STATE OF CALIFORNIA

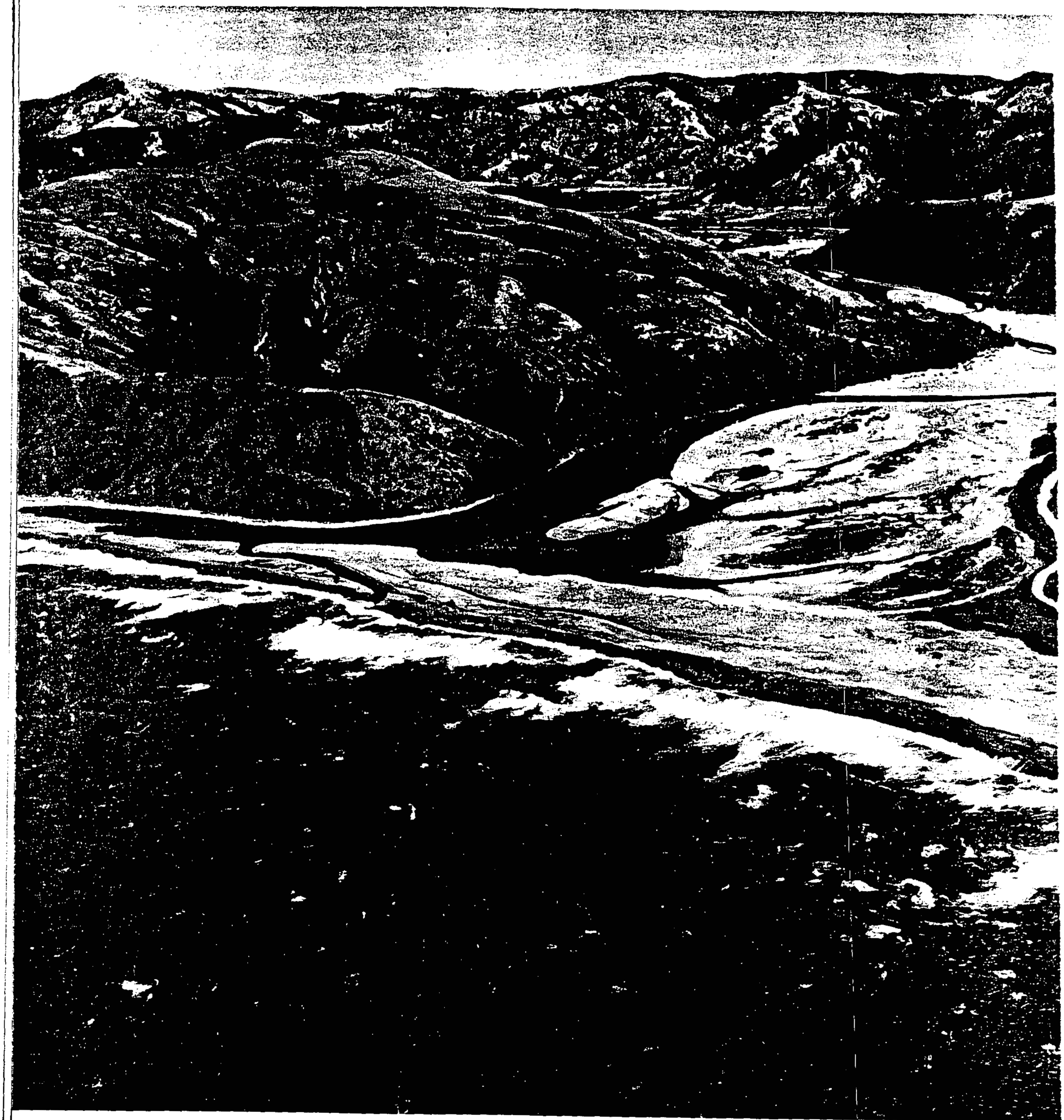
The Resources Agency

Department of Water Resources

Northern District

WATER MANAGEMENT FOR FISHERY ENHANCEMENT ON NORTH COASTAL STREAMS

MAY 1974



MOUTH OF THE MATTOLE RIVER

FOREWORD

One of the most popular outdoor sports in the nation today is fishing, and one of the better places in the nation to engage in that sport has been California's north coastal area. The Klamath, Smith, and Eel Rivers are famous for salmon and steelhead, and other rivers in California's water-rich north coastal area have traditionally provided a variety of fishing opportunities.

However, in recent years the character of north coastal streams has changed drastically. Logging, mining, road construction, and other activities, coupled with two extraordinarily large floods, have changed many north coastal streams from tree-lined meandering channels with deep, cool pools and long riffles, into shallow, silted, warm waterways barren of streamside vegetation. Anadromous fish runs in some north coastal rivers have declined as much as 60 to 80 percent in recent decades. Many of these rivers have become too turbid to fish throughout much of the salmon and steelhead season.

In response to this situation, the California Legislature in 1965 asked the Department of Water Resources to report on the desirability of studying fisheries improvements on small north coastal streams. The Department, in a 1966 report, found that fisheries play a vital role in the north coastal economy and that a study of possible fishery enhancement projects should be made.

That finding, strengthened by subsequent increased public emphasis on the environment, led the Department in July 1971 to initiate, in cooperation with the Department of Fish and Game, a north coastal fisheries enhancement study. The objective of the study was to develop several alternative enhancement possibilities and, if possible, to select one or more of these alternatives for recommended implementation.

This report presents the results of the first phase of study.

Albert J. Dolcini
District Engineer
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CHAPTER I. SUMMARY

The north coastal region of California has a history of offering some of the best salmon and steelhead fishing in the entire nation. The Klamath River, the largest stream in the North Coast, has a reputation as one of the leading producers of steelhead in the nation. Essentially all of California's silver salmon and at least 80 percent of the steelhead are found in north coastal streams. The Smith and Trinity Rivers are famous for their ability to clear rapidly after storms and remain fishable during most of the season. The Eel River has supported extremely large numbers of anadromous fish in years past. Intermediate-size coastal streams such as Redwood Creek and the Mattole and Navarro Rivers have statewide reputations for producing runs of large steelhead, with many being in the 15- to 20-pound class. Even small streams such as Little River and Tenmile River at one time provided excellent fishing. Fisheries are an important part of the north coastal area's recreation service industry which is second only to lumbering in economic value. The annual income from commercial fishing is about equal to that derived from agriculture and is exceeded only by lumbering and recreation.

However, in recent years an ominous cloud has rendered uncertain the future of north coastal fishing. Due to many factors, some natural but many caused by poor land use practices, the character of north coastal streams has changed dramatically. Instead of deep, tree-lined channels with frequent pools and long riffles carrying cool water, many coastal rivers have become shallow, warm, and barren of streamside vegetation. Concurrently, fish populations in these rivers have declined at an alarming rate and many responsible individuals despair of them ever recovering to previous levels. Over the last four decades, king salmon runs have declined about 80 percent in the Klamath River and 60 percent in the Shasta River. During the last three to four decades, average steelhead runs have declined 75 percent in the Eel River at Van Arsdale Dam and 65 percent in the South Fork Eel River at Benbow Dam. Such decreases appear to be typical of many other north coastal streams. The amount of time the streams are clear enough for fishing has also decreased tremendously. The Eel River is too turbid to fish throughout much of the salmon and steelhead season. A similar situation has occurred on many of the smaller north coastal streams. Redwood Creek has been severely damaged as an anadromous fish stream, and the Mattole River, which once cleared in 2 or 3 days, now takes as much as 3 weeks after a storm to become fishable.

Causes for the declines in fish numbers and fishability can be attributed to many factors including floods, dam construction, road building, overgrazing, and logging. However, since floods have occurred periodically throughout history, and since large dams have been constructed on relatively few north coastal streams, the major losses appear to have resulted from poor watershed management practices.

A 1971 report, "An Environmental Tragedy", prepared by a special Governor's Task Force, showed that as much as 88 percent of the stream channels of some north coastal streams, such as Redwood Creek in Humboldt County and the Garcia River in Mendocino County, have been damaged by logging, road building, and overgrazing (no dams exist on these rivers).

One of the most significant inland factors adversely affecting steelhead and silver salmon runs in north coastal streams appears to be a lack of adequate rearing habitat. Many fishery biologists now feel that the extremely low summer flows of north coastal streams which have been damaged by increased sedimentation and riparian vegetation removal is responsible to a large degree for the high mortality rate of young steelhead trout and silver salmon. Low summer flows combined with changes in river character result in poor living conditions due to decreased food production, increased competition for living space, high temperatures, and increased vulnerability to natural enemies.

Several opportunities exist for increasing the numbers of fish and improving fishing conditions in north coastal rivers. They include: (1) construction of fish hatcheries and rearing ponds; (2) removal of fish barriers to make new spawning and nursery areas available; (3) construction of fish passage facilities over immovable barriers; (4) construction of artificial spawning channels with controlled water supply, water temperatures, and selected gravels; (5) watershed management; (6) modification of the operation of existing reservoirs to produce better flows for fish; and (7) construction of streamflow enhancement reservoirs to control floodflows, increase summer and fall flows, and improve water temperatures.

Each of these enhancement possibilities was considered during the early stages of this study. Fish hatcheries, rearing ponds, barrier removal, and artificial spawning channels were determined to have potential for enhancement and are already being evaluated by the Department of Fish and Game. Watershed management, although a promising technique, was considered beyond the scope of this study. Streamflow augmentation was the only enhancement possibility which showed promise of success, was not being studied, and fell within the purview of the Department of Water Resources. Emphasis during this study was therefore placed on evaluation of streamflow augmentation possibilities.

Coastal streams initially considered for study of flow augmentation included Redwood Creek and the Mattole, Navarro, Noyo, Big, Tenmile, and Gualala Rivers. The Mattole River was selected by the Department for concentrated study for the following reasons:

1. It once supported large runs of salmon and steelhead, but present runs are greatly reduced.

2. At least one good dam and reservoir site exists in the upper basin where blockage of upstream fish habitat would be minimal and length of stream which could be enhanced would be large.

3. Natural streamflows at the damsite are low in turbidity, thereby assuring that clear water releases could be made from the reservoir.

4. Lack of adequate rearing area associated with extremely low summer flows appears to be a limiting factor to anadromous fish populations in the river.

5. The river is almost free of nongame fish species; therefore, increased summer flows would benefit mainly steelhead and silver salmon. Increased fall and spring flows would benefit steelhead, silver salmon, and king salmon.

6. The stream was officially identified by Humboldt County as having the highest priority for study of fisheries enhancement possibilities.

Two potential reservoir sites located on the upper Mattole River were evaluated in this study. Either of these reservoirs could greatly increase summer flows throughout the more than 50 miles of river between the damsites and the river mouth. These flows could increase the capability of the river to support juvenile fish until they were ready for "outmigration" to the ocean. Construction of a dam could also increase recreation use, both at the project reservoir and along the river.

The Department of Fish and Game found that it was not possible in this study to estimate the increase in numbers of anadromous fish that would return to the river as a result of a flow augmentation fishery enhancement project. Probably the only sure way of determining the enhancement potential of flow augmentation reservoirs would be to construct a "pilot" project and carefully monitor the returns of fish for several years.

Although this study was supported by the Humboldt County Board of Supervisors and their duly constituted Fish and Game and Water Committees, people living within the Mattole River Basin were united in opposition to construction of a dam. In view of this opposition, and recognizing that a project of this type would require strong local support to obtain public financing, future studies of the Mattole River have been deferred and emphasis has been shifted to fisheries enhancement possibilities on the Upper Eel, and Trinity Rivers.

Conclusions

1. California's north coastal streams from the Russian River to the Oregon border provide habitat for approximately 38 percent of the king salmon, 88 percent of the steelhead, and 95 percent of the silver salmon spawning in California streams.

2. Salmon and steelhead are extremely important to the economy of the north coastal area because of the recreation and tourist trade they help support.

3. In the last three decades, king salmon runs in major north coastal streams have declined by 65 to 80 percent and steelhead runs have declined by as much as 80 percent.

4. Causes of the declines can be attributed to many factors, such as logging, road construction, floods, fires, overfishing, dam construction, mining, land conversions, and overgrazing. Many of the factors adversely affecting river systems are either totally man caused or are accelerated by the activities of man.

5. Several possible fisheries enhancement techniques have been tried in California, Washington, and Oregon with varying degrees of success. These techniques, and their potential application to the North Coast, are:

Enhancement Technique		Application to North Coastal Area
Fish hatcheries and rearing ponds	-	Successful. Additional hatcheries would be beneficial.
Construction of fish passage facilities and barrier removal	-	This is a continuing program that produces worthwhile results.
Artificial spawning channels	-	Little potential on north coastal streams.
Watershed management	-	Would benefit most river basins.
Reoperation of existing reservoirs	-	Very desirable, but possibilities are limited.
Streamflow augmentation	-	Most coastal streams exhibit need for increased summer flows.

6. Summer streamflow augmentation shows good potential for enhancement of small coastal streams but has not been proven in practice. Operation of a "pilot" project is the best way of comparing the benefits of this enhancement possibility with other, more conventional, techniques.

7. Detailed streamflow augmentation studies were limited to two sites on the Mattole River. However, much of the information obtained is applicable to similar projects on other streams.

8. As long as local opposition remains strong, no further fisheries enhancement studies will be made on the Mattole River.

9. Efforts by the Department of Water Resources to improve anadromous fish runs in the north coastal area will continue by means of the ongoing Eel-Russian River Streamflow Augmentation Study, interagency studies on the Trinity, and possible future studies on other coastal streams.

CHAPTER II. ANADROMOUS FISHERY RESOURCES AND TRENDS

Anadromous fish are an outstanding and valuable resource of the north coastal area. The word anadromous, from the Greek anadromos, "upward running", as applied to fish means those species which ascend rivers from the sea for breeding purposes. The species of greatest importance in north coastal streams are king (chinook) salmon, silver (coho) salmon, and steelhead trout. American shad, sturgeon, smelt, and Pacific lamprey are also found in some coastal streams, but their contribution to the fishery is relatively small. Anadromous fish must be able to migrate upstream from the ocean to spawning grounds where adequate streamflow and suitable water temperatures and water quality prevail. Most young king salmon migrate downstream to the ocean soon after hatching, but juvenile silver salmon and steelhead remain in fresh water for one or more years before migrating to the ocean. Thus, they require suitable habitat throughout the entire year. Table 1 lists a few of the known critical physical factors in the freshwater cycle of silver salmon and steelhead.

TABLE 1

CRITICAL PHYSICAL FACTORS IN FRESHWATER
CYCLE OF SILVER SALMON AND STEELHEAD

Physical Factor		Desirable Range
Temperature	- Juveniles	53°-58° F.
	- Spawning	42°-55° F.
Dissolved Oxygen	- Embryos	Above 9 ppm
	- Juveniles	Above 7 ppm
Food-Producing Riffles	- Gravel Size	1/8-10 in.
	- Velocity	1/2-3 fps
Spawning Area, per Spawning Pair		60 sq. ft.
Spawning Gravel Size		1/4-4 in.
Velocity of Flow Over Spawning Beds		1-3 fps
Spawning Water Depth		1/2-3 ft.
Turbidity - Fishing		Less than 30 JTU

While millions of juvenile salmonids are hatched each year, a greatly reduced number survive to migrate downstream to the ocean, and only a relatively small number return to spawn. Before leaving fresh water, approximately 95 percent of the young steelhead fry succumb to predators and natural or artificial hazards such as drying streams, water diversions, and pollution. As the fish grow in the ocean, they are subjected to intense commercial and sport fishing. This affects king and silver salmon much more than steelhead because few steelhead are taken in the ocean. The spawning escapement is comprised of those fish which have successfully negotiated these various hazards (including natural mortality at sea) and returned to their native streams to spawn. Less than 3 percent of the downstream steelhead migrants reaching the ocean are able to return and spawn in their native stream. Approximately two-thirds of the adult king salmon population is caught in the ocean and another 9 percent is taken by the inland sport fishery.

King salmon are found in major streams such as the Smith, Klamath, Trinity, Mad, Eel, and Van Duzen Rivers, and in several smaller rivers and tributaries. They are the largest of all salmon and average about 20 pounds when mature, although spawning fish as large as 50 pounds are common. Fall-run king salmon enter these streams as maturing adults during the late summer or fall, and spawn between October and January. Spring- and summer-run king salmon enter the rivers during the spring and early summer and spend several months in the cool waters of upstream areas before spawning in early fall.

Selection of the spawning site and preparation of the nest or "redd" is accomplished by the female. She then deposits 4,000 to 6,000 eggs, the male fertilizes them, and she immediately covers them with gravel. The eggs usually hatch in 50 to 60 days, depending on water temperatures, and the young salmon begin their journey to the ocean shortly after emerging from the gravel. After about 4 years in the ocean (a range of 2 to 6 years is common) the fish return to the stream of their origin to spawn. All Pacific salmon die after spawning.

Silver salmon is the only other salmon commonly found in California's north coastal streams. A mature silver salmon usually weighs between 7 and 12 pounds. The life history of the silver salmon is somewhat different from that of king salmon. Silver salmon usually enter the streams later than kings, and spawn between November and January. After hatching, juvenile silver salmon usually spend 1 full year in fresh water before entering the ocean. They usually return to spawn at 3 years of age although some precocious males return at 2 years of age. Silver salmon prefer smaller streams than king salmon, although there is overlap in distribution. Silver salmon are abundant in the small coastal streams of Mendocino County where king salmon are virtually absent.

Steelhead trout are present in all suitable streams of the north coastal area and are the most abundant of the salmonid species in this area. Steelhead enter fresh water during the late fall or early winter and spawn during the winter or spring months. Young steelhead spend from 1 to 3 years in fresh water before migrating to the ocean. They return to spawn after 1 or 2 years in the ocean. Although steelhead do not necessarily die after spawning, many succumb to the rigors of migration and spawning, and the number that spawn more than once is small.

Salmon and steelhead have amazing navigational abilities which enable them to return to their native streams after spending several years in the ocean. Sometimes they travel more than a thousand miles from their birthplace. However, some of these fish stray into other tributaries of their native river system, particularly if their home stream is inaccessible. These fish face tremendous hazards and difficulties in their upstream migrations from ocean to place of birth. Fishermen, natural predators, high velocity flows, waterfalls, log jams, and other stream blockages are only a few of the obstacles to migrating fish. These fish are truly magnificent and unique creatures which man has marvelled at and benefited from for thousands of years.

Importance of Anadromous Fishery to North Coastal Area

Fishing in the north coastal area of California is a healthy blend of business and pleasure and is very important to sportsmen, tourists, commercial fishermen, and recreation-oriented businesses. The sportsman is willing to travel great distances and spend considerable sums of money to fish for salmon and steelhead. The commercial fisherman earns his livelihood in part from ocean caught salmon which are in turn supplied to local sea food restaurants and other retail outlets. Many tourist facilities such as resorts, motels, and sporting goods stores are greatly dependent on the sport fisherman trade for business during the early winter months when tourism is at a low point.

Approximately 240,000 angler days are spent annually to catch 90,000 steelhead and 42,000 king and silver salmon on Northern California streams between the Gualala and Smith Rivers. Additionally, about 140,000 angler days per year are expended in ocean sport-fishing for salmon from party boats and private craft. The present yield of ocean caught salmon is 675,000 to commercial fishermen and 41,000 to sportsmen. Although commercial salmon landings make up less than 10 percent of commercial fish landings in the Eureka region ports, they provide nearly 30 percent of the income to fishermen.

Recreation comprises the second largest income producing industry in the north coastal area and commercial fishing ranks fourth, behind lumber, recreation, and agriculture. Therefore, a general decline of north coastal fishery resources should not be taken lightly, or written off as inevitable. Too much is at stake economically and recreationally. Proper steps must be taken to assure the continued survival of our salmon and steelhead resources.

Fish Population Trends

The history of fish runs in the North Coast is a subject which generally results in some controversy even among fishery biologists. The basic problem is the general lack of accurate long-term fish count data on north coastal streams. Most fish counting stations date from the 1930s and were located at fish ladders constructed around dams. Prior to 1930, the main information available is from newspaper reports and accounts of long-time residents.

Data available on salmon and steelhead counts in coastal streams are shown in Figure 1 and Table 2. It becomes obvious with only a very cursory analysis of these data that fish populations at most counting stations have severely declined during the period of record.

King salmon fish counts have been made on the Klamath and Shasta Rivers above their confluence since 1925 and 1930, respectively. These counts have demonstrated a high degree of annual variability with a general downward trend. A trend of substantial decreases was observed on the Klamath River from 1956 through 1969, but high counts were obtained in 1970 and 1971. The Shasta River sustained large reductions in king salmon counts from 1947 through 1957 but demonstrated increases from 1958 through 1964. Recent years have shown a leveling off trend with decreases during 1971 and 1972.

The Mad River at Sweasey Dam, the Eel River at Van Arsdale Dam, and the South Fork Eel River at Benbow Dam all demonstrate large decreases of salmon and steelhead trout. Increases of silver salmon occurred in 1962 and 1963 on the Mad River due to a short-term planting program on the stream. Although of a temporary nature, this increase demonstrated the potential ability of such artificial plantings to increase depleted fish runs. It is expected that the recently constructed Mad River Hatchery will be able to produce long-term increases on the Mad, as well as other north coastal rivers.

It can be concluded from the foregoing data that salmon and steelhead are extremely resilient species with the ability to respond positively to improved environmental conditions as well as negatively to habitat degradations. For example, salmon counts on the Shasta River decreased from a high of 74,500 in 1935 to a low of only 37 in 1948. At this point it would have been logical to predict the extinction of the run, but in 1959 the count was up to approximately 10,000 fish and in 1964 it was 34,000.

Information gained from old newspaper accounts, long-time residents of the area, and fishermen creel censuses also indicate a decline in the north coastal fishery. While it is not possible to ascertain precisely the degree of decline in the coastal fishery, the fact that a decline of significant proportions has occurred is inescapable.

Natural fish runs in Oregon and Washington have experienced similar declines in recent years, but total numbers of anadromous fish have decreased less than in California due to an aggressive planting program. Washington stocks 3.3 million pounds of hatchery salmon annually and claims to be maintaining runs in all but the Columbia River. Oregon stocks 3.4 million pounds of salmon and steelhead and claims maintenance of the runs but not enhancement. California stocks 1 million pounds of salmon and steelhead and the runs are continuing to decline.

FIGURE 1

SALMON AND STEELHEAD COUNTS ON SELECTED CALIFORNIA COASTAL STREAMS

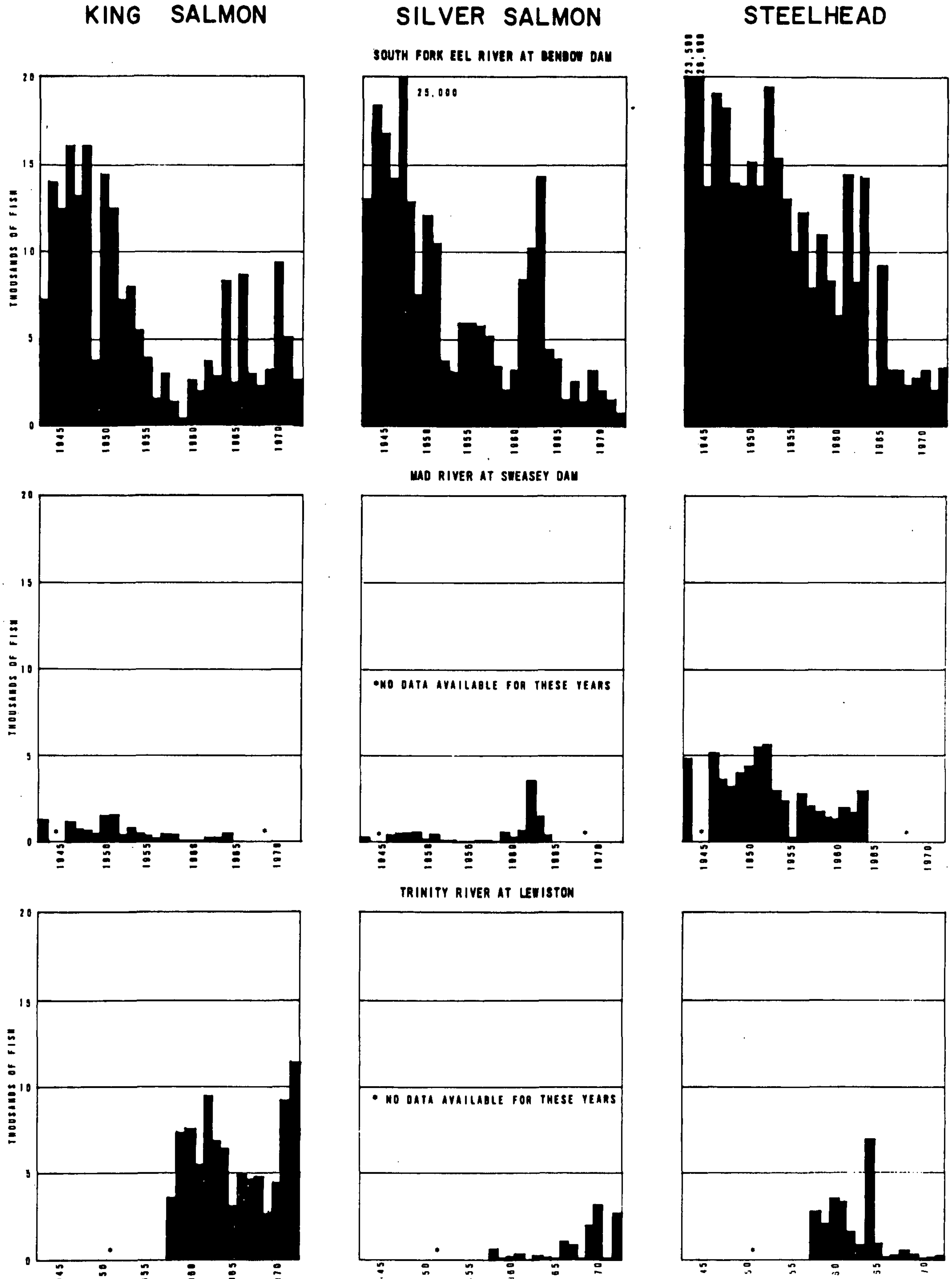


TABLE 2

CALIFORNIA COASTAL STREAMS SALMON AND STEELHEAD COUNT BY CALIFORNIA DEPARTMENT OF FISH AND GAME

Year	Klamath River (Klamathon Racks) Chinook Salmon	Shasta River Chinook Salmon	Trinity River (Lewiston) Chinook Salmon	Trinity River (Lewiston) Coho Salmon	Trinity River (Lewiston) Steel-head	Mad River (Sweasey Dam) Chinook Salmon	Mad River (Sweasey Dam) Coho Salmon	Mad River (Sweasey Dam) Steel-head	Eel River (Van Arsdale Dam) Chinook Salmon	Eel River (Van Arsdale Dam) Steel-head	South Fork of Eel River (Benbow Dam) Chinook Salmon	South Fork of Eel River (Benbow Dam) Coho Salmon	South Fork of Eel River (Benbow Dam) Steel-head
1930 1/	2,392	19,338	--	--	--	--	--	--	--	--	--	--	--
1931	12,611	81,844	--	--	--	--	--	--	--	--	--	--	--
1932	13,740	34,689	--	--	--	--	--	--	--	--	--	--	--
1933	--	11,570	--	--	--	--	--	--	--	3,247	--	--	--
1934	10,340	48,668	--	--	--	--	--	--	--	2,255	--	--	--
1935	14,051	74,537	--	--	--	--	--	--	--	6,310	--	--	--
1936	10,398	46,115	--	--	--	--	--	--	--	6,861	--	--	--
1937	33,144	33,255	--	--	--	--	--	--	--	3,413	--	--	--
1938	16,340	9,090 3/	--	--	--	1,273	498	3,110	--	4,786	6,051	7,370	12,995
1939	--	28,167	--	--	--	1,257	725	3,118	--	3,889	3,424	8,629	14,476
1940	14,965	55,155	--	--	--	1,293	73	5,706	--	2,225	14,691	11,073	18,308
1941	11,204	13,252	--	--	--	3,139	308	4,583	--	--	21,011	13,694	17,356
1942	13,036	11,425	195 4/	--	--	1,676	378	6,650	--	--	10,612	15,037	25,032
1943	--	10,022	--	--	--	1,236	259	4,921	--	--	7,264	13,030	23,415
1944	--	11,498	9,925 4/	--	--	--	--	--	--	9,528	13,966	18,309	20,172
1945	--	18,191	7,510 4/	--	--	--	--	--	--	5,054	12,488	16,731	13,626
1946	--	7,590	274 4/	--	--	1,181 5/	415	5,106	917	4,409	16,024	14,109	19,005
1947	--	341	--	--	--	717	510	3,582	994	176	13,160	25,289	18,225
1948	5,821	37	--	--	--	672	515	3,139	--	2,433	16,312	12,872	13,963
1949	11,504	193	--	--	--	484	512	4,074	--	--	3,803	7,495	13,715
1950	21,584	248	--	--	--	1,505	147	4,430	55	1,091	14,357	12,050	15,138
1951	17,857	2,024	--	--	--	1,519	414	5,543	--	5,444	12,476	11,441	13,774
1952	6,591	1,666	--	--	--	401	72	5,613	--	2,197	7,256	3,711	19,488
1953	6,267	1,605	--	--	--	847	91	2,943	--	2,590	7,948	3,052	15,405
1954	2,042	2,625	--	--	--	409	59	2,390	--	6,131	5,367	5,952	13,609
1955	14,946	1,817	--	--	--	390	2	148	5	3,719	3,974	5,977	10,065
1956	6,770	--	--	--	--	129	21	2,717	--	4,109	1,530	5,717	12,333
1957	2,436	2,234 6/	--	--	--	494	11	1,957	2	5,151	3,050	5,433	7,910
1958	1,950	6,089	3,524	616	2,835	478	3	1,780	--	3,335	1,472	3,344	11,984
1959	3,568	9,875	7,277	119	2,095	19	541	1,376	--	2,206	473	2,119	8,367
1960	6,363 7/	10,698	7,466	208	3,547	55	244	1,343	--	1,130	2,665	3,184	6,370
1961	2,930 8/	8,764 9/	5,397	355	3,243	40	710	1,985	--	1,693	2,046	8,479	14,374
1962	1,399	14,898	9,451	16	1,687	238	3,580	1,708 10/	9	2,030 10/	3,688	10,031	8,303 10/
1963	2,171	31,837	6,740	83	879	232	1,419	2,904	3	846 11/	2,918	14,316	14,255
1964 2/	2,598	34,363	6,303	50	6,941	492	332	--	63	921	8,315	4,468	2,358
1965	678	7,911	3,075	12	943	Ladder Non-Functioning			94	423	2,455 12/	3,804 12/	9,283 12/
1966	3,064	6,062	4,840	1,025	135	Ladder Non-Functioning			148	534	8,649	1,480	3,296
1967	2,667	12,314	4,616	865	232	No Counts			--	531	3,006	2,461	3,292
1968	2,764	14,042	4,771	38	554	No Counts			--	340	2,278 10/	1,289 10/	2,443 10/
1969	2,879	13,625	2,586	1,996	241	No Counts			15	719	3,200 10/	3,170	2,788 10/
1970	10,492	13,405	4,444	3,147	67	Dam Removed			34	1,863	9,367 10/	2,070	3,328 10/
1971	10,769	6,619	9,221	47	242				--	696	5,026 10/	1,509	2,082 10/
1972	3,568	3,641	11,381	2,760	271				--	586	2,640	750	3,320 10/

1/ 1930 refers to counting year 1930-31, etc.
2/ All 1964 data are preliminary. Benbow Dam and Sweasey Dam counts incomplete because of floods.
3/ Counting station moved 7 miles upstream from original location.
4/ Incomplete Fish and Wildlife Service weir counts.
5/ Does not include an estimated 250 fish that passed the dam before counting started.
6/ Counting station moved back to original location near mouth.
7/ Racks not fish-tight. Approximately 6,000 additional fish estimated to have passed upstream.
8/ Counting station moved upstream from Klamathon Racks to Iron Gate Dam.
9/ Racks not fish-tight for one week.
10/ This figure is an estimate--station was closed before the end of the run.
11/ Ladder out of operation December 25 to February 1.
12/ Includes 369 chinooks, 201 coho salmon, and 133 steelhead counted with electric counter.

CHAPTER III. PROBLEMS AND CAUSES

The Eel, Mad, Mattole, and Van Duzen Rivers and other north coastal streams once had grassy, forested watersheds and deep stream channels carrying clean, cool water that abounded with fish. Floods, fires, and earthquakes sometimes disturbed the quality of these streams, but only temporarily. Most healthy basins begin to recover soon after a natural disaster occurs.

However, man with his machines has the ability to make changes in a stream basin on a continuing basis, damaging many river basins faster than natural processes can repair them. Beginning with gold mining in the 1850s and continuing with sheep grazing, land conversions, logging, road construction, and subdivision development up to the present day, the character of most north coastal streams has been altered to the degree that many once excellent salmon and steelhead streams now offer only marginal habitat for these fish.

Even to the casual observer it is apparent that large sections of many north coastal watersheds have experienced severe disturbances. While the expert trained in the discipline of watershed management attempts to quantify these changes through technical analysis, the untrained observer is aware only that the changed landscape he now observes is ugly, and that it is having a devastating effect on the stream.

Severely damaged coastal streams are characterized by one or more of the following conditions: (1) a barren streamside, denuded of overhanging vegetation, a condition which decreases food and cover for fish and increases maximum water temperatures; (2) high summer water temperatures, which are harmful to anadromous fishlife; (3) high wintertime turbidity, resulting in cemented gravels unsuitable for spawning, smothered eggs, gill damage to fish, low food production, and low fishability; (4) channels choked with organic slash and debris, which block fish runs and reduce the dissolved oxygen content of the water; and (5) channels choked with sediment and slide debris so that pools are filled and the channel cross section is flat and shallow.

Natural Factors Contributing to Watershed and Stream Damage

River basins in their natural state are dynamic systems which are continually changing, yet tending toward stability. For example, although the average size of a stream channel is determined by the amount of precipitation falling in the contributing basin over a long period of time, it can be changed significantly in response to a single flood. However, after a period of normal years the channel will slowly revert to its original width and slope. Natural occurrences such as floods, fires, and earthquakes have always been a part of the forces which tend to temporarily disrupt the balance of river systems. Floods alter channel alignment, bring large quantities of silt into the river, and destroy riparian vegetation. Fires remove protective vegetation and cause the soil to become subject to erosion and less able to retard runoff. Earthquakes often trigger slides which contribute to sediment in the river.

1/ Includes 369 chinooks, 201 coho salmon, and 133 steelhead counted with electric counter.

2/ Counting station moved back to original location near mouth.

Several factors combine to make the north coastal landscape susceptible to high erosion rates. Unstable geologic conditions and steep slopes are the primary problems. About 80 percent of the foundation rocks occurring in the Eel and Mad River Basins are classed geologically as Franciscan Formation. This rock type is highly unstable due to the large number of shear zones and faults occurring in it. This extremely weathered formation also contains large amounts of weak shale. When the Franciscan Formation occurs in steep mountainous terrain, slight surface disturbances can often trigger large-scale sliding, creep, and gullying.

Another significant contributing factor to sediment production is the high amount of intense rainfall experienced in the North Coast. Rainfall at Honeydew on the Mattole River, for example, averages 111 inches per year, and intense storms can produce as much as 13 inches in 24 hours. Such heavy rainfall exerts a tremendous eroding force on bare soils and weak geologic formations. Saturated soil conditions are usually a contributing factor involved in sliding of the soil mantle and underlying formations.

A moderate level of sediment production is desirable in north coastal streams. A continuous supply of rock and gravel is necessary to maintain proper streambed composition for fish spawning and food production. A certain amount of sand and fine material is needed for the natural construction of agriculturally important terraces bordering the stream and for replenishment of beach sand. Most streams naturally produce enough sediment for these purposes and it is only when excessive amounts are produced that a stream shows signs of poor health due to siltation. Excess sediment production, which is often due to poor land use practices, adversely affects a stream system in the following ways:

1. The stream channel bottom is raised and pools are filled in, thereby destroying fish habitat and reducing the stream's carrying capacity.

2. Stream gravels are cemented together with fine materials, thereby destroying fish spawning areas and food producing stream bottom organisms.

3. Excessively turbid water kills fish by smothering them in the egg stage or impairing the function of their gills after hatching.

4. Muddy water conditions decrease the beauty and impair the fishability of a stream, thereby reducing recreation uses.

Low summer flows in most Pacific Coast streams is another natural problem. In the coastal basins snowfall is limited to the higher elevation headwater areas and does not appreciably dampen the peak runoff from storms or supplement the low flow during late summer and early fall when almost no precipitation occurs. As a result most north coastal streams drop to a very low stage from June through October. The low flows recorded near the mouths of Redwood Creek, the Mattole River, and the Navarro River, all streams with drainage areas of around 300 square miles, are 6, 20, and 6 cubic feet per second, respectively. Flows of this magnitude do not provide suitable habitat to support optimum numbers of juvenile anadromous fish. As a result many salmonids die due to overcrowding, lack of food, disease, and high temperatures, all of which are related to the lack of adequate streamflows.

Low summer flow is also a significant factor in producing high water temperatures. As a stretch of cool flowing water is exposed to direct sunlight, the rate of heat gain is directly proportional to the exposed surface area and inversely proportional to the rate of flow. As more water flows in a stream, the effect is an increase in the stream distance required to raise the water temperature a given amount. As streamflow drops during the summer, it is heated to maximum ambient temperature in a shorter stream distance than at higher flows.

Young silver salmon and steelhead must survive in coastal streams during low flow periods because they do not migrate to sea until the following year. King salmon migrate out during the spring and therefore are not subjected to the effects of low summer flows.

Activities of Man Adversely Affecting Fishlife

When the effects of stream conditions on fishlife are discussed, it is important to recognize that a direct correlation exists between the condition of the watershed and the health of the stream system. Just as an illness which directly attacks one part of the body actually impairs the function of the entire person, so degradation of one portion of a watershed generally affects the whole basin.

Following is a brief discussion of man-caused changes in watersheds of the North Coast which have tended to adversely affect fishlife. Most of these factors are not intrinsically harmful but become so when the easiest, quickest, and cheapest methods for their accomplishment are used without regard to impact on the land.

Mining

Much of the north coastal area was settled as a result of gold discoveries. Many of the miners were transients looking for quick riches. Therefore, they often tended to overlook or disregard damage to the land caused by their activities. Hydraulic mining using huge water guns emitting high velocity jets washed the top soil off many hills into the streams and laid the underlying rock bare. One example of the results can be seen on the Trinity River at Oregon Gulch above Junction City. Many of the slopes in this area are actively sliding and the gulch is choked with sediment. In addition, huge dredgers washed vast quantities of sediment downstream, leaving unnatural gravel tailings covering many square miles along the river. Few records exist of the effect of mining activities on fishlife, but the great changes it produced leave little doubt that it was heavily damaging.

Logging

North coastal logging, which dates from the early settlement days of around 1850, continues today as the backbone of the north coastal economy. If improper logging practices are followed, the result can be disastrous. Unfortunately, this has been the case in many north coastal areas which exhibit land damages resulting from logging. In 1962 the Department of Fish and Game surveyed 27 north coastal streams which were damaged by logging that year. Redwood Creek in Humboldt County provides an extreme example of a watershed damaged by logging. Redwood Creek drains an area of 280 square miles, a sizeable portion of which was once covered by virgin redwood groves. Almost the entire watershed, with the exception of the portion inside the Redwood National Park, has now been logged. The Department of Fish and Game in a 1966 survey estimated that 76 percent of total stream miles of Redwood Creek had been severely damaged and an additional 12 percent had been moderately or lightly damaged.

Logging damage falls into two main categories: (1) physical destruction of portions of the stream itself by heavy equipment crossing and operating in the stream channel area or by logging roads located adjacent to the stream and (2) sedimentation of stream gravels resulting from accelerated erosion of slopes with removed vegetation and disturbed topsoil. In the worst cases, meandering streams, which once were covered by lush vegetation, contained cool water, and supported plentiful fishlife, are converted into straight channels devoid of surrounding vegetation, with pools and riffles filled with bark, slash, and fine sediment.

It is common logging practice to remove timber and riparian vegetation immediately adjacent to a perennial stream. Stream temperature is most directly related to the amount of solar radiation which it receives. The degree of stream shading from overhanging vegetation is therefore very important. Maximum summertime temperatures of streams which have had this vegetation removed by logging or other land use activities will increase as much as 15 degrees above the prelogging temperatures. Maximum temperatures of logged streams in Northwestern California generally range between 75^{o} F. and 85^{o} F. Prolonged temperatures above 80^{o} F. are lethal to most salmonids. Therefore, if they are to survive such high temperature cycles they must be able to escape to deep pools, shaded tributaries, or cool springs.

Research on timber harvest damage shows that logging can be compatible with anadromous fish production when adequate attention is given to the location and manner in which it is done. Some ways to make logging less damaging to watersheds and stream environments include the following:

1. Leaving buffer strips of vegetation along streams.

2. Planning of roads and skids trails for least erosion.

3. Planting grass on erodible slopes.

4. Not allowing operation of heavy equipment in the stream channel.

5. Logging by special methods such as highline, helicopter, or ballon in areas of extreme slope and erodibility.

6. Cleaning up slash which may wash into the streams.

7. Replanting of cut-over areas.

8. Constructing properly designed stream crossings that provide adequate fish passage.

Noticeable improvements in logging practices have occurred since the mid-1960s when larger timber companies began to respond to increasing public awareness and criticism of logging practices.

Road Construction

Although the North Coast is a rather remote part of California with a low population density, road construction in this area is very extensive. Paved roads connect only the main population areas, but dirt logging roads provide access to almost all parts of the area. If not properly planned and executed, road construction can cause severe erosion and stream sedimentation. Road cut and fill slopes expose large areas of bare, disturbed soil to the eroding action of precipitation. Improper road alignment and drainage can concentrate high velocity water flow in areas unable to carry such flow, and deep gullying of the soil mantle may result. Road cuts in geologically unstable areas can trigger large landslides which eventually make their way to the stream. Many private roads are little more than trails cut through rugged terrain with a bulldozer. Excess material is merely cast over the edge of the road, and little consideration is given to proper slopes or drainage. Governmental agencies responsible for public works are becoming increasingly aware of the potential for damage to watersheds and stream systems through careless road construction and are taking preventive measures to reduce these damages.

Overgrazing and Land Conversion

From early settlement days until the present time sheep grazing has been an important and widespread use of grassland in the north coastal area. Much of this land originally supported timber but has been converted to grass by the removal or killing of the timber and the periodic burning of the land. Frequently, due to overgrazing, the more desirable grass species have been replaced by poorer quality forage which will not support as many animals per acre. Overgrazing produces bare spots on grasslands which are subject to surface erosion and gullying. Conversion of timberland to grassland seldom produces high quality forage. Once the timber is removed, the bare land is subjected to a higher rate of erosion. Fires set to limit the growth of brush and timber on grazing land also expose the scorched, barren soil to higher rates of erosion.

Pollution

The water quality of north coastal streams is generally excellent, except for high turbidity during winter storms. Occasionally, decaying logging debris in a streambed will lower the dissolved oxygen content of a short stretch of stream and discolor the water. Caustic or poisonous materials from logging mills or roadway spills sometimes find their way into north coastal rivers, killing some fish. However, these are relatively infrequent occurrences which have little overall effect on the fishery of these streams.

Overfishing

Salmon and steelhead, because of their mass migrations from the ocean to their stream of origin during a short time span, are more vulnerable to fishing pressure than species that spend their entire life cycle either in a stream or the ocean. Theoretically, it would be possible to catch all of the anadromous fish in a stream merely by constructing an impassable barrier at its mouth. Commercial netting of fish at the mouths of many rivers caused serious declines in anadromous fish populations prior to the establishment of strict fishing regulations. Today, fish and game laws attempt to limit fishing pressure to a level which can be maintained without seriously depressing existing populations. Poaching is still prevalent in a few isolated areas but is not considered to be a significant factor in the fish declines of most north coastal rivers.

One rather uncertain factor which may greatly influence fish populations is the intensive ocean fishing by foreign boats just outside the 12-mile territorial limit of United States' waters. Large foreign vessels capable of harvesting vast amounts of fish and processing them on board ship have begun operation in Pacific Coast waters in recent years. Ocean fishermen groups in this country are very concerned with the potential adverse effect these fishing fleets may have on Pacific Ocean fishery resources. However, resolution of this problem must occur at the level of international governments, and about all that county or state governments can do is try to document the effect of foreign fishing on local fishery resources and make our lawmakers aware of the problem.

Many north coastal streams are presently limited in fish production by the lack of adequate rearing areas for young salmonids. Sufficient adult fish return to spawn in these streams and produce adequate young to fully occupy existing habitat. Overfishing is apparently not the controlling problem in these streams.

Types of Land Damages Resulting From Natural or Man-Related Causes

Many land use activities such as mining, logging, road construction, land conversions, and grazing have taken place in other parts of California and the west with little apparent destructive effect on the landscape. However, similar activities conducted in many areas of the North Coast that have steep terrain and unstable soils have caused damages that will take many decades to repair. Some areas will probably never heal completely.

The Eel River Basin contains numerous slides and other types of soil movements which give it the dubious distinction of having the highest rate of sediment yield known for any basin of comparable size in the United States. This sediment rate averages 3.2 acre-feet per square mile per year and is exceeded only by world record holders such as the notorious Yellow River of China with a rate of 3.8 acre-feet per square mile per year. The Mad and Mattole Rivers are also extremely high sediment producers with rates of 2.1 and 2.7 acre-feet per square mile per year, respectively.

Soil movements which result in high stream sediment production can be divided into the categories of landslides, streambank erosion, soil creep, and sheet and gully erosion.

Landslides

The most outstanding type of soil movement in north coastal drainages is the landslide which dumps large volumes of soil and rock into stream channels. Landslides alone are estimated to account for 25 percent of the total volume of sediment transported by the Eel and Mad Rivers. The area covered by a slide can vary from less than 1 acre to as much as 2,000 acres. The very large areas are broad zones consisting of numerous individual slides which have encroached upon one another. Individual slides vary in length from a few hundred feet to over 3 miles, and most slides have a width to length ratio of approximately 1:4. Most landslides occur under saturated soil conditions and therefore are more active during wet winter months than during the summer. The annual downhill movement of active slides ranges from 1 to 20 feet.

Once a slide has started it is extremely difficult to control. Certain remedial measures, such as shaping the slide surface or dewatering the slide with sidehill drains and ditches, can reduce the movement of small slides, but these methods become prohibitively expensive and ineffective on larger slides. Many slides occur naturally due to heavy rains, floods, fires, or earthquakes, but the total number of slides have increased greatly in the last century due to the activities of man.

Streambank Erosion

Streambank erosion is the largest single source of sediment production in most coastal river systems. During periods of high flow, rivers exert tremendous forces on the confining banks, especially on the outside of curved sections. Almost all types of riverbank material will gradually wear away under this erosive force, but some banks will erode very rapidly if vegetation has been removed or if the bank material consists of loose earth and rock that has been deposited at the edge of the stream by downhill slope movement. Although streambank erosion is a natural phenomenon which occurs in all streams to some degree, it is a process which has been accelerated by man's activities. Logging debris carried by high velocity flows gouges material from streambanks and uproots streambank vegetation. Man-caused slides and other soil movements near stream channels provide a continuous supply of loose, easily erodible material at the river level which is carried away by high flows.

Soil Creep, Sheet and Gully Erosion

Soil creep is a not too thoroughly understood form of soil mantle movement which is widespread in north coastal basins. This slow movement is not very obvious to the untrained eye and is difficult to delineate on photographs. It is characterized by a lightly rolling or undulating slope which appears as a series of waves on an otherwise uniform slope. Soil creep is common in areas of high rainfall where vegetation has been removed. Roads constructed in soil creep areas are extremely difficult to maintain.

Sheet erosion is caused by precipitation immediately after it falls and before it enters a defined channel. During this usually brief interval, runoff flows as a thin, fairly uniform sheet. If sheet flow occurs over healthy grassland or a forest protected by a mat of organic debris such as pine needles or leaves, little sediment is carried with it. However, if raindrops fall and sheet flow occurs on bare, loose soil, a great deal of erosion is likely to occur. Heavy sheet erosion usually develops small rills which concentrate the moving water and finally results in gullying.

Gully erosion appears quite frequently in steep areas converted from timber to grassland. The result is a series of long, narrow gullies. Gullying begins when the vegetation is disturbed and soil is laid bare to the erosive effects of rainfall. Once small rivulets are established in the disturbed soil, the drainage pattern is changed and storm runoff is concentrated in these small channels, thus further enlarging them. Gullies eventually reach an equilibrium condition where they can carry the drainage flows concentrated in them without further erosion, but this usually occurs only after several years of enlarging.

CHAPTER IV. POSSIBLE SOLUTIONS

Anadromous fish populations in the north coastal area have declined significantly in recent years. Much of the blame stems from man's improved ability to alter the natural environment with heavy equipment. However, this same technological ability also provides several possibilities for increasing fish runs. If whole forests can be removed in a summer and long sections of freeway completed in a couple of years, watersheds can be restored and facilities for fish propagation can be constructed to help reverse the trend of declining fish numbers. The development of most fishery enhancement techniques is at an early stage and considerably more experience is required with them before their full potential can be determined. Some past successes have been achieved by construction of fish hatcheries, artificial spawning channels, rearing ponds, and stream improvement devices.

Another enhancement possibility which has not been tried except in conjunction with other water project purposes, is summer streamflow augmentation to provide better living conditions for juvenile fish. Streamflow augmentation could be accomplished by (1) diverting water from another stream, (2) development of ground water wells, or (3) releases from an upstream reservoir. Since the natural summer flow of essentially all north coastal streams is quite small, little opportunity exists for direct diversion from another stream. Also, sufficient quantities of ground water in the headwaters of north coastal streams are not available. Therefore, the only practical possibility of providing streamflow augmentation in the north coastal area is by releases from a headwater reservoir. The following paragraphs discuss each of the above alternative fishery enhancement techniques in more detail.

Hatcheries

Pacific Coast salmon and steelhead enhancement technology began in 1872 with the construction of Baird Hatchery on the McCloud River. In the 100 intervening years, 28 more hatcheries were built in California to produce salmon and steelhead. Six of the 14 hatcheries still in use are primarily catchable-trout operations. Six are mitigation facilities for water projects. One is an egg-collecting station that occasionally also raises small numbers of fish. The Mad River Hatchery near Arcata, constructed in 1971, is the only facility devoted to the enhancement of salmon and steelhead. On the entire Pacific Coast, about 85 hatcheries supplement natural reproduction of salmon and steelhead.

Fish hatcheries have the longest and most successful history of any fishery enhancement technique. Some hatcheries have produced very high returns, while others have been unsuccessful. Cedar Creek Hatchery, on the South Fork Eel River, is a clear-cut example of hatchery enhancement potential. During 9 years of operation, five experimental lots of yearling fish were planted in the South Fork Eel River. Returns from these plants contributed 10.8 percent of the steelhead run over Benbow Dam in 1958, 10.4 percent in 1959, and 5.9 percent in 1960. They also contributed 62 percent of the silver salmon run over Benbow Dam in 1961. Cedar Creek Hatchery was destroyed by floodwaters in 1964. Coleman Hatchery on Battle Creek, a tributary of the Sacramento River, has been credited with producing 15 adult steelhead for every fish spawned (R. J. Hallock, 1961), whereas the escapement ratio under natural spawning is presumed to be about 1:1. Steelhead runs in the American River have increased significantly since 1962 when most operational problems of Nimbus Hatchery below Folsom Lake were solved.

The Trinity River Hatchery, which was constructed in 1963 to mitigate lost spawning and rearing areas above Trinity Dam has not produced as well as expected. The main problem has been its inability to maintain preproject runs of steelhead. Although king and silver salmon runs at Lewiston in recent years have equaled or exceeded preproject runs, steelhead returns have declined from an average of around 3,000 fish prior to completion of the Trinity Project to an average of less than 300 for the last 4 years (see Figure 1 and Table 2). It is anticipated that recently completed corrective measures such as better food, heated incubators, and disease controls, along with additional measures now under study, will ultimately prove successful in increasing steelhead returns. Past experience has shown that most hatcheries must undergo an extended shakedown period of trial and error operation before they become highly productive. The Trinity Hatchery will probably follow this trend.

Artificial Spawning Channels and Incubation Channels

Artificial spawning channels are man-made water courses, usually paralleling a natural stream, designed specifically to provide spawning habitat for fish. Although they do not provide holdover capability for juvenile steelhead or silver salmon, their potential for enhancing king salmon is considered quite good in areas where the lack of spawning gravel is the limiting factor.

Spawning channels, which are newer and less tested than fish hatcheries, are presently being evaluated on the Feather, Mokelumne, Merced, and Sacramento Rivers in California. The largest of these facilities is the Bureau of Reclamation's $20 million spawning channel on the Sacramento River at Red Bluff, which was completed in 1971 as part of the Tehama-Colusa Canal Project. About 5,000 of the 130,000 adult king salmon appearing at the Red Bluff Diversion Dam were used to produce the initial brood stock. The progeny from these fish, which totaled one and one-half million fingerlings, were released during the initial year of operation. The spawning channel is expected to reach its ultimate capacity of 40,000 spawning adults annually by 1982. Present data are insufficient to properly compare the success of this method of enhancement with fish hatcheries, but continued operation of existing facilities should provide this knowledge in the future.

Incubation channels are designed to incubate anadromous fish eggs that are artificially taken and placed in the channel gravels. Few situations arise where water quality, quantity, and spawning gravel are suitable and not already utilized by adequate numbers of free fish. In Washington and Oregon there have been successful developments in applying the principle of incubation channels to hatchery techniques. There are some theoretical advantages in the use of incubation channels. Operational costs should be relatively low because spawning and egg deposition are short-term labor requirements, and gravel cleaning requirements are minor.

Both artificial spawning channels and incubation channels require adequate flows of high quality water. The lack of ground water in the north coastal area and the lack of adequate natural flows of cold water in most coastal streams would severely limit potential sites for these channels except in conjunction with a reservoir project.

Rearing Ponds

Rearing ponds are small artificial pools with circulating water where young fish are fed and protected until they are ready to migrate to sea. Rearing ponds are probably the least expensive method of raising salmoids to smolt size.

The literature on rearing ponds is dominated with reports of incomplete results and abandoned experiments. The ponds tested have differed from one another in almost every imaginable way. An overall comparison of rearing ponds with other enhancement techniques is not possible at this time.

Rearing ponds offer a significant potential for increasing production of silver salmon and steelhead at reasonable costs, provided volunteers can be found to operate and maintain them. Otherwise, their costs approach that of a hatchery. Also, for rearing ponds to be successful, a source of fish for rearing must be found. Possible sources include excess hatchery fish or fish rescued from drying streams. Rearing ponds are presently being tested in several areas along the Pacific Coast. The Humboldt Fish Action Council, an organization of local civic, commercial, and conservation organizations in Humboldt County, is operating two rearing ponds on Cochran Creek near Humboldt Bay. In 1972 and 1973, the Humboldt Bay Municipal Water District constructed rearing ponds on the Mad River. The ponds were washed out by fall storms, as planned, so that the fish would have access to the ocean. The Pacific Lumber Company at Scotia constructed a rearing pond on the Eel River in 1972. Humboldt State University is experimenting with rearing ponds using effluent from a sewage oxidation pond in Humboldt Bay. The Department of Fish and Game operates Bogus Creek steelhead rearing pond in Siskiyou County. Fish and Game also advises Mendocino County in the operation of the Talmadge steelhead ponds and operates a pond on the Mendocino Coast, near Point Arena.

All of these ponds have been in operation for a relatively short period of time and the results of their operation will not be known for several more years. Encouraging fish returns have been experienced on some ponds constructed in Washington and Oregon and there is a strong probability that rearing ponds in California will prove successful in the future.

Stream Improvement and Instream Devices

Stream improvement through removal of log debris dams and natural barriers which block anadromous fish from their spawning and rearing areas has been practiced for many years along the Pacific Coast. Such barrier removal is considered good management practice although no estimates are available as to the degree of fishery enhancement produced through the use of this technique.

Artificial fish shelters and instream devices consisting of small dams, log deflectors, and gabions to form pools and riffles have been tried on a large scale in Michigan and Wisconsin with varying degrees of success. Gabions are wire mesh baskets filled with rocks and wired together to form structures such as deflectors, groins, and weirs. Instream devices on Pacific slope streams are generally considered impractical because of the extreme flow variability of these streams and the high quantities of sediment transported.

Several small California programs involving instream devices have had discouraging results. For example, five of seven devices placed in the South Fork Mokelumne River in 1963 were destroyed by the 1964 flood. Projects in other California streams have become inoperative due to heavy silting or have failed to produce expected benefits. There are no instances of reasonable success with instream devices in California to counterbalance the failures.

Watershed Restoration and Management

It is an unpleasant experience to observe a stream basin which bears the scars of careless land use practices, especially if the observer has known the basin when it was in a relatively undisturbed condition. The natural question of what can be done to heal the basin and stop such damage from occurring in the future arises in the minds of many observers. Watershed restoration and management is one possible answer.

Watershed restoration involves such activities as replanting of trees on barren slopes, removal of debris from the stream channel, and taking corrective steps to slow the rate of sediment production from highly erosive areas. Watershed management is accomplished through the establishment and enforcement of laws and regulations for control of activities which have the potential of seriously damaging the watershed. Logging regulations are a form of watershed management.

Theoretically, watershed restoration and management is probably the soundest and most natural vehicle for fishery enhancement. However, it is also the most costly, the most legally difficult to accomplish, and requires the greatest time to obtain results. The U. S. Department of Agriculture, with major input from the Soil Conservation Service, has evaluated sediment problems in north coastal river basins and has suggested a program to reduce erosion. The recommended program of both land treatment and structural rehabilitation measures for the entire north coastal area would require a capital cost of $160 million and an annual cost of $6 million. Full implementation of the program would take 20 years and would ultimately result in only a 25 percent reduction in the total annual sediment yield. The likelihood of implementation of such a program is small.

If given enough time and respite from future harmful land use activities, most moderate or lightly damaged north coastal streams will heal themselves naturally. Even heavily damaged streams will make substantial recoveries although scars will remain. The riparian vegetation will eventually return along the stream, sediment loads will be reduced, stream channels will deepen, pools will be reformed, and gravels will be loosened and cleaned. If desirable fish habitat returns, the fishery will respond and fill this habitat to capacity. Perhaps in the long run this may be the most desirable form of fishery enhancement, but it will require a lot of time, possibly half a century, and will require legislative land use controls which may be unpopular for economic and philosophic reasons.

While proper watershed management is essential to improving fish runs on all north coastal streams, the only extent to which it can be addressed in this report is with words of encouragement and support. Perhaps a concerned and informed public can do more to implement it.

Recent Legislative Action Related to Watershed Management

Recent legislative action has laid the foundation for certain watershed management controls which could improve conditions for fishlife in future years. The Porter-Cologne Water Quality Control Act of 1970, and requirements of the Federal Environmental Protection Agency, call for preparation of a long-range plan for water quality management. These water quality control plans for all areas of the State are now being prepared by the State and Regional Water Quality Control Boards. The Regional Water Quality Control Board, North Coast Region, administers all coastal basins from the Russian River to the California-Oregon Border. The water quality control plan will include recommendations relating to logging, road construction, and other activities in the north coastal area which affect water quality. This plan is expected to be completed in January 1974.

The Z'berg Forest Practice Act of 1973 created a new State Board of Forestry which will be responsible within the framework of the Act for regulating future logging activities for the best interests of the public. The major emphasis in the Act is placed upon insuring the economic well-being of the community while protecting the regional environment, both present and future. What positive impact this legislative action will have on fishlife in the north coastal area remains to be seen, but expectations are high that environmental abuses will be greatly reduced through this law.

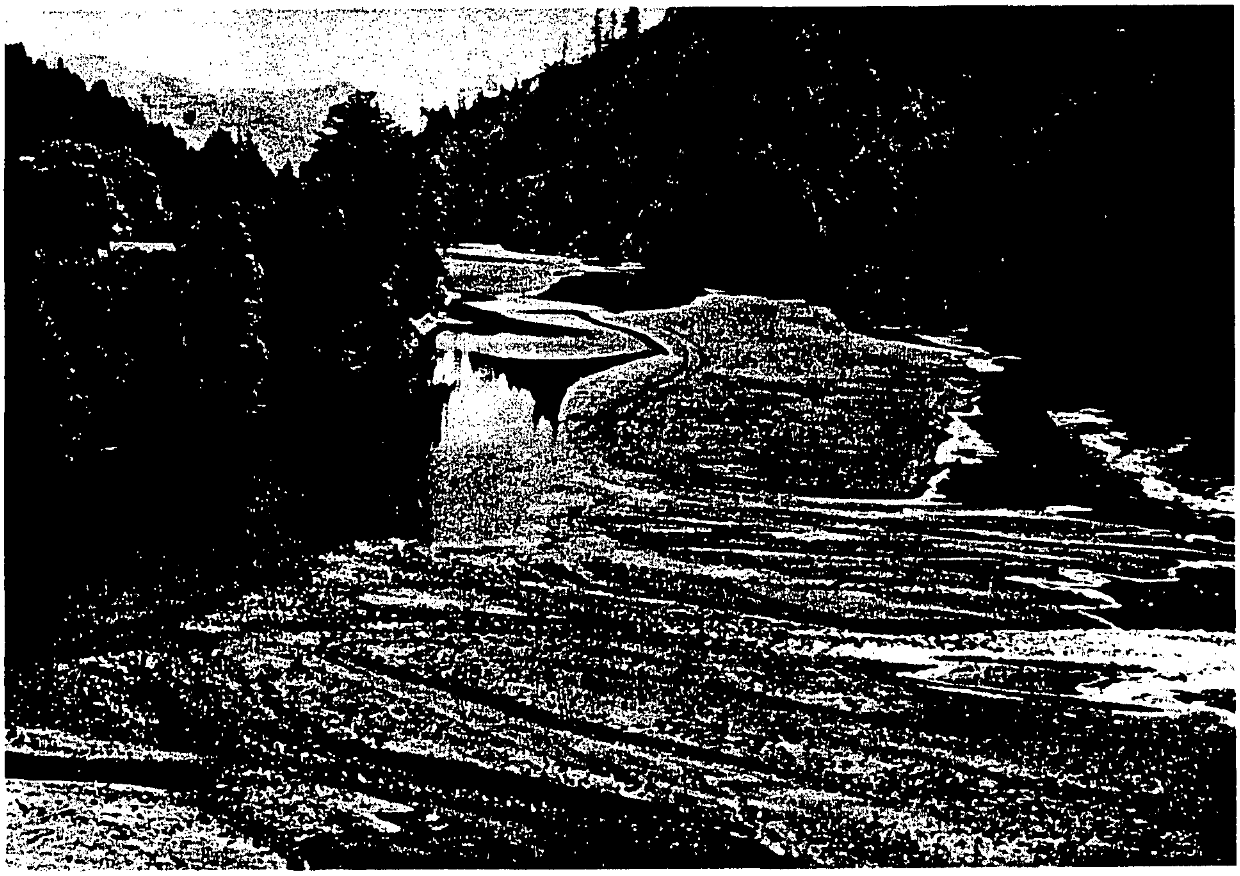
Streamflow Augmentation

There is increasing evidence that the number of steelhead and silver salmon in many north coastal streams are limited not by the amount of available spawning gravels, but by the quality and quantity of the nursery habitat.

The streamflow pattern in most north coastal streams closely follows the pattern of precipitation. This results in more than 97 percent of the annual runoff occurring in the period between October and May. During the winter, intense storms frequently swell many rivers to flood stage, while in the late summer these same channels carry only a thin ribbon of warm water as shown in the photographs on the next page. It is generally acknowledged that the extreme low flows of warm water during the summer degrade the fishery habitat and subject the fish to extreme stresses which result in reduced survival. This is especially true in streams devoid of frequent deep pools and overhanging vegetation as is typical of many north coastal streams. Since coastal silver salmon and steelhead trout spend a year or more in fresh water before migrating to the ocean, they are especially vulnerable to the low summer streamflow pattern. Augmentation of summer streamflows would increase the survival of juvenile salmonids in coastal streams.

High winter streamflows could be stored in the headwater area of a basin and released gradually throughout the summer to improve conditions for salmonids inhabiting the stream. Instead of experiencing a substantial loss of rearing habitat during the summer as would normally occur, the fish for several miles below the dam would receive cool water and the stream's wetted area would be maintained at a level approaching that occurring in the late spring. Consequently, since out-migrating salmonid survival would be higher, the resulting upstream migration of adults would also be increased. There is evidence for the validity of this theory in other areas. For example, the yield of silver salmon to the commercial fishery in Puget Sound has been shown to be strongly correlated to summer stream runoff in the year of stream residence for silver salmon. Silver salmon have been reported to be less available to sportsmen fishing Cowichan Bay, British Columbia, for years which experienced low summer flows during juvenile stages in the Cowichan River. Annual silver salmon catches in Oregon near the Siletz River have been correlated to low summer flows in that river, and low counts of silver salmon smolts have been associated with low summer rainfall in Nile Creek, British Columbia. The results of these investigations demonstrate the importance of summer streamflow to silver salmon and it is probably valid to assume that adequate summer streamflows are even more important to steelhead trout since they commonly remain in fresh water for more than one summer.

Since streamflows at other times of the year are also important to salmonids, it would be necessary to provide flows to maintain adequate conditions for immigration, spawning, incubation, rearing, and emigration. Ideally, a fisheries enhancement project would improve conditions for salmonids during all times of the year and would also improve fishing conditions.



CONTRAST BETWEEN LOW AND HIGH FLOWS OF THE MATTOLE RIVER UPSTREAM FROM THE PETROLIA BRIDGE

SUCCESSFUL STEELHEAD FISHERMEN ON THE LOWER MATTOLE RIVER

JANUARY 1972

CHAPTER V. FISHERY ENHANCEMENT THROUGH STREAMFLOW AUGMENTATION

At the beginning of this investigation, all known fishery enhancement techniques were considered for study. Fish hatcheries, spawning channels, and rearing ponds were already receiving considerable study which would eventually result in a full evaluation of these techniques. Watershed management, although a promising long-range alternative, was considered to be beyond the scope of this study. Streamflow augmentation was the only new enhancement possibility which showed good promise of success, was not receiving current study, and could logically be evaluated by water resources planners in cooperation with Department of Fish and Game biologists. Therefore, the decision to concentrate on streamflow enhancement was reached early in the investigation.

At the beginning of this study, a decision was made to consider only intermediate-size coastal streams. Extremely small streams were avoided because of inadequate water supply, short distance of stream available for enhancement, and inadequate reservoir capacity which could result in high temperatures and rapid siltation. Large rivers were not considered because of the difficulty in determining the postproject effect of a small project on a large stream when the project may not significantly increase natural flows of the lower river system. Also, if fish runs greatly increased below a flow augmentation dam on a tributary stream, it could be argued that these fish were merely diverted from another part of the river system, and therefore could not be considered as actual enhancement.

Many coastal streams were inventoried for their fisheries enhancement potential. Through coordination with the fisheries organizations of Mendocino and Humboldt Counties and local fish and wildlife and water committees, the number of coastal streams were reduced to eight. These included Redwood Creek, and Van Duzen, Mattole, Navarro, Noyo, Big, Tenmile, and Gualala Rivers.

Concurrently with this study, the U. S. Bureau of Reclamation was conducting similar fisheries enhancement studies in the north coastal area. To avoid possible duplication of studies by DWR and USBR, mutual agreement was reached that the Department of Water Resources would confine its studies to the Mattole, Van Duzen, and Navarro Rivers, whereas the Bureau would study Redwood Creek and Big, Tenmile, Gualala, and Noyo Rivers.

The objective of the study was to select and evaluate a pilot flow augmentation fishery enhancement project. The general criteria for selection of a pilot project were as follows:

1. The project should be located in headwaters of an intermediate-size coastal drainage to avoid the problems associated with extremely large or small drainages.

2. The drainage basin must have one or more good dam and reservoir sites located in the headwater area.

3. The stream should have physical access along much of the main stem.

4. The stream must have a history of good fish production and be capable of again producing large numbers of salmon and steelhead if proper stream conditions could be restored.

The concept of summer streamflow augmentation is a relatively simple approach to anadromous fishery enhancement which many fishery biologists feel will increase the number of returning fish to coastal streams. One major advantage of this method of enhancement over hatcheries is that it will produce stocks of "wild" fish which are stronger and healthier and have less tendency toward residualism than artificially reared fish. However, it is a recent concept which has not been tried except in conjunction with water releases for other primary purposes, and therefore, very little information exists concerning this possible method of fishery enhancement.

After commencement of the field work, the Department of Fish and Game found that they could not perform detailed fishery enhancement evaluations on more than a single stream system under this program. By consensus of all participants in the study, the decision was made to limit further field investigations to the Mattole River. However, much of the information developed on the Mattole would be applicable to other stream systems.

Mattole River Basin

The Mattole River was selected for concentrated study for the following reasons: (1) It is a river that once supported large runs of salmon and steelhead, but present runs are greatly reduced. (2) At least one good dam and reservoir site exists in the upper basin where blockage of upstream fish habitat would be minimal and the length of stream which could be enhanced would be large. (3) Natural streamflows at the damsite are low in turbidity, thereby assuring that clear water releases could be made from the reservoir. (4) Lack of adequate rearing area associated with extremely low summer flows and high temperatures appears to be a limiting factor to anadromous fish populations in the river. (5) Few rough fish exist in the river and therefore increased summer flows would benefit mainly steelhead and silver salmon.

The Mattole River Basin is a coastal drainage covering 303 square miles in southern Humboldt County as shown in Figure 7. The river flows into the ocean near the community of Petrolia, 36 miles south of Eureka. The basin is about 35 miles long trending in a northwesterly direction. Its width varies between 4 and 12 miles. It is bordered on the northeast by the Bear and South Fork Eel River drainages and on the southwest by numerous small coastal drainages. Elevations within the Mattole Basin vary from sea level at the mouth to 4,087 feet at Kings Peak on the southwest divide and 3,542 feet at south Rainbow Peak on the northwest divide. The streambed elevation of the main river rises gradually from sea level at the mouth to 1,000 feet near Thorn in the upper basin. The main stem length is 65 miles.

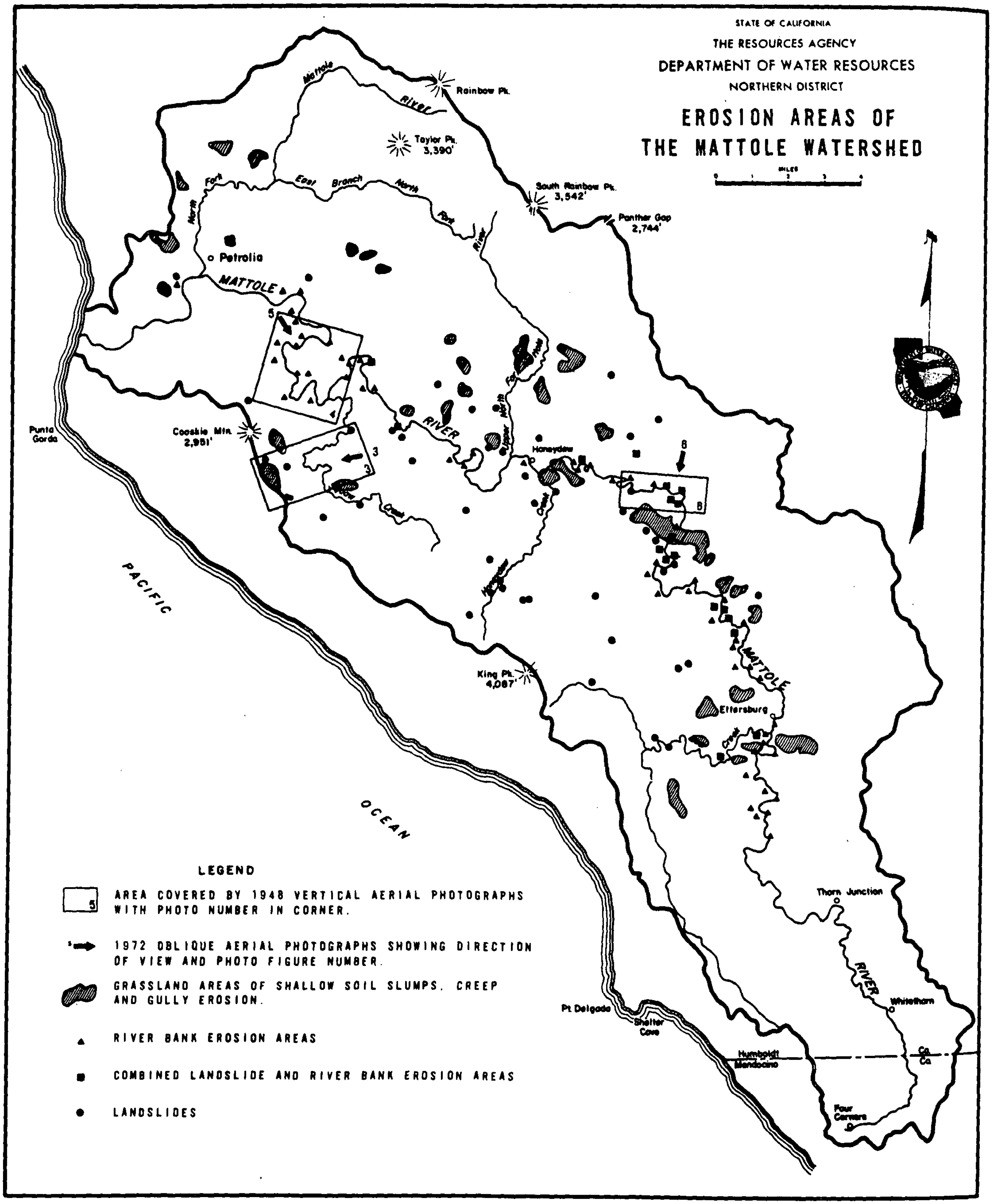
The total population of the basin is less than 1,000 people with most living in the three small communities of Petrolia, Honeydew, and Thorn. Timber cutting, ranching, and agriculture provide most of the jobs in the basin, although some businesses depend heavily on fishermen and tourists for their livelihood. Most of the land is privately owned, but the newly created Kings Range National Conservation Area occupies a sizeable portion of land lying along the southwest basin boundary.

The Mattole River Basin is characterized by steep mountainous terrain with second growth timber and native brush. Recent logging has left scars in the central and lower basin, but the upper basin around the town of Thorn shows few signs of land damage from past logging operations. Recent large scale timber harvest, combined with unstable geologic formations and high rainfall, has tended to change the middle and lower basin from dense forests of fir and some redwood to transitional forests of tanoak, madrone, young fir, and brush. These areas are interlaced throughout with scars from road cuts, slides, and other forms of silt-producing soil movements.

The Indian name Mattole, according to local tradition, means clear water, but today the Mattole has a reputation of being one of the most turbid streams in the north coastal area. The main reason for this is the large amount of silt and organic debris that is being washed from the steep slopes of the watershed into the tributaries and main channel of the river. Many residents of the lower Mattole River area recall the days prior to heavy logging and the disastrous floods of 1955 and 1964 when the river ran deep, narrow, and clean, and the riverbed was composed of large boulders, clean gravel, and sand. A canopy of trees and willows shaded the river throughout most of its length. Many sportsmen who have fished the river for 20 to 30 years tell of times past when the only obstacle to obtaining a limit of steelhead or salmon was transportation to the river over primitive roads. Today, anglers must be satisfied with one or two fish per trip, if they are lucky, and they must expect that at least 75 percent of the time the river will be too turbid to fish.

What has happened to the Mattole River in the last 20 years to change it from a relatively clean-flowing stream with deep pools and unsilted spawning gravels into a wide, shallow, silty waterway largely devoid of shade-producing streamside vegetation? The answer appears to be a combination of natural events and widespread man-caused detrimental influences. The Mattole River Basin has always been affected by floods, fires, and earthquakes, but in comparison has only recently been exposed to clear-cut logging, road building, overgrazing, land conversions, and related burning. Aerial photographs taken in 1948 indicate that the basin was able to fully recover from natural detrimental occurrences of the past, but recent photographs and personal observations lead one to question whether the present heavily damaged basin will ever fully recover from the environmental abuses of the last two decades. Figure 2 shows erosion areas contributing sediment to the Mattole River. Figures 3 through 6 provide comparative photographs of selected basin areas in 1948 and 1972.

FIGURE 2



STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
NORTHERN DISTRICT
EROSION AREAS OF
THE MATTOLE WATERSHED
MILES
Rainbow Pk.
Taylor Pk. 3,390'
South Rainbow Pk. 3,542'
Panther Gap 2,744'
Mattole River
East Branch North Fork River
North Fork
Petrolia
MATTOLE
RIVER
Punta Gorda
Cooskie Mtn. 2,951'
Honeydew
Upper North Fork
King Pk. 4,087'
Ettersburg
MATTOLE
PACIFIC
OCEAN
Thorn Junction
RIVER
Whitethorn
Pt Delgada
Shelter Cove
Humboldt
Mendocino
Co.
Co.
Four Corners
LEGEND
AREA COVERED BY 1948 VERTICAL AERIAL PHOTOGRAPHS WITH PHOTO NUMBER IN CORNER.
1972 OBLIQUE AERIAL PHOTOGRAPHS SHOWING DIRECTION OF VIEW AND PHOTO FIGURE NUMBER.
GRASSLAND AREAS OF SHALLOW SOIL SLUMPS, CREEP AND GULLY EROSION.
RIVER BANK EROSION AREAS
COMBINED LANDSLIDE AND RIVER BANK EROSION AREAS
LANDSLIDES

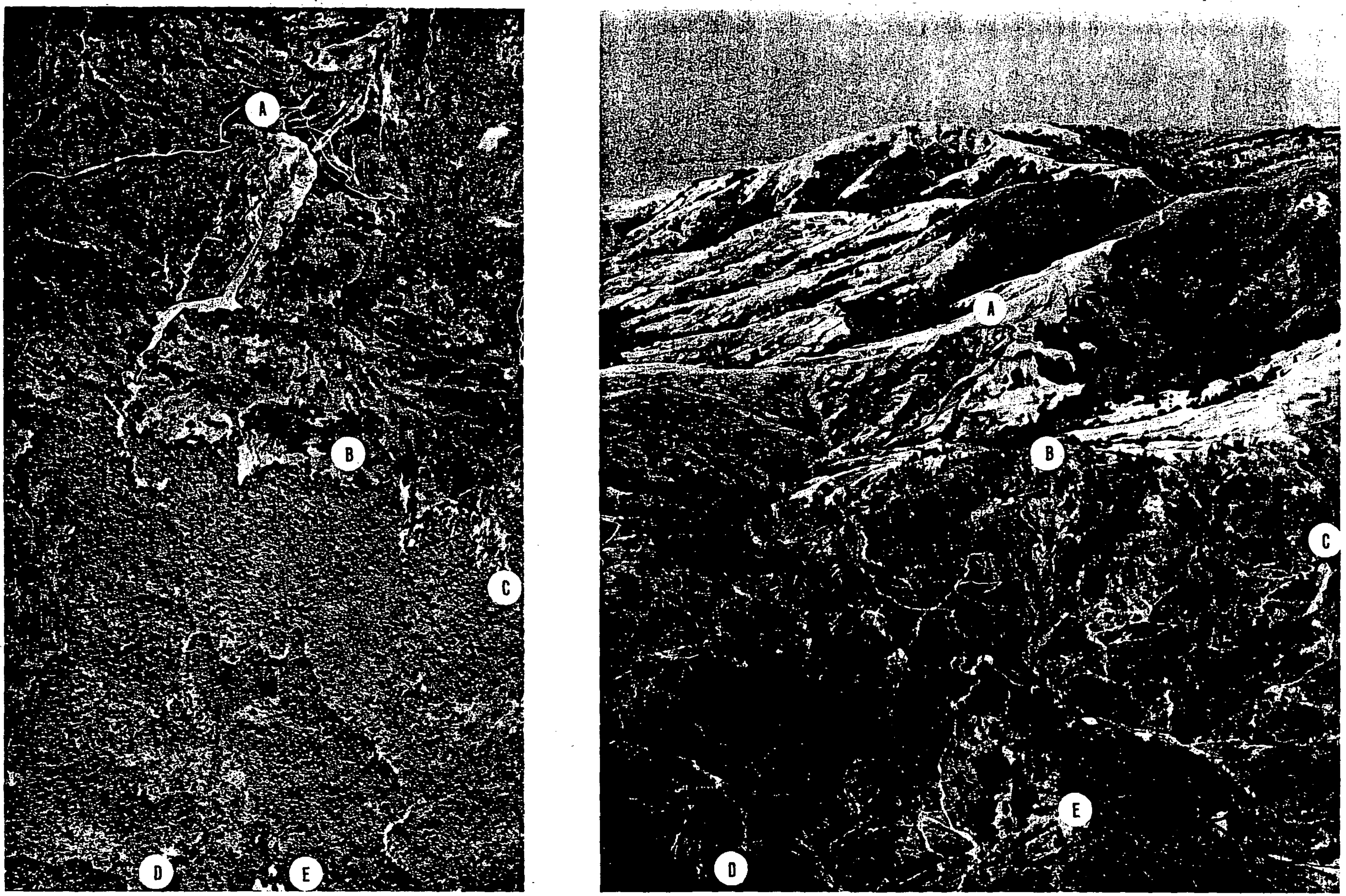


Figure 3

The above photographs show a portion of Squaw Creek drainage and the Cooksie Mountain slide labeled "A". The left photo was taken in 1948 and the right photo in 1972. Notice the greatly changed conditions of the timbered area at the bottom of the photographs in the areas labeled "D" and "E". Slides "B" and "C" did not exist in 1948 and are probably the result of logging activities. Squaw Creek is one of the most turbid streams in the Mattole drainage.

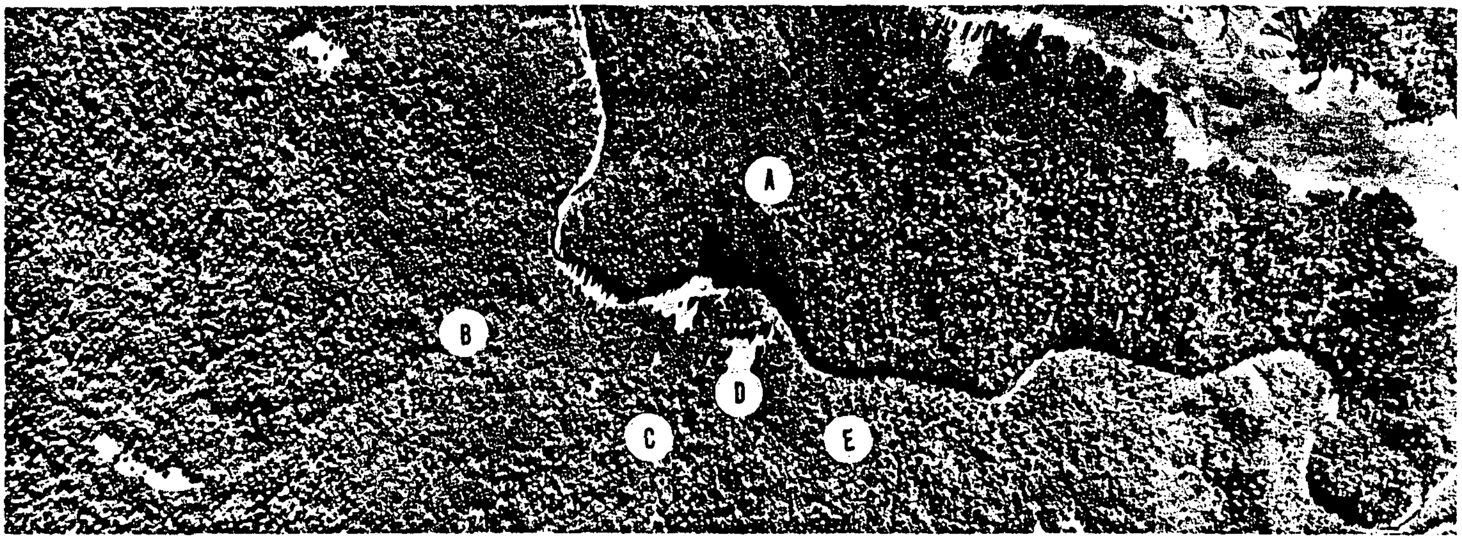
Figure 4

1948 vertical aerial photograph of loop area 5 to 12 river miles upstream from Petrolia. Riparian and hillside vegetation was very abundant. Note especially areas "A" and "B".

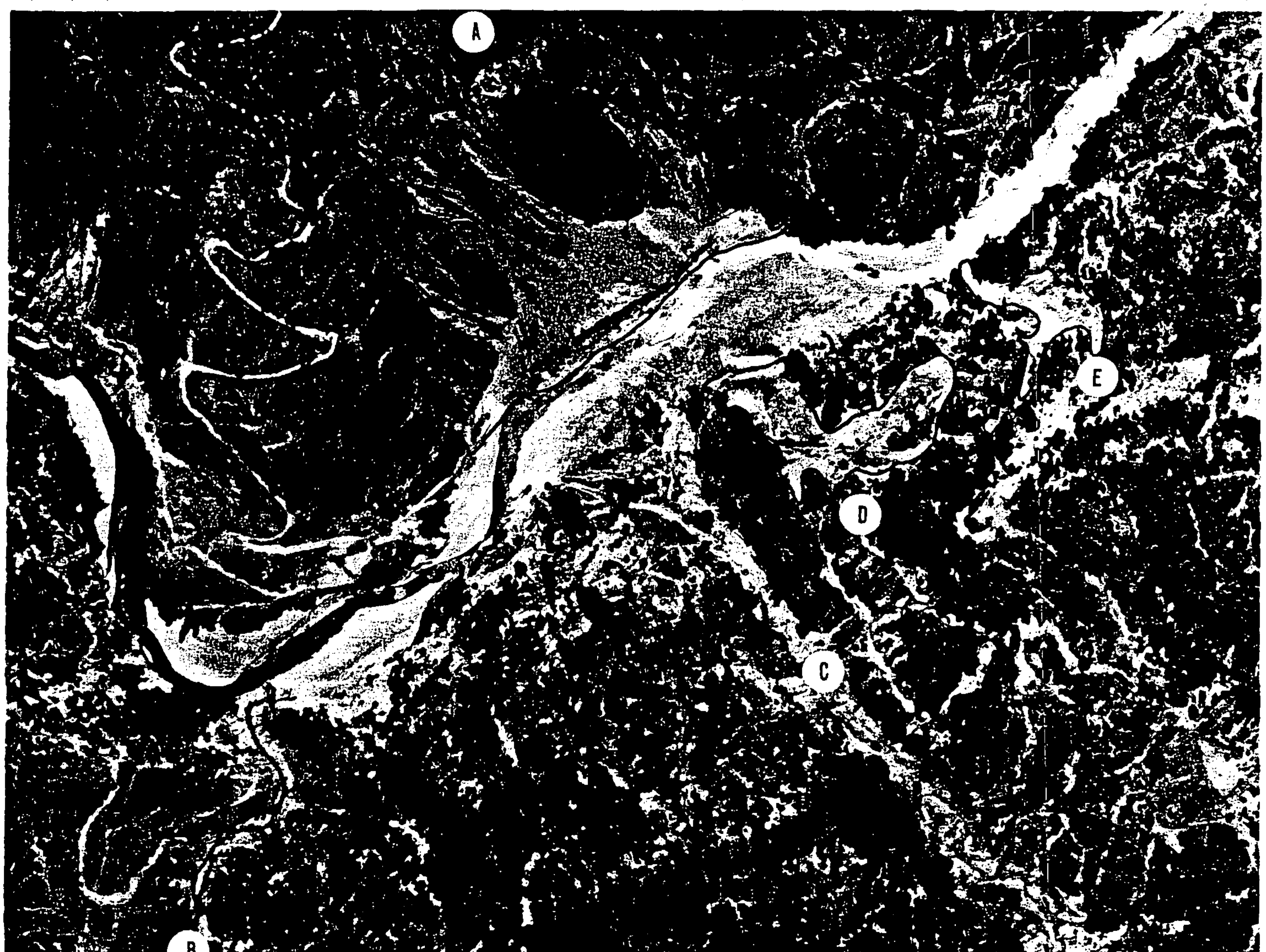
Figure 5

Oblique view of the same area as Figure 4 twenty four years later (1972). Note hill "B" and much of the area beyond it. Tall timber has been replaced by miles of roads and barren erodible soil.

Figure 6



Mattole River approximately 5 river miles upstream from Honeydew. This area has been greatly changed by logging and flooding. Slide "A" was barely visible in 1948 (upper photo) but is now one of the largest and most silt producing slides on the river (lower photo - 1972). Streams "B" and "C" were hidden by vegetation in 1948 but in 1972 were open scars. Slides "D" and "E" did not exist in 1948.



Mattole River Projects

Two potential fishery enhancement dam and reservoir sites, shown in Figure 7, were identified in the headwaters of the main stem Mattole River. The Thorn site is located approximately 1 mile upstream from the town of Thorn. The Nooning Creek site is located immediately above the confluence of Nooning Creek and the Mattole River.

Either of these sites would be able to significantly increase the quantity of summer streamflows throughout the more than 50-mile length of river between the damsites and the river mouth. Improved flow conditions could also be maintained during the adult spawning migrations in the fall and during the out-migration of juvenile smolts on their way to the ocean.

Selection of a preferred damsite was not made because neither project is being recommended for construction at this time. A comparison of engineering, economic, and environmental factors which would be important in making a selection is contained in Tables A-1, A-2, and A-3 of Appendix A to this report.

If future consideration is given to construction of a fisheries enhancement project on the Mattole River, a reevaluation of these factors at that time would exert a strong influence on which site would be selected. Appendix A contains a detailed discussion of both the Thorn and Nooning Creek projects.

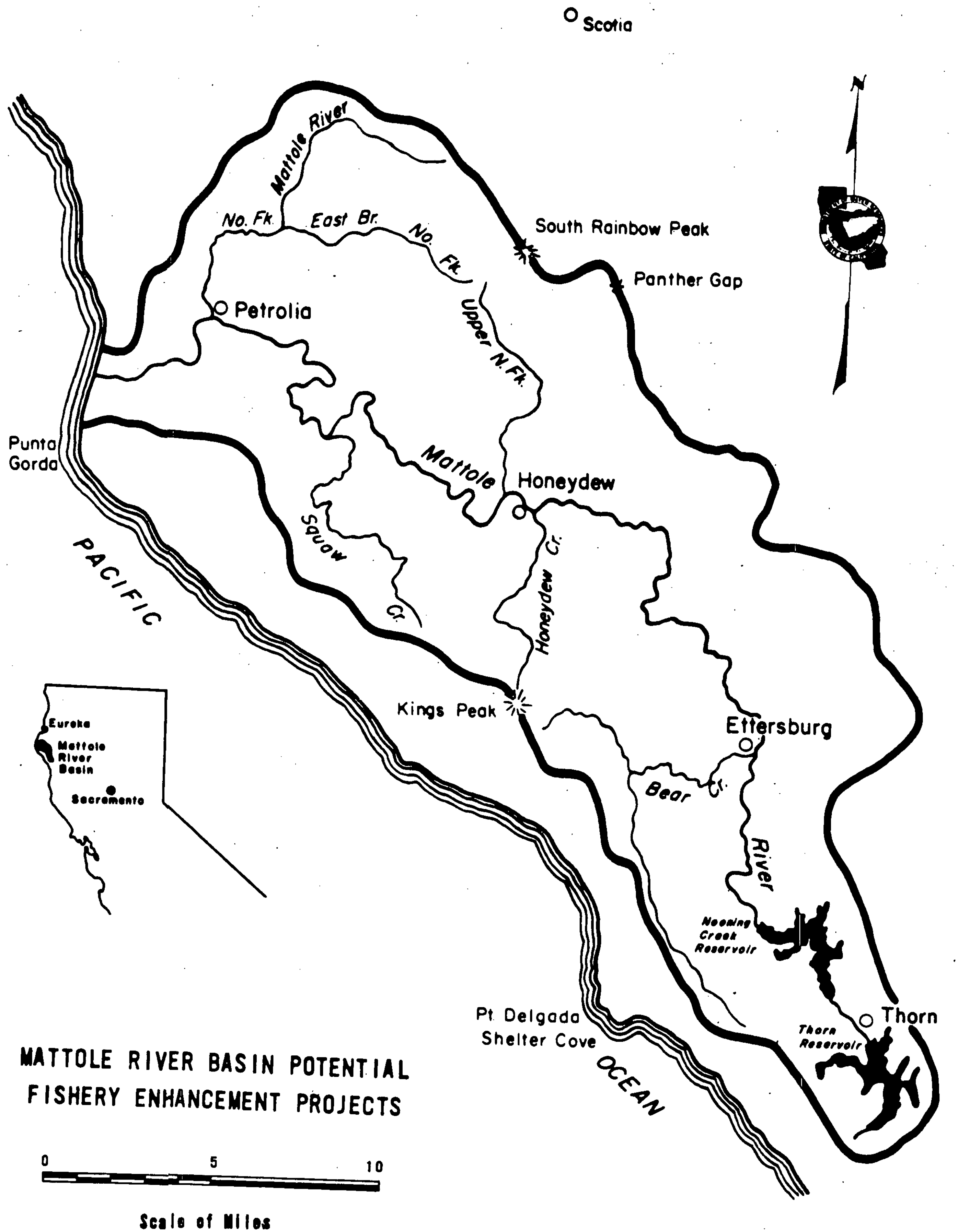
Beneficial and Detrimental Aspects of Mattole River Projects

A dam designed and operated for the single purpose of anadromous fisheries enhancement on the Mattole River would have both benefits and detriments.

Benefits. The most important beneficial aspect of such a project is its capability of storing high winter flows for release during the summer when natural flows drop as low as 2 cfs at the damsites. The low flow at Petrolia near the mouth drops below 30 cfs almost every year. If an additional 30 to 50 cfs were released down the Mattole River during the summer and fall, it would increase the average low flow above natural conditions from 3 to 15 times along the main stem. Such increases in late summer flow would increase the wetted area of the stream channel available for fish rearing habitat and food production. The fish species mainly benefited by increased summer flows would be steelhead trout. King salmon would be benefited by the maintenance of high fall spawning flows.

Another significant benefit of a reservoir in the headwaters of the Mattole River is the downstream cooling effect of reservoir releases. Under normal conditions during the summer months, maximum water temperatures in the main stem of the Mattole drainage rise to 80° F. or above for as long as 5 hours on hot afternoons. Average maximum temperatures of the Mattole River at Nooning Creek and at Ettersburg during July 1973 were 73° F. and 78° F., respectively, and absolute maximum temperatures were 81° F. and 82° F. These high temperatures are detrimental to salmonids

FIGURE 7



MATTOLE RIVER BASIN POTENTIAL FISHERY ENHANCEMENT PROJECTS which usually must escape to cooler pools or tributaries when temperatures approach the 80s. Data collected at Ruth Reservoir, which is similar in size and climatic exposure to the potential Mattole projects, indicate that the maximum expected temperature of reservoir releases would be about 63° F. in the early fall and that average summer temperatures would be around 55° F. Once released into the Mattole River during the summer, this water would increase in temperature at a rate of approximately 1° F. per mile. Estimates based upon temperature data collected in the Mattole River and below small reservoirs in the north coastal area indicate that water released from Mattole River projects in the summer would range between 55° F. and 70° F. for the first 8 miles downstream. Therefore, the cooling effect of a reservoir would benefit fishlife for approximately 16 miles below the reservoir. Fall reservoir release temperatures would average approximately 56° F. on November 1 and 50° F. December 1. These temperatures are within the acceptable range for spawning anadromous fish.

Other benefits of a Mattole River fishery enhancement project would include the following:

1. Capability of maintaining adequate flows for spawning activities during the fall when early storms raise the river enough to attract fish, then recede to the point that migrating fish are unable to continue up the river. Under present conditions these fish are vulnerable to poaching and natural predators.

2. Provision of a facility for fishery enhancement research where controlled flows can be observed and modified.

3. Increased recreational use and aesthetic enjoyment of the Mattole River due to higher maintained flows throughout the summer.

4. Provision of reservoir-related recreation such as boating, fishing, and swimming which is presently very limited in the north coastal area.

Detriments. Detrimental aspects of a fishery enhancement reservoir in the upper Mattole River Basin include the following:

1. Since the project would be experimental, it might not work as well as expected.

2. A dam and reservoir would be expensive ($13 to $17 million).

3. Some homes and land would be inundated.

4. The stream areas above the reservoir would be lost for salmon spawning and rearing although they would provide habitat for trout.

5. Wildlife habitat within the reservoir would be inundated.

6. The county would lose property taxes on land within the project boundary.

Fish and Wildlife Studies

Studies were made by the California Department of Fish and Game to evaluate the impact of a Mattole River flow enhancement project on fish and wildlife. A considerable amount of office and field work was accomplished by a fishery biologist and a seasonal aid over a year-long period of study. Photographs of some of the field work activities are shown on the following page. The types of fish and wildlife data developed for the Mattole River Basin are listed below:

1. A literature review of fishery enhancement techniques.

2. A partial creel census to provide an estimate of the kinds and numbers of fish caught and the number of days the river was fishable.

3. Sampling by shocking at various times and locations to determine the kinds and number of juvenile fish in the stream.

4. Collection of information on the physical characteristics of various stream sections.

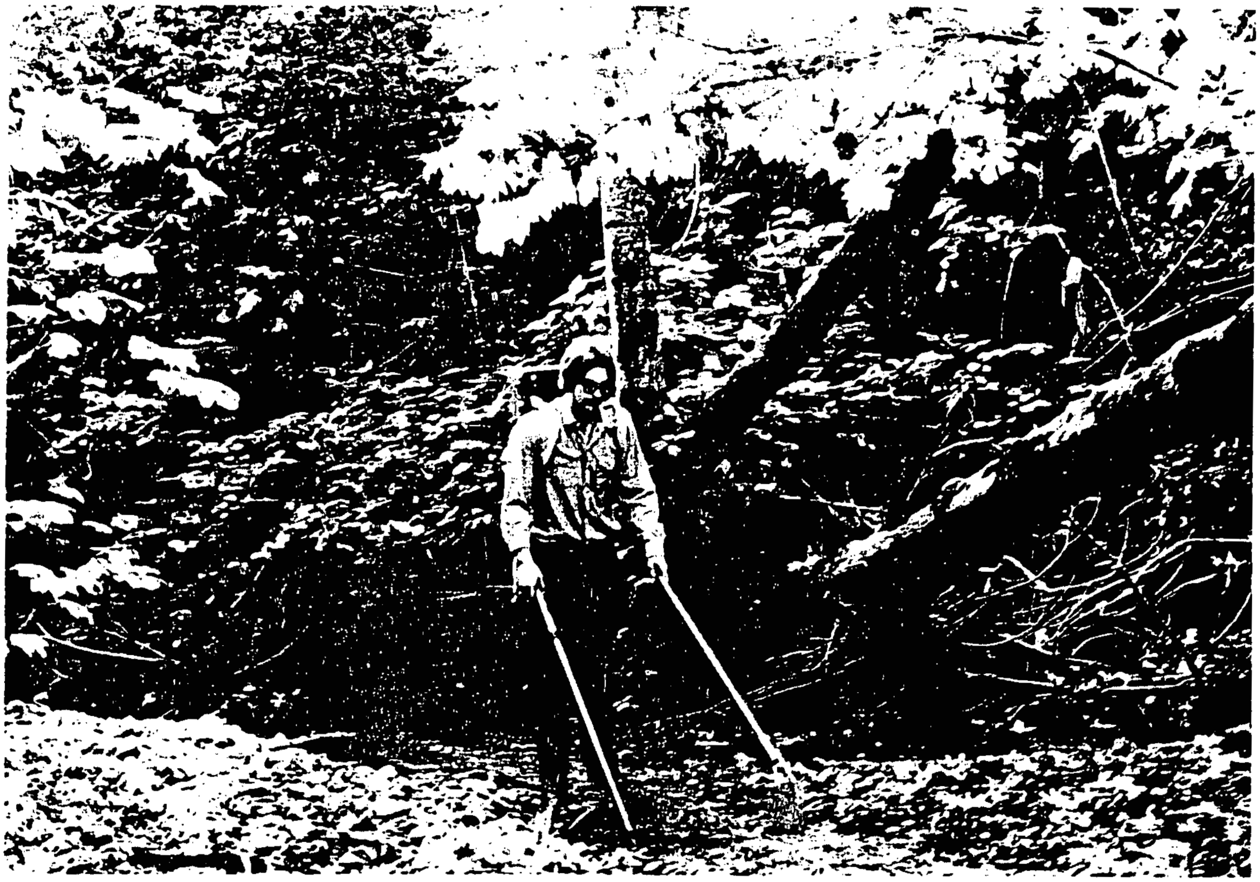
5. Trapping downstream migrant salmonids to gain information on the timing of their emigrations.

6. Measurement of stream temperature to determine its effect on salmonid production.

7. Measurement of stream profiles at various flows and delineation of flow regimes into pool, riffle, shallows, or run components.

One problem that became apparent at the beginning of fishery studies was the general lack of antecedent data on the Mattole River fishery. Very little biological field work of any type had been conducted on the Mattole River prior to the fishery enhancement study. Another complicating factor is the predictive nature of these studies. The biologist is in the uncomfortable position of answering a vast array of "what if" questions about future fishery conditions based upon rather sketchy historic and present stream data.

The basic objective of biologic studies was to estimate the increased populations of adult salmon and steelhead that would return to the river, and the increased commercial and sport catch that would result from the enhancement project. In attempting to develop these estimates, a myriad of other difficult questions arise which must be answered first. For example, what factors are presently limiting fish production? Is it food production, spawning areas, temperature, turbidity, or summer rearing areas that most severely affect fish survival in the river? What role does the



ELECTROFISHING OF SMALL TRIBUTARY STREAM (ABOVE) AND TRAPPING OF DOWNSTREAM MIGRANTS IN MATTOLE RIVER BY DEPT. OF FISH AND GAME PERSONNEL

estuary habitat play in the life cycle of fish? Are predation, overfishing, and poaching significant factors in limiting fish production? What effect will the blocked stream channel above the dam have on future fish production? Also to be contended with is the fact that biologic systems are extremely complex, and that each river system, and each fish species within a given river, have certain unique characteristics which cannot be fully understood by studies conducted on other streams. Even the very basic procedure of collecting fish population information is extremely difficult and time-consuming as evidenced by the general lack of fish count information on north coastal streams. As a result of these difficulties inherent in predicting the results of a fishery enhancement project, fishery biologists are unwilling to make estimates based on insufficient data where they are forced to rely on sketchy past experience and judgment.

Although much information was gained during this study, additional field work and analysis is required to properly evaluate the fishery enhancement potential of a dam and reservoir on the Mattole River. Some of the conclusions reached by the Department of Fish and Game during this study are as follows:

1. The Mattole River supports significant populations of anadromous fish, including steelhead trout, king salmon, and silver salmon.

2. Lack of suitable rearing area appears to limit steelhead and silver salmon production in the Mattole River.

3. Cool water released throughout the summer could increase the survival and growth of juvenile salmonids inhabiting the main river below a flow augmentation dam.

4. Flow augmentation in the fall could enhance conditions for king salmon spawning in the Ettersberg area.

5. A hatchery on the Mattole River could substantially benefit sport and commercial fishermen by increasing salmonid production; however, present unimpounded summer flows are not suitable to support a hatchery.

6. An artificial spawning channel would be of little value on the Mattole River since suitable spawning gravel does not appear to limit salmonid production in the stream.

7. Rearing ponds offer a significant potential for increasing production of silver salmon and steelhead in the Mattole River at reasonable cost if an adequate supply of cool water is available and if enough fish can be obtained to stock the ponds.

8. Watershed restoration through management is the best solution to the problem of declining salmonid resources; however, such a program would be very expensive and would require many years to accomplish.

9. Substantial additional study will be required before fishery enhancement projects in the upper Mattole River can be adequately evaluated.

10. More complete studies are needed to estimate the types and numbers of wildlife that would be lost by construction of a Mattole River reservoir and to formulate mitigation plans for this wildlife.

Public Attitude Toward a Dam and Reservoir on the Mattole River

During the fisheries enhancement study, special efforts were made to inform local governmental bodies of the progress of the study and to get them involved in making decisions regarding which streams should be studied.

Early in the investigation the Boards of Supervisors of Humboldt and Mendocino Counties were interviewed to obtain their views on potential fisheries enhancement studies. The questions asked of the Boards included such items as: which rivers and streams should be studied, what types of enhancement are most desired, and would they support a flow augmentation project. Copies of letters to both Boards and their replies are contained in Appendix B, "Correspondence with Humboldt and Mendocino Counties".

Throughout the investigation periodic progress reports were given to the Boards of Supervisors and their duly formed Fish and Game and Water Committees. Support for the studies was expressed at these meetings.

Near the end of the study a public meeting in the area was held to discuss study findings and to receive comments from residents of the Mattole Basin and nearby areas. Of the approximately 50 people attending the meeting, the overwhelming majority opposed construction of any moderate- or large-size dam on the Mattole River. Residents of the upper basin were opposed to the project because they felt that a dam is an unnatural solution to a problem of nature and that such a project would greatly change the character of the upper valley. Inundation of land and trees, the displacement of homes and two religious institutions, and the influx of more people into the area were mentioned as additional undesirable factors.

Residents of the lower basin were not as adamantly opposed to potential projects as those in the upper basin. However, they were doubtful of the benefits that the community would derive from such projects, and the landowners along the lower river did not want more fishermen attracted to the Mattole River.

As an alternative to a moderately sized dam on the upper Mattole River, several other fishery enhancement possibilities were suggested at the meeting. These included the following:

1. Clearing of logging slash and debris from the bed and banks of the main river and its tributaries.

2. Reforestation of the streambanks.

3. Thinning and reforestation of the surrounding watershed.

4. Construction of small holding ponds on the upper tributaries and watershed to augment ground water storage and increase summer flows.

As was pointed out at the public meeting, the Department agrees that some beneficial effects would result from the first three items. However, the desirability of constructing several small holding ponds in the upper Mattole River Basin for fishery enhancement is questionable. From past experience both the Department of Water Resources and the Department of Fish and Game generally consider small reservoirs undesirable because they would have inadequate storage capacity, would tend to silt up rapidly, and would produce warm water. However, some very small mountain reservoirs at the headwater of streams in the Sierra, Trinity, and Klamath Mountains have been successful in improving stream conditions for fishlife and have proved to be very popular recreation areas. Future consideration of fishery enhancement reservoirs should include an evaluation of these types of small tributary projects.

Because of the adverse feelings of most people living in the basin and the fact that the accomplishments of a flow improvement reservoir cannot be accurately determined without further study, it was decided to publish this progress report on the work accomplished to date and to defer further study. If sufficient public interest is generated in the future, fishery enhancement studies in the Mattole River Basin could be resumed. In the meantime, additional studies relating to possible fishery enhancement opportunities in the north coastal area are under way by the Department of Water Resources and the U. S. Bureau of Reclamation, in cooperation with the Department of Fish and Game and the U. S. Fish and Wildlife Service. These studies are described briefly in the following paragraphs.

Ongoing and Future Fishery Enhancement Studies

Planning of water projects for the primary purpose of fishery enhancement is a recent development resulting from the greatly increased public concern over environmental quality. The public is now demanding that environmental considerations be fully evaluated in the planning of public and private development projects. Both state and federal legislation has recently been enacted to accomplish this purpose.

In response to these changing public values, several programs for the exploration of fishery enhancement through stream habitat improvement methods are now either under way or scheduled in the future. This report deals with the first phase of the general concept of fishery enhancement through flow augmentation. Another study in which the Department is involved is an evaluation of fishery enhancement opportunities below Lake Pillsbury in the upper Eel River Basin. In addition, the Department of Water Resources, the

Bureau of Reclamation, and the Department of Fish and Game have agreed to conduct a cooperative study in an effort to solve the anadromous fishery problems on the Trinity River below Lewiston Dam. Following is a brief description of each of these planned and potential studies.

Eel-Russian River Flow Augmentation Study

This investigation was initiated in September 1972 in response to a request to the California Water Commission from the Eel River Water Council and Humboldt County officials for a study of ways to improve Eel River fisheries and recreation through a modified operation of Lake Pillsbury in the headwaters of the Eel River Basin. A study committee including county, state, and federal governmental agencies and water districts, as well as the Pacific Gas and Electric Company, was formed to provide direction for the study. The major work is being performed jointly by the State Departments of Water Resources and Fish and Game, and by the U. S. Corps of Engineers.

Lake Pillsbury has provided storage in the headwaters of the Eel River since 1922. Most of this water is diverted through a tunnel into Potter Valley in the Russian River drainage for power generation and irrigation in Potter Valley. The project was granted a 50-year license by the Federal Power Commission in 1922. In April 1972 this license expired and the California Department of Fish and Game requested that some of the fishery problems in the Eel River resulting from the diversion be corrected as a condition of relicensing.

The primary problem created by the project is the adverse effect on anadromous fish in the upper Eel River. During the early storms each fall, which attract spawning fish into the upper Eel River, the refilling of Lake Pillsbury and the diversion of most of this water into Potter Valley essentially dewaters the river between storms. Eggs deposited by spawning fish during the highwater periods are lost, and many fish trapped by the intervening low flows die without spawning.

Another problem is low summer flows in the Eel River. During the summer months, a release of only 2 cubic feet per second is made at Cape Horn Dam (Van Arsdale Reservoir) 12 miles downstream from Lake Pillsbury. This release is barely sufficient to maintain a flowing stream; it provides habitat suitable for only nongame fishes and supports only limited recreation uses.

The Potter Valley Project is currently operating on a second interim 1-year license, while the Federal Power Commission considers recommendations by the U. S. Forest Service, the U. S. Fish and Wildlife Service, and the Department of Fish and Game concerning provisions for recreation and preservation of fish and wildlife.

The recommendations contained in the Eel-Russian River study report, which is scheduled for completion in 1974, will provide important input to the Federal Power Commission in its deliberations concerning relicensing of the Potter Valley Power Project.

Bureau of Reclamation Fishery Improvement Studies

The U. S. Bureau of Reclamation, in conjunction with the U. S. Bureau of Sport Fisheries and Wildlife, has conducted a cursory-level fish improvement study on five north coastal streams (Redwood Creek, and Tenmile, Noyo, Big, and Gualala Rivers). The purpose of this study was to select one of these streams for more intensive study with the objective of identifying the best site for construction of a pilot fishery enhancement project.

Big River was selected as potentially the most promising stream for additional study. However, the Bureau recently discontinued its study of small coastal streams. The Bureau's efforts have now been redirected to a cooperative study with the Departments of Water Resources and Fish and Game aimed at solving existing fish problems on the Trinity River below Lewiston Dam.

Trinity River Fishery Studies

The Trinity River studies involve efforts by the U. S. Bureau of Sport Fisheries and Wildlife, the Bureau of Reclamation, the Forest Service, the Bureau of Land Management, and the California State Departments of Water Resources and Fish and Game to find solutions to fish and wildlife problems associated with the construction and operation of Trinity Dam. This study will involve experimental flow manipulation to provide attraction flow for adult salmon and steelhead. It will also include downstream migration studies using experimental flow releases to encourage movement of juvenile salmon and steelhead out of the river and into the ocean. Other studies will include attempts to find solutions to riparian vegetation encroachment and silt deposition on spawning gravels, which have been blamed for reducing the fish populations and fishability of the Upper Trinity River. These studies were initiated in January 1974.

APPENDIX A. THE THORN AND NOONING CREEK PROJECTS FORMULATION

Appendix A gives the technical information on the Thorn and Nooning Creek fishery enhancement projects in the upper Mattole River Basin. Neither of these projects are recommended for construction at this time and therefore neither is selected as the most desirable project.

The Thorn Project

Thorn Dam site is located immediately below Baker Creek and crosses a terrace once occupied by the Thorn Lumber Mill (Figure A-1). The drainage area above this damsite is 11.6 square miles and the average rainfall is 75 inches per year. No streamflow records exist at the damsite; however, a stream gaging station has been maintained on the Mattole River at Petrolia since 1952. By comparing the drainage area and rainfall above the damsite with the drainage area and rainfall at the Petrolia gage, it was possible to estimate the runoff at the damsite. Estimated runoff at the damsite ranges from 9,600 to 62,200 acre-feet annually. The average annual runoff is about 32,900 acre-feet.

In April 1973 a cursory geologic investigation was made of the foundation conditions at Thorn Dam site. The site appears suitable for either an earthfill dam with a pervious outer shell or a rockfill dam. A conservative design is necessary because of the site's close proximity to the San Andreas fault. Sufficient streambed gravel is not available from the Mattole River and local bedrock is probably not suitable for use in a fill type dam; therefore, construction materials would have to be transported from another area. Benbow Lake on the South Fork Eel River has an adequate supply of gravels which is considered as the source of pervious material for cost estimating purposes. Rock for riprap can probably be quarried in the Thorn area.

The dam section (Figure A-2) would consist of an impervious core, surrounded by an outer shell of gravel, with riprap facing on the upstream embankment to protect against wavewash. Approximately 700,000 cubic yards of impervious weathered material would be required for the core. It can be obtained from terraces in the reservoir and downstream along the river. An additional 1,000,000 cubic yards of gravel for the pervious shell and filter material would be needed. It could be transported from Benbow Lake over an 11-mile haul road which would be constructed as part of the project.

An uncontrolled spillway with an ogee crest and concrete chute would protect the dam from overtopping. The spillway, on the left abutment, was sized to discharge 18,000 cfs with 10 feet of freeboard. The outlet works would consist of a low-level intake and conduit capable of discharging 300 cubic feet per second at minimum storage.

The estimated total capitalized cost of the Thorn project is $14,100,000. The two largest field cost items are the dam at $4,600,000 and land acquisition, relocations, and reservoir clearing totaling $4,500,000.

Thorn Reservoir at a normal water surface elevation of 1,160 feet would cover 825 acres and contain 45,000 acre-feet of water. The relationship between elevation, storage capacity, and water surface area is shown

FIGURE A-1

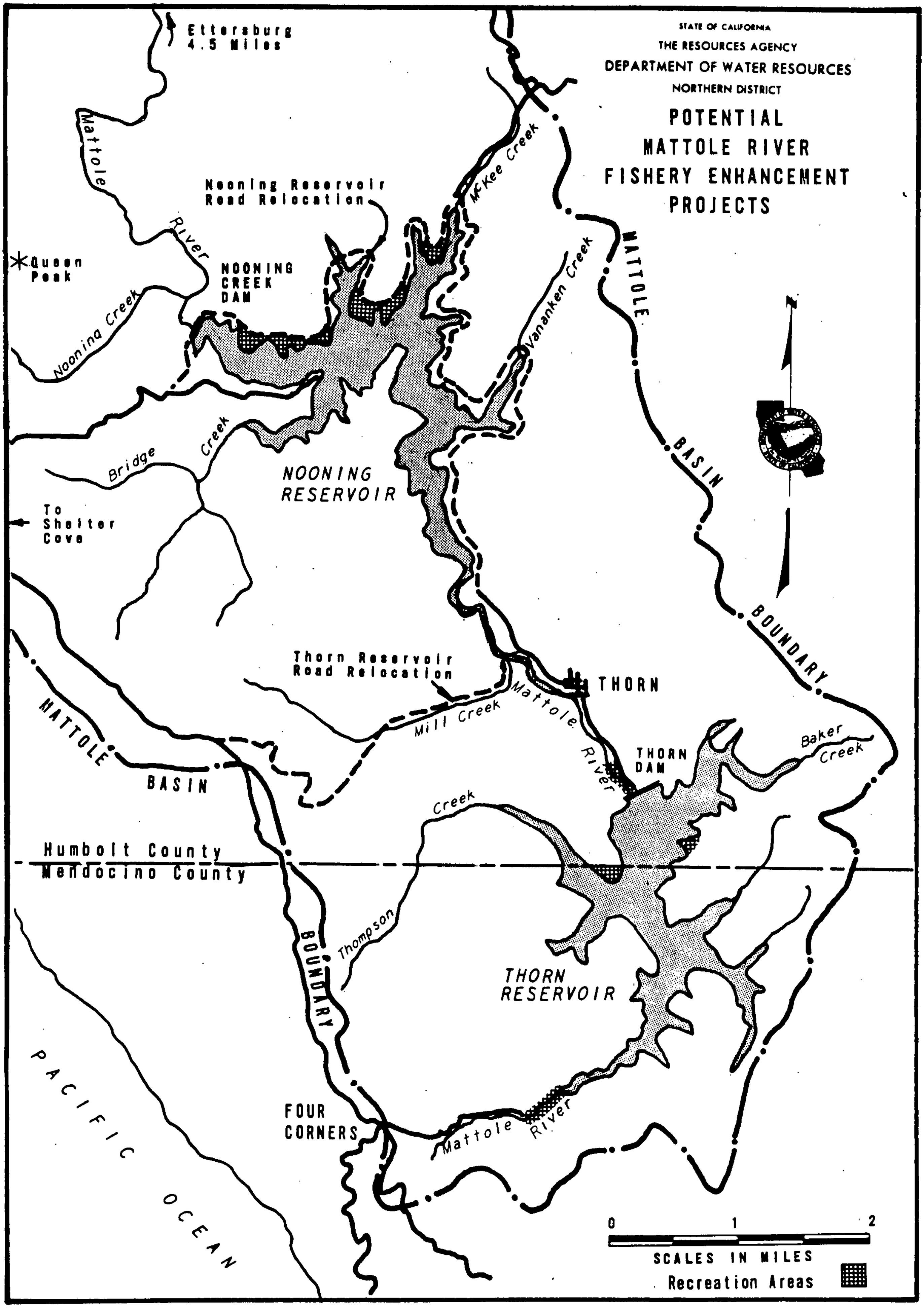
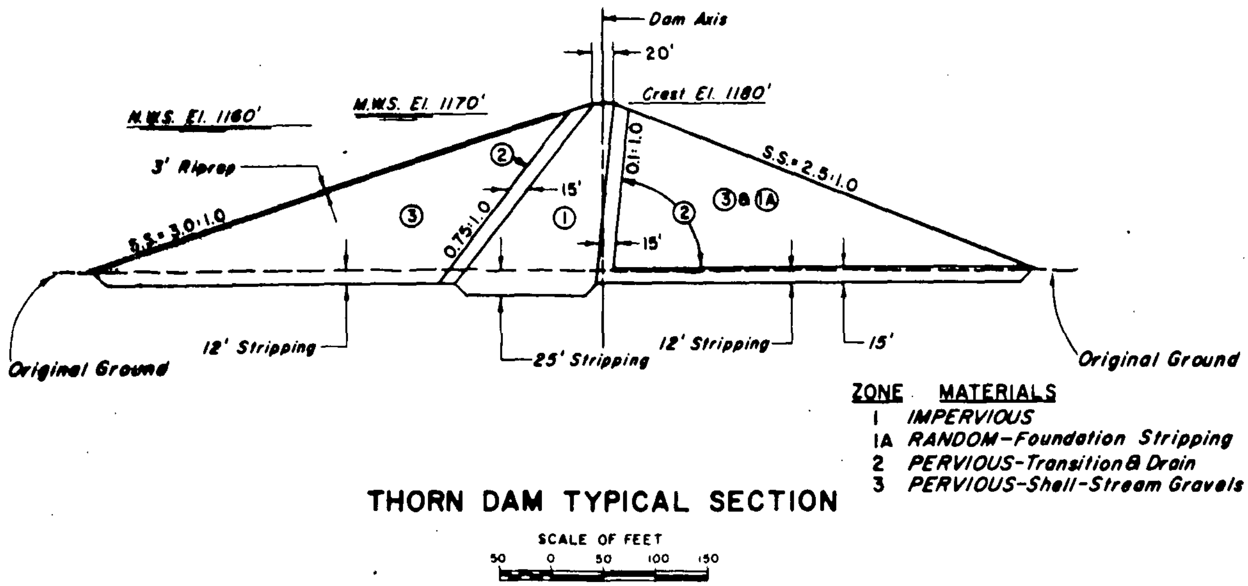

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
NORTHERN DISTRICT
POTENTIAL
MATTOLE RIVER
FISHERY ENHANCEMENT
PROJECTS
Ettersburg 4.5 Miles
Mattole River
Queen Peak
Nooning Reservoir Road Relocation
NOONING CREEK DAM
McKee Creek
Vananken Creek
Nooning Creek
Bridge Creek
NOONING RESERVOIR
To Shelter Cove
MATTOLE BASIN BOUNDARY
Thorn Reservoir Road Relocation
THORN
Mill Creek
Mattole River
THORN DAM
Baker Creek
MATTOLE BASIN
Creek
Humbolt County
Mendocino County
Thompson
BOUNDARY
THORN RESERVOIR
PACIFIC OCEAN
FOUR CORNERS
Mattole River
0
1
2
SCALES IN MILES
Recreation Areas

FIGURE A-2. THORN DAM TYPICAL SECTION

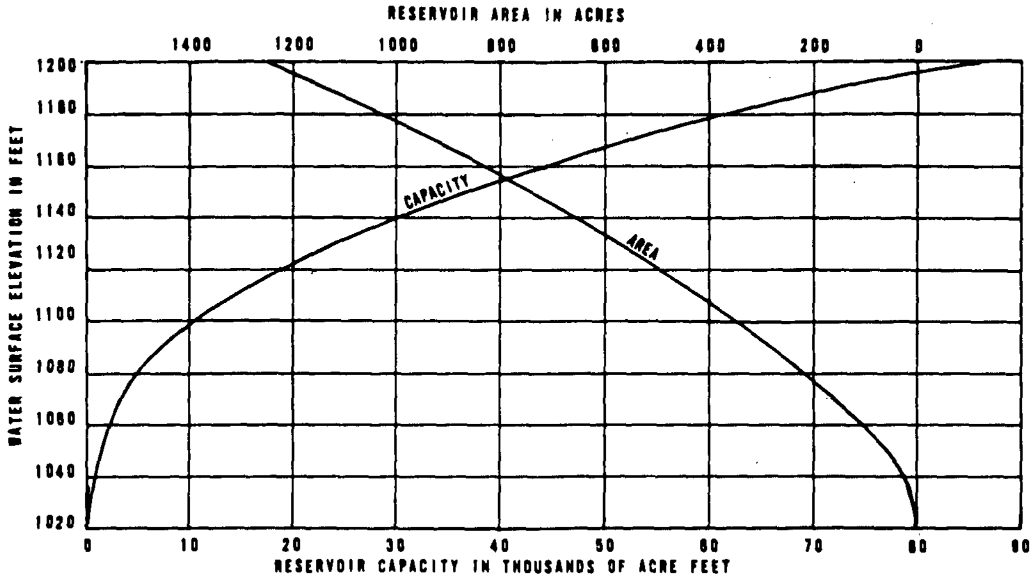


in Figure A-3. Project statistics are given in Table A-1 and environmental effects listed in Table A-2. When full, the reservoir would have 25 miles of shoreline and an average depth of 55 feet. Approximately 3.5 miles of county road in the reservoir area which presently connects Thorn and Four Corners would have to be relocated. The reservoir was sized to provide adequate storage for the maintenance of a minimum flow of 60 cfs at Ettersburg throughout the summer. Table A-3 gives a comparison of low flows in the Mattole River at various locations with and without the flow enhancement project. The critical year during the historic operation study is 1924 when the storage would have reached a minimum of 10,000 acre-feet if the project had been in existence then. Average annual reservoir drawdown would be 14 feet during normal years and 34 feet during dry periods. The reservoir would fill and discharge water over the spillway nearly every year.

A rather large dead storage of 10,000 acre-feet was used in order to insure cool fall releases and to provide adequate storage for resident fish in the reservoir. During normal years additional water would be available in the reservoir for release during the spring to encourage downstream migration of young salmonids or in the fall for attraction of upstream migrating fish. The exact schedule of reservoir operation cannot be exactly predicted because it would be somewhat experimental. The primary releases would be from May through October for improvement of the summer rearing habitat below the reservoir, but additional water would be released for experimentation with flushing, attraction, and maintenance flows during the remainder of the year. Therefore, the largest practicable reservoir storage consistent with available inflow and economic considerations is desirable.

The Thorn Dam would block approximately 4 miles of main stream and 12 miles of tributary nursery area which now supports an estimated 25,000 juvenile salmonids (equivalent to approximately 40 returning adults).

FIGURE A-3. THORN RESERVOIR A-C CURVES



THORN RESERVOIR AREA-CAPACITY CURVES

In a 1972 survey it was found that about 93 percent of these young fish were steelhead and about 7 percent were silver salmon. The dam is upstream of the observed limit of king salmon migration. Thorn Reservoir would inundate an area of 830 acres which now supports an estimated 155 nonmigratory deer and an unknown number of other wildlife. Between 50 and 75 people live in the reservoir area and would be forced to relocate. Many of these residents live in the Redwood Monastary and the Springs of Living Waters Religious Commune. A total of about five private homes would be flooded.

Annual recreational use at Thorn Reservoir would increase from 13,000 recreation days in 1980 to 31,000 by 2030. The recreation potential of this project is only "fair" due to a limited amount of suitable flatland around the reservoir and its remoteness from population centers.

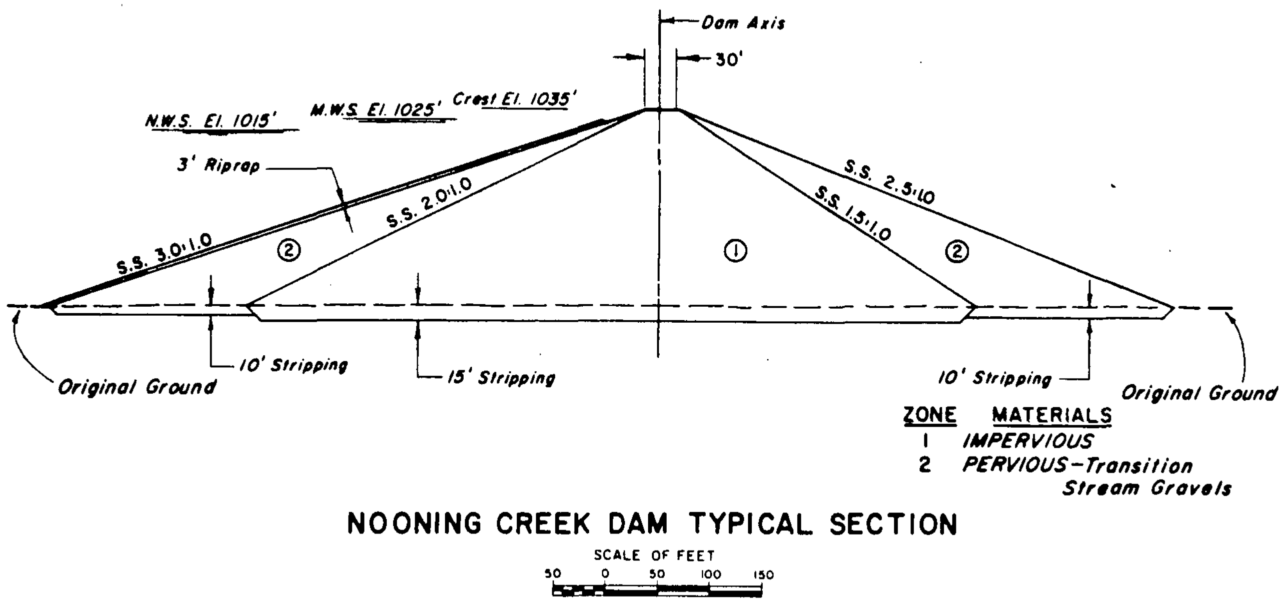
The Nooning Creek Project

The Nooning Creek Dam site is located on the Mattole River approximately 1/4 mile upstream from the confluence of Nooning Creek (Figure A-1). The drainage area above the damsite is 32.6 square miles and the average rainfall over the area is 77 inches per year. Average annual runoff at the damsite is estimated at 98,000 acre-feet per year with extremes ranging between 23,000 and 182,000 acre-feet per year.

A reconnaissance-level geologic field investigation of the Nooning Creek Dam site was conducted in April 1973. This field study revealed relatively good foundation conditions which could support an earthfill or concrete dam of moderate height. Excavation of the top 10 feet of weathered foundation material and a 15-foot core trench beneath the dam section would be necessary.

The dam (Figure A-4) would consist of a large impervious core of 729,000 cubic yards of terrace material obtained within the reservoir area. A relatively thin outer shell of pervious gravels would be placed over the core. The upstream face of the dam would be protected from erosion by large rocks placed as riprap. All materials for construction can be obtained in or near the reservoir area. Approximately 10.6 miles of county road must be relocated around the reservoir.

FIGURE A-4. NOONING CREEK DAM TYPICAL SECTION

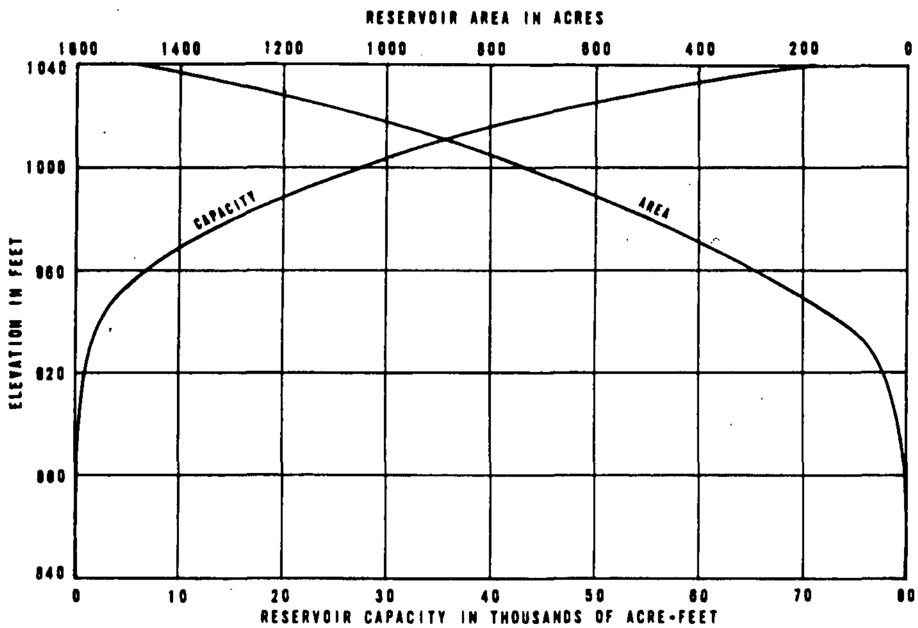


The spillway would consist of an uncontrolled ogee crest and concrete chute on the left dam abutment. The spillway chute would terminate on a terrace 70 feet above the streambed from where the spillway discharges would be released over a terrace area. The spillway was sized to discharge 30,000 cfs with 10 feet of head. The outlet works would be located near the bottom of the reservoir and would be designed to discharge 300 cubic feet per second at minimum pool.

The estimated total capitalized cost of the Nooning Creek Project is $17,900,000. The largest field cost categories are land acquisition, relocations, and reservoir clearing at $8,000,000 and dam construction at $2,800,000.

The Nooning Creek Reservoir when full at elevation 1,015 feet would cover 950 acres and contain 40,000 acre-feet of water. The maximum elevation of the reservoir is limited to a level which would not inundate the town of Thorn. The relationship between elevation, storage, and water surface area is shown in Figure A-5, and project statistics are given in Table A-1. When full, the reservoir would have 27 miles of shoreline and the average depth would be 48 feet. The reservoir would provide adequate storage for the maintenance of a minimum flow of 60 cfs at Ettersberg throughout the summer. The reservoir would fill and discharge water over the spillway every year except during extremely dry years. During normal years additional water would be available in the reservoir for experimentation with adult emigration and juvenile outmigration flows, but the primary releases would be made from May through October for improvement of the summer rearing habitat below the reservoir.

FIGURE A-5. NOONING CREEK RESERVOIR A-C CURVES



NOONING CREEK RESERVOIR AREA-CAPACITY CURVES

The Nooning Creek Dam would block about 12 miles of mainstream nursery area and about 25 miles of tributary nursery area which now supports an estimated 125,000 juvenile salmonids (equivalent to approximately 190 returning adults). Almost all of these fish are young-of-the-year steelhead. Nooning Creek Reservoir would inundate an area of 950 acres which now supports an estimated 90 deer as well as other wildlife. This reservoir would flood the Thorn Junction area which has been subdivided into 1/2-acre to 5-acre lots. Several homes have been built in this area, especially along the east bank of the river from Thorn Junction Bridge to the damsite. The number of people forced to relocate by this reservoir could be as high as 200. Land values in this area are higher than at Thorn Reservoir due to the more intensive development.

The Nooning Creek Project would considerably improve the rearing habitat of the 8 miles of stream from the project to Ettersberg by greatly increasing summer flows (Table A-3) and reducing summer water temperatures below 70° F. This stretch of river contains the cleanest spawning gravel found in the Mattole River and would provide excellent habitat under post-project conditions. Increased summer flows would also significantly benefit the 45 miles of river between Ettersburg and the mouth, although summertime temperatures would reach their preproject levels about 8 miles below Ettersburg.

Annual recreation use at Nooning Creek Reservoir would increase from 20,000 recreation days in 1980 to 48,000 by 2030. This use is higher than that at Thorn Reservoir due mainly to the large area of flatland surrounding the reservoir.

TABLE A-1

MATTOLE RIVER FISHERY ENHANCEMENT
PERTINENT DATA FOR DAMS AND RESERVOIRS

	Item	Reservoir		
		Thorn	Nooning Creek	Ruth
1.	Drainage area above damsite	11.6 square miles	32.6 square miles	121 square miles
2.	Volume of reservoir at NWS	45,000 acre-feet	40,000 acre-feet	52,000 acre-feet
3.	Area of reservoir at NWS	825 acres	950 acres	1,180 acres
4.	Type of dam	Earthfill	Earthfill	Earthfill
5.	Height of dam	160 feet	190 feet	150 feet
6.	Volume of dam	1,900,000 cubic yards	1,000,000 cubic yards	1,050,000 cubic yards
7.	Normal water surface elevation	1,160 feet	1,015 feet	2,654 feet
8.	Maximum water surface elevation	1,170 feet	1,025 feet	2,686 feet
9.	Maximum storage	53,000 acre-feet	54,000 acre-feet	
10.	Minimum storage	10,000 acre-feet	10,000 acre-feet	8,000 acre-feet
11.	Average annual runoff	32,900 acre-feet	98,000 acre-feet	196,000 acre-feet
12.	Maximum annual runoff	62,200 acre-feet	182,000 acre-feet	429,000 acre-feet
13.	Minimum annual runoff	9,600 acre-feet	23,000 acre-feet	32,000 acre-feet
14.	Miles of road relocated	3.5 miles	10.6 miles	
15.	Cost of project	$14,100,000 - 1973	$17,900,000 - 1973	$2,880,000 - 1961 $4,600,000 - 1973*

*Based on USBR cost index.

TABLE A-2

ENVIRONMENTAL EFFECTS OF THORN AND NOONING CREEK RESERVOIRS

Environmental Factors	Thorn	Nooning Creek
Area inundated (square miles)	1.3	1.5
Miles of shoreline	25	27
Miles of main stream blocked	4	12
People displaced	50 to 75	150 to 200
Deer displaced	155	91
Reservoir fish production	Fair (comparable to Ruth and Pillsbury Lakes)	
Reservoir recreation use (initial/maximum annual recreation days)	13,000/31,000	20,000/48,000
Normal reservoir drawdown (feet)	25	25
Rate of reservoir sedimentation	Low	Low
Reservoir water quality	Excellent	Excellent
Water quality below dam	Good	Good
Average summer water release in cubic feet per second from reservoir to maintain 60 cfs at Ettersburg	25	25
Average natural summer flow at damsite (cfs)	2	6
Length of reservoir releases cooling influence on stream (miles)	16	16
Miles of stream habitat potentially enhanced by reservoir releases	58	50

TABLE A-3

COMPARISON OF NATURAL LOW FLOWS ON THE MAIN
MATTOLE RIVER WITH AUGMENTED FLOWS FROM THORN RESERVOIR

Location on River (rearing area station)	Late August Natural Flow cfs	Late August Flow With a Release From Thorn Reservoir of: 40 cfs	55 cfs
Nooning Creek	4	40	55
Bear Creek	6	42	57
Ettersberg	9	45	60
Honeydew Creek	16	52	67
Honeydew	18	54	69
Indian Creek	20	56	71
Petrolia	25	61	76

APPENDIX B. CORRESPONDENCE WITH HUMBOLDT AND MENDOCINO COUNTIES

STATE OF CALIFORNIA—RESOURCES AGENCY

RONALD REAGAN, Governor

DEPARTMENT OF WATER RESOURCES
NORTHERN DISTRICT
2440 MAIN STREET
P.O. BOX 607
RED BLUFF 96080

December 13, 1971

Mr. Guy C. Kulstad, Director
Department of Public Works
Humboldt County
1106 Second Street
Eureka, California 95501

Dear Guy:

The Department of Water Resources on July 1, 1971 initiated a Fishery and Wildlife Enhancement Study of coastal streams in Humboldt and Mendocino Counties. The objective of this investigation is to study streams that have enhancement possibilities and to select one or two for detailed evaluation.

This program, which is being conducted in cooperation with the Department of Fish and Game, is in its infancy; consequently, no plans have as yet been formulated although we have made preliminary field investigations of some enhancement possibilities.

To properly perform this investigation we feel that it is essential that the desires and ideas of local agencies and individuals be fully considered. I would therefore like to suggest an early meeting with you and other representatives of Humboldt County.

Some of the things we might discuss could include the following:

1. What coastal streams are you most interested in, and why?

2. Would you favorably consider construction of a pilot dam and reservoir project on one of the small coastal rivers for streamflow improvement, sediment removal, and increased spawning success, or would you prefer some other type of project?

Mr. Guy C. Kulstad December 13, 1971

3. What are the types of fisheries enhancement you desire? List in order of importance.

a. Increased commercial ocean salmon fishing.
b. Increased ocean sport salmon fishing.
c. Increased river sport salmon fishing.
d. Increased river sport steelhead fishing.
e. Increased reservoir trout fishing.
f. Increased summer trout fishing (for yearling steelhead) and streamside recreation.

4. Would you consider making a declaration by the Board of Supervisors to have a stream such as Redwood Creek, the Upper Van Duzen River, or the Mattole River declared a public highway for fishing purposes, as is provided in the California Fish and Game Code Appendix (Sections 25660-25662). We recognize that any acquisition of land or easement under this provision should involve compensation to the landowner for any loss he incurred. This land acquisition would probably be included as a project feature and would therefore be considered as a project cost.

5. What are the names, addresses, and phone numbers of four or five Humboldt County residents, other than county officials, who are knowledgable on fisheries and who might be interested in this program?

6. In what other ways should the county be involved in the fishereis and wildlife enhancement study?

If you feel that such a meeting would be productive, you might suggest a couple of open dates in early January, and we will arrange to meet with you and others on one of them.

Sincerely yours,

Albert J. Dolcini
District Engineer
Northern District

cc: Dr. Richard L. Ridenhour
Office for Academic Affairs
Humboldt State College
Arcata, California 95521

DEPARTMENT OF PUBLIC WORKS
COUNTY OF HUMBOLDT
1106 SECOND STREET, EUREKA, CALIFORNIA 95501
PHONE (707) 445-7491

May 5, 1972

Mr. Albert J. Dolcini
District Engineer
Department of Water Resources
Northern District
P. O. Box 607
Red Bluff, California

Attention: Mr. Ed Barnes

Re: Board of Supervisors' Recommendations Regarding Coastal Streams

Dear Mr. Dolcini:

Attached for your information is a copy of the Board Order dated April 25, 1972, and the letter to the Board of Supervisors dated April 12, 1972, indicating the County's position regarding your Fisheries and Wildlife Enhancement Program.

If you have any further questions or comments, it is suggested that you give me a call or drop me a note.

Very truly yours,

GUY C. KULSTAD, P. E.
Director

Attachment

BOARD OF SUPERVISORS, COUNTY OF HUMBOLDT, STATE OF CALIFORNIA

Copy of portion of proceedings, Meeting on April 25, 1972

WATER COMMITTEE'S RECOMMENDATIONS
RE WATER REQUIREMENTS AND WATER
RESOURCES APPROVED, PUBLIC WORKS
TO FORWARD TO DEPT. OF WATER RESOURCES

This Board of Supervisors hereby approves the Humboldt County Water Committee's recommendations on the Department of Water Resources' letter dated December 13, 1971, regarding Humboldt County Requirements and Water Resources, Phase 1 and 2.

The Director of Public Works is directed to forward said recommendations to Albert J. Dolcini, District Engineer, Department of Water Resources.

April 12, 1972

Board of Supervisors
County of Humboldt
Courthouse
Eureka, California 95501

Attention: Mr. Richard Milbrodt
Administrative Officer

Re: Water Committee's Recommendations on Department of Water Resources' Letter Dated December 13, 1971

Gentlemen:

The Water Committee has reviewed the attached letter and wishes to make the following recommendations:

(1) "What coastal streams are you most interested in, and why?"

The order of priority would be the Mattole River, the Van Duzen River and Redwood Creek. This investigation would be consistent and compatible with Humboldt County's Water Policy and the Consultant's recommendations in their reports titled "Humboldt County Water Requirements and Water Resources", Phase 1 and 2.

(2) "Would you favorably consider construction of a pilot dam and reservoir project on one of the small coastal rivers for stream flow improvement, sediment removal, and increased spawing success, or would you prefer some other type of project?"

The Committee favored the pilot dam and reservoir project on a small coastal stream and it was also felt that consideration should be given to a fish hatchery, a water study of a coastal stream, fish rearing ponds, and resources analysis.

(3) "What are the type of fisheries enhancement you desire? List in order of importance."

a. "Increased commercial ocean salmon fishing."
b. "Increased river sport steelhead fishing."
c. "Increased ocean sport salmon fishing."
d. "Increased river sport salmon fishing."
e. "Increased reservoir trout fishing."

Board of Supervisors
April 12, 1972
Page -2-

(4) "Would you consider making a declaration by the Board of Supervisors to have a stream such as Redwood Creek, the upper Van Duzen River, or the Mattole River declared a public highway for fishing purposes, as is provided in the California Fish and Game Code Appendix (Sections 25660-25662)? We recognize that any acquisition of land or easement under this provision should involve compensation to the landowner for any loss he incurred. This land acquisition would probably be included as a project feature and would therefore be considered as a project cost."

(Same answer as No. 2)

(5) "What are the names, addresses, and phone numbers of four or five Humboldt County residents, other than County officials, who are knowledgable on fisheries and who might be interested in this program?"

The Committee recommended that the Humboldt County Fish and Game Committee and the Water Committee be listed as the official contacts.

(6) "In what other ways should the County be involved in the fisheries and wildlife enhancement study?"

Mr. Donald Tuttle, Parks Coordinator, is involved in this type of effort.

No other recommendations were made by the Committee.

Very truly yours,

GUY C. KULSTAD, P. E.
Director

Attachment

STATE OF CALIFORNIA—RESOURCES AGENCY

RONALD REAGAN, Governor

DEPARTMENT OF WATER RESOURCES
NORTHERN DISTRICT
2440 MAIN STREET
P.O. BOX 607
RED BLUFF 96080

November 26, 1971

Mr. Albert Beltrami, Administrator
County of Mendocino
Courthouse
Ukiah, California 95482

Dear Al:

During our discussion of November 15 in Ukiah with Supervisors Barbero and Galletti, you asked me to outline the role we expect Mendocino County to play in our fisheries enhancement program.

As was mentioned, fisheries enhancement involves not only increasing the number of fish in North Coastal streams, it also includes making the streams more available for fishing. As Mr. Barbero pointed out, increasing the fish populations will have little value unless they will be available to the fishermen.

Prior to selection of promising fisheries and wildlife enhancement projects, we would like to have your County's view on the following questions.

1. What coastal streams are you the most interested in, and why?

2. Would you favorably consider construction of a pilot dam and reservoir project on one of the small coastal rivers for streamflow improvement, sediment removal and increased spawning success, or would you prefer some other type of project?

3. What are the types of fisheries enhancement you desire? List in order of importance.

    a. Increased commercial ocean salmon fishing.
    b. Increased ocean sport salmon fishing.
    c. Increased river sport salmon fishing.
    d. Increased river sport steelhead fishing.
    e. Increased reservoir trout fishing.
    f. Increased summer trout fishing (for yearling steelhead) and streamside recreation.

Mr. Albert Beltrami November 26, 1971

4. Would you consider making a declaration by the Board of Supervisors to have a stream such as the Noyo, Tenmile, Garcia, or Navarro declared a public highway for fishing purposes, as is provided in the California Fish and Game Code Appendix (Sec. 25660-25662). We recognize that any acquisition of land or easement under this provision should involve compensation to the landowner for any loss he incurred. This land acquisition would probably be included as a project feature and would therefore be considered as a project cost.

5. What are the names, addresses, and phone numbers of 4 or 5 Mendocino County residents, other than county officials, who are knowledgable on fisheries and who might be interested in this program?

6. In what other ways should the County be involved in the fisheries and wildlife enhancement study?

We would appreciate comments on the above questions by early January.

The following is a list of some of the factors we consider of importance in selecting streams for possible pilot fisheries enhancement projects.

1. The stream must be fairly small such that the effects of construction of a pilot project can be properly evaluated.

2. There must be a reasonably good reservoir site high up in the watershed so as to produce sufficient streamflow enhancement water while at the same time not blocking off a significant portion of the salmon and steelhead spawning area.

3. The stream must be physically accessible such that fishermen can walk safely along the stream channel and banks, and roads and trails must be available at reasonable intervals.

4. Legal public access must be available either by the stream presently being in public ownership, by obtaining long-term leases from private corporations, or by acquisition as a part of the project -- under Sec. 25660-25662 of the California Fish and Game Code -- or some other legal means.

5. The stream must have significant present fish populations, or strong evidence that new runs can logically be developed by the project. This will require an inventory of available spawning gravels, holding pools, nursery areas, food supplies, and an estimate of fish populations, past and present.

As we proceed with our Fisheries and Wildlife Enhancement Study, we desire to work closely with your County to get your ideas, desires, and help in making a study that will have your concurrence and support. It would be helpful if you would designate a county representative as contact on this study.

I enjoyed the recent meeting with you and members of your Board and am looking forward to meeting with you again soon.

Sincerely yours,

Albert J. Dolcini
District Engineer
Northern District

ALBERT P. BELTRAMI
COUNTY ADMINISTRATOR
PURCHASING AGENT

TELEPHONE
462 - 4731
EXT. 211

COUNTY OF MENDOCINO
ADMINISTRATIVE OFFICE
COURTHOUSE
UKIAH, CALIFORNIA
95482

February 4, 1972

Mr. Albert J. Dolcini, District Engineer
Northern District, Department of Water Resources
2440 Main Street - P. O. Box 607
Red Bluff, California 96080

Dear Al:

In response to your letter of November 26, 1971, relative to the fish enhancement program, the Board of Supervisors has received the recommendations of their Fish and Game Advisory Committee and has asked me to forward the following answers to the questions that were included in your letter:

1. While most of the coastal streams are worthy of fisheries enhancement programs, the Board specifically designated, in order of preference, the Navarro, the Noyo and Big River.

2. The Board would favorably consider construction of a pilot dam and reservoir project on one of the coastal rivers for streamflow improvement, sediment removal and increased spawning success, but would also like to see a rearing pond or small hatchery concept included as well, because of the serious need for these facilities.

3. In order of importance, the Board recommends:

a. Increased commercial ocean salmon fishing .
b. Increased ocean sport salmon fishing.
c. Increased river sport salmon fishing.
d. Increased river sport steelhead fishing.
e. Increased reservoir trout fishing, no recommendation.
f. The Board is opposed to increased summer trout fishing and streamside recreation.

4. The Board would consider making a declaration to have the Navarro River

declared a public highway for fishing purposes.

5. Names and addresses of persons who would be interested in this progra are:

Ray Welsh, Rt. 1, Box 230, Fort Bragg - 964-2811
Frank Haun, Trailer Cove, Fort Bragg - 964-5873
Wm. Grader, Fort Bragg - 964-3339
Ed Cadd, 625 Holden Street, Ukiah - 462-4891
Londo Franci, Surf Motel, Gualala - 884-3571

All members of the Fish and Game Advisory Committee would like to be included in discussions. Their names and addresses are:

Robert L. Zaina, 2440 S. State Street, Ukiah - 462-7944
Ed Walsh, 10 Mill Court, Ukiah - 462-4560
Glenn Carbrey, 71 Madrone Dr., Willits - 459-5930
Frank Petersen, Sr., Alder & McKinley Sts., Fort Bragg - 964-2805
Leonard Craig, Point Arena - 882-2249

The County will cooperate in the planning and development stages of the fisheries and wildlife enhancement study as appropriate in every fashion possible.

We look forward to working with you on this project and await your answer.

Sincerely,

Al

Albert P. Beltrami
County Administrator

APB:ph