB-SJ
Lake trout	LT
Arctic grayling	AG
Suckers	SKR
Owens sucker	SKR-O
Lost River sucker	SKR-LR
Modoc sucker	SKR-MO
Western sucker	SKR-W
Mountain sucker	SKR-MT
Klamath smallscale sucker	SKR-KS
Klamath largescale sucker	SKR-KL
Santa Ana sucker	SKR-SA
Tahoe sucker	SKR-T
Shortnose sucker	SKR-SN
Humpback sucker	SKR-H
Minnows	
Common carp	CP
Grass carp	GC
Goldfish	GF
Golden shiner	GSH
Sacramento blackfish	BLK
Hardhead	HH
Hitch	HCH
Squawfish	SQ
Colorado squawfish	SQ-C
Sacramento squawfish	SQ-S
Lahotan redside	LRS
Roach	RCH
Tui chub	TC
Dace	DC
Red shiner	PRS
Fathead minnow	FHM

Variety	Abbreviation
Catfish	
Channel catfish	CCF
White catfish	WCF
Blue catfish	BCF
Flathead catfish	FCF
Brown bullhead	BB
Black bullhead	BLB
Yellow bullhead	YB
Mosquitofish	GAM
Molly	MOL
Inland silverside	IS
Striped bass	SB
White bass	WHB
Yellow perch	YP
Bigscale logperch	BLP
Sunfish	
Redeye bass	REB
Smallmouth bass	SMB
Spotted bass	SPB
Alabama spotted bass	SPB-A
Northern spotted bass	SPB-N
Largemouth bass	LMB
Northern largemouth bass	LMB-N
Florida largemouth bass	LMB-F
Warmouth	WB
Green sunfish	GSF
Pumpkinseed	PSD
Redear sunfish	RSF
Bluegill	BG
Northern bluegill	BG-N
Southeastern bluegill	BG-F
Sacramento perch	SP
White crappie	WCR
Black crappie	BCR
Northern Black crappie	BCR-N
Blacknose crappie	BCR-A
Florida black crappie	BCR-F

Variety	Abbreviation
Tule perch	TP
Sculpin	SCP
Stickleback	STB
Striped mullet	MUL
Yellowfin goby	YFG
Longjaw mudsucker	LJM
Tilipia	TIL
Redbelly tilapia	TIL-Z
Mozambique tilapia	TIL-M
Tilapia hornorum	TIL-H
Pupfish	PUP
Bairdiella	BAR
Sargo	SAR
Orangemouth corvina	ORC
Crayfish	CF
Signal crayfish	PL
Shasta crayfish	PF
Red swamp crayfish	PC
Orconectes virilis	OV
Freshwater prawn (Macrobrachium)	MR
Asian clam (Corbicula)	COR

APPENDIX F

STATE AND FEDERAL ENDANGERED AND THREATENED SPECIES ASSOCIATED WITH SALMONID HABITAT

This is a list of the animals found within California or off the coast of the state that have been classified as Endangered or Threatened by the California Fish and Game Commission (state list) or by the U. S. Secretary of the Interior or the U. S. Secretary of Commerce (federal list).

The official California listing of Endangered and Threatened animals is contained in the California Code of Regulations, Title 14, Section 670.5. The official federal listing of Endangered and Threatened animals is published in the Federal Register, 50 CFR 17.11.

Animals that are candidates for state listing and animals proposed for federal listing are also included on this list. A state candidate species is one the Fish and Game Commission has formally noticed as being under review by the Department for addition to the state list. A federal proposed species is one for which a proposed regulation has been published in the Federal Register.

Code Designation: Totals as of October 2001

SE = State-listed Endangered 47
ST = State-listed Threatened 30
FE = Federally listed Endangered 77
FT = Federally listed Threatened 40
SCE = State candidate (Endangered) 1
SCT = State candidate (Threatened) 0
FPE = Federally proposed (Endangered) 3
FPT = Federally proposed (Threatened) 1
FPD = Federally proposed (Delisting) 2
DE = Delisted 1

Common and scientific names are shown as they appear on the state or federal lists. If the nomenclature differs for a species that is included on both lists, the state nomenclature is given and the federal nomenclature is shown in a footnote. Synonyms, names changes, and other clarifying points are also footnoted.

Critical Habitat is defined in Section 3 of the federal Endangered Species Act as specific areas, both occupied and unoccupied, that is essential to the conservation of a listed species and that may require special management considerations or protection.

Recovery Plans are discussed in Section 4 of the federal Endangered Species Act. Each plan incorporates site-specific management actions necessary for the conservation and survival of the species.

The "List Date" for final federal listing and final Critical Habitat designation (Desig.) is the date the listing or designation becomes effective, this is usually not the date of publication of the rule in the Federal Register, it is usually 30 days after publication.

Codes designation for Critical Habitat and Recovery Plans:

F= Final
P= Proposed
R= Revised

Changes to this update of the list are denoted by *

	Listing Status				Critical Habitat		Recovery Plan	
	State	List Date	Federal	List Date	Designation	Date	Version	Date
GASTROPODS								
Trinity bristle snail *(Monadenia setosa)*	ST[1]	10-02-80						
Morro shoulderband (= banded dune) snail *(Helminthoglypta walkeriana)*			FE	1-17-95	F	3-9-01	F	1998
White abalone *(Haliotis sorenseni)*			FE	6-28-01				
CRUSTACEANS								
Riverside fairy shrimp *(Streptocephalus woottoni)*			FE	8-3-93	F	6-29-01	F	1998
Conservancy fairy shrimp *(Branchinecta conservatio)*			FE	9-19-94				
Longhorn fairy shrimp *(Branchinecta longiantenna)*			FE	9-19-94				
Vernal pool fairy shrimp *(Branchinecta lynchi)*			FT	9-19-94				
San Diego fairy shrimp *(Branchinecta sandiegoensis)*			FE	2-3-97	F	10-23-00	F	1998
Vernal pool tadpole shrimp *(Lepidurus packardi)*			FE	9-19-94				

[1] On January 1, 1985, all species designated as “rare” were reclassified as “threatened”, as stipulated by the California Endangered Species Act.

	Listing Status				Critical Habitat		Recovery Plan	
	State	List Date	Federal	List Date	Designation	Date	Version	Date
Shasta crayfish[2] *(Pacifastacus fortis)*	SE ST	2-26-88 10-2-80	FE	9-30-88			F	1998
California freshwater shrimp (*Syncaris pacifica*)	SE	10-2-80	FE	10-31-88			F	1998
INSECTS								
Zayante band-winged grasshopper *(Trimerotropis infantilis)*			FE	2-24-97	F	3-9-01	F	1998
Mount Hermon June beetle *(Polyphylla barbata)*			FE	2-24-97			F	1998
Delta green ground beetle *(Elaphrus viridis)*			FT	8-8-80	F	8-8-80	F	1985
Valley elderberry longhorn beetle *(Desmocerus californicus dimorphus)*			FT	8-8-80	F	8-8-80	F	1984
Ohlone tiger beetle *(Cicindela ohlone)*			FE	10-3-01				
Kern primrose sphinx moth *(Euproserpinus euterpe)*			FT	4-8-80	P	7-3-78		
Mission blue butterfly *(Icaricia icarioides missionensis)*			FE	6-1-76	P	2-8-77	F	1984
Lotis blue butterfly *(Lycaeides argyrognomon lotis)*			FE	6-1-76	P	2-8-77	F	1985
Palos Verdes blue butterfly *(Glaucopsyche lygdamus palosverdesensis)*			FE	7-2-80	F	7-2-80	F	1984

[2] Federal: Shasta (=placid) crayfish

	Listing Status				Critical Habitat		Recovery Plan	
	State	List Date	Federal	List Date	Designation	Date	Version	Date
El Segundo blue butterfly *(Euphilotes battoides allyni)*			FE	6-1-76	P	2-8-77	F	1998
Smith's blue butterfly *(Euphilotes enoptes smithi)*			FE	6-1-76	P	2-8-77	F	1984
San Bruno elfin butterfly *(Incisalia mossii bayensis*[3]*)*			FE	6-1-76	P	2-8-77	F	1984
Lange's metalmark butterfly *(Apodemia mormo langei)*			FE	6-1-76	P	2-8-77	R	1984
Bay checkerspot butterfly *(Euphydryas editha bayensis)*			FT	10-18-87	P	10-16-00	F	1998
Quino checkerspot *(Euphydryas editha quino)*			FE	1-16-97	P	2-7-01		
Laguna Mountains skipper *(Pyrgus ruralis lagunae)*			FE	1-16-97				
Callippe silverspot butterfly *(Speyeria callippe callippe)*			FE	12-5-97	P	3-28-80		
Behren's silverspot butterfly *(Speyeria zerene behrensii)*			FE	12-5-97				
Oregon silverspot butterfly *(Speyeria zerene hippolyta)*			FT	7-2-80	F	7-2-80		

[3] Federal: *Callophrysm,mossi bayensis*

	Listing Status				Critical Habitat		Recovery Plan	
	State	List Date	Federal	List Date	Designation	Date	Version	Date
Myrtle's silverspot butterfly *(Speyeria zerene myrtleae)*			FE	6-22-92			F	1998
Delhi Sands flower-loving fly *(Rhaphiomidas terminatus abdominalis)*			FE	9-23-93			F	1997
FISHES								
Winter-run chinook salmon[4] *(Oncorhynchus tshawytscha)*	SE	9-22-89	FE	2-3-94	F	3-23-99		
Chinook salmon-California coastal ESU[5] *(Oncorhynchus tshawytscha)*			FT[6]	11-15-99	F	2-16-00		
Spring-run chinook salmon *(Oncorhynchus tshawytscha)*	ST	2-5-99	FT[7]	11-15-99	F	2-16-00		
Coho salmon-Central Calif Coast ESU *(Oncorhynchus kisutch)*	SE[8] SE[9]	12-31-95 8-30-02	FT[10]	12-2-96				

[4] Federal: Sacramento River winter run chinook salmon
[5] ESU= Evolutionarily Significant Unit
[6] Naturally spawned coastal spring & fall Chinook salmon between Redwood Creek in Humboldt Co. & the Russian River in Sonoma Co.

[7] Federal: Central Valley Spring-Run ESU. Includes populations spawning in the Sacramento River & its tributaries
[8] The state listing is limited to coho south of San Francisco Bay.
[9] The state endangered listing includes populations south of Punta Gorda.
[10] The federal listing is limited to naturally spawning populations in streams between Punta Gorda, Humboldt Co. & the San Lorenzo River, Santa Cruz Co.

	Listing Status				Critical Habitat		Recovery Plan	
	State	List Date	Federal	List Date	Designation	Date	Version	Date
Coho salmon-So. Oregon/No. Calif ESU[11] *(Oncorhynchus kisutch)*	ST[12]	8-30-02	FT	6-5-97	F	3-17-00		
Little Kern golden trout *(Oncorhynchus mykiss whitei[13])*			FT	4-13-78	F	4-13-78		
Lahontan cutthroat trout *(Oncorhynchus clarki henshawi)*[14]			FT	7-16-75	F	1995		
Paiute cutthroat trout *(Oncorhynchus clarki seleniris[15])*			FT FE	7-16-75 3-11-67				
Steelhead-Northern California ESU[16] *(Oncorhynchus mykiss)*			FT	8-7-00				
Steelhead-Central California Coast ESU[17] *(Oncorhynchus mykiss)*			FT	10-17-97	F	3-17-00		
Steelhead-South/Central California Coast ESU[18] *(Oncorhynchus mykiss)*			FT	10-17-97	F	3-17-00		

[11] Populations between Cape Blanco, Oregon & Punta Gorda, California.
[12] The federal listing includes populations between Cape Blanco Oregon, & Punta Gorda. The state threatened listing includes populations north of Punta Gorda.
[13] Federal: *Oncorhynchus (=Salmon) aguabonita whitei*
[14] Federal: *Oncorhynchus (=Salmo) clarki henshawi*
[15] Federal: *Oncorhynchus (=Salmo)clarki seleniris*
[16] Naturally spawned populations residing below impassable barriers in coastal basins from Redwood Creek in Humboldt Co. to, and including, the Gualala River in Mendocino Co.
[17] Coastal basins from the Russian River, south to Soquel Creek, inclusive. Includes the San Francisco & San Pablo Bay basins, but excludes the Sacramento-San Joaquin River basins.
[18] Coastal basins from the Pajaro River south to, but not including, the Santa Maria River.

	Listing Status				Critical Habitat		Recovery Plan	
	State	List Date	Federal	List Date	Designation	Date	Version	Date
Steelhead-Southern California ESU[19] *(Oncorhynchus mykiss)*			FT	10-17-97	F	3-17-00		
Steelhead-Central Valley ESU[20] *(Oncorhynchus mykiss)*			FT	5-18-98	F	3-17-00		
Bull trout *(Salvelinus confluentus)*	SE	10-2-80	FT	12-1-99				
Delta smelt *(Hypomesus transpacificus)*	ST	12-9-93	FT	3-5-93	F	12-19-94	F	1996
Mohave tui chub *(Gila bicolor mohavensis)*	SE	6-27-71	FE	10-13-70			F	1984
Owens tui chub *(Gila bicolor snyderi)*	SE	1-10-74	FE	8-5-85	F	8-5-85	F	1998
Cowhead Lake tui chub *(Gila bicolor vaccaceps)*			FPE	3-30-98				
Bonytail[21] *(Gila elegans)*	SE SR	1-10-74 6-27-71	FE	4-23-80	F	3-21-94	R	1990
Sacramento splittail *(Pogonichthys macrolepidotus)*			FT	3-10-99			F	1996
Colorado squawfish[22] *(Ptychocheilus lucius)*	SE	6-27-71	FE	3-11-67	F	3-21-94	R	1991
Lost River sucker *(Deltistes luxatus)*	SE SR	1-10-74 6-27-71	FE	7-18-88	P	12-1-94	F	1993
Modoc sucker *(Catostomus microps)*	SE SR	10-2-80 1-10-74	FE	6-11-85	F	6-11-85		

[19] Coastal basins from the Santa Maria River, south to the southern extent of the range (presently considered to be Malibu Creek. Proposed rulemaking 12-19-2000 to extend to southern portion of the range to San Mateo Creek in San Diego Co.).
[20] The Sacramento and San Joaquin Rivers and their tributaries.
[21] Federal: Bonytail chub
[22] Current nomenclature and federal listing: Colorado pikeminnow

	Listing Status				Critical Habitat		Recovery Plan	
	State	List Date	Federal	List Date	Designation	Date	Version	Date
Santa Ana sucker *(Catostomus santaanae)*			FT	5-12-00				
Shortnose sucker *(Chasmistes brevirostris)*	SE SR	1-10-74 6-27-71	FE	7-18-8	P	12-1-94	F	1993
Razorback sucker *(Xyrauchen texanus*)	SE SR	1-10-74 6-27-71	FE	10-23-91	F	3-21-94		
Desert pupfish *(Cyprinodon macularius)*	SE	10-2-80	FE	3-31-86	F	3-31-86	F	1993
Cottonball Marsh pupfish *(Cyprinodon salinus milleri)*	ST	1-10-74						
Owens pupfish *(Cyprinodon radiosus)*	SE	6-27-71	FE	3-11-67			F	1998
Unarmored threespine stickleback *(Gasterosteus aculeatus williamsoni)*	SE	6-27-71	FE	10-13-70	P	11-17-80	F	1985
Tidewater goby *(Eucyclogobius newberryi)*			FPD[23] FE	6-24-99 2-4-94	F	11-20-00		
Rough sculpin *(Cottus asperrimus)*	ST	1-10-74						
AMPHIBIANS								
Calif. tiger salamander - Santa Barbara Co. DPS[24] *(Ambystoma californiense)*			FE[25]	9-15-00				

[23] Proposal to delist refers to populations north of Orange County only.
[24] DPS= Distinct Vertebrate Population Segment
[25] Federal listing refers to the Santa Barbara County DPS only.

	Listing Status				Critical Habitat		Recovery Plan	
	State	List Date	Federal	List Date	Designation	Date	Version	Date
Santa Cruz long-toed salamander *(Ambystoma macrodactylum croceum)*	SE	6-27-71	FE	3-11-67	P	6-22-78	D	1999
Siskiyou Mountains salamander *(Plethodon stormi)*	ST	6-27-71						
Tehachapi slender salamander *(Batrachoseps stebbinsi)*	ST	6-27-71						
Kern Canyon slender salamander *(Batrachoseps simatus)*	ST	6-27-71						
Desert slender salamander *(Batrachoseps aridus)*[26]	SE	6-27-71	FE	6-4-73			F	1982
Shasta salamander *(Hydromantes shastae)*	ST	6-27-71						
Limestone salamander *(Hydromantes brunus)*	ST	6-27-71						
Black toad *(Bufo exsul)*	ST	6-27-71						
Arroyo toad[27] *(Bufo californicus)*			FE	1-17-95	F	3-9-01	F	1999
California red-legged frog *(Rana aurora draytonii)*			FT[28]	5-20-96	F	4-12-01	D	2000

[26] Current taxonomy: *Batrachoseps major aridus*
[27] Former taxonomy: *Bufo microscaphus californicus*
[28] Federal listing does not include Humboldt, Trinity, and Mendocino Counties; Glenn, Lake & Sonoma Counties west of the Central Valley hydrologic Basin; Sonoma Creek & Petaluma River drainages which flow into San Francisco Bay, & north of the Walker Creek drainage which flows to the Pacific Ocean

	Listing Status				Critical Habitat		Recovery Plan	
	State	List Date	Federal	List Date	Designation	Date	Version	Date
Mountain yellow-legged frog - So. Calif. Pop.[29] (*Rana muscosa*)			FPE	12-28-99				
REPTILES								
Desert tortoise *(Gopherus agassizii)*	ST	8-3-89	FT	4-2-90	F	2-8-94	F	1994
Green sea turtle *(Chelonia mydas)*			FT FE	7-28-78 10-13-70	F	3-23-99	R	1998
Loggerhead sea turtle *(Caretta caretta)*			FT	7-28-78	P	3-19-80	R	1998
Olive (=Pacific) Ridley sea turtle *(Lepidochelys olivacea)*			FT	7-28-78	P	3-19-80	R	1998
Leatherback sea turtle *(Dermochelys coriacea)*			FE	6-2-70	F	3-23-99	R	1998
Barefoot banded gecko[30] *(Coleonyx switaki)*	ST	10-2-80						
Coachella Valley fringe-toed lizard *(Uma inornata)*	SE	10-2-80	FT	9-25-80	F	9-25-80	F	1984
Blunt-nosed leopard lizard *(Gambelia silus)*[31]	SE	6-27-71	FT	3-11-67			F	1998
Island night lizard *(Xantusia riversiana)*			FT	8-11-67			F	1984
Southern rubber boa *(Charina bottae umbratica*	ST	6-27-71						
Alameda whipsnake *(Masticophis lateralis euryxanthus)*	ST	6-27-71	FT	12-5-97	F	10-3-00		
San Francisco garter snake *(Thamnophis sirtalis tetrataenia)*	SE	6-27-71	FE	3-11-67			F	1985

[29] Federal listing proposal refers to populations in the San Gabriel, San Jacinto & San Bernardino Mountains only.
[30] Current nomenclature: Barefoot gecko
[31] Current taxonomy: *Gambelia sila*

	Listing Status				Critical Habitat		Recovery Plan	
	State	List Date	Federal	List Date	Designation	Date	Version	Date
Giant garter snake *(Thamnophis couchi gigas)*[32]	ST	6-27-71	FT	10-20-93			D	1999
BIRDS								
Short-tailed albatross *(Phoebastria albatrus)*			FE	8-30-00				
California brown pelican[33] *(Pelecanus occidentalis californicus)*	SE	6-27-71	FE	10-13-70			F	1983
California condor *(Gymnogyps californianus)*	SE	6-27-71	FE	3-11-67	F	9-22-77	R	1996
Bald eagle *(Haliaeetus leucocephalus)*	SE (rev)	10-2-80	FPD FT FE	7-6-99 8-11-95 2-14-78				
	SE	6-27-71	(rev) FE	3-11-67				
Swainson's hawk *(Buteo swainsoni)*	ST	4-17-83						
American peregrine falcon *(Falco peregrinus anatum)*	SE	6-27-71	DE FE	8-25-99 10-13-70	F	9-22-77	F	1982
California black rail *(Laterallus jamaicensis coturniculus)*	ST	6-27-71						
California clapper rail *(Rallus longirostris obsoletus)*	SE	6-27-71	FE	10-13-70			F	1984
Light-footed clapper rail *(Rallus longirostris levipes)*	SE	6-27-71	FE	10-13-70			F	1979

[32] Current taxonomy and federal listing: *Thamnophis gigas*
[33] Federal: Brown pelican, *Pelecanus occidentalis*

	Listing Status				Critical Habitat		Recovery Plan	
	State	List Date	Federal	List Date	Designation	Date	Version	Date
Yuma clapper rail (Rallus longirostris yumanensis)	ST SE	2-22-78 6-27-71	FE	3-11-67			F	1983
Greater sandhill crane *(Grus canadensis tabida)*	ST	4-17-83						
Western snowy plover[34] *(Charadrius alexandrinus nivosus)*			FT	4-5-93	F	12-7-99		
Mountain plover *(Charadrius montanus)*			FPT	2-16-99				
California least tern *(Sterna antillarum browni)*	SE	6-27-71	FE	10-13-70			F	1980
Marbled murrelet *(Brachyramphus marmoratus)*[35]	SE	3-12-92	FT	9-30-92	F	5-24-96	F	1997
Western yellow-billed cuckoo *(Coccyzus americanus occidentalis)*	SE ST	3-26-88 6-27-71						
Elf owl *(Micrathene whitneyi)*	SE	10-2-80						
Northern spotted owl *(Strix occidentalis caurina)*			FT	6-22-90	F	1-15-92		
Great gray owl *(Strix nebulosa)*	SE	10-2-80						
Gila woodpecker *(Melanerpes uropygialis)*	SE	3-17-88						
Gilded northern flicker[36] *(Colaptes auratus chrysoides)*	SE	3-17-88						

[34] Federal status applies only to the Pacific coastal population.
[35] Federal: *Brachyramphus marmoratus marmoratus*
[36] Current taxonomy: Gilded flicker *(Colaptes chrysoides)*

	Listing Status				Critical Habitat		Recovery Plan	
	State	List Date	Federal	List Date	Designation	Date	Version	Date
Willow flycatcher *(Empidonax traillii)*	SE[37]	1-2-91						
Southwestern willow flycatcher *(Empidonax traillii extimus)*			FE	3-29-95	F	7-22-97	D	2001
Bank swallow *(Riparia riparia)*	ST	6-11-89						
Coastal California gnatcatcher *(Polioptila californica californica)*			FT	3-30-93	F	10-24-00		
San Clemente loggerhead shrike *(Lanius ludovicianus mearnsi)*			FE	8-11-77			F	1984
Arizona Bell's vireo *(Vireo bellii arizonae)*	SE	3-17-88						
Least Bell's vireo *(Vireo bellii pusillus)*	SE	10-2-80	FE	5-2-86	F	2-2-94	D	1998
Inyo California towhee[38] *(Pipilo crissalis eremophilus)*	SE	10-2-80	FT	8-3-87	F	8-3-87	F	1998
San Clemente sage sparrow *(Amphispiza belli clementeae)*			FT	8-11-77			F	1984
Belding's savannah sparrow *(Passerculus sandwichensis beldingi)*	SE	1-10-74						
MAMMALS								

[37] State listing includes all subspecies
[38] Federal: Inyo California (=brown) towhee

	Listing Status				Critical Habitat		Recovery Plan	
	State	List Date	Federal	List Date	Designation	Date	Version	Date
Buena Vista Lake shrew *(Sorex ornatus relictus)*			FPE	6-1-00			F	1998
Riparian brush rabbit *(Sylvilagus bachmani riparius)*	SE	5-29-94	FE	3-24-00			F	1998
Point Arena mountain beaver *(Aplodontia rufa nigra)*			FE	12-12-91			F	1998
San Joaquin antelope squirrel *(Ammospermophilus nelsoni)*	ST	10-2-80						
Mohave ground squirrel *(Spermophilus mohavensis)*	ST	6-27-71						
Pacific pocket mouse *(Perognathus longimembris pacificus*)			FE	9-26-94			F	1998
Morro Bay kangaroo rat *(Dipodomys heermanni morroensis)*	SE	6-27-71	FE	10-13-70	F	8-11-77	F	1982
Giant kangaroo rat *(Dipodomys ingens)*	SE	10-2-80	FE	1-5-87			F	1998
Stephens' kangaroo rat *(Dipodomys stephensi)*[39]	ST	6-27-71	FE	9-30-88				
San Bernardino kangaroo rat *(Dipodomys merriami parvus)*			FE	9-24-98	P	12-8-00		

[39] Federal: includes *Dipodomys cascus*

	Listing Status				Critical Habitat		Recovery Plan	
	State	List Date	Federal	List Date	Designation	Date	Version	Date
Tipton kangaroo rat *(Dipodomys nitratoides nitratoides)*	SE	6-11-89	FE	7-8-88			F	1998
Fresno kangaroo rat *(Dipodomys nitratoides exilis)*	SE SR	10-2-80 6-27-71	FE	3-1-85	F	1-30-85	F	1998
Salt-marsh harvest mouse *(Reithrodontomys raviventris)*	SE	6-27-71	FE	10-13-70			F	1984
Amargosa vole *(Microtus californicus scirpensis)*	SE	10-2-80	FE	11-15-84	F	1-15-84	F	1997
Riparian woodrat *(Neotoma fuscipes riparia)*			FE	3-24-00				
Sierra Nevada red fox *(Vulpes vulpes necator)*	ST	10-2-80						
San Joaquin kit fox (Vulpes macrotis mutica)	ST	6-27-71	FE	3-11-67			F	1998
Island fox *(Urocyon littoralis)*	ST	6-27-71						
Guadalupe fur seal *(Arctocephalus townsendi)*	ST	6-27-71	FT	12-16-85				
Steller (=northern) sea lion *(Eumetopias jubatus)*			FT	4-5-90	F	3-23-99		
Wolverine *(Gulo gulo)*	ST	6-27-71						
Southern sea otter *(Enhydra lutris nereis)*			FT	1-14-77			F	1981
Sei whale *(Balaenoptera borealis)*			FE	6-2-70				

	Listing Status				Critical Habitat		Recovery Plan	
	State	List Date	Federal	List Date	Designation	Date	Version	Date
Blue whale (*Balaenoptera musculus*)			FE	6-2-70				
Finback whale[40] *(Balaenoptera physalus)*			FE	6-2-70				
Humpback whale[41] *(Megaptera novaeangliae)*			FE	6-2-70				
Right whale[42] *(Balaena glacialis (*includes *australis*))			FE	6-2-70				
Sperm whale *(Physeter macrocephalus (=catodon))*			FE	6-2-70				
California (=Sierra Nevada) bighorn sheep *(Ovis canadensis californiana)*	SE	8-27-99	FE	1-3-00				
Penninsular bighorn sheep DPS[43] *(Ovis canadensis nelsoni)*	ST	6-27-71	FE	3-18-98	F	3-5-01	F	2000

[40] Also known as Fin whale
[41] Also known as Hump-backed whale
[42] Also known as Black right whale
[43] The subspecies *O.c. cremnobates* has been synonymized with *O.c. nelsoni.* Peninsular bighorn sheep are now considered to be a Distinct Vertebrate Population Segment.

PARTIAL LIST OF STATE AND FEDERALLY LISTED PLANTS

Common Name	Scientific Name	Classification
Ramshaw Meadows Abronia	*Abronia alpina*	FC
Sonoma Alopecurus	*Alopercurus aeequalis*	FE
Marsh Sandwort	*Arenaria paludicola*	SE, FE
Fish Slough Milk-Vetch	*Astragalus lentiginosus* var. *piscinensis*	FT
Sodaville Milk-Vetch	*Astragalus lentiginosus* var. *sesquimetralis*	SE
Bakersfield Smallscale	*Atriplex tularensis*	SE
Bensoniella	*Bensoniella oregona*	SR
Nevin's Barberry	*Berberis nevinii*	SE, FE
Indian Valley Brodiaea	*Brodiaea coronaria* ssp. *rosea*	SE
White Sedge	*Carex albida*	SE, FE
Ash-Gray Indian Paintbrush	*Castilleja cinerea*	FT
Pitkin Marsh Indian Paintbrush	*Castilleja uligosa*	SE
Scott's Valley Spineflower	*Chorizanthe robusta* var. *hartwegii*	FE
Fountain Thistle	*Cirsium fontinale* var. *fontinale*	SE, FE
Chorro Creek Bog Thistle	*Cirsium fontinale* var. *obispoense*	SE, FE
Palmate-Bracted Bird's-Beak	*Cordylanthus palmatus*	SE, FE
Cuyamaca Larkspur	*Delphinium hesperium* ssp. *cuyamacae*	SR
Geysers Dichanthelium	*Dichanthelium lanuginosum*	SE
Cuyamaca Lake Downingia	*Downingia concolor* var. *brevior*	SE
Delta Button-Celery	*Eryngium racemosum*	SE
Boggs Lake Hedge-Hyssop	*Gratiola heterosepala*	SE
Ash Meadows Gumplant	*Grindelia fraxino-pratensis*	FT
Water Howellia	*Howellia aquatilis*	FT
Burke's Goldfields	*Lasthenia burkei*	SE, FE
Mason's Lilaeopsis	*Lilaeopsis masonii*	SR
Western Lily	*Lilium occidentale*	SE, FE
Pitkin Marsh Lily	*Lilium pardalinum ssp. pitkinense*	SE, FE
Baker's Meadowfoam	*Limnanthes bakeri*	SR
Point Reyes Meadowfoam	*Limnanthes douglasii* ssp. *sulphurea*	SE
Parish's Meadowfoam	*Limnanthes gracilis* ssp. *parishii*	SE
Sebastopol Meadowfoam	*Limnanthes vinculans*	SE, FE
Father Crowley's Lupine	*Lupinus padre-crowleyi*	SR
Willowy Monardella	*Monardella linoides ssp. viminea*	SE, FE
Amargosa Nitrophila	*Nitrophila mohavensis*	SE, FE
Calistoga Popcorn-Flower	*Plagiobothrys strictus*	ST, FE
North Coast Semaphore Grass	*Pleuropogon hooverianus*	SC
San Bernardino Blue Grass	*Poa atropurpurea*	FE
Napa Blue Grass	*Poa napensis*	SE, FE
Santa Lucia Mint	*Pogogyne clareana*	SE
Hickman's Cinquefoil	*Potentilla Hickmanii*	SE, FE
Gambel's Water Cress	*Rorippa gambelii*	ST, FE
Tahoe Yellow Cress	*Rorippa subumbellata*	SE, FC
Adobe Sanicle	*Sanicula maritima*	SR
Owens Valley Checkerbloom	*Sidalcea covillei*	SE
Kenwood Marsh Checkerbloom	*Sidalcea oregana* ssp. *valida*	SE FE,
Bird-Foot Checkerbloom	*Sidalcea pedata*	SE, FE

Scadden Flat Checkerbloom	*Sidalcea stipularis*	SE
California Seablite	*Suaeda californica*	FE
California Dandelion	*Taraxacum californicum*	FE
Slender-Petaled Thelypodium	*Thelypodium stenopetalum*	SE, FE
Pacific Grove Clover	*Trifolium polydon*	SR

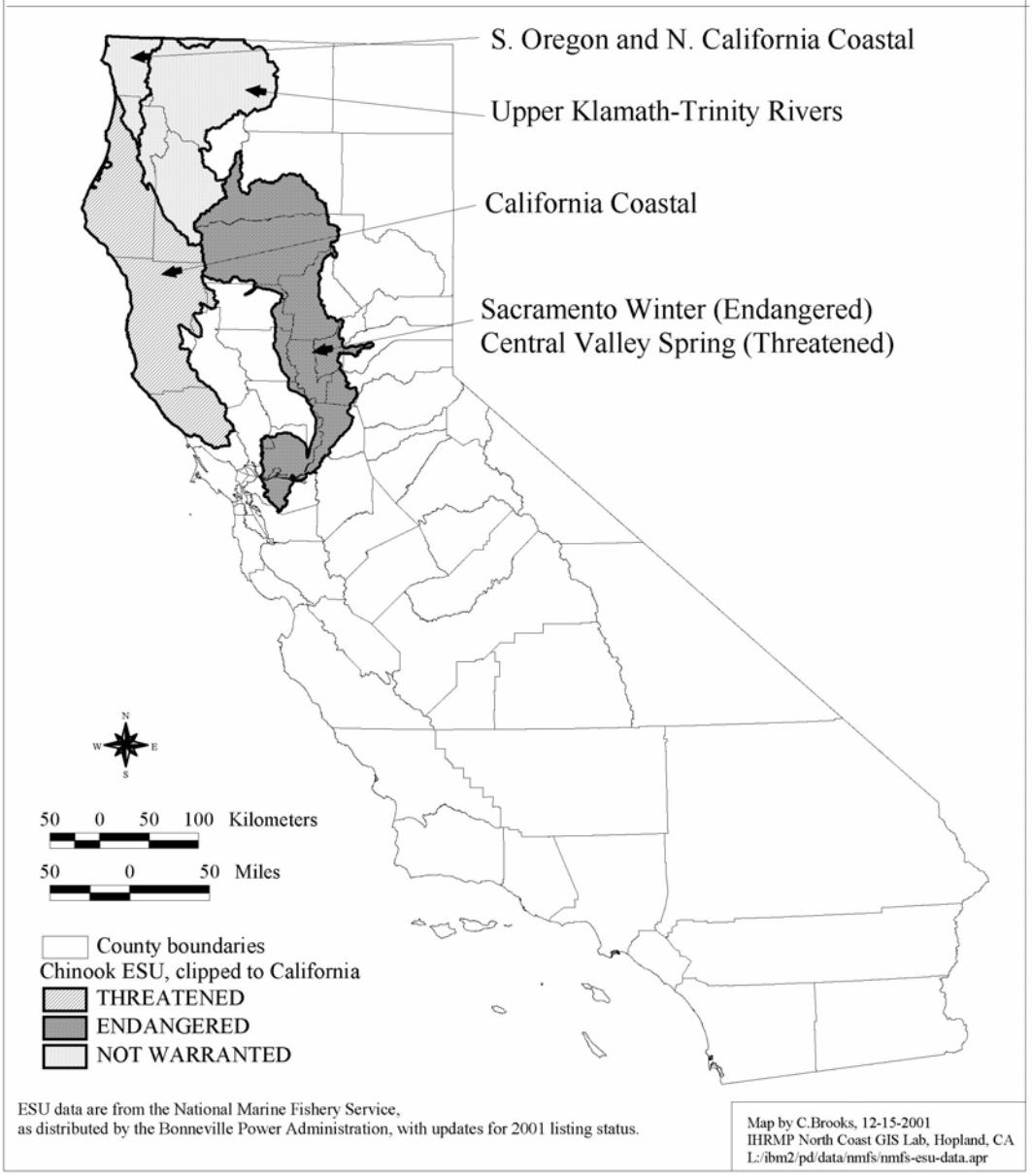
The above list of plants includes only those species in the DFG Natural Diversity Data Base in categories relating to selected aquatic and riparian habitats[44]. The statewide species list for state and federal listed plants, species of special concern and federal category species that could be present in areas in or adjacent to fisheries restoration projects is extensive. Many sensitive plant species or communities that are not considered "aquatic" or "riparian" may occur within or near the riparian zones in some watersheds, and upslope control of sediment sources may involve non-riparian habitats. Occurrence of sensitive plant species within a proposed project site should be investigated on a case-by-case basis by personnel trained in botanical surveys, who have knowledge of local plant species. It is recommended that DFG regional plant ecologists be contacted in initial project planning stages for information about the potential of sensitive plant occurrence in or near the project area. In addition, it is recommended that project planners consult the California Native Plant Society's *Inventory of Rare and Endangered Vascular Plants of California*, and the most current version of DFG's *Special Plants List* for specific species status.

Information regarding life history, habits, and distribution for threatened and endangered plant and animal species is provided in *The Annual Report on the Status of California State listed Threatened and Endangered Animals and Plants,* published by DFG; this report is available online at http://www.dfg.ca.gov.

[44] The plant list was compiled for the following CNDDB Habitats:
Aquatic
Bog and Fen
Freshwater Marsh
Klamath/N. Coast Flowing Water
Meadow and Seep
Riparian Forest
Riparian Woodland
South Coast Flowing Water
Sac. San Joaquin Flowing Water

Chinook Federal Listing Status Map for California
by Evolutionary Significant Unit (ESU).

Please note that the Sacramento Winter ESU (Federal Status: Endangered)
also includes the Central Valley Spring ESU, which has a different Federal listing status (Threatened).



ESU data are from the National Marine Fishery Service,
as distributed by the Bonneville Power Administration, with updates for 2001 listing status.

Map by C.Brooks, 12-15-2001
IHRMP North Coast GIS Lab, Hopland, CA
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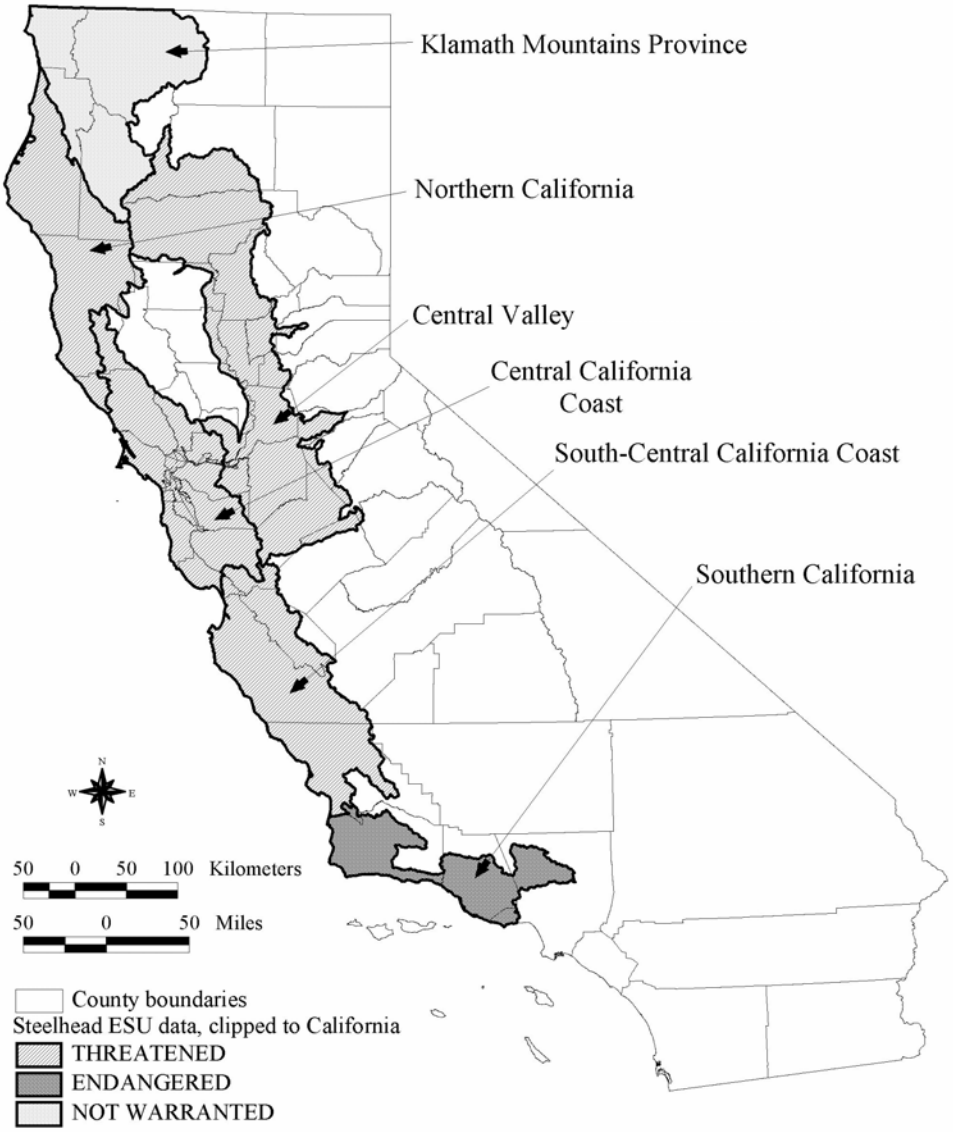
Steelhead Federal Listing Status Map for California
by Evolutionary Significant Unit (ESU).



ESU data are from the National Marine Fishery Service,
as distributed by the Bonneville Power Administration, with updates for 2001 listing status.

Map by C.Brooks, 12-27-2001
IHRMP North Coast GIS Lab, Hopland, CA
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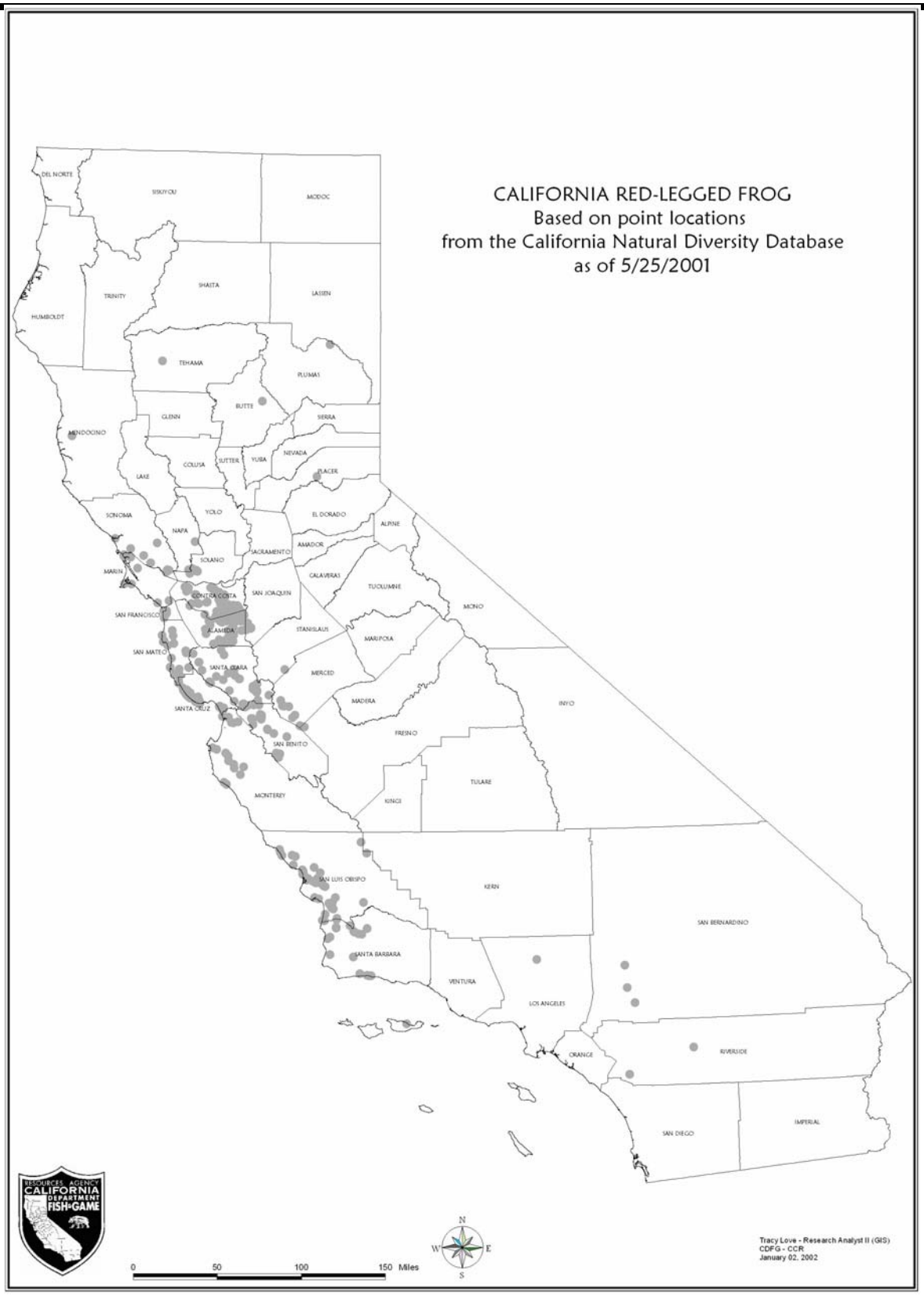
CALIFORNIA RED-LEGGED FROG
Based on point locations
from the California Natural Diversity Database
as of 5/25/2001
DEL NORTE
SISKIYOU
MODOC
HUMBOLDT
TRINITY
SHASTA
LASSEN
TEHAMA
PLUMAS
BUTTE
GLENN
SIERRA
MENDOCINO
COLUSA
SUTTER
YUBA
NEVADA
LAKE
PLACER
SONOMA
YOLO
EL DORADO
ALPINE
NAPA
AMADOR
SACRAMENTO
SOLANO
MARIN
CALAVERAS
TUOLUMNE
CONTRA COSTA
SAN JOAQUIN
MONO
SAN FRANCISCO
ALAMEDA
STANISLAUS
MARIPOSA
SAN MATEO
SANTA CLARA
MERCED
MADERA
INYO
SANTA CRUZ
FRESNO
SAN BENITO
TULARE
MONTEREY
KINGS
SAN LUIS OBISPO
KERN
SAN BERNARDINO
SANTA BARBARA
VENTURA
LOS ANGELES
ORANGE
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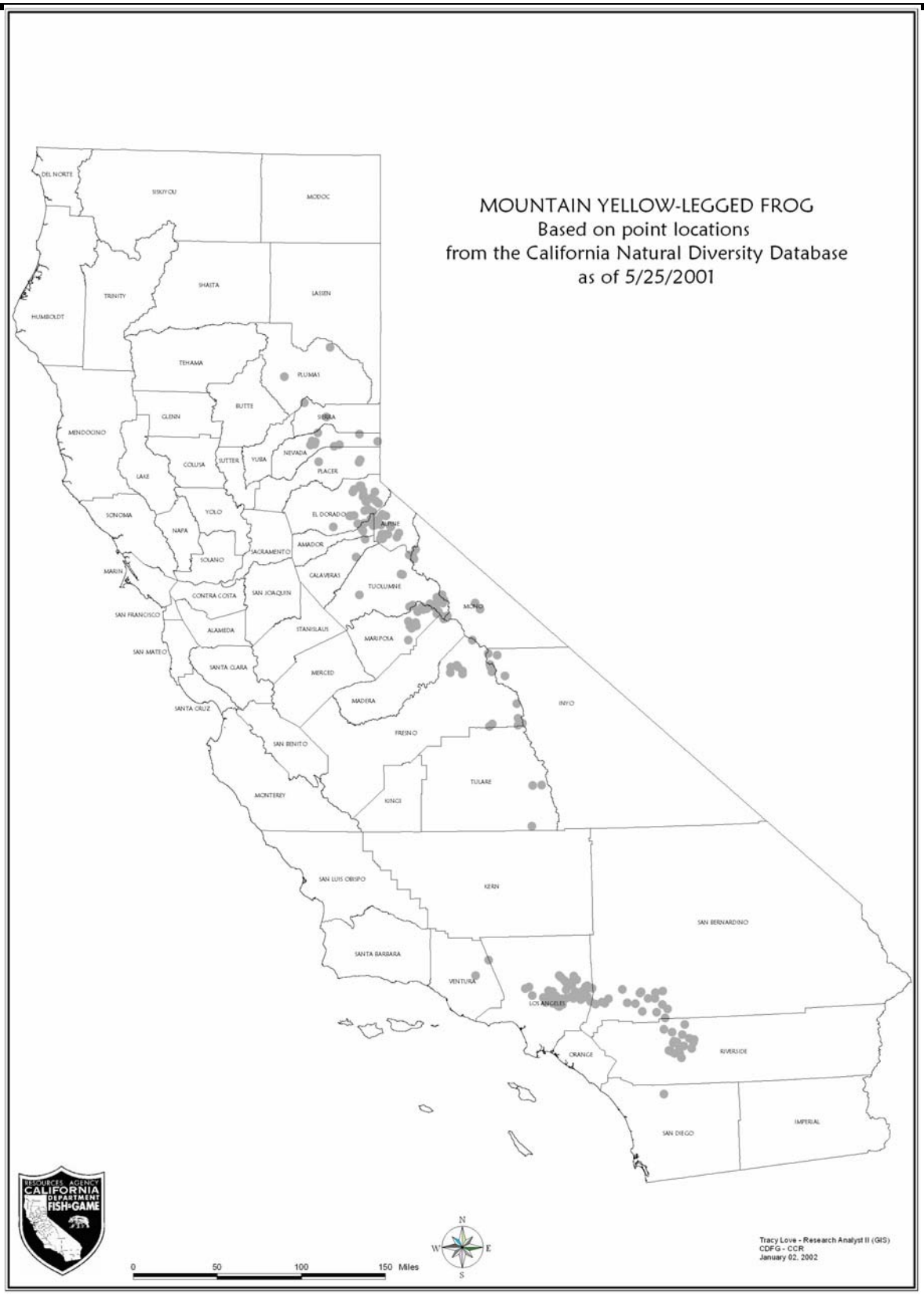
MOUNTAIN YELLOW-LEGGED FROG
Based on point locations
from the California Natural Diversity Database
as of 5/25/2001
DEL NORTE
SISKIYOU
MODOC
HUMBOLDT
TRINITY
SHASTA
LASSEN
TEHAMA
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BUTTE
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SIERRA
MENDOCINO
COLUSA
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NEVADA
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INYO
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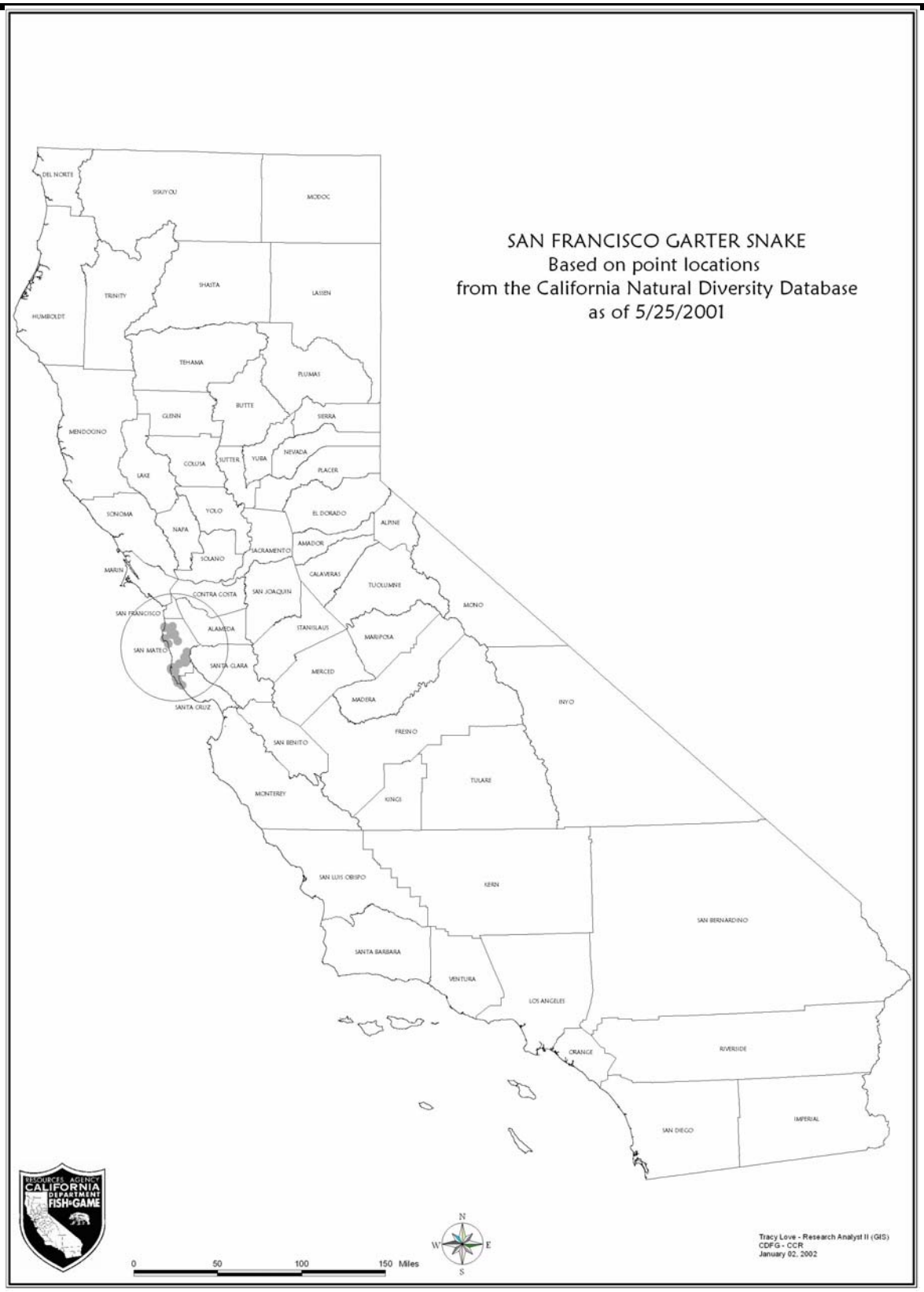
SAN FRANCISCO GARTER SNAKE
Based on point locations
from the California Natural Diversity Database
as of 5/25/2001
DEL NORTE
SISKIYOU
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HUMBOLDT
TRINITY
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TEHAMA
PLUMAS
GLENN
BUTTE
SIERRA
MENDOCINO
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CALIFORNIA DEPARTMENT FISH & GAME
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GIANT GARTER SNAKE
Based on point locations
from the California Natural Diversity Database
as of 5/25/2001
DEL NORTE
SISKIYOU
MODOC
HUMBOLDT
TRINITY
SHASTA
LASSEN
TEHAMA
PLUMAS
BUTTE
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MENDOCINO
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CALAVERAS
TUOLUMNE
CONTRA COSTA
SAN JOAQUIN
MONO
SAN FRANCISCO
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STANISLAUS
MARIPOSA
SAN MATEO
SANTA CLARA
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MADERA
INYO
SANTA CRUZ
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SAN DIEGO
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MARBLED MURRELET
Point locations recorded as of November 1998
The coverage is a point coverage containing approximately 2500 features. The extent of the coverage corresponds to the range of the marbled murrelet in California, mostly the north and central coastal counties.
DEL NORTE
SISKIYOU
MODOC
TRINITY
SHASTA
LASSEN
HUMBOLDT
TEHAMA
PLUMAS
GLENN
BUTTE
SIERRA
MENDOCINO
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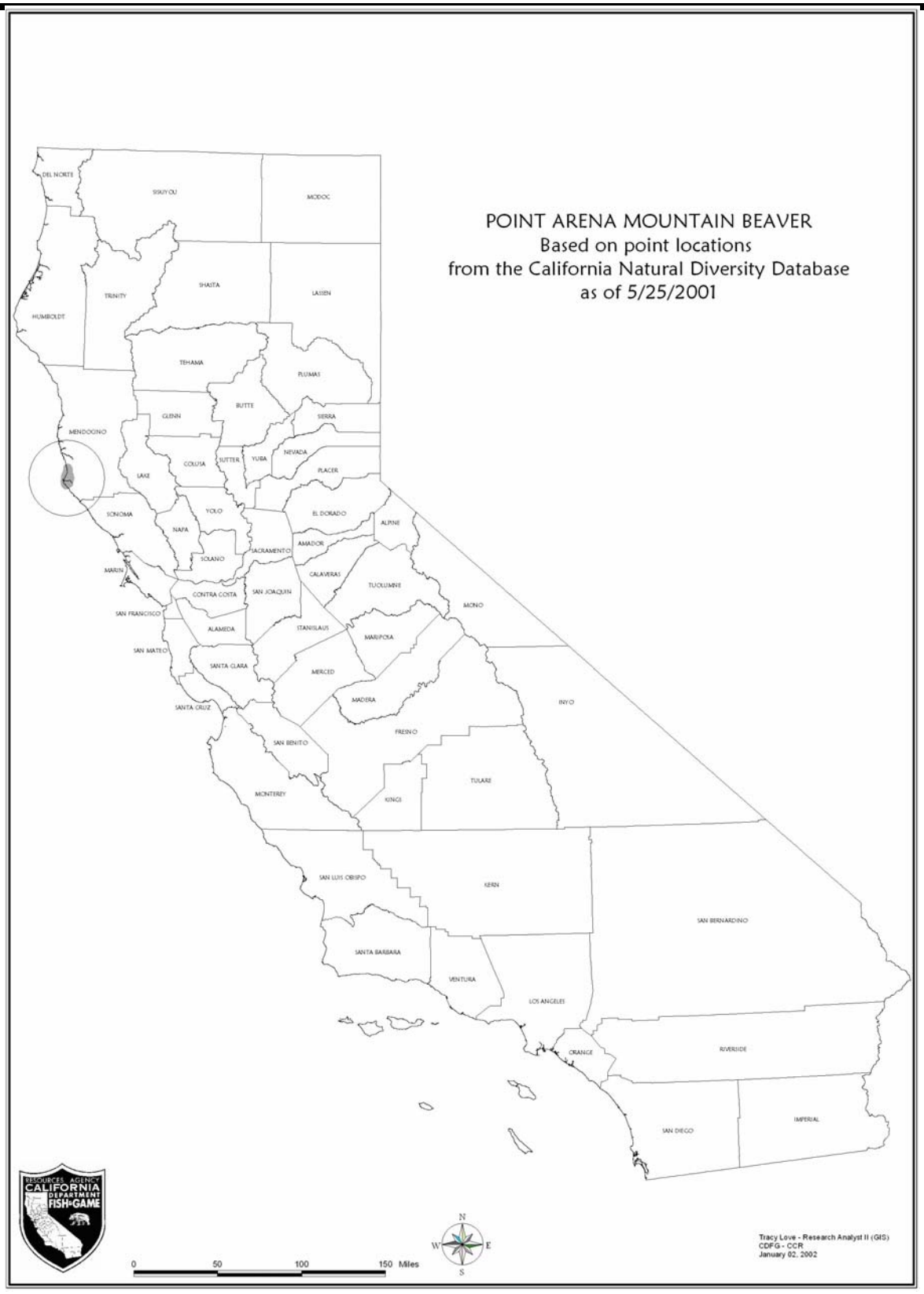
January 02, 2002


POINT ARENA MOUNTAIN BEAVER
Based on point locations
from the California Natural Diversity Database
as of 5/25/2001
DEL NORTE
SISKIYOU
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HUMBOLDT
TRINITY
SHASTA
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SAN DIEGO
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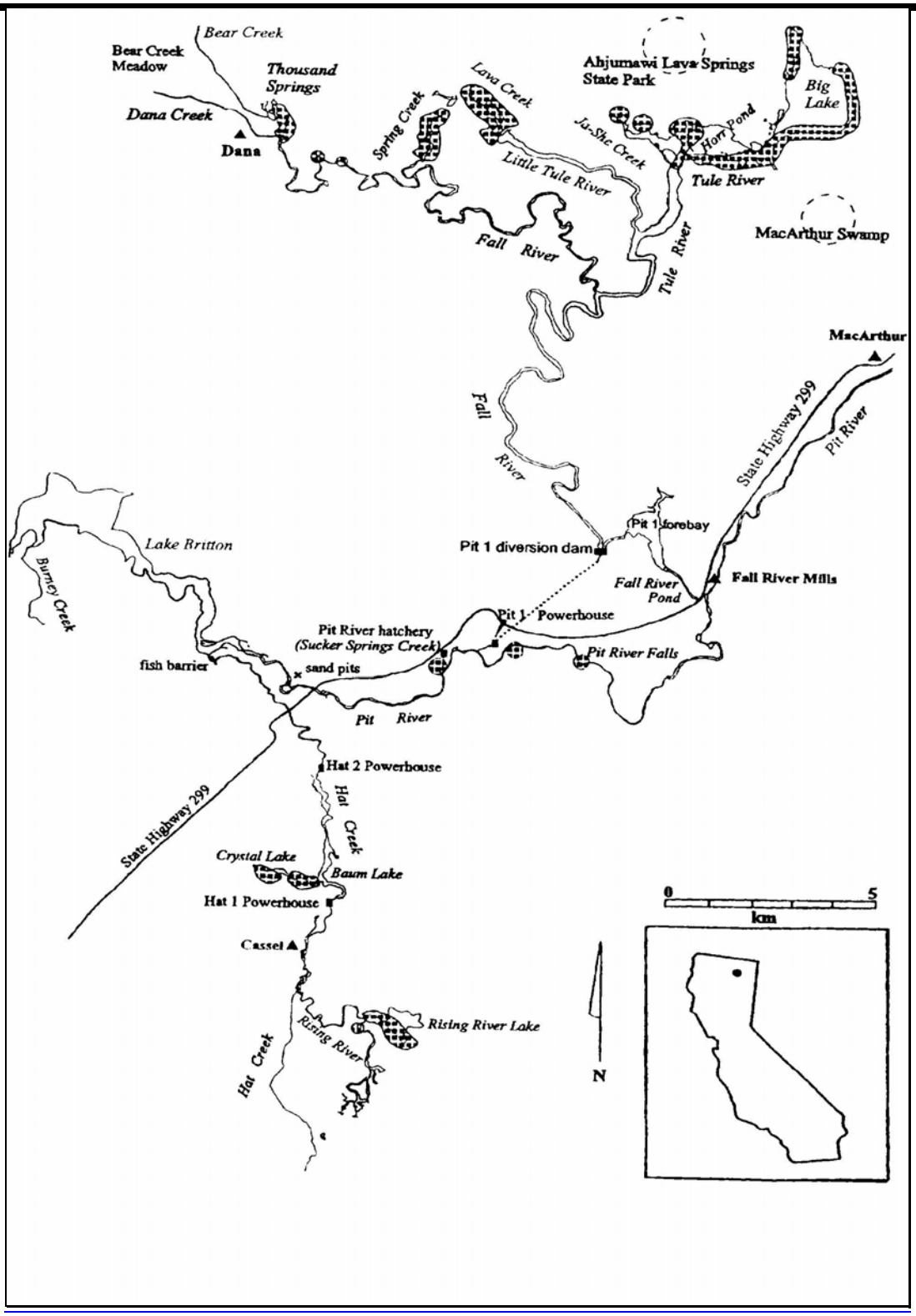
January 02, 2002



Distribution of all known locations of Shasta crayfish in Shasta County (Source: U.S. Fish and Wildlife Service, Recovery Plan for the Shasta Crayfish (*Pacifastacus fortis*), August 28, 1998).

APPENDIX G.

CONVERSIONS, MEASUREMENTS, AND ABBREVIATIONS

Length

To convert	Multiply by
Centimeters to inches	0.3937
to feet	0.03281
Feet to meters	0.304801
to centimeters	30.4801
Inches to meters	0.0254
to centimeters	2.54
to millimeters	25.4
Kilometers to miles	0.6214
to feet	3,280.83
Meters to yards	1.0936
to feet	3.2808
to inches	39.37
Miles to kilometers	1.6094
to meters	1,609.35
Millimeters to inches	0.03937
Yards to centimeters	91.4402
to meters	0.9144

Area

To convert	Multiply by
Acres to hectares	0.405
to square feet	43,560.00
to square kilometers	0.004047
to square meters	4,047.00
to square miles	0.00156
Hectares to acres	2.469
to square feet	107,639.1
to square kilometers	0.01
to square meters	10,000.00
to square miles	0.003858
Square centimeters to square inches	0.155

Area (cont'd)

To convert	Multiply by
Square feet to acres	0.0000229
to hectares	0.0000093
to square centimeters	929.034
to square meters	0.0929
Square inches to square millimeters	645.16
to square centimeters	6.4516
to square meters	0.000645
Square kilometers to acres	247.104
to square miles	0.3861
Square kilometers to hectares	100.00
Square meters to acres	0.000247
to hectares	0.0001
to square feet	10.7639
to square inches	1,550.00
to square yards	1.19599
Square miles to acres	640.00
to hectares	259.20
to square kilometers	2.59
Square millimeters to square inches	0.00155
Square yards to square meters	0.83613

Volume

To convert	Multiply by
Acre-feet to cubic feet	43,560.00
to cubic hectometers	0.0012335
to cubic meters	1,233.5
to cubic yards	1,613.3
to gallons	325,850.00
to cubic kilometers	0.0000012335
Cubic centimeters to cubic feet	0.0000353
to cubic inches	0.061023
to milliliters	1.00
Cubic decimeters to cubic feet	0.035314
to liters	1.00

Volume (cont'd)

To convert	Multiply by
Cubic feet to acre-feet	0.0000229
to cubic centimeters	28,317.00
to cubic decimeters	28.317
to cubic inches	1,728.00
to cubic meters	0.02832
to cubic yards	0.03704
to gallons	7.48
to liters	28.317
to quarts	29.922
Cubic inches to cubic centimeters	16.387
to cubic feet	0.00058
to fluid ounces	0.554
to gallons	0.0043
to liters	0.0164
to pints	0.0346
to quarts	0.0173
Cubic hectometers to acre-feet	810.70
Cubic meters to acre-feet	0.0008107
to cubic feet	35.314
to cubic yards	1.30794
to gallons	264.170
to liters	1,000.00
Cubic yards to acre-feet	0.0006198
to cubic feet	27.00
to cubic meters	0.7646
Cubic yards to gallons	201.974
to liters	764.559
Gallons to acre-feet	0.00000307
to cubic feet	0.1337
to cubic inches	231.00
to cubic meters	0.003785
to cubic yards	0.00495
to fluid ounces	128.00
to liters	3.78543
Liters to cubic decimeters	1.00
to cubic feet	0.035314
to cubic inches	61.0234
to cubic meters	0.001

Volume (cont'd)

To convert	Multiply by
Liters to cubic yards	0.0013079
to gallons	0.26417
to pints	2.11336
to quarts	1.05668
Milliliters to cubic centimeters	1.00
Ounces (fluid) to cubic centimeters	29.5737
to cubic inches	1.8047
Pints to cubic inches	28.875
to liters	0.4732
Quarts to cubic feet	0.03342
to cubic inches	57.75
to liters	0.94636

Weight

To convert	Multiply by
Grams to kilograms	0.001
to pounds	0.002205
to ounces	0.03527
Kilograms to grams	1,000.00
to pounds	2.205
to tons (metric)	0.001
to tons (short)	0.0011025
Ounces to grams	28.349527
to pounds	0.0625
Pounds to grams	453.5924
to kilograms	0.45359
to ounces	16.00
to tons (metric)	0.0004536
to tons (short)	0.0005
Tons (metric) to kilograms	1,000.00
to pounds	2,205.00
to tons (short)	1.1025
Tons (short) to kilograms	907.18
to pounds	2,000.00
to tons (metric)	0.90718

Volume/Time (Flow)

To convert	Multiply by
Acre-feet per day to cubic feet per second	0.5043
to cubic meters per second	0.0143
to gallons per minute	226.24
to million gallons per day	0.3258
Cubic feet/second to acre-feet/day	1.983
to acre-inch per hour	0.992
to cubic feet per day	86,400.00
to cubic meters per second	0.028317
to gallons per day	646,272.00
to gallons per minute	448.80
to gallons per second	7.48
to liters per second	28.317
Cubic meters/second to acre-feet/day	70.0456
to cubic feet per second	35.314
to gallons per minute	15,850.37
to liters per second	1,000.00
to million gallons per day	22.824
Gallons per minute to acre-feet per day	0.00442
to cubic feet per second	0.00223
to cubic meters per second	0.00006309
to gallons per day	1,440.00
to liters per second	0.06309
Liters/second to cubic feet/second	0.035314
to cubic meters per second	0.001
to gallons per minute	15.85
Million gallons/day to acre-feet/day	3.0689
to cubic feet per second	1.547
to cubic meters per second	0.043813
to gallons per minute	695.00

Yield

To convert	Multiply by
Kilograms per hectare to pounds per acre	0.8916
Pounds per acre to kilograms per hectare	1.122

Temperature

°C is equal to (°F - 32) × 5 / 9

°F is equal to (°C × 1.8) + 32

Miscellaneous Water Measurements

1 gallon of water weighs 8.34 pounds
1 cubic foot of water weighs 62.4 pounds

Acre-feet × 43560 / 86400 × X = cubic feet/second discharge over a period of X days

ABBREVIATIONS

Spell out

acres(s)	mile(s)	ton(s)
cent(s)	month(s)	
dollar(s)	ohm(s)	

Abbreviate

alternating current	ac
barrel(s)	bl
body weight	body wt
bushel(s)	bu
centimeter(s)	cm
count per minute	count/min
count per second	count/s
cubic centimeter(s)	cm^3
cubic foot (feet)	ft^3
cubic foot per second	cfs
cubic kilometer(s)	km^3
cubic meter(s)	m^3
cubic meter per second	m^3/s
cubic microns(s)	μ^3
cubic millimeter(s)	mm^3
cubic yards(s)	yd^3

ABBREVIATIONS (cont'd)

Abbreviate	
Day	d
degree (space)	deg or °
degree, Celsius	°C
degree, Fahrenheit	°F
diameter	diam
direct current	dc
dozen	doz
dry weight	dry wt
east	E
fathom	fm
focal length	f/
foot (feet)	ft
gallon(s)	gal
grain(s)	gr
gram(s)	g
hectare	ha
horsepower	hp
hour(s)	h
hundredweight	cwt
inch	in.
kilogram(s)	kg
kilometer(s)	km
kilometer per hour	km/h
latitude	lat
lethal concentration, 50%	LC50
lethal dose, medial	LD50
liter	l
logarithm (common, base 10) in formulas	log, $\log_{10}$
logarithm (natural, base e) in formulas	ln, $\log_e$
longitude	long
meter(s)	m
megagram(s)	Mg
microgram	µg
micron(s) (10^{-3}mm)	µ
mile per hour	mile/h
milligram(s)	mg
milligram(s) per gram	mg/g
milligram(s) per liter	mg/l
milliliter(s)	ml

ABBREVIATIONS (cont'd)

Abbreviate	
millimeter(s)	mm
minimum or minute(s)	min
minute (time)	min
north	N
number (in enumeration)	no.
ounce	oz
page(s)	p.
parts per billion	ppb
parts per million	ppm
percent	%
per thousand	o/oo
pound(s)	lb
pounds per square inch	lb/in^2
second(s) (time)	s
second(s) (angular measure)	"
south	S
species (taxonomy only, singular)	sp.
species (taxonomy only, plural)	spp.
species, new	sp. nov.
specific gravity	sp gr
square	sq
square centimeter(s)	cm^2
square foot (feet)	ft^2
square meter(s)	m^2
square millimeter(s)	mm^2
standard deviation	SD
standard error	SE
subspecies	ssp.
Temperature	temp
Time	use 24-hr system
variety(ies)	var.
volt	v
volume (with number in tables)	V
volume/volume (conc.)	v/v
watt	W
week	wk
weight	wt
west	W

ABBREVIATIONS (cont'd)

Abbreviate	
Yard	yd
Year	yr

Write latitude in the form: lat 33°41'30"N
Write longitude in the form: long 118°09'05"W

APPENDIX H.

THE MANNING ROUGHNESS COEFFICIENT

Typical channel designs rely on hydraulic engineering criteria and geomorphic parameters, such as critical bed and bank shear stresses, considerations of bedload transport, and "equilibrium" valley slopes (Rundquist et al., 1986; Jackson and Van Haveren, 1984). Other work utilizes empirical equations, that despite their limitations, continue to demonstrate their utility (Dury 1973; Williams 1986). The reader is referred to Graf (1971), U.S. Army Corps of Engineers (1970), and Bray (1982) for a review of common design approaches. For our purposes, we will follow a utilitarian approach, that allows designers to predict if a modified cross-section will convey the bankfull discharge.

Geomorphic research (Wolman and Leopold 1957; Hey 1982) has shown that most rivers experience a bankfull flood once every two years, and that these flows are the most important in defining channel shape (Wolman and Miller 1960; Yu and Wolman, 1987). Although other flows are important, for our purposes, bankfull discharge (Qbf) is designated as the design discharge.

The Manning Equation and Profile Alterations

The Manning equation is a common mathematical method for designing channel modifications (Mott 1979; Dunne and Leopold 1978). One form of the Manning equation is presented here.

$$Qbf = (1.49\ R^{2/3}S^{1/2})(1/n)(A)$$

Where:
- Qbf = bankfull discharge (ft^3/s)
- R = hydraulic radius (ft) and R = WP/A, (the ratio of wetted perimeter to cross-sectional area of flowing water), where WP = wetted perimeter (ft)
- A = area of cross-section below the Qbf elevation (ft^2)
- S = average slope of the longitudinal profile or longitudinal template (ft/ft)
- n = the dimensionless Manning roughness coefficient

For the form of the Manning equation described here, discharge (Qbf) can be calculated from a cross-section or preferably, derived from discharge records, slope (average for the reach) is derived from the longitudinal profile data. The Manning roughness coefficient "n" is selected from reference books, or more preferably, back calculated from a specific paired reference cross-section. Hydraulic radius (R) and cross-sectional area (A), both descriptors of cross-sectional configuration, are manipulated using reference templates as a guide, through the introduction of structures or other features to create a suitable geometry for a particular site. It is evident that different channel shapes can have the same hydraulic radius and cross-sectional area, (e.g., a trapezoidal channel verses a semi-circular or triangular channel). Consequently, the real test of this approach is to arrive at an inherently stable channel geometry that also provides quality instream habitat for fish. In this work, there is no better help available than that provided by existing stream features. Since the reference templates serve as examples of existing stream conditions, designers should rely on them as valuable references. Again: Mimic nature.

Because this equation is sensitive to the value of the "n" coefficient, it is easy to under-design or over-design a channel modification. Consequently, references have been developed to assist in assigning an "n" value. These references are based on actual calculations of "n" from known discharge and cross-sectional data (Barnes 1967; Dunne and Leopold 1978; and Jarrett 1985). Because most channels in mountain environments have a high degree of bed armor and channel roughness, "n" values for these channels usually range between 0.05 and 0.08. For specific enhancement cross-sections an "n" value should be back calculated from the matched reference cross-section.

Guidelines for cross-sectional channel shapes are difficult to categorize, because of the range of variation in natural channels. However, a modified trapezoid shape is usually appropriate for riffle and run sections . Pool cross-sections vary with their location in the channel (e.g. bends vs inflections), but most commonly encountered pool cross-sections are asymmetric. In other words, they have shallow slip-off slopes on the inner bank and near steep slopes on the outer bank. Pools also tend to be about 25 percent less wide than riffles. Cross-sectional modifications should mimic these shapes as close as practical. Again, use the matched reference templates as guides for new channel configurations.

Designers only need to fit, through trial and error calculation with the Manning equation, an altered cross-section to the design discharge (Qbf). For example, the first trial cross-section (existing shape with an added structural modification), when solved for its component parts of hydraulic radius (R) and area (A), may produce a configuration which cannot convey the design discharge. With this knowledge, the trial cross-section is modified, using the reference cross section as a guide, but with a larger area, and a greater R value. When this new trial cross-section is broken down into its component parts and inserted into the Manning equation, the design discharge may be slightly higher than necessary. At this point in the iterative process it is often helpful to refer back to the field notes and longitudinal templates to reconfirm or reject earlier assumptions concerning the reference cross-section and the modified cross-section.

The designer should pay close attention to all the channel forming variables (e.g., a bedrock bank, sudden change in stream direction, instream roughness objects, slope and length of up stream riffle, slope and length of down stream riffle, slope and length of pool feature, etc.) when modifying a cross-section. Designers should attempt to simulate as many of these variables as possible using the reference section, field notes and longitudinal profile templates as guides. If a channel design is too "large" for a given Qbf, the section may have a tendency to fill with sediment. Conversely, if a cross-section is too "small" for a given Qbf, then the section may have a tendency to scour. It is important to persevere, and reach a final configuration that fits the channel forming discharge or Qbf. Eventually, an appropriate altered channel cross-sectional shape is derived along with a set of assumptions that must be met during construction.

Another dimension to this process is to observe changes in discharge capacity by varying "n" values. For example, a channel described as having a cobble bottom and clean sides may have an "n" of 0.040, while the same channel with bank vegetation may have an "n" of 0.055. Because it is better to over-design than under-design a channel modification, "n" should be chosen conservatively. For more accuracy in complex situations, individual cross-sections can be divided into vertical segments, with individual "n" values assigned to each segment. This procedure enables greater precision, particularly for complex asymmetrical cross-sections, and is described in detail by Chow (1959). This design process can be simplified by using computer programs for either programmable calculators or micro-computers. Most computer-based drawing programs easily calculate areas for non-symmetrical polygons and perimeters, facilitating rapid iterations.

Channel Manipulation Through Placement of Instream Structures

Longitudinal and Cross-Sectional Analysis of an Actual Reach.

Longitudinal and cross-sectional data for a tributary of the Klamath River in northern California were selected to provide an example of how a designer might install a wing deflector within a reach to create a pool. To illustrate the design methodology described herein, only one of the final cross-section designs is presented; normally, a complete series of design cross-sections would be compiled. The number of cross-sections needed depends on the complexity of the site and the degree of channel changes required. Usually a minimum of 3 or 4 design cross-sections are required, while lengthy or complex sites may require dozens.

Figure H-1 shows a segment of the longitudinal profile identified as a run with the potential for modification into a pool. Notice that the average slope for the reach is similar for both the reference pool and the design site. Also the slopes of both the up and down stream riffles correspond favorably. The field notes identify, "Station 42+23...what appears to be an overly wide channel at this point allows stream energy to be dissipated over a broad cross-section...". Confining the cross-sectional area through the design site might transform this run into a pool.

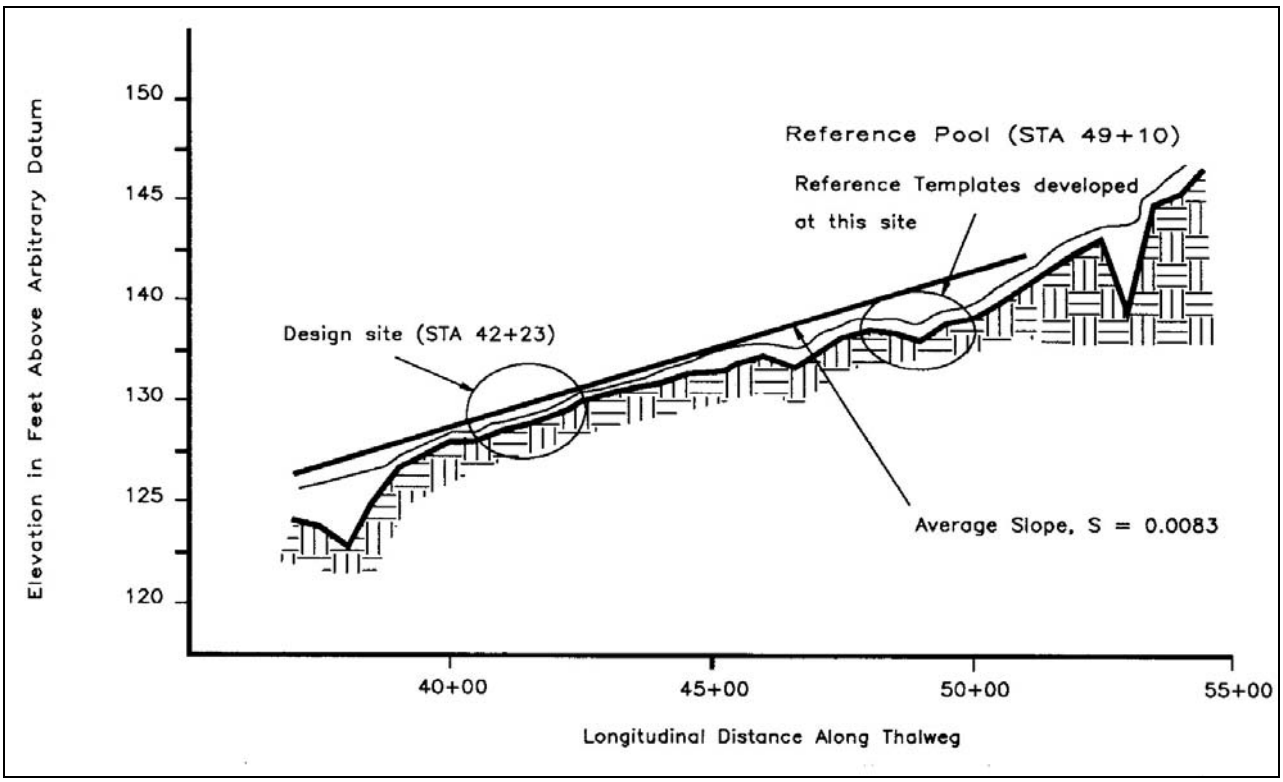


Figure H-1. Longitudinal profile of a design reach, Tarup Creek, Del Norte County, California. (Inter-Fluve, Inc. 1984).

Drafting the cross-sectional survey for the run at Station 42+23 produces the profile in Figure 2. When compared with the selected reference cross section for a pool (Station 49+10), the previously derived conclusions of the field notes can be confirmed; the cross section at STA 42+23 is overly wide and shallow. Since this run is located on a shallow bend to the left, a pool will be designed on the outside of this bend using a log wing deflector to alter the cross section and simulate the shape of the reference section. Note that the reference template matched with the station 42+23 cross section in Figure H-2 has been flipped horizontally to correspond with a left bank pool.

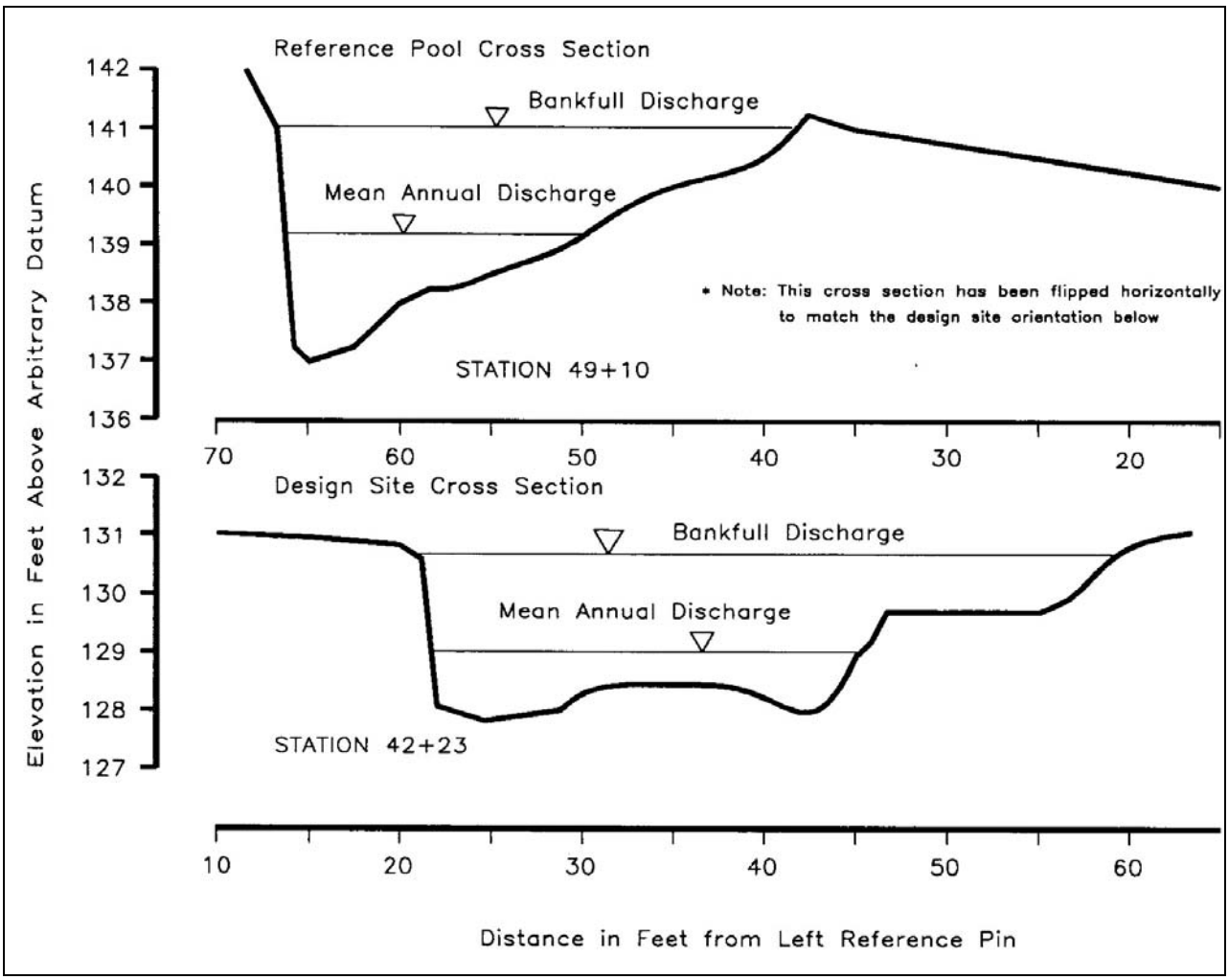


Figure H-2. Cross-sectional profiles of a reference pool and a selected design site, Tarup Creek, Del Norte County, California. (Inter-Fluve, Inc. 1984).

Design of a Habitat Alteration Using the Manning Equation as a Guide.

As previously stated, altered cross-section designs should closely resemble the reference template. The ability to emulate the stability and function of the reference cross section plays a major role in the success of this technique. Remember too, if a channel design is too "large" for a given bankfull discharge (Qbf), the section will have a tendency to fill, and if too "small", the section will have a tendency to scour.

Bankfull discharge elevations for the reference pool and new design criteria are matched by superimposing the reference pool template on the design site template. For clarity, the two templates are shown separately in Figure H-3. Matching bankfull discharge elevations is required to maintain water surface continuity. The "New Design Site Cross Section" replaces the gravel bar of the existing cross section with a log-wing deflector. The new cross section now matches the template. This combination of the reference template, STA 42+23 cross section, and the log-wing deflector becomes the first trial cross section to be subjected to hydraulic analysis.

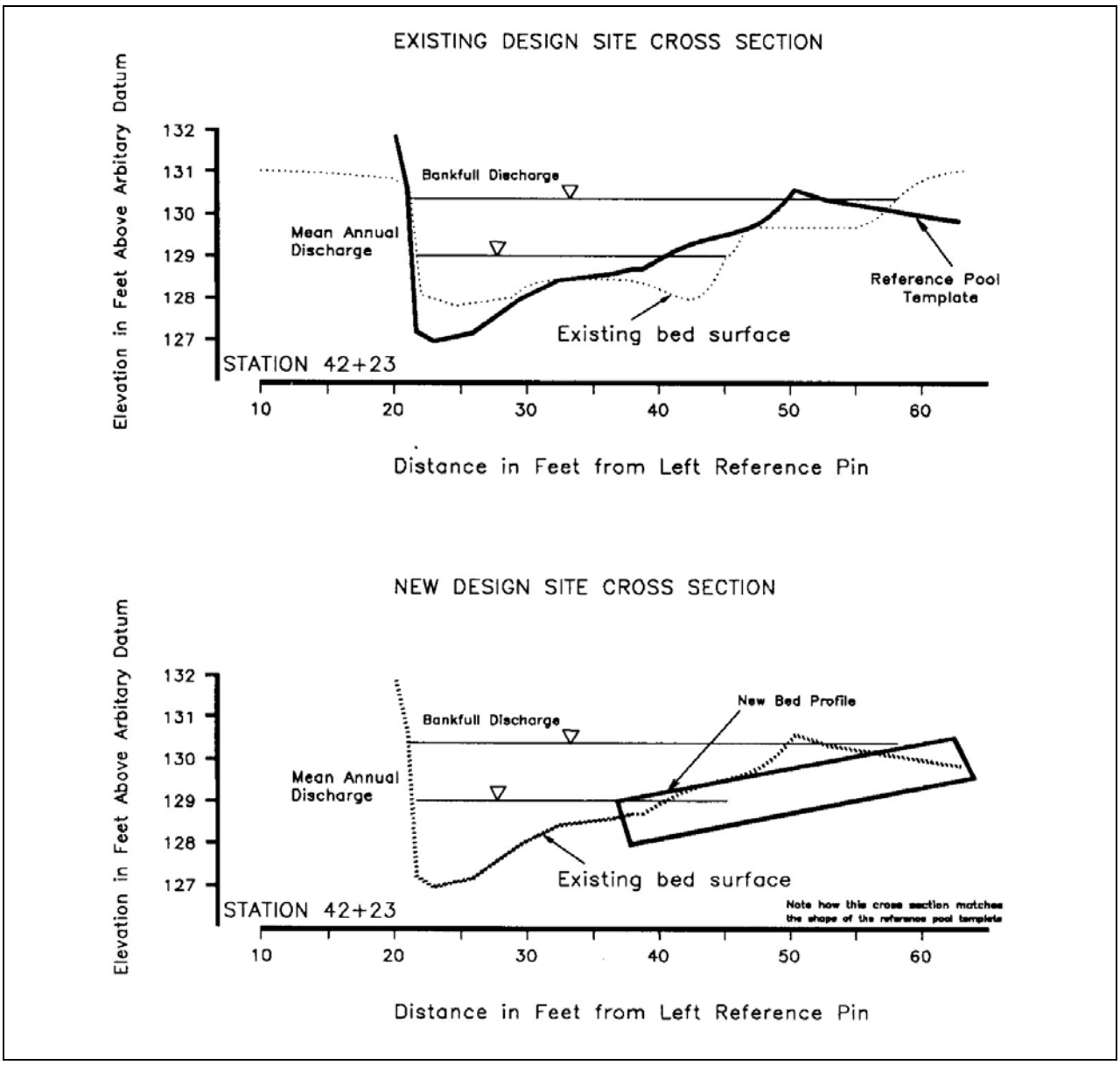


Figure H-3. Cross-sectional profile of a reference pool superimposed on a selected design site, Tarup Creek, Del Norte County, California (Inter-Fluve, Inc. 1984).

Multiple iterations, each time substituting different values for A and R in the Manning equation, results in the final cross section, shown as Figure H-4. Notice that to maintain the same bankfull discharge and provide exemplary pool habitat, cross-sectional area was altered and consequently some bottom material must be removed from the channel to form the pool. Actual construction specifications should depict the placement of this material around the wing deflector, smoothing the log's transition into the existing topography. Further similar hydraulic analysis (not shown in this example) for upstream and downstream stations would produce a series of cross-section designs fully describing the site.

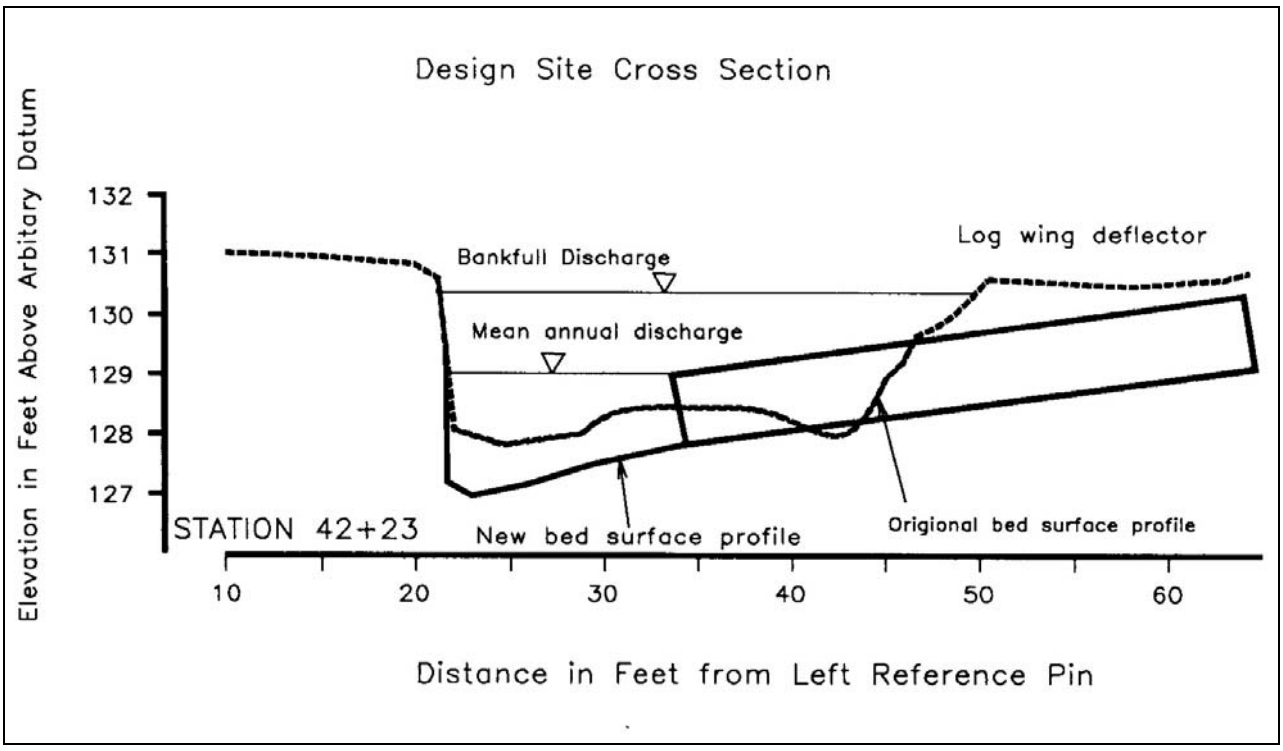


Figure H-4. Final cross-sectional design profile for station 42+23, Tarup Creek, Del Norte County, California. (Inter-Fluve, Inc. 1984).

This hydraulic analysis method enables the designer to estimate the bankfull discharge passed by the enhanced cross-section and clarifies the intensity of work required to modify the stream channel. More importantly, this method allows designers to achieve a major enhancement goal: to faithfully emulate natural cross sections that are providing desirable fish habitats.

Background Theory

Two methods for determining the Manning roughness coefficient or "n" value will be given. The first is from a table of "n" values (Table 1) reproduced with permission from McGraw-Hill, Inc. from the *Handbook of Hydraulics*, Brater, Ernest F. and King, Horace Williams, 1976., Sixth Edition, McGraw-Hill, USA. The second is a method for actually calculating the Manning roughness coefficient "n" based on measurement of flow and channel cross sections by George Heise, Associate Hydraulic Engineer, California Department of Fish and Game. The "n" value from the table will be adequate most of the time. For precise work, the calculated "n" value is recommended.

Table H-1. Values of "n" to be used with the Manning equation.

Surface	Best	Good	Fair	Bad
Uncoated cast-iron pipe	0.012	0.013	0.014	0.015
Coated cast-iron pipe	0.011	0.012*	0.013	
Commercial wrought-iron pipe, black	0.012	0.013	0.014	0.015
Commercial wrought-iron pipe, galvanized	0.013	0.014	0.015	0.017
Smooth brass and glass pipe	0.009	0.010	0.011	0.013
Smooth lockbar and welded "OD" pipe	0.010	0.011*	0.013*	
Riveted and spiral steel pipe	0.013	0.015*	0.017*	
Vitrified sewer pipe	0.010 or 0.011	0.013*	0.015	0.017
Common clay drainage tile	0.011	0.012*	0.014*	0.017
Glazed brickwork	0.011	0.012	0.013*	0.015
Brick in cement mortar; brick sewers	0.012	0.013	0.015*	0.017
Neat cement surfaces	0.010	0.011	0.012	0.013
Cement mortar surfaces	0.011	0.012	0.013*	0.015
Concrete pipe	0.012	0.013	0.015*	0.016
Wood stave pipe	0.010	0.011	0.012	0.013
Plank Flumes:				
Planed	0.010	0.012*	0.013	0.014
Unplaned	0.011	0.013*	0.014	0.015
With battens	0.012	0.015*	0.016	
Concrete-lined channels	0.012	0.014*	0.016*	0.018
Cement-rubble surface	0.017	0.020	0.025	0.030
Dry-rubble surface	0.025	0.030	0.033	0.035
Dressed-ashlar surface	0.013	0.014	0.015	0.017
Semicircular metal flumes, smooth	0.011	0.012	0.013	0.015
Semicircular metal flumes, corrugated	0.0225	0.025	0.0275	0.030
Canals and Ditches:				
Earth, straight and uniform	0.017	0.020	0.0225*	0.025
Rock cuts, smooth and uniform	0.025	0.030	0.033*	0.035
Rock cuts, jagged and irregular	0.035	0.040	0.045	
Winding sluggish canals	0.0225	0.025*	0.0275	0.030
Dredged earth channels	0.025	0.0275*	0.030	0.033
Canals with rough stony beds, weeds on earth banks	0.025	0.030	0.035*	0.040
Earth bottom, rubble sides	0.028	0.030*	0.033*	0.035

Table H–1 (cont'd). Values of "n" to be used with the Manning equation.

Surface	Best	Good	Fair	Bad
Natural Stream Channels				
(1) Clean, straight bankfull stage, no rifts or deep pools	0.025	0.0275	0.030	0.033
(2) Same as (1), but some weeds and stones	0.030	0.033	0.035	0.040
(3) Winding, some pools and shoals, clean	0.033	0.035	0.040	0.045
(4) Same as (3), lower stages, more ineffective slope and sections	0.040	0.045	0.050	0.055
(5) Same as (3), some weeds and stones	0.035	0.040	0.045	0.050
(6) Same as (4), stony sections	0.045	0.050	0.055	0.060
(7) Sluggish river reaches, rather weedy or with very deep pools	0.050	0.060	0.070	0.080
(8) Very weedy reaches	0.075	0.100	0.125	0.150

* Values commonly used in designing.

Calculation of Manning Roughness Coefficient "n" Based on Field Measurements

The following procedure for back calculating Manning roughness coefficients from measured discharge and measured channel cross-sections is based on Geological Survey Water-Supply Paper 1849 *Roughness Characteristics of Natural Channels* (Barnes 1967).

The analysis is limited to turbulent flow in fully rough channels. This condition is usually present in natural channels. It should be noted that channel roughness may vary with depth from the influence of riparian vegetation or other roughness elements in the channel. Where possible, flow measurements should be taken and calculations made at more than one rate of discharge.

Background and Theory

Most open-channel flow formulas can be expressed in the following general terms,

$$Q = C\,A\,R^{X}\,S^{Y} \tag{1}$$

where: Q is the discharge, in cubic feet per second; C is a factor of flow resistance; A is the wetted cross-sectional area of the channel, in square feet; R is the hydraulic radius, in feet; and S is the energy gradient, in feet/feet. The Manning equation is a well known variation of equation (1) and can be used as the basis for computing reach properties and roughness coefficients. The Manning equation is

$$Q = \frac{1.486}{n}\,A\,R^{2/3}\,S^{1/2} \tag{2}$$

where: n is a roughness coefficient and other variables in the equation are as defined above.

The Manning equation was developed for conditions of uniform flow in which the water surface profile and energy gradient are parallel to the streambed, and the area, hydraulic radius, and depth remain constant throughout the reach. For lack of a better solution, it is assumed that the equation is also valid for nonuniform reaches, invariably found in natural channels, if the energy gradient is modified to reflect only the losses due to boundary friction. The energy equation for a reach of nonuniform channel between two adjacent sections is

$$(h + h_v)_1 = (h + h_v)_2 + (h_f)_{1.2} + k(\Delta h_v)_{1.2} \quad (3)$$

where:
- h = Elevation of water surface at the respective sections above a common datum;
- h_v = Velocity head at the respective section=$\alpha V^2/2g$;
- h_f = Energy loss due to boundary friction in the reach;
- h_v = Upstream velocity head minus the downstream velocity head;
- $k(\Delta h_v)$ = Energy loss due to acceleration or deceleration of velocity in a contracting or expanding reach; and
- k = A coefficient taken to be zero for contracting reaches and 0.5 for expanding reaches.

In computing the values of n the value of α, the velocity head coefficient, can be considered to be 1.00.

The friction slope S to be used in the Manning equation is thus defined as

$$S = \frac{h_f}{L} = \frac{\Delta h + \Delta h_v - k(\Delta h_v)}{L} \quad (4)$$

where: Δh is the difference in water-surface elevation at the two sections and L is the length of the reach.

In using the Manning equation the quantity $(1.486/n)AR^{2/3}$, called conveyance and designated K, is computed for each section. The mean conveyance in the reach between any two sections is computed as the geometric mean of the conveyance of the two sections. The discharge equation in terms of conveyance is:

$$Q = \sqrt{K_1 K_2 S} \tag{5}$$

where: S is the friction slope as previously defined.

The average value of the Manning "n" is computed for each reach from the measured discharge, the water surface profile, and the hydraulic properties of the reach as defined by the number of cross sections measured. The following equation, which is based on the same concepts and definitions as equations 2 through 5, is used to compute the value of Manning "n". The equation is applicable to a multi-section reach of M cross sections which are designated 1, 2, 3, ... M-1, M.

$$n = \frac{1.486}{Q} \sqrt{\frac{(h + h_v)_1 - (h + h_v)_M - [(k\Delta h_v)_{1.2} + (k\Delta h_v)_{2.3} + \ldots + (k\Delta h_v)_{(M-1).M}]}{\frac{L_{1.2}}{Z_1 Z_2} + \frac{L_{2.3}}{Z_2 Z_3} + \ldots + \frac{L_{(M-1).M}}{Z_{(M-1)} Z_M}}} \tag{6}$$

where: $Z = AR^{2/3}$ and other quantities are as previously defined.

Computation Procedure

Determine the channel discharge (Q) by using flow meters or any other standard methodology. The flow measurement should correspond to the discharge at which the water surface profile measurements are taken at the selected cross sections.

Prepare a planimetric map of the project reach of the channel by plotting data from a field survey of the site. The location of all cross sections measured should be shown on the map. The waters edge, corresponding to measured discharges, can also be shown on the map for clarification. The distance between cross sections (L) can be determined from the map or derived directly from survey field notes.

Develop the water surface profile along each bank for the measured discharge by plotting the elevation and stationing of the waters edge. The water surface elevations (h) at each cross section can be taken as the average of the water surface elevation on each bank as determined from the water surface profiles.

Plot the channel cross sections from the field survey data. Show the measured water surface elevation on each cross section corresponding to the measured flow.

From the cross section plots measure the wetted perimeter (P), the wetted area (A), and calculate the hydraulic radius (R=A/P) and Z (=$AR^{2/3}$).

From the measured flow and wetted area, calculate the average velocity for the cross section (V=Q/A) and the velocity head ($h_v=V^2/2g$). Calculate deceleration losses between cross sections ($k\Delta h_v$).

Substitute the measured and calculated values of Q, L, Z, h, h_v, and $k\Delta h_v$ into equation 6 and solve for "n".

REFERENCES

Brater, Ernest F. and King, Horace Williams. 1976. Handbook of Hydraulics, Sixth Edition, McGraw-Hill, USA.

Barnes, H.H., Jr. 1967. Roughness Characteristics Of Natural Channels. United States Geological Survey Water Supply Paper 1849.

Bray, D.I. 1982. Regime equations for gravel-bed rivers. Pages 517-542 *in* Gravel-Bed Rivers, ed. by R.D. Hey, J.C. Bathurst and C.R. Thorne, John Wiley and Sons, Chichester.

Chow, V.T. 1959. Open Channel Hydraulics. McGraw-Hill Book Co., New York, 680 pp.

Dunne, T. and L.B. Leopold. 1978. Water In Environmental Planning. W.H. Freeman and Company, New York, 877 pp.

Dury, G.H. 1973. Magnitude-frequency analysis and channel morphometry. Pages 91-121 *in* Fluvial Geomorphology, State University of New York, Binghampton, Publications in Geomorphology, ed. by M. Morisawa.

Graf, W.H. 1971. Hydraulics Of Sediment Transport. McGraw-Hill Book Co., New York, 513 pp.

Hey, R.D. 1982. Design equations for mobile gravel-bed rivers. Pages 553-574 *in* Gravel-Bed Rivers, ed. by R.D. Hey, J.C. Batherst, and C.R. Thorne, John Wiley and Sons, Chichester.

Inter-Fluve, Inc. 1984. In-house computer design program for in-channel modifications. Inter-Fluve, Inc. Bozeman, MT.

Jackson, W.L. and B.P. Van Haveren. 1984. Design for a stable channel in coarse alluvium for riparian zone restoration. Water Resources Bulletin, 20: 695-703.

Jarrett, R.D. 1985. Determination Of Roughness Coefficients For Streams In Colorado. USGS Water Resources Investigation Report 85-4004, 54 pp.

Mott, R.L. 1979. Applied Fluid Mechanics. Charles Merrill Publishing Co. Columbus, Ohio, 405 pp.

Rundquist, L.A., N.E. Bradley, J.E. Baldridge, P.D. Hampton, T.R. Jennings and M.R. Joyce. 1986. Best Management Practices For Placer Mining, Reference Manual and Technical Report. Entrix, Inc., for Alaska Department of Fish and Game, 459 pp.

United States Army Corps of Engineers. 1970. Hydraulic Design Of Flood Control Channels. EM 1110-2-1601.

Williams, G.P., 1986. River meanders and channel size. Journal of Hydrology, 88:147-164.

Wolman, M.G. and J.P. Miller. 1960. Magnitude and frequency of forces in geomorphic processes. Journal of Geology, 68:54-74.

Wolman, M.G. and L.B. Leopold. 1957. River Floodplains: Some Observations on Their Formation. U.S. Geological Survey Paper 282C.

Yu, B. and M.G. Wolman. 1987. Some dynamic aspects of river geometry. Water Resources Research, 23:501-509.

APPENDIX I.

COMPUTER PROGRAMS AND DATABASE STRUCTURES

Documentation for Data Entry and Analysis Program

The Inland Fisheries Division of the Department of Fish and Game has developed an IBM compatible PC program for entering, storing, analyzing, editing, and creating uniform summary tables of fishery habitat and large woody debris inventory data. These programs are written and compiled in dBASE IV language and distributed as public domain software ("Preface, p. i" has information on obtaining a program diskette. The program's menu driven design exactly follows protocol established in this manual and will output data summary tables as illustrated in this manual. The following description is to facilitate use of the program.

Program Hardware Requirements. The program requires a hard disk with a least 3.0 megabytes (mb) of available space and an IBM-compatible PC with at least a 286 processor and 1 mb of random access memory (RAM). The program will run quite slowly under the minimum system configuration. Minimum recommended system configuration is a 386 processor with 4 mb of RAM. The habitat inventory program supports use of a HP Laserjet printer. The large woody debris program supports use of HP Laserjet and dot matrix printers. Neither program supports a mouse.

Installing the Program. The program is distributed on a single 3.5-inch high- density floppy disk in a ZIP file named HABITAT (version). Insert the program diskette in drive A or B and type INSTAL_A or INSTAL_B at the drive prompt. A directory called HABITAT will be created on your hard drive and all necessary program files will be copied to the HABITAT directory. When installation is complete you will be prompted to start the program by typing HABITAT8 at the C> prompt. Follow the instructions on the screen to use the desired programs. Store the diskette in a safe location for backup purposes.

Starting the Habitat Inventory or Large Woody Debris program. The program is started by typing HABITAT8 at the C:\HABITAT> prompt and pressing <Enter>. Follow the menu driven instructions to access the appropriate program.

The program creates new dBASE-type database files to contain the fishery habitat inventory or the large woody debris data, and stores the files in the program directory, although they may also be directed for storage on floppy disks. In order to edit, analyze, or print existing database files, the files must first reside in the program directory (C:\HABITAT) so the program to find them.

Main menu. Selections are made by using the arrow keys to move the highlighted selection bar and then pressing <Enter>.

1. Habitat Typing Program

Create a New Database. This option allows for the creation of a new database. Enter a one to eight character name for the new file with no extension. New database files will be created in the dBASE IV format and located in the current directory. In order to use an existing database file, it must be located in the same directory as the program and it must match the dBASE IV structure created by this program.

Use an Existing Database. This option presents a list of existing database files in the current directory. Choose one by highlighting it, but make sure it is a file of the appropriate structure. Do not use LWD.DBF or NODELETE.DBF.

Exit Program. This selection is the only exit from the program.

Action menu. This menu offers different actions that may be taken with the selected database.

Add. This option allows for adding additional records. The entry screen follows the format of the Habitat Inventory Data Form data sheets present in Part III of the manual. Follow the on-screen instructions for navigating through the screens. Many of the specific data entry lines have error checking routines that limit the range as type of data that may be entered. Pressing <F10> will allow access to dBASE pull-down menus, at the top of the screen. Hold down the <Ctrl> key and press the <End> key to exit when finished entering data.

Edit. This option allows reviewing and editing any records or data in the currently selected database. The default screen shows one record at a time, but you may toggle between this screen and a multiple record or BROWSE screen by pressing <F2>. Press <F10> to access the dBASE pull down menus at the top of the screen and <Ctrl><End> to exit.

Print. This option allows selection of nine different tables of summarized data for printing on HP Laserjet compatible printers.

View. Allows selection of 10 different screen views of summarized data from the currently selected database.

Export. Allows selection of data summaries to be converted to Lotus spreadsheet formats and copied to the hard disk or floppy disks.

File. Allows copying your currently selected database to a floppy disk or deletion of selected database files from the hard disk. **DO NOT DELETE FILES NAMED NODELETE.DBF OR LWD.DBF**

Return to Main Menu. This option allows returning to the main menu to select a different database for action.

Documentation for Geographic Information Systems Analysis

The Inland Fisheries Division of the Department of Fish and Game has developed a data model and Geographic Information System (GIS) interface for viewing, querying and displaying the HABITAT data. The Department of Fish and Game has used software licensed by Environmental Systems Research Institute8 (ESRI). This software has specific hardware requirements. It is beyond the scope of this manual to discuss GIS, the complexity of ESRI software, or the hardware requirements of the software. However, we would like to provide a brief outline for how GIS analysis of the HABITAT data can be developed. A data model was developed in ESRI=s Arc/Info8 software (see http://www.esri.com). The interface was developed in ESRI=s ArcView8 software. This section describes the ArcView interface and functionality. More information on the data model is available on the Internet at:

http://www.esri.com/base/common/userconf/proc96/TO250/PAP218/p218.htm

Byrne, Michael. 1996. California Salmonid Stream Habitat Inventory: A Dynamic Segmentation Application. Proceedings from the 1996 Arc/Info Users Conference.

For more information on Geographic Information Systems in general refer to:

Environmental Systems Research Institute. 1992. Understanding GIS The Arc/Info Method. ESRI. Redlands CA;

or

Environmental Systems Research Institute. 1996. ArcView GIS the Geographic Information System for Everyone. ESRI. Redlands CA.

Documentation For ArcView Habitat Inventory Project

An extension has been created in ESRI=s ArcView 3.0 8 software for spacial analysis of stream habitat inventory databases created.with the HABITAT program. Before these databases can be used, they need.to be converted using the dynamic segmentation process and saved as ArcView8 shape files (see above data model reference for this process). For more accuracy, these files should be calibrated in Arc/Info8 to correct for stream length discrepancies. No other files are required, however, other GIS coverages are often useful and can be added to the views if needed.

The ArcView8 extension, habitat.avx, can be acquired from the Inland Fisheries Division anonymous ftp site. The site is located at maphost.dfg.ca.gov/pub/outgoing/ifd. This file must be placed in the extension directory located with the ArcView8 software. This is usually c:\esri\av_gis30\arcview\ext32\, but might be different depending on where ArcView8 was loaded. To use the extension, open ArcView and go to the file menu. Choose the Extension option, and HABITAT Extension should appear among the available choices. Check the box for this option.

Now notice a new menu on the Project Menu Bar. The new menu is Stream Views and has the following options:

Stream Views
Rearing Habitat
Riparian Veg./Bank Comp.
Spawning Habitat
Miscellaneous
All Of The Above
Switch to Combining Views (or Switch to Separating Views)
Options

Choosing "Rearing Habitat" will create a view for the stream of your choice containing themes that portray the rearing habitat. Before the view is created, it is necessary to choose a dynamically segmented stream shape file. It is possible to choose more than one stream at a time by holding down the <SHIFT> key. The next two menu choices do the same for riparian vegetation/bank composition and spawning habitat. "Miscellaneous" creates themes not belonging in any of the other views. "All Of The Above" creates all four views for the stream(s) of your choice.

When multiple streams are chosen (by holding down the <SHIFT> key), the project allows these stream views to be combined into one view, or made into separate views for each stream. The last choice in the menu simply changes between "Switch to Combining Views" and "Switch to Separating Views" when it is chosen. Combining streams into one view is a useful way to create a single view for an entire watershed.

The base project contains a view named "*** Included Themes - Don't Delete ***", with no themes in it. This view needs to stay in the project for the project to function properly. It can be left empty or filled with themes that automatically will be included in the views created from the "Stream Views" menu. This is a useful way to include streams, roads, vegetation, cities, fish restoration sites, or other pertinent coverages to each view. To create a custom habitat inventory project, save it under a different name with themes added to this view. However, none of the automated views should be in the project when it is saved.

The "Options" menu item allows the user to specify which themes, based on the habitat inventory, are created in the various views. A list of themes is presented with an "X" marking the themes that will be created. Select one or more from the list to toggle the theme(s) on/off. Any new views created will only include the themes that are marked with an "X". The default setting is all themes turned on. However, any changes made will be saved automatically for subsequent sessions.

It is not recommended to save the project after the automated views are created. In most situations, the time required to create new views, is only slightly greater than the time required to open a project in which the automated views were saved. This is because most of the time goes toward querying the database, which needs to be done regardless. However, if subsequent additions or modifications were made to the automated views, it would be necessary to save these changes if needed in the future. In this case, save the project under a different name (e.g. "Mill.apr").

Problems and Potential Problems:

There is a limit as to how many views a project can hold. Depending on computer memory and speed, there may be a long wait or inadequate memory to create views for many streams at once. A little experimentation and caution is advised before choosing many streams simultaneously.

For many of the themes, habitat inventories conducted with the 10% sample protocol display as less complete than those conducted with 100% methodology. If this is not recognized, it could lead to misleading information.

Because the habitat units are small in relation to the stream as a whole, it is often necessary to zoom in to see the individual habitat units. However, zooming in often results in only part of the stream being displayed on the monitor, making it difficult to do spacial analysis for the entire stream.

Often, only one theme can be turned on at a time because the various themes display the same stream line in different ways. However, other streams combined in the same view or included with themes such as roads, boundaries, etc. can be displayed simultaneously.

Some themes created have an empty table and display nothing when turned on. This was left as is for the information it contains. For example an empty "Backwater Pools" theme indicates no backwater pools in the stream or an empty "LGR W/ Gravel/Small Cobble" theme indicates little or no spawning habitat.

Fish Habitat Inventory Database

When a new database is created using the HABITAT program, the following database structure is created (see Part III).

Field	Field Name	Type	Width	Field Description
1	STREAM	Character	25	Stream name
2	LEGAL	Character	11	Legal description using township, range, section
3	LATD	Numeric	2	Latitude in degrees at stream mouth
4	LATM	Numeric	2	Latitude in minutes
5	LATS	Numeric	4	Latitude in seconds
6	LOND	Numeric	3	Longitude in degrees at stream mouth
7	LONM	Numeric	2	Longitude in minutes
8	LONS	Numeric	4	Longitude in seconds
9	QUAD	Character	10	7.5 minute USGS quadrangle name
10	RF3RCHID	Character	17	EPA reach file number
11	PNAME	Character	30	EPA stream name
12	PNMCD	Character	11	EPA stream name unique code at mouth
13	SURVEYORS	Character	25	Names of data collection team
14	DLAT	Numeric	8	Decimal degrees latitude at stream mouth
15	DLONG	Numeric	8	Decimal degrees longitude at stream mouth

Field	Field Name	Type	Width	Field Description
16	FLOW	Character	6	Stream flow in cfs
17	DATE	Date	8	Sample date in day/month/year
18	CHANNLTYPE	Character	4	Channel type, Rosgen system
19	REACH	Character	2	Stream reach number, starting at mouth
20	TIME	Character	5	Time of sample collection start
21	WATER	Character	3	Water temperature in degrees Fahrenheit
22	AIR	Character	3	Air temperature in degrees Fahrenheit
23	HABUNITNUM	Character	16	Habitat unit no. starting at stream mouth
24	HABTYPE	Character	9	Habitat type as defined in manual
25	SIDECHANNL	Character	3	Side channel habitat type
26	MEANLENGTH	Numeric	8	Length (ft) of each habitat type
27	STRM_LGNTH	Numeric	7	Total stream length (ft) from mouth
28	MEAN_WIDTH	Numeric	6	Mean width (ft) of each habitat unit
29	MEAN_DEPTH	Numeric	5	Mean depth (ft) for each habitat unit
30	MAX_DEPTH	Numeric	5	Maximum depth (ft) for each habitat unit
31	AREA	Numeric	10	Area (sq-ft) for each habitat unit
32	DPTPLCREST	Numeric	4	Depth of pool tail crest (ft), pools only
33	RESPOLDPTH	Numeric	5	Residual pool depth (ft), pools only
34	VOLUME	Numeric	10	Water volume (cu-ft) for every unit
35	RESPOOLVOL	Numeric	10	Residual pool volume (cu-ft)
36	EMBEDDED	Numeric	1	Measure cobble embeddedness 1-4
37	SHEL_VALUE	Numeric	1	Estimated shelter value per manual
38	PCT_COVER	Numeric	3	% of unit providing fish cover
39	SHELT_RATN	Numeric	3	Shelter value x % fish cover
40	UNDER_BANK	Numeric	3	% cover provided by undercut banks
41	PER_SWD	Numeric	3	% cover provided by small woody debris
42	PER_LWD	Numeric	3	% cover provided by large woody debris
43	PER_ROOT	Numeric	3	% cover provided by root masses
44	TERR_VEG	Numeric	3	% cover provided by terrestrial vegetation
45	AQUA_VEG	Numeric	3	% cover provided by aquatic vegetation
46	WHITEWATER	Numeric	3	% cover provided by white water
47	PER_BOLDER	Numeric	3	% cover provided by boulders
48	BEDROCKLED	Numeric	3	Dominate substrate bedrock
49	SILT_CLAY	Numeric	1	Dominate substrate silt-clay
50	SAND	Numeric	1	Dominate substrate sand
51	GRAVEL	Numeric	1	Dominate substrate gravel
52	SMCOBBLE	Numeric	1	Dominate substrate small cobble
53	LGCOBBLE	Numeric	1	Dominate substrate large cobble
54	BOLDER	Numeric	1	Dominate substrate boulder
55	BEDROCK	Numeric	1	Dominate substrate bedrock
56	PCT_EXPOSE	Numeric	3	% exposed substrate in unit
57	PCT_CANOPY	Numeric	3	% vegetation canopy
58	PCT_DECID	Numeric	3	% deciduous canopy

Field	Field Name	Type	Width	Field Description
59	PCT_CONIF	Numeric	3	% coniferous canopy
60	RTBKCOMP	Numeric	1	Composition of right bank
61	RTBKDOMINT	Numeric	1	Dominant vegetation on right bank
62	PCT_RTBKCO	Numeric	3	% right bank vegetative cover
63	LFBKCOMP	Numeric	1	Composition of left bank
64	LFBKDOMINT	Numeric	1	Dominant vegetation on left bank
65	PCT_LFBKCO	Numeric	3	% left bank vegetative cover
66	CODE	Character	1	Field reserved for GIS reference
67	MEMO	Memo	10	Notes on stream and channel problems

2. Large Woody Debris Program

The LWD program creates one record within the database for each stream sample section or for each page of the LWD Survey Form. The entire LWD survey is contained within a single dBASE file.

Enter Data from LWD Survey Form. This option prompts the user for the year of survey and a four digit file name that identifies the stream surveyed. The program assigns the first four digits of the file name beginning with "LW" + year (e.g. LW97MILL.DBF). The first data entry screen prompts the user to enter stream background information. The remaining screens prompt for data entry. Data entry screens are organized to correspond with the LWD survey form format for ease of data entry.

Edit Records in Database. On selection of this option the user is prompted to select a stream for data editing from the drop down list. Be certain that the file name selected begins with "LW + year". Before editing, check that the stream name and PNMCD correspond with the correct data sheet. Use caution when editing, the program allows the user to directly access the database.

Select a Stream for Summary Report. This option allows the user to select a stream for a printed summary of each sample section. On selection of this option, the user is first prompted to identify the type of printer in use. The next screen prompts for the name of the stream for summary data. Since many streams have the same name, and several sample sections and reaches usually exist within each stream, the user is prompted to select the appropriate stream and sample section from the list presented. The user has a choice of printing one or both of the summary tables for the selected stream reach.

Exit Program. The only exit from the program is through this selection.

Large Woody Debris Stream and Riparian Survey Database

The following database was developed to store data developed when conducting a large woody debris stream and riparian survey as explained in Part 3 of this manual. The database structure has been standardized to facilitate data incorporation into the DFG statewide fishery GIS. To insure compatibility with the GIS, modifications to the structure should only be made by adding fields to the end of the database.

Field	Field Name	Type	Width	Field Description
1	STREAM	Character	20	Name of stream
2	SAMPLE	Character	2	Number of sample section in reach
3	REACH	Character	2	Number of reach
4	BASIN	Character	15	River basin or drainage system
5	DATE	Date	8	Date of survey
6	SMPLFEET	Numeric	3	Length of sample section in feet
7	TWNSHP	Character	3	Township at mouth
8	RANGE	Character	3	Range at mouth
9	SECTION	Character	2	Section number at number
10	START	Numeric	5	Feet from landmark at reach start
11	STOP	Numeric	5	Feet from landmark at reach end
12	LENGTH	Numeric	5	Total length of reach
13	QUAD	Character	15	Name of USGS 7.5 minute quad
14	LAT_D	Character	2	Degrees of latitude
15	LAT_M	Character	2	Minutes of latitude
16	LAT_S	Character	3	Seconds of latitude
17	LON_D	Character	3	Degrees of longitude
18	LON_M	Character	2	Minutes of longitude
19	LON_S	Character	4	Seconds of longitude
20	GRDIENT	Numeric	3	Water slope in percent
21	CHNTYPE	Character	2	Channel type
22	FLOW	Numeric	5	Stream flow in cfs
23	SID	Numeric	3	Obsolete field, no longer used
24	LANDMARK	Character	20	Permanent landmark or reference
25	A_TEMP	Character	3	Air temperature
26	W_TEMP	Character	3	Water temperature
27	MWETW	Numeric	2	Mean wetted stream width
28	MBFW	Numeric	2	Mean bankfull width
29	MBFD	Numeric	4	Mean bankfull depth
30	MFPW	Numeric	3	Mean flood prone area width
31	SINU	Character	3	Sinuousity ratio
32	SUBST_1_3	Character	3	% substrate with boulders 1-3 feet
33	SUBST_G3	Character	3	% substrate with boulders > 3 feet
34	RBSLOPE	Character	3	Right bank slope in percent
35	RBVEG	Character	3	Dominate vegetation on right bank

Field	Field Name	Type	Width	Field Description
36	STRMVEG	Character	3	Dominate vegetation in stream
37	LBSLOPE	Character	3	Left bank slope in percent
38	LBVEG	Character	3	Dominate vegetation on left bank
39	RBDD1L20	Numeric	2	Rt bank dead/down 1-2'dia. <20'long
40	RBDS1L20	Numeric	2	Rt bk dead/standing 1-2'dia. <20'long
41	RBPER1L20	Numeric	2	Rt bank perched 1-2'dia. <20'long
42	RBRWDD1	Numeric	2	Rt bank root wad dead/down 1-2'dia.
43	RBRWDS1	Numeric	2	Rt bank root wad dead/standing 1-2'dia.
44	RBRWPR1	Numeric	2	Rt bank root wad perched 1-2'dia.
45	STRMDD1L20	Numeric	2	Stream dead/down 1-2'dia. <20'long
46	STRMDS1L20	Numeric	2	Stream dead/standing 1-2'dia. <20'long
47	STMPER1L20	Numeric	2	Not used; no instream “perched” LWD
48	STRWDD1	Numeric	2	Stream root wad dead/down 1-2'dia.
49	STRWDS1	Numeric	2	Stream root wad dead/standing 1-2'dia.
50	LBDD1L20	Numeric	2	Lt bank dead/down 1-2'dia. <20'long
51	LBDS1L20	Numeric	2	Lt bk dead/standing 1-2'dia. <20'long
52	LBPER1L20	Numeric	2	Lt bank perched 1-2'dia. <20'long
53	LBRWDD1	Numeric	2	Lt bank root wad dead/down 1-2' dia.
54	LBRWDS1	Numeric	2	Lt bank root wad dead/standing 1-2'dia.
55	LBRWPR1	Numeric	2	Lt bank root wad perched 1-2' dia.
56	RBDD1G20	Numeric	2	Rt bank dead/down 1-2'dia. >20'long
57	RBDS1G20	Numeric	2	Rt bk dead/standing 1-2'dia. >20'long
58	RBPER1G20	Numeric	2	Rt bank perched 1-2'dia. >20'long
59	RBLVC1G20	Numeric	2	Rt bank live conifer 1-2'dia. >20'long
60	RBLVD1G20	Numeric	3	Rt bank live deciduous 1-2'dia. >20'long
61	STRMDD1G20	Numeric	2	Stream dead/down 1-2'dia. >20'long
62	STRMDS1G20	Numeric	2	Stream dead/standing 1-2'dia. >20'long
63	STMPER1G20	Numeric	2	Not used; no instream “perched” LWD
64	STMLVC1G20	Numeric	2	Stream live conifer 1-2dia.>20'long
65	STMLVD1G20	Numeric	2	Stream live deciduous 1-2dia.>20'long
66	LBDD1G20	Numeric	2	Lt bank dead/down 1-2dia.>20'long
67	LBDS1G20	Numeric	2	Lt bank dead/standing 1-2dia.>20'long
68	LBPER1G20	Numeric	2	Lt bk perched 1-2dia.>20'long
69	LBLVC1G20	Numeric	3	Lt bank live conifer 1-2dia.>20'long
70	LBLVD1G20	Numeric	3	Lt bank live deciduous 1-2dia.>20'long
71	RBDD2L20	Numeric	2	Rt bank dead/down 2-3dia. <20'long
72	RBDS2L20	Numeric	2	Rt bk dead/standing 2-3dia.<20'long
73	RBPER2L20	Numeric	2	Rt bank perched 2-3dia. <20'long
74	RBRWDD2	Numeric	2	Rt bank root wad dead/down 2-3' dia
75	RBRWDS2	Numeric	2	Rt bank root wad dead/standing 2-3'dia.
76	RBRWPR2	Numeric	2	Rt bank root wad perched 2-3' dia
77	STRMDD2L20	Numeric	2	Stream dead/down 2-3dia. <20'long
78	STRMDS2L20	Numeric	2	Stream dead/standing 2-3dia.<20'long

Field	Field Name	Type	Width	Field Description
79	STMPER2L20	Numeric	2	Not used; no instream “perched” LWD
80	STRWDD2	Numeric	2	Stream root wad dead/down 2-3' dia
81	STRWDS2	Numeric	2	Stream root wad dead/standing 2-3'dia
82	LBDD2L20	Numeric	2	Lt bank dead/down 2-3dia. <20'long
83	LBDS2L20	Numeric	2	Lt bk dead/standing 2-3dia.<20'long
84	LBPER2L20	Numeric	2	Lt bank perched 2-3dia. <20'long
85	LBRWDD2	Numeric	2	Lt bank root wad dead/down 2-3' dia.
86	LBRWDS2	Numeric	2	Lt bank root wad dead/standing 2-3'dia.
87	LBRWPR2	Numeric	2	Lt bank root wad perched 2-3' dia
88	RBDD2G20	Numeric	2	Rt bank dead/down 2-3dia. >20'long
89	RBDS2G20	Numeric	2	Rt bk dead/standing 2-3dia.>20'long
90	RBPER2G20	Numeric	2	Rt bank perched 2-3dia. >20'long
91	RBLVC2G20	Numeric	3	Rt bank live conifer 2-3dia.>20'long
92	RBLVD2G20	Numeric	3	Rt bank live deciduous 2-3dia.>20'long
93	STRMDD2G20	Numeric	2	Stream dead/down 2-3dia. >20'long
94	STRMDS2G20	Numeric	2	Stream dead/standing 2-3dia.>20'long
95	STMPER2G20	Numeric	2	Not used; no instream “perched” LWD
96	STMLVC2G20	Numeric	2	Stream live conifer 2-3dia.>20'long
97	STMLVD2G20	Numeric	2	Stream live deciduous 2-3dia.>20'l
98	LBDD2G20	Numeric	2	Lt bank dead/down 2-3dia.>20'long
99	LBDS2G20	Numeric	2	Lt bank dead/standing 2-3dia.>20'long
100	LBPER2G20	Numeric	2	Lt bk perched 2-3dia.>20'long
101	LBLVC2G20	Numeric	3	Lt bank live conifer 2-3dia.>20'long
102	LBLVD2G20	Numeric	2	Lt bank live deciduous 2-3dia.>20'long
103	RBDD3L20	Numeric	2	Rt bank dead/down 3-4dia. <20'long
104	RBDS3L20	Numeric	2	Rt bk dead/standing 3-4dia.<20'long
105	RBPER3L20	Numeric	2	Rt bank perched 3-4dia. <20'long
106	RBRWDD3	Numeric	2	Rt bank root wad dead/down 3-4'dia.
107	RBRWDS3	Numeric	2	Rt bank root wad dead/standing 3-4'd
108	RBRWPR3	Numeric	2	Rt bank root wad perched 3-4'dia.
109	STRMDD3L20	Numeric	2	Stream dead/down 3-4dia. <20'long
110	STRMDS3L20	Numeric	2	Stream dead/standing 3-4dia.<20'long
111	STMPER3L20	Numeric	2	Not used; no instream “perched” LWD
112	STRWDD3	Numeric	2	Stream root wad dead/down 3-4'dia.
113	STRWDS3	Numeric	2	Stream root wad dead/standing 3-4'dia.
114	LBDD3L20	Numeric	2	Lt bank dead/down 3-4dia. <20'long
115	LBDS3L20	Numeric	2	Lt bk dead/standing 3-4dia.<20'long
116	LBPER3L20	Numeric	2	Lt bank perched 3-4dia. <20'long
117	LBRWDD3	Numeric	2	Lt bank root wad dead/down 3-4'dia
118	LBRWDS3	Numeric	2	Lt bank root wad dead/standing 3-4'dia.
119	LBRWPR3	Numeric	2	Lt bank root wad perched 3-4'dia
120	RBDD3G20	Numeric	2	Rt bank dead/down 3-4dia. >20'long
121	RBDS3G20	Numeric	2	Rt bk dead/standing 3-4dia.>20'long

Field	Field Name	Type	Width	Field Description
122	RBPER3G20	Numeric	2	Rt bank perched 3-4dia. >20'long
123	RBLVC3G20	Numeric	2	Rt bank live conifer 3-4dia.>20'long
124	RBLVD3G20	Numeric	2	Rt bank live deciduous 3-4'd>20'long
125	STRMDD3G20	Numeric	2	Stream dead/down 3-4dia. >20'long
126	STRMDS3G20	Numeric	2	Stream dead/standing 3-4dia.>20'long
127	STMPER3G20	Numeric	2	Not used; no instream “perched” LWD
128	STMLVC3G20	Numeric	2	Stream live conifer 3-4dia.>20'long
129	STMLVD3G20	Numeric	2	Stream live deciduous 3-4dia.>20'long
130	LBDD3G20	Numeric	2	Lt bank dead/down 3-4dia.>20'long
131	LBDS3G20	Numeric	2	Lt bank dead/standing 3-4dia.>20'long
132	LBPER3G20	Numeric	2	Lt bk perched 3-4dia.>20'long
133	LBLVC3G20	Numeric	3	Lt bank live conifer 3-4dia.>20'long
134	LBLVD3G20	Numeric	3	Lt bank live deciduous 3-4dia.>20'long
135	RBDD4L20	Numeric	2	Rt bank dead/down > 4dia. <20'long
136	RBDS4L20	Numeric	2	Rt bk dead/standing > 4dia.<20'long
137	RBPER4L20	Numeric	2	Rt bank perched > 4dia. <20'long
138	RBRWDD4	Numeric	2	Rt bank root wad dead/down >4'dia
139	RBRWDS4	Numeric	2	Rt bank root wad dead/standing >4'dia.
140	RBRWPR4	Numeric	2	Rt bank root wad perched >4'dia
141	STRMDD4L20	Numeric	2	Stream dead/down >4dia. <20'long
142	STRMDS4L20	Numeric	2	Stream dead/standing >4dia.<20'long
143	STMPER4L20	Numeric	2	Not used; no instream “perched” LWD
144	STRWDD4	Numeric	2	Stream root wad dead/down >4'dia
145	STRWDS4	Numeric	2	Stream root wad dead/standing >4'dia
146	LBDD4L20	Numeric	2	Lt bank dead/down >4dia. <20'long
147	LBDS4L20	Numeric	2	Lt bk dead/standing >4dia.<20'long
148	LBPER4L20	Numeric	2	Lt bank perched >4dia. <20'long
149	LBRWDD4	Numeric	2	Lt bank root wad dead/down >4'dia
150	LBRWDS4	Numeric	2	Lt bank root wad dead/standing >4'd
151	LBRWPR4	Numeric	2	Lt bank root wad perched >4'dia
152	RBDD4G20	Numeric	2	Rt bank dead/down >4dia. >20'long
153	RBDS4G20	Numeric	2	Rt bk dead/standing >4dia.>20'long
154	RBPER4G20	Numeric	2	Rt bank perched >4dia. >20'long
155	RBLVC4G20	Numeric	2	Rt bank live conifer >4dia.>20'len
156	RBLVD4G20	Numeric	2	Rt bank live deciduous >4dia.>20'l
157	STRMDD4G20	Numeric	2	Stream dead/down >4dia. >20'long
158	STRMDS4G20	Numeric	2	Stream dead/standing >4dia.>20'long
159	STMPER4G20	Numeric	2	Not used; no instream “perched” LWD
160	STMLVC4G20	Numeric	2	Stream live conifer >4dia.>20'l
161	STMLVD4G20	Numeric	2	Stream live deciduous >4dia.>20'l
162	LBDD4G20	Numeric	2	Lt bank dead/down >4dia.>20'long
163	LBDS4G20	Numeric	2	Lt bank dead/standing >4dia.>20'long
164	LBPER4G20	Numeric	2	Lt bk perched >4dia.>20'long

Field	Field Name	Type	Width	Field Description
165	LBLVC4G20	Numeric	2	Lt bank live conifer >4dia.>20'long
166	LBLVD4G20	Numeric	2	Lt bank live deciduous >4dia.>20'long
167	COMMENT	Memo	10	Comments or remarks

Biological Survey Database

The following database was developed to store species occurrence data collected during stream surveys. The database structure was standardized by a technical committee of fishery scientists representing government, industry and private consultants so that the results would be compatible with a statewide geographic information system (GIS). To insure compatibility with the GIS, modifications to the structure should only be made by adding fields to the end of the database.

A database file named BIOSAMPL.DBF is on the floppy disk that accompanies this manual. This is a stand-alone database and is included in the compiled HABITAT program.

Field	Field Name	Type	Width	Field Description
1	SID	Numeric	4	Obsolete field, no longer used
2	BASIN	Character	10	Name of major river basin
3	STREAM	Character	20	Stream name
4	QUAD	Character	10	7.5-minute USGS quadrangle name
5	OBSERVERS	Character	20	Observers or data collectors
6	DATE	Date	8	Sample date in day/month/year
7	LATD	Numeric	2	Latitude in degrees at stream mouth
8	LATM	Numeric	2	Latitude in minutes
9	LATS	Numeric	4	Latitude in seconds
10	LOND	Numeric	3	Longitude in degrees at stream mouth
11	LONM	Numeric	2	Longitude in minutes
12	LONS	Numeric	4	Longitude in seconds
13	UTM_REG	Numeric	2	UTM zone coordinate
14	UTM_N	Numeric	10	UTM north distance in meters
15	UTM_E	Numeric	10	UTM east distance in meters
16	SITE	Character	2	Sample site # (numbered upstream from mouth)
17	DIST	Numeric	5	Distance upstream from mouth in feet
18	TIME	Numeric	4	Time of sampling
19	AIRTEMP	Numeric	2	Air temperature F°
20	H20_TEMP	Numeric	2	Water temperature F°
21	H20_VISIBL	Numeric	2	Water visibility in feet
22	FLOW_CFS	Numeric	4	Stream flow in cubic feet per second
23	REACH	Numeric	3	Stream reach no. from habitat typing data
24	HABTYP1	Numeric	3	Primary habitat type of sample unit
25	HABTYP2	Numeric	3	Secondary habitat type of sample unit
26	HABTYP3	Numeric	3	Tertiary habitat type of sample unit

Field	Field Name	Type	Width	Field Description
27	SAMPL_DIST	Numeric	3	Sampled stream distance in ft.
28	SAMPL_AREA	Numeric	4	Surface area of sampled area sq.ft.
29	EFFORT	Numeric	4	Minutes of electrofishing, seining, etc.
30	METHOD	Character	12	Sample by SNORKEL, BANK, ELECTROFISH, or SEINE
31	TROUT_YOY	Numeric	3	Number of all trout young-of-year
32	STHD_1YR	Numeric	3	Number of 1+ steelhead
33	STHD_2YR	Numeric	3	Number of 2+ steelhead
34	COHO_YOY	Numeric	3	Number of young-of-year coho
35	COHO_1YR	Numeric	3	Number of 1+ coho
36	CHINOOK	Numeric	3	Number of chinook
37	SQUAW_YOY	Numeric	3	Number of squawfish young-of-year
38	SQUAW_1YR	Numeric	3	Number of squawfish adults
39	SUCKER	Numeric	3	Number of suckers, all species
40	ROACH	Numeric	3	Number of roach
41	DACE	Numeric	3	Number of dace
42	SCULPIN	Numeric	3	Number of sculpin
43	STICKLEBAC	Numeric	3	Number of stickleback
44	CRAYFISH	Numeric	3	Number of crayfish
45	SHRIMP	Numeric	3	No. of Syncaris pacifica Federal listed
46	LAMP_LARV	Numeric	3	Number of lamprey ammocetes
47	LAMPREY	Numeric	3	Number of lamprey adults
48	RAINBOW	Numeric	3	Number of rainbow trout
49	CCT_1YR	Numeric	3	Number of cutthroat 1yr+
50	CCT_ADULT	Numeric	3	Number of cutthroat adults
51	SALAMAND	Numeric	3	Number of salamanders of all species
52	TADPOLES	Numeric	3	Number of tadpoles of all species
53	FROGS	Numeric	3	Number of adult frogs of all species
54	WARM_H20	Character	10	Warmwater species by abbrev.
55	TISUESAMPL	Character	1	Tissue samples collected: “Y” or “N”

Examples of optional additional species fields:

Field	Field Name	Type	Width	Field Description
56	GOLDEN	Numeric	3	Number of golden trout
57	BROWNTROUT	Numeric	3	Number of brown trout
58	BROOKTROUT	Numeric	3	Number of brook trout
59	LAKETROUT	Numeric	3	Number of lake trout
60	WHITEFISH	Numeric	3	Number of whitefish
61	L_REDSIDE	Numeric	3	Number of Lahontan redsides
62	KOKANEE	Numeric	3	Number of kokanee

Watershed Overview Database

The following database was developed to store data developed when conducting a watershed overview as explained in Part II of this manual. The database structure has been standardized to facilitate data incorporation into the DFG statewide fishery GIS. To insure compatibility with the GIS, modifications to the structure should only be made by adding fields to the end of the database.

A database file named WATERSHD.DBF is on the floppy disk that accompanies this manual. This is standalone database and included in the compiled HABITAT program.

Field	Field Name	Type	Width	Field Description
1	DATE	Character	8	Data collection date
2	RESEARCHER	Character	20	Investigators names
3	STREAM	Character	20	Stream name from USGS quadrangle
4	TRIB1_TO	Character	15	Receiving stream name
5	TRIB2_TO	Character	15	Name of stream receiving “Trib 1_To”
6	TRIB3_TO	Character	15	Continue down stream-web to the ocean
7	COUNTY	Character	12	County of stream mouth location
8	QUAD	Character	15	Name of USGS quad at stream mouth
9	USGS_QUAD2	Character	15	Name of USGS quad containing stream
10	USGS_QUAD3	Character	15	Name of USGS quad containing stream
11	USGS_QUAD4	Character	15	Name of USGS quad containing stream
12	PNAME	Character	20	EPA reach file designated stream name
13	PNMCD	Character	11	EPA reach file unique code at stream mouth
14	LEGAL	Character	11	Township, Range, Section at stream mouth
15	LATD	Numeric	2	Latitude in degrees at stream mouth
16	LATM	Numeric	2	Latitude in minutes
17	LATS	Numeric	4	Latitude in seconds
18	LOND	Numeric	3	Longitude in degrees at stream mouth
19	LONM	Numeric	2	Longitude in minutes
20	LONS	Numeric	4	Longitude in seconds
21	ACCESS_VIA	Memo	10	Access description
22	HYDROUNIT	Character	8	Hydrologic unit number
23	AERIALS	Logical	1	Are aerial photos available Y or N
24	AERIAL_COM	Memo	10	Comment on aerial photos
25	PRE_SURVE	Logical	1	Previous survey information Y or N
26	SURVEYINFO	Memo	10	Location of previous survey info
27	CR_ORDER	Character	1	Stream order
28	TOT_LENGTH	Numeric	6	Total stream length in miles
29	FED_LENGTH	Numeric	6	Stream length on Federal land
30	STA_LENGTH	Numeric	6	Stream length on State land
31	PRV_LENGTH	Numeric	6	Stream length on private land
32	LENGTH_COM	Memo	10	Comment on stream length

Field	Field Name	Type	Width	Field Description
33	INVENTORY	Logical	1	Fish habitat inventory complete?
34	INVEN_DATE	Character	16	Fish habitat inventory date
35	INVEN_LGTH	Numeric	6	Fish habitat inventory length
36	END_LATD	Numeric	2	End of survey, degrees of latitude
37	END_LATM	Numeric	2	End of survey, minutes of lat.
38	END_LATS	Numeric	4	End of survey, seconds of lat.
39	END_LONGD	Numeric	3	End of survey, degrees of longitude
40	END_LONGM	Numeric	2	End of survey, minutes of long.
41	END_LONGS	Numeric	4	End of survey, seconds of long.
42	INVENT_COM	Memo	10	Comment on fish habitat inventory
43	E_O_ANADRO	Logical	1	Did survey reach end of anadromy?
44	DIST_CHIN	Numeric	5	Distance where chinook were found
45	DIST_COHO	Numeric	5	Distance where coho were found
46	DIST_SH	Numeric	5	Distance where steelhead were found
47	DIST_S_SH	Numeric	5	Distance summer steelhead were found
48	BASIN_AREA	Numeric	8	Watershed area in square miles
49	PCNT_FED	Numeric	3	% watershed in Federal ownership
50	PCNT_STA	Numeric	3	% watershed in State ownership
51	PCNT_PRV	Numeric	3	% watershed in private ownership
52	AREA_COM	Memo	10	Comment on watershed area
53	BASE_FLOW	Numeric	7	Base stream flow in cfs
54	MOUTH_ELEV	Numeric	5	Elevation of stream mouth
55	HEAD_ELEV	Numeric	5	Elevation of stream headwaters
56	LAKE_NUM	Numeric	3	Number of lakes in watershed
57	LAKE_AREA	Numeric	5	Area of all lakes in watershed
58	FISH_CHIN	Logical	1	Chinook present in watershed?
59	FISH_COHO	Logical	1	Coho present in watershed?
60	FISH_SH	Logical	1	Steelhead present in watershed?
61	FISH_SH_S	Logical	1	Summer steelhead present?
62	FISH_SQ_S	Logical	1	Squawfish present?
63	FISH_OTHER	Logical	1	Are other species present?
64	FISH_COM	Memo	10	Comments about fish community
65	ETS_SPECIE	Logical	1	Threatened & endangered spp. present?
66	ETS_COM	Memo	10	Comment about T&E species
67	ENDEM_PR	Logical	1	Are endemic fish stocks present?
68	ENDEM_COM	Memo	10	Comment on endemic fish stocks
69	MAN_CW_NAT	Logical	1	Natural stock coldwater fishery
70	MAN_CW_MIX	Logical	1	Mixed stock coldwater fishery
71	MAN_AN_NAT	Logical	1	Natural stock anadromous fishery
72	MAN_AN_MIX	Logical	1	Mixed stock anadromous fishery
73	MAN_WW	Logical	1	Warm water fishery
74	MAN_OTHER	Logical	1	Other management objectives
75	FLOW_DATA	Logical	1	Is stream flow data available?

Field	Field Name	Type	Width	Field Description
76	FLOW_COM	Memo	10	Comment on stream flow data
77	WQUAL_DATA	Logical	1	Is water quality data available?
78	WQUAL_COM	Memo	10	Comment on water quality data
79	LAND_1A	Logical	1	Land use code - paved roads
80	LAND_1B	Logical	1	Land use code - unpaved roads
81	LAND_2	Logical	1	Land use code - timber harvest
82	LAND_3A	Logical	1	Land use code - open pit mining
83	LAND_3B	Logical	1	Land use code - hard rock mining
84	LAND_3C	Logical	1	Land use code - suction dredging
85	LAND_4A	Logical	1	Land use code - grazing
86	LAND_4B	Logical	1	Land use code - cultivation
87	LAND_5A	Logical	1	Land use code - Federal wilderness
88	LAND_5B	Logical	1	Land use - State park or wilderness
89	LAND_6A	Logical	1	Land use code - large hydro project
90	LAND_6B	Logical	1	Land use code - small hydro project
91	LAND_6C1	Logical	1	Out of basin water diversion
92	LAND_6C2	Logical	1	Land use - in basin water diversion
93	LAND_7A	Logical	1	Land use code - ski areas
94	LAND_7B	Logical	1	Land use code - campgrounds
95	LAND_8	Logical	1	Land use code - dispersed recreation
96	LAND_9	Logical	1	Land use code - urbanization
97	LAND_10	Logical	1	Land use - off highway vehicle area
98	LAND_COM	Memo	10	Land use comments
99	GEN_COM	Memo	10	General comments

Carcass Survey Database

The following database was developed to store data collected during carcass surveys using the methodology explained in Part IV of this manual. The database structure has been standardized to facilitate data incorporation into the DFG statewide fishery GIS. To insure compatibility with the GIS, modifications to the structure should only be made by adding fields to the end of the database.

A database file named CARCASS.DBF is on the floppy disk that accompanies this manual. This is a stand-alone database and is included in the compiled HABITAT program.

Field	Field Name	Type	Width	Field Description
1	DATE	Date	8	Date of survey
2	BASIN	Character	15	Drainage basin name
3	COUNTY	Character	3	County at creek mouth
4	PNAME	Character	20	EPA reach file designated stream name
5	PNMCD	Character	11	EPA reach file unique code at stream mouth
6	STREAM	Character	15	Stream name on USGS quadrangle
7	LEGAL	Character	15	Township, Range, and Section at mouth
8	LATD	Numeric	2	Latitude degrees at stream mouth
9	LATM	Numeric	2	Latitude minutes at stream mouth
10	LATS	Numeric	4	Latitude seconds at stream mouth
11	LOND	Numeric	3	Longitude degrees at stream mouth
12	LONM	Numeric	2	Longitude minutes at stream mouth
13	LONS	Numeric	4	Longitude seconds at stream mouth
14	ST_LAT_D	Numeric	2	Lat. degrees at downstream start
15	ST_LAT_M	Numeric	2	Lat. minutes at downstream start
16	ST_LAT_S	Numeric	4	Lat. seconds at downstream start
17	ST_LON_D	Numeric	3	Lon. degrees at downstream start
18	ST_LON_M	Numeric	2	Lon. minutes at downstream start
19	ST_LON_S	Numeric	4	Lon. seconds at downstream start
20	END_LAT_D	Numeric	2	Lat. degrees at upstream end
21	END_LAT_M	Numeric	2	Lat. minutes at upstream end
22	END_LAT_S	Numeric	4	Lat. seconds at upstream end
23	END_LON_D	Numeric	3	Lon. degrees at upstream end
24	END_LON_M	Numeric	2	Lon. minutes at upstream end
25	END_LON_S	Numeric	4	Lon. seconds at upstream end
26	MILES	Numeric	4	Approximate miles of survey
27	NLCHIN	Numeric	3	No. of live chinook
28	NLCOHO	Numeric	3	No. of live coho
29	NLSTH	Numeric	3	No. of live steelhead
30	NLOTHER	Numeric	3	No. of live unknown species
31	NFCHINM	Numeric	3	No. of fresh male chinook carcasses
32	NFCHINF	Numeric	3	No. of fresh female chinook carcasses
33	NFCOHOM	Numeric	3	No. of fresh male coho carcasses
34	NFCOHOF	Numeric	3	No. of fresh female coho carcasses
35	NFSTH	Numeric	3	No. of fresh steelhead carcasses
36	NNFCHIN	Numeric	3	No. of non-fresh chinook carcasses
37	NNFCOHO	Numeric	3	No. of non-fresh coho carcasses
38	NNFSTH	Numeric	3	No. of non-fresh steelhead carcasses
39	NNFOTHER	Numeric	3	No. of non-fresh non-ID'ed carcasses
40	CWT_REC	Numeric	3	No. of coded-wire tag recoveries
41	REDDS	Numeric	3	Number of redds counted

Habitat Project Evaluation Survey Database

The following databases were developed to store habitat project evaluation data collected during evaluation surveys. To insure compatibility with the GIS, modifications to the structure should only be made by adding fields to the end of the database.

Database files named EVLDATA.DBF and EVALGEN.DBF are on the floppy disk that accompanies this manual.

Database File: EVALGEN.DBF General project information

Field	Field Name	Type	Width	Field Description
1	STREAM	Character	20	Name of stream
2	BASIN	Character	15	Name of drainage or system
3	PNAME	Character	20	EPA reach file designated stream name
4	PNMCD	Character	11	EPA reach file unique stream
5	EVALUATOR	Character	15	Name of evaluator
6	DATE	Date	8	Date of evaluation
7	CNTRNO	Character	7	Contract number of project
8	FY	Character	5	Fiscal year of contract
9	SOURCE	Character	10	Funding source
10	CONTACT	Character	12	DFG contact person
11	CONTRACTOR	Character	15	Project contractor
12	MULTI_LOC	Logical	1	Multiple site contract? (Y/N)
13	AMOUNT	Character	6	Dollar amount of project
14	P_OWNER	Character	15	Property owner
15	ACCESS	Character	50	Description of access to site
16	CHANNLTYPE	Character	3	Channel type(s) in project reach
17	STR_ORDER	Character	1	Stream order of project stream
18	DRAIN_AREA	Numeric	5	Drainage area in sq. mi.
19	QUAD	Character	15	Name of USGS 7.5 min. quad. map
20	LATD	Numeric	2	Degrees of latitude
21	LATM	Numeric	2	Minutes of latitude
22	LATS	Numeric	4	Seconds of latitude
23	LOND	Numeric	3	Degrees of longitude
24	LONM	Numeric	2	Minutes of longitude
25	LONS	Numeric	4	Seconds of longitude
26	P_COMPL	Character	8	Month and year project completed (mm/yy)
27	LAST_EVAL	Character	8	Month and year of last evaluation (mm/yy)
28	PREPROJ	Logical	1	Preproject data available
29	PRE_LOC	Character	20	Location of preproject data
30	ASBUILT	Logical	1	As-built plans available
31	ASBILT_LOC	Character	20	Location of as_built plans
32	NCONST	Numeric	2	Number of structures built

Field	Field Name	Type	Width	Field Description
33	NEVAL	Numeric	2	Number of structures observed
34	PAGES	Character	2	Number of evaluation pages
35	COMMENTS	Memo		Comments of project/evaluation

Database File: EVLDATA.DBF Structure or site evaluation.

Field	Field Name	Type	Width	Field Description
1	STREAM	Character	20	Name of stream
2	BASIN	Character	15	Name of drainage or basin
3	PNAME	Character	20	EPA reach file designated stream name
4	PNMCD	Character	11	EPA reach file unique code at mouth
5	DATE	Date	8	Date of evaluation
6	CNTRNO	Character	7	Contract number of project
7	FY	Character	5	Fiscal year of contract
8	RPOINT	Character	15	Reference point in stream
9	DLAT	Numeric	6	Decimal degrees latitude at mouth
10	DLONG	Numeric	7	Decimal degrees longitude at mouth
11	RPOINT_FT	Numeric	5	Feet from reference point
12	FT	Numeric	5	Stream length of habitat type(s) effected
13	CHANNLTYPE	Character	4	Channel type in project area
14	OBJECTV	Character	1	Restoration objective of structure
15	TYPE	Character	3	Type of habitat structure
16	OBJ_RATE	Character	1	Rating of objective
17	OBJ_COM	Character	150	Comments of objective rating
18	CON_RATE	Character	1	Rating of condition
19	CON_COM	Character	150	Comments of condition rating
20	PROBLEM1	Numeric	2	Structural problems
21	PROBLEM2	Numeric	2	Structural problems
22	PROBLEM3	Numeric	2	Structural problems
23	PROBLEM4	Numeric	2	Structural problems
24	PROB_COM	Character	150	Comments of structural problems
25	MAN_MOD	Logical	1	Maintenance or repair recommended
26	IMPROVE	Logical	1	Improvements to increase effectiveness
27	MOD_COM	Character	150	Comments on maintenance or improvements
28	HABTYP	Character	4	Habitat type associated with structure
29	WIDTH	Numeric	3	Bankfull stream width
30	MAXPOOL	Numeric	4	Maximum depth of pool
31	TAILCRST	Numeric	4	Depth of the pool tail crest
32	COMPLX	Numeric	1	Shelter complexity
33	COVER	Numeric	2	Percent cover
34	FISH	Character	150	Comments of fish observed
35	PHOTO	Character	1	Photo taken (Y/N)

APPENDIX J.

STREAM INVENTORY REPORT

JUGHANDLE CREEK

INTRODUCTION

A stream inventory was conducted during the fall of 1996 on Jughandle Creek. The survey began at the confluence with an intermittent left bank tributary in the center of section 5; 55 minutes walking distance downstream from the rock quarry. The inventory was conducted in two parts: habitat inventory and biological inventory. The objective of the habitat inventory was to document the habitat available to anadromous salmonids in Jughandle Creek. The objective of the biological inventory was to document the presence and distribution of juvenile salmonid species.

The objective of this report is to document the current habitat conditions, and recommend options for the potential enhancement of habitat for coho salmon and steelhead trout. Recommendations for habitat improvement activities are based upon target habitat values suitable for salmonids in California's north coast streams.

WATERSHED OVERVIEW

Jughandle Creek is a tributary to the Pacific Ocean, located in Mendocino County, California (Map 1). Jughandle Creek's legal description at the confluence with the Pacific Ocean is T18N R18W S36. Its location is 39E22'37" north latitude and 123E48'55" west longitude. Jughandle Creek is a first order stream and has approximately 4.3 miles of blue line stream according to the USGS Fort Bragg, Mathison Peak, and Mendocino 7.5 minute quadrangles. Jughandle Creek drains a watershed of approximately 3.1 square miles. Elevations range from sea level at the mouth of the creek to 800 feet in the headwater areas. Redwood forest dominates the watershed. The watershed is primarily owned by the Jackson Demonstration State Forest and is managed by the California Department of Forestry and Fire Protection for timber production. Vehicle access exists via Road 530. Foot access is available from the rock quarry at the bottom of the road.

METHODS

The habitat inventory conducted in Jughandle Creek follows the methodology presented in the *California Salmonid Stream Habitat Restoration Manual* (Flosi and Reynolds, 1991 rev. 1994). The California Conservation Corps (CCC) Technical Advisors and Watershed Stewards Project/AmeriCorps (WSP/AmeriCorps) Members that conducted the inventory were trained in standardized habitat inventory methods by the California Department of Fish and Game (DFG). This inventory was conducted by a two-person team.

SAMPLING STRATEGY

The inventory uses a method that samples approximately 10% of the habitat units within the survey reach (Hopelain, 1994). All habitat units included in the survey are classified according to habitat type and their lengths are measured. All pool units are measured for maximum depth. Habitat unit types encountered for the first time are further measured for all the parameters and characteristics on the field form. Additionally, from the ten habitat units on each field form page, one is randomly selected for complete measurement.

HABITAT INVENTORY COMPONENTS

A standardized habitat inventory form has been developed for use in California stream surveys and can be found in the *California Salmonid Stream Habitat Restoration Manual*. This form was used in Jughandle Creek to record measurements and observations. There are nine components to the inventory form.

1. Flow:

Flow is measured in cubic feet per second (cfs) at the bottom of the stream survey reach using standard flow measuring equipment, if available. In some cases flows are estimated.

2. Channel Type:

Channel typing is conducted according to the classification system developed and revised by David Rosgen (1985 rev. 1994). This methodology is described in the *California Salmonid Stream Habitat Restoration Manual*. Channel typing is conducted simultaneously with habitat typing and follows a standard form to record measurements and observations. There are five measured parameters used to determine channel type: 1) water slope gradient, 2) entrenchment, 3) width/depth ratio, 4) substrate composition, and 5) sinuosity.

3. Temperatures:

Both water and air temperatures are measured and recorded at every tenth habitat unit. The time of the measurement is also recorded. Both temperatures are taken in degrees Fahrenheit at the middle of the habitat unit and within one foot of the water surface.

4. Habitat Type:

Habitat typing uses the 24 habitat classification types defined by McCain and others (1988). Habitat units are numbered sequentially and assigned a type identification number selected from a standard list of 24 habitat types. Dewatered units are labeled "dry". Jughandle Creek habitat typing used standard basin level measurement criteria. These parameters require that the minimum length of a described habitat unit must be equal to or greater than the stream's mean wetted width. Channel dimensions were measured using hip chains, tape measures, and stadia rods. All units were measured for mean length; additionally, the first occurrence of each unit type and a randomly selected 10% subset of all units were sampled for all features on the sampling form (Hopelain,

1995). Pool tail crest depth at each pool unit was measured in the thalweg. All measurements were in feet to the nearest tenth.

5. Embeddedness:

The depth of embeddedness of the cobbles in pool tail-out reaches is measured by the percent of the cobble that is surrounded or buried by fine sediment. In Jughandle Creek, embeddedness was ocularly estimated. The values were recorded using the following ranges: 0 - 25% (value 1), 26 - 50% (value 2), 51 - 75% (value 3) and 76 - 100% (value 4). Additionally, a value of 5 was assigned to tail-outs deemed unsuited for spawning due to inappropriate substrate particle size, having a bedrock tail-out, or other considerations.

6. Shelter Rating:

Instream shelter is composed of those elements within a stream channel that provide salmonids protection from predation, reduce water velocities so fish can rest and conserve energy, and allow separation of territorial units to reduce density related competition. The shelter rating is calculated for each fully-described habitat unit by multiplying shelter value and percent cover. Using an overhead view, a quantitative estimate of the percentage of the habitat unit covered is made. All cover is then classified according to a list of nine cover types. In Jughandle Creek, a standard qualitative shelter value of 0 (none), 1 (low), 2 (medium), or 3 (high) was assigned according to the complexity of the cover. Thus, shelter ratings can range from 0-300 and are expressed as mean values by habitat types within a stream.

7. Substrate Composition:

Substrate composition ranges from silt/clay sized particles to boulders and bedrock elements. In all fully-described habitat units, dominant and sub-dominant substrate elements were ocularly estimated using a list of seven size classes and recorded as a one and two respectively.

8. Canopy:

Stream canopy density was estimated using modified handheld spherical densiometers as described in the *California Salmonid Stream Habitat Restoration Manual*. Canopy density relates to the amount of stream shaded from the sun. In Jughandle Creek, an estimate of the percentage of the habitat unit covered by canopy was made from the end of approximately every third unit in addition to every fully-described unit, giving an approximate 30% sub-sample. In addition, the area of canopy was estimated ocularly into percentages of coniferous or deciduous trees.

9. Bank Composition and Vegetation:

Bank composition elements range from bedrock to bare soil. However, the stream banks are usually covered with grass, brush, or trees. These factors influence the ability of stream banks to withstand winter flows. In Jughandle Creek, the dominant composition type and the dominant vegetation type of both the right and left banks for each fully-described unit were selected from the habitat inventory form. Additionally, the percent of each bank covered by vegetation was estimated and recorded.

BIOLOGICAL INVENTORY

Biological sampling during stream inventory is used to determine fish species and their distribution in the stream. In Jughandle Creek fish presence was observed from the stream banks, and three sites were electrofished using one Smith-Root Model 12 electrofisher. These sampling techniques are discussed in the *California Salmonid Stream Habitat Restoration Manual*.

DATA ANALYSIS

Data from the habitat inventory form are entered into Habitat, a dBASE 4.2 data entry program developed by Tim Curtis, Inland Fisheries Division, California Department of Fish and Game. This program processes and summarizes the data, and produces the following six tables:

- Riffle, flatwater, and pool habitat types
- Habitat types and measured parameters
- Pool types
- Maximum pool depths by habitat types
- Dominant substrates by habitat types
- Mean percent shelter by habitat types

Graphics are produced from the tables using Quattro Pro. Graphics developed for Jughandle Creek include:

- Riffle, flatwater, pool habitats by percent occurrence
- Riffle, flatwater, pool habitats by total length
- Total habitat types by percent occurrence
- Pool types by percent occurrence
- Total pools by maximum depths
- Embeddedness
- Pool cover by cover type
- Dominant substrate in low gradient riffles
- Percent canopy
- Bank composition by composition type
- Bank vegetation by vegetation type

HABITAT INVENTORY RESULTS

* ALL TABLES AND GRAPHS ARE LOCATED AT THE END OF THE REPORT *

The habitat inventory of October 28, 29, and 30, 1996, was conducted by Craig Mesman (CCC) and Dionne Wrights (WSP/AmeriCorps). The total length of the stream surveyed was 8,327 feet with an additional 265 feet of side channel.

Flow was estimated to be 0.35 cfs during the survey period with a Marsh-McBirney Model 2000 flowmeter on October 30, 1996.

Jughandle Creek is an F4 channel type for 8,028 feet and an A4 channel type for 299 feet of stream reach surveyed. F4 channels are entrenched, meandering, riffle/pool channels on low gradients with high width/depth ratios and gravel-dominant substrates. A4 channel types are steep, narrow, cascading, step pool streams with high energy/debris transport associated with depositional soils and gravel-dominant substrates.

Water temperatures taken during the survey period ranged from 48 to 50 degrees Fahrenheit. Air temperatures ranged from 42 to 56 degrees Fahrenheit.

Table 1 summarizes the Level II riffle, flatwater, and pool habitat types. Based on frequency of **occurrence** there were 38% pool units, 31% riffle units, 29% flatwater units, and 2% was dry (Graph 1). Based on total **length** of Level II habitat types there were 44% flatwater units, 32% pool units, 22% riffle units, and 1% was dry (Graph 2).

Twelve Level IV habitat types were identified (Table 2). The most frequent habitat types by percent **occurrence** were low gradient riffle units, 30%; mid-channel pool units, 25%; and step run units, 17% (Graph 3). Based on percent total **length**, step run units made up 34%, mid-channel pool units 22%, and low gradient riffle units 21%.

A total of 127 pools were identified (Table 3). Main channel pools were most frequently encountered at 69% and comprised 76% of the total length of all pools (Graph 4).

Table 4 is a summary of maximum pool depths by pool habitat types. Pool quality for salmonids increases with depth. Thirty-four of one hundred and twenty-seven pools (26.8%) had a depth of two feet or greater (Graph 5).

The depth of cobble embeddedness was estimated at pool tail-outs. Of the 127 pool tail-outs measured, 6 had a value of 1 (5%); 27 had a value of 2 (21%); 29 had a value of 3 (23%); 30 had a value of 4 (24%); and 35 had a value of 5 (27%), or were not suitable for spawning (Graph 6). On this scale, a value of 1 indicates the highest quality of spawning substrate.

A shelter rating was calculated for each habitat unit and expressed as a mean value for each habitat type within the survey using a scale of 0-300. Pool habitat types had a mean shelter rating of 37, and flatwater habitats had a mean shelter rating of 32 (Table 1). Of the pool types, the backwater pools had the highest mean shelter rating at 48. Main channel pools had a mean shelter rating of 37 (Table 3).

Table 5 summarizes mean percent cover by habitat type. Small woody debris is the dominant cover type in Jughandle Creek. Boulders are the next most common cover type. Graph 7 describes the pool cover in Jughandle Creek.

Table 6 summarizes the dominant substrate by habitat type. Gravel was the dominant substrate observed in 82% of the low gradient riffles measured. Small cobble was the next most frequently observed dominant substrate type and occurred in 18% of the low gradient riffles (Graph 8).

The mean percent canopy density for the stream reach surveyed was 98%. The mean percentages of deciduous and coniferous trees were 64% and 36%, respectively. Graph 9 describes the canopy in Jughandle Creek.

For the stream reach surveyed, the mean percent right bank vegetated was 93.8%. The mean percent left bank vegetated was 93.2%. The dominant elements composing the structure of the stream banks consisted of 3.3% bedrock, 3.3% boulder, 45.6% cobble/gravel, and 45.6% sand/silt/clay (Graph 10). Brush was the dominant vegetation type observed in 53.3% of the units surveyed. Additionally, 6.5% of the units surveyed had deciduous trees as the dominant vegetation type, and 13.0% had coniferous trees as the dominant vegetation, including down trees, logs, and root wads (Graph 11).

BIOLOGICAL INVENTORY RESULTS

Three sites were electrofished on October 24, 1996, in Jughandle Creek. The sites were sampled by Craig Mesman and Dionne Wrights.

The first site sampled included habitat units 243 through 251, a step run, low gradient riffle, step run, lateral scour pool - root wad enhanced, low gradient riffle, mid-channel pool, low gradient riffle and step run, approximately 6,869 feet from the beginning of the survey and above an LDA approximately 134 feet long. The site yielded a total of 5 steelhead.

The second site included habitat units 292 through 298, a plunge pool, low gradient riffle, run, mid-channel pool, step run, low gradient riffle and plunge pool, approximately 7,866 feet from the beginning of the survey. The site yielded a total of 7 steelhead.

The third site sampled was the mid-channel pool at the end of the survey 8,327 feet from the beginning, and 275 feet above the confluence with a left bank tributary that enters Jughandle Creek at the upper end. The site yielded 1 steelhead.

DISCUSSION

Jughandle Creek is an F4 channel type for the first 8,028 feet of stream surveyed and an A4 for the remaining 299 feet. The suitability of F4 and A4 channel types for fish habitat improvement structures is as follows: F4 channels are good for bank placed boulders, single and opposing wing deflectors, channel constrictors and log cover. A4 channels are good for bank-placed boulders, fair for low stage weirs, opposing wing deflectors and log cover and poor for medium stage weirs, boulder clusters, single wing deflectors and log cover.

The water temperatures recorded on the survey days October 28 through 30, 1996, ranged from 48 to 50 degrees Fahrenheit. Air temperatures ranged from 42 to 56 degrees Fahrenheit. This is a good water temperature range for salmonids. To make any further conclusions, temperatures would need to be monitored throughout the warm summer months, and more extensive biological sampling would need to be conducted.

Flatwater habitat types comprised 44% of the total **length** of this survey, riffles 22%, and pools 32%. The pools are relatively shallow, with only 34 of the 127 (27%) pools having a maximum depth greater than 2 feet. In general, pool enhancement projects are considered when primary pools comprise less than 40% of the length of total stream habitat. In first and second order streams, a primary pool is defined to have a maximum depth of at least two feet, occupy at least half the width of the low flow channel, and be as long as the low flow channel width. Installing structures that will increase or deepen pool habitat is recommended.

Ninety-four of the 127 pool tail-outs measured had embeddedness ratings of 3, 4 or 5. Only 6 had a 1 rating. Cobble embeddedness measured to be 25% or less, a rating of 1, is considered to indicate good quality spawning substrate for salmon and steelhead. In Jughandle Creek, sediment sources should be mapped and rated according to their potential sediment yields, and control measures should be taken.

The mean shelter rating for pools was low with a rating of 37. The shelter rating in the flatwater habitats was slightly lower at 32. A pool shelter rating of approximately 100 is desirable. The relatively small amount of cover that now exists is being provided primarily by small woody debris in all habitat types. Additionally, boulders contribute a small amount. Log and root wad cover structure in the pool and flatwater habitats are needed to improve both summer and winter salmonid habitat. Log cover structure provides rearing fry with protection from predation, rest from water velocity, and also divides territorial units to reduce density related competition.

All of the low gradient riffles measured had gravel or small cobble as the dominant substrate. This is generally considered good for spawning salmonids.

The mean percent canopy density for the stream was 98%. This is a relatively high percentage of canopy. In general, revegetation projects are considered when canopy density is less than 80%.

The percentage of right and left bank covered with vegetation was high at 93.8% and 93.2%, respectively. In areas of stream bank erosion or where bank vegetation is not at acceptable levels, planting endemic species of coniferous and deciduous trees, in conjunction with bank stabilization, is recommended.

RECOMMENDATIONS

1) Jughandle Creek should be managed as an anadromous, natural production stream.

2) Increase woody cover in the pools and flatwater habitat units. Most of the existing cover is from small woody debris. Adding high quality complexity with woody cover is desirable and in some areas the material is locally available.

3) Active and potential sediment sources related to the road system need to be identified, mapped, and treated according to their potential for sediment yield to the stream and its tributaries.

4) Where feasible, design and engineer pool enhancement structures to increase the number of pools. This must be done where the banks are stable or in conjunction with stream bank armor to prevent erosion.

5) The limited water temperature data available suggest that maximum temperatures are within the acceptable range for juvenile salmonids. To establish more complete and meaningful temperature regime information, 24-hour monitoring during the July and August temperature extreme period should be performed for 3 to 5 years.

COMMENTS AND LANDMARKS

The following landmarks and possible problem sites were noted. All distances are approximate and taken from the beginning of the survey reach.

0' Begin survey at confluence with intermittent left bank tributary (center of section 5). This is a 55 minute walk downstream from the "rock pit." Channel type is an F4.

61' Flow in tributary is <0.10 cubic feet per second (cfs). Accessible to fish.

1,259' Flowing right bank tributary <0.10 cfs. Very steep and full of wood. Not accessible to anadromous fish.

1,727' Stump on right bank with a sign: "State Park Boundary."

2,256' Left bank tributary, <0.10 cfs. Small, narrow, steep. Not accessible to anadromous fish.

2,755' Log debris accumulation (LDA), 15' long x 15' wide x 4' high retains approximately 3' deep gravel. Not a barrier.

3,326' Left bank tributary at top of unit, <0.10 cfs. Small, no distinct channel. Not accessible to anadromous fish. Large ravine.

4,009' Four logs parallel to flow catching small woody debris and filling the channel. Retaining little sediment. Right bank tributary comes into top of unit. Flow is <0.10 cfs. Narrow, steep, with no distinct channel.

4,748' Garbage in the stream and on left bank.

4,855' Left bank tributary, <0.10 cfs. Flows through a rock pit. Not accessible to anadromous fish. Lined with garbage.

4,957' Garbage ends here.

5,184' Right bank tributary <0.10 cfs. Narrow with no distinct channel. Not accessible to anadromous fish.

5,533' Small woody debris (SWD) accumulation clogs channel.

5,642' Left bank tributary, <0.10 cfs. Narrow, steep, and not accessible to anadromous fish. Tributary flows through a large ravine.

5,710' Corrugated metal pipe under old road crossing, 8' wide x 8' high. Good condition.

6,025' LDA, 15' long x 25' wide x 5' high. Retaining sediment 4' high.

6,227' Three logs parallel to flow retaining gravel approximately 3' deep. Not a barrier.

6,380' Root wad retaining 4.5' of sediment.

6,443' Gradient begins increasing here.

6,692' Water percolates through woody debris and gravel. Debris retains 5' of gravel.

6,706' LDA retaining 4.5' of sediment creating a 4.5' high jump.

6,734' LDA retaining 3' of sediment and creating a 3.5 high jump.

6,784' LDA across channel. The material came from a slide and fallen trees.

6,869' First electrofishing site.

6,897' Channel back to low gradient with gravel dominant.

7,130' Right bank tributary.

7,798' LDA, 8' long x 15' wide x 4' high. Retaining sediment, may hinder passage.

7,866' Second electrofishing site.

8,052' Channel type changes to A4.

8,056' Left bank tributary, <0.10 cfs. Steep, narrow, not accessible to anadromous fish.

8,232' LDA, retaining sediment 5' deep and creating a 5' high jump.

8,327' End of Survey. Last electrofishing site and the highest fish observation. The channel above here becomes narrow and choked with vegetation. The channel is also steep (4-10%). The stream flow is also becoming intermittent.

Table J-1. Summary of riffle, flatwater, and pool habitat types.

JUGHANDLE CREEK — Drainage: PACIFIC OCEAN

Table 1 - SUMMARY OF RIFFLE, FLATWATER, AND POOL HABITAT TYPES — Survey Dates: 10/28/96 to 10/30/96

Confluence Location: QUAD: FORT BRAGG LEGAL DESCRIPTION: — LATITUDE:39°22'37" LONGITUDE:123°48'55"

HABITAT UNITS	UNITS FULLY MEASURED	HABITAT TYPE	HABITAT PERCENT OCCURRENCE	MEAN LENGTH (ft.)	TOTAL LENGTH (ft.)	PERCENT TOTAL LENGTH	MEAN WIDTH (ft.)	MEAN DEPTH (ft.)	MEAN AREA (sq.ft.)	ESTIMATED TOTAL AREA (sq.ft.)	MEAN VOLUME (cu.ft.)	ESTIMATED TOTAL VOLUME (cu.ft.)	MEAN RESIDUAL POOL VOL (cu.ft.)	MEAN SHELTER RATING
103	13	RIFFLE	31	18	1900	22	5.5	0.2	114	11762	35	3573	0	12
97	10	FLATWATER	29	39	3819	44	6.6	0.4	171	16560	61	5878	0	32
127	23	POOL	38	22	2761	32	7.7	0.8	169	21409	153	19471	118	37
5	0	DRY	2	15	74	1	0.0	0.0	0	0	0	0	0	0
1	0	CULVERT	0	38	38	0	0.0	0.0	0	0	0	0	0	0

TOTAL UNITS	TOTAL UNITS	TOTAL LENGTH (ft.)	TOTAL AREA (sq. ft.)	TOTAL VOL. (cu. ft.)
333	46	8592	49731	28921

Table J-2. Summary of habitat types and measured parameters.

JUGHANDLE CREEK — Drainage: PACIFIC OCEAN

Table 2 - SUMMARY OF HABITAT TYPES AND MEASURED PARAMETERS — Survey Dates: 10/28/96 to 10/30/96

Confluence Location: QUAD: FORT BRAGG LEGAL DESCRIPTION: — LATITUDE:39°22'37" LONGITUDE:123°48'55"

HABITAT UNITS #	UNITS FULLY MEASURED	HABITAT TYPE	HABITAT OCCURRENCE %	MEAN LENGTH ft.	TOTAL LENGTH ft.	TOTAL LENGTH %	MEAN WIDTH ft.	MEAN DEPTH ft.	MAXIMUM DEPTH ft.	MEAN AREA sq.ft.	TOTAL AREA EST. sq.ft.	MEAN VOLUME cu.ft.	TOTAL VOLUME EST. cu.ft.	MEAN RESIDUAL POOL VOL cu.ft.	MEAN SHELTER RATING	MEAN CANOPY %
100	11	LGR	30	18	1828	21	5	0.2	0.7	93	9270	21	2149	0	6	99
1	1	HGR	0	8	8	0	8	0.1	0.3	45	45	5	5	0	10	100
2	1	CAS	1	32	64	1	10	0.5	1.1	420	840	210	420	0	70	92
41	6	RUN	12	21	860	10	7	0.4	0.9	179	7357	60	2462	0	12	97
56	4	SRN	17	53	2959	34	6	0.4	0.7	158	8828	61	3440	0	63	99
3	1	TRP	1	57	170	2	6	1.0	2.6	366	1098	366	1098	183	10	100
84	12	MCP	25	23	1915	22	8	0.8	2.7	162	13645	141	11858	113	40	98
4	2	LSL	1	20	81	1	10	1.1	2.3	212	848	224	898	171	38	100
5	2	LSR	2	21	105	1	7	1.0	2.1	136	680	173	866	157	40	100
2	1	LSBk	1	26	51	1	8	0.7	1.9	224	448	157	314	134	5	100
23	3	PLP	7	14	331	4	6	0.8	2.3	91	2101	76	1746	63	35	98
6	2	BPL	2	18	108	1	8	0.7	1.9	184	1104	143	859	102	48	98
5	0	DRY	2	15	74	1	0	0.0	0.0	0	0	0	0	0	0	0
1	0	CUL	0	38	38	0	0	0.0	0.0	0	0	0	0	0	0	0

TOTAL UNITS	TOTAL UNITS	LENGTH (ft.)	AREA (sq.ft)	TOTAL VOL. (cu.ft)
333	46	8592	46264	26114

Table J-3. Summary of pool types.

JUGHANDLE CREEK — Drainage: PACIFIC OCEAN

Table 3 - SUMMARY OF POOL TYPES — Survey Dates: 10/28/96 to 10/30/96

Confluence Location: QUAD: FORT BRAGG LEGAL DESCRIPTION: — LATITUDE:39°22'37" LONGITUDE:123°48'55"

HABITAT UNITS	UNITS FULLY MEASURED	HABITAT TYPE	HABITAT PERCENT OCCURRENCE	MEAN LENGTH (ft.)	TOTAL LENGTH (ft.)	PERCENT TOTAL LENGTH	MEAN WIDTH (ft.)	MEAN DEPTH (ft.)	MEAN AREA (sq.ft.)	TOTAL AREA EST. (sq.ft.)	MEAN VOLUME (cu.ft.)	TOTAL VOLUME EST. (cu.ft.)	MEAN RESIDUAL POOL VOL. (cu.ft.)	MEAN SHELTER RATING
87	13	MAIN	69	24	2085	76	7.8	0.9	178	15495	158	13786	118	37
34	8	SCOUR	27	17	568	21	7.5	0.9	149	5075	147	5014	122	33
6	2	BACKWATER	5	18	108	4	8.0	0.7	184	1104	143	859	102	48

TOTAL UNITS	TOTAL UNITS	TOTAL LENGTH (ft.)	TOTAL AREA (sq.ft.)	TOTAL VOL. (cu.ft.)
127	23	2761	21673	19660

Table J-4. Summary of maximum pool depths by pool habitat types.

JUGHANDLE CREEK — Drainage: PACIFIC OCEAN

Table 4 - SUMMARY OF MAXIMUM POOL DEPTHS BY POOL HABITAT TYPES — Survey Dates: 10/28/96 to 10/30/96

Confluence Location: QUAD: FORT BRAGG LEGAL DESCRIPTION: — LATITUDE:39°22'37" LONGITUDE:123°48'55"

UNITS MEASURED	HABITAT TYPE	HABITAT PERCENT OCCURRENCE	<1 FOOT MAXIMUM DEPTH	<1 FOOT PERCENT OCCURRENCE	1-<2 FT. MAXIMUM DEPTH	1-<2 FOOT PERCENT OCCURRENCE	2-<3 FT. MAXIMUM DEPTH	2-<3 FOOT PERCENT OCCURRENCE	3-<4 FT. MAXIMUM DEPTH	3-<4 FOOT PERCENT OCCURRENCE	>=4 FEET MAXIMUM DEPTH	>=4 FEET PERCENT OCCURRENCE
3	TRP	2	0	0	1	33	2	67	0	0	0	0
84	MCP	66	4	5	61	73	16	19	3	4	0	0
4	LSL	3	0	0	2	50	2	50	0	0	0	0
5	LSR	4	3	60	1	20	1	20	0	0	0	0
2	LSBk	2	0	0	2	100	0	0	0	0	0	0
23	PLP	18	0	0	14	61	8	35	0	0	1	4
6	BPL	5	0	0	5	83	1	17	0	0	0	0

TOTAL UNITS
127

Table J-5. Summary of mean percent cover by habitat type.

JUGHANDLE CREEK — Drainage: PACIFIC OCEAN

Table 5 - SUMMARY OF MEAN PERCENT COVER BY HABITAT TYPE — Survey Dates: 10/28/96 to 10/30/96

Confluence Location: QUAD: FORT BRAGG LEGAL DESCRIPTION: — LATITUDE:39°22'37" LONGITUDE:123°48'55"

UNITS MEASURED	UNITS FULLY MEASURED	HABITAT TYPE	MEAN % UNDERCUT BANKS	MEAN % SWD	MEAN % LWD	MEAN % ROOT MASS	MEAN % TERR. VEGETATION	MEAN % AQUATIC VEGETATION	MEAN % WHITE WATER	MEAN % BOULDERS	MEAN % BEDROCK LEDGES
100	8	LGR	0	69	0	0	9	0	0	23	0
1	1	HGR	0	0	0	0	0	0	0	100	0
2	1	CAS	0	0	10	0	0	0	0	90	0
41	4	RUN	15	25	30	0	13	0	0	18	0
56	4	SRN	25	13	38	0	0	0	0	25	0
3	1	TRP	30	70	0	0	0	0	0	0	0
84	12	MCP	3	28	54	3	0	0	1	11	0
4	2	LSL	0	15	85	0	0	0	0	0	0
5	2	LSR	30	25	45	0	0	0	0	0	0
2	1	LSBk	0	100	0	0	0	0	0	0	0
23	3	PLP	13	0	23	17	0	0	3	43	0
6	2	BPL	25	40	35	0	0	0	0	0	0
5	0	DRY	0	0	0	0	0	0	0	0	0
1	0	CUL	0	0	0	0	0	0	0	0	0

Table J-6. Summary of dominant substrate by habitat type.

JUGHANDLE CREEK — Drainage: PACIFIC OCEAN

Table 6 - SUMMARY OF DOMINANT SUBSTRATES BY HABITAT TYPE — Survey Dates: 10/28/96 to 10/30/96

Confluence Location: QUAD: FORT BRAGG LEGAL DESCRIPTION: — LATITUDE:39°22'37" LONGITUDE:123°48'55"

TOTAL HABITAT UNITS	UNITS FULLY MEASURED	HABITAT TYPE	% TOTAL SILT/CLAY DOMINANT	% TOTAL SAND DOMINANT	% TOTAL GRAVEL DOMINANT	% TOTAL SM COBBLE DOMINANT	% TOTAL LG COBBLE DOMINANT	% TOTAL BOULDER DOMINANT	% TOTAL BEDROCK DOMINANT
100	11	LGR	0	0	82	18	0	0	0
1	1	HGR	0	0	0	100	0	0	0
2	1	CAS	0	0	0	0	0	100	0
41	5	RUN	0	20	80	0	0	0	0
56	4	SRN	0	25	75	0	0	0	0
3	1	TRP	0	0	100	0	0	0	0
84	12	MCP	25	33	42	0	0	0	0
4	2	LSL	0	50	50	0	0	0	0
5	2	LSR	0	50	50	0	0	0	0
2	1	LSBk	0	0	100	0	0	0	0
23	3	PLP	33	67	0	0	0	0	0
6	2	BPL	0	0	100	0	0	0	0
5	0	DRY	0	0	0	0	0	0	0
1	0	CUL	0	0	0	0	0	0	0

Table J-7. Fish habitat inventory data summary.

STREAM NAME: JUGHANDLE CREEK
SAMPLE DATES: 10/28/96 to 10/30/96
STREAM LENGTH: 8327 ft.
LOCATION OF STREAM MOUTH:
USGS Quad Map: FORT BRAGG — Latitude: 39°22'37"
Legal Description: — Longitude: 123°48'55"

SUMMARY OF FISH HABITAT ELEMENTS BY STREAM REACH

STREAM REACH 1

Channel Type: F4	Canopy Density: 98%
Channel Length: 8028 ft.	Coniferous Component: 38%
Riffle/flatwater Mean Width: 6 ft.	Deciduous Component: 62%
Total Pool Mean Depth: 0.8 ft.	Pools by Stream Length: 33%
Base Flow: 0.4 cfs	Pools >=3 ft.deep: 3%
Water: 048- 050°F Air: 042-056°F	Mean Pool Shelter Rtn: 38
Dom. Bank Veg.: Brush	Dom. Shelter: Large Woody Debris
Vegetative Cover: 96%	Occurrence of LOD: 36%
Dom. Bank Substrate: Cobble/Gravel	Dry Channel: 26 ft.

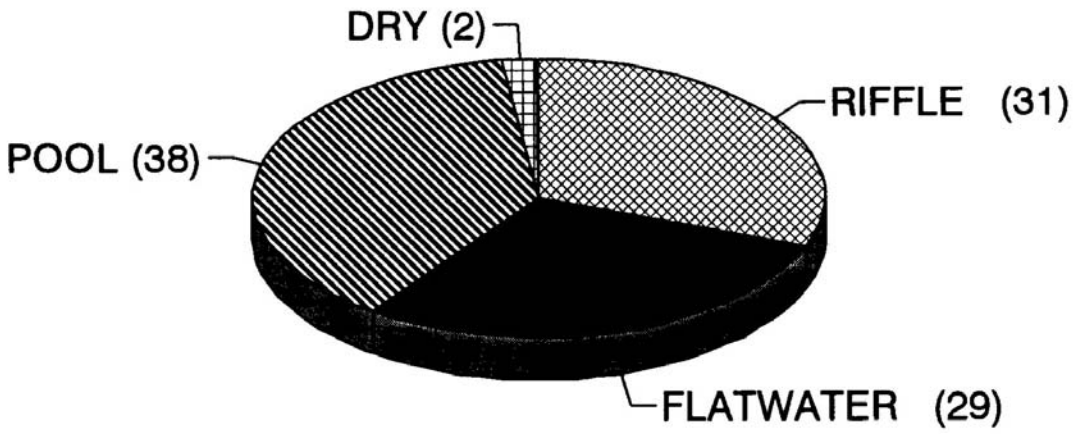
Embeddness Value: 1. 5% 2.20% 3. 23% 4. 25% 5. 27%

STREAM REACH 2

Channel Type: A4	Canopy Density: 98%
Channel Length: 299 ft.	Coniferous Component: 10%
Riffle/flatwater Mean Width: 9 ft.	Deciduous Component: 90%
Total Pool Mean Depth: 1.0 ft.	Pools by Stream Length: 24%
Base Flow: 0.4 cfs	Pools >=3 ft.deep: 0%
Water: 049- 049°F Air: 049-049°F	Mean Pool Shelter Rtn: 27
Dom. Bank Veg.: Brush	Dom. Shelter: Boulders
Vegetative Cover: 94%	Occurrence of LOD: 8%
Dom. Bank Substrate: Cobble/Gravel	Dry Channel: 48 ft.

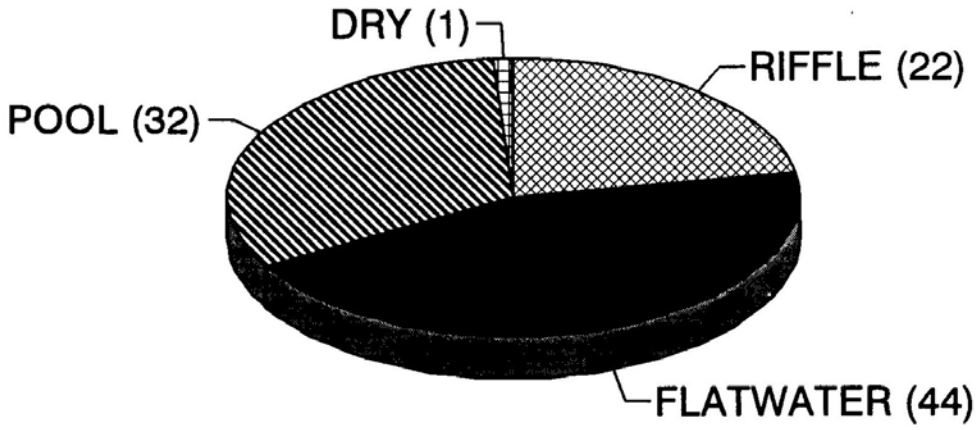
Embeddness Value: 1. 0% 2.50% 3. 17% 4. 0% 5. 33%

JUGHANDLE CREEK
HABITAT TYPES BY PERCENT OCCURRENCE

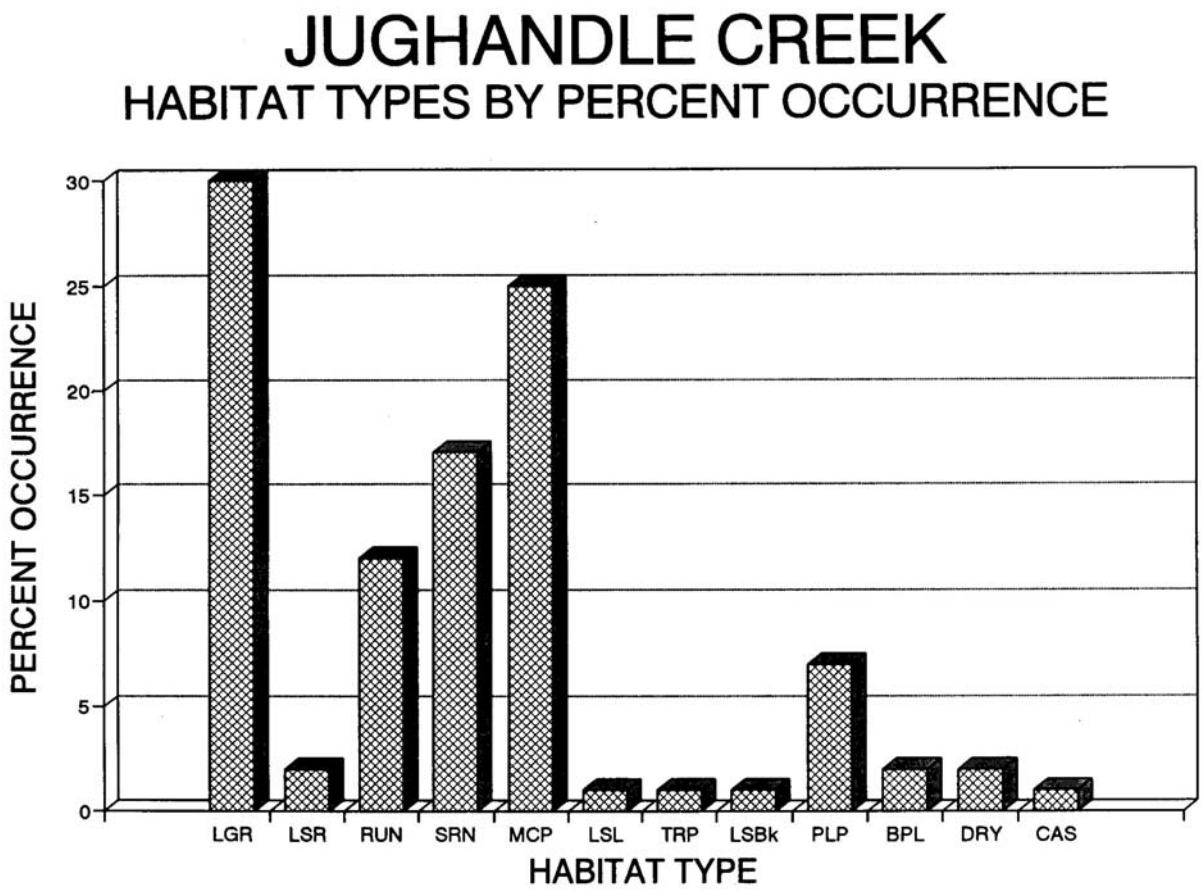


Graph J-1. Habitat types by percent occurrence.

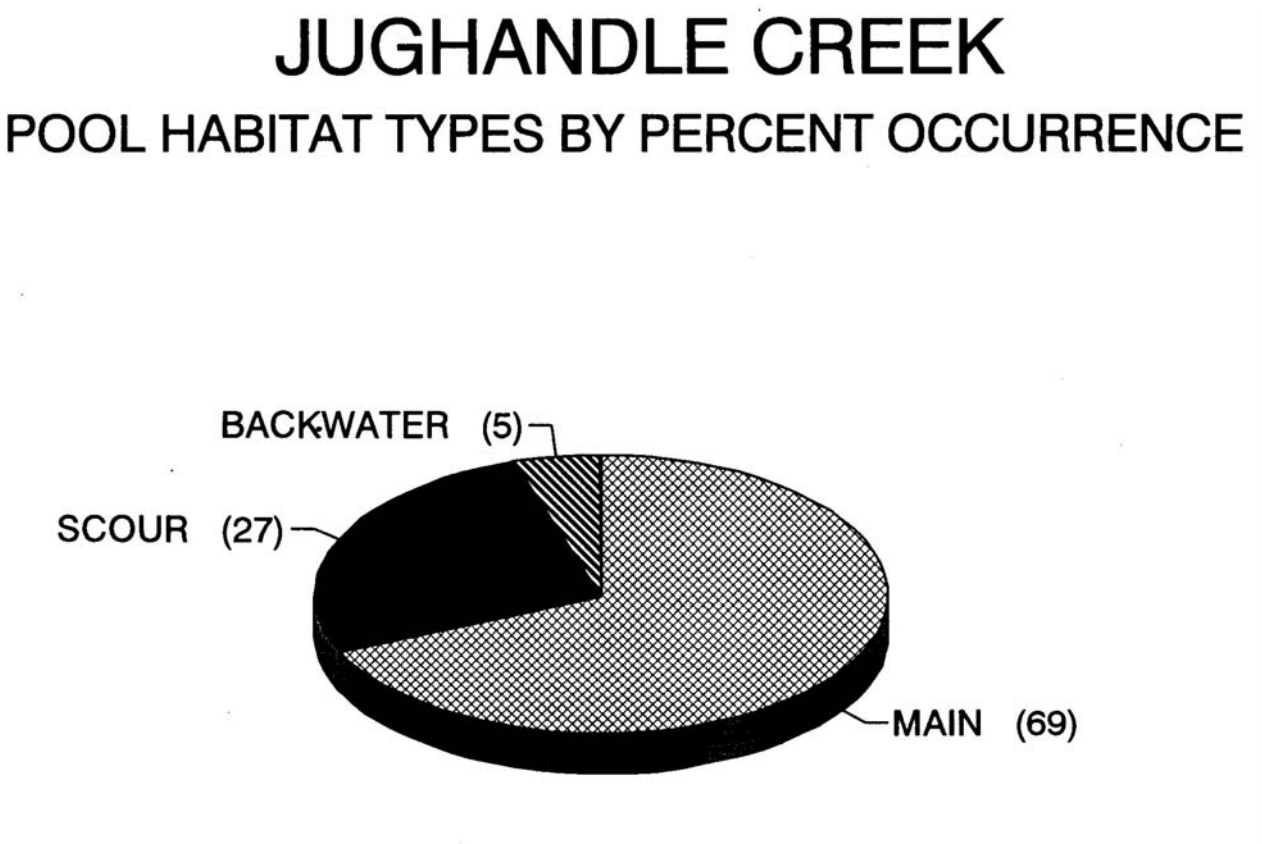
JUGHANDLE CREEK
HABITAT TYPES BY PERCENT TOTAL LENGTH



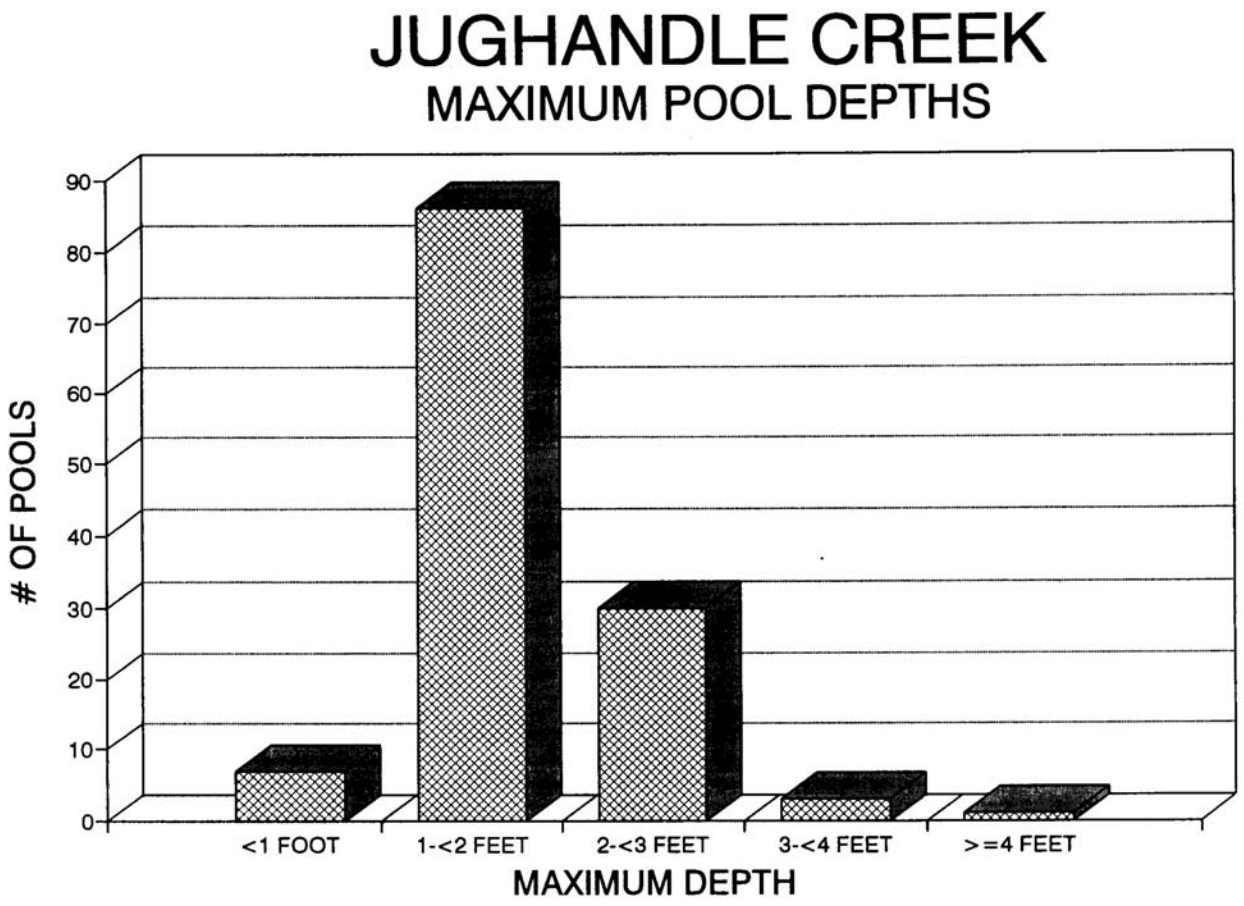
Graph J-2. Habitat types by percent total length.



Graph J-3. Habitat types by percent occurrence.

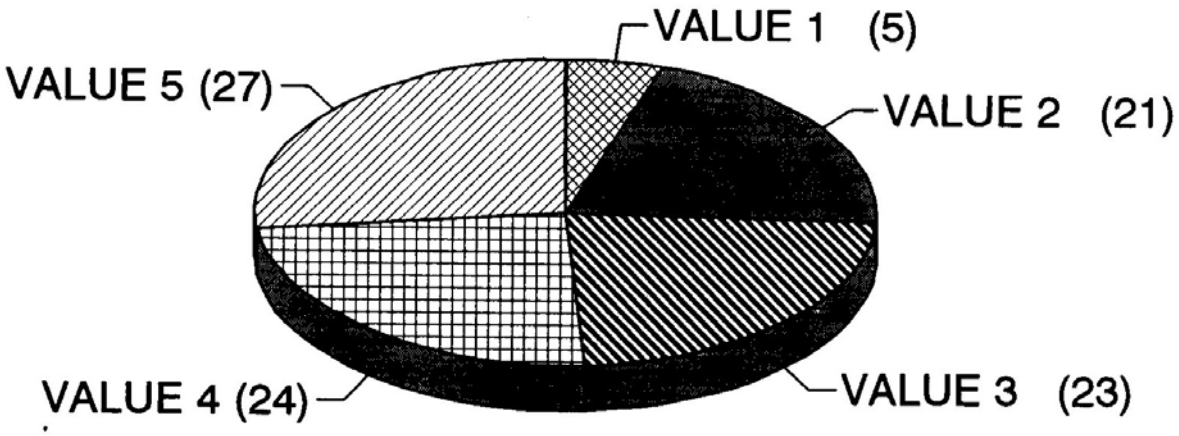


Graph J-4. Pool habitat types by percent occurrence.



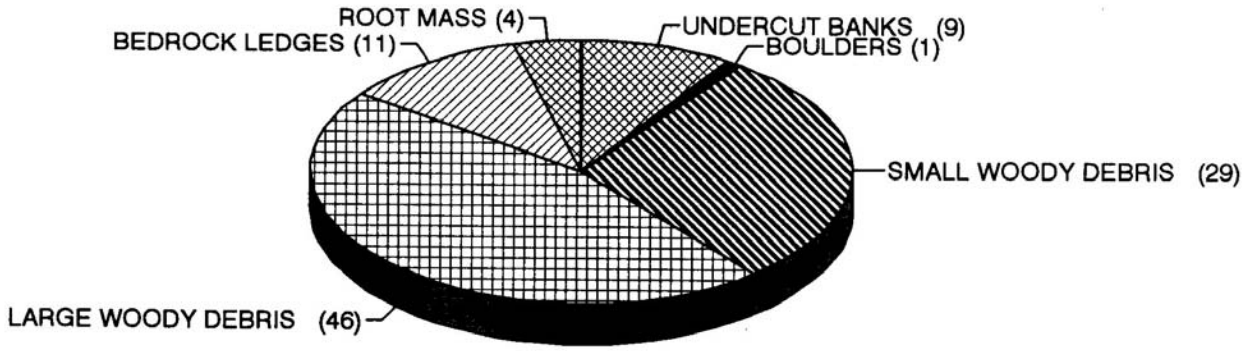
Graph J-5. Maximum pool depths.

JUGHANDLE CREEK
PERCENT EMBEDDEDNESS

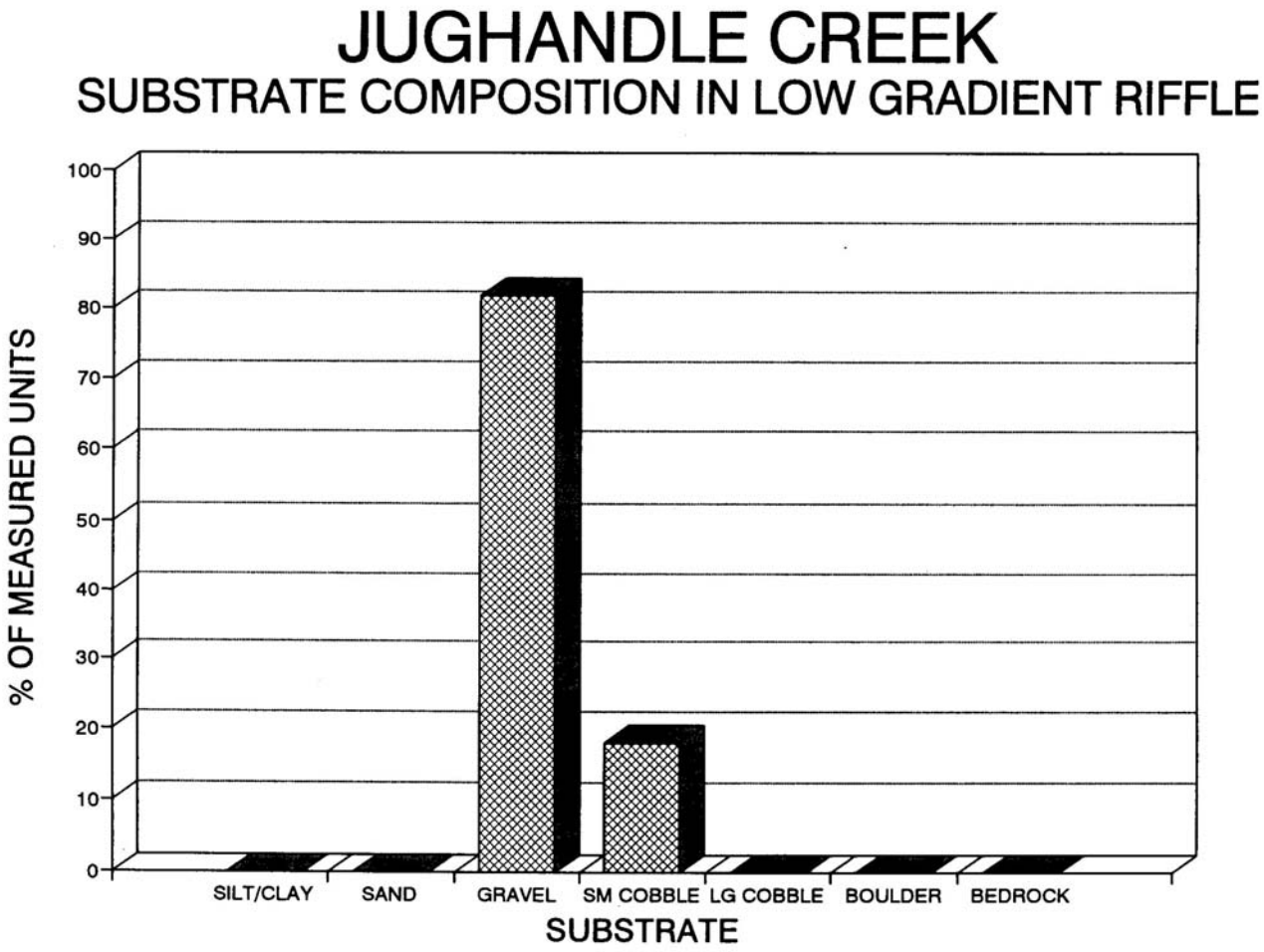


Graph J-6. Percent embeddedness.

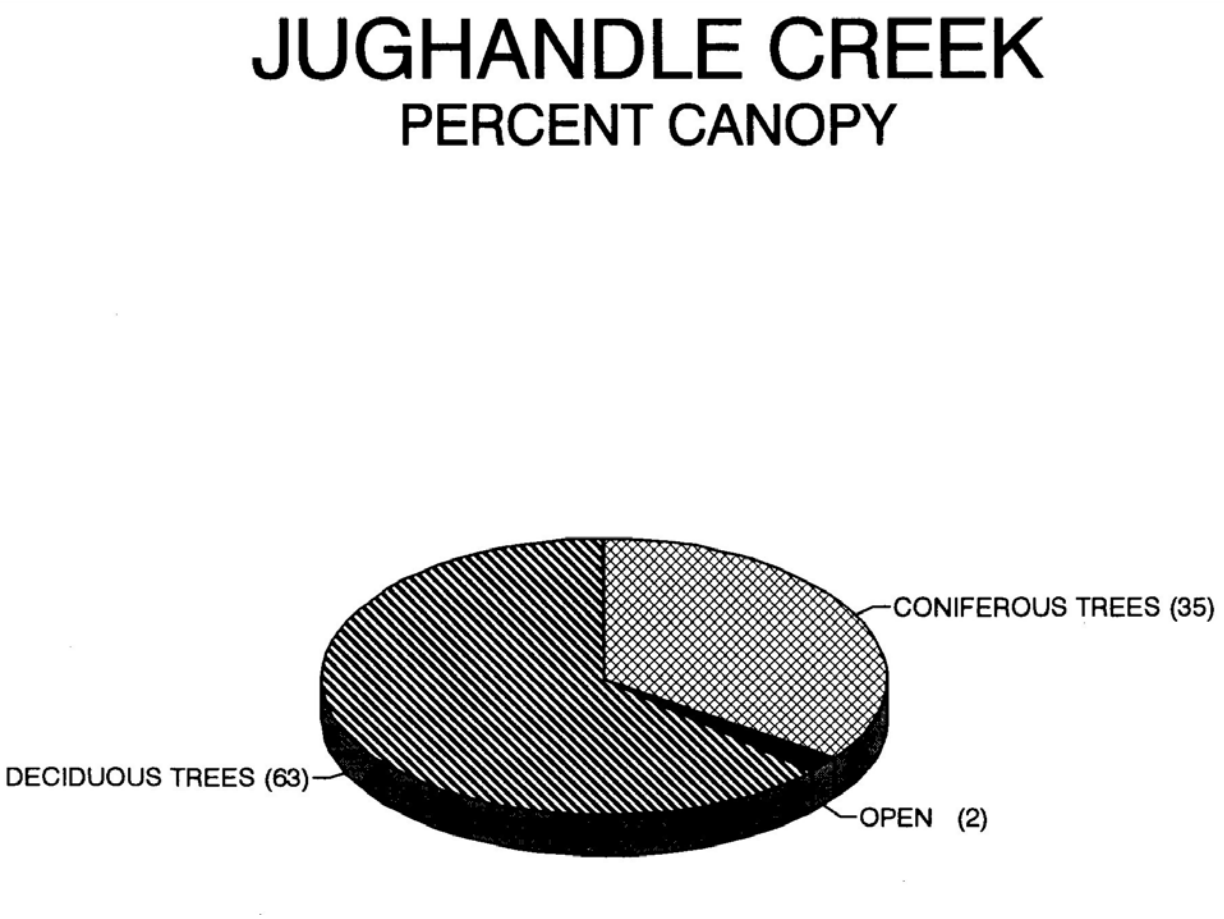
JUGHANDLE CREEK
MEAN PERCENT COVER TYPES IN POOLS



Graph J-7. Mean percent cover types in pools.



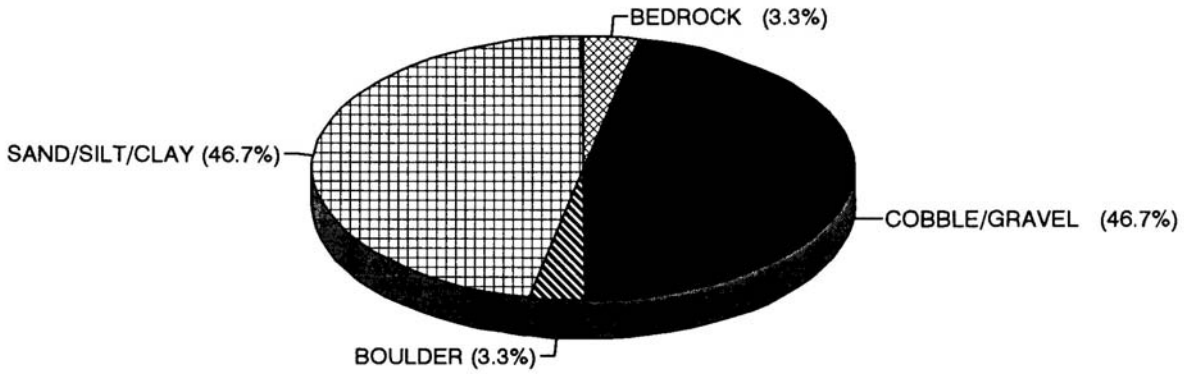
Graph J-8. Substrate composition in low gradient riffles.



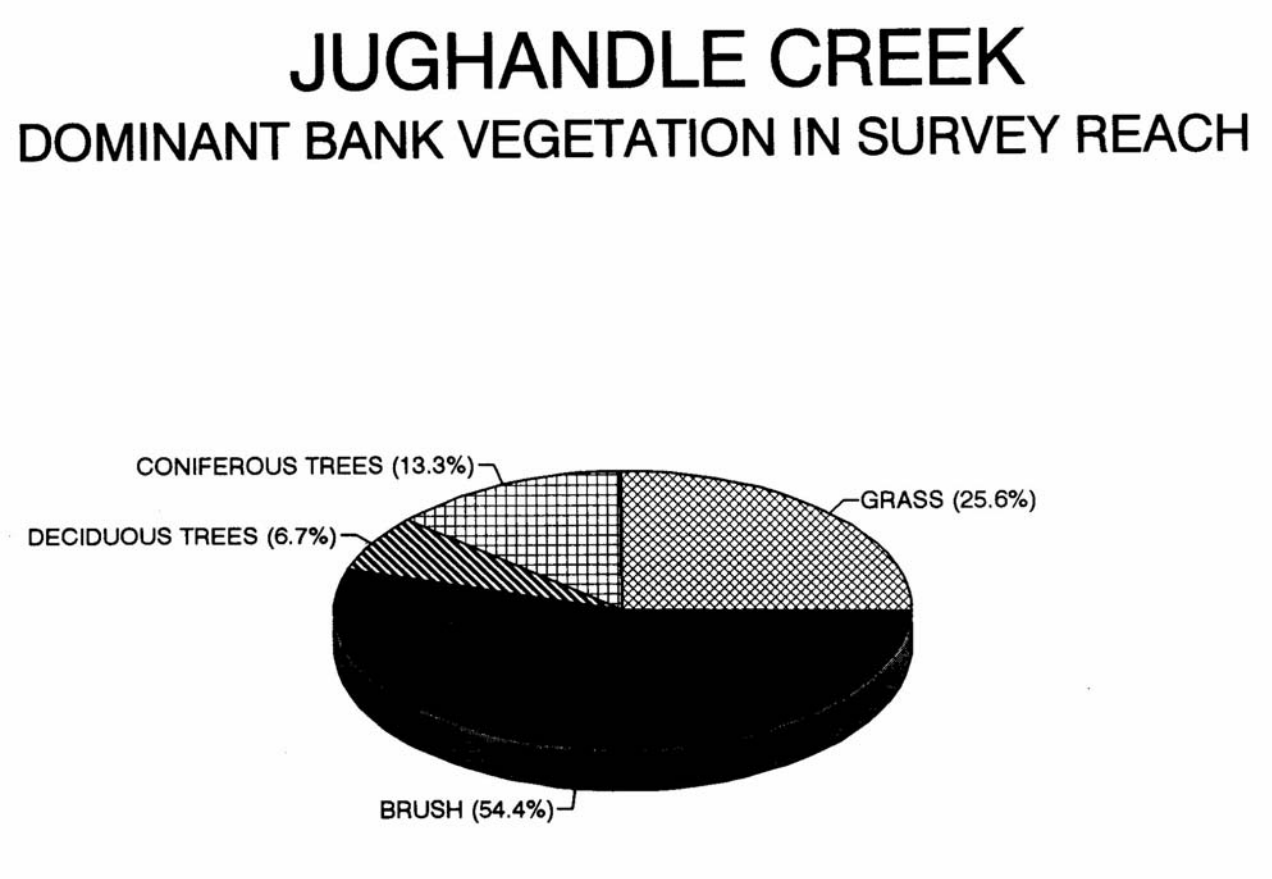
Graph J-9. Percent canopy.

JUGHANDLE CREEK

DOMINANT BANK COMPOSITION IN SURVEY REACH



Graph J-10. Dominant bank composition in survey reach.



Graph J-11. Dominant bank vegetation in survey reach.

APPENDIX K.

TOOLS

Following is a check list of the most commonly used tools for stream enhancement/restoration projects. The tools needed will depend on the specific project. Before traveling to the work site a check of the tools must be done to insure that everything is available when needed.

Hand tools include:
shovels
rock bars
sledge hammers
splitting mauls
picks
pulaski's
peeves
pliers
wire cutters
tape measures
files for the tools
fence post/rebar driver
cable cutter (guillotine type)
log carriers

Power tools include:
chain saws including:
- extra chain
- extra bars
- plastic wedges
- file guide with file
- chain depth gauge
- raker file
- extra spark plugs
- extra air filter
- tool for adjusting chain and bar
- grease gun for roller nose or sprocket nose bar
- can spray degreaser
- can for mixed gas and bar oil
- auto parts brush
- rags
- fire extinguisher
- single bit axe

various spare parts (bar nuts, gas filters, etc.)
backpack for carrying equipment and supplies

chain saw winch

skill saw with metal cutting blade

gas powered drills: These come in a variety of sizes for various applications.
The largest gas powered drills are used to drill rock for chipping and blasting. Smaller gas powered drills are available to drill rock. Some gas powered drills are only used to drill wood. Each has its place and function. Correct selection depends on the needs of the project.

electric rotary hammer with carbide tipped rock drills:

gas powered generator
heavy duty outdoor extension cord
ground fault interrupter

electric drill with drill bits (wood augers)

Griphoist including:
tool box containing:
handle puller
spare shear pins
claw hammer
crescent wrench
socket set (standard and metric)
screwdriver set
allen wrenches
hack saw with extra blades
snatch blocks (two per griphoist)
shackles (to attach cable straps or chains together)
chokers (three per griphoist)
chain (12 ft. minimum to anchor the griphoist)
cable straps (various sizes from 10 to 100 feet long)
extra mainline
rock nets (these can be made from chain or bought pre-made)
cable gripper

Safety equipment including:
first aid kit
hard hats
earplugs
gloves
boots
eye and face protection
chaps for use with chain saws

Shuttling equipment
backpacks
wheelbarrows
hand carried stretchers
all terrain vehicles with trailer

APPENDIX L.

TWO-PIN METHOD

Procedure

The two-pin method is useful to locate natural and human influenced features within a project site relative to two permanent reference points (Miller, O'Brien, Koonce, 1988). It can used to describe and map existing geomorphic channel conditions of a proposed restoration site. It is useful during restoration project design, layout, and construction phases, and during subsequent project phases of monitoring and evaluation.

The two-pin method is based on establishing a reference pin at the upstream and downstream ends of a given enhancement site. These pins are placed on one side of the stream, with each pin located further upstream and downstream than the extent of the enhancement structure. By convention, Pin 1 is downstream of Pin 2.

Enhancement sites along the channel are referenced according to a curvilinear traverse line along one side of the stream. For example, Site 12+50 is equivalent to a distance of 1,250 feet upstream from an assigned starting point. By convention, references begin at the downstream end of an enhancement section and progress upstream. Generally, the traverse line simply follows the course of the stream. Bearings and azimuths are not recorded for meander curvature. Specific locations on the traverse line could be referenced to a nearby stadia or route survey (i.e., a road centerline) by recording distance and bearings from specific points along such surveys.

All the important channel features are located using triangulation of intersecting horizontal distances from the reference pins. Once the pins are in place, a tape measure is stretched from each pin. The intersection of the two tapes defines a measuring point (Figure L-1). A scale map is drawn for each site showing large woody debris, instream boulders, etc. (Figure L-2).

Each enhancement structure is laid out on the ground using wire flags so that the structures can be triangulated and accurately mapped. The triangulation distances are recorded in a standardized table (Table L-1). The design elevations for the top of the log or boulder ends are also measured from the reference pins. By convention the elevation of pin 1 is recorded as 0 (Table L-1).

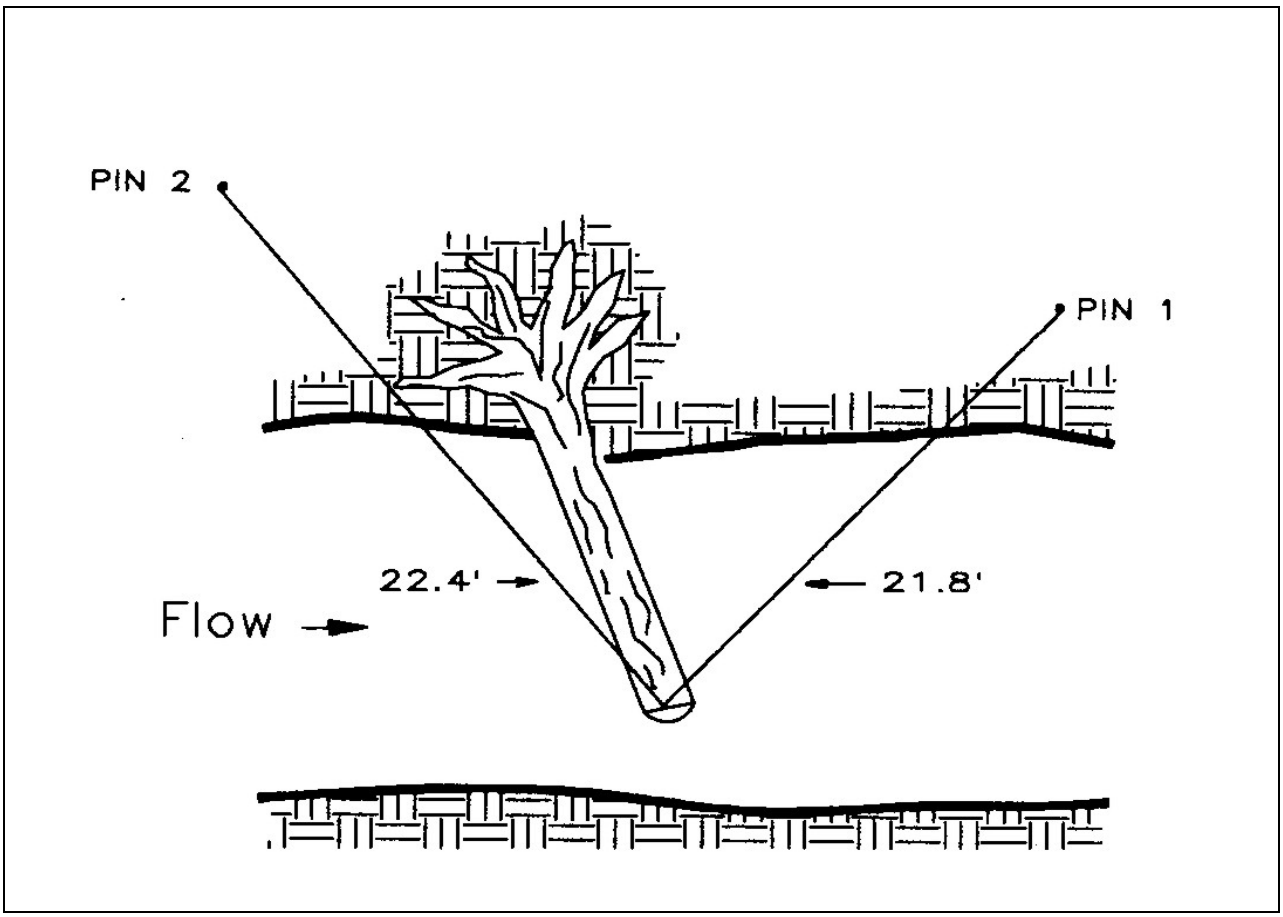


Figure L-1. Location of the left bank end of a downed tree as determined by the intersection of the distances from two reference pins (Miller, O'Brien, Koonce, 1988).

Table L-1. Measured distances and elevations of existing and prescribed structural components relative to the two reference pins at station 171+20 along Tarup Creek, Del Norte County, California. Existing features are described by numbers: prescribed features by letters: all corresponding with those in Figure 2. (Adapted from Inter-Fluve, 1987)

Item			Distance(ft)		Elevation(ft)[a/]	
			Pin 1	Pin 2	Pin 1	Pin 2
Pin 1			57		-0.4	
Pin 2			57		+0.4	
Log 1,		instream end	19	57		
Log 2,		instream end	37	41		
Log 3,		instream end	47	34		
Log 4,		instream end	50	20		
Boulder 5,	center		36	51		
Boulder 6,	center		31	48		
Log A,		upstream end, top	49	16	-3.5	-3.9
Log A,		downstream end, to	30	44	-4.9	-5.3
Log B,		bank end	41	67		
Log B,		instream end	29	56	-5.4	-5.8
Log C,		bank end	33	65		
Log C,		instream end	31	58	-5.7	-6.1
Boulder D,	center		28	45	-4.9	-5.3
Boulders E,	left bank edge		10	54		

a/ Elevation from pin: + above; - below

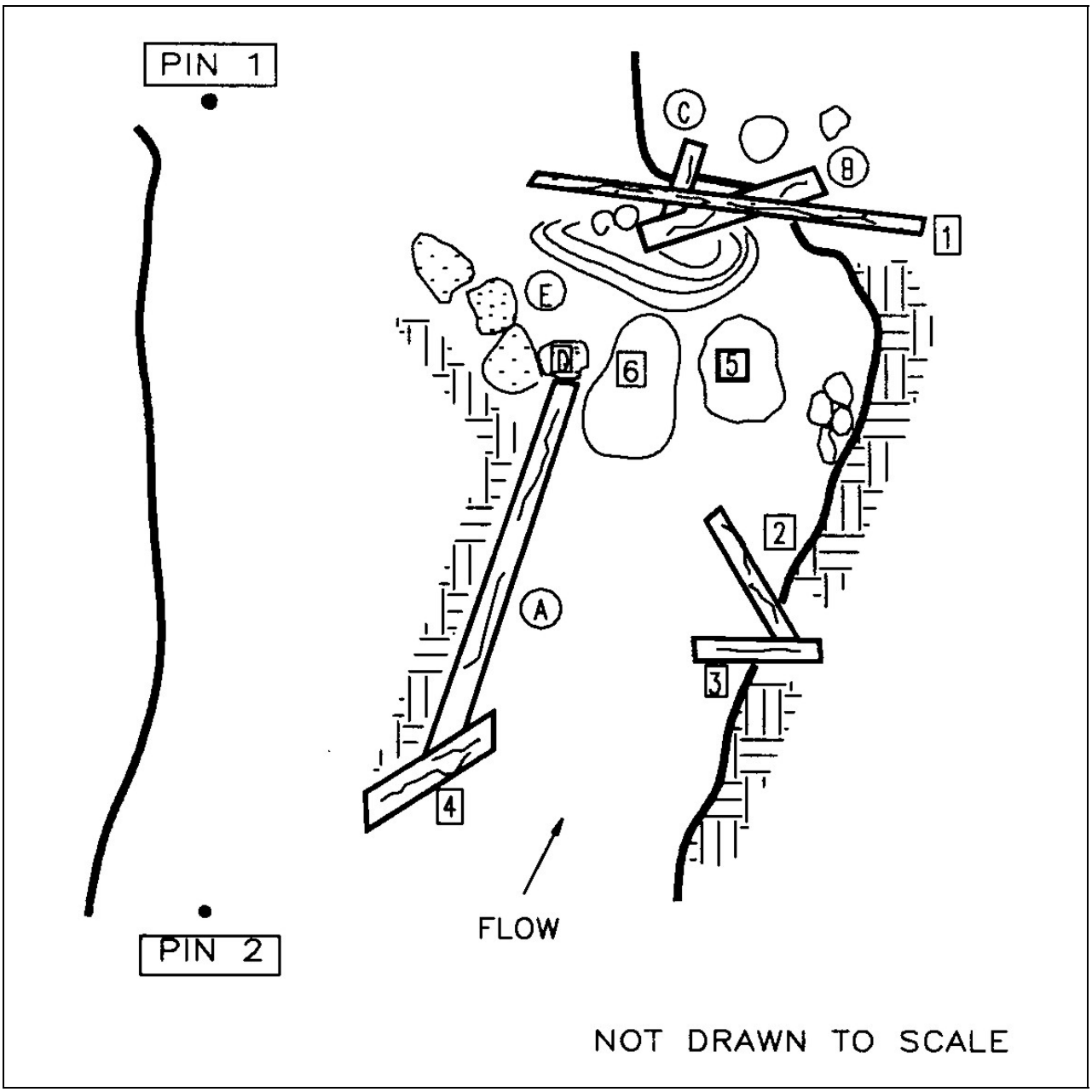


Figure L-2. Typical to-scale plan schematic depicting existing (numbered) and prescribed (lettered) features relative to reference pins. Features correspond with those in Table L-1 (Miller, O'Brien, Koonce, 1988).

At each site notes should be taken describing the condition of the channel. For each enhancement structure the anticipated results of the project are noted. Materials available on site are also recorded. A table of materials and availability is developed (Table L-2). This information helps the construction crew conceptualize what has been designed.

Table L-2. Materials, with estimated dimensions and quantities, required for a station 171+20 along Tarup Creek, Del Norte County, California. The sources for individual items are indicated as available on-site, near to the site or through a specified supplier. Lettered items correspond with those in Figure L-2.

Material	Size		Quantity	Source
	Diameter	Length		
Log A, redwood	2 ft.	32 ft.	1	onsite
Log B, redwood	1.5 ft.	14 ft.	1	nearsite
Log C, redwood	1.5 ft.	7 ft.	1	nearsite
Galvanized cable	3/8 in.	35 ft.	1	supplier
Galvanized cable	1/2 in.	20 ft.	1	supplier
Cable clamps	3/8 in.		4	supplier
Cable clamps	1/2 in.	4		supplier
Rock	2 ft.			near & offsite
Willow cuttings	1/2 in.	2 ft.	100	near & offsite

Construction

Following the enhancement designs during construction involves the simple reversal of the scaled plan map and dimension table preparation process. Fiberglass tapes are stretched from each reference pin to the distances noted in the structure location table. The intersection designates a structural feature, such as the bank end of a log or the center of a boulder. Temporary wire-flags are placed at each intersection point until all important features are delineated. In this way, the location and orientation of a log weir can be identified, and the log can be related to other elements of the design. Once the scaled plan map is verified, construction can begin. The amount of excavation or fill for prescribed features is determined by measuring the appropriate depths using a hand-held Abney level, a tripod-based builders level, or in simple cases, a string level.

Inherent Error In The Methodology. Under ideal conditions, the two-pin method allows little room for error between design intention and construction implementation. Aside from simple misinterpretation, any errors are the result of limits in the measurement system. Elevations can be established to a level of accuracy by extending measurement precision to a higher level of magnitude. For example, if 0.5 foot is an acceptable margin of error, measurements should be recorded in the structure location table to within 0.1 foot.

The plan location of enhancement features is based on intersecting distances from two fixed points. The intersection of two non-parallel lines defines only one position. The two-pin method is similar to that used in maritime navigation, where a "fix" is determined by the intersection of two distance circles. Error can arise in prescribed feature locations due to the inherent short-comings of the triangulation method. Because measurements occur twice, once for design and once for construction, errors can be compounded.

While measuring from reference pins using the two-pin method, a small intersecting angle would occur in two scenarios: 1) when a measured position is quite far from the reference points (Figure L-3); and 2) when a position does not fall roughly between the reference points (Figure L-4).

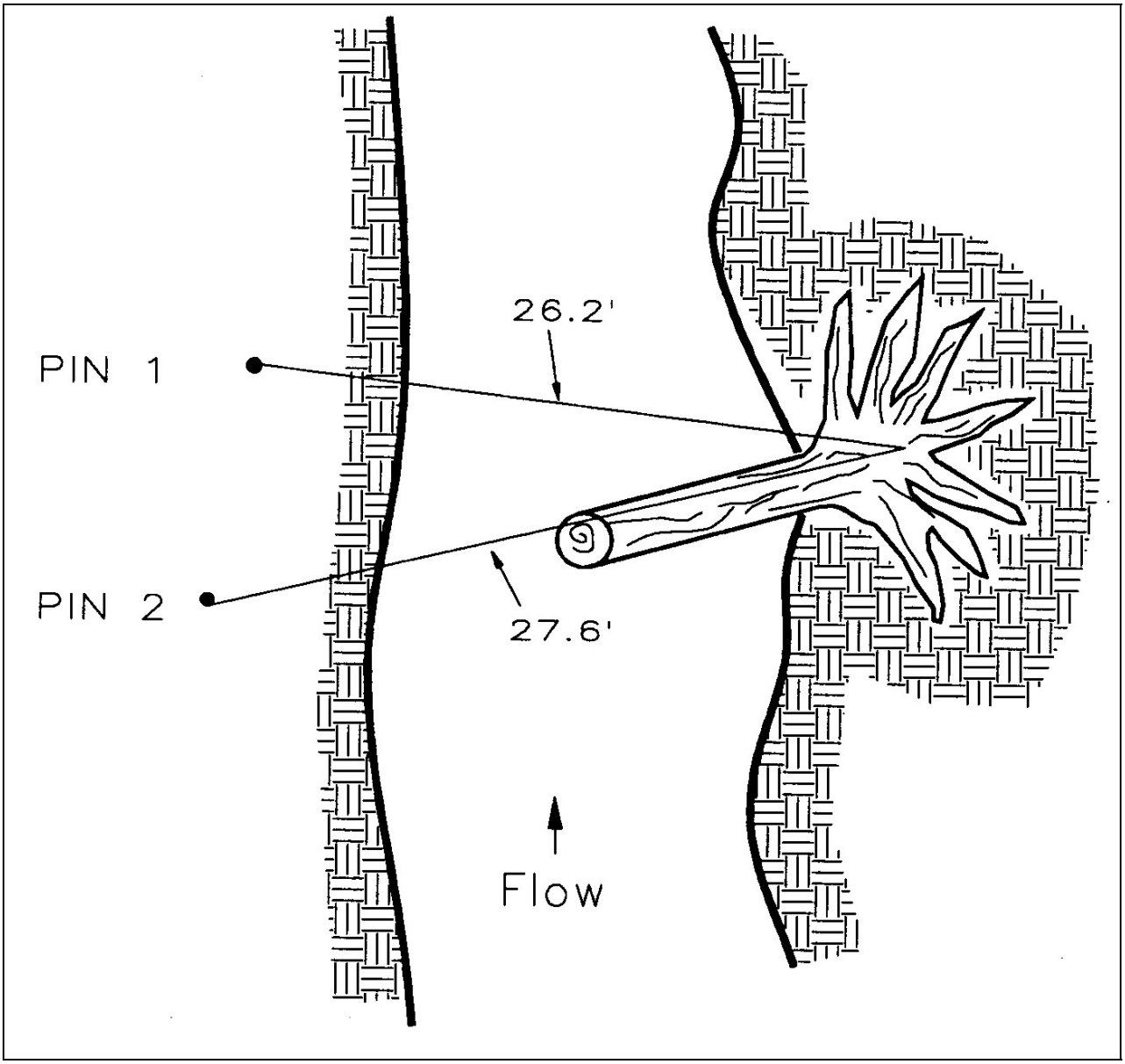


Figure L-3. Measured position quite far from reference pins results in an acute angle with a high potential for measurement error (Miller, O'Brien, Koonce, 1988).

Two important guidelines should be followed to reduce the amount of fix error:

1) Reference pins should always be placed upstream and downstream from the furthest extent of the prescribed enhancement structure. In this way, position lines from the downstream pin never extend downstream and those from the upstream pin never extend upstream (Figure L-4). More than 2 pins may be utilized on very large scale sites, or those sites occurring on tight radius bends.

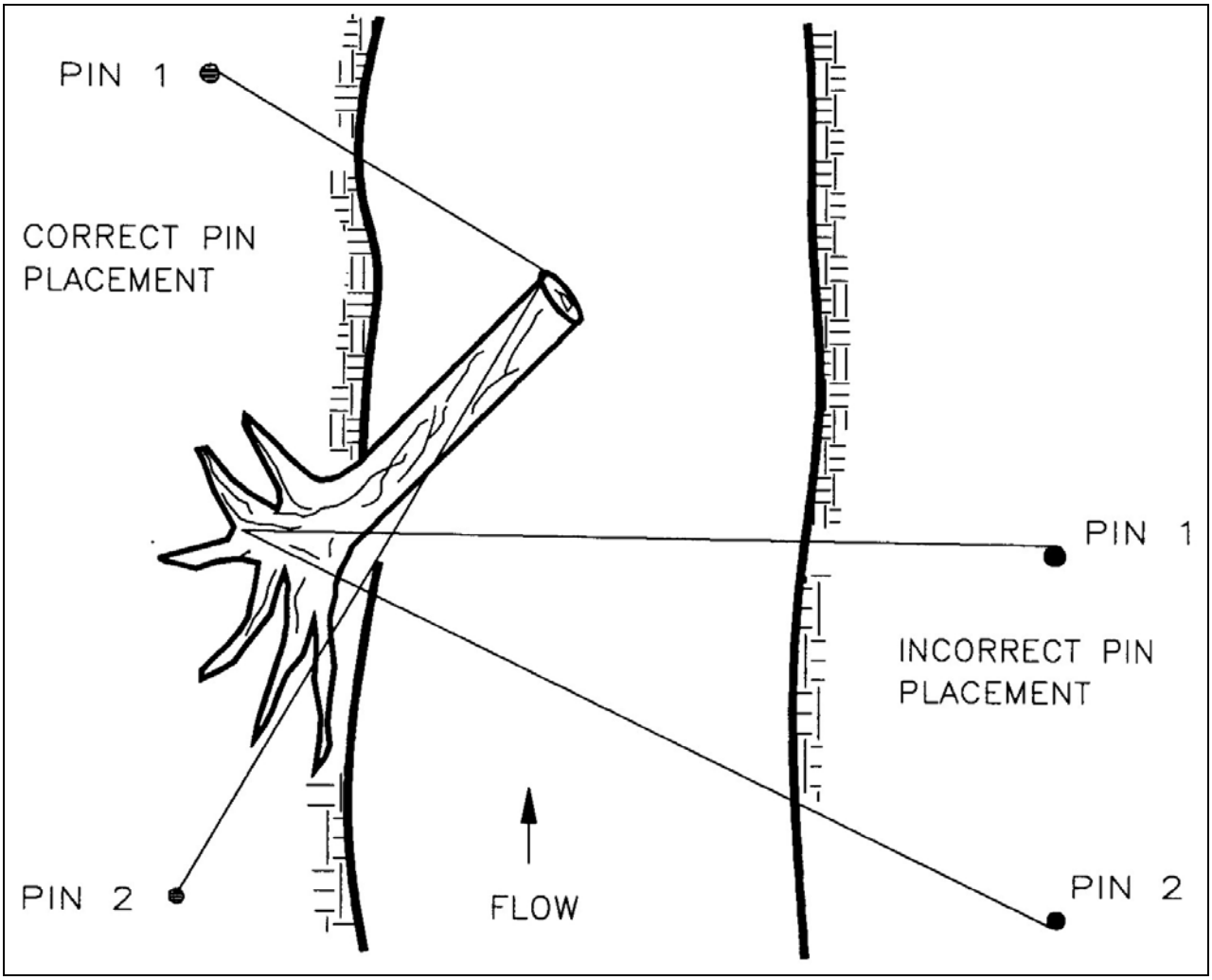


Figure L-4. Reference pins should be placed well upstream and downstream of the area to be measured. In this way, the intersecting angle approaches 90 degrees (Miller, O'Brien, Koonce, 1988).

2) Reference pins should be placed so that the longest measurement across the channel does not exceed 1/2 of the distance between pins. Usually, acceptable results are given if the pins are located so the distance between them is slightly more than twice the channel width (Figure L-5).

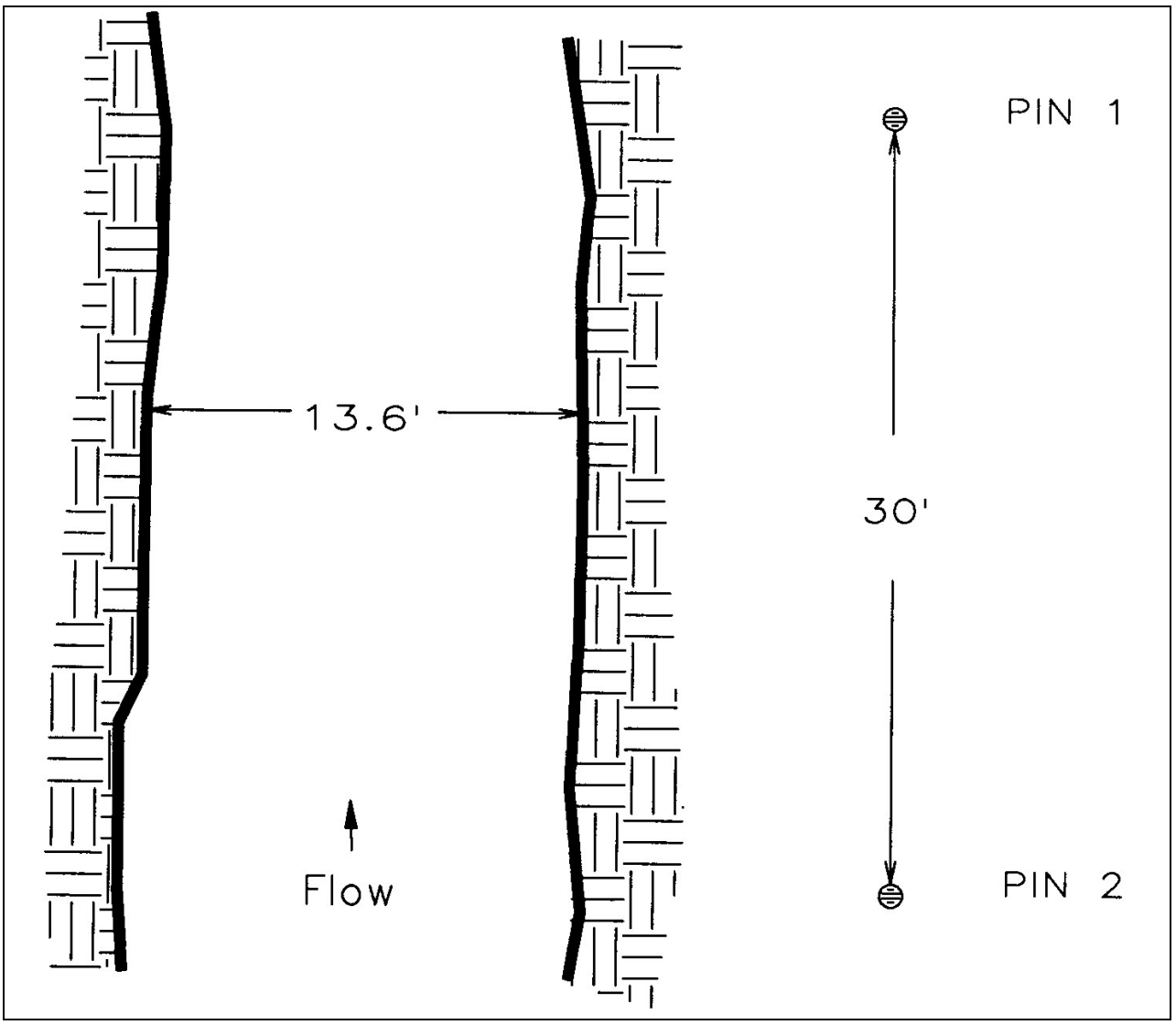


Figure L-5. Proper spacing of reference pins is slightly greater than twice the channel length (Miller, O'Brien, Koonce, 1988).

Management Implications

Stability Analysis. The two-pin method is a relatively precise, inexpensive means to evaluate the long-term stability of enhancement structures. Post-construction documentation of selected locations of structural components can be compared with measurements following annual high flow periods or even specific runoff events. For example, the plan and profile location of a group of boulders in an instream cluster can be documented by measuring the fix and elevation at the center of each boulder. With such records, any movement of the boulders following runoff events can be readily qualified.

Habitat and Bedform Mapping. Where sampling occurs over a short area, a plan schematic can be developed using the two-pin method to depict the location of different parameter measurement sites. For example, the location of benthic invertebrate, substrate and water quality sampling sites can be illustrated on a plan map. General geomorphic maps of bedforms such as pools, riffles and bars of stream channels can be developed utilizing the two-pin method.

Contract Specifications. Managers involved with the setup and coordination of instream habitat construction who prepare typical engineering-style blueprint design documents may find the two-pin method more cost efficient and easily implemented by work crews. Similarly, projects which stipulate background biological sampling may use the two-pin method to identify specific sample sites for contractors. In some cases, design details or sampling areas identified with this methodology could result in more specific proposals from bidders, thereby allowing more accurate comparison of contract line items.

Location maps for each project reach, which show the stream section and any roads or trails associated with it, are versatile tools. They can be constructed by tracing on mylar or acetate the area and features necessary from a map or an aerial photograph. Photocopies are then taken of the transparency and can be reduced or enlarged as needed for field maps. During the field layout, all on site construction materials and access routes for work crews, equipment, and materials should be located on these maps and thoroughly described.

Photographic documentation of the project site, using established photo points, is desirable during the layout phase (Part VIII). It is the most cost-effective means of recording site conditions at any particular time and should be used frequently throughout a project's lifetime. Photographs taken during pre-project phases can be taken out in the field in clear plastic protective cases and used to help compare views and align new photographs.

The actual project site layout is the transition between the planning phase and the construction phase and is a critically important stage for any project. If adequate time is used to set it up right in the field, using all the tools available to you, the actual construction phase will run smoothly and cost-effectively. Thorough documentation is strongly recommended using field notebooks, site location maps, stream reach maps, cross section diagrams, and photographs. It is recommended to establish photo points, using the two-pin method if necessary, to document the progress and effects of the project. Photo documentation is best when aspect, light, camera, and lens selection is consistent.

REFERENCES

Koonce, Gregory P. 1990. Two-Pin Method for the Layout of Stream Habitat Enhancement Designs. Proceedings of the Eighth Annual California Salmon, Steelhead and Trout Restoration Conference. Eureka, California, USA.

Miller, Dale E., R. J. O'Brien, and G. P. Koonce. 1988. Two-Pin Method for the Implementation of Instream Habitat Enhancement Designs. Presented at the 1988 Fisheries Bioengineering Symposium in Portland, Oregon, USA.

APPENDIX M.

SPECIALTY INSTRUMENTS

Geographic Information System (GIS)

The generally accepted definition of a GIS is an automated system that inputs, manages, manipulates, analyzes, and displays geographic data in digital form. Data in a GIS are spatially referenced, that is, defined by their location on the earth, and can be mapped. Each object is identified by a specific geographic location using latitude and longitude coordinates, described by single or multiple characteristics, and related to other features in the GIS. Therefore, three pieces of information are essential for each feature entered into a GIS database: where it is, what it is, and how it relates to other features (e.g., which streams link to form a river basin).

A GIS system has the capability of making maps and analyzing data within spatial parameters. For example, a GIS containing the appropriate data can produce a map of all restoration projects involving instream structures in tributaries to the South Fork Eel River. A similar, but more specific query of, "show only those projects in tributaries known to contain coho", would produce another map. Another query might ask to either list or display on a map all salmonid rearing projects within 50 miles of Fort Bragg.

Uses of spatial data within a GIS format provide resource managers, specialists, and planners a variety of analytical and monitoring tools. GIS capabilities include: 1) the geographic display of environmental, infrastructure, and social features, 2) display maps of geographic characteristics needed for analysis, 3) visually present changes of environmental or other features based on monitoring data, and 4) model alternative scenarios for management plans.

The GIS software presently in use by the California Department of Fish and Game is ARC/INFO.

The key component for entering data into the GIS system is location. Location is defined by latitude and longitude coordinates determined from USGS maps and a "Coordinator" tool, or a Global Positioning System (GPS) instrument.

Coordinator

The Coordinator is designed to enable the user to precisely determine the north latitude and west longitude of any point on all United States Geological Survey (USGS) and Canadian Department of Mines Topographic maps currently available and produced to the following scales: 1:20,000; 1:24,000; 1:25,000; 1:30,000; 1:50,000; 1:62,500; 1:63,600; 1:100,000 and 1:250,000.

The following steps are used to determine latitude and longitude of any point selected on USGS topographic maps.

Step 1. Carefully mark the point on the map for which the latitude and longitude is to be determined.

Step 2. Determine the scale to which the map has been produced. The scale referred to is printed in the white border area of every topographic map, generally either in the center of the lower border or, occasionally, in one of the four corners of the map. The most commonly used USGS topographic maps by DFG are the 7.5 minute quadrangle series at a 1:24,000 scale. The 15 minute series USGS topographic maps at a 1:62,500 scale are no longer produced but still exist in most offices. **BE CERTAIN YOU USE THE CORRECT SCALE FOR THE MAP YOU HAVE**.

Step 3. Select the scale on the Coordinator that corresponds to the map scale determined in Step 2. Each Coordinator scale designation appears on the extreme left of the Coordinator, at the base of and at right angle to the scale to which it pertains. (Note that 1:20,000 is shown as 1:20K, 1:24,000 as 1:24K, etc.)

Step 4. Observe that every topographic map has a beginning north latitude printed on the bottom left and right border of the map area and an ending north latitude printed on the top left and right border of the map area. The beginning west longitude of every map is printed on the top and bottom of the right map border and the ending west longitude is printed on the top and bottom of the left map border.

Step 5. Additionally, there are intermediate points every 2'30" between the beginning and ending north latitude and west longitude printed along the corresponding vertical and horizontal borders of the map area on 1:20K, 1:24K, 1:25K and 1:30K maps. Intermediate points are at 5'00" intervals on 1:50K, 1:62.5K and 1:63.6K maps and at 15'00" intervals on 1:100K and 1:250K maps.

Step 6. Furthermore, within the map area itself, note that where hypothetical lines that would connect corresponding intermediate latitude and longitude points would intersect, there exist + marks.

IN USING YOUR COORDINATOR, IT IS IMPORTANT TO REMEMBER THAT LONGITUDE ALWAYS INCREASES IN AN EAST TO WEST (from right to left) DIRECTION AND, IN THE NORTHERN HEMISPHERE, LATITUDE ALWAYS INCREASES IN A SOUTH TO NORTH (going up) DIRECTION.

Step 7. DETERMINING NORTH LATITUDE. Create a line across the map at the nearest intermediate points (Step 5) above and below the point you have marked in Step 1. These lines will hereafter be referred to as "framing lines." If your Step 1 point falls between the bottom edge of the map area and the first intermediate point, or between the top edge of the map area and the first intermediate point below, it is only necessary to create a single framing line as the map area edge will serve as the other framing line.

Step 8. Using the Coordinator scale selected in Step 3, lay the Coordinator on the map so that the scale begins on the framing line below your Step 1 point, and ends on the framing line above it AND that your Step 1 point falls on the Coordinator scale itself.

Step 9. Reading the Scale. Each scale on the Coordinator has two sets of incremental designations, the LEFT beginning at 30" and the RIGHT beginning at 00". It is essential in reading the scale, if your lower framing line is at 30", that you read from the left scale that begins at 30" and if the lower framing line is at 00", that you read from the right scale that begins at 00".

Having determined the correct incremental scale designation to use, note that as you read up the scale, each time you would reach the 00" point on the Coordinator scale, you must add 1' to the beginning north latitude at your lower framing line.

Step 10. DETERMINING WEST LONGITUDE. West longitude is determined in a generally similar manner as north latitude (i.e., by creating framing lines running north and south at the intermediate (Step 5) points on either side of your Step 1 point). Similar to determining north latitude, if your Step 1 point falls between either edge of the map area and the first intermediate point, only a single framing line need be created. Unlike the "imaginary" latitude lines which are ALWAYS equidistant and absolutely parallel between the equator and the north pole, LONGITUDE "LINES" are furthest apart at the equator and gradually converge to zero separation at the north pole. For this reason, the Coordinator must be positioned DIAGONALLY between your north-south Longitudinal framing lines.

Reading the Scale. The same scale on the Coordinator is used for determining BOTH north latitude and west longitude. MAKE CERTAIN that the Coordinator is positioned with the scale reading from right to left (east to west) as this is the direction in which longitude increases. Read the appropriate incremental scale designations as in Step 5, being careful to note whether your beginning intermediate longitude is at 30" or 00".

NOTE: Some Step 1 points near the edges of any topographic map dictate that one framing line be created past the edge of the map for computing west longitude ONLY, due to the diagonal positioning of the Coordinator required.

Global Positioning System (GPS)

GPS is a satellite-based positioning system operated by the U.S. Department of Defense (DOD). The system consists of 24 satellites orbiting the earth every 12 hours at an altitude of 12,600 nautical miles. Four satellites orbit in each of six different planes. Each satellite contains several high-precision atomic clocks and constantly transmits radio signals using its own unique identifying code.

When locating a position on earth, a GPS unit receives radio signals from "visible" satellites and computes the distance from each satellite to the receiver. The GPS computer uses triangulation to calculate a location point and displays this point in latitude and longitude. The satellites act as reference points for position fixes. Good quality fixes require signal reception from four satellites, a satellite constellation. Distance measurements from each satellite to the GPS receiver are performed within the receiver by timing how long it takes a radio signal to reach the GPS unit, and then calculating the distance based on time and the speed of radio waves (speed of light x time = distance). Most receivers measure time in nanoseconds, one-billionth of a second.

GPS accuracy depends on geometric position of satellites within a constellation, atmospheric conditions, and if DOD is introducing error into the system for national security purposes. Software is available to correct for DOD error. Uncorrected error can result in fix errors of $\pm$300 feet (100 meters); corrected positions are accurate to within 12 feet (2 meters) or less.

GPS can be used to obtain fixes for defining points, lines or areas. Locations of specific sites (e.g., bridges, stream confluences, project sites, problem areas) can be determined by collecting 150 to 200 points or fixes and averaging them to obtain a mean latitude and longitude. Most receivers record a fix every one to two seconds. Longer fix intervals can be selected. Stream courses can be tracked by walking along the stream channel and recording GPS fixes every one to five seconds. GPS points recorded while walking the perimeter of a lake will provide a perimeter line and surface area calculation of the lake. Fix data can be recorded within the GPS unit and later downloaded onto computer disks. Software enables averaging for point fixes, line drawing indicating points along a route (e.g., a stream course), area measurements, distances between points, and other measurements using data points. GPS data can be exported to a GIS system for further analysis.

GPS technology is rapidly being developed and improved. Early GPS units were three-channel receivers. Most GPS units produced today are five- to eight-channel receivers. More channels reduces satellite acquisition time and provides better signal "lock" in vegetative cover. Newer GPS units also have improved displays and are more user-friendly than earlier models.

The primary drawback to using GPS in streams is the difficulty in receiving and maintaining satellite signals under vegetation or stream canopy. GPS radio signals travel "line-of-sight" and do not penetrate solid objects well. Basically, if you cannot see the sky, the GPS unit will not receive the satellite signal. This problem is overcome by using "offsets" when determining a fix. Offsets require the GPS unit to be located in an adjacent open area where a fix can be obtained, at a measured distance and direction from the stream. Remote antennas have also proven useful to acquire signals under stream canopy cover. The antenna, attached to a pole, is moved and tilted around until satellites are "locked on".

Spherical Densiometer

The spherical densiometer can be used as a hand held instrument to estimate relative vegetative canopy closure or canopy density caused by vegetation. Vegetation canopy closure is the area of the sky over the selected stream channel that is bracketed by vegetation (regardless of density). Canopy density is the amount of the sky blocked within the closure by vegetation. Canopy closure can be constant throughout the season if fast growing vegetation is not dominant, but density can change drastically if canopy vegetation is deciduous.

Spherical densiometers are produced with either convex or concave reflecting surfaces. These instructions are for a convex (Model A) spherical densiometer. The mirror surface of the densiometer has 37 grid intersections forming 24 squares. At a probability level of 95 percent, tests show the average measurements of the same overstory area can be excepted to be within $\pm$2.4 percent of the mean. Because the instrument has a curved (convex or concave) reflecting surface resulting in a field the includes lateral as well as overhead positions, an overlap of side readings occurs when readings are taken from the same point. To account for this bias, the modifications developed by Strichler (1959) are used and modified to more accurately measure canopy closure and density. Strichler uses only 17 of the line intersects as observation points by taping a right angle on the mirror surface (Figure M- 1).

For Stream Orders 1 Through 4 - Stand in the middle of the habitat type area and in the center of the stream facing downstream. The densiometer is held in the hand, in front of the body at about waist level, with the arm from the hand to the elbow parallel to the water surface. The convex densiometer is held away from the observer's body with the apex of the V pointed toward the observer. The observer's eye reflection should seen along the margin of the original grid (Figure M-1). Level the densiometer using the bubble indicator and maintain the level and standard eye positions while recording. The grid between the V formed by the tape encloses 17 observation points. Each point has a value of 1.5 percent when four different recordings are made. The number of points (line grid intersects) that are covered by vegetation are counted when measuring canopy density. The number of points surrounded by vegetation are counted when measuring canopy closure. Measurements are taken in the four quadrants while standing on the same point (facing downstream, right bank, upstream, left bank).

The points counted for each reading are totaled and multiplied by 1.5 to obtain the percentage of canopy density or closure.

If all possible observation points are counted the total value will be 102 percent (68 × 1.5 = 102). Although this error is small and not considered important for comparisons of relative values, the following correction factor can be applied to determine the correct percentile:

Calculated value	Subtract from Calculated value
less than 30	0
30 to 60	-1
over 60	-2

Example: (8+11+7+12)(1.5) = 57% subtract 1% = 56% density

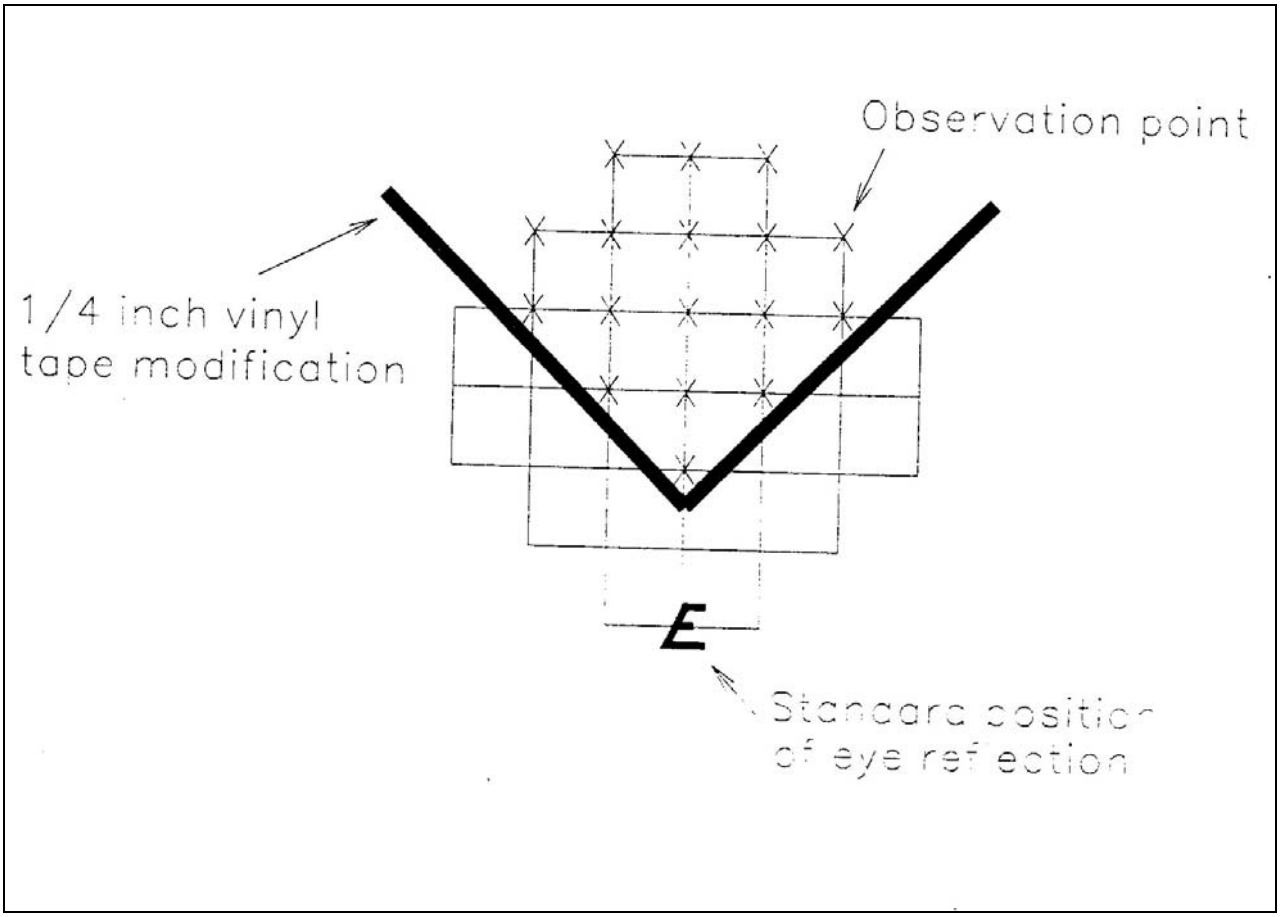


Figure M-1. Modified grid of convex spherical densiometer showing the 17 observations points (X's) and the position of the observer's eye reflection.

REFERENCES

Platts, W.S., D. Amour, G.D. Booth, M. Gryant, J.L. Bufford, P. Culpin, S. Jensen, G.W. Lienkaemper, G.W. Minshall, S.B. Monsen, R.L. Nelson, J.R. Sedell, and J.S. Tuhy. 1987. Methods for Evaluating Riparian Habitats with Applications to Management. US Dept of Agriculture, Forest Service, Intermountain Research Station, General Technical Report INT-221.

Strichler, G.S. 1959. Use of the densiometer to estimate density of forest canopy on permanent sample plots. Research Note INT-180. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station, 5p.

APPENDIX N.

PERMITS, AGREEMENTS, AND ENVIRONMENTAL DOCUMENTS

Each instream fish habitat restoration project requires some type of permit, although the number and type of permits necessary will depend on the type of project being considered. One or more of the following permits may be required:

- **Access Agreement**. This agreement is necessary to not only do the development work, but to enter onto property other than your own to do preliminary survey work. This agreement must be reached between the project sponsor and the property owner or manager (examples 1 and 2).

- **Streambed Alteration Agreement**. This agreement, issued by the Department of Fish and Game, is necessary to perform any physical manipulation of the stream, including vegetation, within the high water mark. (Fish and Game Code, Sections (1601/1603)

- **U.S. Army Corps of Engineers 404 Permit**. This permit, required pursuant to the Clean Water Act, may or may not be needed, but if the project proposes removal or placement of any materials in the stream area, or if the project area is a wetland, then the project proponent must apply to the Corps of Engineers to determine if a permit is necessary.

- **U.S. Army Corps of Engineers Section 10 Permit**. This permit, required pursuant to the Harbors and Rivers Act, is to be obtained for any construction between high water marks of navigatable rivers.

- **Section 401 of the Clean Water Act**. Section 401 of the Clean Water Act requires that the California Regional Water Quality Control Board determine consistency between proposed projects, California water quality laws, and certain sections of the Clean Water Act. The California Regional Water Quality Control Board has established specific procedures for implementing this section. The project proponent may be required to submit a "Request for Certification" form to the California Regional Water Quality Control Board.

- **Department of Fish and Game Trapping and Rearing Permit**. If your restoration project is for to rearing fish, then a trapping and rearing permit must be obtained from the Department before any fish may be handled. This permit process requires the applicant to submit and have approved a five-year management plan before the permit will be issued (Appendix B). Contact the local DFG district fishery biologist.

- **County and State Right-of-Way permits**. If your project is near any roads it could require agreements or permits with county and state public works departments. In addition, many counties have ordinances against working within a riparian corridor along a stream area. This usually falls under the county planning department.

- **State Lands Commission**. State Lands Commission is a permitting agency responsible for riverbed lands owned in fee by the State as sovereign lands, subject to the public trust for water-related commerce, navigation, fisheries, recreation, open space, and habitat. Project proponents should contact the State Lands Commission to determine if the project falls under Commission jurisdiction.

- **California Environmental Quality Act (CEQA)**. Anytime an individual or a group (including public agencies), contracts with the Department of Fish and Game for fish habitat restoration projects, an environmental review is necessary. Individuals or groups conducting habitat restoration projects in a volunteer capacity may also need to have an environmental review of proposed projects, and should discuss proposed projects with the DFG district fishery biologist during the planning stages.

- **National Environmental Policy Act (NEPA).** This applies to projects which are carried out, financed, or approved in whole or part by federal agencies.

- **National Marine Fisheries Service (NMFS)**. Written authorization must be obtained for any activities that may impact a federally listed species.

California Environmental Quality Act (CEQA)

Anytime an individual or group enters into a contract with the Department of Fish and Game, or the Wildlife Conservation Board, an environmental review of the project is necessary. A "project" is defined as any action which may result in a physical change in the environment. This is the case in any fish habitat restoration project.

POLICY

California Department of Fish and Game (DFG) policy requires that consideration of potential environmental impacts of all actions is of highest priority, and that DFG shall involve affected Federal, State, and local agencies, private organizations, and members of the public to the fullest extent practicable in the environmental assessment process.

PROCESS

Fish and Game personnel will conduct an internal informal consultation with appropriate staff to determine CEQA documentation needed for its projects based on interpretation of the CEQA statutes and guidelines. Projects may be found to be categorically exempt. If this is the level of documentation necessary then a categorical exemption will be prepared, circulated within the Department, and then filed in the Governor's Office of Planning and Research, State Clearinghouse. If projects do not qualify for this exemption, then it is raised to the next level of environmental review, Negative Declaration. If a Negative Declaration is not sufficient then an Environmental Impact Report (EIR) must be prepared.

CATEGORICAL EXEMPTION

Categorically exempt projects are those which fall within one of many classes which have been determined by the Secretary for Resources not to have significant adverse environmental effects. An environmental checklist (example 3) and initial study is used to determine if the project is categorically exempt.

NEGATIVE DECLARATION

A negative declaration consists of an initial study, environmental checklist and a formal finding that the project will not have a significant adverse effect. The document contains: 1) description and title of the project; 2) location of the project with accompanying maps; 3) proposed finding that the project will not have significant adverse effect on the environment; 4) copy of the initial study documenting reasons to support the finding; and 5) mitigation measures, if any, included in the project to avoid potentially significant negative effects.

ENVIRONMENTAL IMPACT REPORT

An Environmental Impact Report is an informational document that must be considered by each affected agency prior to its approval or disapproval of a project. Environmental Impact Reports provide agencies and the public with detailed information about the environmental effects of proposed projects; lists ways in which the significant effects of such a project might be minimized; and indicates alternatives to projects. This level of review is time consuming and expensive and would reduce the cost effectiveness of most fish habitat restoration projects.

EXAMPLE
(RIPARIAN AREA MANAGEMENT PLAN AGREEMENT)
ACME STUMP GRUBBERS
P.O. Box 456
Halfway Hill, CA 95677

RIPARIAN AREA MANAGEMENT PLAN AGREEMENT

I. PURPOSE

The following agreement details the requirements of both the landowner and the Acme Stump Grubbers regarding a livestock exclusion, riparian vegetation restoration project on the real property controlled by the landowner named below. Said property is located approximately two miles upstream of the mouth of Trickle Creek, tributary to Ample Creek (see map attached to proposal).

I, _____, hereinafter called "Landowner", am aware that a riparian vegetation restoration project has been submitted to the California Department of Fish and Game for funding consideration. I understand the objectives of the project as proposed in the Trickle Creek Stream Restoration Project #1. The project has been explained to me by Acme Stump Grubbers. I support the goals of the project.

For the purpose of this agreement, riparian area shall be defined as the area, including the necessary fence(s), between the fence(s) and the middle of the stream channel. This specifically includes the stream bank and associated vegetation within this area.

I understand the purpose of the livestock exclusion fence detailed in the proposal mentioned above is to exclude livestock from the riparian zone on my property. The fence will allow mature riparian vegetation to become reestablished. A mature riparian community will provide increased stream bank stability, shade and cover for fish and wildlife. The project can only be successful if the fence is maintained long enough for the riparian community to become reestablished.

II. REQUIREMENTS

Acme Stump Grubbers agrees to:

1. Contingent on receiving funding from the California Department of Fish and Game, provide monies for purchase of materials and supplies to construct livestock exclusion fencing on landowners real property as described in proposal.

2. Provide labor necessary for initial installation of livestock exclusion fencing on landowner's real property.

3. Provide technical assistance during the contract life for management of the riparian area.

Landowner agrees to:

1. Maintain livestock exclusion fence(s) for a period of 10 years from the last date of execution shown below. Maintenance will include repair of fences to a level that will effectively exclude livestock from the livestock exclusion project area. Maintenance will not include damage that exceeds 50 percent of the fence due to natural disaster.

2. Totally exclude livestock from the project area until newly planted trees become well-established. If controlled, limited grazing is essential, landowner will submit a written plan, to the California Department of Fish and Game for approval, that will detail how the limited grazing will not cause damage to desirable vegetation or stream banks within the project area.

3. Once it has been established by the California Department of Fish and Game that limited grazing within the project area is acceptable, grazing will be limited to an amount that will not cause damage to the newly planted trees or stream banks. Generally acceptable limits will be to remove 50 percent of the current year growth of grasses and forbs. Livestock shall be removed before they begin to browse on woody plants. Newly planted trees damaged by browsing will be replaced at landowners expense.

III. DURATION OF NOTICE

The term of this agreement shall be _____ months for work performance, and 10 years for maintenance, inspection, and monitoring purposes from the last date of execution shown below. This is provided that Acme Stump Grubbers or the California Department of Fish and Game shall give Landowner reasonable actual notice prior to each needed access. Reasonable and actual notice may be given by mail, in person, or by telephone.

This agreement can be amended only by prior written agreement of both parties executing this permit.

IV. LIABILITIES

Reasonable precautions will be exercised by Acme Stump Grubbers to avoid damage to persons and property.

Acme Stump Grubbers agrees to indemnify and hold harmless the landowner and agrees to pay for reasonable damages proximately caused by reason of the uses authorized by this permit, except those caused by the gross negligence or intentional conduct of the landowner.

Date _____

_____
Landowner Signature

Date _____

_____
Chuck E. Chainsaw
Acme Stump Grubbers

EXAMPLE
(LANDOWNER AGREEMENTCCOOPERATIVE FISH REARING PROJECTS)
Dry Creek Salmon Enhancement Project
P.O. Box 123, Pine Valley, CA 95678
Access/Entry Agreement

I. PURPOSE

The following agreement details requirements of both the landowner and the Dry Creek Salmon Enhancement Project regarding establishment of a fishery enhancement project on real property controlled by the landowner named below. Said property is located four and one half miles from the mouth of Dry Creek, tributary to Muddy River (See map attached to proposal).

I, _____, hereinafter referred to as "Landowner", am aware that a fish rearing facility and trapping sites are located on Dry Creek, tributary to Muddy River, located on Big Trees Lumber Company property. The project has been explained to me by the Dry Creek Salmon Enhancement Project. I support the goals of the project.

II. ACCESS PERMISSION

Landowner hereby grants Dry Creek Salmon Enhancement Project and California Department of Fish and Game representatives permission to enter onto real property owned by the Landowner to perform pre-project evaluation; and, if an agreement for the project is entered into between the Dry Creek Salmon Enhancement Project and the California Department of Fish and Game, Landowner grants permission to perform the fishery enhancement work, to conduct field inspections, and to monitor project for needed maintenance or equipment removal for the life of the project. Access shall be limited to those portions of landowner=s real property where actual fishery enhancement work is to be performed and those additional portions of real property which must be traversed to gain access to the work site.

III. DURATION OF NOTICE

The term of this agreement shall commence upon signing of this Agreement and terminate on _____. This Agreement may be terminated by either party at any time, without cause, upon sixty (60) days written notice to the other party.

IV. LIABILITIES

Reasonable precautions will be exercised by Dry Creek Salmon Enhancement Project to avoid damage to persons and property.

Dry Creek Salmon Enhancement Project agrees to indemnify and hold harmless the landowner and agrees to pay for reasonable damages proximately caused by reason of the uses authorized by this permit, except those caused by the gross negligence or intentional conduct of the landowner.

Date _____ _____
Landowner Signature

Date _____ _____
Bob R. Float
Dry Creek Salmon Enhancement Project

ENVIRONMENTAL CHECKLIST FORM

PROJECT LOCATION: _____ City _____ County

PROJECT ADDRESS: _____

_____

PROJECT DESCRIPTION: _____

_____

_____

ENVIRONMENTAL IMPACTS:

(CEQA requires that an explanation of all "yes" and "maybe" answers be provided along with this checklist, including a discussion of ways to mitigate the significant effects identified. You may attach separate sheets with the explanations.)

		Yes	**Maybe**	**No**
I.	EARTH. *Will the proposal result in:*			
a.	Unstable earth conditions or changes in geological substructures?	_____	_____	_____
b.	Disruptions, displacements, compaction or overcovering of the soil?	_____	_____	_____
c.	Change in topography or ground surface relief features?	_____	_____	_____
d.	The destruction, covering or modification of any unique geologicor physical features?	_____	_____	_____
e.	Any increase in wind or water erosion of soils, either on or off the site?	_____	_____	_____

	Yes	Maybe	No
f. Changes in deposition or erosion of beachsands, or changes in siltation, deposition or erosion which may modify the channel of a river or stream or the bed of the ocean or any bay, inlet or lake?	_____	_____	_____
g. Exposure of people or property to geologic hazards, such as earthquakes, landslides, mudslides, ground failure, or similar hazards?	_____	_____	_____
II. WATER. *Will the proposal result in:*			
a. Substantial changes in currents, or the course of direction of water movements, in either marine or freshwaters?	_____	_____	_____
b. Changes in absorption rates, drainage patterns, or the rate and amount of surface runoff?	_____	_____	_____
c. Changes in the amount of surface water in any water body?	_____	_____	_____
d. Discharge into surface waters, or in any alteration of surface water quality, including, but not limited to, temperature, dissolved oxygen, petroleum products or turbidity?	_____	_____	_____
e. Change in the quantity of ground waters, either through direct additions or withdrawals, or through interception of an aquifer by cuts or excavations?	_____	_____	_____
f. Substantial reduction in the amount of water otherwise available for public water supplies?	_____	_____	_____
g. Exposure of people or property to water related hazards such as flooding or tidal waves?	_____	_____	_____

	Yes	Maybe	No
III. PLANT LIFE. *Will the proposal result in:*			
a. Change in the diversity of species, or number of any species, including upland, riparian and aquatic plants?	_____	_____	_____
b. Reduction of the numbers of any unique, rare, or endangered species of plants?	_____	_____	_____
c. Introduction of new species of plants into an area, or in a barrier to the normal replenishment of existing species?	_____	_____	_____
d. Reduction in acreage of any agricultural crop?	_____	_____	_____
IV. ANIMAL LIFE. *Will the proposal result in:*			
a. Change in the diversity of species, or numbers of any species of animals (birds; land animals, including reptiles; fish and shellfish; benthic organisms or insects)?	_____	_____	_____
b. Reduction of the numbers of any unique, rare, or endangered species or animals?	_____	_____	_____
c. Introduction of new species of animals into an area, or result in a barrier to the migration or movement of animals?	_____	_____	_____
d. Deterioration to existing fish or wildlife habitat?	_____	_____	_____
e. Result in activities during sensitive life stages, i.e. nesting, spawning, incubation, fry emergence, etc.	_____	_____	_____
V. NOISE.			
a. Will the proposal result in increases in existing noise levels?	_____	_____	_____

	Yes	Maybe	No
VI. LAND USE.			
a. Will the proposal result in substantial alteration of, or conflict with, the present or planned land use of an area, i.e. mining or timber harvest?	_____	_____	_____
VII. NATURAL RESOURCES.			
a. Will the proposal result in an increase in the rate of use of any natural resources?	_____	_____	_____
VIII. RISK OF UPSET. *Will the proposal involve:*			
a. A risk of an explosion or the release of hazardous substances (including, but not limited to oil, pesticides or chemicals) in the event of an accident or upset conditions?	_____	_____	_____
b. Possible interference with an emergency response plan or an emergency evacuation plan?	_____	_____	_____
IX. TRANSPORTATION/CIRCULATION. *Will the proposal result in:*			
a. Generation of substantial additional vehicular movement?	_____	_____	_____
b. Substantial impact upon existing transportation systems?	_____	_____	_____
X. PUBLIC SERVICES. *Will the proposal have an effect upon, or result in a need for new or altered governmental services in any of the following areas:*			
a. Parks or other recreational facilities?	_____	_____	_____
b. Maintenance of public facilities, including roads?	_____	_____	_____

	Yes	Maybe	No
XI. HUMAN HEALTH.			
a. Will the proposal result in exposure of people to potential health hazards?	_____	_____	_____
XII. AESTHETICS. *Will the proposal result in:*			
a. The obstruction of any scenic vista or view open to the public?	_____	_____	_____
b. The creation of an aesthetically offensive site open to public view?	_____	_____	_____
XIII. RECREATION.			
a. Will the proposal impact upon the quality or quantity of existing recreational opportunities including boating or kayaking?	_____	_____	_____
XIV. CULTURAL RESOURCES. *Will the proposal:*			
a. Result in the alteration of or the destruction of a prehistoric or historic archaeological site?	_____	_____	_____
b. Result in adverse physical or aesthetic effects to a prehistoric or historic building, structure, or object?	_____	_____	_____
c. Have the potential to cause a physical change which would affect unique ethnic cultural values?	_____	_____	_____
d. Restrict existing religious or sacred uses within the potential impact area?	_____	_____	_____

	Yes	Maybe	No
XV. MANDATORY FINDINGS OF SIGNIFICANCE.			
a. **Potential to degrade:** Does the project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community,reduce the number or restrict the range of a rare or endangered plant or animal or eliminate important examples of the major periods of California history or prehistory?	_____	_____	_____
b. **Short-term:** Does the project have the potential to achieve short-term, to the disadvantage of long-term, environmental goals? (A short-term impact on the environment is one which occurs in a relatively brief, definitive period of time. Long-term impacts will endure well into the future.)	_____	_____	_____
c. **Cumulative:** Does the project have impacts which are individually limited, but cumulatively considerable? (A project may impact on two or more separate resources where the impact on each resource is relatively small, but where the effect on the total of those impacts on the environment is significant.)	_____	_____	_____
d. **Substantial adverse:** Does the project have environmental effects which will cause substantial adverse effects on human beings, either directly or indirectly?	_____	_____	_____

XVI. DISCUSSION OF ENVIRONMENTAL EVALUATION. (If more room is needed attach explanations to checklist.)

XVII. DISCUSSION OF LAND USE IMPACTS. (If more room is needed attach explanations to checklist.)

(Note: This is only a suggested form pursuant to CEQA Guidelines, Section 15063(d). Public agencies are free to devise their own format for initial studies. However, the DETERMINATION is an essential component of this form.)

APPENDIX O.

TEN PERCENT SAMPLING PROTOCOL FOR HABITAT TYPING INVENTORY SURVEYS

Since 1990 numerous anadromous salmonid streams in California have been inventoried for fish habitat utilizing fish habitat typing methods described by Flosi and Reynolds (1994). Habitat typing involves the identification, description, and measurement of distinct fish habitats within the wetted channel. Surveyors usually begin at the mouth of a stream and proceed upstream. They identify each fish habitat type and record up to 35 individual measurements or observations for each habitat type unit. Typically, this method is applicable in first through fourth order streams with an average wetted width of less than 75 feet. These streams can usually be waded. A team of two experienced surveyors are able to complete about one-half mile of stream (or about 100 habitat units) per day. The primary use of fish habitat typing data by the Department of Fish and Game, and others, is to identify and prioritize streams or stream reaches in need of restoration. The resulting stream descriptions are considered a general "basin level" view for planning purposes and not a rigorous "project level" view that describes site specific details. For example, a stream might reveal a lower than expected frequency of pools throughout the survey area, which indicates a potential restoration opportunity of deploying pool-forming structures.

Past practice has been to determine and record all characteristics of each habitat unit as called for on the Habitat Inventory Data Form. However, experience in analyzing over 200 stream habitat inventory data sets has indicated that adequate stream descriptive detail for “basin level” planning can be accomplished with a sampling level of about 10 percent. Possible strategies for subsampling habitat type units in streams or stream reaches at about a 10 percent level included:

1) a systematic sample with a random start of every tenth unit,
2) a systematic sample stratified by habitat type, where each habitat type was sampled at a pre-determined interval,
3) a 10% random sample of all habitat units,
4) a random sample within every 10 consecutive habitat units.

Each proposed sampling strategy has some drawbacks. The systematic random sample with a random start was perceived to be too non-random, except for the start. Both complete and systematic random sampling of habitat types requires prior knowledge of the population of habitat types available and is impractical for field application. A random sample of all habitat units is perhaps statistically the most sound, but might not reflect land use or ownership differences if a particular random sample allowed for no samples in some areas. Because of the desire to have samples selected throughout the entire stream reach, to avoid possible sampling gaps in some watershed ownership parcels, the stratified sampling method (strategy No. 4) was selected as the preferred sampling strategy. This sampling strategy was modified by adding to the randomly selected habitat type set, a sample set that included the first occurrence of each habitat type. This modification ensured that all habitat types were represented at least once in the entire sample.

RECOMMENDATIONS

1. Segment the stream into sub-reaches consisting of 10 consecutive habitat units. The Habitat Inventory Data Form contains spaces for 10 habitat units per page. Habitat unit numbers begin at the downstream end of the survey and continue sequentially upstream to the end of the survey area.

2. Obtain a random number table or a 10-sided die.

3. Randomly select a number from one through ten by tossing a die or using the random number table.

4. The number selected is the first randomly sampled habitat unit within the first 10 habitat units. Mark this habitat unit on Form 1 of the Habitat Inventory Data Form. Now, randomly select another number from one to ten. This is the habitat unit to randomly sample in the second set of 10 habitat units. If the number is "3", select the 3rd habitat unit on Form 2, or habitat unit No. 13. Mark this number on Form 2 of the Habitat Inventory Data Form. Continue selecting random numbers and marking forms to indicate random habitat units until you have enough forms for the day.

   Hint: use a felt tipped marking pen to highlight the entire column of the randomly selected unit.

5. Begin the survey at the downstream end of a stream, reach or stream channel type change.

6. The actual survey involves:
   a. Walk and measure the entire stream length.
      1). Identify every habitat unit by type.
      2). Measure the length of each unit.

   b. Record all measurements and observations (complete sample) for each first-time encounter of each habitat type found in a stream channel type reach.

   c. Record all measurements and observations (complete sample) for every randomly selected habitat unit number.

   Optimizing pool habitat is a high priority for restoration projects. To enable these survey data to function as a crude monitoring tool of pool scour and deposition dynamics, including relative quality of spawning substrate in pool tail crests, the following parameters are recommended for each pool habitat:

d. Measure maximum depth, pool tail crest depth and pool tail embeddedness in all pool habitat types.

Another high priority restoration prescription is improvement of riparian canopy density. To enable graphic display and analysis of canopy densities linearly along a stream reach, the following is recommended:

e. Determine canopy density in at least every third habitat unit.

Refer to following example:

EXAMPLE HABITAT INVENTORY SURVEY PROCEDURE FOR MODIFIED 10 PERCENT RANDOM SAMPLE

Random numbers: 6, 3, 4, 9, 4, 3, 8, 5, 2, 7, 6, 6, 1

Habitat unit No.	Habitat type	Action
1	LGR	Complete sample, first occurrence
2	RUN	Complete sample, first occurrence
3	MCP	Complete sample, first occurrence
4	LGR	Length and habitat type only
5	RUN	Length and habitat type only
6 Random	LSL	Complete sample, random selection
7	GLD	Complete sample, first occurrence
8	LGR	Length and habitat type only
9	LSR	Complete sample, first occurrence
10	RUN	Length and habitat type only
11	LGR	Length and habitat type only
12	MCP	Length, habitat type, max depth, pool tail depth and embeddedness, canopy
13 Random	RUN	Complete sample, random selection
14	LGR	Length and habitat type only
15	CRP	Complete sample, first occurrence
16	POW	Complete sample, first occurrence
17	RUN	Length and habitat type only
18	LSL	Length, habitat type, max depth, pool tail depth and embeddedness
19	LGR	Length and habitat type only Canopy
20	GLD	Length and habitat type only
21	PLP	Complete sample, first occurrence
22	LGR	Length and habitat type only
23	LSR	Length, habitat type, max depth, pool tail depth and embeddedness
24 Random	LGR	Complete sample, random selection
25	RUN	Length and habitat type only

Habitat unit No.	Habitat type	Action
26	GLD	Length and habitat type only
27	LSBo	Complete sample, first occurrence
28	SRN	Complete sample, first occurrence
29	LSR	Length, habitat type, max depth, pool tail depth and embeddedness
30	LGR	Length and habitat type only
-----Stream channel type changes to A3 - defines a NEW reach		
31	LSB	Complete sample. first occurrence
32	HGR	Complete sample, first occurrence
33	POW	Complete sample, first occurrence
34	PLP	Complete sample, first occurrence
35	LGR	Complete sample, first occurrence
36	RUN	Complete sample, first occurrence
37	LSB	Length, habitat type, maximum depth, pool tail depth and embeddedness
38	HGR	Length and habitat type only
39 Random	CCP	Complete sample, random selection
40	LGR	Length and habitat type only

APPENDIX P.

CALIFORNIA SALMONID FISHES

Anadromous Species

Taxonomy. Since recent taxonomic changes have included steelhead and cutthroat within the genus *Onchorhynchus*, there are now four species of salmon found in California streams in significant numbers. They are chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*Oncorhynchus kisutch*), steelhead trout (*Oncorhynchus mykiss*), and coast cutthroat (*Oncorhynchus clarkii*). These species are generally found along the west coast of the North American continent from the Bering Sea to central California, with coast cutthroat range and population numbers more limited than the others towards the south. Typically, the fish farther north grow slower and remain longer in fresh water as juveniles before migrating to the ocean and beginning their rapid growth phase in salt water. Specifics of the life cycles of these fish vary from place to place depending on climate, food supply, and other critical factors.

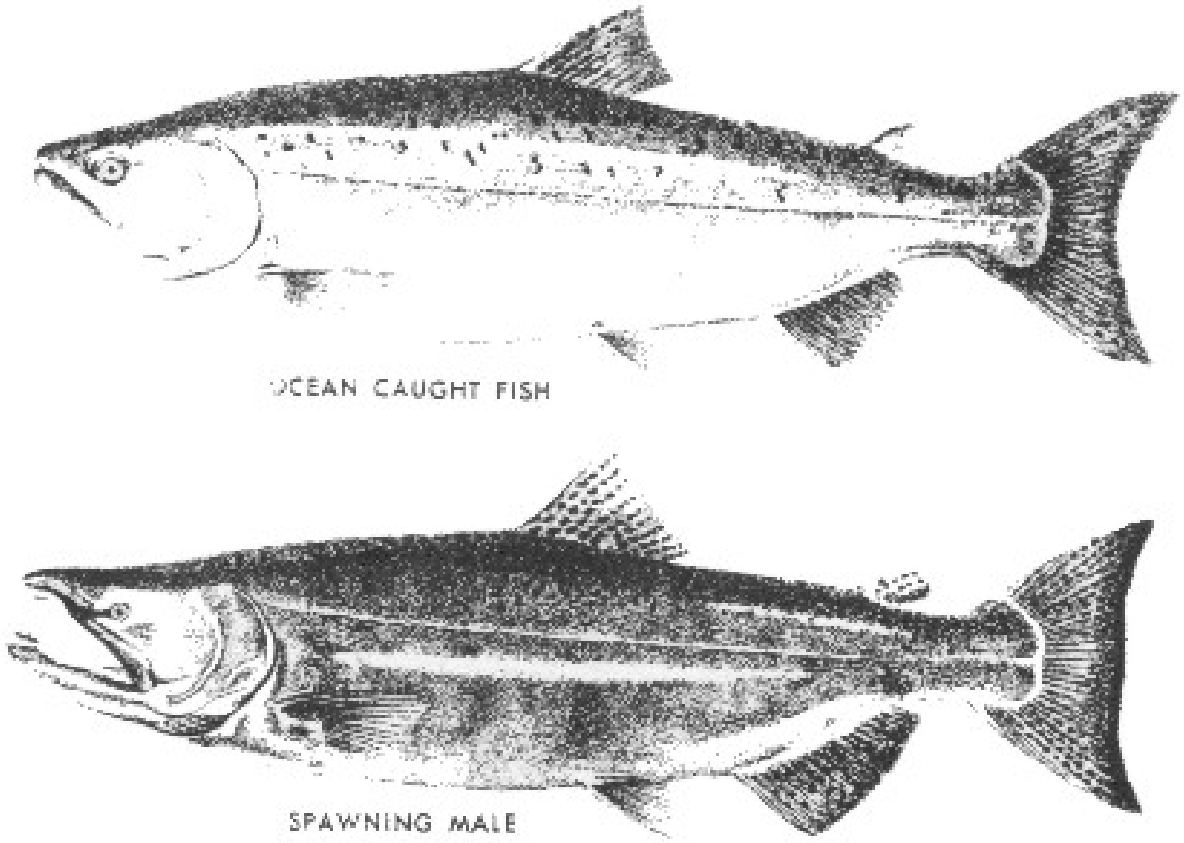
Races. The term "race", as used here, describes temporal occurrence of upstream migrating adults within a river system, and is not meant to imply any genetic distinction between different "races" of the same species. Races of anadromous salmonids are presently identified according to the time of year the adult fish first enter fresh water, although some are identified by their geographic range. Therefore, a spring-run steelhead, sometimes called a "summer steelhead" because it is seen in fresh water during the summer, is a steelhead trout that usually begins its upstream migration in the springtime. In California there are spring-, fall-, and winter-run steelhead trout; spring-, fall-, late-fall-, and winter-run chinook salmon; and fall- and winter-run coho salmon. Information on coast cutthroat trout is inadequate to say much more than that they are variable.

Chinook salmon that enter coastal streams in early winter have a shorter freshwater journey and spawn much earlier than Sacramento River winter-run chinook. Coastal "winter-run" chinook that spawn almost immediately after entering fresh water are more properly classed as late fall-run, whereas the Sacramento River winter-run spawning does not begin until April or May. Sacramento River winter-run chinook spawn in June, July, and August. Almost all north coast salmon spawning occurs from mid-November through February. Steelhead spawning seasons begin a little later and run into April.

There are flow timing differences between streams, and all streams do not support the same species or races of salmonids. For example, timing for the adult run of salmon and steelhead in the Klamath River system is typically earlier than for the Eel or Smith Rivers. Many coastal streams (including the Eel and Smith Rivers) do not have sufficient flows to allow adult migration until rains have increased discharge in November and December. In such streams, low flows control upstream migration timing and, therefore, spawning cycles.

Adult Life Histories

Chinook Salmon



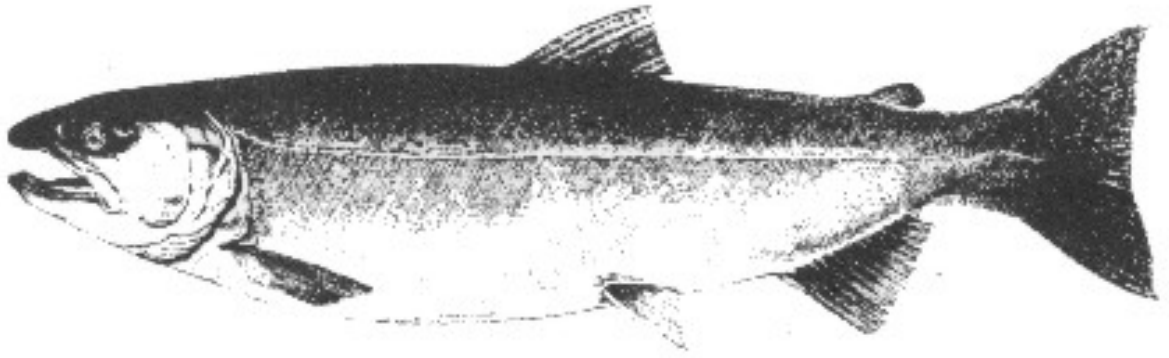
Chinook salmon runs are categorized by the time of year during which they enter the river systems on their spawning migration. In California's coastal rivers there are two clearly identified runs, or races, of chinook salmon. They are fall-run and spring-run. Fall-run chinook leave ocean waters and begin to enter the river systems in late August and September, and then proceed upstream if water temperatures are cool enough and if flow is adequate to allow their passage (Table P-1). If conditions in the river are not suitable, fall-run chinook remain in the ocean or in the lower river sections until early season storms raise stream flow and provide cooler water. Spawning usually occurs from October through January. Spring-run chinook enter river systems during the spring runoff period, remain in fresh water through the summer months, and begin spawning the following fall a little earlier than the fall-run fish. Spring-run spawning is usually completed from the end of September to mid-October. These fish have been designated as a species of special concern in California. In rivers that have both spring-and fall-run chinook, the spawning periods may overlap for several weeks. California also has late-fall-run and winter-run chinook, but they have only been formally identified in the Sacramento River system. The Sacramento River winter-run chinook salmon has been designated by the State of California and the United States Government as endangered.

Chinook salmon are riffle spawners and typically construct redd (nest) sites near the head of riffles in gravel 6 inches (15 cm) or less in diameter. During courtship, the female may dig several false redds before actually spawning, and communal or multiple redds are common under crowded conditions. As the female releases her eggs into the redd an attending male or males fertilize them. Upon completion of the spawning act, the female covers the eggs with 8-14 inches (20-36 cm) of gravel.

Chinook salmon die after spawning. During the period between spawning and death, the female may remain near or over the redd which may discourage excavation by other salmon that are seeking suitable places to spawn.

Eggs develop in gravel for about eight weeks (50-60 days) before hatching, depending on water temperatures (Table P-1). After absorption of the yolk sac, young salmon emerge from the gravel and begin actively foraging. Passive downstream movement of young chinook salmon begins shortly after emergence. Downstream movement is nearly complete by late June, at which time river flows are decreasing. At this time young chinook salmon are 3-5 inches (8-13 cm) long, and most are actively moving downstream. Most juveniles enter the ocean as fingerlings in the spring and early summer, but some may remain in streams or estuaries and enter the ocean as yearlings in the fall.

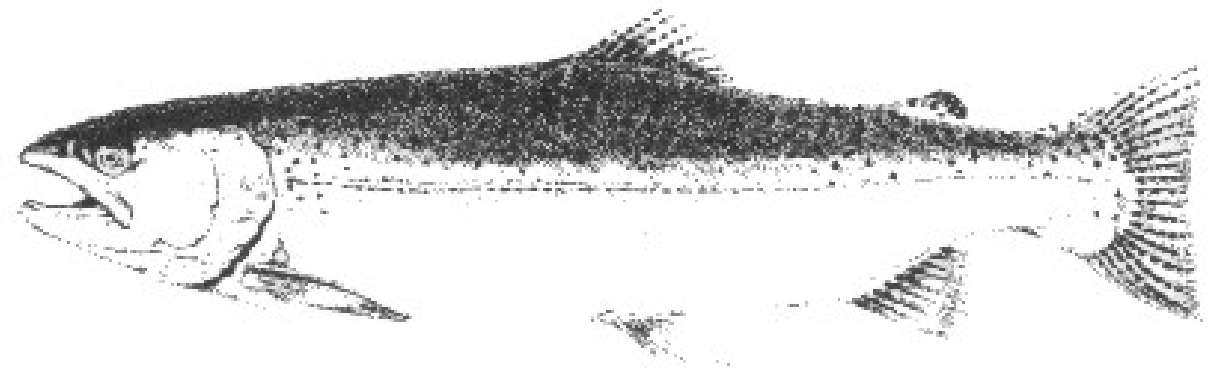
Coho Salmon



The spawning migration of coho salmon is similar to that of chinook salmon but starts later in the season. Like chinook, coho salmon are riffle spawners and their courtship and spawning are similar. Although there is some overlap of spawning habitats, coho salmon typically utilize smaller streams and gravel than do chinook.

Egg development is like that of chinook salmon, but after emergence, many coho salmon do not leave the river nursery area. Instead, coho salmon may remain a year or more before smolting (undergoing the changes necessary to enter saltwater) and entering the ocean. Yearling coho salmon enter the ocean during the spring when they are 5-6 inches long. In the smaller coastal streams, most coho enter the ocean during their first year as 1-3 inch fish.

Steelhead Trout

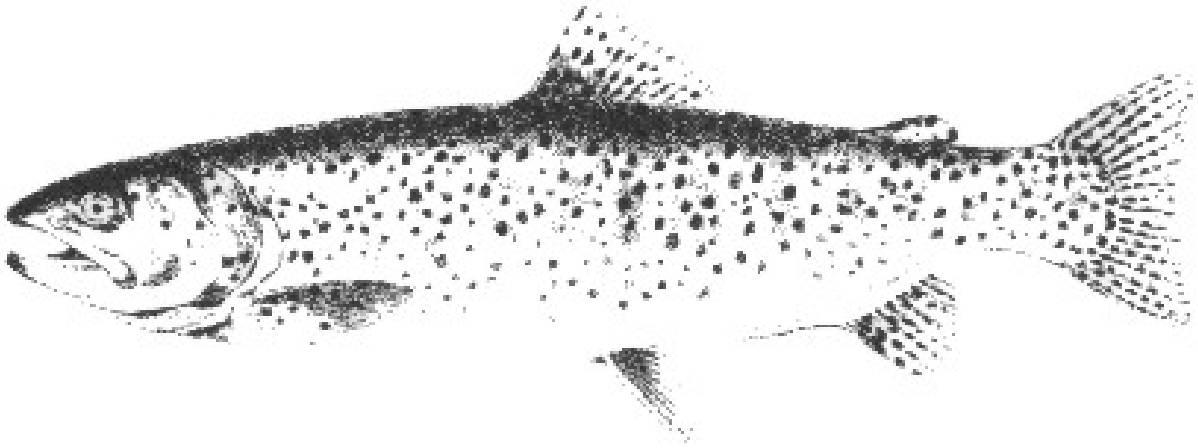


Adult steelhead enter river systems during most months of the year. Those entering during late summer through October are called fall-run steelhead, those entering during November through April are called winter-run steelhead, and those entering during May and June are called spring-run steelhead. In California, the Eel and Klamath-Trinity river systems have fall runs of predominately two-year-old steelhead returning from only two to four months in the ocean. These fish, called "half-pounders," range from 12 to 16 inches in length and do not mature to spawn during this migration.

Fall- and winter-run steelhead spawn a few weeks to a few months after they enter fresh water. Spring-run steelhead (descriptively named "summer steelhead") remain in the freshwater environment through the summer and spawn the following winter. Steelhead usually spawn in smaller tributary streams than salmon, and utilize smaller gravel. Spawning takes place from December to May. Egg development rate is temperature dependent and usually requires about 31 days at 50^{E} Fahrenheit (Table P-1).

Unlike chinook and coho, up to 50 percent of adult steelhead survive to spawn in more than one season. First-time spawners are usually three or four years old and will have spent one or two years in fresh water and one or two years in the ocean. Most steelhead enter the ocean after spending two years in freshwater.

Coastal Cutthroat Trout



Coastal cutthroat trout are found in coastal streams from the lower Van Duzen River north, within approximately 25 miles from the coast. Their upstream migration usually occurs in the late fall or early winter and, typically, spawning takes place in small streams. Coast cutthroat may not venture far in the ocean and often return to fresh water after one year or less in salt water.

Juveniles rear for two or more years in fresh water before migrating to the sea, and some fish live out their lives as freshwater residents. Reproducing populations of these fish are frequently found in small coastal streams above barriers to steelhead upstream migration. There is a valid concern that when steelhead trout are provided access to these areas, they may eliminate or partially replace the coast cutthroat trout through competition for food and living space.

Juvenile Life Histories

The rate at which salmon and trout eggs mature and hatch is controlled by their environment. Generally, if the water is above 50E Fahrenheit, oxygen supply is adequate, and silt and algae are not excessive, then the eggs develop and hatch at an optimum rate. However, if water temperature gets much above 58E Fahrenheit, the eggs will not mature (Table P-1). Various races of salmonids have evolved to spawn at the most opportune times and locations available within their home streams that will provide their eggs with the best chance for survival.

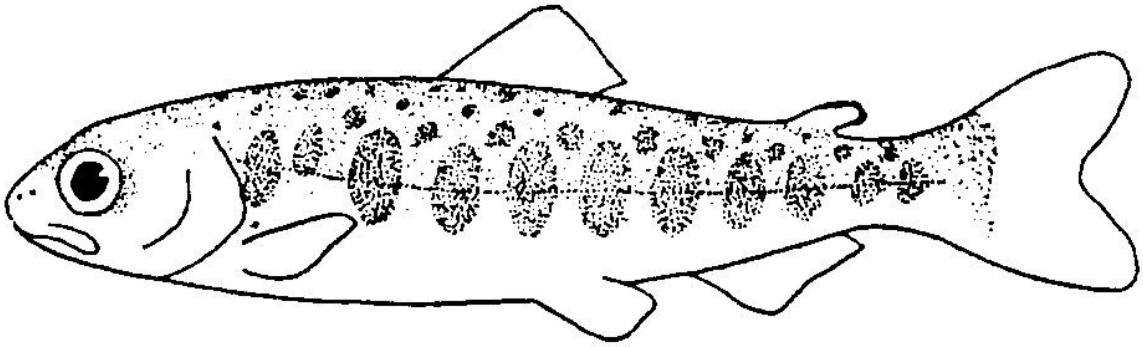
Chinook salmon juveniles may take up temporary residence in their natal environment (the surroundings where they emerged from the gravel) or they may begin to passively be carried downstream while they are feeding, and seek escape cover when threatened. Although in more northerly streams, coho typically leave fresh water as 1- or 2-year-olds, out-migration as first-year juveniles appears to be common for California coho. Juvenile coho numbers in coastal streams are observed to diminish rapidly during the spring months, and coho have been monitored moving downstream through lower stream reaches. This departure is often related to low flows and elevated water temperatures. Because adult coho return to the streams in greater numbers than could be accounted for by out migrating 1- or 2-year olds, 0-age fish apparently contribute significantly to California populations.

Juvenile salmon and steelhead have different habitat preferences in a stream. Chinook and coho

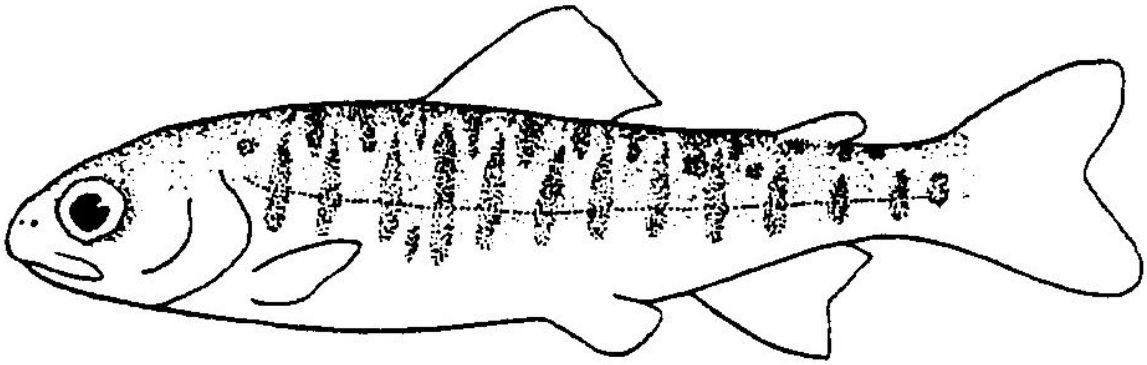
prefer pool environments, and steelhead tend to select glides and riffles. This does not mean that they will not be seen together, and their preferred feeding or resting habitat is not necessarily the habitat they will be found in when disturbed. Generally, as fish grow older and larger they require larger habitat. Therefore, if they rear for one or more years in fresh water, they will need adequate space and water quality.

Juvenile Salmonids

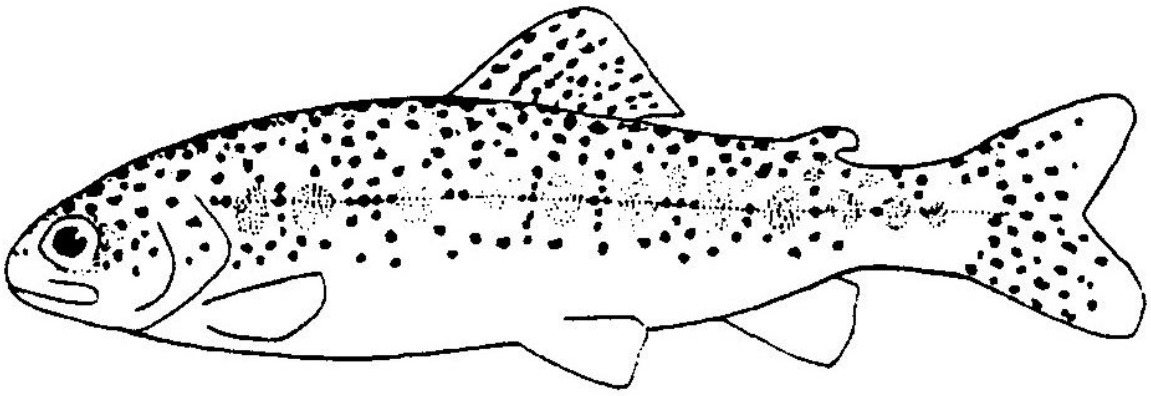
Chinook Salmon



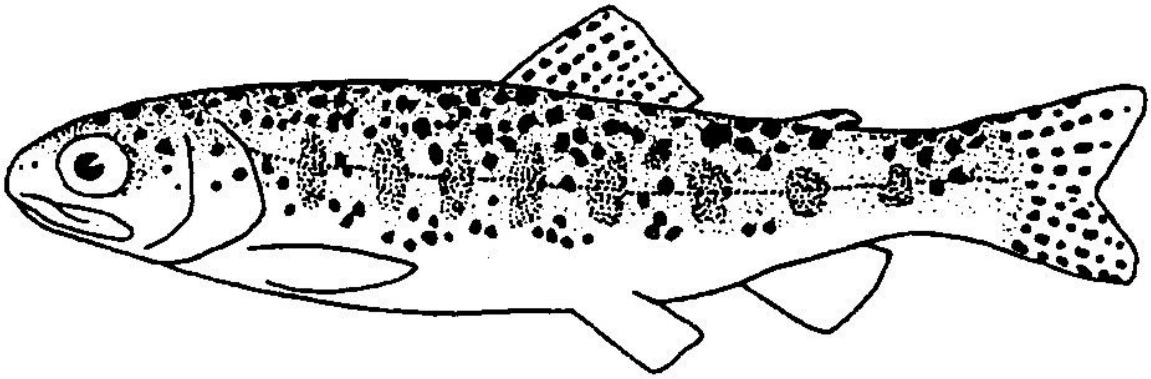
Coho Salmon



Steelhead Trout



Coastal Cutthroat Trout



Resident Species

In addition to four anadromous salmonids, there are ten species or subspecies of native resident trout, and three species of non-native resident trout in California. Coastal rainbow trout, *(Oncorhynchus mykiss irideus)*, is the most widespread and popular resident trout in California. This is the resident or non-anadromous form of steelhead trout. Eagle Lake rainbow trout, *(Oncorhynchus mykiss aquilarum)*, are a highly specialized form of rainbow, capable of surviving in highly alkaline waters. They provide a popular, hatchery supported sport fishery in Eagle Lake. The three subspecies of golden trout include: 1) Volcano Creek (S. F. Kern River) golden trout, *(Oncorhynchus mykiss aquabonita);* 2) Little Kern River golden trout, *(O. m. whitei);* and 3) Kern River rainbow trout, *(O. m. gilberti).* Although the native ranges of these species were confined to the Kern River drainage, golden trout have been transplanted in many suitable waters throughout the state. Resident forms of cutthroat trout include Lahontan cutthroat trout (*Oncorhynchus clarki henshawi*), and Paiute cutthroat trout (*O. c. seleniris*). Lahontan cutthroat trout are the most widespread and the more popular sport fish of the two. California is also home to three remnant populations of redband trout, a close relative of the coastal rainbow. Although the taxonomic status of the redbands is presently unclear, California currently recognizes three subspecies, McCloud River redband trout (*Oncorhynchus mykiss* subspecies.), Goose Lake redband trout (*O. c.* subspecies), and Warner Lakes redband trout (*O. c.* subspecies). One native species of char, the

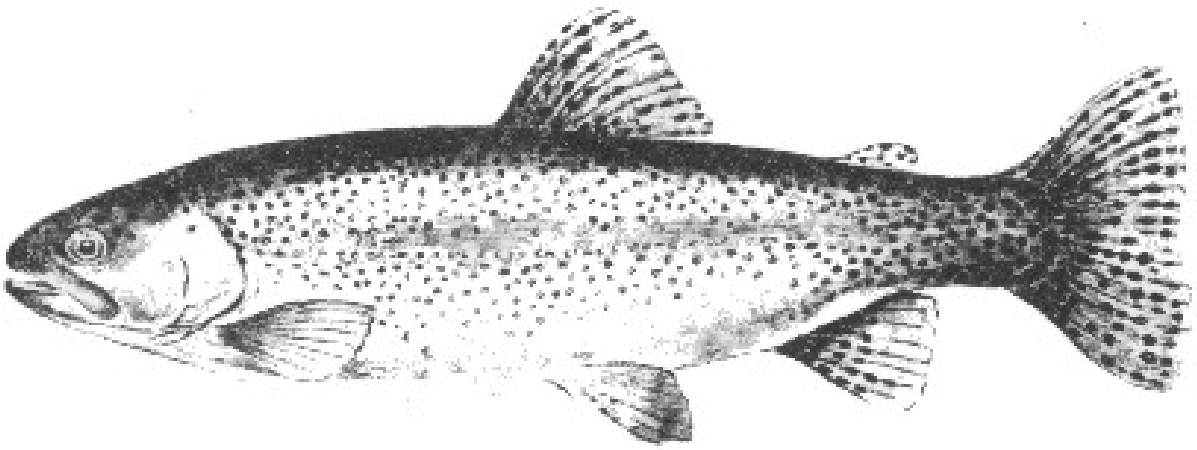
bull trout (*Salvelinus confluentus*) is now extinct in California.

Two of the most popular and easily recognized trout in California are non-natives, the brown trout (*Salmo trutta*) and the brook trout (*Salvelinus fontinalis*). A third non-native trout, the lake trout (*Salvelinus namaycush*), is locally popular in Lake Tahoe. All three of these species have established self-sustaining populations in many waters throughout the state.

Finally, a landlocked form of sockeye salmon, the Kokanee (*Oncorhynchus nerka*), is planted in several reservoirs throughout northern and central California and provides a popular fishery for the trout angler.

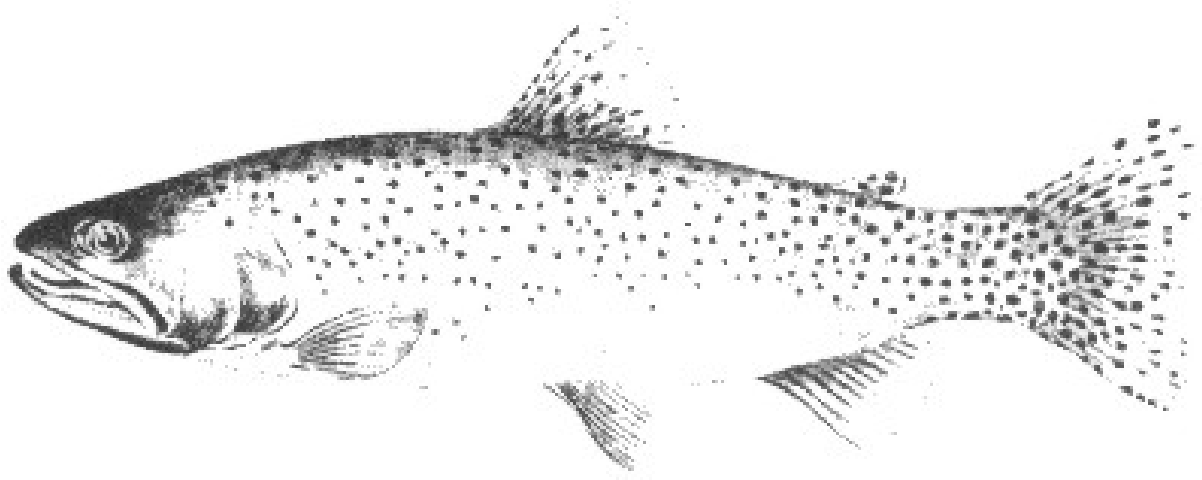
Resident salmonid adults spawn in fine gravel under conditions similar to those used by anadromous salmonids. Brook trout and Kokanee are capable of spawning in both streams and lake margins. Juvenile resident salmonids frequently rear and live out their life span in the immediate vicinity of their birthplace. Others may move downstream to larger streams or, like Kokanee, migrate to a lake environment.

Rainbow Trout



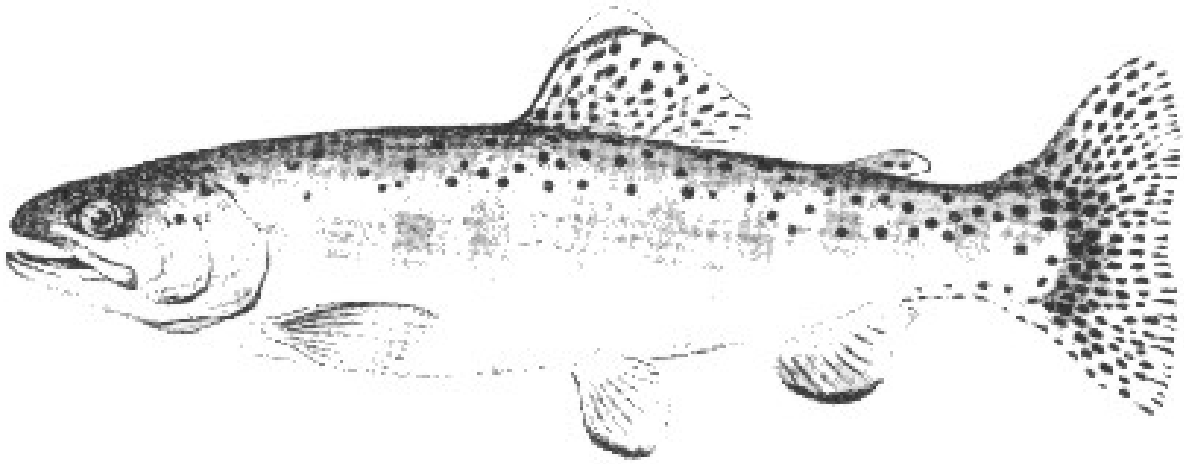
Rainbow trout are native and, partly as a result of being the fish most commonly raised and planted from the hatchery system, are widely distributed throughout California streams. They normally spawn in the spring in cold streams (50^{E}-58^{E} Fahrenheit) and rarely attain the size of steelhead (anadromous rainbow trout).

Lahontan Cutthroat Trout



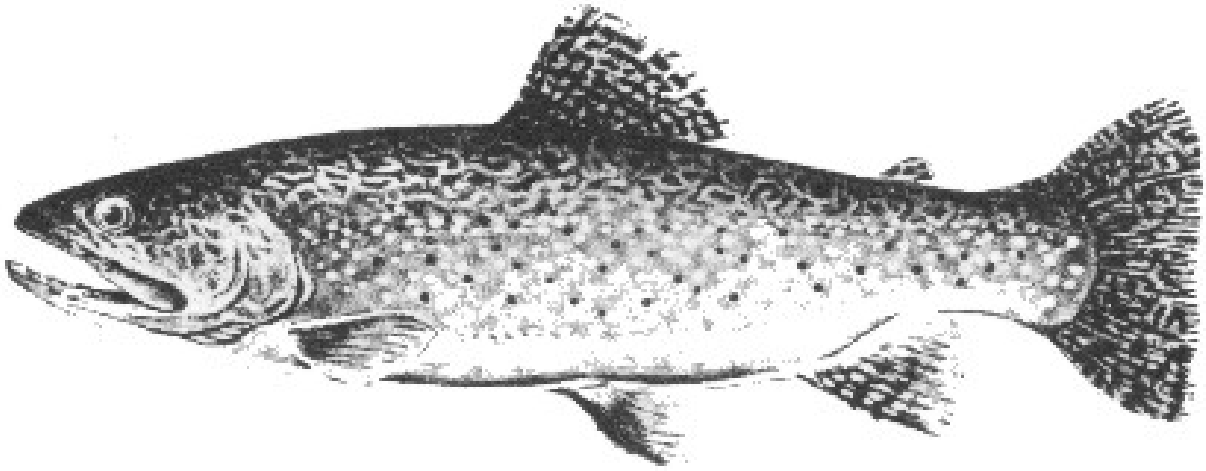
Lahontan cutthroat trout are native to the Truckee, Walker, and Carson River drainages on the east side of the Sierra Nevada in California. Their close relative in California, the Paiute cutthroat trout has a more restricted distribution on the east side of the Sierra Nevada range. These fish are a federally designated threatened species. Resident cutthroat trout are cold water spring spawners. The range of Lahontan cutthroat trout has been expanded by hatchery programs, but is generally limited to higher elevation streams and lakes.

Golden Trout



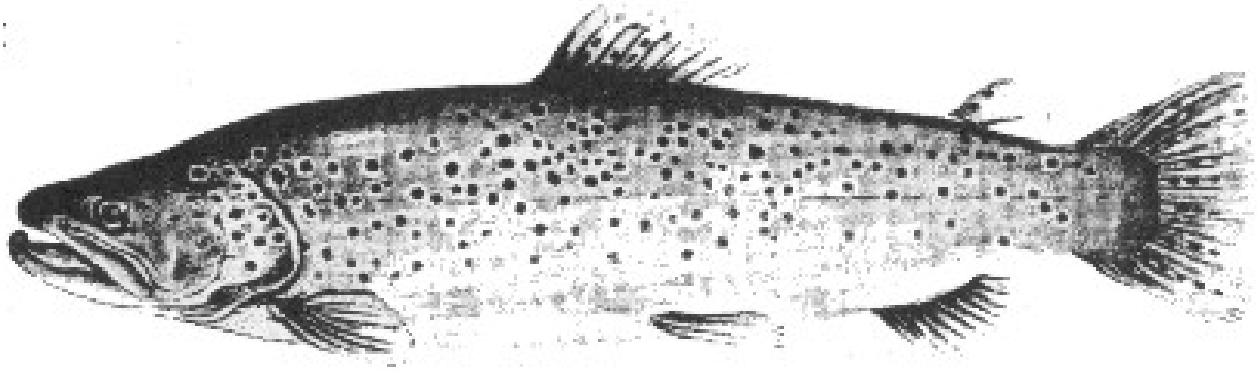
Found native to a few high-elevation streams in the Kern River drainage, this species has been successfully introduced to several other drainages. They are adapted to small, high-elevation waters and provide a specialized recreational opportunity. Spawning occurs in the spring as water temperatures increase in the small high mountain streams. The Little Kern golden trout is a federally threatened species, and the Volcano Creek golden trout is a species of special concern.

Brook Trout



Brook trout, not native to California, have been planted throughout most of the state's trout waters. It is a prolific fall spawner in high-mountain lakes, reservoirs, and streams. Overabundance and stunting have been a recurrent problem in many areas, and hatchery production and planting of brook trout is limited to a few waters where recreational harvest or natural kills control the population.

Brown Trout



Brown trout, another non-native fish, are widely scattered throughout California as a result of experimental and management planting in most of the state's inland trout waters. They are abundant in only a few areas, and tend to tolerate warmer water (55^{E}- 60^{E} Fahrenheit) than rainbow trout. Large brown trout are particularly picivorous and aggressive, and in warmer waters, tend to out compete other trout species. Spawning occurs in fall and early winter.

Table P-1. Temperature requirements, degrees Fahrenheit, for various life stages of salmon and steelhead (Reisner and Bjornn, 1979).

Species	Adult migration	Spawning	Incubation	Juvenile rearing
Chinook				
Fall	51 - 67	42 - 57	41 - 58	45 - 58
Spring	38 - 56	42 - 57	41 - 58	57 - 67
Coho	45 - 60	40 - 49	40 - 56	53 - 58
Steehead	-	39 - 49	-	45 - 58

REFERENCES

Barnhart, R.A. 1986. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Pacific Southwest) -- Steelhead. U.S. Fish and Wildlife Service. Biol. Rep. 82 (11.60). U.S. Army Corps of Engineers, TR EL-82-4. 21 pp.

Hassler, Thomas. J., 1987. Species Profiles: life histories and environmental requirements of coastal fishes and invertebrates (Pacific Southwest) -- Coho. U.S. Fish and Wildlife Service Biol. Rep. 82 (11.70). U.S. Army Corps of Engineers, TR EL-82-4. 19 pp.

Reiser, D.W., T.C. Bjornn. 1979. Habitat requirements of anadromous salmonids. Pages 1-54 *in* W.R. Meehan, ed. Influence of forest and range management on anadromous fish habitat in western America. Pacific N.W. Forest and Range Experiment Station. USDA Forest Service, Portland. General Technical Report, PNW-96.

APPENDIX Q.

GLOSSARY

Acronyms and Abbreviations:

A_{FP}	-	Flood-Prone Area
BLM	-	U.S. Bureau of Land Management
BY	-	Brood Year
CALTRANS	-	California Department of Transportation
CCC	-	California Conservation Corps
CDF	-	California Department of Forestry
cfs	-	Cubic feet per second
CEQA	-	California Environmental Quality Act
CESA	-	California Endangered Species Act
CMP	-	Corrugated Metal Pipe
CPOM	-	Course Particulate Organic Matter
CWT	-	Coded-Wire Tag
d_{bkf}	-	Bankfull Depth
DO	-	Dissolved Oxygen
DOC	-	Dissolved Organic Carbon
DOD	-	Department of Defense
DOM	-	Dissolved Organic Matter
DFG	-	Department of Fish and Game
DWR	-	Department of Water Resources
ELP	-	Environmental License Plate
EPA	-	Environmental Protection Agency
ESA	-	Endangered Species Act of 1973 (Federal)
ESD	-	Environmental Services Division, DFG
FPOM	-	Fine Particulate Organic Matter
FL	-	Fork Length
FY	-	Fiscal Year
GIS	-	Geographic Information System
GPS	-	Global Positioning System
HSA	-	Hydrologic Sub Area
IFD	-	Inland Fisheries Division, DFG
IFIM	-	Instream Flow Incremental Methodology
LDA	-	Log Debris Accumulation
LOD	-	Large Organic Debris
LWD	-	Large Woody Debris
NDDB	-	Natural Diversity Database
NEPA	-	National Environmental Policy Act
NHD	-	Natural Heritage Division, DFG
NMFS	-	National Marine Fisheries Service

NOAA	-	National Oceanic and Atmospheric Administration
Q_{bkf}	-	Bankfull Discharge
RRIF	-	Renewable Resources Investment Fund
SB	-	Senate Bill
SCS	-	Soil Conservation Services
SWD	-	Small Woody Debris
TDS	-	Total Dissolved Solids
USBR	-	U.S. Bureau of Reclamation
USCOE	-	U.S. Army Corps of Engineers
USDA	-	U.S. Department of Agriculture
USFS	-	U.S. Forest Service
USFWS	-	U.S. Fish and Wildlife Service
USGS	-	U.S. Geological Survey
W_{bkf}	-	Bankfull Width
W_{FP}	-	Flood-Prone Width
WLPZ	-	Watercourse and Lake Protection Zone
WUA	-	Weighted Usable Area
YOY	-	Young-of-Year

Abstraction: a) The long-term to permanent removal of surface flow from the channel; b) A simple type of stream capture.

Accretion: a) A process of accumulation by flowing water, whether of silt, sand, pebbles, etc.; b) Channel-flow; the gradual increase in the flow of a stream due to influent seepage.

Aggradation: The geologic process by which stream beds, floodplains, and the bottoms of other water bodies are raised in elevation by the deposition of material eroded and transported from other areas. It is the opposite of degradation.

Alkalinity: A measure of the power of a solution to neutralize hydrogen ions (H^+) usually expressed as mg/l $CaCO_3$.

Alluvial stream: Named after the silts, clays, sands, and gravels of river origin that compose their bed, banks, and floodplains, alluvial streams are characterized by a distinctive S-shaped channel pattern that is free to shift slowly (meander) in the valley. Repeated bank cavings do not widen the channel as they do in erodible bed streams. Alluvial streams have their bed materials conveyed from upstream, and they tend to be large.

Alluvium: A general term for all deposits resulting directly or indirectly from the sediment transport of streams, thus including the sediments laid down in riverbeds, floodplains, lakes, fans and estuaries.

Anchor ice: Ice formed below the surface of a stream, on the stream bed or upon a submerged body or structure.

Apparent velocity: The rate of flow of subsurface water through the substrate, expressed as the volume of water flowing per unit of time through a unit area (of solids plus voids). Also called interstitial velocity.

Armoring: a) The formation of an erosion-resistant layer of relatively large particles on the surface of the stream bed which resists degradation by water currents, resulting from removal of finer particles by erosion; b) The application of various materials to protect stream banks from erosion.

Attribute: See Habitat component.

Bank: See Stream bank.

Bank storage: Infiltration of water into stream bank material during periods of high flow.

Bankfull discharge: The discharge corresponding to the stage at which the flood plain of a particular stream reach begins to be flooded. The point at which bank overflow begins.

Bankfull stage: Corresponds to the discharge at which channel maintenance is most effective, that is, the discharge at which moving sediment, forming or removing bars, forming or changing bends and meanders, and generally doing work that results in the average morphologic characteristics of channels. The bankfull stage is the most effective or is the dominate channel-forming flow, and has a recurrence interval of 1.5 years. (Dunne & Leopold, 1978).

Bar: a) A ridge-like accumulation of sand, gravel, or other alluvium material formed in the channel, along the banks, or at the mouth of a stream where a decrease in velocity induces deposition; b) An alluvial deposit of sand, gravel, or other material, at the mouth of the stream or at any point in the stream itself which obstructs flow and induces depositions. Chamberlain (1980) gives a description of bar types as follows:

braiding - pattern of river bars with numerous interconnected small channels.

diamond/braiding - multiple diamond-shaped interconnected mid-channel bars characteristic of braided rivers.

dunes - wave-like bed form common in relatively active sand bed channels.

islands - bars or land segments within the stream channel that are relatively stable, usually vegetated, and normally surrounded by water.

junction bar - a bar formed at the junction of two streams, usually because sediment transported by a tributary is deposited in the slower-moving water of the main stream.

lee bar - a bar caused by eddies and lower current velocities and formed in the lee of large immovable objects such as boulders or logs.

mid-channel bar - bar found in the mid-channel zone, not extending completely across the channel.

point bar - bar found on the island of meander bends.

side bar - bar located at the side of a river channel, usually associated with the inside of slight curves.

transverse bar - bar that extends diagonally across the full width of the active stream channel.

Basin: See Drainage area.

Beaded Stream: A stream consisting of a series of small pools or lakes connected by short stream segments; eg., a stream commonly found in a region of paternoster lakes or an area underlain by permafrost.

Bedload: Sediment moving on or near the stream bed and frequently in contact with it.

Bedload discharge: The quantity of bed load passing a given point in a unit of time, expressed as dry weight.

Bed roughness: A measure of the irregularity of stream bed materials as they contribute to resistance to flow. Commonly measured in terms of Manning's roughness coefficient.

Benthos: Organisms living on or within a stream's substrate.

Berm: A levee, shelf, ledge or bench along a stream bank that may extend laterally into the channel to partially obstruct the flow, or parallel to the flow to contain the flow within its stream banks. May be natural or man-made.

Biomass: a) The weight of a taxon or taxa per unit of stream surface; b) Amount of substance in a population, expressed in material units, such as living or wet weight, dry weight, ash-free weight, nitrogen content, etc.; also called standing crop.

Bog: A wetland comprised of in-situ accumulations of poorly to moderately decomposed peat that are derived chiefly from sphagnum mosses. The water is acidic.

Bole: See large organic debris.

Boulder: Stream substrate particle larger than 256 mm (10 inches) in diameter. See Substrate particle size table.

Braided: A stream that divides into a interlacing or tangled network of several branching and reunited channels separated from each other by branch islands or channel bars.

Buffer strip: Vegetation strip left intact along a stream or lake after logging.

Canopy: The overhead branches and leaves of stream-side vegetation.

Canopy cover: The vegetation that projects over the stream. Can arbitrarily be divided into two levels: **Crown cover** is more than three feet (1 m) above the water surface. **Overhang cover** is less than three feet (1 m) above the water surface.

Canopy density: The percentage of the stream covered by the canopy of plants, sometimes expressed by species.

Carrying capacity: The maximum average number or biomass of organisms or a given species that can be sustained on a long term basis under a given flow regime by a stream or stream reach.

Catchment area: See Drainage area.

Channel: A natural or artificial waterway of perceptible extent that periodically or continuously contains moving water. It has a definite bed and banks which serve to confine the water.

Channelization: Straightening of a stream or the dredging of a new channel to which the stream is diverted.

Channel pattern: The configuration of a stream as seen from above. Described in terms of its relative curvature, it includes:

straight: Very little curvature within the reach.

sinuous: Slight curvature within a belt of less than approximately two channel widths.

irregular: No repeatable pattern.

irregular meander: A repeated pattern vaguely present in the channel plan. The angle between the channel and the general valley trend is less than 90 degrees.

regular meander: Characterized by a clearly repeated pattern.

tortuous meander: A more or less repeated pattern characterized by angles greater than 90 degrees.

Channel stability: A measure of the resistance of a stream to erosion that determines how well a stream will adjust to and recover from changes in flow or sediment transport.

Channel width: The horizontal distance along a transect line from bank to bank at the high water marks, measured at right angles to the direction of flow. Multiple channel widths are summed to represent total channel width.

Checkdam: A small dam designed to retard the flow of water and sediment in a channel, used especially for controlling soil erosion. Also used in channels to divert intragravel water toward surface water for interchange of dissolved gases.

Climatic year: A continuous 12-month period during which a complete annual cycle occurs. The USGS uses the period October 1 to September 30 in the publication of its records of streamflow. Also called a water year.

Cobble: Stream substrate particles between 64 and 256 mm (2.5 and 10 inches) in diameter. Syn: Rubble. See Substrate particle size table.

Colluvium: A general term for loose deposits of soil and rock moved by gravity; e.g. talus.

Community indicators: See Biological indices.

Competence: The maximum size of particle that a stream can carry. This is governed by water velocity.

Conductivity: A measure of the ability of a solution to carry an electrical current dependent on the total concentration of ionized substances dissolved in the water.

Consumptive use of water: Occurs when water is taken from a stream and not returned.

Cover: Anything that provides protection from predators or ameliorates adverse conditions of streamflow and/or seasonal changes in metabolic costs. May be instream cover, turbulence, and/or overhead cover, and may be for the purpose of escape, feeding, hiding, or resting.

Cross-sectional area: The area of a stream, channel, or waterway opening, usually taken perpendicular to the stream centerline.

Debris: Material scattered about or accumulated by either natural processes or human influences.

Debris jam: Log jam. Accumulation of logs and other organic debris.

Debris loading: The quantity of debris located within a specific reach of stream channel, due to natural processes or human activities.

Degradation: The geologic process by which stream beds and flood plains are lowered in elevation by the removal of material. It is the opposite of aggradation.

Dendric: Channel pattern of streams with tributaries that branch to form a tree-like pattern.

Density: Number of individuals per unit area/unit volume.

Deposition: The settlement or accumulation of material out of the water column and onto the stream bed. Occurs when the energy of flowing water is unable to support the load of suspended sediment.

Depth: The vertical distance from the water surface to the stream bed.

Detritus: a) A non-dissolved product of disintegration or wearing away. Pertains to organic or inorganic matter; b) A collective term for loose rock or mineral matter that is worn off or removed directly by mechanical means; especially fragmental material such as sand, silt, and clay, moved from place of origin.

Discharge: Volume of water flowing in a given stream at a given place and within a given period of time, usually expressed as cubic meters per second (m^3/sec), or cubic feet per second (cfs).

Dissolved oxygen: The concentration of oxygen dissolved in water, expressed in mg/l or as percent saturation, where saturation is the maximum amount of oxygen that can theoretically be dissolved in water at a give altitude and temperature.

Diversion: A temporal removal of surface flow from the channel.

Diversity index: The relationship of the number of taxa (richness) to the number of individuals per taxon (abundance) for a given community. See Habitat quality index.

Dominant discharge: The cycle of rising and falling flows in the vicinity of bankfull flows, sustained over a long enough period that it alters a natural channel by dislodging, transporting, and distributing bed materials.

Drainage area: Total land area draining to any point in a stream, as measured on a map, aerial photo or other horizontal plane. Also called catchment area, watershed, and basin.

Drainage density: The relative density of natural drainage channels in a given area, expressed as r miles (or kilometers) of stream channel per square mile (or square kilometer) of drainage area. Syn: stream density.

Drift: a) Voluntary or accidental dislodgement of aquatic invertebrates from the stream bottom into the water column where they move or float with the current; b) Any detrital material transported in the water current.

Eddy: A circular current of water, sometimes quite strong, diverging from an initially flowing contrary to the main current. It is usually formed at a point at which the flow passes some obstruction or on the inside of river bends. Often forms backwater pools or pocket water in riffles.

Embeddedness: The degree that larger particles (boulders, rubble, or gravel) are surrounded or covered by fine sediment. Usually measured in classes according to percentage of coverage of larger particles by fine sediments.

Ephemeral stream: See Stream, Ephemeral.

Fall: a) A free fall or precipitous descent of water. The plural, falls, may apply to a single waterfall or to a series of waterfalls; b) A very fast white water cascade.

Fen: Peat land fed by relatively fast moving, nutrient-rich water. Water usually neutral to basic and rich in calcium. The peat is mainly made up of decaying sedges and rushes.

Fill: a) The localized deposition of material eroded and transported from other areas, resulting in a change in bed elevation. This is the opposite of scour; b) The deliberate placement of (generally) inorganic materials in a stream, usually along the bank.

Fine sediment: The fine grained particles in stream banks and substrate. These are defined by diameter, varying downward from 0.24 inch (6 mm).

Fish depth: See Fish elevation.

Fish elevation: The elevation of a fish above the stream bed measured at the tip of the fish's snout. See Focal point.

Fish habitat: The aquatic environment and the immediately surrounding terrestrial environment that, combined, afford the necessary biological and physical support systems required by fish species during various life history stages.

Flood: Any flow that exceeds the bankfull capacity of a stream or channel and flows out of the floodplain; greater than bankfull discharge.

Flood level: The elevation of the water surface of a stream during a particular flood.

Floodplain: Any flat, or nearly flat lowland that boarders a stream and is covered by its waters at flood stage. Also floodplain, flood-plain.

Flood recurrence interval: See Recurrence interval.

Flow: a) The movement of a stream of water and/or other mobile substances from place to place; b) The movement of water, and the moving water itself; c) The volume of water passing a given point per unit of time. Syn: Discharge.

> **base flow:** The portion of the stream discharge that is derived from natural storage i.e., groundwater outflow and the draining of large lakes and swamps or other source outside the net rainfall that creates surface runoff; discharge sustained in a stream channel, not as a result of direct runoff and without the effects of regulation, diversion, or other works of man. Also called sustaining, normal, ordinary of groundwater flow.

duration flow: A curve which expresses the relation of all the units of some item such as head, flow, etc., arranged in order of magnitude along the ordinate, and time, frequently expressed in percentage, along the abscissa. A graphical representation of the number of times given quantities are equaled or exceeded during certain periods of record.

enhancement flow: An improvement of flow that provides improvement over natural conditions for the aquatic, terrestrial, and other recreation resources. See improvement flow.

flushing flow: That discharge (natural or human-caused) of sufficient magnitude and duration to scour and remove fines from the stream bed gravel to maintain intragravel permeability.

improvement flow: That discharge which will improve upon existing aquatic organisms and/or related recreational activity by correcting for water quality deterioration and/or utilization pressures. See enhancement flow.

index flow: The discharge at the time of measurement.

instantaneous flow: That discharge measured by any instant in time, applied to any recommended flow term when modified by the appropriate adjective.

instream flow: Streamflow regime required to satisfy a mixture of conjunctive demands being placed on water while it is in the stream.

instream flow requirements: That amount of water flowing through a stream course needed to sustain instream values at an acceptable level.

interstitial flow: See intergravel flow.

intergravel flow: That portion of the surface water that infiltrates the stream bed and moves through the substrate pores.

laminar flow: The type of flow in a stream of water in which each particle moves in a direction parallel to every particle.

least flow: Negotiated lowest flow in a regulated stream that will sustain an aquatic population at agreed upon levels. The flow may vary seasonally. See **minimum flow.**

low flow: The lowest discharge recorded over a specified period of time. Also called minimum flow.

mean flow: The average discharge at a given stream location, usually expressed in (m^3/sec or cfs), computed for the period of record by dividing the total volume of flow by the number of days, months, or years in the specified period.

minimum flow: a) The lowest discharge recorded over a period of time (preferred definition); b) Negotiated lowest flow in a regulated stream that will sustain an aquatic population at agreed upon levels. This flow may vary seasonally. (This recently developed definition is in conflict with definition (a); to avoid confusion (a) should not be used. A suggested alternative is to apply this definition to the term **least flow.**

modified flow: The discharge at a given point in a stream resulting from the combined effects of all upstream and at-site operations, diversions, return flows, and consumptive uses.

natural flow: The flow as it occurs under natural unregulated conditions at a given stream location.

optimum flow: The discharge regime that allows for the maximum expression of the carrying capacity of any specified use of the stream. Any flow above or below this flow becomes limiting to the use under consideration.

peak flow: The highest discharge recorded over a period if time. Often thought of in terms of spring snow melt, summer, fall or winter rainy season flow. Also called maximum flow.

regime: a) The condition of a stream with respect to the rate of its average flow as measured by the volume of water passing different cross sections in a specified period of time. In this unspecialized sense, the term is incorrectly used as a synonym of regime; b) The existence in a stream channel of a balance or grade between erosion and deposition over a period of years.

regulated flow: The flow in a stream that has been subjected to regulation by reservoirs, diversions, or other works of man.

return flow: That portion of the water previously diverted form a stream, and subsequently returned to that stream, or to another body of ground or surface water.

seven day/Q 10 (7 day/ 10): That low flow which has occurred for seven consecutive days within a ten year period. A specific critical low flow.

subsurface flow: That portion (part or all) of the water that infiltrates the stream bed in moves horizontally through and below it. It may or may not return to the stream channel at some point downstream.

survival flow: That instantaneous discharge required to prevent death of an aquatic organism in a stream during specified short periods of time (e.g., 7 days) of extremely low flow.

turbulent flow: That type of flow in which any particle of water may move in any direction with respect to any other particle.

uniform flow: A flow in which the velocities are the same in both magnitude and direction from point to point. Uniform flow is possible only in a channel of constant cross section and gradient.

Fluvial: Pertaining to streams or produced by stream action.

Focal point: the location, and the conditions at that location, occupied by an organism. Microhabitat measurements are thus focal point measurements.

Frazil ice: Fine spicules of ice formed in water too turbulent for the formation of sheet ice. Frazil forms in supercooled water when the air temperature is far below freezing (most often below -8^{E} Centigrade or 18^{E} Fahrenheit).

Fredle index: An index of the quality of spawning gravel obtained by dividing geometric mean diameter of particle size by the sorting coefficient.

Freshet: A rapid temporary rise in the stream discharge and level caused by heavy rains or rapid melting of snow and ice.

Gabion: A wire basket filled with stones, used to stabilize banks. Not recommended for habitat enhancement.

Geometric mean diameter (d_g): A measure of the central tendency of particle size composition of substrate materials sometimes used as an index of the quality of spawning gravels. Also referred to as D50 size.

Graded stream: A geomorphic term used for streams that have apparently achieved, throughout long reaches, a state of practical equilibrium between the rate of sediment transport and the rate of sediment supply. Such a stream is in regimen. Syn: a mature stream.

Gradient: a) The general slope, or rate of the change in vertical elevation per unit of horizontal distance, of the water surface of a flowing stream; b) The rate of change of any characteristic per unit of length.

Gravel: Substrate particle size between 2 and 64 mm (0.08 and 2.5 inches) in diameter. See Substrate particle size table.

Habitat: The place where a population lives and its surroundings, both living and nonliving; includes the provision of life requirements such as food and shelter.

Habitat component: A single element (velocity, depth, cover, etc.) of the habitat or environment in which a fish or other aquatic species or population may live or occur. Syn: Attribute.

Habitat type: A land or aquatic unit, consisting of an aggregation of habitats having equivalent structure, function, and responses to disturbance.

Hardness: The total concentration of calcium and magnesium ions expressed as mg/l calcium carbonate. Syn: Total hardness.

Humus: Partially decomposed organic material found in soil and water.

Hydraulic control point: The top of an obstruction to which stream flow must rise before passing over, or a point in the stream where the flow is constricted.

Hydraulic gradient: a) The slope of the water surface; b) The drop in pressure head per length in the direction of stream flow.

Hydraulic radius: The cross-sectional area of a stream divided by the wetted perimeter.

Hydraulics: Refers to water, or other liquids, in motion and their action.

Hydrograph: A graph showing, for a given point on a stream, the discharge, stage, velocity, or other property of water with respect to time.

Incident light: Visible light reaching the water surface.

Indicator organisms: Organisms that respond predictably to various environmental changes, and whose presence, or abundance, are used as indicators of environmental conditions. See Water quality indicators.

Instream cover: Areas of shelter in a stream channel that provide aquatic organisms protection from predators or competitors and/or a place in which to rest and conserve energy due to a reduction in the force of the current.

Instream flow requirements: See Flow, instream flow requirements.

Intermittent stream: See Stream.

Interrupted stream: See Stream.

Interstitial velocity: See Apparent velocity.

Kinetic energy: The energy of a body or a system with respect to the motion of the body or of the particles in the system.

Large woody debris: A large piece of relatively stable woody material having a diameter greater than 30 cm (12 inches) and a length greater than 2 m (6 feet) that intrudes into the stream channel. Syn: LOD, large organic debris, log. Specific types of large woody debris include:

affixed logs: Single logs or groups of logs that are firmly embedded, lodged or rooted in a stream channel.

bole - Term referring to the stem or trunk of the tree.

large bole - 10 m (33 feet) or more in length; often in the stream for extended periods.

small bole - less than 10 m (33 feet), usually sections of bole; seldom stable, usually move downstream on high flows.

deadheads: Logs that are not embedded, lodged, or rooted in the stream channel, but are submerged and close to the surface.

digger log: Log anchored to the stream banks and/or channel bottom in such a way that a scour pool is formed.

free logs: Logs or group of logs that are not embedded, lodged or rooted in the stream channel.

root wad: The root mass of the tree. Syn: butt ends.

snag: a) A standing dead tree; b) Sometimes a submerged fallen tree in large streams. The top of the tree is exposed or only slightly submerged.

sweeper log: Fallen tree whose bole or branches form an obstruction to floating objects.

Types of large organic debris accumulation:

clumps: Accumulations of debris at irregularly spaced intervals along the channel margin, not forming major impediments to flow.

jams: Large accumulations of debris partially or completely blocking the stream channel, creating major obstructions to flow.

scattered: Single pieces of debris at irregularly spaced intervals along the channel.

Least flow: Negotiated lowest flow in a regulated stream that will sustain an aquatic population at agreed upon levels. See Flow, minimum.

Macroinvertebrate: An invertebrate animal (without backbone) large enough to be seen without magnification.

Mainstem: The principal, largest, or dominating stream or channel of any given area or drainage system.

Manning's "n": An empirical coefficient for computing stream bottom roughness used in determining water velocity in stream discharge calculations.

Marsh: A water-saturated, poorly drained wetland area, periodically or permanently inundated to a depth of up to 2 m (6 feet), that supports an extensive cover of emergent, non-woody vegetation, essentially without peat-like accumulations.

Microhabitat: That specific combination of habitat elements in the locations selected by organisms for specific purposes and/or events. Express the more specific and functional aspects of habitat and cover. Separated from adjoining microhabitats by distinctive physical characteristics such as velocity, depth, cover, etc.

Moveable bed: A stream bed made up of materials readily transportable by the streamflow.

Normal high water: A water level attained commonly during runoff season. Distinguished from extreme high water.

Off channel pond: A pond, not a part of the active channel, but connected to the main stream by a short channel. Generally in old flood terraces, but called wall-based channel ponds when located near the base of a valley wall.

Organic debris: Debris consisting of plant or animal material.

Organic materials:

coarse particulate organic matter (CPOM): Organic material having at least a dimension ranging from 0.04 to 3.9 inch (1 mm to 10 cm) 0.04 to 3.9 in). Technically includes both living and dead material, but often used more specifically to detritus.

dissolved organic matter (DOM) or Dissolved organic carbon (DOC): Organic material having a least dimension smaller than 0.45 micron (Passes through a 0.45 micron filter).

fine particulate organic matter (FPOM): Organic material having a least dimension ranging from 0.45 micron to 0.04 inch (1 mm).

Orientation: An organism's position relative to the direction of stream flow.

Overbank storage: Flow of water out of the stream channel and onto the valley floor floodplain during flood flows.

Overhead cover: Material (organic or inorganic) that provides protection to fish or other aquatic animals from above; generally includes material overhanging the stream less than a particular distance above the water surface. Values less than 0.5 m (1.5 feet) and less than 1 m (3 feet) have been used.

Percent fines: Percentage of fine sediments in substrate samples, expressed as a percentage by weight or volume less than some specified diameter. See Fine sediment.

Perennial stream: See stream.

Periphyton: Algae and associated microorganisms growing attached on any submerged surface.

Permeability: A measure of the rate of which water can pass through a given substrate. Depends upon composition and degree of compaction of the substrate (usually gravel). The apparent velocity per unit of hydraulic gradient. Units: cm/hr.

pH: A measure of the hydrogen-ion activity in a solution, expressed as the negative $\log_{10}$ of hydrogen ion concentration on a scale of 0 (highly acidic) to 14 (highly basic) with a pH of 7 being neutral.

Ponding: An increase in water surface elevation upstream of a blockage or an obstruction.

Pool feature: The condition or object that characterizes a pool's formation. These include: logs, trees, roots, stumps, brush, debris, channel meanders, sediment, culverts, bridges or other manmade objects, beaver dams, or tunnels.

Pool-riffle ratio: The ratio of the surface area or length of pools to the surface area or length of riffles in a given stream reach, frequently expressed as the relative percentage of each category.

Production: a) The process of producing organic material; b) The quantity of organic material produced.

Productivity: a) Rate of new tissue formation or energy utilization by one or more organisms; b) Capacity or ability of an environmental unit to produce organic material; c) The ability of a population to recruit new members by reproduction.

Profile: A graphical presentation of elevation vs distance, as in channel cross sections and longitudinal sections. In open channel hydraulics, it is a plot of water surface elevation against channel distance.

Reach: a) Any specified length of stream; b) A relatively homogeneous section of a stream having a repetitious sequence of physical characteristics and habitat types; c) A regime of hydraulic units whose overall profile is different from another reach.

representative reach: A length of stream which represents a large section of the stream with respect to area, depth, discharge, and slope.

specific reach: A length of channel uniform with respect to selected habitat characteristics or elements (discharge, depth, area, slope, population of hydraulic units), fish species composition, water quality, and type and condition of bank cover.

Recurrence interval: Expected or observed time intervals between hydrological events of a particular magnitude described by stochastic or probabilistic models (log-log plots).

Regime: See Flow, regime.

Revetment: See Riprap.

Rill: One of the first and smallest channels formed by surface runoff.

Riparian: Pertaining to anything connected with or immediately adjacent to the banks of a stream or other body of water.

Riparian vegetation: Vegetation growing on or near the banks of a stream or other body of water on soils that exhibit some wetness characteristics during some portion of the growing season.

Riparian vegetation erosion control rating: A system for ranking the relative effectiveness of riparian vegetation for controlling bank erosion (Platts et al. 1983).

Riparian area: The area between a stream or other body of water and the adjacent upland identified by soil characteristics and distinctive vegetation. It includes wetlands and those portions of floodplains and valley bottoms that support riparian vegetation.

Riprap: A layer of large, durable materials (usually rock) used to protect a stream bank from erosion. May also refer to the materials themselves. Syn: revetment.

Rock-fill dam: A dam composed of large, broken, and loosely placed or pervious rocks with either an impervious core or upstream facing or surface layer.

Roughness coefficient: See Manning's "n".

Rubble: Stream substrate particles between 64 and 256 mm (2.5 and 10 inches) in diameter. Syn: cobble.

Scour: The localized removal of material from the stream bed by flowing water. This is the opposite of fill.

Sediment: Fragmental material that originates from weathering of rocks and decomposition of organic material that is transported by, suspended in, and eventually deposited by water or air, or is accumulated in beds by other natural phenomena.

Sediment discharge: The mass or volume of sediment (usually mass) passing a stream transect in a unit of time. The term may be qualified, for example, as suspended-sediment discharge, bedload discharge, or total-sediment discharge, usually expressed as tons per day.

Sediment load: The portion of the total sediment load that moves in suspension, free from contact with the stream bed, and is made up of particles having such density or grain size as to permit movement disassociated from the stream bed. Density and grain size vary according to the amount of turbulence. Only unusually swift streams are turbulent enough to lift particles larger than medium-sized sand from their beds. See Bedload.

Seep: An area of minor ground water outflow onto the land surface or into a stream channel. Flows are too small to be a spring.

Sinuosity: a) The ratio of channel length between two points on a channel to the straight line distance between the same two points; b) The ratio of channel length to down valley length. Channels with sinuosities of 1.5 or more are called "meandering".

Slack water: A quiet part of, or a still body of water in, a stream; e.g., on the inside of a bend, where the current is slight.

Slough: a) Low, swampy ground or overflow channels where water flows sluggishly for considerable distances; b) Side channel slough formed by channelization; c) A sluggish channel of water, such as a side channel of a stream, in which water flows slowly through low, swampy ground, or a section of an abandoned stream channel containing water most or all of the year, but with flow only at high water, and occurring in a floodplain or delta; d) A marsh tract lying in a shallow, undrained depression on a piece of dry ground; e) A term used for a creek or sluggish body of water in a bottom-land.

Solar radiation: Electromagnetic energy from the sun in all wavelengths.

arc of the sun: The distance the sun travels on any given day in degrees from when it first strikes the water until it leaves the water. The arc of the sun on August 1st is used as a standard.

direct solar radiation: Radiation that reaches the water surface in an unobstructed straight line.

reflected solar radiation: Radiation that does not penetrate the water surface, but is redirected away from that surface.

total solar radiation: The sum of direct, reflected and refracted radiation reaching any one point.

Sorting coefficient: A measure of the distribution or variability of particle sizes in the substrate. The usual measure, computed as d75/d25 is equivalent to the standard deviation of the log transformed frequency curve, hence a measure of dispersion of particle sizes. A substrate with a large sorting coefficient is termed "well sorted". The terms d75 and d25 are those diameters for which 75 percent and 25 percent of the cumulative size-frequency distributions are larger.

Specific reach: See Reach.

Spring creek: A stream that derives most of its flow from ground water, with relatively constant flow and temperature.

Stability rating: An index of the resistance or susceptibility of the stream channel and banks to erosion (Platts et al. 1983).

Stage: The elevation of a water surface above or below an established datum or reference.

Standing crop: The abundance, total weight or energy content of organisms existing in an area at a given time. See Biomass.

Standing stock: The number of organisms (usually fish) present in an area at a particular time. Smaller sizes not susceptible to capture may sometimes be excluded.

Stream: (includes creeks and rivers): A stream is a body of water that flows at least periodically or intermittently through a bed or channel having banks and supports fish or other aquatic life. This includes watercourses having a surface or subsurface flow that supports or has supported riparian vegetation. Streams in natural channels may be classified as follows:

a) Relation to time:

ephemeral: One that flows briefly only in a direct response to precipitation in the immediate locality and whose channel is at all times above the water table.

intermittent or seasonal: One in contact with the ground water table that flows only at certain times of the year as when the ground water table is high and/or when it receives water from springs or from some surface source such as melting snow in mountainous areas. It ceases to flow above the stream bed when losses from evaporation or seepage exceed the available streamflow.

perennial: One that flows continuously throughout the year. Syn: Permanent streams.

b) Relation to space:

continuous: One that does not have interruptions in space.

interrupted: One that contains alternating reaches that are either perennial, intermittent, or ephemeral.

c) Relation to ground water:

insulated: A stream or reach of a stream that neither contributes to nor receives water from the zone of saturation. It is separated from the zones of saturation by an impermeable bed.

gaining: A stream or reach of stream that receives water from the zone of saturation.

losing: A stream or reach of stream that contributes water to the zone of saturation.

perched: Either a losing stream or a insulated stream that is separated from the underlying ground water by a zone of aeration.

d) Other:

incised: A stream that has, through degradation, cut its channel into the bed of the valley.

Stream bank: The portion of the channel cross section that restricts lateral movement of water at normal water levels. The bank often has a gradient steeper than 45 degrees and exhibits a distinct

break in slope from the stream bottom. An obvious change in substrate may be a reliable delineation of the bank.

lower bank: The periodically submerged portion of the channel cross section from the normal high water line to the water's edge during the summer flow period.

upper bank: That portion of the topographic cross section from the break in the general slope of the surrounding land to the normal high water line.

Stream capacity: Total volume of water that a stream can carry within the normal high water channel. Also called stream bottom.

Stream classification: Various systems of grouping or identifying streams possessing similar features according to geomorphic structure (e.g., gradient), water source (e.g., spring creek), associated biota (e.g., trout zone) or other characteristics. A hierarchical classification.

Stream corridor: A stream corridor is usually defined by geomorphic formation, with the corridor occupying the continuous low profile of the valley. The corridor contains a perennial, intermittent, or ephemeral stream and adjacent vegetative fringe.

Stream density: Kilometers of stream per square kilometer or area. Syn: Drainage density.

Stream/estuary ecotone: An area near the stream mouth extending from the upper limit of tidal influence seaward to the lower limit of marsh vegetation. Its size depends on stream gradient and range of tidal heights.

Stream flow: See Flow (a).

Stream/forest ecotone: An area of the stream directly influenced by riparian vegetation, including the stream bank and upland area adjacent to the stream. Its size depends on the stream width, type of vegetation, and the physical characteristics of the adjoining uplands.

Stream frequency: The number of streams per square kilometer of area.

Stream order: The designations (1, 2, 3, etc.) of the relative position of stream segments in a drainage basin network: The smallest, unbranched, perennial tributaries, terminating at an outer point, are designated order 1; the junction of two first-order streams producers a stream segment of order 2; the junction of two second-order streams produces a stream segment of order 3, etc. Use of small-scale maps (<2 in/mile) may cause smaller steams to be overlooked, leading to gross errors in designation. Ideally, designations should be determined on the ground or from large-scale air photos.

Stream pattern: See Channel pattern.

Stream power: The rate of doing work, or a measure of the energy available for moving rock, sediment particles, or woody or other debris in the stream channel, as determined by discharge, water surface slope, and the specific weight of water.

Stream reach: A portion of a stream that is relatively homogeneous based on geomorphology, stream flow, geology, and sinuosity. It is frequently bounded by significant tributaries, diversions, reservoirs, etc. It also may be thought of as a series of short reaches with common morphology.

Stream shore water depth: The water depth at the stream shoreline or at the edge of a bank overhanging the shoreline. This depth could be greater than 0 if the bank is undercut.

Stream width: See wetted width.

Structure: a) Any object, usually large, in the stream channel that controls water movement; b) The diversity of physical habitat within a stream; c) When applied to a biological community, the organization of taxa into various functional or trophic groups.

Substrate: The mineral and/or organic material that forms the bed of the stream.

Suspended sediment: See Suspended load.

Swamp: Tree or tall shrub dominated wetlands that are characterized by periodic flooding and nearly permanent subsurface water flow through mixtures of mineral sediments and organic materials, essentially without peat-like accumulation.

Swimming speed: Swimming speeds of stream fish vary from essentially zero to over 19.7 feet per second (six meters per second), depending upon species, size and activity. Three categories of performance are generally recognized.

> **cruising speed:** The speed that a fish can maintain for an extended period of time without fatigue. This implies a lack of stress, and is the maximum speed traveled by undisturbed individuals.
>
> **sustained (prolonged) speed:** The speed that a fish can maintain for a prolonged period, but which ultimately results in fatigue. At this speed the fish is under some degree of stress.
>
> **burst (darting) speed:** The speed that a fish can maintain for a very short time, generally 5-10 seconds, without gross variation in performance. Burst speed would be employed for feeding or escape, and represents maximum swimming speed.

Thalweg: The line connecting the lowest or deepest points along a stream bed.

Torrent: A temporary flow condition in streams created by heavy rainfall or rapid snow melt; characterized by near bankfull discharge, sizable increase in velocity, standing waves, and loss of the typical stepped profile and hydraulic diversity of habitat.

Total dissolved solids (TDS): A measure of inorganic and organic materials dissolved in water (passing through a 0.45 micron filter); often referred to as Filterable Residue (FR) and expressed as mg/l FR. Sometimes considered similar to conductivity as and indicator of potential production in habitat quality indices.

Total suspended solids: The organic and inorganic material left on a standard glass fiber filter

(0.45 micron) after a water sample is filtered through it; often referred to as Non-Filterable Residue (NFR).

Trash collector dam: A fence-like structure or grillwork of heavy wire, metal or logs placed across a stream to intercept and hold debris flowing downstream, creating a dam or blockage. Used to protect bridge crossings, create pools, and store gravel for spawning habitat. Syn: Debris catcher, grizzly.

Tributary: A stream feeding, joining, or flowing into a larger stream. Syn: Feeder stream, side stream. Tributary types based on watershed geomorphology include:

lower valley wall tributaries: Characterized by moderately steep gradients and occur at the slope break between the valley wall and valley floor.

terrace tributaries: Results from spring networks on valley floor, and from tributaries draining valley side slopes and continuing across terraces to the main stream.

upper valley wall tributaries: Possess very steep gradients, high velocities, and flow over a stepped profile of alternating pools and cascades.

upper valley wall tributaries: Run along the base of the valley wall, parallel to the main stream channel.

wall based tributaries: Run along the base of the valley wall, parallel to the main stream channel.

Turbidity: a) Relative water clarity; b) A measurement of the extent to which light passing through water is reduced due to suspended materials. Measured by several non-equivalent standards (e.g., Nephelometric Turbidity Units, NTU; Formazin Turbidity Units, FTU; Jackson Turbidity Units, JTU).

Turbulence: The motion of water where local velocities fluctuate and the direction of flow changes abruptly and frequently at any particular location, resulting in disruption of laminar flow. It causes surface disturbance and uneven surface level, and often masks subsurface areas because air bubbles are entrained in the water.

Undercut bank: A bank that has had its base cut away by the water action along man-made and natural overhangs in the stream.

Vegetative fish cover: Vegetation materials such as algal mats and organic debris capable of providing protection for fish and other aquatic organisms.

Velocity: The time rate of motion; the distance traveled divided by the time required to travel that distance.

critical velocity: a) The maximum swimming speed that a fish can sustain over a specified distance or length of time, or the maximum water velocity against which a fish can sustain a

position over a specified length of time; b) The velocity in a channel at which flow changes from laminar to turbulent; c) Velocity through which a fish will not swim, creating a velocity barrier.

fish velocity or focal point velocity: Represents the velocity at the location occupied by a fish, measured at the fish's snout. Syn: Snout velocity, facing velocity.

mean column velocity: The average velocity of the water measured on an imaginary vertical line at any point in a stream. A measurement at 60 percent of the depth, measured from the surface, closely approximates the average velocity for the water column. In water greater than 76 cm (30 in) in depth, the average of measurements made at 20 percent and 80 percent of the depth approximates the mean column velocity.

mean cross sectional velocity: Represents the mean velocity of water flowing in a channel at a given cross-section. It is equal to the discharge divided by the cross-section area of the cross section.

profile: A curve representing the velocity of flow along a given line.

swimming velocity: See Swimming speed.

thalweg velocity: The mean column velocity at the thalweg.

V-notch: a) Narrow, steep-sided ravine or valley with V-shaped cross-section whose bottom usually contains a watercourse; b) A type of weir containing a V-shaped notch used for gauging discharge in small streams.

Wash load: The load that because of its fine size has such a small settling velocity that it would be held in suspension. It is essentially synonymous with suspended load.

Water width: See Wetted width.

Water year: See Climatic year

Water yield: The total outflow from all or part of a drainage basin through either surface channels or subsurface aquifers within a given time (e.g., one year).

Watershed: See Drainage area.

Weighted Usable Area (WUA): a) An index of the capacity of a stream reach to support the species and life stage being considered, expressed as actual area or percentage of habitat area predicted to be available per unit length of stream at a given flow; b) The total surface area having a certain combination of hydraulic and substrate conditions, multiplied by the composite probability of use by fish for the combination of conditions at a given flow.

Weir: a) A notch or depression in a levee, dam, embankment, or other barrier across or bordering a stream, through which the flow of water is measured or regulated; b) A barrier constructed across a stream to divert fish into a trap; c) A dam (usually small) in a stream to raise the water level or divert its flow.

Wetland: An area subjected to periodic inundation, usually with soil and vegetative characteristics that separate it from adjoining non-inundated areas.

Wetted perimeter: The length of the wetted contact between a stream of flowing water and the stream bottom in a vertical plane at right angles to the direction of flow.

Wetted width: The width of the water surface measured at right angles to the direction of flow and at a specific discharge. Widths of multiple channels are summed to represent total wetted width.

White water: Occurs where flows are sufficiently fast and turbulent to entrain air bubbles in the water.

Woody Debris: See Large woody debris.

REFERENCES

Chamberlain, T.W. 1980. Aquatic survey terminology. British Columbia Ministry of Environment, Assessment and Planning Division, Technical Paper No. 2, Victoria, British Columbia.

Dunne, T. and L.B. Leopold. 1978. Water in Environmental Planning. W.H. Freeman and Co., San Francisco, CA, 818 p.

Helm, William T., ed. 1985. Glossary of stream habitat terms. Western Division, American Fisheries Society. USA.

Platts, W.S., D. Armour, G.D. Booth, M. Gryant, J.L. Bufford, P. Cuplin, S. Jensen, G. W. Lienkaemper, G.W. Minshall, S.B. Monsen, R.L. Nelson, J.R. Sedell, and J.S. Tuhy. 1987. Methods For Evaluating Riparian Habitats With Applications To Management.

United States Department of Agriculture, Forest Service General Technology Report INT 221 U.S. Department of Agriculture, Forest Service. February 1990. Fish habitat assessment handbook. USFS, Region 5 FHS 2609.23, Draft Copy.

APPENDIX R.

FORMS

WATERSHED OVERVIEW WORK SHEET

Date _____/_____/_____ **Investigator** _____
Stream Name _____ **PNMCD** _____
Tributary to _____ **Tributary to** _____
Tributary to _____ **Tributary to** _____
County _____ **USGS Quad** _____

Location T _____ R _____ S _____ **Latitude** _____ **Longitude** _____

Access Via _____

Hydrologic Boundary Delineation _____

Aerial Photos (Source) _____
_____

Stream Order _____ **Total Length** _____ miles

Drainage Area _____ sq. mi. **Summer Base Flow** _____ cfs

Elevations Mouth _____ feet Headwaters _____ feet

Lakes in Watershed Number _____ Surface Area _____ sq. mi.

Fish Species (Data Source) _____,
_____, _____,
_____, _____,

Endangered / **Threatened** / **Sensitive Species** (Data Source)
_____, _____,

Endemic Stocks (Data Source) _____

Fishery Management Concept
Cold Water: Natural Production _____
Mixed Production _____
Anadromous: Natural Production _____
Mixed Production _____
Warm Water: _____
Other: _____

Stream Flow Data (Source) _____
_____

Water Quality Data (Source) _____
_____

Ownerships in Stream Mi. Federal _____._____ State _____._____ Private _____._____
Additional Information _____

Major Land Uses in the Watershed: _____, _____, _____, _____, _____
Additional Information _____

Comments _____
_____

STREAM CHANNEL TYPE WORK SHEET

Form # ____ of ____

Channel Type _____ **Channel Change Location (Habitat Unit#)** _____
Cross-Section Location (Habitat Unit#) _____ **Date** _____/_____/_____
Stream _____
T____**R**____**S**_____ **Surveyors** _____
Quad _____ **Lat** ____ ____ ____ **Long** ____ ____ ____

Single Thread Channel _____ (Y/N) **Multiple Channel** _____ (Y/N)

Bankfull Width (W_{bkf}) = _____ (ft.)

Transect Recording Box

Dist.																				
Depth																				
Sub.																				

Sum of Depths _____

Dominant Substrate Determination:

	Substrate:	Number	
1.	Bedrock	= ____	
2.	Boulder (>10")	= ____	(Circle Most
3.	Cobble (2.5 - 10")	= ____	Frequent
4.	Gravel (0.08 - 2.5")	= ____	Occurrence)
5.	Sand (<0.08)	= ____	
6.	Silt / Clay	= ____	

Entrenchment Determination:

Step 1: Maximum Bankfull Depth _____ x 2 = _____ (W_{FP} Elev.)

Step 2: Determine Flood-Prone Width at WFP Elevation = _____ (W_{FP})

Step 3: Flood-Prone Width (W_{FP}) / Bankfull Width (W_{bkf}) = Entrenchment
W_{FP} _____ (ft.) / _____ (ft.) = _____ **(Entrenchment)**

Width/Depth Determination:

Step 1: Sum of Depths _____ / No. Depths _____ = Mean Bankfull Depth (d_{bkf}) ____

Step 2: Bankfull Width (W_{bkf}) / Mean Bankfull Depth (d_{bkf})=Width/Depth Ratio
W_{bkf} _____ (ft.) / d_{bkf} _____ (ft.) = _____ **(W/D Ratio)**

Sinuosity Determination (Only For A or G Types):

Stream Length _____ / Valley Length _____ = Sinuosity _____

Water surface slope Determination:

Downstream Level - Upstream Level / Distance (D) = Energy Gradient
DSL _____ (ft.) - USL _____ (ft.) / (D) _____ (ft.) = _____

HABITAT INVENTORY DATA FORM

Form # of

Date / / | Stream Name | T | R | S

Surveyors | Lat. | Lon.

Quad. | Channel Type | Reach | BFW | @HU#

Time | H_20 F° | Air F° | Flow | Pg Length | Totl. Length

Habitat Unit Number												
Habitat Unit Type												
Side Channel Type												
Mean Length												
Mean Width												
Mean Depth												
Maximum Depth												
Depth Pool Tail Crest												
Pool Tail Embeddedness												
Pool Tail Substrate												
LWD Count D>1&L6to20												
LWD Count D>1&L>20												
Shelter Rating Shelter Value												
% Unit Covered												
% undercut bank												
% swd (d<12")												
% lwd (d>12")												
% root mass												
% terr. vegetation												
% aqua. vegetation												
% bubble curtain												
% boulders (d>10")												
% bedrock ledges												
Substrate Composition 2 Most Dominant A) Silt/Clay												
B) Sand												
C) Gravel (0.08-2.5")												
D) Sm Cobble (2.5-5")												
E) Lg Cobble(5-10")												
F) Boulder (>10")												
G) Bedrock												
Percent Exposed Substrate												
PERCENT TOTAL CANOPY												
% Hardwood Trees												
% Coniferous Trees												
Bank Composition & Vegetation Rt Bk Composition												
Rt Bk Dominant Veg												
% Rt Bk Vegetated												
Lft Bk Composition												
Lft Bk Dominant Veg												
% Lft Bk Vegetated												
Bank Composition Types	**omments**: **S**tructures **C**hannel **D**iversions **T**ribs **E**rosion **B**iota **P**assage **A**ccess **G**PS **O**the											
1) Bedrock												
2) Boulder												
3) Cobble/Gravel												
4) Silt/Clay/Sand												
Vegetation Types												
5) Grass												
6) Brush												
7) Deciduous Trees												
8) Evergreen Trees												
9) No Vegetation												

Hab Unit#	Comments

Diagrams

STREAM BANK OR UNDERWATER OBSERVATION FIELD FORM

Form No. _____ of _____ **Date** ____/____/____

Stream Name _____ **T** _____ **R** _____ **S** _____

Drainage _____

Lat: _____ **Long:** _____ **Quad:** _____

Observer(s) _____

Time _____ **Air Temperature** _____ **Water Temperature** _____

Reach No. _____ **Habitat Unit No.** _____ **Habitat Type** _____

Reference Point _____

Distance from the confluence or other reference point _____

Length of stream sampled in feet _____

Observation Method: _____ **Stream Bank** _____ **Underwater**

Species	Size Class	Numbers	Species	Size Class	Numbers

Comments _____

_____

_____

_____

DAILY SALMON SPAWNING STOCK SURVEY FIELD FORM

Stream: _____ **T** _____ **R** _____ **S** _____
Lat: _____ **Long:** _____ **Quad:** _____
Drainage: _____ **County:** _____
Starting location: _____ **Lat:** _____ **Long:** _____
Ending location: _____ **Lat:** _____ **Long:** _____
Feet/miles surveyed: _____
Date of survey: _____/_____/_____ **Weather: Clear** _____ **Overcast** _____ **Rain** _____
Water clarity: 0-2 ft. _____ **2-4 ft.** _____ **>4 ft.** _____
Water temp: _____ **Air temp:** _____ **Time:** _____
Crew: _____

Number of live fish observed: **Chinook adults** _____ **Chinook grilse** _____ **Coho** _____
Steelhead _____ **Unknown** _____

Number carcasses examined:

Chinook		Coho	
Male (FL)	Female (FL)	Male (FL)	Female (FL)

Tag number of adipose clipped fish and snout recoveries:

Other fin clips observed: _____
_____

Number of skeletons observed:
Chinook _____ Coho _____ Steelhead _____ Unknown _____

Number of redds observed: _____

Comments:

ELECTROFISHING FIELD FORM Form # _____ of _____

Date __/__/__ Stream Name _____ Site # ___ Drainage _____ T ___ R __ S __

PNMCD _____ Lat _____ Long _____ Quad _____
Distance from Confluence _____

Reach # _____ Channel Type _____ Reference Point _____
Distance from RP _____ Up _____ Down _____

Personnel: E-Fish _____ Netting _____
Measurements _____ Recorder _____

Habitat Unit #..... |_____|_____|_____|_____| Start Stop Conductivity (µS/cm)

Habitat Unit Type ..... |_____|_____|_____|_____| Time |_____|_____|

Mean Length..... |_____|_____|_____|_____| H2O° |_____|_____| Flow (cfs)

Mean Width ..... |_____|_____|_____|_____| Air° |_____|_____|

Mean Depth..... |_____|_____|_____|_____|

Pass# _____ Effort(s) _____ + _____ = **Total Effort(E1)** _____ (seconds) Freq. _____ (Hz)
Output Voltage _____

Species	**Fork Length (mm)**															

Summary: Species _____ Catch _____ Wt. _____ Mortalities _____;
Species _____ Catch _____ Wt. _____ Mortalities _____;
Species _____ Catch _____ Wt. _____ Mortalities _____;
Species _____ Catch _____ Wt. _____ Mortalities _____;

Comments:

ELECTROFISHING FIELD FORM
SUPPLEMENTAL PAGE Form # _____ of _____

Date __/__/__ Stream Name _____ Site # ___ Drainage _____ Pass # _____

Start Time _____ **End** Time _____ **Start** Water Temp _____ **End** Water Temp _____
Start Air Temp _____ **End** Air Temp _____
Effort(s) _____ + _____ = **Total Effort (E_2)** _____ (seconds) Freq. ____ (Hz) Output Voltage ____

Species	**Fork Length (mm)**															

Summary: Species _____ Catch _____ Wt. _____ Mortalities _____;
Species _____ Catch _____ Wt. _____ Mortalities _____;
Species _____ Catch _____ Wt. _____ Mortalities _____;
Species _____ Catch _____ Wt. _____ Mortalities _____;

Comments:

(1 - [(N_2 * E_1) / (N_1 * E_2)]) * 100 = Pass Depletion
(1 - [(____ * ____) / (____ * ____)]) * 100 = _____ Pass #2 Depletion

Site # _____ Pass # _____

Start Time _____ **End** Time _____ **Start** Water Temp _____ **End** Water Temp _____
Start Air Temp _____ **End** Air Temp _____
Effort(s) _____ + _____ = **Total Effort (E_2)** _____ (seconds) Freq. ____ (Hz) Output Voltage ____

Species	**Fork Length (mm)**															

Summary: Species _____ Catch _____ Wt. _____ Mortalities _____;
Species _____ Catch _____ Wt. _____ Mortalities _____;
Species _____ Catch _____ Wt. _____ Mortalities _____;
Species _____ Catch _____ Wt. _____ Mortalities _____;

Comments:

(1 - [(N_3 * E_2) / (N_2 * E_3)]) * 100 = Pass Depletion
(1 - [(____ * ____) / (____ * ____)]) * 100 = _____ Pass #3 Depletion

L W D I N V E N T O R Y F O R M

Stream: _____ **Sample** _____ of _____ **Reach No.** _____

Date _____/_____/_____ **Drainage:** _____ **USGS Quad:** _____

Reference Point: _____ **Sample Length (Ft)** ___

Reach Location (Feet From Ref.Pt) Start _____ Stop _____ Total _____

Lat ___ ___ ___ N **Long** ___ ___ ___ W (Reach start or Ref.Pt.) **T** _____ **R** _____ **S** _____

Surveyors: _____

CHANNEL CHARACTERISTICS (Attach Channel Typing Form)

Discharge Q _____ cfs Gradient _____ % Channel Type: _____

Percent Substrate in Boulders: (1'- 3') _____%; (>3') _____%

Air Temp _____ Water Temp _____

	Right Bank % Slope _____ Dom. Veg. _____					**Stream** Dom. Veg. _____				**Left Bank** % Slope _____ Dom. Veg. _____				
	D/D	D/S	Per	Live C	Live D	Dead/ Down	D/S	Live C	Live D	D/D	D/S	Per	Live C	Live D
1-2d 6-20														
Root														
1-2d >20'														
2-3d 6-20														
Root														
2-3d >20'														
3-4d 6-20														
Root														
3-4d >20'														
>4d 6-20														
Root														
>4d >20'														

Note any LDAs (log jams), estimate size LxWxH and no. pieces. Note if gravel is retained upstream. Tally live conifer "C" and deciduous "D" trees separately. Tally root wads by diameter of "trunk". Include root wads <6' total length.

Comments:

ESTIMATE CALIBRATION FORM

Stream Name _____ **Date** _____

Surveyors _____

Reach No. _____

	Right Bank		**Stream**				**Left Bank**	
Sample	EST DIA.	TRUE DIA.	EST DIA.	TRUE DIA.	EST LENG.	TRUE LENG.	EST DIA.	TRUE DIA.
%								
Dis								

Reach No. _____

	Right Bank		**Stream**				**Left Bank**	
Sample	EST DIA.	TRUE DIA.	EST DIA.	TRUE DIA.	EST LENG.	TRUE LENG.	EST DIA.	TRUE DIA.
%								
Dis								

Calibration Form Key

Stream Name: Enter name of stream
Date: Enter date of survey (mm/dd/yy)
Surveyors: Enter name of persons conducting the survey
Reach No.: The number that corresponds with the Reach No. on the LWD Survey Form.
Sample: The number corresponding with the Sample No. on the LWD Survey Form.
EST DIA.: Enter the estimated diameter.
TRUE DIA.: Enter the measured diameter.
EST LENG.: Enter the estimated length.
TRUE LENG.: Enter the measured length.
% Enter the average percent difference between estimate and true.
Dist.: Enter the 50-foot distance estimate and measurement.

PROJECT SITE COMPLETION FORM

Stream: _____ **Date:** _____ **Page** _____ **of** _____
Contractor/Organization: _____
Inspector: _____ **Contract No.:** _____ **FY:** ___/___
Landowner: _____
Estimated Cost: _____
Length of Project/Numbers of Structures: _____
Reference Point: _____ **Lat:** _____ **Long:** _____
Feet From Reference Point: _____ ❑ UP / ❑ DN **Channel Type:** _____
Constructed Using: ❑ Hand Crew ❑ Heavy Equipment ❑ Both
Project Objective: ❑ Instream Habitat ❑ Erosion Control ❑ Fish Passage
Type of structure: _____

Project Completion Check Points:	**YES**	**NO**	
1. Project techniques according to manual	❑	❑	If no, explain: _____
2. Materials of recommended type and size	❑	❑	If no, explain: _____
3. Structure positioned correctly to meet objectives	❑	❑	If no, explain: _____
4. Followed permit(s) specifications	❑	❑	If no, explain: _____
5. Landowner(s) agreed with work and materials used	❑	❑	If no, explain: _____

Original Habitat Type: _____ **Target Habitat Type:** _____

Habitat Maximum Depth: _____ **ft.** **Bankfull Stream Width:** _____ **ft.**

Comments: _____

If Revegetation: ❑ Riparian ❑ Upslope ❑ Both (photo required for revegetation.)

Describe Density or Coverage: _____

Photographs: ❑ Yes ❑ No If yes, location of photographs: _____

STREAM HABITAT ENHANCEMENT PROJECT EVALUATION

GENERAL PROJECT INFORMATION FORM

STREAM: _____ WATERSHED: _____

EVALUATOR: _____ DATE: _____

CONTRACT NO.: _____ FY: _____/_____ FUND SOURCE: _____

DFG CONTACT: _____ CONTRACTOR: _____

DOES THIS CONTRACT INCLUDE OTHER STREAMS OR LOCATIONS: Y ___ N ___

AMOUNT SPENT ON EVALUATED PORTION OF CONTRACT: $_____
(May include total contract amount or a portion of contract)

PROPERTY OWNER: _____

ACCESS DIRECTIONS: _____

_____

CHANNEL TYPE(S): _____ STREAM ORDER: _____ DRAINAGE AREA (SQ MI): _____

USGS QUAD (7.5 MIN): _____

PROJECT LOCATION AT DOWNSTREAM END: LAT. _____ LONG. _____

DATE PROJECT COMPLETED: MONTH _____ YEAR _____

DATE OF LAST EVALUATION: MONTH _____ YEAR _____

PRE-PROJECT EVALUATION OR DATA AVAILABLE: Y ___ N ___ IF YES WHERE? _____

_____

ARE AS-BUILT DATA OR PROPOSED DESIGNS AVAILABLE: Y ___ N ___ IF YES WHERE? _____

_____

NO. OF STRUCTURES CONSTRUCTED: _____ NO. OF STRUCTURES EVALUATED: _____

COMMENTS: _____

_____

NUMBER OF EVALUATION PAGES ASSOCIATED WITH THIS FORM: _____

GENERAL PROJECT EVALUATION OR COMMENTS: _____

_____

_____

_____

STREAM HABITAT ENHANCEMENT PROJECT EVALUATION
INDIVIDUAL STRUCTURE OR SITE FORM

STREAM: _____ DRAINAGE: _____ PAGE_____ of _____

DATE: _____/_____/_____ STREAM PNAME: _____ PNAME CODE: _____

EVALUATOR(s): _____ CONTRACT NO.: _____ FY: _____/_____

REFERENCE POINT: _____ LAT: _____._____ LONG: _____._____
(DECIMAL DEGREES) (DECIMAL DEGREES)

FEET FROM REFERENCE POINT: _____ ❑ UP ❑ DN CHANNEL TYPE: _____

RESTORATION OBJECTIVE: ❑ 1 ❑ 2 ❑ 3 TYPE OF STRUCTURE: _____

HOW WELL IS STRUCTURE MEETING HABITAT OBJECTIVE? (circle number)

1 (EXCELLENT) _____ **2 (GOOD)** _____ **3 (FAIR)** _____ **4 (POOR)** _____ **5 (NO VALUE)** _____

COMMENTS: _____

_____

CONDITION OF STRUCTURE - consider structural integrity only (circle number):

1 (EXCELLENT) _____ **2 (GOOD)** _____ **3 (FAIR)** _____ **4 (POOR)** _____ **5 (NO VALUE)** _____

COMMENTS: _____

_____

STRUCTURE PROBLEMS (check appropriate items):

1. ❑ ANCHOR FAILURE,
2. ❑ CABLE FAILURE,
3. ❑ CHANNEL SHIFT,
4. ❑ BOULDER/LOG SHIFT,
5. ❑ UNDERMINED,
6. ❑ BURIED BY BEDLOAD,
7. ❑ UNDERBUILT,
8. ❑ LOGS/BOULDERS STRANDED OUT OF CHANNEL,
9. ❑ BANK EROSION AT SITE AND/OR DOWNSTREAM,
10. ❑ CREATED SEDIMENT TRAP,
11. ❑ POOR DESIGN,
12. ❑ POOR PLACEMENT,
13. ❑ EX-FENCE FAILURE,
14. ❑ OTHER.

COMMENTS: _____

_____

Repair recommended: ❑ Yes ❑ No Enhancement to improve cover or effectiveness recommended: ❑ Yes ❑ No

HABITAT TYPE (associated with structure) _____ BANKFULL STREAM WIDTH _____ FT.

MAXIMUM POOL DEPTH _____ FT. DEPTH OF POOL TAIL CREST _____ FT.

SHELTER COMPLEXITY: ❑ 0 ❑ 1 ❑ 2 ❑ 3 × SHELTER % COVER: _____ = SHELTER RATING: _____

OBSERVED SALMONIDS NO.: 0+ _____, 1+ _____, 2+ _____, ADULTS _____, REDDS _____

COMMENTS: _____

_____

REVEGETATION: RIPARIAN ___ UPSLOPE ___ BOTH _____ (Photo required for reveg.) DESCRIBE DENSITY: _____

PHOTO NO. PRINT: ROLL _____ FRAME _____ SLIDE: ROLL _____ FRAME _____

COMMENTS: _____

APPENDIX S.

FISH SCREEN CRITERIA[1]

DEPARTMENT OF FISH AND GAME

1. STRUCTURE PLACEMENT

A. Streams And Rivers (flowing water): The screen face shall be parallel to the flow and adjacent bankline (water's edge), with the screen face at or streamward of a line defined by the annual low-flow water's edge.

The upstream and downstream transitions to the screen structure shall be designed and constructed to match the back-line, minimizing eddies upstream of, in front of and downstream of, the screen.

Where feasible, this "on-stream" fish screen structure placement is preferred by the California Department of Fish and Game.

B. In Canals (flowing water): The screen structure shall be located as close to the river source as practical, in an effort to minimize the approach channel length and the fish return bypass length. This "in canal" fish screen location shall only be used where an "on-stream" screen design is not feasible. This situation is most common at existing diversion dams with headgate structures.

The current National Oceanic and Atmospheric Administration Fisheries - Southwest Region criteria for these types of installations shall be used.

C. Small Pumped Diversions: Small pumped diversions (less than 40 cubic-feet per second) which are screened using "manufactured, self-contained" screens shall conform to the National Oceanic and Atmospheric Administration Fisheries - Southwest Region criteria.

D. Non-Flowing Waters (tidal areas, lakes and reservoirs): The preferred location for the diversion intake structure shall be offshore, in deep water, to minimize fish contact with the diversion. Other configurations will be considered as exceptions to the screening criteria as described in Section 5.F. below.

2. APPROACH VELOCITY (Local velocity component perpendicular to the screen face)

A. Flow Uniformity: The design of the screen shall distribute the approach velocity uniformly across the face of the screen. Provisions shall be made in the design of the

[1] June 19, 2000 Version

screen to allow for adjustment of flow patterns. The intent is to ensure uniform flow distribution through the entire face of the screen as it is constructed and operated.

B. Self-Cleaning Screens: The design approach velocity shall not exceed:

1. Streams And Rivers (flowing waters) - Either:

a. 0.33 feet per second, where exposure to the fish screen shall not exceed fifteen minutes, or

b. 0.40 feet per second, for small (less than 40 cubic-feet per second) pumped diversions using Amanufactured, self-contained@ screens.

2. In Canals (flowing waters) - 0.40 feet per second, with a bypass entrance located every one-minute of travel time along the screen face.

3. Non-Flowing Waters (tidal areas, lakes and reservoirs) - The specific screen approach velocity shall be determined for each installation, based on the species and life stage of fish being protected. Velocities which exceed those described above will require a variance to these criteria (see Section 5.F. below).

(Note: At this time, the U.S. Fish and Wildlife Service has selected a 0.2 feet per second approach velocity for use in waters where the Delta smelt is found. Thus, fish screens in the Sacramento-San Joaquin Estuary should use this criterion for design purposes.)

C. Screens Which Are Not Self-Cleaning: The screens shall be designed with an approach velocity one-fourth that outlined in Section B. above. The screen shall be cleaned before the approach velocity exceeds the criteria described in Section B.

D. Frequency Of Cleaning: Fish screens shall be cleaned as frequently as necessary to prevent flow impedance and violation of the approach velocity criteria. A cleaning cycle once every 5 minutes is deemed to meet this standard.

E. Screen Area Calculation: The required wetted screen area (square feet), excluding the area affected by structural components, is calculated by dividing the **maximum** diverted flow (cubic-feet per second) by the allowable approach velocity (feet per second). Example:

1.0 cubic-feet per second / 0.33 feet per second = 3.0 square feet

Unless otherwise specifically agreed to, this calculation shall be done at the **minimum** stream stage.

3. SWEEPING VELOCITY (Velocity component parallel to screen face)

A. In Streams And Rivers: The sweeping velocity should be at least two times the allowable approach velocity.

B. In Canals: The sweeping velocity shall exceed the allowable approach velocity. Experience has shown that sweeping velocities of 2.0 feet per second (or greater) are preferable.

C. Design Considerations: Screen faces shall be designed flush with any adjacent screen bay piers or walls, to allow an unimpeded flow of water parallel to the screen face.

4. SCREEN OPENINGS

A. Porosity: The screen surface shall have a minimum open area of 27 percent. We recommend the maximum possible open area consistent with the availability of appropriate material, and structural design considerations.

The use of open areas less than 40 percent shall include consideration of increasing the screen surface area, to reduce slot velocities, assisting in both fish protection and screen cleaning.

B. Round Openings: Round openings in the screening shall not exceed 3.96mm (5/32in). In waters where steelhead rainbow trout fry are present, this dimension shall not exceed 2.38mm (3/32in).

C. Square Openings: Square openings in screening shall not exceed 3.96mm (5/32in) measured diagonally. In waters where steelhead rainbow trout fry are present, this dimension shall not exceed 2.38mm (3/32in) measured diagonally.

D. Slotted Openings: Slotted openings shall not exceed 2.38mm (3/32in) in width. In waters where steelhead rainbow trout fry are present, this dimension shall not exceed 1.75mm (0.0689in).

5. SCREEN CONSTRUCTION

A. Material Selection: Screens may be constructed of any rigid material, perforated, woven, or slotted that provides water passage while physically excluding fish. The largest possible screen open area which is consistent with other project requirements should be used. Reducing the screen slot velocity is desirable both to protect fish and to ease cleaning requirements. Care should be taken to avoid the use of materials with sharp edges or projections which could harm fish.

B. Corrosion And Fouling Protection: Stainless steel or other corrosion-resistant material is the screen material recommended to reduce clogging due to corrosion. The use of both active and passive corrosion protection systems should be considered.

Consideration should be given to anti-fouling material choices, to reduce biological fouling problems. Care should be taken not to use materials deemed deleterious to fish and other wildlife.

C. Project Review And Approval: Plans and design calculations, which show that all the applicable screening criteria have been met, shall be provided to the Department before written approval can be granted by the appropriate Regional Manager.

The approval shall be documented in writing to the project sponsor, with copies to both the Deputy Director, Habitat Conservation Division and the Deputy Director, Wildlife and Inland Fisheries Division. Such approval may include a requirement for post-construction evaluation, monitoring and reporting.

D. Assurances: All fish screens constructed after the effective date of these criteria shall be designed and constructed to satisfy the current criteria. Owners of existing screens, approved by the Department prior to the effective date of these criteria, shall not be required to upgrade their facilities to satisfy the current criteria unless:

1. The controlling screen components deteriorate and require replacement (i.e., change the opening size or opening orientation when the screen panels or rotary drum screen coverings need replacing),

2. Relocation, modification or reconstruction (i.e., a change of screen alignment or an increase in the intake size to satisfy diversion requirements) of the intake facilities, or

3. The owner proposes to increase the rate of diversion which would result in violation of the criteria without additional modifications.

E. Supplemental Criteria: Supplemental criteria may be issued by the Department for a project, to accommodate new fish screening technology or to address species-specific or site-specific circumstances.

F. Variances: Written variances to these criteria may be granted with the approval of the appropriate Regional Manager and concurrence from both the Deputy Director, Habitat Conservation Division and the Deputy Director, Wildlife and Inland Fisheries Division. At a minimum, the rationale for the variance must be described and justified in the request.

Evaluation and monitoring may be required as a condition of any variance, to ensure that the requested variance does not result in a reduced level of protection for the aquatic resources.

It is the responsibility of the project sponsor to obtain the most current version of the appropriate fish screen criteria. Project sponsors should contact the Department of Fish and Game, the National Oceanic and Atmospheric Administration Fisheries (for projects in marine and anadromous waters) and the U.S. Fish and Wildlife Service (for projects in anadromous and fresh waters) for guidance.

Copies of the current criteria are available from the Department of Fish and Game through the appropriate Regional office, which should be the first point of contact for any fish screening project.

Northern California and North Coast Region; 601 Locust Street, Redding, CA 96001 - (530) 225-2300.

Sacramento Valley and Central Sierra Region; 1701 Nimbus Drive, Rancho Cordova, CA 95670 - (916) 358-2900.

Central Coast Region; 7329 Silverado Trail/P.O. Box 46, Yountville, CA 94599 - (707) 944-5500.

San Joaquin Valley-Southern Sierra Region; 1234 E. Shaw Avenue, Fresno, CA 93710 - (209) 243-4005.

South Coast Region; 4649 View Crest Avenue, San Diego, CA 92123 - (619) 467-4201.

Eastern Sierra and Inland Deserts Region; 4775 Bird Farms Road, Chino Hills, CA 91709 - (909) 597-9823.

Marine Region; 20 Lower Ragsdale Drive, #100, Monterey, CA 93940 - (831) 649-2870.

Technical assistance can be obtained directly from the Habitat Conservation Division; 1416 Ninth Street, Sacramento, CA 95814 - (916) 653-1070.

The current National Oceanic and Atmospheric Administration Fisheries criteria are available from their Southwest Region; 777 Sonoma Avenue, Room 325, Santa Rosa, CA 95402 - (707) 575-6050.

Fish Screening Criteria for Anadromous Salmonids [1]
National Oceanic and Atmospheric Administration Fisheries
Southwest Region

January 1997

I. General Considerations

This document provides guidelines and criteria for functional designs of downstream migrant fish passage facilities at hydroelectric, irrigation, and other water withdrawal projects. It is promulgated by the National Oceanic and Atmospheric Administration Fisheries (NOAA), Southwest Region as a result of its authority and responsibility for prescribing fishways under the Endangered Species Act (ESA), the Federal Power Act, administered by the Federal Energy Regulatory Commission (FERC), and the Fish and Wildlife Coordination Act (FWCA), administered by the U.S. Fish and Wildlife Service.

The guidelines and criteria are general in nature. There may be cases where site constraints or extenuating circumstances dictate a waiver or modification of one or more of these criteria. Conversely, where there is an opportunity to protect fish, site-specific criteria may be added. Variances from established criteria will be considered on a project-by-project basis.

The swimming ability of fish is a primary consideration in designing a fish screen facility. Research shows that swimming ability varies depending on multiple factors relating to fish physiology, biology, and the aquatic environment. These factors include: species, physiological development, duration of swimming time required, behavioral aspects, physical condition, water quality, temperature, lighting conditions, and many others. Since conditions affecting swimming ability are variable and complex, screen criteria must be expressed in general terms and the specifics of any screen design must address on-site conditions.

NOAA may require project sponsors to investigate site-specific variables critical to the fish screen system design. This investigation may include fish behavioral response to hydraulic conditions, weather conditions (ice, wind, flooding, etc.), river stage-discharge relationships, seasonal operations, sediment and debris problems, resident fish populations, potential for creating predation opportunity, and other pertinent information. The size of salmonids present at a potential screen site usually is not known, and can change from year-to-year based on flow and temperature conditions. Thus, adequate data to describe the size-time relationship requires substantial sampling over a number of years. NOAA will normally assume that fry-sized salmonids are present at all sites unless adequate biological investigation proves otherwise. The burden of proof is the responsibility of the owner of the screen facility.[2]

New facilities which propose to utilize unproven fish protection technology frequently require: 1) development of a biological basis for the concept; 2) demonstration of favorable behavioral responses in a laboratory setting; 3) an acceptable plan for evaluating the prototype installation;

[2] Adapted from NOAA, Southwest Region

and 4) an acceptable alternate plan should the prototype not adequately protect fish. Additional information can be found in *Experimental Fish Guidance Devices*, position statement of the National Oceanic and Atmospheric Administration Fisheries, Southwest Region, January 1994.

Striped Bass, Herring, Shad, Cyprinids, and other anadromous fish species may have eggs and/or very small fry which are moved with any water current (tides, streamflows, etc.). Installations where these species are present may require individual evaluation of the proposed project using more conservative screening requirements. In instances where state or local regulatory agencies require more stringent screen criteria to protect species other that salmonids, NOAA will generally defer to the more conservative criteria.

General screen criteria and procedural guidelines are provided below. Specific exceptions to these criteria occur in the design of small screen systems (less than 40 cubic feet per second) and certain small pump intakes. These exceptions are listed in Section K. Modified Criteria for Small Screens, and in the separate addendum entitled: Juvenile Fish Screen Criteria For Pump Intakes, National Oceanic and Atmospheric Administration Fisheries, Portland, Oregon, May 9, 1996.

II. General Procedural Guidelines

For projects where NOAA had jurisdiction, such as FERC license applications and ESA consultations, a functional design must be developed as part of the application or consultation. These designs must reflect NOAA design criteria and be acceptable to NOAA. Acceptable designs typically define type, location, method of operation, and other important characteristics of the fish screen facility. Design drawings should show structural dimensions in plan, elevation, and cross-sectional views, along with important component details. Hydraulic information should include: hydraulic capacity, expected water surface elevations, and flows through various areas of the structures. Documentation of relevant hydrologic information is required. Types of materials must be identified where they will directly affect fish. A plan for operations and maintenance procedures should be included-i.e., preventive and corrective maintenance procedures, inspections and reporting requirements, maintenance logs, etc. - particularly with respect to debris, screen cleaning, and sedimentation issues. The final detailed design shall be based on the functional design, unless changes are agreed to by NOAA.

All juvenile passage facilities shall be designed to function properly through the full range of hydraulic conditions expected at a particular site during fish migration periods, and shall account for debris and sedimentation conditions which may occur.

III. Screen Criteria for Juvenile Salmonids

A. Structure Placement

1. General:
The screened intake shall be designed to withdraw water from the most appropriate elevation, considering juvenile fish attraction, appropriate water temperature control downstream or a combination thereof. The design must accommodate the expected range of water surface elevations.

For on-river screens, it is preferable to keep the fish in the main channel rather that put them through intermediate screen bypasses. NOAA decides whether to require intermediate bypasses for on-river, straight profile screens by considering the biological and hydraulic conditions existing at each individual project site.

2. Streams and Rivers:

Where physically practical, the screen shall be constructed at the diversion entrance. The screen face should be generally parallel to river flow and aligned with the adjacent bankline. A smooth transition between the bankline and the screen structure is important to minimize eddies and undesirable flow patterns in the vicinity of the screen. If trash racks are used, sufficient hydraulic gradient is required to route juvenile fish from between the trash rack and screens to safety. Physical factors that may preclude screen construction at the diversion entrance include excess river gradient, potential for damage by large debris, and potential for heavy sedimentation. Large stream-side installations may require intermediate bypasses along the screen fact to prevent excessive exposure time. The need for intermediate bypasses shall be decided on a case-by-case basis.

3. Canals:
Where installation of fish screens at the diversion entrance is undesirable or impractical, the screens may be installed at a suitable location downstream of the canal entrance. All screens downstream of the diversion entrance shall provide an effective juvenile bypass system - designed to collect juvenile fish and safely transport then back to the river with minimum delay. The angle of the screen to flow should be adequate to effectively guide fish to the bypass. Juvenile bypass systems are part of the overall screen system and must be accepted by NOAA.

4. Lakes, Reservoirs, and Tidal Areas

a. Where possible, intakes should be located off shore to minimize fish contact with the facility. Water velocity from any direction toward the screen shall not exceed the allowable approach velocity. Where possible, locate intakes where sufficient sweeping velocity exists. This minimizes sediment accumulation in and around the screen, facilitates debris removal, and encourages fish movement away from the screen face.

b. If a screen intake is used to route fish past a dam, the intake shall be designed to withdraw water from the most appropriate elevation in order to provide the best juvenile fish attraction to the bypass channel as well as to achieve appropriate water temperature control downstream. The entire range of forebay fluctuations shall be accommodated by the design, unless otherwise approved by NOAA.

B. Approach Velocity

Definition: *Approach Velocity* is the water velocity vector component perpendicular to the screen face. Approach velocity shall be measured approximately three inches in front of the screen surface.

1. Fry Criteria - less than 2.36 inches {60 millimeters (mm)} in length.

If a biological justification cannot demonstrate the absence of fry-sized salmonids in the vicinity of the screen, fry will be assumed present and the following criteria apply:

Design approach velocity shall not exceed:
Streams and Rivers: 0.33 feet per second
Canals: 0.40 feet per second
Lakes, Reservoirs, Tidal: 0.33 feet per second (salmonids) [3]

2. Fingerling Criteria - 2.36 inches {60 mm} and longer

If biological justification can demonstrate the absence of fry-sized salmonids in the vicinity of the screen, the following criteria apply:

Design approach velocity shall not exceed:
All locations: 0.8 feet per second

3. The *total submerged screen area required* (excluding area of structural components) is calculated by dividing the maximum diverted flow by the allowable approach velocity. (Also see Section K, Modified Criteria for Small Screens, part 1).

4. The screen design must provide for uniform flow distribution over the surface of the screen, thereby minimizing approach velocity. This may be accomplished by providing adjustable porosity control on the downstream side of the screens, unless it can be shown unequivocally (such as with a physical hydraulic model study) that localized areas of high velocity can be avoided at all flows.

C. Sweeping Velocity

Definition: *Sweeping Velocity* is the water velocity vector component parallel and adjacent to the screen face.

1. Sweeping Velocity shall be greater than approach velocity. For canal installations, this is accomplished by angling screen face less than 45E relative to flow (see Section K. Modified Criteria for Small Screens). This angle may be dictated by specific canal geometry, or hydraulic and sediment conditions.

D. Screen Face Material

[3] Other species may require different approach velocity standards. e.g. in California the U.S. Fish & Wildlife Service requires 0.2 fps approach velocity where delta smelt are present in the tidal areas of the San Francisco Bay estuary.

1. Fry criteria. If a biological justification cannot demonstrate the absence of fry-sized salmonids in the vicinity of the screen, fry will be assumed present and the following criteria apply for screen material:

a. Perforated plate: screen openings shall not exceed 3/32 inches (2.38 mm), measured in diameter.

b. Profile bar: screen openings shall not exceed 0.0689 inches (1.75 mm) in width.

c. Woven wire: Screen openings shall not exceed 3/32 inches (2.38 mm), measured diagonally (e.g.: 6-14 mesh).

d. Screen material shall provide a minimum of 27% open area.

2. Fingerling criteria

If biological justification can demonstrate the absence of fry-sized salmonids in the vicinity of the screen, the following criteria apply for screen material:

a. Perforated plate: Screen openings shall not exceed 1/4 inch (6.35 mm) in diameter.

b. Profile bar: screen openings shall not exceed 1/4 inch (6.35 mm) in width.

c. Woven wire: Screen openings shall not exceed 1/4 inch (6.35 mm) in the narrow direction.

d. Screen material shall provide a minimum of 40% open area.

3. The screen material shall be corrosion resistant and sufficiently durable to maintain a smooth and uniform surface with long term use.

E. Civil Works and Structural Features

1. The face of all screen surfaces shall be placed flush with any adjacent screen bay, pier noses, and walls, allowing fish unimpeded movement parallel to the screen face and ready access to bypass routes.

2. Structural features shall be provided to protect the integrity of the fish screens from large debris. Trash racks, log booms, sediment sluices, or other measures may be needed. A reliable on-going preventive maintenance and repair program is necessary to ensure facilities are kept free of debris and the screen mesh, seals, drive units, and other components are functioning correctly.

3. Screens located in canals - surfaces shall be constructed at an angle to the approaching flow, with the downstream end terminating at the bypass system entrance.

4. The civil works design shall attempt to eliminate undesirable hydraulic effects (e.g. - eddies, stagnant flow zones) that may delay or injure fish, or provide predator opportunities. Upstream training wall(s), or some acceptable variation thereof, shall be utilized to control hydraulic

conditions and define the angle of flow to the screen face. Large facilities may require hydraulic monitoring to identify and correct areas of concern.

F. Juvenile Bypass System Layout

Juvenile bypass systems are water channels which transport juvenile fish from the face of a screen to a relatively safe location in the main migratory route of the river or stream. Juvenile bypass systems are necessary for screens located in canals because anadromous fish must be routed back to their main migratory route. For other screen locations and configurations, NOAA accepts the option which, in its judgement, provides the highest degree of fish protection given existing site and project constraints.

1. The screen and bypass shall work in tandem to move out-migrating salmonids (including adults) to the bypass outfall with minimum injury or delay. Bypass entrance(s) shall be designed such that out-migrants can easily locate and enter them. Screens installed in canal diversions shall be constructed with the downstream end of the screen terminating at a bypass entrance. Multiple bypass entrances (intermediate bypasses) shall be employed if the sweeping velocity will not move fish to the bypass within 60 seconds [4] assuming the fish are transported at this velocity. Exceptions will be made for sites without sufficient hydraulic conditions, or for screens built on river banks with satisfactory river conditions.

2. All components of the bypass system, from entrance to outfall, shall be of sufficient hydraulic capacity to minimize the potential for debris blockage.

3. To improve bypass collection efficiency for a single bank of vertically oriented screens, a bypass training wall may be located at an angle to the screens.

4. In cases where insufficient flow is available to satisfy hydraulic requirements at the main bypass entrance(s), a *secondary screen* may be required. Located in the main screen=s bypass channel, a secondary screen allows the prescribed bypass flow to be used to effectively attract fish into the bypass entrance(s) while allowing all but a reduced residual bypass flow to be routed back (by pump or gravity) for the primary diversion use. The residual bypass flow (not passing through the secondary screen) then conveys fish to the bypass outfall location or other destination.

5. Access is required at locations in the bypass system where debris accumulation may occur.

6. The screen civil works floor shall allow fish to be routed to the river safely in the event the canal is dewatered. This may entail a sumped drain with a small gate and drain pipe, or similar provisions.

[4] In California, 60 second exposure time applies to screens in canals, using a 0.4 fps approach velocity. Where more conservative approach velocities are used, longer exposure times may be approved on a case-by-case basis, and exceptions to established criteria shall be treated as variances.

G. Bypass Entrance

1. Each bypass entrance shall be provided with independent flow control, acceptable to NOAA.

2. Bypass entrance velocity must equal or exceed the maximum velocity vector resultant along the screen, upstream of the entrance. A gradual and efficient acceleration into the bypass is required to minimize delay of out-migrants.

3. Ambient lighting conditions are required from the bypass entrance to the bypass flow control.

4. The bypass entrance must extend from floor to water surface.

H. Bypass Conduit Design

1. Smooth interior pipe surfaces and conduit joints shall be required to minimize turbulence, debris accumulation, and the risk of injury to juvenile fish. Surface smoothness must be acceptable to the NOAA.

2. Fish shall not free-fall within a confined shaft in a bypass system.

3. Fish shall not be pumped within the bypass system.

4. Pressure in the bypass pipe shall be equal to or above atmospheric pressure.

5. Extreme bends shall be avoided in the pipe layout to avoid excessive physical contact between small fish and hard surfaces and to minimize debris clogging. Bypass pipe centerline radius of curvature (R/D) shall be 5 or greater. Greater R/D may be required for supercritical velocities.

6. Bypass pipes or open channels shall be designed to minimize debris clogging and sediment deposition and to facilitate cleaning. Pipe diameter shall be 24 inches (0.610 m) or greater and pipe velocity shall be 2.0 fps (0.610 mps) or greater, unless otherwise approved by NOAA. (See *Modified Criteria for Small Screens* for the entire operational range).

7. No closure valves are allowed within bypass pipes.

8. Depth of flow in a bypass conduit shall be 0.75 ft. (0.23 m) or greater, unless otherwise authorized by NOAA. (See *Modified Criteria for Small Screens).*

9. Bypass system sampling stations shall not impair normal operation of the screen facility.

10. No hydraulic jumps should exist within the bypass system.

I. Bypass Outfall

1. Ambient river velocities at bypass outfalls should be greater that 4.0 fps (1.2 mps), or as close as obtainable.

2. Bypass outfalls shall be located and designed to minimize avian and aquatic predation in areas free of eddies, reverse flow, or known predator habitat.

3. Bypass outfalls shall be located where there is sufficient depth (depending on the impact velocity and quantity of bypass flow) to avoid fish injuries at all river and bypass flows.

4. Impact velocity, including vertical and horizontal components, shall not exceed 25.0 fps (7.6 mps).

5. Bypass outfall discharges shall be designed to avoid adult attraction or jumping injuries.

J. Operations and Maintenance

1. Fish screens shall be automatically cleaned as frequently as necessary to prevent accumulation of debris. The cleaning system and protocol must be effective, reliable, and satisfactory to NOAA. Proven cleaning technologies are preferred.

2. Open channel intakes shall include a trash rack in the screen facility design which shall be kept free of debris. In certain cases, a satisfactory profile bar screen design can substitute for a trash rack.

3. The head differential to trigger screen cleaning for intermittent type systems shall be a maximum of 0.1 feet (.03 m), unless otherwise agreed to by NOAA.

4. The completed screen and bypass facility shall be made available for inspection by NOAA to verify compliance with design and operational criteria.

5. Screen and bypass facilities shall be evaluated for biological effectiveness and to verify that hydraulic design objectives are achieved.

K. Modified Criteria for Small Screens (Diversion Flow less than 40 cfs)

The following criteria vary from the standard screen criteria listed above. These criteria specifically apply to small screens. Forty cfs is the approximate cut off: however, some smaller diversions may be required to apply the general criteria listed above, while some larger diversions may be allowed to use the Asmall screen@ criteria below. NOAA will decide on a case-by-case basis depending on site constraints.

1. The required screen area is a function of the approach velocity listed in Section B, Approach Velocity, Parts 1, 2, and 3 above. Note that Amaximum@ refers to the greatest flow diverted, not necessarily the water right.

2. Screen Orientation:

a. For screen lengths six feet or less, screen orientation may be angles perpendicular to the flow.

b. For screen lengths greater than six feet, screen-to-flow angle must be less than 45 degrees. (See Section C Sweeping Velocity, part 1).

c. For drum screens, design submergence shall be 75% of drum diameter. Submergence shall not exceed 85%, nor be less than 65% of drum diameter.

d. Minimum bypass pipe diameter shall be 10 inches (25.4 cm), unless otherwise approved by NOAA.

e. Minimum pipe depth is 1.8 inches (4.6 cm) and is controlled by designing the pipe gradient for minimum bypass flow.

Questions concerning this document can be directed to NOAA Hydraulic Engineering Staff at:

National Oceanic and Atmospheric Administration Fisheries
Southwest Region
777 Sonoma Ave., Room 325
Santa Rosa, CA 95402
Phone: (707) 575-6050

Fish Screen Operation and Maintenance
Best Management Practices

- Fish screens shall be operated and maintained in compliance with current law, including Fish and Game Code, and Department of Fish and Game (DFG) fish screening criteria. DFG screening criteria may be referenced on the internet at: http://www.dfg.ca.gov/fish/Resources/Projects/Engin/Engin_ScreenCriteria.asp

- Notwithstanding Fish and Game Code section 6027, fish screens and bypass pipes or channels shall be in-place and maintained in working order at all times water is being diverted.

- If a screen site is dewatered for repairs or maintenance when targeted fish species are likely to be present, measures will be taken to minimize harm and mortality to targeted species resulting from fish relocation and dewatering activities. The responsible party shall notify DFG before the project site is de-watered and the stream flow diverted. The notification will provide a reasonable time for DFG personnel to supervise the implementation of a water diversion plan and oversee the safe removal and relocation of salmonids and other fish life from the project area. If the project requires dewatering of the site, and the relocation of salmonids, the responsible party will implement the following measures to minimize harm and mortality to listed salmonids:

- All electrofishing shall be performed by a qualified fisheries biologist and conducted according to the National Marine Fisheries Service (NMFS), Guidelines for Electrofishing Waters Containing Salmonids Listed under the Endangered Species Act, June 2000.

- The responsible party will provide fish relocation data to DFG on a form provided by the DFG, unless the relocation work is performed by DFG personnel.

- Additional measures to minimize injury and mortality of salmonids during fish relocation and dewatering activities shall be implemented as described in Part IX, pages 52 and 53 of the *California Salmonid Stream Habitat Restoration Manual*.

- If a fish screen is removed for cleaning or repair, a replacement screen shall be installed immediately or the diversion shut down until a screen is in place.

- Fish screens shall be inspected and maintained regularly (not less than two times per week) to ensure that they are functioning as designed and meeting DFG fish screening criteria.

- Existing roads shall be used to access screen sites with vehicles and/or equipment whenever possible. If it is necessary to create access to a screen site for repairs or maintenance, access points should be identified at stable stream bank locations which minimize riparian disturbance.

- Sediment and debris removal at a screen site shall take place as often as needed to ensure that screening criteria are met. Sediment and debris will be removed and disposed of where they will not re-enter the water course.

- Stationary equipment used in performing screen maintenance and repairs, such as motors, pumps, generators, and welders, located within or adjacent to a stream shall be positioned over drip pans.

- Equipment which is used to maintain and/or repair fish screens shall be in good condition and checked and maintained on a daily basis to prevent leaks of materials that could be deleterious to aquatic life, wildlife, or riparian habitat.

- All activities performed in or near a stream will have absorbent materials designed for spill containment and cleanup at the activity site for use in case of an accidental spill. Clean-up of spills shall begin immediately after any spill occurs. The State Office of Emergency Services (1-800-852-7550) and DFG shall be notified immediately after any spill occurs.

- To the extent possible repairs to a fish screen or screen site shall be made during a period of time when the target species of fish are not likely to be present (for example, in a seasonal creek, repair work should be performed when the stream is dry).

- Equipment used to maintain and/or repair fish screens shall not operate in a live stream except as may be necessary to construct coffer dams to divert stream flow and isolate the work site.

- For minor actions, where the disturbance to construct coffer dams to isolate the work site would be greater than to complete the action, measures will be put in place immediately downstream of the work site to capture suspended sediment.

- Turbid water which is generated by screen maintenance or repair activities shall be discharged to an area where it will not re-enter the stream. If the DFG determines that turbidity/siltation levels resulting from screen maintenance or repair activities constitute a threat to aquatic life, all activities associated with the turbidity/siltation shall cease until effective DFG-approved sediment control devices are installed and/or abatement procedures are implemented.

- No debris, soil, silt, sand, bark, slash, spoils, sawdust, rubbish, cement, or concrete or washings thereof; asphalt, paint, or other coating material; oil or petroleum products; or other organic or earthen material from any fish screen operation/maintenance/repair or associated activity of whatever nature shall be allowed to enter into, or placed where it may be washed by rainfall or runoff into a stream channel. When operations are completed, any excess materials or debris shall be removed from the work area and disposed of in a lawful manner.