FISH AND WILDLIFE PROBLEMS ARISING FROM THE WILLAMETTE VALLEY PROJECT

by

OREGON STATE GAME COMMISSION

FISH COMMISSION OF OREGON

Portland, Oregon
March 1, 1948

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FOREWORD

This report[1/] has been compiled after careful study of the Review of Survey Report of the Willamette River and Tributaries, Oregon, by the Corps of Engineers. The object of such a report is to present the fish and wildlife problems involved from all aspects of the Willamette Valley Project.

The report is presented in two sections; one dealing with fisheries resources and the other with wildlife resources of the Willamette Valley. The bases for the conclusions drawn in this report are derived principally from biological data obtained by the research staffs of the Oregon Game and Fish Commissions.

Plans for amelioration of harm or damage to fish and wildlife resources are presented. Because of the magnitude of the project, there can be no assurance that the fish and wildlife resources of the Willamette River Basin can be maintained at their present levels.

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INTRODUCTION

The fisheries resources of the State of Oregon are one of its greatest assets. Since long before the advent of the white settlers, the Indians of the region depended upon the natural resources in general, and on the salmon fisheries resources in particular for one of their main sources of food and barter. The economy of the Northwest since the early settling of the territory always has been closely integrated and correlated with the fisheries, first mainly as an industry and more recently as a valuable recreational resource advertised and sought after by people from every part of the United States.

The actual total value of the fisheries of Oregon unquestionably exceeds one billion dollars and a large majority of the citizens of this state are directly or indirectly dependent upon the fisheries for a livelihood or utilize the resource from a recreational standpoint.

The most important parts of the resource are the salmon and trout which live entirely or part of their lives in the inland waters of the state. A portion of the administrative duties provided in the constitution of the State of Oregon are those pertaining to the conservation of the natural resources of the State, including its fisheries resources. Since it is the duty of the Oregon Game and Fish Commissions to protect and conserve the fisheries resources, it lies within their province to study and examine any program by any body or government agency which would effect a major change in the management of these fisheries.

The Willamette River Project, as contemplated by the Corps of Engineers in their "Review of Survey Report, Willamette River and Tributaries, Oregon", dated October 15, 1947, (hereinafter referred to as the Review Report),

basically and radically affects the fisheries resources of the Willamette River; therefore, as provided for in Public Law 732, the following report is being submitted which is to be included in the report by the Corps of Engineers to the governors of the respective states and to the National Congress.

This project is not new, nor have the fisheries interests failed to inform the Corps of Engineers through numerous official communications and innumerable informal and formal conferences of the fisheries problems involved. This can be corroborated by statements of the Review Report. The fisheries authorities have attended meetings, expressed opinions, given the Engineers staff the benefit of the experience and data which pertain to the fisheries problems and in every manner possible have made clear the needs of the fisheries resources. The Engineers, in cooperation with the U. S.Fish and Wildlife Service, carried on extensive investigations with thoroughly competent personnel to determine the effects of the development program on fish life. These studies were finally incorporated into a report published by the U. S. Fish and Wildlife Service as Special Scientific Report No. 33, by Joseph A. Craig and Lawrence D. Townsend. Since that time the Oregon Fish and Game Commissions have made further studies of the Willamette River fisheries in 1946, 1947, and are continuing with their investigations.

The Review Report consists of a main report and nine appendices, (A through I). The fisheries agencies have been provided with six of the nine appendices (C through H) and the main report. The body of this report and each of these seven volumes deals with the plans affecting the habitat, migration, ultimate survival and maintenance of the fisheries resources of the Willamette Basin.

Each of the appendices studied includes vital data bearing upon the relationship of the Willamette Valley Project to the fisheries resources of the basin. Reference will be made to the Review Report and to the appendices by means of the numbered paragraphs used.

Previously the fisheries agencies, not having the coordinated program or analysis, could plan only in very general terms. Careful study of the Review Report has brought to light in every part of the project, in every plan for construction, maintenance, and operation, vital factors which may have serious consequences on the fisheries resources.

In laying plans for the maintenance of fish populations in relation to proposed dams and other changes in Willamette Valley streams, suitable bases for evaluating the anticipated damage to these waters must be determined. Basically fish production depends upon spawning habitat and food in natural waters. Any change that affects these factors must be evaluated. Direct losses because of extreme fluctuations must also be considered. The changes proposed and their effects are discussed under each phase of the project.

Recommendations and investigations in the previously mentioned Special Scientific Report No. 33 and from the Oregon Fish and Game Commissions have been incorrectly interpreted in many cases (e.g., para. 45, main report): "The total annual value of the Willamette River chinook salmon runs has been estimated by the Fish Commission to be $1,037,000 at present, or $5,189,000 potentially. It should be noted that realization of these values would be impossible, inasmuch as they represent the Fish Commission's estimate of the potential market value of fish which are not harvested and which must presumably be allowed to spawn in order to maintain the annual runs". This statement is far from the facts. The preliminary annual values calculated above as over one million dollars now, and potentially over five millions of dollars were based on <u>actual production</u> or <u>harvest</u> being utilized by the commercial industry in the ocean and Columbia River and the large recreational fishery in the Willamette River. This value <u>does not include</u> the seed stock as stated in the above mentioned paragraph.

Another misinterpretation of fact may be found in paragraph 532, Appendix C; The Corps of Engineers state without any basis, "The fact that a great part

of the adult fish that normally migrate beyond the dam sites now are taken for artificial propagation makes this plan the least expensive and best adapted to the present fish cultural practices of the Oregon Fish Commission". This last statement is not true. For example in 1947 less than ten per cent of the Willamette salmon run migrating past Willamette Falls was handled for artificial propagation. On Cascadia Fork, Fall Creek, and Calapooya Rivers, no eggs are taken. The entire runs into these tributaries now spawn naturally and will be completely blocked.

As another example of the misconceptions found throughout the Review Report, minimizing the values of the fisheries resources, paragraph 464, of Appendix C mentions: "Fishermen making use of these facilities are estimated to catch an average of 30,000 pounds of salmon each year". This statement refers to the tremendous sports fishery in the Portland vicinity in which approximately one-hundred thousand man-days are expended in catching as many as 30,000 salmon weighing approximately seventeen pounds each, or a total catch of 510,000 pounds in this one area alone. Special Scientific Report No. 33 established a catch of 30,000 salmon in 1941. The statement of 30,000 pounds is seventeen times too low.

The tone of the Review Report definitely indicates that beneficial results to the fisheries resources may be expected from the multiple-purpose development of the Willamette River and its tributaries. Appendix C, paragraph 537, states: "The construction of the improvements proposed for Willamette Basin would have beneficial effects to fish life in the basin". Again in the main report paragraph 555: "Expansion of existing hatching and rearing-pond facilities and construction of new facilities would compensate for the loss of spawning and rearing grounds, and would practically double egg capacity for salmon propagation". Throughout the entire report, the idea is presented that the fisheries resources of the basin will not be damaged; on the contrary, it is alleged that many benefits actually will accrue to the fisheries.

Paragraph 490 of the Review Report which discusses the pollution problem indicates that fisheries will benefit from the pollution dilution program. Actually the reduction of flows in the spring filling period may have a far more detrimental effect on the fish than the assumed benefits from the increased flows during the summer.

Operation schedules in nearly all cases call for large and violent fluctuations of flow. Nowhere has the fact been mentioned that bottom areas periodically desiccated are permanently removed from fish food production thereby drastically reducing the value of stream mileage involved as fish-producing water. Fisheries investigations have shown that only those areas permanently covered with water will continue to produce fish-food organisms. When operating schedules call for immediate changes in flow from several thousand cubic feet per second down to zero, the loss due to bottom area desiccation will be high.

A large number of the proposals call for channel straightening, clearing, snagging, and bank clearing and surfacing. How can this sort of thing benefit fish life when all investigations by fisheries workers on stream improvement for trout show that these activities are harmful to fish environment? "Methods for the Improvement of Michigan Trout Streams" by Hubbs, Greeley, and Tarzwell, states that adequate shelter and a satisfactory balance between pool and riffle area are essential to a good trout stream. In many cases the addition of low dams, current deflectors, or other shelter are necessary to make a stream suitable for a maximum population of trout. Brushy banks improve a stream by furnishing shelter, protection, and a larger supply of terrestrial foods. Many other publications could be quoted to support these facts.

Examination of papers and communications to the Corps of Engineers and statements made before various meetings will show no instance where official fisheries agencies or competent fisheries personnel ever made the claim that

the fisheries will be benefited by the Willamette Valley Project as now recommended. The over-all outlook is depressing in view of the size and ramifications of the project. The fisheries program will be formed in great wisdom and will be carried out with good fortune if salmon, steelhead and trout are not reduced greatly in numbers, even with the most vigorous attempts at preservation. All competent fisheries authorities on the Pacific Coast are thoroughly agreed and have never wavered from the considered opinion that any and all multiple-purpose dams blocking major salmon runs have an ultimate and definite deleterious effect on them.

A properly executed system of levees would probably be beneficial to fish life, particularly as the most extensive construction would be in the lower reaches. As is shown in Appendix E, Plate I, this would be the case with a simple levee plan. From the fisheries standpoint levees alone possess numerous advantages.

Many of the phases of the program such as Cascadia Dam on the South Santiam, canalization of the lower McKenzie River, methods of revetment, and borrowing gravel and material from the stream bottom, are new to the fisheries agencies. All of these new features produce new hazards to the fisheries resources. These are considered in the following pages and recommendations will be made. The changes in plans have vitally affected the costs of the fisheries facilities and a revised schedule of costs of the fisheries installations, based on the minimum requirements necessary to perpetuate the valuable Willamette River fisheries resources, is therefore included.

Fish ladders are not considered feasible in connection with dams of the heights of those proposed in the Review Report. Aside from the difficult problem of getting upstream migrating fish over the dams, an insurmountable problem in the light of present knowledge is presented in providing safe passage of downstream migrants past the dams.

The Middle Fork Willamette River watershed supports large game fish populations involving particularly cutthroat and rainbow trout. There is an extensive sport fishery for these fine fish on the tributaries and on the main stream throughout most of its length.

The anadromous species frequenting Middle Fork Willamette River is the spring chinook salmon. The Fish Commission began a study of these fish in 1946. Information gathered to date indicates that Middle Fork Willamette spring chinook pass over Willamette Falls in late April and early May and enter Middle Fork in June. The vanguard has often arrived at the Meridian damsite as early as May 15th. The fish remain in cool, deep pools in the main river and larger tributaries throughout the summer and then spawn in the early fall.

The Fish Commission maintains racks in the main river near Oakridge and in Salmon Creek. A part of the run is allowed to pass through the racks and many fish spawn in the main river below. There is no spawning of consequence below the Meridian damsite.

The value of the annual harvest of Middle Fork Willamette River salmon is estimated to be in excess of $200,000. Fisheries experts believe that the run can be increased to the size it was a decade or two ago, i.e., the run can be quintupled, and the annual value may be increased to at least $1,000,000, were the river left in its present state. Meridian and Fall Creek dams will eliminate all of the spawning areas of Middle Fork Willamette River, resulting in grave danger of extinction of the runs. Every effort is being made by the Fish Commission to safeguard the spring chinook populations, but the present operating schedule, as presented in the Review Report, is such that their fate is in doubt.

The Corps of Engineers have made several erroneous statements pertaining to Middle Fork Willamette fish populations and it is pertinent at this time to

point out the nature of such statements.

In Appendix D, Paragraph 19, fish problems are discussed. It is pointed out that fisheries interests, (The Fish and Game Commissions), have estimated costs involved in each case. The Review Report fails to indicate, for example, that both have pointed out, that in spite of the best knowledge and techniques available, there is no assurance that salmon runs can be maintained in the face of the environmental changes produced by the dams.

In spite of the fact that the Review Report states: "Meridian Reservoir would block the main stream to migratory fish to the detriment of fish life and recreation", (Appendix D, paragraph 37), the report states elsewhere, (Appendix D, paragraph 34) "The proposed Willamette Basin Project is of a multiple-purpose nature, designed primarily for flood control and navigation, but including large drainage, irrigation, power, fish life, recreation, and stream purification benefits." Inasmuch as the anadromous fish runs and trout populations of every tributary are jeopardized, it is difficult to envision any "large fish life benefits" on Middle Fork Willamette River or elsewhere.

Hills Creek Dam

Hills Creek Dam will provide an impassible barrier to fish and will flood 6.8 miles of Middle Fork Willamette River beginning at a point near the mouth of Hills Creek, three miles upstream from Oakridge. The effects of flooding of this section of river have been considered in the previous proposal submitted by the Oregon State Game Commission for restitution for game fish losses. These are covered in a preliminary manner in the facilities described in the Review Report. Conditions in the stream section below Hills Creek Dam will be altered markedly with respect to fish as may be seen in Appendix H, Table 1, wherein it is shown that the filling-season flows will be reduced from 510 second feet to a possible average minimum of 100 second feet which is reserved for fish. In the schedule proposed for regulating discharge from Hills Creek as shown in Appendix H, Table 3, it may be observed by comparing columns A, B, D,

and F, that immediate changes in regulated flow from zero to 6,400 cubic feet per second and 5,100 to zero cubic feet per second may be produced. This does not provide for the minimum release of 100 cubic feet per second which Table 1 states has been reserved for fish preservation. Such rapid changes in discharge rate and the accompanying fluctuations in the level of water and the velocity in the channels of the stream between Hills Creek and the back water from the proposed Meridian Dam would produce, each time that major operational changes are undertaken, acutely deleterious effects upon the stream with respect to the fish life therein. The effect would be to strand fish and scour the bottom with consequent destruction of feeding area, food organisms, spawning grounds, and eggs deposited in the area. These effects would inevitably be bad along the entire twelve-mile section of Middle Fork Willamette River reaching to the back water from Meridian Reservoir.

The nature of the changes which would occur in water stored in Hills Creek Reservoir and subsequently released during the late summer for navigation and other uses is entirely unknown as this reservoir was not even under consideration during the time that the investigation which formed the basis for Special Scientific Report No. 33 was in progress. The proposed storage and discharge curves for this reservoir should be studied with respect to the probably temperatures that might be expected in the water to be discharged in the late summer. It is quite probably that the deleterious effect of releasing stored water at high temperature late in the summer which has been shown would occur below other reservoirs may occur below Hills Creek also. Furthermore, the anticipated satisfactory late summer discharges from Meridian Dam as previously determined for the Lookout Point site were predicated upon the inflow of water the temperature of which had not been altered by previous storage. Therefore, the effects of the warming of water in Hills Creek Reservoir may be responsible for the production of water conditions below Meridian Reservoir which will be unsatisfactory to fish life.

Waldo Lake Diversion

The Waldo Lake diversion and storage project is described in Appendix D,

paragraphs 192 to 198, tables 19 and 20 and plate 34. This natural lake at an altitude of 5,410 feet has an outlet into North Fork Willamette River at the present time. By means of a diversion tunnel, it is proposed to provide 220,000 acre-feet of storage capacity in this lake to be made available by a maximum draw down of forty feet. The proposed use of Waldo Lake depends upon the simultaneous occurrence of several factors. "Storage from Waldo Lake is released only when the natural flows and reservoir storages at Meridian and Hills Creek Reservoirs are unable to produce their combined prime power and when there is a deficiency of prime power in the Columbia River power system." According to Paragraph 78 of Appendix H, the storage assigned exclusively to power would be required from October through March of a critical power production year, of which 1936-1937 is an example. It is anticipated in the Review Report that this would occur in about one year out of ten. Waldo Lake, according to Paragraph 83, provides special storage to supplement power storage at Hills Creek and Meridian only during these same critical years. In view of the fact that the average annual run-off from Waldo Lake is omly slightly in excess of 21,000 acre-feet, it appears that the proposed maximum draw down occurring once in ten years would eliminate substantially future natural drainage of the lake through North Fork Willamette River. According to Chart 5 of Appendix H, the operation of this draw down in the past would have reduced the level of Waldo Lake below its natural outlet during the period from November 1936 to October 1943. This destruction would have occurred to produce an average increase in flow at Meridian Dam of 777 cubic feet per second for three months of the critical year. The effect upon the fish resources of Waldo Lake from prolonged draw down is difficult to estimate. Fisheries experts agree that the maximum draw down contemplated for this lake would have disastrous effects upon the productivity of the lake for several years following such draw down. Another undesirable feature is that the diversion discharge will be made into a stream other than that through which Waldo Lake naturally discharges. This stream is Black Creek which is in turn a tributary of Salmon Creek. Black Creek and Salmon Creek are comparatively small streams. The distance from

Waldo Lake to Middle Fork Willamette River by way of these streams is about 28 miles, the last fifteen of which are below the confluence of Black Creek with Salmon Creek. According to figures in Table 1 of the Review Report (House Document 544) the maximum twenty-four hour discharge from Salmon Creek at its mouth is only 1,840 cubic feet per second, while the minimum daily discharge is 107 cubic feet per second. It appears, therefore, that the 28 miles of stream which will drain the proposed diversion from Waldo Lake will receive sudden influxes of water which will be about eight times as great as the minimum flow and almost half as large as the flow during a maximum flood. Here again, there is every reason to believe that such sudden extensive discharges into a comparatively restricted stream channel will result in a large amount of scouring with the destruction of fish feeding areas, fish food, fish protective areas, and the probable loss of fish through stranding over banks.

There will be deleterious effects upon the flows in North Fork Willamette River which will result from the diversion of Waldo Lake into Black Creek. The Corps of Engineers estimate of an annual average output from Waldo Lake of 23,000 acre-feet would represent an average annual flow in North Fork Willamette River of approximately thirty cubic feet per second. No data are available which will form the basis for an estimate of the probably damage to North Fork Willamette River as the result of this amount of reduction of flow, although it is known that this will be an important reduction in volume of this stream. The Waldo Lake diversion will result in a definite loss in productivity of North Fork Willamette River for a distance of 41 miles. This is a famous angling stream and the losses occurring to trout fishing will be serious.

Meridian and Dexter Dams

Meridian Dam and reservoir constitute major units in the development of the Willamette Valley Project. The originally authorized site for the construction of a major dam on Middle Fork Willamette River was at Lookout Point. For engineering reasons, the Meridian site was substituted for Lookout Point and construction actually has commenced at this location. This selection of site

was made subsequent to the studies contained in Special Scientific Report No. 33, and further studies are in order to elucidate the effect of the proposed storage schedules upon the characteristics of the water which will be discharged from this reservoir late in the summer. As was discussed previously, the storage characteristics of the water at Meridian Reservoir will undoubtedly be modified through the receipt in Meridian Reservoir of water which has been previously stored in Hills Creek Reservoir.

The maximum variation of discharges from the Meridian Dam would be from zero to 16,000 cubic feet per second and immediate reductions from 13,000 to zero cubic feet per second would occur in flood regulation (Table 3, Appendix H). In addition variations in water released, depending upon fluctuations in power loads, would produce fluctuations in the river stages of about thirteen feet. This is a condition which the Corps of Engineers considers adverse to fish life. In consideration of this, and for other reasons, they propose the erection of a reregulating dam located three miles below Meridian Dam at the Dexter site. This dam, which will raise the water level 55 feet, would be regulated in such a manner that the short time fluctuation in discharge from Meridian would be reduced or smoothed by storage in the upper four feet of the Dexter Reservoir. Since this dam will have no effect upon flood control, the principal discharges therefrom will be controlled by the discharge from Meridian Dam. The foregoing information has been taken from Paragraph 217 of Appendix D. It is evident that the agreed loss of productivity which will occur in Meridian Reservoir will also be found in the three miles of river from Meridian to Dexter Dam. Again, it must be emphasized that the absolute minimum flows for fish preservation of Table 1, Appendix H, appear to have been disregarded in the actual flood regulating schedules as proposed in Table 3, Appendix H.

The excessive instantaneous increases in discharge rate from Meridian Reservoir may be reasonably expected to produce deleterious conditions in the stream as far down as the confluence with the McKenzie River, a distance of about 27 miles. The maximum destruction from scouring would occur between

Dexter Dam and the confluence of the first major tributary, Fall Creek, which enters about six miles below. Lesser damages are expected to occur from such scouring in the succeeding eleven miles to the mouth of Coast Fork.

The implications of the above discussion are manifold. The Corps of Engineers has stated that further negotiation regarding water flows may be necessary. Consequently, it is possible that Table 3 will not be followed and that the dams will be operated so that there always will be some water left in the channel. On the other hand, if the present schedule is to be followed, fish life will be greatly reduced in the affected areas. The loss of spring chinook salmon run alone, if the run is wiped out, could be between $5,000,000 and $25,000,000. Such possible losses have not been taken into consideration.

Fall Creek Dam

Fall Creek Dam would be located on Big Fall Creek near the mouth of Wineberry Creek and would produce a reservoir which would flood 6.4 miles of the main Big Fall Creek. Of the various structures proposed for Middle Fork Willamette River, this is the only dam which will be constructed exclusively for flood control purposes. It will permit the transfer of flood storage capacities from Meridian Reservoir in a manner which will provide for the maximum generation of power at Meridian. Fall Creek Reservoir has been proposed since Special Scientific Report No. 33 was written and, therefore, the proposed operating schedule of this reservoir has never been studied from the standpoint of the effects which will be produced by the proposed early summer high discharge rates.

Fall Creek is a tributary of the lower Middle Fork Willamette River having a small run of chinook salmon which will be completely cut off from their spawning grounds by the recommended dam. The structure is to be 171 feet in height and it will be impossible for adult salmon to surmount the structure or for young fish to pass safely down.

Fall Creek Reservoir will be evacuated beginning sometime between June 1st and July 1st and will be completely emptied between August 1st and November 15th, depending on waterflow conditions.

This schedule again brings up the important problem of temperatures. Under some conditions, salmon and trout suffer distress and death when temperatures of 70° to 75° are reached, and it is quite probably that such temperatures will prevail below this dam in many years under the proposed schedules. Virtually all lakes and impoundments stratify into three layers during the summer. When the storage is drawn down from 150,000 acre-feet to 10,000 acre-feet (more than ninety per cent removal) the cold deep water will be drawn off first, after which the warm waters of the epilimnion will appear. Salmon and game fish below the dam at such times will be distressed and many will die, depending upon the exact temperature prevailing. As any fish culturist knows, eggs laid in the gravel will experience a severe mortality due to prolonged temperatures above the limits of tolerance.

Furthermore, as pointed out in Appendix H, Table 3, Column D, the water flow below Fall Creek Dam will be shut off completely at times of floods, the water flow being reduced from 3,100 second feet to zero immediately. The disastrous effect of these procedures will be such that large numbers of fish for miles below the dam will be exterminated.

A summary of the probable effects of the structures proposed in the Review Report indicates that the dams and the reservoirs with their proposed operating schedules would produce stream conditions adverse to fish life and aquatic productivity in the main Middle Fork Willamette River from the head of the back water from Hills Creek Reservoir to the confluence with Coast Fork. As noted above, these effects will also occur throughout the length of North Fork, Black Creek, Salmon Creek, and in Big Fall Creek from the upper end of the back water of Fall Creek Reservoir to the confluence of Fall Creek with Middle Fork. Chinook salmon will be barred from the entire extent of their present natural spawning grounds. Waldo Lake will have its natural productivity severely impaired. The upstream sections will be barred to the spawning migrations of rainbow trout from stream areas below the dams, thereby reducing natural propagation in the extensive sections above the reservoirs.

Levees and Channel Rectifications

Certain sections of the Middle Fork Willamette River will be markedly affected by recommended features covered in the Review Report other than the dams and the reservoirs. Six miles of levees are proposed along the banks of the Middle Fork as described in Appendix E, Paragraphs 46 to 51, and as shown in Plate 7 of that Appendix. Such levees may alter the natural banks of the stream damaging seriously the aquatic environment. Such leveed sections of stream may become essentially canals. The plan for levee construction includes the maintenance of such banks by the employment of dumped rip-rap and bituminous surfacing of the stream side of the levees. Such construction will markedly impair or even largely destroy the natural shelter and food producing areas along the banks of Middle Fork from Jasper to the confluence with Coast Fork on one or both sides of the stream.

Canalization of natural stream courses by such means must be critically reviewed from the standpoint of fish life. According to Appendix E, Paragraph 34, the "borrow" materials for the construction of the levees will be "taken from the river side of the levees". It appears evident that the systematic borrowing of material from the stream over a distance of six miles will result in at least temporary loss of productivity in that area of stream bottom.

According to Appendix F, still additional construction is proposed along Middle Fork under the classification of "bank protection, channel clearing, and snagging". The general solution of such problems as bank protection, particularly the prevention of erosion, is greatly to be desired from fisheries aspects as well as for other considerations. The proposed plans to clear out debris and to substitute natural bank materials, natural bank vegetation and cover with the type of structures described in Appendix F, Paragraphs 21, 22, and 23, can cause serious harm if not properly done. This type of construction merely would serve to reduce still further the productivity of the section of stream along which it was placed. Fortunately, these changes in the banks will be confined to about 22,000 lineal feet on Middle Fork of which about 6,000 lineal feet will be between Meridian and Hills Creek Dams.

MCKENZIE RIVER

Original plans for a multiple-purpose structure on McKenzie River involved a dam at the Quartz Creek site across the main river about fifty miles above its mouth. Other sites at Nimrod, three miles below Quartz Creek damsite, and at Thurston, only seventeen miles above the mouth, were favored at various times by the Corps of Engineers. Opposition to sites on the main stem of the lower McKenzie from residents and sport and commercial fisheries interests was so insistent, however, that damsites on three tributaries were selected in preference to a main stream structure.

Present plans call for three dams; one on Gate Creek, one on Blue River, and one on South Fork McKenzie River at Cougar Creek. Extensive channel rectification and levee construction also is proposed on the lower portion of McKenzie, particularly from Hendrick's Bridge to the mouth, a distance of about twenty-one miles.

McKenzie River is among the best trout streams in the United States and is the major spawning tributary for Willamette River spring chinook salmon. There is excellent trout fishing on both the tributaries and the main river. Rainbow trout are the most abundant species, but cutthroats and Dolly Varden are also numerous. There is an important sport fishery along the main river involving in many cases the use of boats and guides. The McKenzie River affords some of the best white-water boat fishing on the continent. Large resorts have been built that depend on sport fishing for their success. According to the Review Report (Appendix D, Paragraph 42) recreational investments along the river from Leaburg to mile 74 total $2,650,000.

As a salmon stream, the McKenzie is unequalled. Extensive spawning grounds exist from its mouth upstream for a distance of eighty miles. So far as is known now, the only anadromous species of fish frequenting the McKenzie is the spring chinook salmon.

The Fish Commission conducted intensive studies on McKenzie River in 1946 and 1947. In both years about forty per cent of the spawning salmon found in all Willamette River tributaries above Willamette Falls were located on McKenzie River spawning grounds. Approximately 50,000 chinook salmon surmounted these falls in those years, and so the McKenzie run may be estimated at 20,000 fish. This run is roughly twice the size of that to Middle Fork Willamette River and its value is, therefore, about twice as great. Whereas the present annual harvest from the Middle Fork run is worth about $200,000, that from the McKenzie is valued at roughly $400,000. Likewise, the value may be raised to at least $2,000,000 annually.

It should be pointed out here that investments in McKenzie River salmon have been made at distant places. Substantial investments in boats and equipment have been made at moorages on the lower Willamette River and by sport fishermen near Portland. In 1947 about 92,300 man-days were expended on the lower Willamette River by sport anglers fishing for spring chinook salmon. McKenzie River chinooks are caught in Columbia River commercial gear and by troll fishermen at sea. Therefore, a part of the tremendous investment in these fisheries is assignable to McKenzie River spring chinooks.

In the Review Report (Appendix D, Paragraph 43), it is stated: "Biologists of the Commission state that in most years a considerable portion of the migratory fish are allowed to pass the taking sites to spawn naturally". The statement is true but infers that the Commission can take all sexual products of the entire run by closing the racks completely. Such is not the case. Large numbers of salmon annually spawn naturally from the racking site to the mouth of McKenzie River. For example in 1947 about fifty per cent of the McKenzie run spawned naturally below the racks. As will be pointed out later, these fish will be directly and adversely affected by the recommended levee construction and channel rectification along the lower McKenzie.

At one point the Corps of Engineers made some computations and concluded that McKenzie River salmon populations would benefit to the amount of $105,000 annually as a result of the proposed dam construction. A basic assumption having

no foundation in experience or known facts was made that the runs spawning in the fifty per cent of the area below the tributary dams would experience a 45 per cent increase. The Oregon Fish and Game Commissions feel that adequately planned operations of the dams could be beneficial to salmon and trout. Qualified men of both fisheries agencies have concluded that the proposed operating schedules are not favorable for these species. Because of the possible deleterious effects of proposed channel work on the river from Hendrick's Bridge to the mouth, there is reason to believe that a decline in salmon and trout production in this area may occur unless present schedules and plans are altered to conform with the requirements of the species concerned.

Cougar Dam

Cougar Dam will be located on South Fork McKenzie River about 4.4 miles above its mouth. It will raise the water 425 feet and flood 6.0 miles of the South Fork and almost two miles of East Fork McKenzie River.

In most years the amount of water in the reservoir will vary from 240,000 acre-feet to a minimum of 28,000 acre-feet, a decrease of about ninety per cent (Appendix H, Chart 8). Such extreme fluctuation will result in a low production of fish foods and low fish carrying capacity for the reservoir.

The damage to fisheries resulting from Cougar Dam have been considered previously by both Commissions. They are: 1. The destruction of about eight lineal miles of excellent spawning, feeding and rearing areas for salmon and trout in the stream areas to be flooded; 2. The destruction of the recreational resource resulting from the withdrawal of this stream area from access by fishermen; 3. The prevention of salmon and trout migrations into the entire area of South Fork above the dam and elimination of the stream from salmon production; 4. The destructive effects of the possible discharge of water of high temperature into South Fork McKenzie River and main McKenzie by late summer draw down; and 5. The destruction produced by wide fluctuations in discharge from the dam during the flood control period.

From the studies of the Corps of Engineers on McKenzie River, it was found that in 1946 the recreational values per mile of river averaged $74,400

investment and $13,400 annual expenditures. While these studies made no attempt to evaluate separately the South Fork McKenzie River, it is not unfair to assume that this stream possesses at least equal potential values for recreational purposes. The direct losses to potential recreational resources in the area to be flooded by the dam may be estimated conservatively at $593,000 investment and $107,000 expenditures on the basis of 1946 values. The recreational value of the reservoir may compensate for this loss to a slight degree.

The magnitude of damage resulting from blockage of South Fork McKenzie River to the natural migration of trout cannot be definitely estimated at this time. Current studies of trout migration in McKenzie River being carried out by the Game Commission are designed to provide information bearing on this subject. At the present time it is known that an extensive migration of mature rainbow trout occurs into the South Fork and that this migration extends for a number of miles above the dam-site. The blockage and consequent elimination of spawning fish will provide serious obstacles to the maintenance of the game fish supply of the McKenzie River.

The question of damages from the discharge of water of unsuitable temperature, or other characteristics, for fish cannot be decided on the basis of present studies. The proposed operating schedule should be studied in detail to determine water temperatures below the dam. If these are abnormally high, the effects on South Fork McKenzie River below the dam will be deleterious, and may jeopardize the main McKenzie River below the mouth of the South Fork.

The proposed operating schedule during the flood season has the same features that will produce destruction of fish as was described for the reservoirs on Middle Fork Willamette River. According to Appendix H, Table 3, fluctuations in discharge from 4,000 to zero and zero to 4,000 cubic feet per second are planned. These flows are projected in spite of the proposals of Table 1 of Appendix H which shows 200 to 300 cubic feet per second reserved for fish. The channel destruction and stranding of fish that will occur will fortunately be limited to the 4.4 miles of stream to the mouth of South Fork.

The borrow area proposals for construction at Cougar Dam, as given in Appendix D, Paragraphs 244 and 245 and Plate 44, may seriously damage over two miles of the South Fork below the dam. Silting will be heavy in the main McKenzie River during construction. The extent of damage to fish life and fish producing areas cannot be accurately forecast from available information.

Blue River Dam

Blue River Dam will be located about 0.6 mile above the mouth of Blue River just upstream from the confluence of Simmons Creek. It will raise the water 277 feet and flood 6.7 miles of Blue River and short distances of minor tributaries.

In most years the amount of stored water in the reservoir will vary from 5,000 to 90,000 acre-feet, i.e., the amount of water will be almost twenty times as great during maximum storage periods than during minimum periods. Because of excessive fluctuations in levels, it is unlikely that trout populations will find the reservoir satisfactory from the standpoint of food.

The damages to fisheries have been considered previously by both Commissions. These are: 1. Total destruction of 6.7 lineal miles of excellent spawning, feeding and rearing areas for game fish, and similar loss of about two miles (to an impassible falls) of available spawning, feeding, and rearing areas for salmonoid fish; 2. Total destruction of 6.7 miles of angling area; 3. Unfavorable changes in environmental conditions below the dam when impounded water is released.

The nature of the changes in temperature and other characteristics of the water in Blue River below the dam, and in McKenzie River below the confluence of Blue River, deserve detailed study in relation to the proposed operating schedules. The proposals of Table 3 of Appendix H would permit rapid alterations in discharges from 2,500 to zero and zero to 2,500 cubic feet per second. The destruction produced by these operations will probably be confined to the channels of Blue River below the dam (0.6 mile).

Borrow areas for construction are described in Appendix D, Paragraph 265 and Plate 47. Major silting of the McKenzie River may occur during the period

of construction with consequent reduction of downstream productivity. If these borrow areas are not chosen with regard to fish life, serious damage may occur in a three-mile section of the McKenzie near the mouth of Blue River. Ill-advised borrowing may leave large gravel pits for loss of fish through stranding. Inasmuch as the loss of fish from these operations cannot be accurately estimated now, both Commissions reserve the right to enter claims for additional damages at a later date.

Gate Creek

Gate Creek Dam will be located 0.4 mile from the mouth of Gate Creek and will raise the water 242 feet, flooding about four miles of Gate Creek and 1.5 miles of South Fork Gate Creek.

In most years the amount of stored water will vary from 5,000 to 55,000 acre-feet. Pool levels will vary accordingly. Normally, emptying of the pool will begin between June 1st and July 1st and the pool will be emptied sometime from August 1st to November 15th.

Gate Creek is now closed to angling as a spawning and nursery stream, and it is difficult to ascribe direct recreational values to the sport fisheries there. This stream is being preserved as a spawning and rearing area for rainbow trout. The Game Commission is currently conducting investigations to increase its fish rearing facilities as well as to develop greater use of its waters for natural propagation of game fish in McKenzie River as a whole. Perfection of the Commission's plans for extensive use of the lower part of Gate Creek Valley for game fish rearing purposes will greatly enhance the value of Gate Creek. Accomplishment of plans currently under study will make available to the Game Commission a potentially valuable and economically feasible means of carrying out its commitments to provide greatly augmented plantings of legal-size trout in the McKenzie River. This program is vital to the maintenance of game fish in keeping with the increasing demand by anglers. It is all the more essential in view of the additional demands that will be placed upon the Commission's facilities for artificial propagation of game fish

following damage to natural stream conditions.

Surveys of potential water supplies for game fish propagation reveal that the choice of streams suitable for these purposes in the McKenzie drainage is markedly restricted. Gate Creek is one of the few practicable streams for expansion of facilities. The continued availability of suitable game fish rearing areas is an absolutely essential condition. The Corps of Engineers gives financial recognition for the still greater expansion of game fish propagation facilities in the Review Report.

Gate Creek at the present time provides an extensive area for the spawning of rainbow trout which migrate from the main McKenzie River. A dam near its mouth would thus eliminate Gate Creek as an effective natural spawning area contributing to the stocks of McKenzie River. As such it would reduce the productivity of not only the area to be flooded, but of the entire section of stream presently used for spawning area by rainbow trout. Current studies of trout migrations in McKenzie River will provide a better basis for estimating the extent of damages than is now available.

The damages that would occur through the discharge of unsuitable water from Gate Creek Reservoir in the summer cannot be decided on present information. Unless highly unfavorable changes take place in the stored water, the comparatively small volumes discharged at any one time would probably be rapidly diluted to innocuous concentrations by the large volume of McKenzie River water just below the dam. If, however, McKenzie River already had its water characteristics deteriorated by the receipt of stored water from Cougar and Blue River Reservoirs, the additional load of altered water from Gate Creek might be adequate to impair the quality of water in McKenzie River. The integrated plans for regulated discharges of Gate Creek plus the other reservoirs on McKenzie River warrant a complete and detailed study.

The proposed flood control regulating schedule for Gate Creek as given in Appendix H, Table 3, indicates that immediate alterations in regulated discharge from 1,500 to zero and zero to 1,500 cubic feet per second are planned. While

such severe and rapid fluctuations in the small channel capacity of Gate Creek will only affect 0.4 mile of that stream, it is considered that sudden 1,500 cubic feet per second fluctuations of McKenzie River would be harmful to fish therein at least as far downstream as the Leaburg Dam.

The proposed borrow area for construction materials is described in Appendix D, Paragraph 278 and Plate 50. The same problems pertain here as in connection with the other dams discussed above.

Levees, Channel Rectification, and Revetments

On McKenzie River a large expenditure is proposed for the construction of supplemental levees, bank revetments, and rectification of channel.

According to Appendix E, Table 2, 31 miles of levees will be constructed with a mean height of seven feet. These are shown on Plate 2, Appendix E, as extending on one or both sides of the stream from Hendrick's Bridge to the confluence with the Willamette River. The proposed levees on the left bank would be nearly continuous from Hendrick's Bridge to the mouth. On the right bank high ground is present in many places and the levees would be discontinuous. Heretofore, fisheries agencies have had no opportunity to examine the details of these proposed constructions which may cause widespread damage to the fisheries resources of the area, both anadromous and resident. For bank protection, debris of all sorts would be blasted or burned, and trees and brush which form obstructions in the channel would be cleared. Heavy machinery will be used on these projects and the prospect is for a canal-like river through a significant part of its length. In 1947, bank protection work apparently was conducted near the Wilson Farm during and after the salmon spawning season. State fisheries agencies were not informed about the plans or progress of the work.

The Fish Commission estimates that fifty per cent of the salmon entering McKenzie River utilize the section of stream below Hendrick's Bridge for spawning. By the studies of the Corps of Engineers, the investment and annual expenditures on McKenzie River in relation to the game fishery averages

$74,400 and $13,400 per mile respectively, as of 1946. The 26 miles below Hendrick's Bridge which would be affected by the proposed construction have recreational values of not less than $1,926,000 investment and $344,600 annual expenditure. These are subject to jeopardy by the recommended plan.

The construction methods proposed for the levees, as described in Appendix E, Paragraph 29, and 34, would be such as to disturb greatly the natural bottom of the river and to create unnatural bank conditions. "Penetration asphalt was selected as the material best adapted to conditions along contemplated levees..... Asphalt in the amount of two and one-half gallons per square yard would be applied to the top course." Such construction would destroy large areas of natural stream conditions for salmon and trout. In addition, the plans (Appendix E, Paragraph 34) that "all borrow materials for the construction of levees would be taken from the river side of the levees" which are advocated in part for improvement of channel sections have been made without full careful regard for the destructive effects of such operations on fish life, fish spawning areas, and fish foods. Ill-advised construction of the nature discussed above in which fish life is not considered during the construction period or planning may be decidedly deleterious to salmon and trout populations.

According to Paragraphs 56 and 175 of Appendix E, one of the major items of channel improvements will be the complete changing of the sections of McKenzie and Willamette Rivers at their confluence. The present mouth of McKenzie River, which is located at river mile 172.5, would be moved nearly four miles upstream to river mile 176.4. This will make an artificial confluence of the two streams and cause the abandoment of valuable fish producing areas of McKenzie River. The Corps of Engineers find that it will be necessary to ".....realign and rectify the channel (of Mckenzie River) for a distance of 1.5 miles upstream from the proposed new mouth....". The new mouth for McKenzie River will, therefore, affect 5.4 miles of the natural stream. This work, which is evaluated nowhere in the Review Report as a means of reducing flood conditions, would destroy or impair some of the most important natural

spawning areas for chinook salmon on McKenzie River. It would markedly reduce the game and food fish productivity of this section of McKenzie River. The effects might be manifest in still more serious ways. The proposed construction would alter the natural channels through which the salmon migrate from the sea, and through which the famous red-side trout of McKenzie River migrate to and from the lower river. No one can give assurance that the marked alterations in channel as proposed at the confluence of these two streams will not profoundly affect the migrations through this area. The Commissions are concerned over the omission of any reference to the time of year which the proposed channel improvements are to be carried out and the lack of evidence that the Corps of Engineers has given even nominal consideration to the fisheries aspects of this construction. In this connection, it may be repeated that neither Commission has been consulted with regard to these channel modifications.

The bank revetments will affect the same general area of McKenzie River as will the proposed levees, as shown in Appendix F, Plate 4. In addition, there will be 3,170 feet of such works along McKenzie River between Hendrick's Bridge and Leaburg. According to Paragraph 17 of Appendix F, much of the bank-protection work is necessary because "....under regulated conditions bankfull stages will prevail from 1 to 28 days each year, and average six days longer under regulated conditions than under natural conditions. These prolonged bankfull stages would result in additional bank erosion.... Therefore, bank erosion in certain areas probably would be at least as great under regulated conditions as under natural conditions...." In correcting this condition much care will be required to avoid serious damage to the natural environment.

The various plans for controlling floods on Calapooya River were considered in detail by the Corps of Engineers and a damsite was selected about fifty miles above the mouth. The dam would be 130 feet high and back up water for a distance of 3.6 miles.

Calapooya River is inhabited by rainbow and cutthroat trout in its upper reaches. Spring chinook salmon and steelhead annually enter Calapooya River. The Finley Dam below Crawfordsville blocks the salmon and has done so in some degree for 100 years. Yet a vestigial run remains probably because there are some favorable resting pools and spawning areas below the dam.

The proposed Holley Dam will cut off all spawning grounds and without fish facilities the present small run would be wiped out. The structure will also interfere with resident trout. Although the Corps of Engineers claim benefits to fish life, (Appendix D, Paragraph 325) such statements are questionable. Salmon and trout will be affected adversely and spiny-rays are not expected to be benefited. Principal destruction will be through: (1) Blocking of fish movements; (2) Fluctuating water levels in the reservoir and in the river below; (3) High and varying late summer water temperatures below the dam.

In times of approaching high waters, twelve hours before a forecast flow of 2,200 second-feet, the outlet gates will be turned off completely and the outflow below the dam will be zero (Appendix H, Table 3). Fish life below the dam may be drastically reduced.

Normally, storage will vary from 90,000 acre-feet to 7,000 acre-feet (Appendix H, Chart 13). Draw down will begin May 1 to July 1, and the pool will be emptied by November 15th. Serious temperature problems, such as those anticipated for Middle Fork Willamette River, will a rise at Holley Dam because of its schedule of operation. Water flows will often be more than twenty times those that now prevail. The maintenance of racks and the operation of fish

cultural facilities will be most difficult. The reservoir may compensate to some small extent for the loss of upstream spawning areas depending upon its productivity.

Original plans for multiple-purpose water control on the South Santiam River involved one main-stem dam near Sweet Home. Industrial developments in that area removed this from consideration and others were then considered. Several sites near Waterloo and one near Foster, all of which involved the main stem of South Santiam were considered as late as the summer of 1947. Fisheries and local interests objected to these sites on various grounds, and they are not now recommended. In September, 1946, three alternative sites were first considered, namely: Green Peter on Middle Santiam River; Wiley Creek on Wiley Creek; and Jordan on Thomas Creek, (Appendix D, Paragraph 109). Local residents objected strenuously to the construction of Jordan Dam (Appendix D, Paragraph 127), so Cascadia site was selected late in 1947.

Recommended plans call for construction of four dams on South Santiam River. Green Peter Dam is recommended and White Bridge is to be built for re-regulating water flows. The latter structure will inundate the Fish Commission's hatchery. Wiley Creek and Cascadia Dams on Wiley Creek and Cascadia Fork, respectively, are recommended.

The South Santiam is a good trout stream and a fine salmon and steelhead spawning stream. Trout fishing is good on all three tributaries to be blocked by the dams. Spawning migrations of resident trout will be blocked and the inundated areas will be lost to a large extent to trout production, and completely to stream angling.

As a spawning ground for salmon and steelhead, South Santiam River above the damsites is excellent. There are large deep pools offering protection and resting areas for the fish and large reaches of good spawning gravel. Salmon observed in that river system during the last two years have been in better physical condition and suffered fewer pre-spawning mortalities than those in any other tributary of the Willamette River system. In 1947, approximately twelve per cent of the spring chinooks located on spawning grounds of the

Willamette system were found in the South Santiam. Inasmuch as about 45,000 of these fish surmounted Oregon City Falls, this indicates a spawning population of roughly 5,400 fish. This population is about sixty per cent of that in the Middle Fork Willamette River and the value is correspondingly less, i.e., about $120,000 annually with a potential annual value of at least $600,000. It is estimated that 84 per cent of South Santiam River run will be blocked by the proposed dams.

No precise data have been obtained regarding steelhead populations of South Santiam River and estimates are therefore subject to considerable error. Best known estimates indicate a spawning population of 4,000 fish in South Santiam River of which eighty per cent will be blocked by the proposed dams. At the present time, the annual harvest of this run may be $2,500.

In Appendix C, Paragraph 544, it is stated: "South Santiam River is heavily polluted by pulp mill, cannery, and domestic wastes introduced at Lebanon. Increased flows during low-water periods would assist in abating pollution and would increase the present potential fish productivity of the stream". The statement is partially true in that South Santiam River is heavily polluted at Lebanon, but the conclusions are questionable. The most important species in the South Santiam are anadromous and these species are in such grave danger of extinction because of the proposed dam construction and operation that potential productivity may be nil. The potential productivity surely will be reduced because of elimination of spawning areas. Furthermore, and fortunately, anadromous fish are generally not found in the polluted area during the critical months of July, August, September, and October. The young migrate down and the adults migrate up during periods of high water. Actually, regulated flows eliminating the periods of high water may adversely effect the fish in the polluted area.

Cascadia Dam

It is recommended in the Review Report that Cascadia Dam be built at a site about seven miles above the confluence of Cascadia Fork with Middle Santiam River. The reservoir produced will be six miles in length. The dam will be about 239

feet in height and will block the passage of all migratory fish.

This dam was proposed recently and fisheries agencies have had little opportunity to consider the problems concerned. Salmon and steelhead using this tributary all spawn above the damsite. It will completely eliminate spawning areas. In 1947 about one-third of the spring chinook run to South Santiam River spawned in Cascadia Fork.

Study of Appendix H, Chart 14, indicates that draw down of Cascadia Reservoir will begin from May 1 to June 1 and will be completed about November 15. Usually, the stored water will be reduced from 47,000 to 4,000 acre-feet in that period, a decrease of more than ninety per cent. Along with the Middle Fork of the Willamette River, the South Santiam is expected to be one of the critical temperature areas and the anticipated prevalence of high temperatures in the late summer in Middle Fork Willamette River apply equally well to South Santiam River. Without question, a serious temperature problem exists, and critical temperatures may be reached with the initial removal of the deep cold layer and subsequent draw down of the warm surface layers. If blocked adults choose to spawn below the dam, high or rapidly changing temperatures may be expected to cause large mortalities of adults and eggs.

The direct removal of six miles of trout stream and substitution of a dam impassable to resident trout will have serious effects on game fish populations. Highly fluctuating forebay levels will limit food production and hence fish production.

Because of large summer flows, it may be impossible to maintain racks of the simple type involved in the preliminary estimates for fish facilities. Flows will be ten times as great as normal in the summer under the same circumstances.

Reference is made to Appendix H, Table 3, in which flows during high waters are listed. Twelve hours before a predicted inflow of 6,000 second-feet, the outflow will be completely shut-off. This will cause serious harm in the six miles down to the confluence with Middle Fork Santiam River. Benefits to fish life appear questionable. If such operating schedules are maintained

the same destruction as described for stream sections below other dams will occur below Cascadia.

Green Peter

The recommended Green Peter Dam will be located on Middle Fork Santiam River four miles above its confluence with Cascadia Fork, at which place the two combine to form South Santiam River. Its height will be about 315 feet, and it will cut off approximately half the South Santiam salmon runs from their spawning grounds. The reservoir will be eleven miles in length, and some fifteen miles of trout waters will be replaced by a reservoir of questionable productivity.

White Bridge Dam will be constructed for regulating the excessive discharges from Green Peter. It will inundate the Fish Commission salmon hatchery. The proposed reservoir is shown in Appendix D, Plate 65, but proposed borrow areas are not given.

According to Appendix C, Chart 15, draw down of Green Peter reservoir will begin from July 1 to September 1 and will be completed by November 15. Maximum draw down will be from 360,000 acre-feet to 38,000 acre-feet. This may cause serious temperature problems. Large summer flows will make racking the river difficult and the costs for salmon and steelhead facilities have been reviewed with that in mind. Flows will be more than ten times those now prevailing, according to Appendix H, Chart 15.

Attention is drawn to Appendix H, Table 3. Twelve hours before a predicted flood, the outflow would be immediately reduced to zero. Possibly White Bridge Dam would continue passing water and alleviate this drastic conditions, but no statement to that effect has been found. In any event the rate of change of flow will be great and the effect on fish life will be serious. These large variations in flow will affect stream conditions for long distances below the dam.

Wiley Creek

The recommended Wiley Creek Dam will be located 4.7 miles above the mouth of that stream, which joins South Santiam River at Foster. It will be 196 feet

high and it will form a reservoir 2.6 miles long. Anadromous fish will be blocked by the structure.

Wiley Creek has a good trout population and is frequented by both steelhead trout and spring chinook salmon. Yet in Appendix D, Paragraph 385, it is stated: "Salmonoid fish do not spawn in Wiley Creek....". Biologists found twenty salmon in one pool in Wiley Creek, 2.1 miles above the forks of Big and Little Wiley, i.e., above the damsite, on August 4, 1946. The steelhead run is considered by residents contacted to be larger than the chinook run.

Draw down of Wiley Creek Reservoir is scheduled to begin from July 1 to September 1 and will be completed by November 15 to December 1. The amount of stored water in the reservoir will vary between 47,000 and 4,000 acre-feet. Flows in the summer will be about twenty times those now prevailing on some occasions.

Forebay fluctuations will reduce productivity. Draw down of water from the upper warm layers may be expected to occur and mortalities of salmon and trout below the dams may be encountered. In addition high summer flows will call for relatively expensive facilities.

NORTH SANTIAM RIVER

Detroit Dam will be located about six miles downstream from the town of Detroit. It will raise the water 371 feet, flooding the town of Detroit and the Fish Commission's egg-taking station at the mouth of Breitenbush River. It will also flood 8.5 miles of North Santiam River, 1.5 miles of Breitenbush River and various lengths of minor tributaries.

The damages from this dam have been considered by both Commissions in communications to the Corps of Engineers. They are: 1. The destruction of seventeen miles of spawning, feeding and rearing areas for salmon, steelhead, and resident trout in the stream sections to be flooded; 2. The prevention of salmon, steelhead, and trout migrations into extensive stream sections above the dam. 3. Deleterious downstream conditions resulting from fluctuations in discharge; and 4. Possible abnormal temperatures below the dam.

It is well-known that extensive runs of steelhead trout reach the stream areas far above the proposed Detroit reservoir. Evidence secured by the Game Commission in 1942 and 1946 makes it seem probable that a considerable proportion of the angler's catches in the upstream sections was composed of yearling steelhead before they had begun to migrate to the sea. The effects of the dam will be, therefore to reduce the game fish productivity over the entire watershed of North Santiam River above the dam. Augmented artificial propagation to substitute for reduced productivity should be provided.

Salmon runs into the area above the Detroit dam constituted about 23 per cent of the entire escapement of salmon located on the spawning grounds above the Willamette Falls during surveys throughout the 1947 season. According to observations made in 1941 and 1942 (Special Scientific Report No. 33, Page 27) about two-thirds of the chinook salmon observed on the spawning grounds of North Santiam River were found above the dam site. Records of the Oregon Fish Commission for 1947 indicate that about 71 per cent of salmon spawned above the Detroit dam site.

Field personnel of the Game Commission conservatively estimate that annual expenditures for the seventeen miles of stream affected would amount to approximately $45,000.00. It is difficult to place monetary values upon actual or potential angling streams of western Oregon. The increasing pressures that the fishing intensity will produce as the human population continues to grow makes it mandatory that conservation agencies preserve from destruction every mile of stream that is possible.

Detroit Dam is the only major dam in the Willamette Valley project that will be located as planned at the time that the studies of special Scientific Report No. 33 were conducted. At that time, however, the water level rise was planned for only 259 feet, and a single low-level outlet was proposed. In the analysis of probably water temperatures for the old Detroit Dam it was shown that the water to be discharged according to the original operating schedule, would have been unsuitably warm in some years. The design changes for Detroit as shown in the Review Report increases the maximum depth of stored water by 112 feet. Three sets of conduits through the dam will draw off stored water at levels which are to be located 178, 229, and 304 feet respectively below normal pool elevation. No data are given in the Review Report which would indicate the relative discharge that might take place from the various conduits under any particular circumstances. The highest of these conduits will be located approximately eighty feet nearer the surface of the water than was contemplated in the original Detroit Dam. It appears likely, therefore, that stored water of unsuitable temperature will be discharged much more frequently as presently designed, than under the previous plan. Detailed studies of the regulated discharges are in order. Modification of discharges may be necessary to provide safe water conditions below the Detroit Dam. This is very important; without continuous water temperatures corresponding with those existing under present natural conditions salmon and trout cannot be expected to survive.

The proposed operating schedules for Detroit Dam during the flood season have the same objectionable features as in the other schedules for Willamette

reservoirs. According to Table 3 of Appendix H, rapid changes in flow from 7,000 to zero and from zero to 10,000 cubic feet per second are planned. The channel destruction and stranding of fish which will result from such fluctuations in discharge will not be relieved by the operation of Big Cliff re-regulating dam, 2.8 miles below Detroit Dam. The effects of these discharges will be felt to an appreciable extent throughout the length of North Santiam River, 48.5 miles to its confluence with South Santiam River.

Big Cliff re-regulating dam will raise the water level about ninety feet. This dam is designed for power and as a means of smoothing out the large daily variations in output from the Detroit power plant. Complete flooding of the stream section between Detroit and Big Cliff Dams will largely eliminate angling from this area.

No plans for reservoirs on Pudding, Molalla, and Clackamas Rivers are included in the Review Report and consequently reservoirs are not considered by the fisheries agencies at this time. Appendix E, Plates 1 and 6, indicate that no levees are planned for the above streams.

Bank protection, channel clearing, etc., is planned. According to the table in Appendix F, Paragraph 2, there are three places each along the Pudding, Molalla, and Clackamas Rivers, respectively, that require bank-protection work. Channel improvements are required, according to Appendix F, Paragraph 4, along twenty miles of Molalla River and 22 miles of Clackamas River. Penetration asphalt, sand-cement grouted gravel, and gravel blanket stabilization types of revetment may be used. To improve the channels, tree and brush growths and encroaching bars would be removed, adversely affecting shade, cover, and fish food production. All of the proposed construction will affect the spring chinook, silvers, steelhead, and trout using these streams. The removal of bars and gravel from the stream will have a negative effect on the spawning and rearing areas involved.

Johnson Creek is a small tributary entering WillametteRiver near Milwaukie. A large section of this stream was canalized in the past, but the work has not been maintained. Also, a severe pollution condition originates near Gresham.

At present, Johnson Creek supports a sport fishery for adult steelhead trout during the winter and a trout fishery in the spring and summer. Its potential recreational value is high. The Oregon Sanitary Board has directed Gresham to clean up the pollution originating there, and this situation should be under control in the near future. With that done, the stream can support its shareof the increasing angling pressure near Portland.

Under the proposed plan Johnson Creek will become practically a ditch from Gresham to its mouth. A satisfactory environment for trout, and this includes young steelhead, must contain both pools and riffles as well as cover. None of these is found in a ditch. It seems as if adequate flood control could be provided, and yet leave the stream, under normal conditions, a trout stream. This creek, if it can keep the appearance of a natural stream, situated as it is in an urban area, becomes an invaluable asset to the community. If it is changed into a canal or ditch, it becomes, if anything, a hazard. Such canalization does not bear out the claims of the Review Report that its proposals will benefit the fisheries.

COAST FORK WILLAMETTE

Cottage Grove Reservoir

The dam forming Cottage Grove Reservoir is 95 feet in height from stream bed to crest, and impounds a usable storage of 30,000 acre-feet of water. The operation schedule as given in Table 3, Appendix H indicates immediate changes in flow of 2,300 to 1,200 cubic feet per second and 1,200 to 2,300 cubic feet per second. Such fluctuations cannot be considered beneficial to fish life.

The Review Report states in Appendix C, Paragraph 539 that before construction of this dam the stream provided trout fishing in the early spring, and that since construction good catches have been made below the dam. From this it is concluded that the dam has improved environment for fish. This conclusion is not entirely justified, as the fact that trout fishing was good in early spring may indicate spawning migrations to areas in the upper tributaries. The construction of the dam blocked these migrations, resulting in a greater temporary concentration of fish below the barrier. The long-term effect probably will be depletion or extinction of these runs. Thus the overall effect on the resource cannot be considered beneficial.

The reservoir itself in early years produced fair fishing for cutthroat trout which since has seriously deteriorated. Studies have indicated that fishing may be maintained here by planting legal trout.

Dorena Reservoir

The dam forming Dorena Reservoir will be 145 feet in height from stream bed to crest, and is located seven miles from the mouth on Row River, a tributary of Coast Fork Willamette River. The operation schedule given in Table 3, Appendix H calls for immediate changes in outflow between 3,200 and 5,000 cubic feet per second. Such sudden changes do not contribute to a good fish environment.

The construction of this dam may make some improvement in the fish habitat below it by controlling temperatures, but, as in the case of Cottage Grove

Reservoir, it will block passage of a fine race of rainbow trout attempting to reach the headwater streams to spawn. Some angling will undoubtedly be made available in the reservoir itself, but its quality and quantity are not expected to be good because of fluctuating levels.

WEST SIDE TRIBUTARIES

The streams originating in the Coast Range and entering the Willamette River from the west in general do not support runs of salmon and steelhead but have long been famous for excellent cutthroat trout fishing. The upper reaches of these streams are the natural spawning grounds of this species. Brood fish ascend the streams to the smaller headwaters in their spawning migrations. Also, the lower reaches of some of the west side tributaries furnish good spiny-ray angling. Expansion of angling on these types is desirable because of changed conditions in watersheds and to relieve pressure on trout populations.

Long Tom River

The present Fern Ridge Reservoir on Long Tom River will be slightly modified under the proposals in the Review Report by increasing the height of the dam two feet. The operating schedule as given in Table 3 of Appendix H does not call for immediate reduction of outflow to zero cubic feet per second as does that of other dams, but does reduce it uniformly to zero from 3,000 cubic feet per second. Such drastic fluctuation of flow could hardly have beneficial effects on fish life in the stream below.

Paragraph 297, Appendix D, implies that cutthroat were not present in Long Tom River before the construction of Fern Ridge Dam. This was undoubtedly thought to be true. It further states that they were caught in the stream below the dam after its construction. The clear implication is that the dam is to be credited for their presence. Is it not more likely that these fish had always used the river and only became more noticeable when their migration was stopped by the dam? This situation should be investigated.

Sustained yield fishing in the reservoir itself is subject to conditions far from conducive to high production. Much of the area is very shallow at normal pool level, and operation of the reservoir for flood control will

periodically expose to desiccation large portions of the bottom, thus removing them from fish food production. This condition will result in low production of fish per acre at levels maintained during the recreational season. Here spiny-ray fish have completely replaced trout.

Marys River

The proposals for Marys River proper consist primarily of levees, channel clearing, and channel cut-offs in the lower reaches. This stream originally furnished considerable cutthroat fishing and presumably such works will not prevent this species from migrating to its spawning grounds in the headwaters of the main stream. Channel cut-offs, however, will reduce the area in the lower reaches that is actual or potential spiny-ray habitat. By reducing pool areas and increasing velocities, the habitat for these fish will be damaged.

West Muddy Creek, a tributary of Marys River, currently produces cutthroat fishing, yet the proposal places a levee across its mouth. Drainage conduits through this levee equipped with tide gates may or may not permit free passage of trout. Cut-off channels will reduce the length of stream channel by almost half, thus removing eighteen miles. Angling license sales in the state have more than doubled in the ten years ending in 1946 and are still increasing, making the loss of existing waters a serious problem.

The proposals in the Review Report call for a reservoir holding 24,000 acre-feet of usable storage on Tumtum River, a tributary of Marys River. Cutthroat are an important gamefish in the drainage. The regulation schedule in Table 3, Appendix H, calls for immediate changes in outflow from 1,500 to zero and zero to 1,500 cubic feet per second. Such fluctuations will have a deleterious effect on fish life of any species below the dam through lowering of the basic productivity of the stream.

Luckiamute River

The Luckiamute River system supports a native cutthroat population. This race of native cutthroat has suffered badly during the past fifteen years from the march of civilization, and further artificial improvements to the

streams cannot be expected to aid them. The Lewisville Reservoir on Little Luckiamute River will block any chance of brood fish reaching spawning areas in the headwaters of this stream. The operating schedule here parallels those on other reservoirs with the same deleterious affects.

Cut-off channels in the lower reaches will remove appreciable stretches of the river from fish production, and a tributary, Soap Creek, will be cut-off by a levee with access only by means of tide gates. Due to the changes in level, normal to the operation of such a reservoir, it is doubtful if good angling could be maintained in it to compensate for the fishing water removed by cut-off channels.

Changes in Willamette River resulting from proposed flood control and particularly proposed increased multiple use will be profound. Willamette River is an avenue of migration for steelhead and cutthroat trout, spring chinook, a few fall chinook, and a limited run of silver salmon. Steelheads appear in the lower river in small numbers in November and are found migrating over Oregon City Falls as late as May. Spring chinook normally pass over Willamette Falls during March, April, May, and June. Fall chinook have almost disappeared from the Willamette system and none pass Willamette Falls. Silver salmon move through the lower Willamette on their way to the spawning grounds in Clackamas, Molalla, and Tualatin Rivers during November and December.

There are good rainbow and cutthroat trout populations in Willamette River. These trout migrate into and out of the tributaries. Other game fish include such species as catfish, bass, crappie, bluegill sunfish, and perch. These fish are a major hope for spreading the constantly increasing angling pressure in Oregon waters.

Pollution Dilution

The fisheries aspects of pollution abatement have been given considerable attention in the Review Report (Paragraph 202, Section IX and X of Appendix C). Paragraphs 516, 538, 544, and 545 of Appendix C make direct or inferential statements that the pollution dilution which is anticipated to occur as the result of higher summer discharges will be an aid to the salmon and steelhead populations. The Oregon Fish and Game Commissions have been studying the movements of both young and adult anadromous fish. To date the results indicate that no young spring chinook or steelhead trout are to be found at any points in the main part of Willamette River during the critical pollution months of August and September. Likewise, there are no authenticated reports of adults being in the main river during those months, as both the chinook salmon and steelhead upstream migrations are completed prior to the time pollution becomes

a block. This means that the important species for which benefits are claimed by pollution abatement are not present in the critical areas at critical periods. Thus, the claims for fish benefits through pollution dilution are of a dubious nature.

It is pointed out that the complexities of pollution abatement are so diverse that fisheries and sanitation authorities should be warned against complacency from reliance upon the effects of dilution. Eventually complete treatment of pollutants will be required. It seems unwise to advocate a protracted delay in the construction and installation of definitive pollution treatment processes. The claim for benefits to pollution abatement through dilution will inevitably be seized upon by dilatory industries and municipalities as a valid basis for postponing adequate treatment. Thus, while summer oxygen conditions may be improved temporarily, the nuisance and health hazards of untreated industrial and domestic sewage still will remain.

According to Paragraphs 504 and 505 or Appendix D, the benefits are computed on the basis of reservoir discharges increasing the flow to 6,500 cubic feet per second from the natural flow of 2,500 cubic feet per second. This computation is made for conditions at Salem (according to Paragraph 494, Appendix D). This paragraph states categorically: "Storage releases from the proposed reservoirs would increase the minimum flow to 6,500 second-feet and appreciably lessen the degree of pollution." The basic data for natural and regulated discharges fails to substantiate the claims for the degree of dilution stated. Reference is made to Plate 7 of Appendix H which shows the natural and regulated flows at Oregon City and Salem.

Examination of this plate indicates that at no time in the period 1926 to 1945 did the mean monthly natural discharge at Salem fall to or below 2,500 cubic feet per second. In only 6 of the 120 months in this period did the discharge fall to or below 2,550 cubic feet per second. The data of the same plate show that the regulated discharges would have dropped below 6,500 cubic feet per second in 20 or 21 of the 120 months of the period. Moreover, this would

have occurred during one or more months in 6 or 7 of the 20 years of record. The source of doubt in this record is associated with the discharge for August 1932 in which the regulated discharge at Salem is indicated as 6,500, while that at Oregon City is indicated as 5,800 cubic feet per second. At Oregon City the regulated flow would drop to or below 5,000 cubic feet per second during one or more months in four out of twenty years. At this station the discharge would fail to reach 6,500 cubic feet per second in 18 out of 120 months, or one or more times in 7 out of 20 years.

Claims for benefits because of pollution abatement that would be favorable to fish life cannot be substantiated when the conditions of pollution would not be satisfactory in 30 to 35 per cent of years. A feature which must be emphasized is that water conditions must be continuously satisfactory for fish. The improvement of water conditions by regulation, but with lethal pollution still present during 30 to 35 per cent of years, is not a sound solution from a fisheries standpoint. Such proposals only serve as illusions of improvement.

The controlled discharges of Willamette River may result in increased summer pollution. Under present conditions a large flushing effect is present in the lower river during the winter and spring. During these periods of high discharge the accumulated organic sludges and septic areas on the river bottom are eliminated. By reducing flushing of the stream bed additional organic matter will be present throughout the year and will require more oxygen for its decomposition.

The final point of exception to pollution abatement benefits is the fact that the most seriously polluted area of the whole Willamette River will not be materially helped by the increased dilution. No benefit for abatement of pollution is claimed for the eighteen miles of Willamette River from Sellwood Bridge to the mouth (Appendix C, Paragraph 513). If this section is uninhabitable for fish, then the entire river is closed to use by anadromous fish during the period of such pollution and no benefits to anadromous fish can be claimed.

In spite of unfavorable conditions in large areas due to pollution, certain parts of the main stem of the Willamette are important from a recreational fisheries standpoint. The most important is the spring chinook sport fishery. On the upper part of the main stem, generally between Eugene and Harrisburg, there exists a boat fishery for rainbow and cutthroat trout that is of considerable importance. Also, spiny-ray fishing on various sloughs is of some importance now, and its importance will increase. Progress is being made by the State Sanitary Authority in getting the river cleaned up, and when this is accomplished, the recreational value of the main stem will increase.

Main Stem Construction

Levees are proposed for the main stem of the Willamette River discontinuously from the confluence with the Long Tom up to Eugene. Trout, salmon, and other game fish in large numbers are present in these areas at various times of the year. Removal of gravel for levee construction and other channel improvements may be harmful if the areas are used by salmon for spawning. Food conditions for fish will also be adversely affected.

Overflow channel closures are indicated for unspecified points along the main stem. Rather extensive drainage is also proposed for the future. At the present time sloughs and shallow lakes along the main stem and on the valley floor are furnishing considerable recreation in the form of spiny-ray fishing. No figures are available at present on the monetary value of these waters as recreational sites; however, it is appreciable and rapidly increasing. The Oregon State Game Commission is engaged in a survey of these areas and plans to expand and improve this fishery to help accommodate increasing angling pressure.

The above mentioned overflow channel closures and drainage programs should be studied carefully with these facts in mind before they are carried out. It is entirely possible that such a program could be so planned as to improve such recreational facilities. It should be understood that in many cases a given acreage can produce a greater amount of food as a fish pond than it can as a field producing terrestrial crops.

Regulated flows following completion of the project may have serious consequences on the migration of fish over Willamette Falls. On either side of the falls lie large industrial plants which take all of the waterflow during low water periods. Fish ascending the river at low water move against the current until they arrive at the tailrace of the plants as there is insufficient attraction from the fish ladder. Occasionally the mills close down for several hours and the migration over the falls jumps almost immediately to several thousand fish a day. Many of these may be delayed too long to reach their spawning grounds. Fortunately, natural flows are normally fairly high in the spring and considerable water spills over the face of the falls. Under such circumstances the fish are attracted up to the fish ladder.

Under present plans for storage, the spring waterflows will be drastically reduced at the falls. This may be disastrous and adequate spring flows must be provided, even in critical years.

Spring flows at Oregon City must be considered with regard to downstream migration of young salmon, steelhead, and trout. The movements of these young fish have been studied (Special Scientific Report No. 33) and are now being investigated by both Commissions. The studies indicate that young fish migrate down past the falls from October through May with the bulk of the fish passing in March, April, and May. Fish dropping down river on their way to the sea must either pass over the face of the falls or go through the power tubes. During high-water flows, most of the fish pass safely over the face of the falls, but at low flows they have no alternative but to pass through the power tubes. In the latter case, significant mortalities occur, the exact extent of which is not known. It is a common occurrence, however, for observers to see dead and injured fingerlings appear at the outlets of the draft tubes.

Under the proposed reservoir storage schedules, the flows are expected to be so low during March, April, and May that there will be little or no flow over the face of the falls (Appendix C, Paragraph 525). Consequently, increased mortalities among adult salmon and steelhead are expected to occur.

Table 1 Reservoirs and Pertinent Information On Each

Reservoir	Stream	Height of Dam 1/	Miles Flooded	Pool Area Normal	Pool Area Minimum	Borrow Area	Power
Cottage Grove	Coast Fork Willamette R.	73	3.0	1,160	293	--	
Dorena	Row River	100	4.9	1,840	450	--	
Hills Creek	Middle Fork Willamete R.	275	6.8	2,420	980	Downstream	X
Waldo Lake	N. Fork of Middle Fork Willamette	---	---	6,100	5,000	--	X
Meridian	Middle Fork Willamette	238	14.2	4,360	1,860	Upstream & Downstream	
Dexter	Middle Fork Willamette	56	3.3	1,025	960	Upstream	X
Fall Creek	Fall Creek	171	6.4	1,880	440	Upstream	
Cougar	S. Fork McKenzie	423	6.0	1,415	380	Downstream	X
Blue River	Blue River	277	6.7	1,010	100	Downstream	
Gate Creek	Gate Creek	225	4.0	605	147	Downstream	
Fern Ridge	Long Tom River	36.5	5.5	9,300	1,760	--	
Tumtum	Tumtum River	63	5.5	1,050	310	Upstream	
Holley	Calapooya River	130	3.6	2,120	400	Upstream	
Cascadia	S. Santiam	239	6.0	1,700	470	Upstream	
Green Peter	Middle Santiam	321	11.0	3,580	910	Upstream & Downstream	X
White Bridge	Middle Santiam	99	3.1	270	220	---	X
Wiley Creek	Wiley Creek	196	2.6	600	130	Upstream & Downstream	

1/ Minimum tailwater to normal pool

Table 1 - Continued

Reservoir	Stream	Height of Dam 1/	Miles Flooded	Pool Area		Borrow Area	Power
				Normal	Minimum		
Detroit	N. Santiam	377	8.5	3,580	1,451	--	X
Big Cliff	N. Santiam	91	2.8	100	76	Downstream	X
Lewisville	Little Luckiamute	54	6.0	3,300	660	Upstream & Downstream	

1/ Minimum tailwater to normal pool.

GAME FISH FACILITIES

Game fish populations will be subject to damage from three principle sources: 1. Blocking of migratory routes; 2. Flooding of productive stream areas by relatively sterile reservoirs; and 3. Alteration of stream courses to the detriment of the game fish environment. The amount and character of the damage will vary from stream to stream because of different degrees of productivity and damage. These factors make the evaluation of damages a complex problem because they make necessary a forecast of future ecological conditions.

At a conference held at the Game Commission offices on March 31, 1947, attended by representatives of the conservation agencies and the Corps of Engineers, the latter indicated that basic data relating to the game fish problems was needed for consideration before April 12. Accordingly, a hurried hatchery program was drawn up and presented. This report was prepared under stress because it had to be submitted in a very short time. It recommended the planting of 1,058,000 six-inch fish to be reared in two hatcheries, each of which would have a capacity of 529,000 legal-size fish. The estimated cost of construction on the 1947 basis was $662,000 with an annual operating cost for both hatcheries of $104,750. In view of the lack of time in which to consider fully all problems involved and in view of the fact that various dams were being added and dropped from the list in preparation by the Corps of Engineers, the recommendations submitted under date of April 7, 1947 were not approved by the Game Commission.

Many changes occurred in plans presented by the Corps of Engineers between April 1947 and the date of receipt of the Review Report, which fact further nullifies the original standards submitted. As an illustration of the changes, the original list of fish to be planted in amelioration of the harm to be caused

by each dam covered sixteen separate projects, of which four have been dropped and seven new ones added. These additions made it necessary to conduct further field studies during the summer of 1947. The data obtained made it possible to re-calculate damage on Marys, South Santiam, Calapooya, Mckenzie, and Middle Fork Willamette Rivers, all of which were concerned in the proposed changes. Therefore, the facilities presented here differ from those in the Review Report.

As a State conservation agency, the Game Commission is striving to improve angling conditions in the waters of Oregon and a definite program to this effect is in operation in the Willamette Valley. By blocking normal migrations of cutthroat, rainbow, and steelhead trout from their ancestral spawning grounds and substituting deepwater reservoirs for miles of beautiful, productive stream, the proposed dams in this area will make necessary drastic revisions in this program. Careful analysis of all available data indicates that approximately 1.5 million legal-size fish will have to be reared and planted each year. Such a program will be necessary to produce results comparable to those that would have been derived under the existing Commission program if the dams had not been built. It is felt, moreover, that the ultimate that may be reached under present conditions will never be attained under any program with the proposed construction completed. The restitution desired is the best that can be determined on the facts available but no restitution can mitigate for or replace the loss to the natural resource and its basic productivity.

The number of six-inch fish which should be planted in restitution to the State of Oregon for the losses that will result from the project are listed in Table 2. These are based on field studies of the stream sections to be flooded and close scrutiny of the project plans. To produce the 1,543,160 legal-size fish recommended in Table 2, three gamefish hatcheries will be required. There are three prospective hatchery sites on the Middle Fork, North Santiam, and McKenzie, but further study should be made of alternate sites available on other streams in the area before final decision is made as to the exact location of each. Much care will have to be exercised in order that the best possible sites

can be selected in relation to water supplies, water temperatures, and land for buildings and ponds, and hauling distances.

Table 3 gives a breakdown of construction and equipment costs for each of the three gamefish hatcheries recommended. Table 4 lists annual operating costs.

The number of legal-size fish listed in Table 2 for rearing and planting in amelioration of the harm or damage from each reservoir and to stream courses, would not necessarily all be planted in the reservoirs or streams named. Places of planting will depend upon food and water conditions existing after completion of each unit of the project. The reservoirs will be stocked in relation to their productivity and a portion at least will be planted in the main streams and tributaries above the dams. It is not unlikely too, that in some instances a portion at least, might well be planted below the reservoirs where water conditions are suitable. Loss of stream areas whether by flooding or channel improvements will require the substitution of other areas. This will call for intensive field work by trained fisheries workers so that the best possible survival and use by anglers may be had from the fish reared. All trout reared in hatcheries provided by the Corps of Engineers will be planted in Willamette drainage.

While it is impossible to accurately forecast future aquatic conditions, certainly those reservoirs lying in the lower valley areas with gently sloping margins and richer soils will be much more productive of fish life than those lying in rocky, upstream canyons with sparse soils. The former will have a greater expanse of better lighted, shallow water areas than the latter, and therefore will be more productive of plankton and bottom fish foods. A few of the reservoirs may be expected to produce some fishing but its character will depend almost entirely upon the type of terrain flooded and range and extent of annual fluctuations in levels of properly managed and stocked, some of them at least, may become popular with recreationists as are Cottage Grove and Fern Ridge. As it appears now, the 1.5 million fish recommended will do much to replace present good trout fishing and contribute a major recreational asset to the project.

Fishing for warm-water, spiny-ray fishes in sloughs, oxbow lakes, and overflow channels along the Willamette River provides excellent recreational fishing close to centers of population. It is to be hoped that the channel improvements proposed will not involve complete elimination of such waters with consequent loss of much angling for these types of fish. If carefully planned, it would be possible todevelop and possibly stabilize waters in certain overflow areas to the betterment of fishing.

Changes wrought on fishery resources by the Project merit a careful long-term study to develop a management stocking and improvement program for the reservoirs and contiguous waters. These investigations will include plantings of marked fish followed by creel census work to determine survival in relation to costs of artificial propagation, temperature analyses in and below reservoirs to determine effects on natural reproduction and survival, and field work on reservoir areas to determine changes in basic productivity as the reservoirs age. These studies are estimated to cost $25,000 annually, and an additional $10,000 should be allottedthe first year for initial expenses in setting up the program.

The total cost of the proposed plan for amelioration of harm to game fish resources may be summarized as follows:

Construction costs for three hatcheries	$ 1,034,460.00
Annual operation and maintenance	179,085.00
Annual cost of research and management program	25,000.00
Initial costs in connection with game fish study program	10,000.00

Table 2 POUNDS AND NUMBERS OF 6" FISH RECOMMENDED FOR PLANTING IN AMELIORATION FOR HARM TO GAMEFISH RESOURCES FROM THE WILLAMETTE VALLEY PROJECT.

Dam or Location	Lbs. of Fish	No. 6" Fish 1/
Meridian	39,480	394,800
Hills Creek	12,000	120,000
Waldo Lake	5,500	55,000
Dexter	8,640	86,400
Fall Creek	3,840	38,400
Blue River	4,700	47,000
Gate Creek	1,250	12,500
Cougar Creek	6,850	68,500
Holley	2,160	21,600
Cascadia	3,600	36,000
Green Peter	6,600	66,000
White Bridge	1,860	18,600
Wiley Creek	420	4,200
Detroit	9,000	90,000
Big Cliff	1,800	18,000
Cottage Grove	580	5,800
Dorena	920	9,200
Tumtum	525	5,250
Lewisville	1,650	16,500
McKenzie R. watercourse damage and fluctuating flows	23,116	231,160
Middle Fork watercourse damage and fluctuating flows	9,825	98,250
Watercourse damage and fluctuating flows on other tributaries	10,000	100,000
TOTALS	154,316	1,543,160

1/ Ten 6" fish weigh one pound.

Table 3

ESTIMATED COST OF CONSTRUCTION AND EQUIPMENT FOR
A GAMEFISH HATCHERY TO PRODUCE 514,000 SIX-INCH FISH ANNUALLY

Construction	1947 Estimate
Purchase of site	$ 15,000.00
Grounds: preparation, excavation, walks, roads, drainage, etc.	25,500.00
Hatchery buildings @ $15.00 per sq. ft.	60,000.00
Brood ponds and spawning house: 6	10,700.00
Rearing ponds and raceways	35,000.00
Headworks and main water supply line	22,600.00
Water distribution system to ponds	8,200.00
Utility house and garage	10,000.00
Cold storage plant: 60 ton, 20' x 40' @$20.00 per sq. ft.	25,000.00
4 residences at $12,000 each	48,000.00
4 garages at $1,000 each	4,000.00
Domestic water supply	4,500.00
Power and light	14,200.00
Gasoline storage house for tanks, pumps, etc.	4.100.00
Equipment	
Miscellaneous Permanent Fish Cultural Equipment	5,000.00
Motor vehicles including DNE tank truck for use in planting fish	10,000.00
Sub-Total	$301,800.00
Contingencies at 15 per cent	45,270.00
TOTAL PROJECT COST	$347,070.00

Table 4 ANNUAL OPERATING COSTS TO REAR 514,000 SIX-INCH FISH PER YEAR.

Fish Food 285,000 lbs. at an average price of 13¢ per lb.	$37,050.00
Salaries 6 permanent and 3 seasonal employees	16,405.00
Workman's Compensation	90.00
Retirement Board	900.00
Civil Service Assessment	60.00
Boots, spawning gloves, aprons, and other necessary hatchery clothing	75.00
Office Supplies	65.00
Telephone	50.00
Postage, freight, and express	150.00
Meals and lodging	100.00
Heat, light, and power	1,000.00
Hatchery supplies - nets, seines, dipping tubs, pails, brushes, chemicals, lumber, etc.	1,200.00
Maintenance of buildings, grounds, and machinery	2,200.00
Motor vehicle supplies	350.00
Total Estimated Cost Per Year	$59,695.00

High dams on the Willamette River will block over fifty per cent of the entire salmon run entering this river (Table 5). The loss of this spawning and rearing area will vitally affect the resource unless these segments of the runs can be successfully artificially propagated. Since there seems no alternative at the present time but to trap the fish destined to spawn above these barriers and artificially spawn them for subsequent rearing, a plan incorporating this conclusion is presented. Preliminary estimates of cost are included here as well as a tentative plan of salvage. Needless to say, changes in program will be necessary after further studies are completed and the final plans for construction and operation of the project are presented.

Preliminary estimates of the costs of fisheries facilities were made in 1947; the engineers have included these in their Review Report. However, because of the increased costs, coupled with the drastic changes in plans for the Willamette River Project as noted in previous sections of the report, a revision of the plans and cost estimates has been made.

Middle Willamette River

According to the counts of salmon past the Willamette Falls made during 1946 and 1947, 55,000 and 45,000 adult salmon passed over the fish ladder respectively, each year. During 1941, the run was much greater, although no counts of the total run past the Willamette Falls were made. Special Scientific Report No. 33, indicated a sports catch of 30,000 salmon in 1941. The hatchery egg-take records of the Oregon Fish Commission were also exceedingly large during that year. Therefore, it is a well-established fact that a run considerably greater than either the 1946 or 1947 runs entered the Willamette River in very recent years (i.e., 1941). Using the relationship between the sport catches in the lower Willamette River recreational fishery in 1941 and 1946, and the sizes of the runs past the Willamette Falls in the two years in question, the size of

the 1941 run is calculated to have been about 122,000 salmon. Again, using the Willamette River egg-takes for the two years in question as an index of the run, an estimated 195,000 salmon passed over the falls. Therefore, the 1941 run of salmon passing the Willamette Falls probably amounted to somewhere between 120,000 and 200,000 adult salmon. It would appear that the plans for facilities at the various dams might be made to accommodate the proportions of a run of this magnitude going into each stream. Table 5 presents data on the distribution of runs into the various stream systems (unpublished ms. of the Fish Commission, Johnson, Mattson, and Schoning, 1947). The estimates presented in this table are based on field studies during the summer of 1947. There is no attempt to draw the conclusion that every year the distribution in the Willamette system is identical. In addition, the surveys and studies on the tributary rivers did not account for all the salmon passing the falls. Furthermore, although no salmon were found spawning in the main Willamette River, studies made on this section were not so comprehensive as on the tributaries.

Using the distribution of salmon into the various tributaries as presented in Table 5, it would appear that the maximum expected run to the Middle Willamette would approach between 25,600 and 42,000 salmon. If all these salmon were to appear below the Meridian dam, fisheries facilities to handle approximately 77,000,000 to 126,000,000 eggs would be necessary. Since it appears from Special Scientific Report No. 33, page 13, that all adult spring chinook salmon may have spent at least one year in fresh water, facilities for hatching about 100,000,000 eggs and rearing to one year of age about 80,000,000 fingerling should be provided. These fish would weigh about 2,000,000 pounds, would require about 6,000,000 pounds of food, and 700 ponds would be needed for rearing. The food costs would be about $400,000 annually and the operational costs would be over $1,000,000.

This is a unique situation. No hatchery has been envisaged of this magnitude; the lack of a sufficient quantity of food alone precludes at the present a

Table 5 THE DISTRIBUTION OF SPRING CHINOOK SALMON IN THE WILLAMETTE RIVER SYSTEM.

Willamette River System	Distribution in Per cent within The Tributaries	Distribution in Per cent into the Various Tributaries
McKenzie River		39%
Natural spwaning above main rack	21.2%	
Handled at main rack	29.6%	
Below main rack	49.2%	
North Santiam River		23%
Above Detroit dam-site	71.0%	
Below Detroit dam-site	15.4%	
Little North Santiam River	13.6%	
Middle Willamette River		21%
Main river	64.0%	
Salmon Creek	19.0%	
North Fork of Middle Willamette	15,0%	
Big Fall Creek	2.0%	
South Santiam River		12%
Middle Santiam	51.0%	
South Santiam (Cascadia Fork)	33.0%	
Crabtree and Thomas Creeks	16.0%	
Molalla River		4%
Abiqua Creek and Calapooya River		1%

hatchery of this size. It is obvious that the Middle Willamette River chinook salmon cannot be properly handled by any means now known to insure the maintenance of the run. The miles and miles of rearing areas cannot be adequately replaced. However, some parts of the run can undoubtedly be maintained, and perhaps by improving chances for survival of adults and young at the Willamette River Falls and other places in the river, a good portion of the run can be perpetuated even though the spawning stocks might be materially reduced. In 1941, over 10,000,000 eggs were taken on the Middle Willamette. Estimating conservatively from recent studies that this was one-third of the run, a total take of 30,000,000 is arrived at as a basis for fisheries facilities.

At the present time it is planned to handle the eggs and young in two stations on the Middle Willamette River; at an expanded Oak Ridge site and at a new station to be located below the proposed Dexter Dam. In this manner the entire run to this tributary will not be jeopardized by some unforseen problem at one of the hatcheries.

Combined Plan of Operation for Both Hatcheries on the Middle Willamette:

1. Take 30,000,000 eggs from about 10,000 adult salmon.
2. Of the surviving fingerling, 13,500,000 will be liberated in the early spring of their first year. A survival of approximately 12,500,000 may be expected in the fall of their first year, when they should weigh about 214,000 pounds.
3. Depending upon results of marking experiments to determine the proper time of liberation, 7,800,000 will be liberated in the fall at one year from the egg stage.
4. The remaining approximately 5,000,000 yearlings will be held until the early spring of their second year. These fish will weigh approximately 200,000 pounds.
5. A summarization of the total pounds liberated would be as follows:

33,700 pounds in the spring of first year;

133,500 pounds in the fall of the first year;

200,000 pounds in the spring of second year for a total of 364,000 pounds.

The probable food consumption per year would be about 1,000,000 pounds with a food cost of about $60,000 annually.

A summary of estimated costs would be as follows:

Initial Costs		$791,722
New hatchery	$498,400	
Hatchery expansion	293,322	
Annual operating costs		166,000
Salaries	58,000	
Maintenance	48,000	
Fish food costs	60,000	

South Santiam River

The four dams on the South Santiam (Green Peter, White Bridge, Cascadia, and Wiley Creek) will effectively block all salmon and steelhead from their natural spawning grounds. At the present time, hatchery facilities on the Middle Fork take a portion of the runs to this tributary, but the entire stocks spawning in the Cascadia Fork and Wiley Creek are allowed to spawn naturally. At the present time no significant spawning occurs below the proposed dam sites. Facilities will have to be provided to rack the entire runs below the confluence of both forks and artificially propagate the offspring.

From Table 5, it appears that about twelve per cent of the entire Willamette River salmon runs enter the South Santiam. Assuming a maximum run of 150,000 fish past Willamette Falls, the South Santiam run would equal 18,000 spring chinook. The size of the steelhead run is unknown, but from what observations have been made, the run may equal 3,000 fish. Again it is planned a hatchery smaller than theoretically necessary to handle the maximum run. The 1941 egg take at the South

Santiam hatchery was over 3,000,000 eggs. This may be assumed to be about 75 per cent of the run entering that tributary. Probably about an equal amount entered the Cascadia Fork, Wiley Creek, and Calapooya River. Thus hatchery facilities should be large enough to handle about 8,000,000 spring chinook eggs.

In 1939, about 3,500,000 steelhead eggs were taken for artificial propagation in the Middle Fork of the Santiam. Steelhead also enter Cascadia Fork, Wiley Creek, and Calapooya River. Since all the steelhead eggs cannot be taken because of high water during the late winter, and a considerable run enters the other tributaries of the South Santiam and Calapooya River, fisheries facilities for about 8,000,000 steelhead eggs must also be made available.

The tentative plan calls for a single large hatchery below the re-regulating dam, White Bridge. Racks will be constructed either on both the Cascadia Fork and the Middle Fork or below the confluence of the two; temporary racks and egg-taking facilities will be installed below the Holley Dam on the Calapooya, although it is planned to transfer this run into the South Santiam because of its small size and the little opportunity the river development plans give for expansion of the salmon runs on this tributary.

Combined Plan of Operation for the Hatchery on the South Santiam:

1. Take a maximum of 8,000,000 spring chinook eggs in the fall.
2. Liberate about 5,000,000 in the early spring, holding about 2,000,000 until fall.
3. Liberate approximately 1,000,000 in the fall, holding about 1,000,000 over until spring of their second year.
4. Take a maximum of 8,000,000 steelhead eggs in the spring, and hold until late fall.
5. Liberate about 5,000,000 steelhead fingerling in the fall.
6. Hold 2,000,000 fingerling over until spring and liberate after the spring chinook liberations. If marking experiments show that the steelhead must be reared until two years of age before liberation, this change in the plan will be effected for a portion

of the fingerling of this species.

7. Summarizing, the total pounds of fingerling liberated of both species would be as follows:

(a) chinook

5,000,000 fingerling liberated first spring - 12,500 lbs.

1,000,000 fingerling liberated in fall at one year - 18,000 lbs.

1,000,000 fingerling liberated in spring of second year - 40,000 lbs.

(b) steelhead

5,000,000 fingerling liberated during first fall 62,000 lbs.

2,000,000 fingerling held over and liberated in spring - 70,000 lbs.

A summary of estimated costs would be as follows:

Relocation of Hatchery		$451,000.00
Annual operating costs		108,000.00
Salaries	$30,000.00	
Fish food	48,000.00	
Operation and Maintenance	30,000.00	

North Santiam River

Both salmon and steelhead migrate into the North Santiam River. This large tributary contains the second largest run of spring chinook in the Willamttte River System. According to Table 5, the North Santiam carries 23 per cent of the entire Willamette run of spring chinook. It must be noted that of this large run, 71 per cent now migrate above the proposed Detroit dam-site. Using the 1941 run as a basis, it is not out of the question to expect as many as 34,000 salmon to enter the North Santiam each year. Of these, 71 per cent, or about 30,000 may normally pass the Detroit dam-site. If that were the case, then 102,000,000 eggs would be artificially taken and reared. However, here again facilities for a run of this size will not be recommended. A study of the data gathered during the past two years and an analysis of the egg-take

records leads to the conclusion that a hatchery capable of hatching and rearing about twenty millions of eggs may suffice.

Although the size of the steelhead populations of this river is not known, egg takes by the Fish Commission of almost 2½ millions of eggs have occurred in recent years. It is assumed that a total of five millions of steelhead eggs may be taken after the dam is constructed.

The tentative plan on this river system includes enlarging the present Mehama hatchery and constructing a new hatchery on the Marion Forks above the town of Detroit. This plan will call for two hatcheries on the North Santiam instead of one and increase greatly the possibility of maintaining the runs. The Marion Forks water supply is of a very desirable quality, and excellent success has been achieved holding spring chinook through the entire year, using this water supply.

Combined Plan of Operation for the Hatcheries on the North Santiam.

1. Take 20,000,000 spring chinook eggs and eye all eggs at the Mehama hatchery. Of these, take 5,000,000 eyed eggs to the Marion Forks hatchery.
2. Liberate approximately 10,000,000 fingerling in the first spring from the Mehama hatchery. Hold about 5,000,000 at the Marion Forks hatchery and about 5,000,000 at the Mehama hatchery until fall at one year of age.
3. Liberate about 6,000,000 in the late fall; 3,000,000 from each hatchery.
4. Liberate the remainder in the spring of the following year.
5. Take approximately 5,000,000 steelhead eggs in the spring and eye them all at the Mehama hatchery. Three million eyed eggs will be taken to the Marion Forks hatchery and 2,000,000 will be held at Mehama.
6. Liberate 2,500,000 in the first fall; hold the remainder until

the following spring.

7. Liberate the remainder at one year of age unless marking experiments provide evidence of a need for holding two years.

8. Summarizing, the total fingerling of both species liberated from this hatchery:

   (a) chinooks

9,800,000 liberated first spring	24,200 lbs.
6,000,000 liberated first fall	100,000 lbs.
3,000,000 liberated in spring of second year	120,000 lbs.

   (b) steelhead

2,500,000 liberated during first fall	31,000 lbs.
2,000,000 liberated during spring at one year	80,000 lbs.

   (c) total liberations amount to approximately 355,000 lbs of salmon and steelhead each year.

A summary of estimated costs would be as follows:

Initial costs		$575,000.00
Expansion of Mehama station	$321,300	
Marion Forks construction	217,000	
Annual operating costs		149,000.00
Salaries	40,000	
Operation	35,000	
Fish food	24,000	

McKenzie River

The present contemplated plans for tributary dams on the McKenzie River will do less damage to the salmon runs of this, the most important tributary, than to any other of the affected rivers in the Willamette drainage.

Although the damage to the runs from canalization of the lower river may be considerable and serious, the loss of the tributaries from dams will not be as

serious to the maintenance of the run as on other major tributaries. Nevertheless, miles of valuable spawning and rearing area will be lost to fisheries use, and facilities must be provided to compensate for this loss.

It is recommended that the present hatchery be expanded and larger pond capacity be provided for additional rearing of greater numbers of fingerling.

Combined Plan of Operation for the Hatchery Expansion on the McKenzie River.

1. Take 5,000,000 additional spring chinook eggs each fall.
2. Rear until spring and then liberate 1,000,000 fingerling.
3. Hold remainder until fall and then liberate 2,000,000 in the fall.
4. Of the remaining over 1,000,000 surviving until spring, they will be liberated in March or April.
5. A summarization of the additional young liberated from the hatchery each year:

1,000,000 liberated in spring	2,500 lbs.
2,000,000 liberated in fall	33,300 lbs.
1,000,000 liberated in spring of second year	46,000 lbs.

A summary of estimated costs of hatchery expansion are as follows:

Initial cost of expansion		$201,250.00
Annual operation		45,000.00
Salaries	$12,000.00	
Operation	15,000.00	
Food	18,000.00	

Hatchery Management Studies

The Willamette Valley Project introduces problems entirely new to hatchery and fisheries maintenance programs. Therefore, a hatchery biological study must be provided to find a solution to these problems brought about by the total obstruction of entire runs of salmon and steelhead.

An initial expense of $20,000 will be necessary to establish a field laboratory at the Middle Willamette hatchery and $25,000 annual expense will adequately

provide for the implementation of the program.

Table 6 Cost of Fisheries Facilities for Salmon and Steelhead

	Type of Facilities	Initial Costs 1/	Annual Operation	Total Direct Costs
Meridian	Hatchery expansion	$293,322	$166,000	$791,722
	New Hatchery	498,400		
McKenzie	Hatchery Expansion	156,250	45,000	150,000
Calapooya	Racks to transfer run	11,500	--- 2/	--- 2/
(Costs grouped in report under (South Santiam)				
South Santiam	New Hatchery	440,100	108,000	451,600
North Santiam	Hatchery expansion	366,280	149,000	608,165
	New hatchery	241,885		
		Sub-Total	$468,000	$2,001,487
Hatchery Management Studies		23,000	25,000	23,000
	Total		$493,000	$2,024,487

[1]Contingencies at 15 per cent are included.
[2]Items listed under South Santiam. Five thousand dollars are included under South Santiam for annual operation.

Table 7 COST OF CONSTRUCTION OF A NEW HATCHERY

BELOW MERIDIAN DAM, MIDDLE WILLAMETTE RIVER FOR SALMON

Initial Expense	
Hatchery site	$10,000
Houses at $14,000 (4)	56,000
Hatchery Building, including office	60,000
Troughs	2,400
Landscapping	5,000
Garage and Workshop	12,600
Cold storage plant and food grinding room	45,000
Access roads	4,000
Sewage Disposal and Incinerator	3,500
Domestic Water Supply	4,500
Fish Racks and Traps	10,000
Ponds (40)	100,000
2 Liberation tank trucks	18,000
Hatchery water supply Diversion works, pipe lines, settling tank.	83,000
Hatchery Equipment	20,000
Sub-total	$433,400
Contingencies at 15 per cent	65,000
Total direct costs	$498,400
Annual Operation:	
Salaries	$ 38,000
Operation and maintenance	28,000
Fish Food	30,000
	$ 96,000

Table 8 COST OF EXPANSION OF OAK RIDGE HATCHERY, MIDDLE WILLAMETTE RIVER

Initial Expense		
Hatchery building, repair and expansion		$32,000
Two additional houses		28,000
Cold storage plant		25,000
Garage, workshop and grinding room		14,000
Sewage disposal and incinerator		3,500
Ponds		75,000
Troughs		1,800
Water supply		50,000
Landscapping		5,000
One liberation tank truck		9,000
Hatchery equipment		14,000
	Sub-total	$257,300
Contingencies at 15 per cent		36,022
	Total direct costs	$293,322

Annual Operation		
Operation and maintenance		$ 20,000
Food		30,000
Salaries		20,000
	Total	70,000

Table 9 COST OF EXPANSION OF MCKENZIE RIVER SALMON HATCHERY

Initial Expense of Expansion		
2 Houses		$28,000
Ponds (15)		37,000
Water Supply		10,000
Refrigeration		25,000
Building Expansion		25,000
Equipment		10,000
	Sub-total	$135,000
Contingencies at 15 per cent		21,250
	Total Direct Costs	$156,250
Annual Operation (Additional)		
Salaries		$12,000
Operation and maintenance		15,000
Food		18,000
		$45,000

Table 10 COST OF SOUTH SANTIAM AND CALAPOOYA RIVERS

SALMON AND STEELHEAD HATCHERY

Direct Costs	
Land	$ 10,000
Houses (4)	56,000
Water Supply	60,000
Ponds (42 ponds)	105,000
Hatchery building and troughs, including small laboratory room and superintendent's office	50,000
Fish Racks and Traps (Cascadia, Calapooya, and Middle Fork)	30,000
Sewage Disposal	3,500
Roads	4,000
Landscaping	5,000
Garage and Workshop and Food Grinding Room	15,000
Cold Storage Plant	40,000
Equipment (2 hatchery trucks (pickup and 1½ ton truck)	18,000
Sub-total Direct Costs	396,500
Contingencies at 15 per cent	55,100
Total	451,600
Annual Costs	
Food	48,000
Salaries	30,000
Operation and Maintenance	30,000
Total	$108,000

Table 11 COST OF NORTH SANTIAM SALMON AND STEELHEAD HATCHERY, MEHAMA STATION

Initial Expense	
Additional land	$ 5,000
Expansion of hatching house	15,000
Troughs	1,800
2 additional dwellings	28,000
Cold Storage Plant	30,000
Water Supply	70,000
Ponds (32)	80,000
2 liberation trucks	18,000
Utility buildings including grinding room	20,000
Sewage disposal and incinerator	3,500
Racks and Traps	10,000
Trap in Big Cliff Dam for Steelhead	10,000
Landscaping	5,000
Equipment	25,000
Sub-total Direct Costs	$321,300
Contingencies at 15 per cent	44,980
Total	$366,280
Annual Operation	
Operation and Maintenance	$ 20,000
Food	44,000
Salaries	25,000
	$ 89,000

Table 12 COST OF MARION FORKS SALMON AND STEELHEAD HATCHERY, NORTH SANTIAM RIVER

Initial Expense	
3 Houses	$42,000
Hatching House	16,000
Cold Storage	25,000
Garage and Workshop and Grinding Room	14,000
Sewage Disposal and Incinerator	3,500
Ponds (32)	80,000
Troughs (54)	1,680
Water Supply	10,000
Landscaping	5,000
Equipment	12,000
Access Roads	3,000
Sub-Total Direct Costs	$212,180
Contingencies at 15 per cent	29,705
Total Direct Costs	241,885
Annual Operation	
Operation and Maintenance	$15,000
Food	30,000
Salaries	15,000
Total	$60,000

SUMMARY

The Oregon Game and Fish Commissions have examined the Willamette River Review Report and have found many phases of the project which vitally affect the welfare and survival of the fisheries resources of the Willamette Basin.

The complete obstruction of most of the streams in the Willamette Basin with the notable exception of the McKenzie River will reduce the game fish inhabiting these rivers and will block about ninety per cent of migratory species of fish which now spawn in these streams.

Present schedules for reservoir regulation will require readjustment to provide minimum requirements for fishery resources.

Present plans for channel improvements, bank revetments, levees, and selection of borrow areas are not clearly defined as to times, places, or methods. If these plans are not carefully designed with respect to aquatic resources, irreparable damage will result.

Recommendations for hatchery facilities, stream improvement, and a necessary investigational program, are included to compensate partially for the widespread changes in environmental conditions which will result to fisheries from the Willamette Valley Project.

Because of the magnitude and complexity of the Project, the program recommended for amelioration of the harm or damage to fishery resources may not provide for the perpetuation of these resources at their present levels of abundance.

1. Hatchery Facilities and Fishways Recommended for Anadromous Fish:

(a) Middle Willamette River: A new hatchery be constructed below the proposed Dexter Dam, and the present hatchery at Oak Ridge expanded.

(b) McKenzie River: The present hatchery be expanded to compensate for the loss of spawning areas by high dams on the tributaries.

(c) South Santiam including the Calapooya: A single large hatchery to be placed below the White Bridge re-regulating dam on the Middle Fork South Santiam. Eggs from the Calapooya River, Wiley Creek, and South Fork (Cascadia Dam) as well as the entire run into the Middle Fork will be artificially reared at this hatchery.

(d) North Santiam: The present hatchery at Mehama be expanded, and a new hatchery be located on the Marion Forks above the Detroit Dam.

(e) Facilities for hatchery biological program be provided to study some of the more critical problems in maintaining salmon runs artificially. A sum of $20,000 for initial costs and $25,000 annually be provided for these studies. The first year's allotment be provided in 1948 in order to begin studies with regard to the exact location and design of facilities.

(f) Funds be provided for the above facilities in the amounts specified in the section on fisheries facilities on Table 6. Total direct cost, $2,001,500; annual operation $468,000.

(g) Two additional fish ladders to be placed at the Willamette River Falls to alleviate if possible the effects of reduced flows. One ladder to be constructed concurrently with Detroit and Meridian Dams and the other to be constructed before or during lock construction.

(h) A ladder to be built over the falls in the Little North Fork Santiam River to increase natural spawning areas.

2. Hatchery Facilities Recommended for Gamefish:

(a) To compensate for the loss of gamefish resources by the Willamette Valley Project, the planting of 1,543,160 legal-size fish annually in the Willamette drainage is recommended as presented in Table 2.

(b) In order to rear these fish three game fish hatcheries are recommended for construction, at a gross capital cost of $1,034,460. Each hatchery should have a capacity sufficient to rear approximately 514,000 legal-size fish per year (Table 3).

(c) Annual operating costs of each hatchery is estimated to be $59,695, (Table 4). A total sum of $179,085 should be made available annually for labor, materials, hatchery supplies, and fish food necessary for rearing and planting the fish.

(d) Improvement work on over-flow areas, oxbow lakes, and sloughs along the main Willamette should be accomplished to stabilize and develop fishing for spiny-ray fishes.

(e) The sum of $10,000 initial expense and $25,000 annually be made available for long-term studies of the basic effects of the Willamette Project on game fish resources. This sum should be provided immediately for studies during 1948 in order that fisheries management programs on impoundments be formulated in advance of construction.

3. A permanent method of contact between the Oregon Fish and Game Commissions and the Corps of Engineers be inaugurated during and after completion of the projects in order that emergencies affecting fisheries may be immediately acted upon without un ue delay caused by administrative procedure.

4. Copies of the operating schedules on each dam, powerhouse, or diversion should be supplied to each Commission, and the Commissions should receive simultaneous duplicate copies of all orders to operators of projects affecting flow regime below the dams. Modification of operating

schedules be provided to the Commissions at least 48 hours before any major flow change.

5. The proposed wire and radio broadcasts of headwater hydrologic conditions be made available to the Commissions.

6. The discharges below reservoirs agreed upon be absolute minimum flows below which they will never be allowed to drop.

7. Adequate temperature records at various depths in the impoundments and below the dams be regularly kept and supplied to the Fish and Game Commissions.

8. Daily flow data below each dam be transmitted regularly to the Commissions at thirty-day intervals.

9. Water in the stream channels below the dams should be at all times of sufficient depth and of correct temperature for fish as determined by the Fish and Game Commissions. Outlets at various levels in the reservoirs may provide these conditions.

10. When Fall Creek Dam is constructed, water releases be scheduled to operate for optimum conditions for fish as determined by the Fish and Game Commissions.

11. Reservoir regulation schedules be reviewed by the fisheries agencies and the Corps of Engineers to arrange sufficient flows over the crest of the Willamette Falls.

12. Plans for channel improvements, bank revetments, and levees be revised after consultation with fisheries agencies.

13. The selection of borrow sites be carefully selected after a consultation with the Fish and Game Commissions.

14. Fisheries facilities should be completed at least one full year before the rivers are blocked by the dams.

WILDLIFE PROBLEMS

Introduction

Evaluation of the effects of the Willamette Valley Project does not give sufficient attention to the manner in which wildlife will be affected. This section of the report will point out the benefits and losses that will occur to the various game and fur animal species, and present recommendations concerning methods of mitigating losses. The existing game resources of Oregon comprise an important segment of the economy of the state, and the value of this resource is becoming increasingly greater as population increases.

Population, soil, climatalogical and other basic data have been given in sufficient detail in the Corps of Engineers' reports that there will be no need to elaborate on or discuss them at this time.

Mammalian game species involved in the Willamette Basin are deer, elk, bear, rabbits and squirrels. Upland game species consist of ringnecked pheasants, quail, grouse and Hungarian partridge. Migratory species include band-tailed pigeons, snipe, ducks and geese. Fur species present in the basin are muskrats, beaver, mink, otter, marten, red fox, grey fox, racoon and skunk.

With respect to game resources, two general categories of land area are involved in the Willamette Valley Project. These are: (1) Upstream areas above the valley floor proper, and (2) Valley floor areas including all others. These terms, as defined here, will be used in this report.

IMPOUNDMENT AREAS AND UPSTREAM MODIFICATIONS BY WATERSHED

North Santiam

The two dams located on North Santiam River will remove 3,740 acres of game habitat in the impoundment areas. Game species affected by the total elimination of this habitat will include big game and grouse. Furbearers will

be affected by elimination of stream habitat on the impoundment site and substitution of a poor habitat due to forebay fluctuations. In addition, most of the furbearer habitat for some distance downstream from the dams will be lost because rapid fluctuations in the water level will make the area unsuitable for these species.

It is not believed that the impoundments will have any beneficial effect upon waterfowl, as forage plants used by resident birds will be eliminated completely in the reservoir areas. In addition, any nesting induced as a result of impounding water will create a hazard of nest loss when fluctuating water levels will either flood out or dry up the nesting sites.

South Santiam

The four dams located on South Santiam River and its tributaries will remove 6,152 acres of game habitat from the impoundment areas. Most of the land involved is timber land, the majority of which has been cut over and provides excellent game habitat. Game species affected by impoundments in this basin include big game and grouse. Total elimination of the habitat in the impoundment area will result from inundation. Furbearers will be affected by elimination of stream habitat in the impoundment site and in the borrow areas. In addition, downstream populations will be adversely affected because of extreme fluctuations of water levels due to power draw-downs. This type of operation involving the constant raising and lowering of the stream practically eliminates bank denning species such as beaver and muskrat. Impoundment areas will have little value for furbearers and waterfowl. Annual fluctuation in levels caused by reservoir manipulation will produce low water levels at the time when waterfowl would need them most. No forage plants for waterfowl will be produced in a fluctuating impoundment of this type, which would eliminate use by any great number of resident birds.

Calapooya River

The one dam located on Calapooya River will remove 2,120 acres of game habitat in the impoundment area. Big game and grouse will be affected by the total elimination of this habitat in the impoundment and on any downstream borrow areas. Furbearers will be affected by the elimination of habitat along the stream in the impoundment site and a substitution of poor habitat in the impoundment area due to flood control fluctuations. In addition, most of the furbearer habitat for some distance downstream from the dam will be rendered unsuitable because of rapid water fluctuations.

It is not believed that the impoundment will have any great beneficial effect upon waterfowl. However, this area is located close enough to the valley floor that there will be some use as a resting area during the winter months. During the period of greatest waterfowl usage reservoir regulation will cause a low pool level and this, together with complete lack of forage plants, will result in limited waterfowl use.

McKenzie River

The three dams located on McKenzie River and its tributaries will totally eliminate 3,045 acres of game habitat in the impoundment area. Game species affected will be big game and grouse. In addition, nearly a total elimination of habitat will take place in the borrow area to be utilized near the confluence of South Fork and main stem McKenzie River. The impoundment areas will be unsuitable for furbearers owing to reservoir fluctuations. In addition, the furbearer habitat now existing along the streams in the impoundment area will be completely removed. The borrow area will be rendered highly unsuitable for any furbearing animals.

It is not believed that the impoundments will have any beneficial effect upon waterfowl owing to reservoir fluctuations which will result in a complete lack of forage plants in the area. All dams are located far enough away from

the valley so that utilization by waterfowl during the wintering period would be extremely light under any circumstances.

Middle Fork Willamette River

The four impoundment areas to be located on Middle Fork Willamette River and its tributaries will remove 9,730 acres of game habitat in the impoundment area. In addition, areas utilized for downstream borrow sites will also be unsuitable for game. Species affected by the total elimination of habitat in the impoundment area include big game and grouse. Furbearer habitat on the streams in the impoundment site will be totally eliminated and furbearer conditions in the impoundment itself will be highly unsuitable because of fluctuations required by reservoir regulation. Waterfowl value on the impoundments of Middle Fork Willamette River and its tributaries will undoubtedly be higher than on any other series of impoundments. A flyway exists between the Willamette Valley and the Klamath Basin in Klamath County via Willamette Pass and Waldo Lake. Therefore, undoubtedly these reservoirs would be utilized to a considerable extent as resting areas for brief periods during the fall migrations. However, reservoir regulation will hold the pool at a low level during the period of greatest need by waterfowl and will totally eliminate any forage plants. Therefore it is believed that utilization will occur only for short periods during the heavier flights.

Waldo Lake

Lowering of the water in Waldo Lake will eliminate the available waterfowl forage and render this area unsuitable for any feeding by waterfowl, reducing it to the status of a resting area. It is not believed that any nesting utilization or any resident bird populations would be developed because of reservoir regulation methods.

Although Waldo Lake water storage aspects of the Willamette Valley Project do not involve any regular, frequent, or predictable draw-down, certain game

species will be vitally affected by this phase of the project. The most important aspect of the project will be its effect upon waterfowl. Waldo Lake lies on the flyway between the Willamette Valley and Southeastern Oregon and is utilized intensively by ducks as a major resting and minor feeding area during migration. Since any anticipated draw-down of the lake requires some 6½ years to refill, it is evident that any such draw-down would completely destroy the limited amounts of waterfowl foods now present on this lake, and render the lake practically unsuitable for waterfowl feeding on their migration.

Coast Fork Willamette River

The one dam on Row River, a tributary of Coast Fork Willamette River, will remove 1,820 acres of game habitat. Species primarily affected will be big game and grouse. Furbearer habitat along the streams covered by the impoundment will be totally eliminated and habitat along the edges of the impoundment site will be highly undesirable because of fluctuations. Downstream furbearer habitat will be rendered much less suitable because of more rapid fluctuations of water levels from operating schedules. Waterfowl would utilize the site as a resting area but reservoir fluctuations, particularly low water in late fall, would eliminate forage plants and reduce the pool far below optimum conditions. The dam site is located at approximately the southern boundary of major waterfowl usage in the Willamette Basin.

Long Tom River

Raising of the Fern Ridge Dam two feet will flood approximately 1,000 acres once every 25 years. This is not expected to change the present game use of the Fern Ridge Dam area in any measureable way. When this extra area is flooded, it will drive any resident population out for the duration of the flood period.

Marys River

The one dam located on Tumtum River, a tributary of Marys River, will

totally remove 1,050 acres of game habitat. Species primarily affected by the total elimination of habitat will be big game and grouse. In addition, habitat on any downstream borrow area will be rendered highly unsuitable. Furbearers will be affected by the total elimination of stream habitat in the impoundment site and its replacement by an undesirable environment in a fluctuating pool.

Waterfowl will use the area for a resting ground to a limited extent. No known major flyway exists between the Willamette Valley and the coast at this point. The reservoir operation schedule calls for minimum pool levels during the time of year when waterfowl would be using the reservoir. Under these regulation conditions, few forage plants can be produced on the impoundment. Downstream effects upon furbearers will be adverse because of fluctuations in water levels.

Luckiamute River

The one dam on Luckiamute River will remove 3,300 acres of game habitat from production. Species primarily affected will be upland game and big game. This reservoir site, located on the valley floor, provides excellent pheasant habitat. In addition, a limited number of blacktail deer utilize the area and their habitat will be eliminated. All furbearer habitat in the impoundment site will be eliminated and habitat around the impoundment will be highly unsatisfactory due to fluctuations. Waterfowl will use this impoundment although the extent of use will depend upon water levels. Reservoir conditions will approach a minimum pool during the late fall months when waterfowl usage can be expected to be heavy. Reservoir regulation will completely prohibit the production of any waterfowl forage plants. However, as this area does lie on the valley floor, it is expected that it would be utilized more than any other proposed impoundment as a resting area for waterfowl. Tables 16, 17 and 18 list statistical data pertaining to the effects in each area and present game densities therein.

BANK PROTECTION AND CHANNEL IMPROVEMENTS IN THE VALLEY FLOOR

Levees

Only those levees classified as being in group 1 by the Corps of Engineers will be considered in this discussion. A total of 87 miles of levees are proposed in the Reveiw Report. Of these, 50 miles will be on Willamette River between the Long Tom and Springfield, 6 miles on Middle Fork Willamette and 31 miles on McKenzie River. The standard designs specified give a top width of 10 feet with a gravel roadway on top of the levee. All levees are to be reveted on the outside of sharp curves with an asphalt revetment. All borrow areas will be on the river side and pumping to remove local outside runoff will be necessary. It is expected that bank full capacity on these levees will occur every two years. General specifications for the levees on each stream vary. However, the placements will be from 700 feet to 5,200 feet apart. Game species affected by these levees will include upland game, furbearing animals and waterfowl. Upland game will be benefited because of the clearing of brush involved in construction of levee areas, which will open up the habitat. However, the gravel roadway and revetments will reduce the suitability of the levees for any upland game habitat. The net effect on upland game will be slightly beneficial. Furbearer habitat will be rendered less suitable because of brush clearing, gravelling of the roadway and reveting the levees. Borrowing from the stream bed itself will result in the removal of gravel bars and other materials which are present furbearer habitat. In this respect borrow areas will be unsuited for furbearers. Clearing dry land borrow areas will decrease suitability for furbearers.

In conjunction with levees there will by numerous overflow channel closures. The exact areas of these closures will not be determined until reservoir regulation begins, and it is decided where closures are needed. These closures will be detrimental to waterfowl in that they will reduce ponding,

lower the water table, and prevent flooding of lands behind the closures and the levees, thus reducing the waterfowl winter habitat on the flooded lands throughout the valley. Overflow closures are to be constructed on Coast Fork Willamette, Santiam, North Santiam, South Santiam, and the Main Stem Willamette River from the Long Tom to Newberg.

Bank Protection

The total number of areas which will undergo bank protection is listed as 171. Wherever these bank protection areas occur on outside curves, it is believed they will have no major effect upon game species. These areas are subject to considerable erosion and are not at present utilized to any appreciable extent by bank denning furbearers.

Channel Improvements

Three hundred miles of channel improvements on Willamette River and its tributaries are proposed. This will involve snag removal, channel rectification and clearing, and the removal of gravel bars, and will affect waterfowl and furbearers. Waterfowl will be benefited to a limited extent by the removal of brush. However, any cutoffs made on the main stream, such as that contemplated at the mouth of McKenzie River, will remove available waterfowl habitat. Spoil from these limited channel constructions, if disposed of in the old channel, will further reduce their habitat. The removal of bars and rerouting of channels will reduce the furbearer habitat throughout the course of the river.

DRAINAGE

Nineteen areas throughout the length of the valley are proposed for major drainage improvements. In many instances this will involve channel rectification and improvement of the existing channels. Some areas such as Turner Prairie will involve the major construction of drainage ditches. The total

area ultimately to come under this drainage program both through Federal and private efforts will be 480,000 acres. The proposed areas, as shown in Table 13, include all of the major waterfowl wintering areas in the Willamette Valley. The primary effect of this drainage program will be upon waterfowl with secondary effects upon furbearers and upland game. Of the 386,710 acres under the ultimate potential drainage, at least 138,700 acres are vitally needed waterfowl wintering habitat. This will be completely destroyed. Waterfowl utilization of these areas is confined approximately to a four-month period from November through February. The U.S. Fish and Wildlife Service annual waterfowl inventory data for 1948 showed a count of 70,000 waterfowl utilizing the Willamette Valley. A supplementary airplane census taken by the Game Commission on January 17, 1947, showed a count of 7,500 additional waterfowl in areas not accessible during the regular census. These figures must be considered as low because of the present low population of waterfowl on the North American continent. This is believed to be an all time low by the U.S. Fish and Wildlife Service. Waterfowl hunting is a major recreation throughout the Willamette Valley, particularly on areas where drainage is contemplated.

Upland game will be benefited to a very limited extent by the drainage programs. Birds will have slightly more habitat during the high water periods and the limited clearing of brush along the right-of-ways to be acquired will give a slight benefit to these species.

Furbearers will lose important habitat owing to channel improvements and channel cutoff. Any bank denning or dam-building furbearers will be a source of annoyance on the drainage ditches to be constructed.

FLOOD CONTROL

The flood control aspects of the entire Willamette Valley Project as affecting game, under this heading are considered to mean the maintenance of minimum

low water flows and the removal of the dangers of flooding. It is believed that the entire removal of flooding will be a slight benefit to upland game birds owing to their ability to utilize all habitat all year long and to the probable extension of agricultural enterprises closer to the river. Waterfowl will be affected adversely by the lack of overflow waters and standing rain water which are utilized to a great extent by wintering birds. Furbearers will be affected adversely by extreme fluctuations of the river during controlled run-offs as well as a longer period of bank full flow each year than exists at present. It is felt that one flood a year or every two or three years is not as detrimental to furbearers as will be rapid fluctuations of river levels several times a year and the maintenance of bank full conditions for a considerably longer period under the reservoir regulation planned. In addition, both waterfowl and furbearers will suffer because of an anticipated reduction in habitat areas in the sloughs, old channels and ox bow lakes prevalent in the southern half of the Willamette Valley. This will be caused by maintenance of mean low flows and cut-off improvements in this area.

IRRIGATION

Reports prepared by the Corps of Engineers list 452,100 acres in the Willamette Basin as being available for ultimate irrigation. Since, from the proposed projects, most of this irrigation will be the result of private enterprise at a future date, the effects will not become known for considerable time.

Pumping Irrigation

The immediate additional irrigation to be undertaken in the Basin projects will be additions to the present systems of pumping from streams and utilization of over-head sprinkling systems. This will affect game by causing more intensive farming throughout the areas where it will be undertaken. The species affected will be upland game. The preponderance of crops produced under an

over-head sprinkler system in the past have been row crops and pasture, both of which are low value pheasant habitat. Therefore, the immediate effects of this type of irrigation would be detrimental to pheasant populations.

Canal-Fed Irrigation Systems

It is felt that canal-fed irrigation systems will be beneficial to upland game by causing an extension of diversified farming and the farming of land that does not at present produce crops. Furbearer and waterfowl usage of the canals and feeder ditches would increase, providing, however, that water remained in the ditches throughout the year. Undoubtedly, bank denning furbearers will cause considerable damage problems on any ditches to be constructed. Any highly intensified farming which would result from these irrigation systems together with the row cropping that usually is undertaken in these enterprises would be detrimental to both upland game and waterfowl by the removal of cover and feeding areas.

SUMMARY

1. Big Game: Big game will be affected by the removal of 31,957 acres of habitat in the impoundment sites plus that destroyed in downstream borrow areas.
2. Grouse: Grouse will be affected by the removal of 31,957 acres of habitat in the impoundment sites and that destroyed in any downstream borrow areas.
3. Waterfowl: Waterfowl will be affected adversely by the complete removal of at least 138,700 acres of winter habitat by the proposed drainage programs. In addition, any channel closures and dumping of spoil into existing sloughs, channels and ox bow lakes will remove the habitat involved for both resident and migrating waterfowl.
4. Furbearers: Furbearers will be affected adversely by the Willamette Valley Project due to more frequent river fluctuations and bank full stages caused by proposed methods of reservoir regulation. In addition, bank protection, cut-off channel closures and channel improvements will remove an acre of furbearer habitat for each acre of such work undertaken.
5. Upland Game Birds: The net effect upon upland game birds of the entire scope of the Willamette Valley Project is believed to be negligible. Brush clearing and the prevention of floods will undoubtedly make available a limited amount of habitat that is not utilized at present, however, this habitat would be slightly more than overbalanced by the amount of habitat that would be unusable because of reduction of existing cover and more intensive and changed land use practices.

1. Big Game: At present there is no known method of mitigating the complete loss of habitat which will result from construction of the proposed impoundments. It has been the experience of Oregon and other states that wherever large numbers of transient or semi-transient construction workers move into an area a considerable loss of big game populations occur due to illegal hunting. Therefore, the Game Commission asks that sufficient money be made available to place a full-time law enforcement officer in each river basin during construction work on the dams. Previous experience with losses to game populations due to this fact indicate that they are severe and that it takes many years, in most cases, for the resident big game herds to build back to their previous levels.

2. Grouse: The same program recommended above for big game is recommended for grouse.

3. Waterfowl: The already restricted winter habitat of waterfowl in the Willamette Valley will be practically eliminated by the proposed drainage and flood control projects. The following methods of mitigation are believed the most feasible at the present time. In order that some food will be available for waterfowl near the impoundments where waterfowl use is anticipated, it is hereby requested that not less than an average of 200 acres of farm land per reservoir be purchased and fenced adjacent to Fern Ridge, Cottage Grove, Dorena, Holley and Lewisville Dams and annually planted to suitable grain crops for waterfowl feed. A grant providing an annual sum of $30,000 to cover maintenance and farming costs be made to the appropriate operating agency for carrying out this program on a continuing basis. Lands should be purchased in strips rather than blocks for this purpose.

Maintenance of as many sloughs and ox bow lakes as possible is recommended. If over-flow channels are to be closed, close only the upper ends, leaving the lower ends open for replenishment by river waters and, by the installation and maintenance of tide gates, assure permanent water levels.

Since at least 138,700 acres of excellent winter waterfowl habitat are to be destroyed by the drainage programs, it is hereby requested that permanent marsh areas be acquired, developed, diked and furnished adequate free water to maintain them as permanent year-long marshes on the replacement basis that one acre of permanent marsh equals the food and other habitat benefits of 14 acres of intermittent flooded habitat. Based on this ratio, it is requested that 9,907 acres of permanent marsh be established in the Willamette Valley at such locations as may be selected by the Oregon State Game Commission, and diking, water supply and other development work be undertaken according to specifications to be submitted by the Oregon State Game Commission for each individual area concerned. Owing to uncertain final decisions as to irrigation water deliveries and ultimate agricultural effects, the areas will not be listed for acquisition and development until such time as the various works proposed and recommended by the Corps of Engineers in the Willamette Basin are nearing the construction stage and a more complete evaluation of their overall effects upon each game species may be more thoroughly measured on an individual project segment basis. They should be selected and developed prior to construction of the dams in order to have developed for use suitable habitat to replace that to be lost. The total acreages involved for permanent marsh area will not change materially once the entire basin project is being developed. Under no circumstances will the intended ratio of replacement of permanent marsh for intermittently flooded lands be reduced.

As an alternative to this procedure, if drainage can be withheld on certain proposed areas, waterfowl habitat will be less adversely affected. These

areas as indicated in Appendix G are:

Turner Prairie	Mud and Basket Sloughs
Area east of Albany	West Muddy and Marys River
Ferguson Creek	East Muddy and Lake Creek
Bear Creek	

This will not eliminate the waterfowl habitat losses but will retain several of the most vital areas for waterfowl. The remaining loss of habitat could then be substituted by establishing permanent marsh on a replacement ratio of 1 acre of marsh to each 25 acres of habitat lost. As at least 66,500 acres of remaining habitat will be lost, it will then be necessary to construct 2,660 acres of permanent marsh to replace this. This additional marsh would be constructed in such of the areas as will not be drained, and is specified by the State Game Commission. Water will be furnished free and development will be in accordance with specifications of the State Game Commission.

It will be necessary that money be provided in perpetuity from the Willamette Valley Project for operation and maintenance of the marshes created at a rate of $6.00 per acre per year. If marshes are created in blocks smaller than 500 acres, the maintenance cost will be increased to $8.00 per acre. These sums include labor and other expenses necessary to produce the best waterfowl conditions.

4. Furbearers: Less specific data are known about the management of furbearers throughout the United States in relation to impoundments and drainage activities of this magnitude than about the management of other game resources. For this reason complete evaluation of the over-all effects on furbearers of the Willamette Valley Project cannot be made until long-range investigations can be completed. However, the general data presented in the preceding pages are correct. The value of the fur catch in the 1946-47 season

in the Willamette Basin counties was $29,568.88./1 Since the over-all effect on furbearers will be highly detrimental, it is requested that sufficient money be made available to the managing agency to establish a major furbearer research program employing not less than two technically qualified men for a five-year period in order that a complete management program may be formulated for furbearers in the Willamette Basin to safeguard what will remain of this resource after the Willamette Valley Project is completed. Sufficient money to operate a maintenance project on furbearers following results of research at the rate of $15,000 per year is requested.

5. Upland Game Birds: The over-all effects of all phases of the Willamette Valley Project in their ultimate objective will be slightly detrimental to upland game populations. Some of the work will involve acquisition of right-of-ways by the Corps of Engineers and part will be acquisition of private or district right-of-ways for irrigation canals. It is suggested that mitigation of damage for these species can be undertaken best by utilizing any acquired right-of-ways and cleared areas in the best interests of the game species involved. It is therefore requested that each right-of-way acquisition to be undertaken for dikes, canals, levees and irrigation canals have the provision attached thereto that the appropriate administrative agency shall have the authority at any time to set up any portion or portions either continuous or in intermittent blocks, of these right-of-ways as wildlife sanctuaries for the benefit of upland game, waterfowl and furbearing animals. And that further such provision for refuge establishment will include the privilege of planting such food or cover improvements at any time upon these right-of-ways as will not interfere with the primary intent of the construction or the local agricultural economy. All areas not established as refuges will be left open to access by the general public for hunting and fishing.

/1 Includes Clackamas, Benton, Lane, Linn, Marion, Polk Counties

TABLE 13. HABITAT LOST IN DRAINAGE AREAS

Project	Area Potentially Benefited (Acres)	Improvement Length in Miles	Essential Waterfowl Habitat Estimated (Acres)
Coyote and Spencer Creeks	8,920	19.7	3,900
Amazon Creek	22,080	33.1	6,800
Flat Creek	21,900	35.6	6,000
Bear Creek	3,470	6.2	3,000
Ferguson Creek	3,140	3.6	2,000
East Muddy & Lake Creeks	55,330	80.6	23,500
West Muddy & Marys River	33,100	39.	17,100
Calapooya River	58,000	48.7	15,000
Area East of Albany	16,200	33.8	8,500
Beaver Creek	11,700	5.	5,200
Soap Creek	7,600	6.2	3,500
Ash Creek	4,470	9.2	2,500
Turner Prairie	10,400	17.4	8,800
Mud and Basket Sloughs	13,100	10.4	8,700
Shelton Ditch	------	2.3	------
Salt Creek	8,840	10.2	3,900
Ash Swale	8,860	9.6	4,700
Pudding River	99,600	39.2	15,000
Johnson Creek	------	12.5	------
TOTAL	386,710	422.3	138,700

TABLE 14. COST OF FURBEARER RESEARCH PROGRAM

	Annual
Salaries	$ 7,000.00
Office Supplies	100.00
Telephone	50.00
Meals and Lodging	4,000.00
Field Supplies	1,000.00
Motor Vehicle Supplies	2,000.00
TOTAL	$14,150.00

3-Year Cost $42,450.00

TABLE 15. SUMMARY OF MITIGATION OF WILDLIFE LOSSES

Proposed Mitigation	Annual Cost
Game Law Enforcement Officers (8) (No cost specified until the agency for administration is designated)	----------
Land for reservoir feeding sites (1,000 acres minimum size, cost not specified)	----------
Cost of farming reservoir feeding sites per annum	$30,000.00
Land and development for marsh areas (Cost not specified, from 9,907 to 2,660 acres in area)	----------
Cost of maintenance of marsh areas (Total cost to depend on area. Cost $6.00 per acre per annum for over 500 acre areas; $8.00 per acre per annum for under 500 acre areas.)	----------
Furbearer research project (2 men for 5 years) per annum	$14,150.00
Furbearer management program (To start after research project is completed) per annum	$15,000.00

TABLE 16. IMPOUNDMENTS AND THEIR NET EFFECTS ON WILDLIFE AND GAME SPECIES

Stream System and Area of Impoundments	Dam	Impoundment Area in Acr.	Borrow Area	Effects on Game Species				
				Big Game	Grouse	Furbearers	Waterfowl	Upland Game Birds
North Santiam 3740 Acres	Detroit	3,600	---	Detrimental	Detrimental	Detrimental	None	None
	Big Cliff	140	Downstream	"	"	"	"	"
South Santiam 6152 Acres	Cascadia	1,700	Upstream	"	"	"	"	"
	Green Peter	3,580	Upstream and down	"	"	"	"	"
	White Bridge	272	---	"	"	"	"	"
	Wiley Creek	600	Upstream and down	"	"	"	"	"
Calapooya River 2120 Acres	Holley	2,120	Upstream	"	"	"	"	"
McKenzie River 3045 Acres	Gate Creek	605	Downstream	"	"	"	"	"
	Blue River	1,030	Downstream	"	"	"	"	"
	Cougar	1,410	Downstream	"	"	"	"	"
Middle Fork of Willamette 9730 Acres	Fall Creek	1,870	Upstream	"	"	"	Beneficial	"
	Hills Creek	2,420	Downstream	"	"	"	"	"
	Meridian	4,360	Upstream and down	"	"	"	"	"
	Dexter	1,080	Upstream	"	"	"	"	"
	Waldo Lake	------	---	None	None	"	Detrimental	"
Coast Fork Willamette 1820 Acres	Dorena	1,820	---	Detrimental	Detrimental	"	Beneficial	"
Long Tom 1050 Acres	Cottage Grv.	1,000	---	None	None	"	None	Detrimental
Marys River 1050 Acres	Tumtum	1,050	Upstream	Detrimental	Detrimental	"	"	None
Luckiamute 3300 Acres	Lewisville	3,300	Upstream and down	None	None	"	Beneficial	Detrimental
	TOTAL	31,957						

TABLE 17. FURBEARER HABITAT LOST IN IMPOUNDMENTS

Stream System	Miles of Stream in Impoundment	Miles of Stream Immediately Below Impoundment Rendered Unsuitable (Estimated)	Estimated % Decrease of Furbearers Immediately Below Impoundments
North Santiam	13.3	10	50%
South Santiam	22.7	20	60%
Calapooya	3.6	6	20%
McKenzie	16.7	14	50%
Middle Fork Willamette	30.7	25	60%
Coast Fork Willamette	4.9	4	15%
Marys River	5.5	6	15%
Luckiamute River	6.0	7	15%
TOTAL	103.4	92	

TABLE 18. GAME SPECIES ELIMINATED IN IMPOUNDMENT SITES

Stream System	Acreage of Impoundments	Sections	Game Densities				Game Population Eliminated			
			Deer Per Section	Grouse Per Section	Pheasants Per 100 Acres	Quail	Deer	Grouse	Pheasants	Quail
North Santiam	3,740	5.85	5	3	--	-	29	18	---	--
South Santiam	6,152	9.65	5	3	--	-	48	29	---	--
Calapooya	2,120	3.32	5	4	--	-	17	13	---	--
McKenzie	3,045	4.75	5	4	--	-	24	19	---	--
Middle Fork Willamette	9,730	15.13	5	4	--	-	76	61	---	--
Coast Fork Willamette	1,820	2.85	5	3	--	-	14	14	---	--
Long Tom	1,000	----	-	-	9	-	--	--	90	--
Marys River	1,050	1.64	17	5	--	-	28	8	---	--
Luckiamute	3,300	5.1	1	2	10	2	5	10	330	66
TOTAL							241	172	420	66