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R890512

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^{1/} August 15, 1941. Stanford University, California

INTRODUCTION

The essential function of the California State Division of Fish and Game is to insure the exploitation of the State's fish and game resources in such a way that the maximum sustained yield will be obtained. In this task the several Bureaus of the Division have their special functions to perform. It is the function of the Bureau of Fish Conservation to provide the maximum in the way of sport fishing in the inland waters.

In order to fulfill its function, the Bureau of Fish Conservation must possess certain knowledge. This consists of (1) a basic knowledge of the life histories of the fresh-water and anadromous fishes, (2) a basic knowledge of the streams and lakes of the State, (3) a knowledge of the fisheries in existence and of the wants of the fishermen, and (4) a knowledge of the methods by which the stock of fresh-water fishes may be maintained and the desired type of fishing supplied to the anglers. As this knowledge is accumulated, it will be possible to modify the practices now in existence and to put into effect new practices. Once the worth of the recommended practices is decided upon, limiting factors in their execution will be legislation, funds, and man power.

Several approaches to the gaining of the needed knowledge and to its application are possible. In order to gain the desired knowledge and also to help plan its application, the Bureau of Fish Conservation maintains a staff of biologists. Five large areas of the State have been designated biological districts, with a biologist assigned to each one, and it is the special function of each district biologist to study and solve the problems in his district.

The applied program of the Bureau of Fish Conservation consists of a broad program of propagation and stocking of game fishes, of fish rescue, and recently, to a limited extent, of the physical and biological improvement of fishing or nursery waters.

As an example of an area in which studies have been continued over a period of years we may consider the coast district, which as now constituted includes all of the coastal streams from Monterey County north through Del Norte County, exclusive of the Sacramento-San Joaquin drainage. Many of the problems within this coastal area are common to a number of the streams. Primarily, these problems deal with three species of native fishes, the Steelhead Trout, King Salmon, and Silver Salmon and, in Del Norte and Humboldt counties, also with the Cutthroat Trout. The Steelhead Trout is a game fish only and is taken in the immature stage in the streams and in the adult form in the streams and at sea. The salmon are primarily of commercial importance, but are caught as game fish as adults both in the streams and at sea.

The problems that concern the Steelhead Trout have been well presented in a paper by A. C. Taft (1933). (See bibliography at the end of this report for titles of cited references.) The main problem is that the intensive fishery creates too great a drain on this species by taking both adult and immature fish and that most of our coastal waters get so low during the summer months, because of a dry season, that they can support only a limited population of fish of angling size. With the two species of salmon, the main task is not to provide angling for the immature fish, but to maintain a sufficient stock of young fish and to insure their exit to sea, so that the resulting adult fish will provide runs of sufficient size to maintain a sport fishery.

In order to meet these problems several lines of attack have been followed. An experimental stream, Waddell Creek, has been set aside to study the life history of the Steelhead Trout and Silver Salmon under natural conditions. In several other streams, the Klamath River, Eel River, Scott Creek, San Lorenzo River, and Santa Ynez River, marking and tagging experiments have been carried on to study the life history of the steelhead and two species of salmon and the effectiveness of stocking practices. In the Klamath River, Eel River, Scott Creek, and San Lorenzo River, counts have been made of downstream and/or upstream migrants. Creel censuses have been conducted on all of the above-mentioned streams and in other streams as well. Stream surveys have been made of many individual waters and more intensive surveys have been made of the Klamath River system (exclusive of the Trinity River drainage) and of the Eel River system. A program of general stocking has been carried on throughout the coastal area, wherever it was felt it was most needed. In late years (especially as a result of the surveys) programs of fish rescue and stream improvement, the latter consisting mainly of stream clearance and small stream channel improvement, have been instituted.

As a result of these studies in the coastal area, a large store of knowledge, of the type that it was pointed out previously is needed to provide the maximum sustained yield, has been accumulated. In a number of instances recommendations for the solution of problems that have been studied have been made. In some instances these recommendations have been carried out; in other instances, even when approved by the central office of the Bureau, they have not been carried out. When they have not been carried out, it has most often been due to the lack of one of three things:

(1) proper legislation, (2) man power or funds, and (3) lack of time of those in supervisory positions to put the recommendations into effect. It is generally true, then, that although new problems will undoubtedly continue to arise in the various biological districts and some of them will require immediate solution and action, there has already accumulated more to do than there has been time, money, or men with which to do it.

Particularly following the extensive surveys of the Klamath River watershed (1934) and the Eel River watershed (1938) programs of legislative action, stocking, screening of diversions, water use, fish rescue, and stream improvement were formulated. For the reasons cited above, only a limited portion of these programs has been put into effect.

Obviously, unless conditions change or unless portions of the programs are shown to be otherwise at fault, the unfulfilled recommendations should be put into effect as rapidly as possible. There are several possible approaches to putting the recommendations in effect and to meeting new problems as they arise.

One of the approaches is to follow essentially the same organization as now in effect, modifying the applied practices (stocking, fish rescue, and physical and biological stream and lake improvement) as legislation, supervision, funds, and man power permit. Under this system of organization each district biologist would continue surveys of the streams and stream systems not yet surveyed, paying special attention to those now stocked, until the entire area in each district was covered at least in a preliminary way, and would continue to meet the special problems of his area as they arose. The advantage of this organization

is that the problems most in need of attention over a wide area may be faced as they arise. On the other hand, one of the main disadvantages of this system is that there still remains a system of multiple supervision even within a small area. The biologist and his assistants make an investigation and their recommendations, but the execution of these recommendations depends, even when funds and man power are available, on regulations that must be passed by the Legislature and enforced by another Bureau, on stocking that is directed in a general way from the central office in San Francisco but is under the supervision of a hatchery superintendent or foreman not under the direction of the biologist, upon fishway installation and fish screen installation that is under the direction of another Bureau, and upon general management practices which sometimes are and sometimes are not under the direction of the biologist.

An alternative to the present system would be the creation of fish management areas, in which practically all phases of the management program would be under the immediate direction of a management area supervisor. These management areas would correspond approximately to the biological districts now in effect, plus additional areas not now included in biological districts or created by the subdivision of districts that are now too large. At the present time it appears that such a program is so far in the future that it is not profitable to discuss details of its operation in this report.

A plan with more hope of immediate realization appears to be that of the creation of fish management areas mainly for the purpose of better coordinating the activities of the Bureau of Fish Conservation alone. The

advantages of a fish management area even of such limited scope appear to be that through such coordination of the activities of the Bureau certain phases of its work, such as fish rescue, stream improvement, creel censuses, stream censuses, and fish planting, could be operated on a more intensive scale and in a better-planned way, with emphasis shifted from any of them to any others as results obtained in the form of fluctuations of the stock of fishes, conditions of the streams and lakes, and the success of angling indicated.

If such a fish management area is tried out on an experimental basis it should be composed of some area in which multiple land and water use are least prevalent^{and} in which many of the waters are situated in public lands, so that results of the program will be easier to analyze and there will be greater control over the stock of fishes. At the present time it appears that of the major drainage basins in California the Eel River system best meets these requirements and is therefore best suited to be tried out as a Bureau of Fish Conservation management area. A considerable portion of the waters lie in State Park or National Forest land, the amount of land available for agricultural use is quite limited, there is practically no mining or oil development, very few diversions, and a limited permanent population, with no areas suitable for the growth of large cities. The principal uses of land are for lumbering and grazing. These have had a serious effect on the streams by creating erosion, with greater floods, lower summer flows, and higher summer water temperatures. The number of diversions of water and projects for the large-scale use of water are few, but the several that are present (Scott Dam at Lake Pillsbury, Cape Horn Dam at Van Arsdale Reservoir, and Benbow Dam) have had a serious

effect on the stream system and the fishes present by cutting off considerable spawning areas and reducing summer flows, with higher summer temperatures as a result of the latter. Some major land or water use is in effect ~~in effect~~ in practically every area of California, however, and must be accepted and incorporated in the management area programs.

Now that the general plan of fish management areas has been presented, it is only prudent to consider the obstacles that may stand in the way of the successful operation of a fish management area in California at the present time. In general, the obstacles may be placed in two categories, (1) those arising from lack of control and (2) those arising from lack of funds or man power.

(1) Obstacles arising from lack of control.

If an area is to be completely managed it must be controlled. Under present conditions the Division of Fish and Game and the Bureau of Fish Conservation do not have control over any sizable area. They do not have legislative control. Seasons and size and bag limits are set by the Legislature. Within the Eel River system a program of legislation designed to conserve the supply of fishes and maintain the maximum sustained yield was formulated (Shapovalov, 1939) and proposed to the Legislature, following the official approval of the majority of the sportsmen's organizations in the area, but was not passed by the Legislature. It was therefore possible only to put into effect a small part of the regulatory program through certain stream closures made by order of the Director of the Department of Natural Resources. How much more success a legislative program would meet if a management area were created, it is difficult to estimate.

The Division and Bureau do not have control over the land, except

in some limited phases. Many of the problems encountered and many of the ill effects on the fishes have resulted from the methods of lumbering, grazing, and water use in effect in the area. Deforestation through lumbering has caused erosion along the streams, greater floods, higher water temperatures, and lower water in the summer months. Grazing has had approximately the same effects. Water use has created several large dams that have impeded or blocked the runs of spawning fishes, destroyed spawning areas, diverted the natural flow of the streams, increased water temperatures, and caused fluctuation of the water, in large portions of the watershed. With the creation of a management area, control over these factors would not be assumed by the Division and the most that might be hoped for would be an alleviation of some of the ill effects resulting from them. This could be done in the form of construction of fishways and removal of barriers blocking spawning runs. However, on privately owned land the permission of the owners would have to be secured to carry out this program (likely in most cases it would be granted, since most of the improvements to the fish and to fishing would also benefit the property owners). However, without additional legislation there would be no guarantee that the harmful practices would not be repeated nor that the waters would not be closed to public fishing.

Also, the management area would be only a Bureau of Fish Conservation management area, and not a Division management area. The work of the other Bureaus affecting fishing in the area, such as law enforcement, would not be under the control of the management area supervisor and would depend upon the funds and man power furnished by the other Bureaus and upon the cooperation secured from them.

Problems Common to the Coastal Streams

Of several problems common to the sport fishery in nearly all of the coastal streams of California, one of the most serious is the catching of a large proportion of small trout. Since these small trout are as a rule the young of the sea-run steelhead, and since it is the desire of many anglers to catch the adult fish, it becomes obvious that to a greater or less extent a choice will have to be made between an intensive fishery for the immature trout or for the adults. Once the biological facts have been determined, and in this case they have been determined as regards the essential phases of the life history of the steelhead, then it is largely a matter of establishing the proper seasons, with the elimination of the summer season or the winter season, or a combination of the two seasons that will be consistent with sound conservation principles. In other words, conservation of the steelhead is now dependent primarily upon the enactment of protective legislation.

However, all possible ways of providing a greater proportion of larger trout during the summer fishing season, if the latter is retained, should be explored. This problem might be approached from three angles:

- (1) Protective legislation, such as a delayed opening of the fishing season, enabling many of the small trout to escape to the ocean before becoming available to anglers, and as a result leaving a greater proportion of larger fish when the season opens. This has already been tried by the June 1 opening on the Eel River and neighboring waters. Creel censuses should be conducted to study the size composition of the fish during various portions of the fishing season.

- (2) The planting of non-migratory trout, or at least trout with a strong tendency to remain a longer time or to maturity in the streams. Such fish should be marked before planting and should be planted only if returns may reasonably be expected. There is no point in the Eel River system which at present appears a suitable place to secure such returns. Planting of ~~marked~~ fish of a supposed non-migratory strain (Mt. Whitney Rainbow) was carried out in another coastal steelhead stream, the San Lorenzo River, and returns on this marking may provide data of considerable interest in regard to this whole problem.

The first part of this approach to the problem may be called the development of a non-migratory strain of a native species. The second part, the planting of non-migratory alien trout, should be tried only if other phases of the experimental program fail to produce satisfactory angling. The Eel River system is fortunate in having almost no alien species of trout in it.

- (3) The environmental improvement of the streams, to encourage the native steelhead trout to remain in the streams for a longer time, so that fish that would normally migrate to sea as one year olds would tend to stay until they were two year olds, those that would normally migrate as two year olds would tend to stay until they were three year olds, and some fish would tend to stay to maturity, thus becoming "resident" fish. In order to carry out this approach with some certainty of method, it would be highly desirable to have more knowledge regarding two points, namely, (a) the possibility of environmental improvement and (b) the factors that influence our steelhead trout to behave in any given manner. Under the first point

comes the development of stream improvement devices that are suitable to our coastal streams from the points of view of durability and creation of desired effect. These devices should probably be of the kind that create holes by a digging action. An experimental program to determine the most suitable types of such devices and to study their mechanical action and influence on fish was started at Waddell Creek in 1940. Since this stream has already been studied and living quarters established, and since the stream is of a size quite suitable for the installation of such devices, being so low during the late summer that devices may be easily installed, and reaching such flood stage that the stability and durability of such devices may be tested thoroughly, and since the use of the stream for experimental purposes has been offered for an additional period of years, it appears that from the point of economy of both money and effort this phase of the program may best be carried out in Waddell Creek. Under the second point come the determination of what causes a Steelhead Trout to migrate to sea at a given age or remain to become a "resident" fish, and of what determines whether a Steelhead Trout or salmon will return to spawn as a grilse (a fish with only one growing season spent at sea) or as an "adult" (a fish with two or more growing seasons spent at sea). Studies at Waddell Creek, some that were instituted near the start of the experimental program and some that were begun only in 1940, are designed to shed light on these questions. Until we have a grasp of the answers to them, it hardly seems profitable to expend money and effort on those phases of an experimental program the formulation of which (the experiments themselves) depends

upon knowing the answers to these questions. In other words, the design of any experiment or experimental program is dependent upon the character of the knowledge already possessed.

Problems Specific to the Eel River Drainage

In addition to the problems common to many of the coastal streams of California, local problems are encountered. Throughout California as a whole, and to this the Eel River system is no exception, there are certain subjects or certain waters that are "sore spots" with the anglers. These are subjects or waters that are "problem children" for the Division of Fish and Game, and create heated discussion year after year. The Eel River has several of these, as follows:

1. Bannock Dam Fishways.
2. Fishway at Cape Horn Dam at Van Arsdale Reservoir.
3. Blocking of Spawning Grounds by Scott Dam at Lake Pillsbury.
4. Debris and Pollution in the Streams in and about Little Lake Valley, near Willits.
5. Flow in Eel River below Van Arsdale Reservoir, to Confluence with Middle Fork of Eel River.
6. Spearing of Spawning Runs of Salmon and Steelhead in Lower Eel River.
7. Teaching for Immature Trout, Especially Prior to the Opening of the Summer Fishing Season (April-May).
8. Death of Trout During Hot Spells, Especially in South Fork of Eel River between Dyerville and Rattlesnake Creek and in the Main Eel River between Dyerville and Bell Springs Station.
9. Pollution from Creameries near Ferrale.

All of the above subjects have already been investigated and reported upon, and recommendations made in previous reports. In a few

who have operated the fishways at Benson Dam (Vestal, Taylor, Weger, Woodruff,

in various reports illustrated by diagrams and photographs, the men

Recommendations.

Benson Dam have not functioned in entirely satisfactory fashion in the past.

more, it was pointed out in this and other reports that the fishways at the movement of upstream migrants to a greater or less extent. Further- a fact is Benson Dam, even with the best fishways possible, will hamper in the more-mentioned report it was pointed out that any dam of as great The north fishway was blocked by slides during the entire season. However, when 44,072 adult salmon and steelhead passed through it, by actual count. through the south fishway at present was shown during the 1940-41 season, information or on interpretation of the facts. That they can not pointed out that much of this criticism was not based on facts, but on Benson Dam. In my general report on the Del River (Shapovalov, 1939) I tion in the existing structure and the operation of the two fishways at numerous specimens and others have many times expressed dissatisfaction-

The Problem.

1. Benson Dam Fishways.

recommendations made, and action taken is here presented. tions have been allowed to be dominant. A summary of the problems involved, definite policy adopted in some cases; in other instances the recommendation- action of the Bureau of Fish Conservation, such action has been taken or a those cases in which solution of the problems has been dependent upon the on cooperation of agencies other than the Bureau of Fish Conservation. In instance satisfactory solution of the problem is dependent upon the action

and Gilman) and I have made specific recommendations for the improvement of both the south and north fishways.

Action.

In October of 1933 the Division of Fish and Game made changes to the north fishway at Benbow Dam which improved matters there to some extent, but this fishway still does not function satisfactorily, even when not blocked by slides. The north fishway was blocked by slides during the entire 1940-41 season and because of the loose character of the bank and drainage from above there will be a likelihood of it being blocked in future years. Falling rocks, caused by drainage and earthquakes, will be a constant source of danger to the lives of men counting fish at the north fishway.

None of the recommendations regarding improvements to the south fishway has been carried out. The men operating this fishway have regulated and directed the flow at the entrance to the fishway by temporary installation of sand bags and boards.

2. Fishway at Cape Horn Dam at Van Arsdale Reservoir.

The Problem.

During the past few years, at least, the fishway at Cape Horn Dam has not operated satisfactorily. The fish have had difficulty in entering the ladder and ascending it and have been badly battered in being tossed around on the rocks below the dam and in trying to enter the fishway.

Recommendations.

The improper functioning of the fishway at Cape Horn Dam was cited by me in my general report on the Eel River (Shapovalov, 1939). On several other occasions I have submitted suggestions for improvement, together with diagrams and photographs.

Action.

The entrance to the fishway was repaired in December of 1938 by the Division of Fish and Game. Following this the fishway again did not function properly and in 1940 more work was done by the Division, with several concrete walls installed. However, during the season of 1940-41 the fishway still did not function satisfactorily and the fish entered the tanks of the Snow Mountain Egg Collecting Station, located at the dam, in a badly battered state.

3. Blocking of Spawning Grounds by Scott Dam at Lake Pillsbury.

The Problem.

Scott Dam, forming Lake Pillsbury, has no fishway over it and has cut off some of the best spawning grounds in the entire watershed (Gravelly Valley). Formerly salmon and steelhead ran past the site of the dam to spawn. Now no King Salmon pass even through the fishway at Cape Horn Dam, perhaps partly because the entrance to the fishway does not function satisfactorily at low water. At times considerable numbers of sea-run steelhead concentrate below Scott Dam.

Recommendations.

In our 1933 report Elden H. Vestal and I recommended that a fishway be constructed over Scott Dam and designated this a project of major scope and importance.

Action.

No action has been taken in regard to the building of a fishway over Scott Dam.

4. Debris and Pollution in the Streams in and about Little Lake Valley, near Millits.

The Problem.

From the neighboring forested hills a number of small streams descend into Little Lake Valley and unite to form Outlet Creek, which in turn flows into the Eel River some 17 miles below. The gradient throughout Little Lake Valley is very slight, so that instead of cutting a deep channel through the valley the streams that enter it have a natural tendency to meander and spread out. It is only near the lower end of the valley that Outlet Creek has cut a definite channel, and even there the gradient is slight and the water does not push through with great force. During periods of heavy rains the streams flowing into Little Lake Valley flood the large, open meadow below the town of Willits, forming a temporary lake. At times the water may be three or four feet deep for several days. Salmon and steelhead ascending from the ocean enter this lake and run into the small streams entering it, to spawn. There was probably never a definite channel through the meadow, because of the slight gradient, but the situation has been greatly aggravated by the accumulation of all sorts of rubbish and debris in the lower courses of the small streams entering the valley and by the construction of picket fences across them. As a result the channels of these small streams have filled in in their lower courses and fish in the temporary lake have difficulty in locating them and in fighting their way through to the spawning grounds. The situation was still further aggravated by Willits city septic tank pollution.

Local sportsmen and other residents were greatly disturbed by the conditions described and requested the Division of Fish and Game to make an investigation. With local residents, I made a survey of conditions in November, 1937, and followed this with a full report (Chapovalov, 1937).

Recommendations.

Following our survey in 1937 local residents recommended that (1) the debris be cleaned out of the streams now blocked and clogged and (2) a channel be dug from the head to the lower end of the meadow. In my reports I pointed out that the problem was not only one affecting the fish alone, but a problem of multiple land use, with agricultural interests and State Highway 101 affected by the flood waters, and that therefore I did not believe it to be within the province of the Division of Fish and Game to carry out whatever work was feasible, but that the Division should encourage and approve any work that might be done to improve conditions. I stated that (1) pollution and dumping of debris and rubbish should be stopped and (2) debris and brush now clogging and blocking the channels should be removed. In regard to the proposed cutting of channels I pointed out that because of the slight gradient there was some doubt that a channel cut through the valley would work effectively and that it might be better to widen rather than deepen the channel and that Outlet Creek below the valley might be cleared of brush and debris, to permit greater getaway of the water. However, I pointed out that since the channel ran through the property of several individuals, their unanimous consent would first have to be obtained, and that whether the project was feasible from both the legal and engineering viewpoints would have to be decided by the proper authorities and by the persons concerned.

Action.

Following the survey I got in touch with Mr. Filbrick, in charge of the Northwestern CCC camp at Willits, who said that he would be quite willing to cooperate with the Division of Fish and Game in carrying out

any work that was "practical". He said that he considered the clearing out of brush, logs, and other debris from the beds of the various streams in Little Lake Valley as practical and would be very willing to do this work if the Division of Fish and Game or some similar agency sponsored the project. However, apparently no action was taken by any of the parties concerned and now apparently the camp has been abandoned.

I also got in touch with city officials and private individuals who were responsible for the dumping of rubbish and garbage in the streams and secured promises that no more dumping would be done. However, the last time that I visited it the Millits city dump was still located on the banks of Broadus Creek in such a place that high water swept cans and other refuse down the stream. I also called to the attention of officials the harm done by the dumping of brush and other materials by county road crews, the railroad, and other agencies.

After the survey of 1937 was made the city septic tank was replaced by a sewage disposal plant and a sewer system.

5. Flow in Bel River below Van Arsdale Reservoir, to Confluence with Middle Fork of Bel River.

The Problem.

Two dams on the Bel River have profoundly affected conditions for fish life in a large portion of the river system, the Cape Horn Dam, which creates Van Arsdale Reservoir, and Scott Dam, which creates Lake Pillsbury. Lake Pillsbury is a large storage reservoir of the Pacific Gas and Electric Company. Water is released down Bel River to Van Arsdale Reservoir, where it is diverted through a tunnel to a power plant in Potter Valley; part is then used for irrigation and the remainder flows into Last Branch of Russian River.

Through the major portion of the year the amount of water released from Lake Pillsbury is fairly constant (150 to 185 second-feet) and parallels the amount diverted from Van Arsdale Reservoir through the tunnel (175 to 190 second-feet). The amount of water released down the Del River from Van Arsdale Reservoir is quite small during the major portion of the year (1 to 3 second-feet). The minimum flow passing the dam at Van Arsdale Reservoir down the Del River during the water years 1937-38 and 1938-39 was 0.4 of a second-foot. Such a minimum flow is not sufficient to keep the trout and salmon occurring in the Del River below Van Arsdale Reservoir in good condition and at times during low water numbers of fish have died. This has caused many complaints by sportsmen and local residents.

Those complaining of existing conditions have stated that the natural flow of the Del River at Cape Horn Dam is not permitted to go down the Del River. Measurements of flow published in U. S. G. S. publications and estimates of flow made by Elden H. Vestal and me during our 1938 survey and reported on by me in full in a previous report (Shapovalov, 1940) bear out this contention. For example, as nearly as the picture may be drawn, on August 23, 1938, approximately 55 second-feet was entering Lake Pillsbury, 124 second-feet was being let out of Lake Pillsbury and flowing into Van Arsdale Reservoir, plus minor contributions from tributaries to the intervening stretch, 177 second-feet was being diverted into the Russian River drainage, and 1.7 second-feet was allowed to pass into the Del River below Van Arsdale Reservoir. It is apparent that considerably more water was entering Lake Pillsbury and would have constituted the natural flow of the Del River below the site of Van Arsdale Reservoir than was being released down the Del River from Van Arsdale Reservoir. This picture is

probably representative of conditions existing at these points during the dry season.

Recommendations.

Since only a statement of conditions had been requested, no recommendations were made in my previously mentioned report on this subject. From the viewpoint of the salmon and steelhead in the Del River drainage it would obviously be desirable that at least the natural flow at Cape Horn Dam be allowed to pass down the Del River at low water and it is recommended that everything possible be done to have the Pacific Gas and Electric Company let out such a flow.

Action.

Insofar as I know, protests to the Pacific Gas and Electric Company have been made by individuals and at certain critical times by the Division of Fish and Game, but no definite policy in regard to flow has been adopted.

6. Spearing of Spawning Runs of Salmon and Steelhead in Lower Del River.

The Problem.

In past years, at times of low water, especially in October and November, a great deal of illegal spearing of salmon and steelhead has taken place in the lower Del River, especially from Fernbridge to Fortuna. The species most affected has been the King Salmon. At times of low water this species congregates in the pools of the lower reaches of the river and attempts to pass upstream over the broad, shallow riffles, at which time the fish are speared, especially at night. On occasions the lower river has been lit up like a Christmas Tree from the lights of spearkers. The situation has aroused the anger of sportsmen, who on numerous occasions have demanded better law enforcement. The local warden has

done as much as he could, but to have effective control at least two or three wardens must work together in a group, approaching poachers from opposite directions. The problem is accentuated by the fact that patrol officers that might otherwise be available have been sent away with the start of the deer season.

Recommendations.

The situation cited was previously mentioned in my general report on the Del River (Shapovalov, 1939) and it was recommended that adequate law enforcement be provided. The recommendation is again made that in view of the importance of the problem extra men be sent in during critical periods to assist the local warden, even if the deer season is on.

Action.

Since my report was made some additional help has been assigned to the area during periods when needed and local sportsmen have stated that the situation was greatly improved during the autumn of 1940.

7. Poaching for Immature Trout, Especially Prior to the Opening of the Summer Fishing Season (April-May).

The Problem.

Local sportsmen report that there is a great deal of poaching on immature trout, especially during the months of April and May, prior to the opening of the summer fishing season. Some reports state that more trout are caught out of season than in season. Likely some of these reports maximize the situation, but undoubtedly there is a good deal of this type of poaching, especially along tributaries of the South Fork of Del River and in other portions of the Del River system extending through the Coast Redwood belt. Especially during the past decade numerous small lumber camps at which shakes, pickets, posts, ties, and tan bark oak are produced have been established in these areas.

These are not camps made up of single men, but of families. Many of these persons are migrants from the "dust bowl" and the camps operate with a slim margin of profit, so that these persons "live off the country" to a large extent.

Recommendations.

In my general report in 1939 I stated that a sound program of management should include wise conservation legislation and good enforcement of this legislation when enacted. The Eel River system as a whole is not adequately patrolled, but that does not mean that is less adequately patrolled than some other sections of California. Poaching that is carried out for sport should be prosecuted vigorously. Every effort should be made to stop this type of poaching, through education and with the cooperation of sportsmen. On the other hand, the taking of fish and game for food is a problem that is inextricably tied up with our whole social and economic system and therefore can not be solved by efforts of the Division of Fish and Game alone. It is certainly wrong for large quantities of our natural resources to be destroyed for the support of a very few persons.

Action.

On the whole, I believe that poaching is somewhat less in extent than it was at the time of the 1938 survey. This has come about from abandonment of some of the small camps, with the coming of opportunities for employment elsewhere, and through education and better organized law enforcement. However, it would not be correct to say that any direct and concerted action has been taken to meet this problem.

3. Death of Trout During Hot Spells, Especially in South Fork of Eel River between Overtville and Rattlesnake Creek and in the Main Eel River between Overtville and Bell Springs Station.

The Problem.

Nearly every year during one or more hot spells during the low water period trout die in South Fork of Del River between Overville and Antlershane Creek and in the main Del River between Overville and Bell Springs Station. Some losses also occur in the Van Duzen River. In some years, as in 1938, the mortality is quite heavy. J. A. Sales (1938) stated that at that time approximately 50 per cent of all the young steelhead in fifty miles of the South Fork and fifty miles of the main Del were killed.

Sales found four diseases (Ichthyophtherius, bacteria in the mouth, fin rot and fungus, and copepods) to be present in the affected fish. However, I believe that high water temperatures are the primary cause of death, since the fish apparently die only during the hot spells. Many of the young steelhead become somewhat bleached and yellow in color and congregate at the cooler water coming from tributary streams. Paul A. Shaw (1939) found normal oxygen and pH (alkalinity) values at the time of mortality.

The high water temperatures occurring during mortality of young steelhead in the areas cited above may in some respects be called due to natural causes. But it is my belief that they are accentuated by (1) low water due to man-made causes and (2) exposure of the water to the sun due to man-made causes. The low water is created by the diversion of a large portion of the natural flow at Van Arsdale Reservoir, daily low water below Penbow Dam, caused by fluctuation at the power plant at the dam, and deforestation, caused by lumbering and by destruction of cover by sheep and cattle (both by eating and by trampling).

The water is exposed through deforestation and also heats up more than it would normally because it does become abnormally low in the streams and because it is exposed in the reservoirs (Benbow Dam, Van Arsdale Reservoir, and Lake Pillsbury).

Recommendations.

In my annual stocking recommendations made since the 1938 survey I have recommended that no fish be planted in the South Fork of Eel River between Dyerville and Rattlesnake Creek, as was formerly done, but instead be planted in the cooler section of the stream (above Rattlesnake Creek) and in the main Eel River below Dyerville.

It has also long been my thought that cutting of trees should be prohibited within a certain distance of any stream, say 50 feet to 50 yards, and it my recommendation that legislation to this effect be sought. Such legislation would not only be of help to important fisheries, both commercial and sporting, but would also be of great importance in preventing erosion, thus effecting flood control at the source, and in maintaining a more esthetically pleasing appearance of our streams for the many thousands of sportmen and vacationists.

That part of the suggested stream improvement work that consisted of the opening of the mouths of tributaries into the larger streams, uniting of divided channels at the mouths, and rearranging of rubble and boulders to make the mouths more accessible, was designed to permit the young steelhead to enter the cooler waters of the tributaries during periods of warm water in the main streams.

Action.

In 1940 steelhead were still being planted (75,040) in that section of the South Fork of Eel River that is subject to high temperatures.

In 1941 the allotment sheet instructed that the fish be planted in the South Fork of Del River above Rattlesnake Creek.

I have discussed my proposal to prohibit cutting of trees within 50 feet to 50 yards of a stream with several persons, but no action has been taken along this line.

Insofar as man power has been available, that part of the stream improvement program calling for the improvement of the mouths of tributary streams has been carried on. However, there has been a shortage of man power in the Bureau for this type of work.

9. Pollution from Creameries near Ferndale and Fernbridge.

The Problem.

The most serious pollution in the Del River system has occurred from the several large creameries along the lower Del River, in the vicinity of Fernbridge and Ferndale. This situation was brought under control in 1933 but in August, 1933, Elden H. Vestal and I noted that again considerable amounts of creamery wastes were being dumped into the Del and into Salt River, a branch of the Del.

Recommendations.

Strenuous efforts and constant vigilance should be maintained in order that all forms of pollution in the Del River be prevented. Any violations of the pollution laws should be vigorously prosecuted and the conditions immediately remedied.

Action.

The situation existing in August, 1933, was reported and remedial measures taken.

PROGRAM

General Considerations

Now that the problems facing the coastal area in general and the

Del River specifically and possible approaches to their solution have been presented, the program for a fish management area may be considered.

Headquarters.

There is no central location in the Del River drainage from which all or even a major part of the work could be carried out with the return of the personnel to the headquarters each day. The most that could be done in the way of centralization would be the location at one point of a hatchery, a central storehouse for equipment not in use, a laboratory and office for the man in charge, and living quarters for the personnel of the hatchery and for the man in charge. The other work is so scattered that the crews could not work out of the headquarters except at infrequent intervals. For example, the fish rescue and stream improvement crews would work in widely scattered areas and would have temporary quarters as they carried out their operations. The same would apply to the men doing creel census work. Possible headquarters for fish rescue and stream improvement work are discussed under those subjects on the following pages. The counting work at Benbow Dam should be continued, with headquarters for the crew at Garberville. At Cape Horn Dam, the Snow Mountain Egg Collecting Station should continue operations and the personnel attached to it would live there or in Potter Valley. The supervisor of the management area would have to be on the road, away from headquarters, most of the time.

The design and character of the living quarters, office, and laboratory depend upon whether the headquarters is to be considered as a permanent headquarters of the supervisor or a field headquarters. If it is to be considered a permanent headquarters, then provision should be

made for the construction of a laboratory with good light, running water, electricity (both for lighting and plugs), sufficient shelves to house both an extensive library and collections of fishes, aquatic organisms, and biological equipment. This laboratory should be entirely apart from a storeroom that would house nets and other equipment for fish rescue, stream improvement, and fish planting work. Living quarters for the man in charge should consist of a building equivalent to a fish hatchery superintendent's quarters. If the headquarters is to be treated as a field office that will be in use only a portion of the year, even if it is a large portion of the year, then the construction of the laboratory and office may be much simpler, for the basic library, collections, and biological equipment of the supervisor, such as microscopes, tabulating machines, permanent files (including stream survey files), and collections of scales and scale books may be kept at the permanent headquarters. At several of the hatcheries situated in the Coast Redwood belt the atmospheric conditions have been such that so much moisture has accumulated in the offices attached to the hatcheries that they have not been used by the men in charge for office purposes, but have been allowed to stand idle or have been used as work shops, with the office work done in the living quarters. Stationery and other papers have stuck together and been ruined. These problems are all intensified and magnified for a biologist, whose library is more extensive and may be of considerable value. Consideration should also be given to the effect on valuable biological equipment.

Supervision.

There should be attached to the management area in a supervisory capacity a man who thoroughly understands the use of dynamite and of

equipment, such as tractors, bull-dozers, large saws, and block and tackle, necessary for the large-scale removal of log jams.

The supervisor of the management area, or possibly the foreman of the stream improvement crews, should determine the need for stream improvement over the Del River system, especially of the annual type, such as divided channels of streams, log jams, and mouths of small tributaries blocked by sand and gravel bars. The need for improvement of existing fishways, the construction of new fishways, and removal of semi-permanent log jams has already been determined and listed for a number of projects in this area and further projects could almost certainly be lined up faster than the work could be carried out by the improvement crews.

The statements regarding location of places needing stream improvement also apply to fish rescue work, except that in rescue work, even more than in the "annual" type of stream improvement, it is largely a repeat proposition each year, that is, the same streams need work done in them each year. Depending upon seasonal climatic conditions, the opening and starting dates of this work may be advanced or delayed, and also there may be a lull in the work if a period of cool and foggy weather or showers sets in, but the general limits of the work may be determined fairly accurately in advance. The main points in regard to fish rescue work are to have (1) experienced personnel, so that at least one man with each crew will have been in the area the previous season and knows the character of the stream, roads, etc., (2) personnel adequate in numbers, not only to do the actual work but also sufficient so that one man may make a survey at the start of the season or preceding work in any given area, to determine the general program and outline a tentative schedule of work, and (3) adequate equipment.

Legislation

I believe that the most important thing that could be done for the improvement of fishing in the Eel River, and most of the other coastal areas as well, would be the enactment of sound conservation legislation. In my previous general report (Shapovalov, 1939) I discussed the need for the enactment of suitable regulations and outlined them as follows:

(1) A daily bag limit of 15 fish or 10 pounds and one fish from May 30 to September 30, inclusive.

(2) A daily bag limit of 2 salmon and 3 steelhead, irrespective of size, from October 1 to the last day of February, inclusive.

The above regulations to apply to the tributaries as well as to the main Eel, during both the summer and winter seasons, with the following exceptions:

(a) The South Fork of Eel River to be closed at all times from the Benbow Dam to a point 1000 yards below the Benbow Dam and as signed by the Division of Fish and Game.

(b) The usual regulations of no fishing within 250 feet of a fishway or 150 feet of the upper side of a fish screen, or the lower side of a dam, or to take fish except salmon within $\frac{1}{2}$ mile of either side of a spawning station to apply at such places, with the exception of the Benbow Dam.

These regulations were subsequently approved by the Redwood Empire Council of Fish and Game Clubs and presented to the California State Legislature in the form of proposed changes to Sections 62, 63, 290 (b), 612, 613, 615, 651, 652, 653, 655, 656, and 629 of the California Fish and Game Code, but were not enacted into law. Following this, a portion of the regulations were put into effect by certain closures by order of the

Director of the Department of Natural Resources, as follows:

"All streams tributary to the Pacific Ocean on the coast of Humboldt county and all portions of said streams from their mouths to their headwaters, including tributary streams, lagoons, lakes (excepting Lake Pillsbury) and reservoirs, closed to and including May 31.

"South Fork of Eel River for a distance of 3,000 feet below the Benson Dam of the Benbow Power Company.

"Eel River for a distance of 3,000 feet below the Van Arsdale Dam of the Pacific Gas & Electric Company."

In the closures ordered by the Director of the Department of Natural Resources the opening day of the summer season was made June 1, instead of the proposed May 30, in order not to conflict with Memorial Day ceremonies. Either a June 1 or a May 29 opening are satisfactory, in my opinion. The closure of the Eel River for a distance of 3,000 feet below the Cape Horn Dam at Van Arsdale Reservoir is also satisfactory; it is not an essential change from that section of the Fish and Game Code that prohibits fishing within $\frac{1}{2}$ mile of a spawning station (the Snow Mountain spawning station of the Division is located at Cape Horn Dam). The 3,000 foot closure below Benbow Dam coincides exactly with the regulation proposed in 1939.

My opinion still remains that the remainder of the regulations as reported in 1939 should be put into effect. As was stated in that report, it must not be expected that a program of fish rescue, stream improvement, and pollution abatement alone will be sufficient to prevent further depletion. Changes in the regulations governing the Eel River drainage basin should be made. It is folly to speak of an area as being "managed" if proper regulations are not enacted and enforced. The area is then only

being aided, not controlled, and management, to be effective, means control.

Any given area for which regulations are proposed can not be considered alone, but must be considered in relation to adjacent areas. If the regulations of adjacent areas are not coordinated, there is danger of an undue burden being placed on one or more of them. This applies especially to seasons. If the trout season opens on a certain date in one area, and on a later date in an adjacent area, the anglers are liable to and in practice do concentrate on the former first and on the latter area when it, in turn, is opened. Quite naturally, too, the more regulations there are the more confusing it is to the angler and the more difficult is made the work of the law enforcement officer. In general, therefore, the regulations should be as uniform as is consistent with basic biological requirements. It is better that a few more fish be taken in a given district or of a given species than to have a special season or other regulations for that district or that species. There is at present a confusing and un-necessary multiplicity of fish and game laws in California and the whole Fish and Game Code should be drastically revised if we are to make important steps in the direction of sound conservation practice. As a concrete step in this direction it is proposed that the game districts be made separate from the fish districts, and that the fish districts follow natural drainage basins.

Law Enforcement

In order for any regulations that are in effect in the area to have a real value, they should be adequately enforced. Although every effort should be made on the part of other members of the Division of Fish and Game and other individuals to cooperate with the Bureau of

patrol, the enforcement must be carried out mainly by that Bureau.

For various reasons, mainly lack of personnel during those seasons when it was needed, enforcement of regulations left much to be desired at the time of the 1938 survey. Considerable spearing and some netting was being done in the lower Eel River and considerable pre-season angling for immature trout in March and April in the upper reaches. One reason for the lack of personnel when needed was the taking of men to work in the deer areas at just the time that low water occurred and the runs of salmon and steelhead were making their appearance in the lower river (August). During the autumn of 1938 on some nights the lower Eel River was lit up like a Christmas Tree from the lights of poachers. Since then, according to reports of local residents, the situation has improved noticeably and there was little complaint of wholesale violations at the time of my visit to Fortuna in October, 1940.

Fish Rescue

In the Eel River drainage, the principal areas requiring fish rescue work are the following: (1) Side channels and drying main channels in the lower main Eel and Van Duzen rivers, in the former from Fern Bridge to Weymouth and in the latter from its confluence with the Eel to the 101 Highway Bridge or a short distance above; (2) Tributaries of the Van Duzen River to Bridgeville, mostly in the lower courses; (3) Tributaries of the main Eel and the South Fork of Eel River and East Branch of Eel River, mostly in the lower courses from Weymouth (Price and Howe Creeks) to about Richardson Grove; (4) Streams in Round Valley and vicinity (Covalo area, including Short Creek and nearby streams);

(5) Streams below Lake Pillsbury (principally Soda Creek) and below Van Arsdale Reservoir (principally Tomki Creek and tributaries). In the cases of Short Creek, Soda Creek, and Tomki Creek and tributaries, in most or at least in many years the need for fish rescue work will extend along considerable stretches of stream, while in the other streams the work will be done mainly in the lower courses, usually from the mouth to not more than several hundred yards above the mouth. There are a few exceptions to the latter statement, especially following years of light rainfall, when there is need for fish rescue work along several miles of certain tributaries of the South Fork of Bel River, for example, Bull Creek and Salmon Creek.

Fish rescue work carried out since 1938 also gives an indication of the periods when work would be required in the future and is summarized in the following table.

Starting and ending dates and places of fish rescue work in the North

Coast district, 1933-1941.

	Prairie Creek Hatchery crew	Lower Bel River crew	Upper Bel River crew
	(Parmer Cr.) start--May 27 (Hunter Cr.)		
1938	end --Aug. 26 (H. T. Mad R.)	None	None
	start--Apr. 24 (Parmer Cr.)	Apr. 30 (Hatcher Cr.)	June 23 (Short Cr.)
1939	end --Oct. 3 (Lost Man Cr.)	Sept. 10 (Bull Cr.)	Aug. 25 (Williams Cr.)
	start--Apr. 26 (Lynot Cr.)	May 13 (Bear Gulch)	May 28 (Soda Cr.)
1940	end --Aug. 23 (Rowdy Cr.)	Aug. 31 (Usal Cr.)	Aug. 5 (Soda Cr.)
	start	May 28 (Dean Cr.)	
1941	end		

Thus, during two and one-half years of fish rescue work in the Bel River drainage, the earliest that fish rescue work has been started is April 30 and the latest that it has been carried on is Sept. 10. Stream improvement work has started as early as April 25 and has continued as late as Sept. 7. In certain sections, in abnormal years, it might be necessary to carry out fish rescue work as early as April 1 or as late as September 30, but normally the season may be expected to lie between May 1 and September 1.

As was outlined in my previous general report, two-man fish rescue crews are probably the most advantageous, everything considered. The other considerations mentioned in this report also apply to the present program. A start could be made with two or three two-man crews operating in the Bel

River drainage, depending upon whether a separate stream improvement crew was employed or whether the improvement work was entirely combined with the rescue operations. Headquarters for all of the crews could not be established at one point, except for winter storage of equipment. One crew could have headquarters at Fortuna or Garberville, depending to some extent upon whether it did rescue work outside the Eel River drainage or not. Considerable work should be done in the Klamath River system, the Smith River system, the Winchuck River system, and the streams tributary to the Pacific Ocean between these river systems. It is assumed that a separate crew or crews would work in these areas. The same crew could also work in Redwood Creek and the North Fork of Mad River. However, rescue work in the upper Mad River, Mattole River, upper Mattole River, and Usal Creek should logically be handled by a crew or crews operating in the Eel River system. Another crew could have headquarters at Covelo and a third crew at Snow Mountain Dog Collecting Station or some nearby point. However, a certain amount of overnight stops at cabins, resorts, and ranger stations will be necessary. One of the members of each crew should have been a member of the previous year's crew.

Pick-up trucks are not altogether satisfactory, inasmuch as equipment can not be locked up overnight, but may have to be used for the present. Trucks should, of course, have aerating equipment, and should have four-speed transmissions. Seines should be furnished and maintained in good condition. Based upon experiences of fish rescue crews in past seasons, the following list of nets to be supplied to each two-man crew is recommended:

One beach seine 30 ft. x 3 ft., 1/4 in. sq. mesh.

One beach seine 30 ft. x 4 ft., 1/4 in. sq. mesh, leads spaced 4 in. apart.

One beach seine 12 ft. x 4 ft., 1/8 in. sq. mesh or bobbinet.

One bobbinet seine 25 ft. x 3 ft., 1/4 in. sq. mesh, leads spaced 2 in. apart.

One hand minnow seine 4 ft. long x 3 ft. deep, gathered a little at both cork line and lead line to form a slight bag, of not coarser than 1/4 in. sq. mesh, and equipped with brails (wooden handles). Mop handles make very suitable brails. These should be ringed by grooves about 3 inches apart and by means of these securely tied to the seine.

Two hand dip nets of bobbinet, approximately 12 in. x 16 in.

If bobbinet is absolutely unavailable, as it might be because of war conditions, 1/3 in. sq. mesh "Common Sense" minnow seine may be substituted. Seines made of this material will not last as long as bobbinet and will not be as effective.

Other equipment should include 10-gallon fish cans, two planting buckets, standard fish-weighing scales, two shovels, one axe, one pick, and one saw. Men should be equipped with hip boots, bathing trunks, and wading shoes (crepe or rubber soled shoes are good for this purpose). At least one thermometer should be included. The crews should be provided with maps.

Physical Improvement of Streams

Unlike fish rescue, in which a small number of men could handle the fish as rapidly as necessary in almost any season, almost any number of men could be put on stream improvement work, depending upon how fast it was desired to carry out the work. This applies, of course, to what may be considered as "permanent" stream improvement, i.e., the removal of log jams (some of which have been in the streams for many years). The "annual" type of stream improvement, like the opening of mouths of tributaries into the main streams, uniting of side channels with the main stream, improving entrances of small tributaries into main streams, and straightening of channels on a small scale, is more like fish rescue in

its personnel requirements. In the past the stream improvement work has been carried out by the same men that did the fish rescue work, and was adapted to the fish rescue program, with the improvement work being done before and after the main fish rescue season, and during lulls (caused, e. g., by cool spells) in the fish rescue activities. In the future it might be well to try out one or two separate stream improvement crews. I am not yet certain how many men should form one crew, but I believe that two men working together would form an efficient team and could carry out all but the heaviest work, if provided with the proper equipment. My recommendation is that at the start one two-man crew be tried out. Normally, the season for the improvement work might be expected to extend from May 1 to September 1, although in some years it might be started in April and extended into September. In past years, stream improvement work has started as early as April 25 and has continued as late as September 7. The following table shows starting and ending dates and places of stream improvement work in the north coast district, 1939-1941.

Starting and ending dates and places of stream improvement work in
the north coast district, 1939-1941*

1939	April 25 (Redwood Cr.) Sept. 3 (Bear Cr.)
1940	May 13 (Bear Gulch) Sept. 7 (Elk Creek)
1941	May 26 (Hartsook Cr.)

* Lower Del River Crew is the only one that has conducted stream improvement work in this area. No stream improvement work was done prior to 1939.

There should be cooperation in the exchange of information between the fish rescue crews and the stream improvement crews and in some cases actual collaboration in carrying out the work. For example, if one of the fish rescue crews has a big job to carry out in a restricted area, requiring the pulling of a large net, it might well call upon a stream improvement crew for assistance, and, conversely, a stream improvement crew, having a large log jam to remove, might call upon a fish rescue crew for temporary assistance if the rescue work was not pressing. In general, the requirements of the fish rescue crews should be given precedence, for their work often can not be put off, whereas the work of the stream improvement crew may be delayed without serious ill effect. Another time when the fish rescue crews might call upon the stream improvement men for help would be during a hot spell, when a number of streams were drying fast and rapid work over a large area was necessary.

The type of equipment furnished to the stream improvement crews will depend to some extent upon the scale of the operations. If the larger

log jams are to be removed, use of tractor equipment and block and tackle will be necessary. If only smaller jams are to be removed or if in some of the larger jams the logs are only to be cut up, without being removed, then saws and axes may be sufficient. In many cases it is satisfactory to cut the logs into 5 to 10 foot lengths, without removing them from the stream bed, and to depend upon high water carrying them out of the stream. Probably for the present pick-up trucks will be assigned to both the fish rescue and stream improvement crews, but these are not entirely satisfactory, as was pointed out by me in a previous report (Shapovalov, 1939), for the reason that equipment can not be locked up overnight, and it is necessary for the crews to spend many nights away from headquarters. A sedan delivery or station wagon type of vehicle might be more desirable for the improvement crew. As an alternative, a combination truck of the pick-up type but with a large locked compartment back of the driver's compartment might be the most satisfactory both for stream improvement and fish rescue operations.

Biological Improvement of Streams

By biological improvement of streams is meant the improvement of the biological environment for the fishes which it is desired to maintain. It means the control of predators and competitors, and the maintenance of an adequate food supply. Among predators are included animals both within and outside the waters: other fishes and snakes, birds, and mammals. Competitors are composed chiefly of other fishes. These may be competitors for food, for spawning grounds, or simply for space. Predators may affect the adults, the immature fish, or the eggs.

An important start on one phase of this subject was made in 1938 and 1939 by Elden A. Vestal, who made a study of the food and feeding

habits and other phases of the life-history of mergansers, the "fish ducks" of local residents, in the Del River drainage. These valuable data have not yet been published.

The control of undesirable species of fishes, the so-called "rough fish" or "scrap fish", may be studied and executed from several approaches. The native rough fish of the Del River drainage are composed of one species of sucker, sticklebacks, and fresh-water sculpins. The eel-like lampreys perhaps may also be included in this group. Introduced rough fishes are the Square-tailed Catfish, Green Sunfish, and possibly the Bluegill. Apparently the only other species of introduced fish in the Del River drainage is the Eastern Brook Trout, which, insofar as I know, is found only in a limited area.

Rough fish may be removed on a large scale by seining, trapping, or poisoning, if it is decided that it is desirable to reduce their numbers or to attempt to eliminate them. It may also be possible to control certain of the species by erecting barriers in the streams that would bar their upstream migration.

At the present time I believe that the native rough fish (suckers, sticklebacks, and sculpins) do little harm or no harm in the Del River drainage basin as a whole.

The sunfishes and catfish I believe to be undesirable elements in a stream system such as the Del River, but there appears to be no economically justifiable way of eliminating them from the entire system, especially since the Green Sunfish are established in huge numbers in Lake Pillsbury. Where they are found locally, as in the streams of Little Lake Valley (Millits), there is a possibility of eliminating them entirely, if the effort is deemed justifiable.

A certain measure of control could be put into effect if the fish rescue crews killed all of the rough fish that were determined to be undesirable. Those of sufficient food value could be distributed to charitable institutions. I have several times recommended that some policy be adopted by the Bureau of Fish Conservation in regard to the disposal of the different kinds of rough fishes taken by fish rescue crews, but no action has been taken in this connection.

Studies of the other phases of this subject, such as stomach contents of various fishes and abundance of stream bottom foods, would be undertaken as time permitted.

Stream Censuses

Complete counts of the adult salmon and steelhead passing upstream have been made at Benbow Dam during the 1933-39, 1939-40, and 1940-41 seasons. Since such counts are one of the best indices of the fluctuations in population of the salmon and sea-run steelhead, this program of fish counting should be continued in the future. To provide a sound basis for judgment regarding abundance, these counts must be made over a number of successive years, inasmuch as the life cycle of the fishes involved extends over several years. Another reason for continuing the work in the future is that if any major projects affecting the Eel River drainage basin are proposed, such as power or diversion dams, there will be some basis for evaluating the fishery and the abundance of these fishes. Such data have been sadly lacking at the start of construction of some major dams in California, such as Chasta Dam on the Sacramento River and Scott Dam at Lake Pillsbury on the Eel River. When such data are at hand, even if the construction of the dam is deemed essential, there is a basis for determining the need for a fishway and the amount of money that should justifiably

be invested in a fishway or other fish protective projects.

During the above three years, the fish counting has been carried on with the following personnel and during the following periods:

Personnel employed and periods spent in operation of Benbow Dam fishways,

1938-39 to 1940-41.*

1938-39 Oct. 4 (Oct. 8) to May 10 (May 1).

Oct. 4 - April 12, 3 men

April 13 - May 10, 1 man

1939-40 Oct. 5 (Oct. 26) to May 10 (May 9).

Oct. 5 - Dec. 12, 2 men

Dec. 13 - Feb. 29, 3 men

March 1 - March 30, 2 men

March 31 - May 10, 1 man

1940-41 Oct. 10 (Oct. 25) to May 25 (May 22).

Oct. 1 - Oct. 10, 1 man

Oct. 25 - May 25, 2 men

* Dates in parentheses are those on which first and last adult upstream fish were counted through fishways; other dates are starting and ending days of operation of fishways, including construction work.

During the 1939-40 season 4 to 6 men were on duty from Jan. 10 through Jan. 13, to assist in the removal of a large stump that had lodged in the south fishway. Occasional temporary help may have to be called in or hired in similar emergencies.

The number of men required to count upstream adult salmon and steelhead will depend upon whether one or two fishways are operated. If only

one fishway is operated, two men will be required for the bulk of the season; if both fishways are operated, three men will be required for most of the season. The normal season will extend from about Oct. 5 through May 25.

On April 21 and 22, 1939, 41,112 King Salmon fish of the season marked by the removal of the adipose and left ventral fins were planted in the South Fork of Eel River above Benbow Dam (at Richardson Grove and at Piercy). A few of these returned as grilse during the season of 1940-41 and passed through the Benbow Dam fishways. The bulk of the marked fish are expected to return during the 1942-43 season, although a number may return in 1941-42 and some in 1943-44 and even later. Especially during the seasons of 1941-42 and 1942-43, careful watch should be kept at the Benbow Dam fishways for these marked fish. It is impossible to examine individually all of the King Salmon entering the fishways and when the run is heavy it is considerable of a chore to examine large samples. It appears that the only feasible plan is to examine as many of the fish as possible, taking the opportunity when it presents itself. As was done during the 1940-41 season, a screened gate should be prepared beforehand, to be dropped into the port above the counting board, in case a tagged fish is seen passing over the counting board. The fish may then be dipped out.

It would be desirable to secure returns on marked fish and to make counts of the runs at points in the Eel River system other than Benbow Dam, but there is no place where such work may be done at present other than the Cape Horn Dam fishway, where only steelhead are taken. Because of the character of the streams and high flood water, it would probably not be possible to install a counting rack in any of the larger streams

of the system and there would be little to be gained by putting in counting racks in the smaller streams.

Creel Censuses

It would probably be desirable to conduct creel censuses on certain streams and at certain times of the year. Voluntary reports of anglers are not satisfactory and should not be planned on as a means of finding out what the anglers are catching. The personnel of the management area would have to conduct these creel censuses. The creel census which has been made along the South Fork of Eel River on opening day of the summer fishing season should be continued and the program of creel censuses expanded as it was felt desirable.

In conducting creel censuses the species and length of fish caught, the immediate locality, the fishing time, and the lure used should be recorded. At times it might be desirable to collect scale samples in the course of this work. The above statements apply to the summer angling for immature fish, but creel censuses during the season for adult salmon and steelhead might also be desirable. In the case of the adult fish, the sex should also be recorded and when possible the weight.

Stream Surveys

Nearly every portion of the Eel River drainage was covered by Shapovalov and Vestal during their 1938 survey and recommendations made for the general management of the basin, but of course a number of individual streams are still to be examined.

If production fish planting is still being carried on, initial stress in stream survey work should be laid on those waters that are being planted, so that any faults in the stocking may be corrected. Also, those waters should be surveyed for which stocking has been specifically requested.

Routine stream surveys would normally be carried out between June 1 and September 30. Before the former date and after the latter date high water and rainfall normally so affect conditions that it is not profitable to carry on routine surveys.

In addition to the routine survey of streams and the very few lakes present in the Eel River drainage, time should be taken to treat various special problems that might be uncovered.

Experimental Fish Planting and Marking and Tagging

If fish are planted on an experimental basis in wild streams, they must nearly always be marked or tagged in some manner, so that they may be recognized when caught. Provision must also be made for securing the returns, by anglers or at counting or egg-collecting stations. Voluntary reports made by anglers as a general rule are not satisfactory if dependence is placed upon them alone. If returns are to be secured from anglers, they must be secured by the method of creel censuses conducted by fisheries workers and responsible persons under their direction. Opportunities for counting and egg collecting stations are very limited in the Eel River drainage, largely because of the difficulty of maintaining racks during floods. At present there are two places at which counts may be secured, Rainbow Dam and Cape Horn Dam. At the Cape Horn Dam only steelhead enter the fishway and all of the run may be examined. At Rainbow Dam all of the three principal game fishes, steelhead, King Salmon, and Silver Salmon, come in such large numbers that only a limited number may be examined and the problem of representative sampling is one that is very difficult to solve.

My recommendation is that the data of the Scott Creek and San Lorenzo River and probably the Santa Ynez River marking and tagging experiments be analyzed before any marking experiments, with the possible exception of King Salmon, are conducted in the Eel River system. Then, if it ^{is} desirable to conduct experiments in the Eel River system, that these be conducted with steelhead planted immediately below the Cape Horn and/or, if a hatchery is established on a tributary of the South Fork of Eel River above Benbow Dam, at a point in the South Fork near the hatchery. Marked King Salmon and Silver Salmon may also be planted at the latter point. Following such marking, every effort should be made to secure returns at Benbow Dam and/or the Snow Mountain Egg Collecting Station. Also, a program should be organized for securing returns from the intensive sport fishery in the lower course of the Eel River, from the mouth to Eureka. Cooperation should be secured by verbal arrangement and the posting of notices and through the media of talks and newspaper articles. It may be desirable to offer some reward for the return of scars and tags with complete accompanying data.

It may be possible and desirable for one of the men assigned to the fish management area to secure data on ocean-caught marked salmon as they are landed in the commercial fishery at Eureka. During the past several years this information has been secured by a member of the Bureau of Patrol.

Production Fish Planting

For the reasons stated in my previous general report, (Shapovalov, 1939) operation of the Fort Seward Hatchery is now not satisfactory. In that report it was recommended that the operation of the hatchery for

production use be discontinued immediately, but that it might be desirable to operate it for one or even several seasons as a place in which to rear trout and salmon for special stocking experiments. It was further recommended that several stocking experiments with marked fish be conducted before building another hatchery to replace the Port Seward establishment. The subject of the manner of stocking was also discussed, with the recommendation made that, if returns from fish marking experiments justified further production stocking, the planting be more specialized than in the past. By that it is meant that the stocking, instead of consisting of a general distribution of rather small fish throughout the river system to fairly large tributaries in which natural propagation is already extensive, with the hope of keeping up the supply of fish in the river system by sheer numbers, should instead be directed toward planting of barren tributaries or barren sections of streams above falls and the planting of areas in which in certain years adverse climatic conditions or small spawning runs have caused subnormal natural propagation. In other words, under the conditions of our coastal streams artificial propagation at best must be considered as an aid to natural propagation, rather than a replacement of it.

The stocking experiments that were recommended were not carried out, with the exception of the planting of one lot of marked young King Salmon in the South Fork of Eel River in the spring of 1939. Returns on this marking are now being secured. However, fish marking experiments have been conducted in other coastal streams, such as the San Lorenzo River, Scott Creek, and the Santa Inez River, and as soon as returns are secured on these experiments and the results analyzed, much valuable information that will guide the stocking in the Eel River and many of the

other coastal streams in California, may be expected. Preliminary examinations of the data, based on returns to date, indicate that in the coastal streams the returns on aged fish may be so much greater than on much smaller fish that stocking of aged fish is justified, despite increased costs.

If a production hatchery is established at the present time, it is recommended that this hatchery be so situated and equipped that it can handle aged fish. Aged fish mean rearing tanks or ponds, not just troughs.

As outlined ⁱⁿ my 1939 report and above, the stocking from this hatchery should be conducted in a specialized manner, depending upon the needs of the different streams during that season, instead of the fish being planted in the same streams year after year.

As outlined by me in my yearly stocking recommendations, those portions of the streams that are subject to high temperatures should not be stocked.

Cooperation of Sportsmen and of Other Public Agencies in Providing Information and in Carrying out the Work

Sportsmen and members of public agencies such as the State Division of Parks could undoubtedly be of great help in providing information of various sorts, and their help in this direction and in the direction of urging the enactment of sound conservation legislation should be solicited. Much of the information that would be secured from co-operators would deal with places requiring stream improvement or rescue work. Other ways in which interested persons could cooperate, for example, by turning in data on marked and tagged fish, have been dealt

with elsewhere in this report.

It is doubtful that outside persons would be of much help to the management area workers in the actual execution of the work, except in scattered instances. In any case, such help should not be relied upon in any long-range program.

Educational Work

Educational work to acquaint sportsmen and other interested persons with the purposes of the management area and the activities of its personnel could be carried on in a variety of ways. Posters describing the work and also special posters telling anglers of the ways in which they could cooperate, as by turning in data on marked and tagged fish, could be placed in sporting goods stores and other suitable places. Leaflets for the same purpose could be distributed at the headquarters of the management area and in other ways. Popular articles in newspapers and in the CALIFORNIA CONSERVATIONIST could tell of the purposes and work of the area and describe the progress made and deal with special phases of the management program. Semi-popular and scientific articles in CALIFORNIA FISH AND GAME and other journals could present the more technical aspects of the management work. Talks could be given before sportsmen's organizations, schools, and service clubs and over the radio.

Pollution

Pollution in the Del River system was described in my previous general report (Shapovalov, 1939). At times pollution has created serious ill effects on fish life. The most serious pollution has occurred from the several large creameries along the lower Del River, in the vicinity of Fernbridge and Ferndale. This situation was brought under

control in 1936 but in August, 1938, Elden H. Vestal and I noted that considerable amounts of creamery wastes were again being dumped into the Sel and into Salt River. The situation was reported and remedial measures taken.

Other sources of pollution have occurred in isolated instances of garbage dumps, faulty sewage disposal systems, mill ponds, and sawdust. A new sewage disposal system completed at Millits will help to keep the streams in that vicinity clean. The Millits city dump, however, was still located on the bank of a fine spawning stream when last seen, with refuse from the dump carried into the stream at high water. At times in the past the lumber mill ponds at Scotia have broken or leaked through into the Sel River.

Strenuous efforts and constant vigilance should be maintained in order that all forms of pollution in the Sel River be prevented. Any violations of the pollution laws should be vigorously prosecuted and the conditions immediately remedied. The enforcement of the pollution laws will have to be carried out mainly by the Pollution Detail of the Division.

Special Problems

In addition to carrying out the regular program of the management plan as outlined in the preceding pages it will be desirable to devote some time to special problems now existent or that may arise.

Further observations should be carried out on the various natural and artificial barriers to salmon and steelhead spawning runs. The artificial barriers include both dams with inadequate fishways (Benbow Dam and Cape Horn Dam) and those with no fishways (principally Scott Dam). The natural barriers include both those that are impassable to upstream fish and those that only impede upstream migrants. Among the natural

barriers of importance are Asa Bean Falls on the Middle Fork of Eel River, falls on the North Fork of Eel River called "The Fishery", falls on the East Branch of South Fork of Eel River, and falls on the main Eel River above Lake Pillsbury.

Further observations might also be made on some of the other "sore spots" previously mentioned in this report, such as the Willits drainage and pollution situation.

Further studies might also be made of the interesting spring-run steelhead, known locally as "summer salmon", which ascend the Van Duzen River and the Middle Fork of Eel River.

Utilization of Relief Labor

The possible utilization of unskilled relief labor in the area that would be included in the proposed fish management area was discussed in a separate report made to the Bureau of Fish Conservation by me on August 7, 1941. Three projects, stream improvement, fish rescue, and creel censuses, were discussed in some detail. These projects could be put into operation whether or not a fish management area was established.

Utilization of Convict Labor

If unskilled convict labor became available, it could be utilized only on large-scale but compact projects. The most likely possibility is that such labor could be used on an extensive channel deepening and clearance and bank protection project, in the lower Eel River between the mouth and the vicinity of the entrance of the Van Duzen River. There is evidence that the tremendous pools of this stretch of stream have filled in to a considerable degree over a period of years. Large logs and stumps have become lodged in the stream bed in this section. At times of flood water there has been considerable erosion of the banks, with the

result that many acres of fertile land have been swept away, as a consequence of which the lower river shifts its course as much as a quarter of a mile or more from season to season. The proposed project would have for its purpose prevention of flood damage to the banks, preservation and re-creation of the large pools for fishing purposes and as resting places for the salmon and steelhead, and preservation of a single channel, to facilitate navigation and the upstream migration of the salmon runs. Several hundred men could be employed, but the supervision of an engineer would be required.

There is also possibility that convict labor could be utilized to make several large falls, such as Asa Bean Falls on the Middle Fork of Hel River, accessible to fish. Probably around 50 men could be used on such a project, which would consist mainly of rock blasting. A man experienced in the use of dynamiting of large rocks would have to be in charge of such a project.

The above projects could be carried out whether or not a fish management area was created.

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PHOTOGRAPHS



Fig. 1. A stream annually requiring fish rescue. Short Creek, in Round Valley, Mendocino Co. Eleven hundred young steelhead were taken from this isolated pool, which later went dry. Over 77,000 steelhead were rescued from this little stream in 1932. Photo taken July 10, 1938.



Fig. 2. A stream annually requiring fish rescue and stream improvement. Murphy Creek, Richardson Grove State Park, Humboldt Co. Young salmon and steelhead were in this dead end pool, blocked by a sand and gravel bar from the South Fork of Eel River. Photo taken June 25, 1938.



Fig. 3. The spreading mouth of Newman Creek, Humboldt Co. In such cases a single channel should be dug through to the main stream, here the Eel River. Photo taken Aug. 5, 1938.



Fig. 4. Divided channels of Redwood Creek, Humboldt Co. The two main channels seen in the photo should be united to form one main channel into the South Fork of Eel River. Photo taken June 12, 1938.



Fig. 5. Divided and spreading mouth of Dean Creek, Humboldt Co. A single channel should be dug through to the main stream, here the South Fork of Eel River, in such cases to facilitate exit and entry of young steelhead and salmon. Photo taken June 21, 1933.



Fig. 6. A huge log jam at the mouth of East Fork of Howe Cr., Humboldt Co., resulting from lumbering operations. Note man in center of photo. This is a semi-permanent type of obstruction blocking spawning salmon and steelhead. Photo taken Aug. 16, 1933.



Fig. 7. A major stream improvement project. Asa Bean Falls on Middle Fork of Del River, Trinity Co. A natural falls 50 ft. high, difficult for steelhead to ascend. Relief or convict labor might be utilized on this project. Photo taken July 14, 1968.

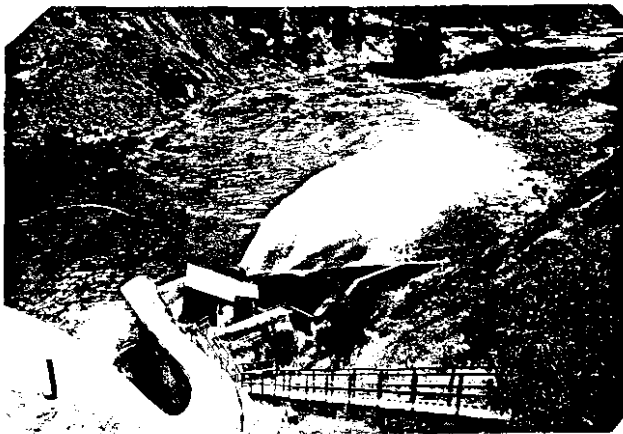


Fig. 8. Scott Dam at Lake Pillsbury, Lake County. This dam, with no fishway, has cut off some of the best salmon and steelhead spawning grounds in the Del River system. A fishway is recommended. Photo taken July 29, 1968.



Fig. 9. Cape Horn Dam at Van Arsdale Reservoir, Mendocino Co. The fishway seen at the right of the photo does not function properly, since steelhead have difficulty in entering it at high water and are also badly battered on the rocks seen in the center of the photo. Photo taken March 7, 1940.

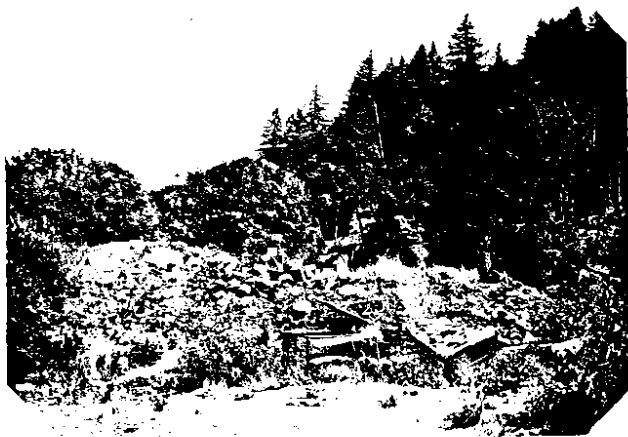


Fig. 10. An example of pollution of a salmon and steelhead spawning stream through the dumping of debris and garbage. Willits city dump on Broadway Dr., Mendocino Co. Photo taken July 17, 1938.



Fig. 11. An example of pollution through the dumping of garbage and debris. Salt River, a tributary of Eel River in Humboldt Co. Photo taken Aug. 15, 1963.



Fig. 12. Pollution from creamery wastes dumped into Salt River, Humboldt Co., from Valley Flower Cooperative Creamery. Photo taken Aug. 15, 1963.