CASE STUDY REPORT #6
RUTH DAM
MAD RIVER

I. Introduction

The Mad River, located in the north coastal area of California, flows in a northwesterly direction through a narrow trough that gradually expands near the coast. The river enters the Pacific Ocean about 10 miles north of Eureka and the entrance to Humboldt Bay. The drainage area includes about 500 square miles (Figure 1).

Ruth Dam, located 79 miles upstream from the mouth of the Mad River, was constructed in 1961 by the Humboldt Bay Municipal Water District (HBMWD). The dam impounding Ruth Reservoir has a maximum storage capacity of 52,000 acre-feet covering an area of 1,200 acres.

Ruth Dam is operated by HBMWD for the storage of water to be used for municipal and industrial purposes in the Humboldt Bay area.

Approximately 70 miles downstream from Ruth Dam, near Arcata, HBMWD diverts about 80 cfs of streamflow by means of collector wells which extract water through gravel beds (Essex intake).

Upstream of the HBMWD diversion and just above the confluence with the North Fork, the Department of Fish and Game owns

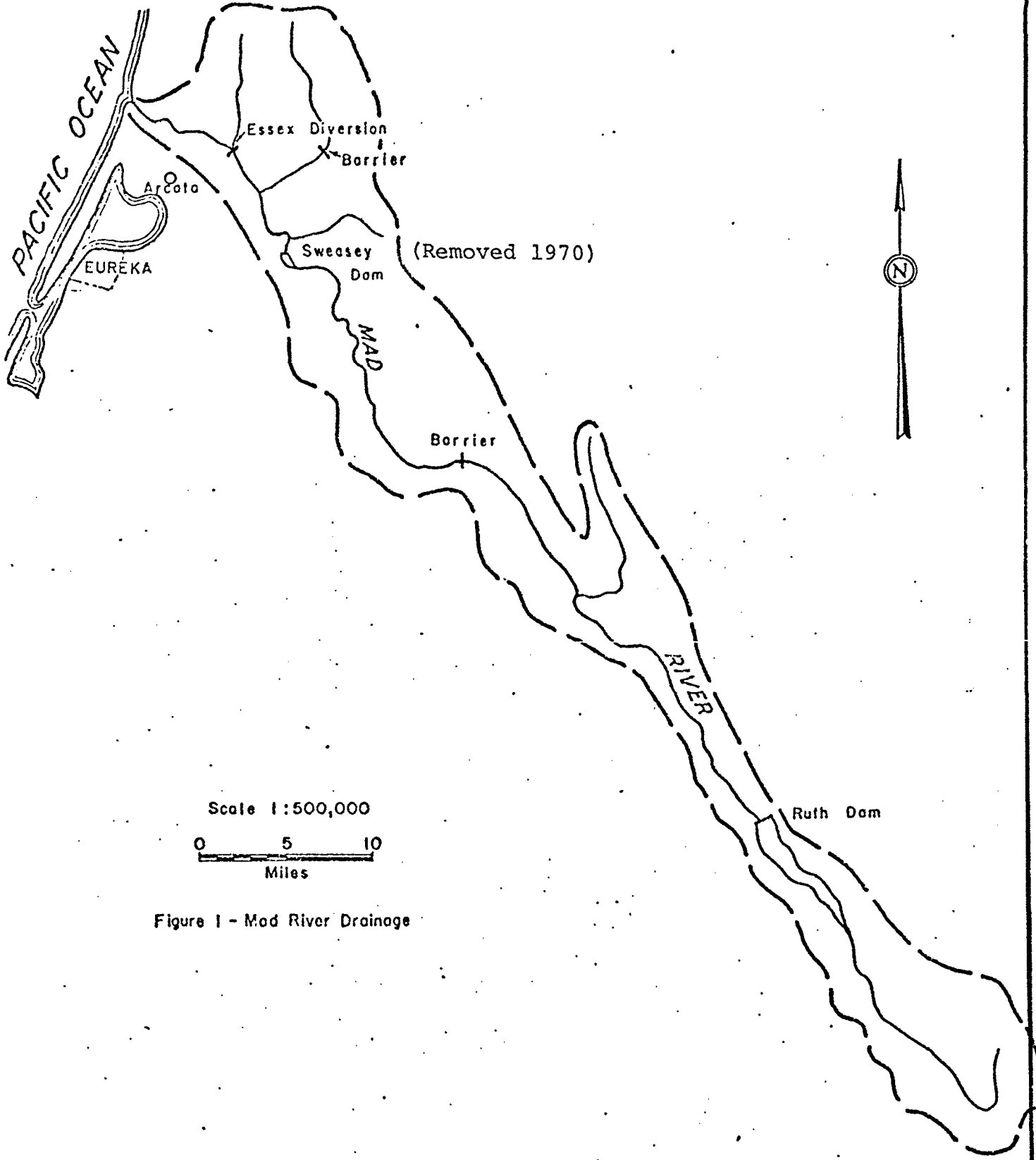


Figure 1 - Mad River Drainage

Figure 1

LOCATION MAP

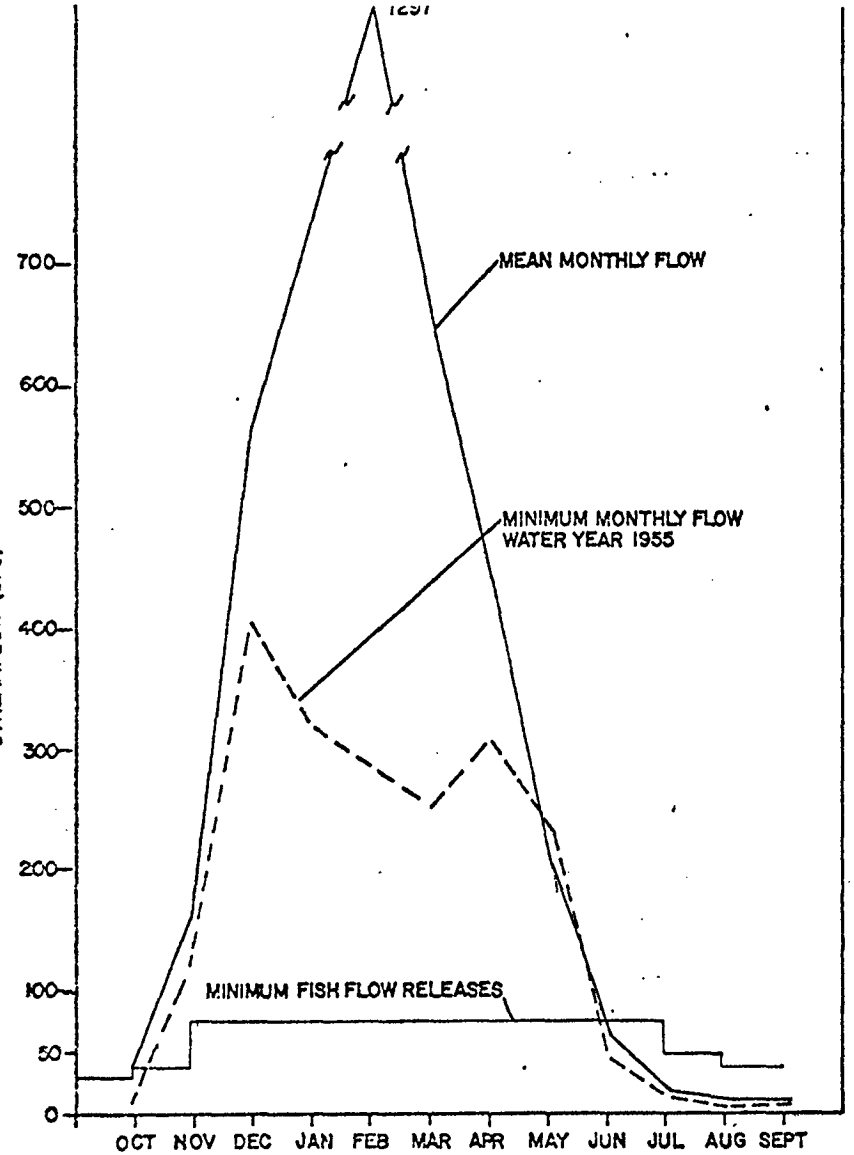
Source: California Department of Fish and Game, 1968.

and operates a king salmon, silver salmon and steelhead hatchery. The Mad River hatchery began operating in 1967 and was intended to supplement natural reproduction of salmon and steelhead in other coastal streams as well as the Mad River. Total production for king salmon, silver salmon and steelhead in 1974 was about 1,900,000 fish, averaging close to one ounce each. This is a department-owned installation and is not part of any water projects mitigation feature.

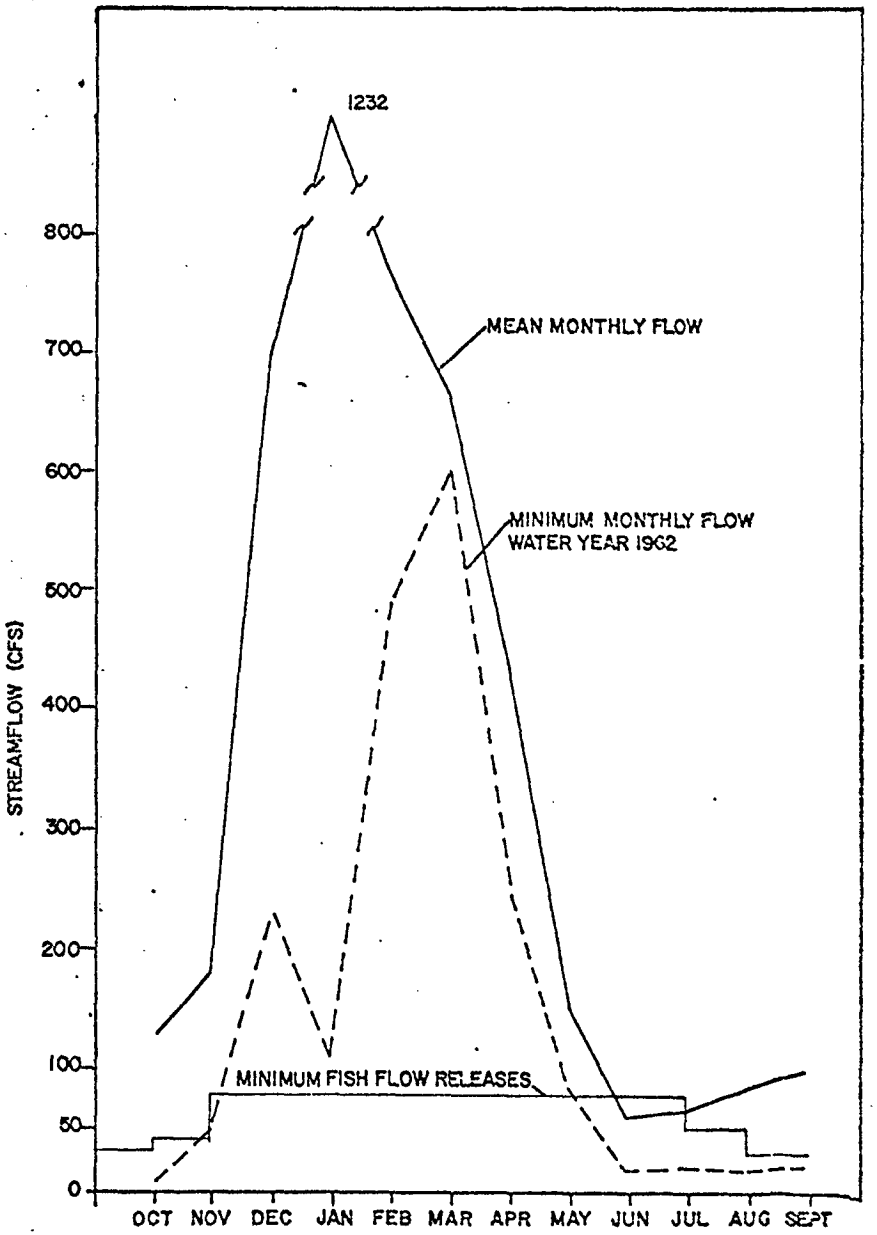
II. Pre-Project Conditions

The Mad River, like other streams in the north coastal area, has high precipitation and runoff during the winter and spring months. A dry season occurs from May to October, thus natural stream flows during the summer and fall are generally low (Figure 2). Occasionally during the dry time of year the entire flow in sections near the mouth would be under the gravel, leaving dry stretches of channel (Department of Fish and Game, 1958).

The most important pre-project Mad River fishery resources from the standpoint of recreation and economics are the anadromous fish populations. The three major anadromous fish using the spawning grounds and nursery habitat of the river are the king salmon, silver salmon and steelhead trout. Other anadromous fish, such as coastal cutthroat and sturgeon, are present in smaller numbers.



PRE-PROJECT: OCTOBER 1953—SEPTEMBER 1960
GAUGE STATION NO. 4605
SOURCE: USGS WATER SUPPLY PAPER 1735



POST-PROJECT: OCTOBER 1961—SEPTEMBER 1973
GAUGE STATION NO. 11480500
SOURCE: USGS SURFACE WATER RECORDS VOL. I

FIGURE 2
STREAMFLOW CONDITIONS, MAD RIVER
RUTH RESERVOIR

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Rainbow trout are important resident fish in the upper reach of the river and in most of the upper watershed tributaries.

The upstream migration of most of the salmon and steelhead begins with the onset of heavy fall rains. At the time of entry into the Mad River estuary, during minimum flow years, the migration is influenced by a sand bar at the river mouth. In years when the mouth is not blocked by the sand bar, king salmon are usually the first species of salmon found migrating upstream, sometimes as early as August. Often the migration is blocked farther upstream where the flow of the river is not sufficient to provide a surface flow (Department of Fish and Game, 1958).

Silver salmon and steelhead trout do not enter the Mad River in large numbers until the streamflow rises to higher levels. The migration and spawning activities usually peak about a month after those of the king salmon. Steelhead migration continues through the winter months with most of the spawning activities taking place in late winter or early spring.

On the main stem of the Mad River about halfway between the river mouth and the present Ruth Dam site, a 2-mile section of river channel is composed of large boulders with

a 25-foot fall at the head of the section. This fall, near the confluence of Wilson Creek, is the upstream limit of anadromous fish migration (see Figure 1). Another similar barrier is present on the North Fork Mad River as shown on Figure 1. The removal of these natural barriers would approximately double the spawning habitat for salmon and steelhead.

A partial barrier to fish migration was Sweasey Dam located 17 miles above the river mouth (see Figure 1). The dam, owned by the City of Eureka, was built in 1938 and demolished in 1970 because of excessive sedimentation in the reservoir and non use. Sweasey Dam was equipped with a fish ladder and an unscreened diversion that continuously conveyed a little over 5 cfs to the City of Eureka (USGS, 1960).

The effect of Sweasey Dam as a partial barrier to migrating fish and the efficiency of the fish ladder is not fully known. The dam has been a complete barrier to fish during flood flows on the Mad River when the fish ladder has been completely destroyed or made difficult to ascend. The ladder was destroyed once in 1955 by flood flows and was not repaired until the following season.

In 1938 the Department of Fish and Game began counting upstream migrant fish passing over Sweasey Dam. These counts are some measure of pre-project fish populations in the Mad River, but do not provide a direct indication of fish populations using downstream spawning grounds.

Pre-project counts taken at the dam showed a significant decline in the populations of salmon and steelhead using the spawning grounds between Sweasey Dam and the barrier falls near Wilson Creek. The king salmon spawning run dwindled from a peak of 3,139 fish in 1941 to only 19 fish in 1959. The small number of fish counted in 1959 could be the result of the flood flows that occurred in 1955 which adversely affected migration and egg survival. Steelhead trout runs declined by almost 50 percent from the late 1930's to the years immediately prior to the construction of Ruth Dam in 1961.

The mean number of king salmon passing over Sweasey Dam from 1938 to 1958 was 756 fish annually. The range of the annual counts was from a high of 3,139 in 1941 to a low of 19 in 1959. The number of upstream migrants peaks in the month of November.

The Department of Fish and Game conducted a tagging study during two spawning seasons to estimate the size of the king salmon run on the Mad River. From the results of the study, it was estimated that on the average, about 5,200 king salmon spawn on the Mad River (Department of Fish and Game, 1958).

The average number of silver salmon spawning above Sweasey Dam was 322 fish annually from 1938 to 1954. The range during this period was from 725 in 1939 to a low of 59 in 1954. Although no tagging studies were conducted, the Department of Fish and Game estimated that 2,108 silver salmon spawned annually in the Mad River.

pre-project dry year flow (1955) of 5 cfs (Figure 2). An anticipated minimum flow of 37 cfs was to be provided in the river below the HBMWD diversion. This would represent a greater flow than the pre-project minimum when the riffles would be almost dry at times. The Department of Fish and Game did not know whether the project flow would keep the river open to the ocean. It was conceivable that the sand bar would still obstruct the mouth of the river during years of light rains in the late fall and early winter months (Department of Fish and Game, 1957). The Department of Fish and Game in its 1957 report stated that: "Provisions should be made so that adequate amounts of water could be released from Ruth Dam to break the sand bar and keep the mouth open until natural stream flow is sufficient to do so". It had to be determined what minimum stream flow would be required and the optimum timing of the minimum in-stream flow requirements needed to provide passage at the mouth.

The water district's plan of operation for Ruth Reservoir was to impound water during winter rains and release water during summer and fall months. At the storage phase of the reservoir, no water would normally be released; stream flow accretion below the dam site was expected to provide an adequate amount of stream flow for the HBMWD intake 70 miles downstream. The Department of Fish and Game recommended (1958) that a minimum stream flow release of 5 cfs be made from Ruth Dam to prevent stranding immediately below the dam and maintain a surface flow along the upper river channel.

When Ruth Dam was constructed in 1961, the Department of Fish and Game negotiated an agreement with the HBMWD that established terms for the protection and preservation of fish and wildlife and partial compensation for the loss of spawning beds inundated by the reservoir (spawning beds that could be used after removal of the barrier falls).

To prevent stranding of fish in the river channel below Ruth Dam during the time that water is to be impounded, a constant release of 5 cfs from the outlet of the dam was required in the agreement. This flow would be augmented by releases at the dam for downstream diversion at Essex and maintenance of surface flows at the river mouth.

The department further required that waters would not be stored in Ruth Reservoir when flows to the ocean below the HBMWD diversion are less than the following:

Month	cfs
October	40 cfs
November to June	75 cfs
July	50 cfs
August	40 cfs
September	30 cfs

Records of in-stream flow release negotiation did not reveal the reasoning behind this particular flow release recommendation. It must be assumed that these minimum in-stream flows were to provide anadromous fish with transportation

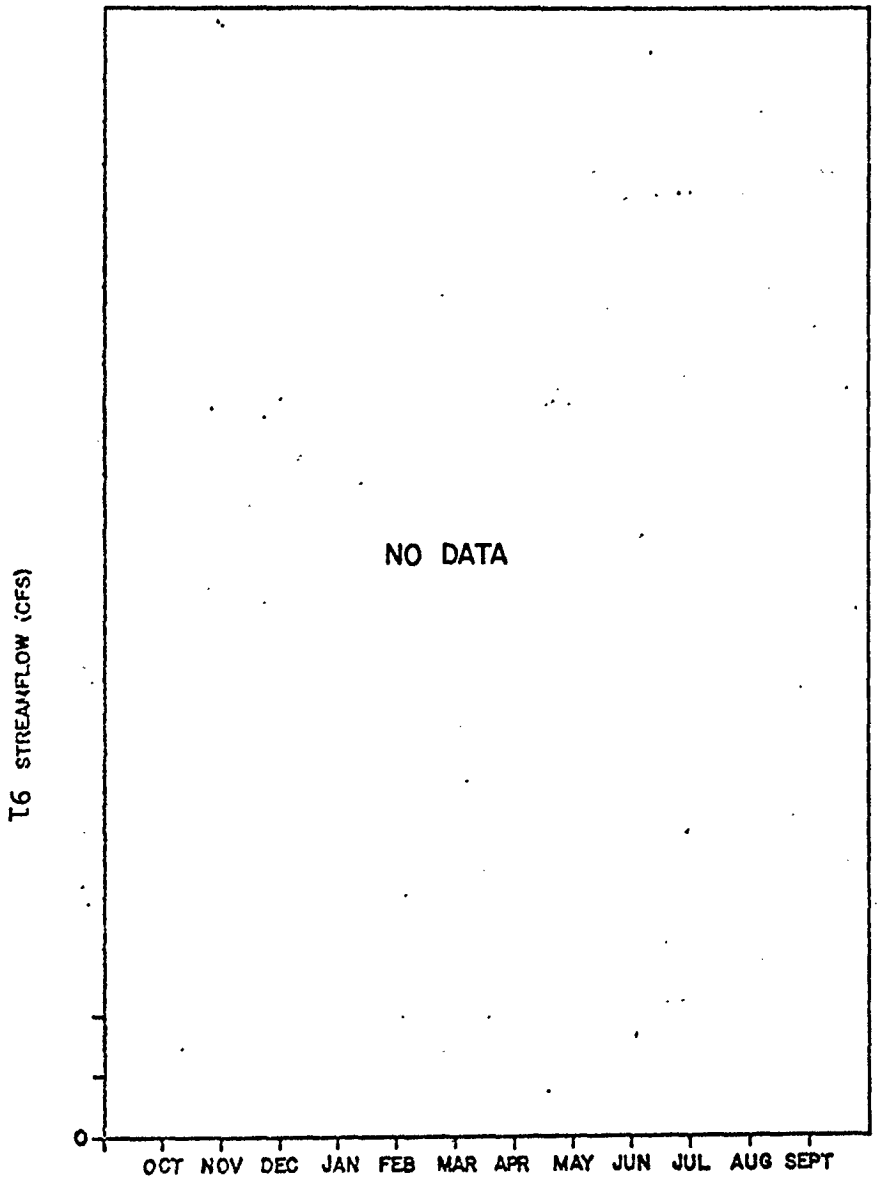
flows at the sand bar and along the lower 9-mile reach of the river. Year-round minimum flows to the estuary section of the river would provide habitat for estuarine and salt tolerant species of fish.

A final term of the minimum fish flow agreement signed by HBMWD required that the agreement be incorporated in the terms of the State Water Rights Permit that was issued to the district.

IV. Post-Project

The operation of Ruth Dam provided for greater stream flow in the Mad River in late summer and early fall over pre-project conditions. The stream flow hydrograph (Figure 2) illustrates this increased flow during the dry time of year from Ruth Dam to the HBMWD intake. The stream flow to the ocean, nine miles below the intake has averaged 60 cfs during the late summer and early fall (see Figure 3). This flow regime improved conditions at the river mouth and in the estuary.

The Mad River estuary, located about 6 miles below the HBMWD intake, provides habitat for some of the more important fishery resources of the Mad River. The in-stream flow requirements below the diversion provide for the maintenance of the anadromous fish populations and other species of fish using the estuarine habitat, i.e., starry flounder, ocean perch, sculpin. When the flows to the ocean below the intake are



PRE-PROJECT:
GAUGE STATION NO.
SOURCE:

POST-PROJECT: OCTOBER 1963–SEPTEMBER 1973
GAUGE STATION NO. USGS 11481000
SOURCE: SURFACE WATER RECORDS VOL.I

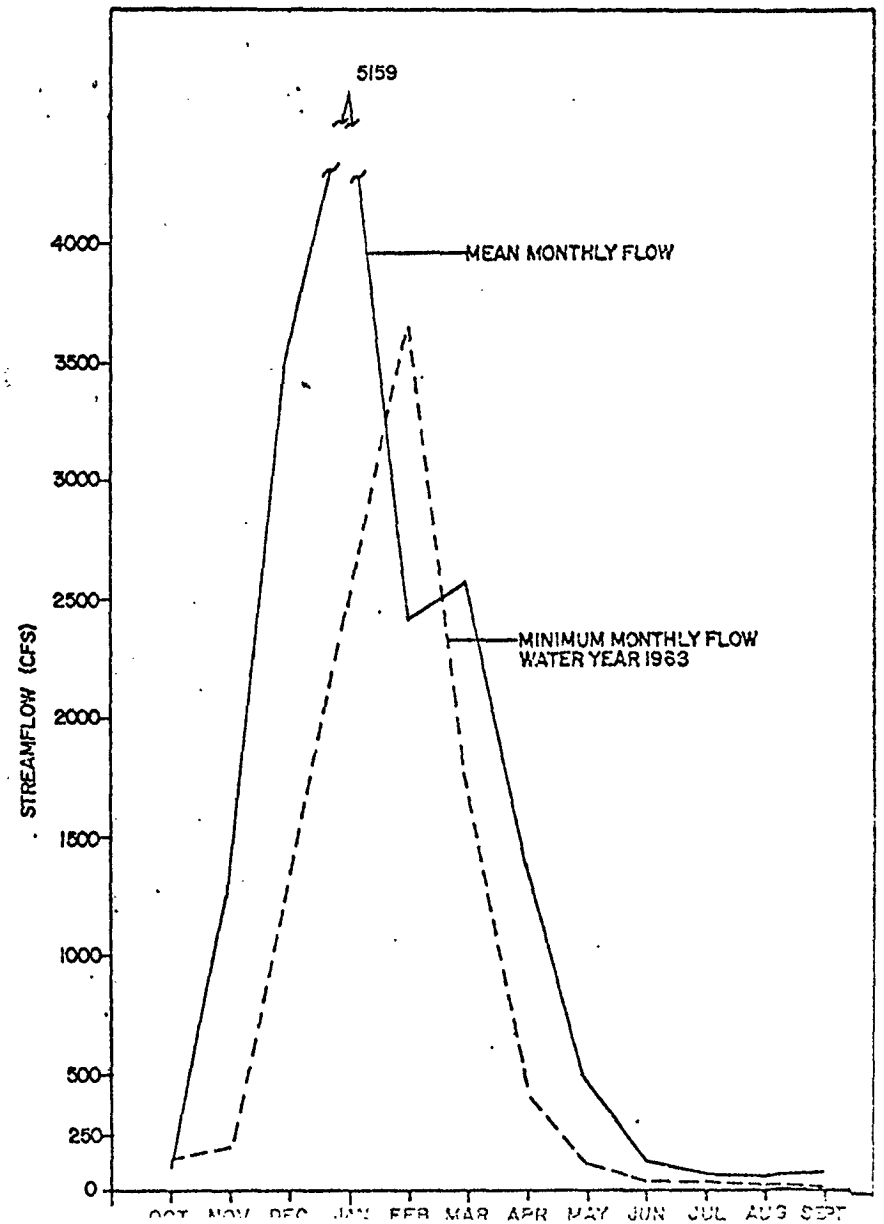


FIGURE 3
STREAMFLOW CONDITIONS, MAD RIVER
BELOW ESSEX INTAKE

greatly reduced, salt water penetrates farther upstream and changes the salinity gradients present in the estuary.

The estuary, with its salinity gradient, serves as an acclimatization and holding area for returning as well as out-migrating salmon, steelhead and coastal cutthroat. It is also an important rearing area for seaward migrant juvenile king salmon and of lesser importance to the juvenile silver salmon and steelhead. Streamflows into the estuary deliver nutrients and provide habitat for several other species of fish.

Estimates of population size for Mad River salmon and steelhead runs occurring after the operation of Ruth Reservoir were not found. Estimates of the numbers of fish that could be accommodated by the available spawning gravels are: 1,000 king salmon, 8,000 silver salmon and 6,000 steelhead (U. S. Army Corps of Engineers, 1972). These estimates were based on the assumption that a permanent natural barrier to upstream migration exists 50 miles above the river mouth (see Figure 1).

Salmon and steelhead counts taken at Sweasey Dam showed a sharp decline in the spawning runs in the years immediately before the construction of Ruth Dam. The runs never fully recovered from this decline until the Department of Fish and Game began operating the Mad River hatchery in 1967. Fish artificially spawned at the hatchery supplement the natural reproduction in the river.

The lack of recovery after increased flows is not clearly defined. The presence of Sweasey Dam during pre-project conditions undoubtedly had an undesirable effect on anadromous fish migrations. Although the dam had a fish ladder, it generally caused stress on upstream migrating fish and limited their passage during times of exceptionally high flows. Since removal of the dam in 1970, some observations indicate increased steelhead runs into the upper reaches of the river and increased use of king salmon spawning areas in upstream reaches where they had rarely spawned in previous years. It is unknown what contribution the Mad River hatchery has made to this increased range of the upstream migration. The relatively short period of time since 1970 does not permit a realistic assessment of recent trends.

Another factor preventing salmon and steelhead from reaching their full potential is the suspended sediments in the waters of the river and its tributaries. This condition results from the combination of an unstable watershed and logging and road construction. The loss of spawning gravel due to the sedimentation of fine materials and associated changes in stream flow regime have eliminated much spawning habitat. In addition, unpredictable phenomena such as the exceptionally severe storm of 1964, when many of the stream channels were scoured while others had sediment deposition up to 8 feet in depth, has had effects on the fish habitat.

Another source of turbidity is the discharge from Ruth Reservoir at the base of the dam. The outflow is exceptionally turbid (usually in excess of 15 JTU). The turbidity from this source is discernible as far as 22 miles downstream from the dam.

The persistent high turbidity levels in the river below Ruth Dam have adversely affected aquatic plant production, degraded the habitat of bottom-dwelling organisms and have interfered with the feeding activities of fish.

Available USGS records show that the Mad River basin is one of the highest silt-producing basins in the United States (U. S. Army Corps of Engineers, 1972). The total sediment yield from the river's entire drainage is about 1,070 acre-feet per year.

V. Conclusion

The storage of winter runoff by Ruth Dam has provided an increased instream flow in the Mad River as compared to the pre-project natural streamflow condition (see Figure 2). The increased streamflow assists in the maintenance of a salinity gradient and associated habitat in the Mad River estuary.

Apparently the minimum flow of 5 cfs immediately below Ruth Dam provides a survival habitat for some fish.

Insofar as can be determined, no investigation was made to determine an ecologically required minimum flow.

The winter minimum flows below Humboldt Bay MWD water intake have created created more stability in the tidal portion of the river although this general effect was not quantified. It is assumed that it has improved conditions for the migrations of anadromous fish during dry years and during years when rainfall does not start until late autumn. The project permitted Sweasey Dam to be removed, and this dam was a serious impediment to salmon and steelhead migrations.

Turbidity increases in the Mad River below Ruth Dam were not anticipated. Releases from Ruth Reservoir added additional turbidity to the Mad River and this condition has adversely modified downstream trout habitat.

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