SANTIAM AND CALAPOOIA SUBBASIN

Fish Management Plan

Oregon Department of Fish & Wildlife

SANTIAM AND CALAPOOIA SUBBASIN FISH MANAGEMENT PLAN

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March 1992

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INTRODUCTION

A high priority of the Willamette Basin Fish Management Plan (ODFW 1988a) was the preparation of plans for subbasins within the Willamette basin. The Santiam and Calapooia Subbasin Plan was developed to provide specific direction for management of the fish resources of the Santiam and Calapooia subbasins. The scope of the plan includes the main stem, North, and South Santiam and Calapooia rivers and their tributaries. Separate mini-plans will be written for reservoirs and lakes in the subbasin.

ODFW is committed to the planning process as an integral part of all current and future management by the agency. The Santiam and Calapooia Plan is one element of the Department's planning efforts. Species plans for coho, steelhead, trout and warmwater game fish have been adopted, and a management plan for chinook salmon is being prepared. These statewide plans guide the development of more localized plans for individual river basins and subbasins.

These plans serve several needed functions. They present a logical, systematic approach to conserving our aquatic resources. They establish management priorities and direct attention to the most critical problems affecting our fisheries so that the Department's funds and personnel can be used accordingly. They inform the public and other agencies about the Department's management programs and provide them with the opportunity to help formulate those programs.

The Santiam and Calapooia Plan was developed by the Oregon Department of Fish and Wildlife with the assistance of a public advisory committee and a technical advisory committee. The public advisory committee represented user groups and interested members of the community at large. The function of this committee was to help identify objectives and actions and to serve as a sounding board for public interests. The public advisory committee members were:

Member	Affiliation
Al Buhr	Santiam Flycasters
Richard Bunse	Oregon Trout
Joe Coffey	Santiam Flycasters
George Hann	Northwest Steelheaders, Stayton Chapter
Mike Huddleston	Northwest Steelheaders, Salem Chapter
Tim Rushing	Northwest Steelheaders, Albany Chapter
Bill Sanderson	North Santiam Guides
Bob Weiler	Northwest Steelheaders, Albany Chapter

The technical advisory committee was composed of representatives of federal and state fishery and land management agencies and electrical utilities. This committee contributed information used in the plan and reviewed drafts of the plan. Members of this committee were:

Member	Affiliation
Sterling Anderson	Marion Co. Community Development Dept.
John Detar	Linn Co. Planning & Building Dept.
Bob House	Bureau of Land Management
Linda Prendergast	Pacific Power & Light
Lee Vaughn	Department of Forestry

The habitat, steelhead, and salmon sections of the plan were originally prepared as part of the Integrated System Plan for Salmon and Steelhead Production in the Columbia River Basin (ODFW 1990a, Columbia Basin Fish and Wildlife Authority 1990). Those sections have since been modified to fit ODFW's format for subbasin plans and to comply with the ODFW's Natural Production and Wild Fish Management policies (OAR 635-07-521 through 635-07-529).

The plan is divided into sections that deal with habitat, the major fish species or groups of species, and angling access. Each of these sections contains:

1. Background and Status--historical and current information on the topic of that section that helps explain the context of the policies, objectives, and actions that follow.

2. Policies--constraints or principles developed specifically for management activities in the subbasin related to that species or topic.

3. Objectives--what is intended to be accomplished.

4. Actions--solutions or methods for accomplishing the objectives.

GENERAL CONSTRAINTS

Besides the statewide species plans and the Willamette Plan, the Santiam and Calapooia Plan must also conform to other established constraints such as federal acts (e.g., Wild and Scenic Rivers, Wilderness, Endangered Species), state statutes, administrative rules, memoranda of understanding and other policies.

Legal Considerations

The Department of Environmental Quality (DEQ) has developed state water quality standards that are in compliance with federal water quality standards. State water quality standards are specifically directed at fish bearing waters. DEQ administrative rules (Chapter 340, Division 41) address water quality standards basin by basin.

Senate Bill 140 (ORS 537.332 through 537.360) directed the Water Resources Commission to convert minimum stream flows into in-stream water rights following review. In 1989 the Oregon Fish and Wildlife Commission adopted administrative rules (OAR 635-400-000 through 635-400-040) regarding in-stream water rights. Minimum streamflows were adopted for 15 locations in the Santiam and Calapooia subbasins. Although legislation does not guarantee the availability of these flows, it does give minimum flows priority over water rights obtained subsequently. Streams in the Santiam and Calapooia subbasins have been adjudicated.

House Bill 2990 of 1985 (codified in part as ORS 543.015 and ORS 543.017) provides strict standards to protect anadromous fish, resident game fish and recreation from adverse effects of hydroelectric development. Its general impact has been to halt hydro development on anadromous fish streams.

The Oregon Revised Statutes (ORS) require fish ladders and fish screens at dams and water diversions to provide upstream and downstream fish passage.

The Oregon Forest Practices Act (Forest Practices Act) (ORS 527.610 to 527.730) was adopted in 1972. Commercial timber operations on state and private land are regulated by the act, which is administered by the Oregon Department of Forestry. Forest management activities on U.S. Forest Service and Bureau of Land Management lands are designed to comply with Forest Practices Act rules and state water quality standards. The Forest Practices Act does not apply within the urban growth boundary of towns and cities.

The Oregon Removal-Fill Law requires a permit for the removal or filling of 50 cubic yards or more of material in natural waterways. The Division of State Lands oversees the program, reviews applications and issues permits, and enforces the law.

The Oregon Riparian Tax Incentive Program of 1981 provides a tax exemption to land owners for riparian lands included in a management plan developed by the land owner and ODFW personnel.

The Oregon Land Conservation and Development Commission has developed statewide planning goals. Goals that affect fishery resources include Goal 5, which addresses fish and wildlife areas and habitats, and Goal 6, which addresses water quality.

Oregon Senate Bill 523 of 1985 initiated a coordinated effort among state resource agencies for planning and management of the state's water resources.

ODFW goals and policies for commercial and sport fishing regulations, fish management, and salmon hatchery operation, including the Natural Production and Wild Fish Management policies, are adopted as Oregon Administrative Rules (OAR).

Marion and Linn County Comprehensive Land Use Plans contain goals and policies for riparian protection, erosion prevention, and fish and wildlife habitat protection.

Procedures Developed by ODFW

A Department Guide for Introductions and Transfers of Finfish into Oregon Waters (1982), and Fish Disease Control Guidelines (1979) provide direction for management of fish.

Agreements with Other Agencies

Each of the land and water management agencies in the Santiam and Calapooia subbasins has regulatory authority over some aspect of land or water use, or has overall responsibility for specific land or water areas. Each agency has its own policies, procedures, and management directives associated with its area of responsibility. No single agency has total jurisdiction over an entire river basin. For this reason, coordinated involvement and cooperation among fishery, land, and water managers is necessary to achieve comprehensive management of a watershed to the benefit of the entire system and its resources.

Memoranda of understanding among ODFW and the Bureau of Land Management (BLM), the U.S. Forest Service (USFS), and the U.S. Army Corps of Engineers (USACE) describe cooperative activities for protecting and improving fish habitat on federal lands. Contractual agreements exist with the National Marine Fisheries Service and the U.S. Fish and Wildlife Service concerning Columbia River and ocean salmon fisheries, marine fish investigations, and hatchery production. Annual contracts with the USACE have been established to mitigate for fish production lost as a result of USACE projects.

ODFW comments on USFS and BLM project proposals as well as the general land management plans. The plan review process provides a forum for the state to address habitat improvement or protection for fishery resources. The Willamette National Forest has completed their management plan. The BLM has initiated its planning process for western Oregon. USFS and BLM fish habitat improvement projects require close coordination with the Department of Fish and Wildlife's Salmon and Trout Enhancement Program (STEP).

ODFW and the state Water Resources Department (WRD) have a memorandum of understanding to coordinate review and action on water rights applications that conflict with protection of fish and wildlife habitats (Memorandum of Understanding, Oregon Department of Fish and Wildlife - Oregon Water Resources Department 1990). WRD is currently updating its management programs for the Willamette basin. Programs affect future water rights, set priorities for water use, and prescribe actions to solve water problems. ODFW, along with other state natural resource agencies, has identified issues that ODFW will cover and contribute to the Water Resources Department's planning process. Final adoption of new programs is expected in 1991.

The Governor's Watershed Enhancement Board provides an opportunity for private individuals as well as organizations to become involved in watershed rehabilitation projects. An Oregon Fish and Wildlife Commission member is a member of this board.

Linn County Planning and Zoning Department and Marion County Community Development Department are local government agencies involved in land and water management in the Santiam and Calapooia subbasins which would like additional assistance in determining the impact of land-use decisions on fish and wildlife resources.

General Policies

The following general policies apply to all subbasin plans in the Willamette basin, including the Santiam and Calapooia subbasins.

Policy 1. To the extent authorized by law, the Department shall seek compensation for losses of production due to development and other man-made causes.

Policy 2. Hatchery production shall be evaluated to determine if benefits exceed costs.

Policy 3. The number of hatchery fish stocked in the Willamette Basin, regardless of species and size, shall not be increased and stream systems not currently receiving hatchery fish shall not be stocked, with the following exceptions:

- **(a) Experimental programs where the number of fish released is relatively small and a planned and funded evaluation program exists;**
- **(b) Rehabilitation programs for native species;**
- **(c) As provided for in subbasin plans adopted by the Commission in public hearing; and**
- **(d) Special situations approved by the Commission in public hearing.**

Policy 4. Stocking levels and areas shall be addressed in subbasin plans.

HABITAT

Background and Status

Basin Description

The Santiam and Calapooia rivers originate in the Cascade mountain range of Oregon and flow west into the Willamette River at River Mile (RM) 108 and RM 119.5, respectively (Figure 1). The Santiam River (EPA Reach 1709.0005.001.00.00) has two main tributaries. The North Santiam River is approximately 92 miles long. It joins the South Santiam River, approximately 66 miles long, 11.7 miles above the confluence of the Santiam and the Willamette River. The entire Santiam basin is 1,827 square miles in size. The Calapooia River (EPA Reach 1709.003.074.00.00) is approximately 75 miles long and drains an area of 374 square miles.

The North Santiam drains forested watersheds extending eastward into the High Cascades. This area is characterized by high plateaus containing scattered volcanic peaks and rugged slopes. Mass wasting events and soil erosion are relatively uncommon (USFS 1987a). The headwaters of the South Santiam are in the geologically older Western Cascades. Mass wasting is more prevalent than in the High Cascades due to steep slopes, thicker soils of low strength and a tendency for soils to become saturated with water (USFS 1987a). Rock falls, rapid debris slides, slow-moving earth flows and soil creep occur. Gentle slopes and broad alluvial flats separated by low hills are found in the west (Franklin and Dyrness 1973).

The upper Calapooia River drains the western portion of the western Cascade Range. The gradient flattens as it approaches the Willamette Valley, where the river meanders through agricultural land, as does the Santiam River. Soils on the valley floor are derived from silty alluvial deposits (Langridge 1987 and Williams 1972).

Sediment production from eroding slopes contributes to river and stream turbidity. Silting of spawning gravel and substrates important for aquatic invertebrate production and juvenile salmonid rearing may occur when quantities exceed the streams normal routing capacity. Rivers and streams which have been identified as having eroding channels and banks and sediment related problems include the Breitenbush River, Middle Santiam River, South Santiam River, Wiley Creek and the Calapooia River (USFS 1987a).

The Santiam and Calapooia subbasins have a temperate maritime climate with moderately dry, warm summers and mild, wet winters. Mean annual temperatures range from 46º F at higher elevations to 53º F in the Willamette Valley. Winter temperatures below 10º F and summer temperatures above 100º F are unusual.

Subsurface movement of water accounts for nearly all streamflow, except in areas where land use practices have decreased the infiltration capacity of the soil. This helps maintain cool water temperatures

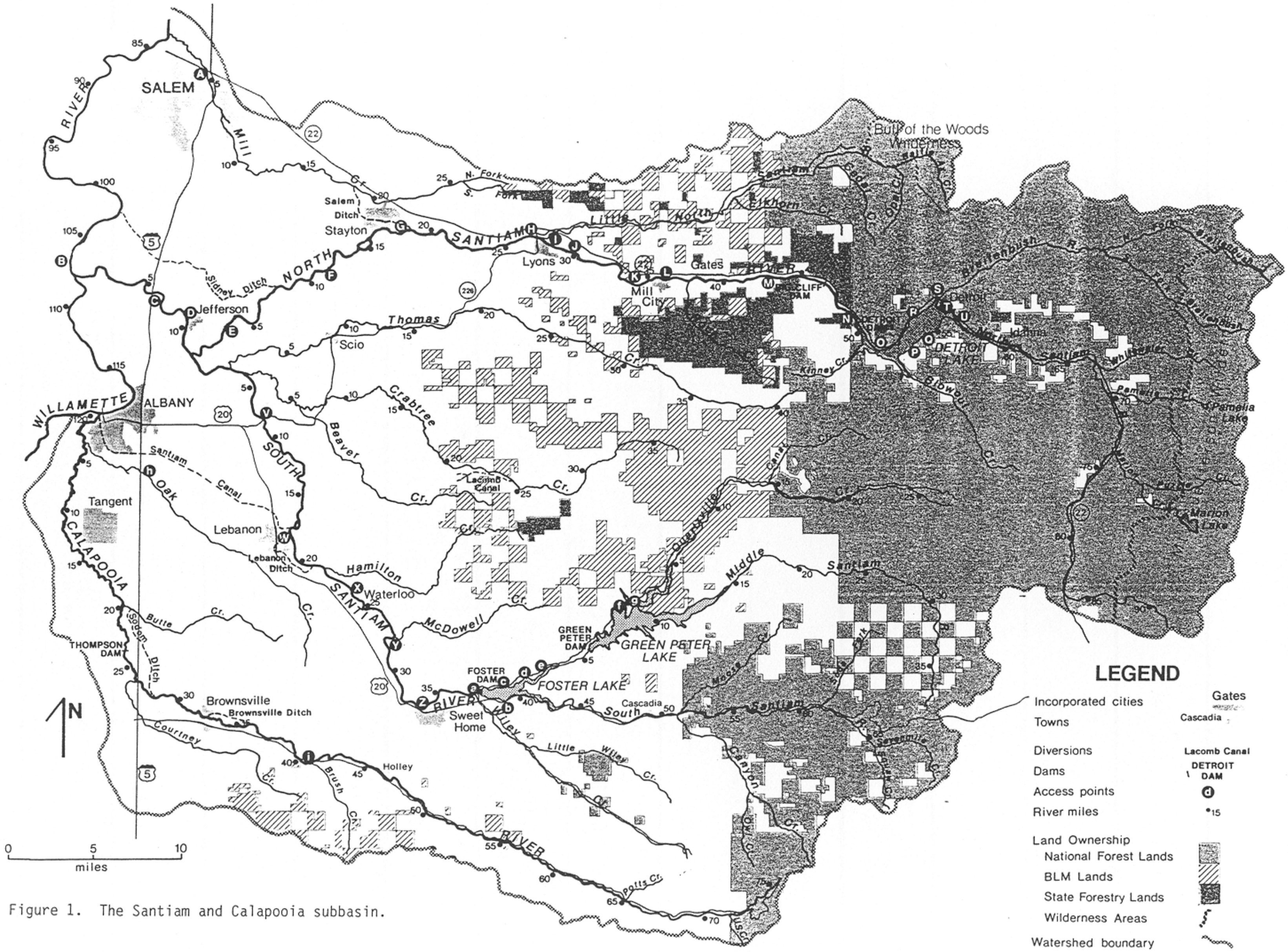


Figure 1. The Santiam and Calapooia subbasin.

and sustained flows in the High Cascades and eastern portions of the Western Cascades during the summer. Streams and rivers at lower elevations are subject to lower flows and higher temperatures during the summer and early fall (Table 1).

Table 1. Mean seasonal water temperature data (°F) for rivers in the Santiam and Calapooia subbasins, 1977-1986 (USGS, unpublished data).

Station	Fall	Winter	`Spring	Summer
No. Santiam R. below Boulder Cr. near Detroit	46	39	43	54
Breitenbush R. above French Cr.	46	37	43	54
No. Santiam R. at Niagra	54	41	43	48
So. Santiam R. below Cascadia	50	41	46	61
So. Santiam R. near Foster	52	43	48	54
So. Santiam R. at Waterloo	52	43	48	59
Santiam R. at Jefferson	54	43	48	61
Calapooia R. at Holley	52	43	50	66
Calapooia R. at Albany	54	43	54	68

In 1984, the U.S. Army Corp of Engineers (USACE) initiated a study of the temperature and flow effects of reservoirs on the North and South Santiam rivers. Water discharged during the summer from Detroit Reservoir is 9-14° F lower than natural water temperatures (USACE 1988). Summer cold water from Foster Reservoir varies from 13-20° F and from Green Peter Reservoir 22-27° F lower than natural water temperatures. Low water temperatures during the summer delay migration of adults and decrease growth rates of juvenile fish. Water discharged from the reservoirs in the fall is 2-9° F warmer than natural water temperatures. Warm water temperatures in the fall may accelerate incubation of eggs resulting in premature emergence of chinook fry.

Water temperatures commonly exceed 70° F in lower Thomas and Crabtree creeks. This prevents many species and stocks of anadromous salmonids from holding and rearing in these reaches.

Upland vegetation in the Santiam and Calapooia subbasins stabilize soils on steep slopes, thereby reducing mass wasting and the resulting sedimentation, increased turbidity, and other impacts in streams and rivers down slope. Vegetation intercepts and stores precipitation and removes soil moisture through evapotranspiration. This buffers the effect of storm events on mass wasting and soil movement. Roots of vegetation bind soil particles together and often anchor soils to underlying bedrock, thereby strengthening soils and increasing slope stability (Swanston and Swanson 1976).

Vegetation in riparian areas provides shade, which maintains low water temperatures during summer and early fall. Large trees, particularly conifers, provide woody debris which enhances channel stability, provides structure and fish habitat, moderates sedimentation, and increases retention of spawning gravel (USFS 1987a). Vegetation provides nutrients to the soil and stream through litter drop. This provides an energy base for production of aquatic invertebrates, important food organisms for fish.

Streamflow quantity and quality are usually favorable for salmonids in the Santiam and Calapooia except in lower areas of the subbasin. Here, stream gradient is low, and reaches of the Santiam and Calapooia rivers experience low flows in the summer and early fall. Water diversion for agricultural, industrial, and municipal needs further aggravate low flow problems. Water temperatures of the lower Calapooia and South Santiam rivers commonly exceed 75º F in summer months. Releases of cooler water (temperatures generally less than 55º F) from Detroit and Big Cliff Reservoirs alleviate some of these problems in the lower North Santiam, but can delay upstream migration in upper reaches of the North Santiam River. The Oregon DEQ assessed the biological and chemical water conditions of selected streams in the subbasins (DEQ 1978). They concluded that most major rivers and some tributaries had moderate water quality ratings with regard to sedimentation and elevated temperatures.

A 12-mile segment of Quartzville Creek was designated a federal wild and scenic river in 1988. A 9.3-mile segment of the Little North Fork of the Santiam River was designated an Oregon Scenic Waterway by the Oregon Rivers Initiative in November 1988. Designated rivers have scenic, fishery, wildlife and recreational uses protected. The Little North Fork Scenic Waterway extends from the confluence of Battle Ax and Opal creeks downstream to the boundary of the Willamette National Forest.

Land Use

Approximately 40 percent of the land in the Santiam and Calapooia subbasins is public land, of which 34.4 percent is managed by the U.S. Forest Service (USFS) (Table 2). The headwaters of the Santiam and the uppermost tributaries of the Calapooia originate in the Willamette National Forest. At lower elevations these rivers flow through a mixture of private, BLM, and state-owned lands. Most of this land is managed for commercial production of Douglas-fir. Along the valley floor, privately owned irrigated and non-irrigated agricultural lands predominate.

Table 2. Landownership in the Santiam and Calapooia subbasins (acres and percent of total) (Oregon Water Resources Department, unpublished data).

Watershed	BLM	USFS	USACE	State	Private	Total
North Santiam	20,366 (3.8%)	325,256 (60.9%)	1,946 (0.4%)	1,148 (0.2%)	185,416 (34.7%)	534,132
South Santiam	61,287 (9.2%)	150,780 (22.7%)	394 (<0.1%)	347 (<0.1%)	452,708 (68.0%)	665,516
Calapooia	5,413 (2.7%)	5,904 (2.9%)		189,879 (94.4%)	201,196	
Total	87,066 (6.2%)	481,940 (34.4%)	2,340 (0.2%)	1,495 (0.1%)	828,003 (59.1%)	1,400,844

Forestry

Most of the land at higher elevations in the Santiam and Calapooia subbasins is managed by the USFS as part of the Willamette National Forest. Vegetation in wilderness areas is unaltered except by natural events, such as fire and wind. Wilderness areas found in USFS land in the Santiam subbasin include the Bull of the Woods Wilderness, the Mount Jefferson Wilderness, the Middle Santiam Wilderness, and the Menagerie Wilderness Area. Most of the other areas are managed for timber production.

The Oregon Department of Forestry and the BLM manage other public forest lands. Major forest products industries owning large amounts of forest lands in the subbasin include Timber Service, Willamette Industries, Weyerhaeuser, and Champion International. Farmers and small woodlot owners own parcels of commercial forest land scattered throughout the foothills at lower elevations.

Timber management related alterations to a watershed increase the likelihood that storm events will cause damage to streams, fish habitat, and stream habitat improvement structures (USFS 1987a). Road building activities decrease slope stability through alteration of slopes and surface and subsurface drainage patterns (Sidle et al. 1984). Of 725 soil and debris slides reported by National Forests in Oregon following major storm events, 54 percent were associated with roads and 24 percent with logged areas (USFS 1987a). These proportions were also found in the Willamette National Forest, which received the most extensive damage of all the National Forests in Oregon. Chesney (1983) found that 71 percent of the landslides occurring in the Willamette National Forest enter stream channels and 43 percent result in debris torrents in the channels.

Current erosion and sediment production in the Willamette National Forest is well above natural levels (USFS 1987a). Table 3 gives sensitivity indices developed by the Willamette National Forest for watersheds in the Santiam and Calapooia subbasins. These indices were developed to represent the tendency toward mass wasting in a watershed and resulting sedimentation of streams.

Table 3. Mass wasting and sedimentation indices. Watersheds with high index ratings are more likely to receive impacts to water quality than those with low indices (from USFS 1987a).

Watershed	Sensitivity Index
Little North Santiam River	Moderate
Breitenbush River	High
North Santiam tributaries	Moderate
North Santiam, Blowout Cr., Woodpecker Cr.	Moderate
North Santiam upstream tributaries	Low
Quartzville Creek	High
Middle Santiam River	High
South Santiam River	Moderate
Wiley Creek	High
Calapooia River	Moderate

Harvesting of riparian zone conifers results in decreased amounts of large woody debris in streams, which provide needed fish habitat structure. Most streams in the Willamette National Forest are deficient in large woody debris (USFS 1987a). Timber harvesting and road construction in riparian areas can also increase stream water temperatures.

Riparian areas along USFS Class I and II streams (Class I streams are those having water for municipal or domestic use or large numbers of fish; Class II streams contain or have the potential for resident sport fish) receive the greatest amount of protection through USFS harvest standards and guidelines (USFS 1987a). Water temperature and water quality guidelines are established for these streams. Riparian areas along Class III and IV streams receive protection only to ensure the water quality of Class I and II streams downstream. (Class III streams are perennial streams having no fish; Class IV streams are intermittent.) Up to 50 percent of the streamside area along Class IV streams may be harvested (USFS 1987b). Yet most sediment from timber harvesting and road building enters stream systems through Class III and IV streams.

ODFW has expressed several concerns with the Draft Environmental Impact Statement and Proposed Land and Resource Management Plan for the Willamette National Forest (ODFW 1988b). ODFW recommended roadless area designation for several watersheds in the Santiam subbasin (ODFW 1988b). These areas include Elkhorn and Opal creeks in the Little North Santiam subbasin, Pyramid Creek and the Middle Santiam River in the Middle Santiam subbasin, and Moose Creek and Gordon Meadows in the South Santiam drainage basin.

The Willamette National Forest contains two mining areas in the Santiam basin, the Little North Santiam and Quartzville. Shiny Rock mine on the Little North Santiam has been commercially mined for gold and silver. Big Minerals, Inc. is a commercial placer mine located on McQuade Creek, a tributary of Quartzville Creek. Suction dredging for gold by Tambercal, a commercial in-stream mining operation, occurs in the Calapooia River on USFS land. The DEQ issues permits for large scale suction dredging. Stream impacts from these operations include increased turbidity and rearrangement of spawning gravel.

Agriculture

Agriculture is an important element of the mid-Willamette Valley economy. Approximately 25 percent of the Santiam and Calapooia subbasin land area, about 365,000 acres, is privately owned farm land (Linn County Planning and Zoning Department 1985, Marion County Planning Department 1981). Approximately 15 percent of this land is irrigated and 85 percent non-irrigated (Oregon Water Resources Department, unpublished data).

In the lowlands, riparian vegetation is often removed by private landowners seeking to expand their farmland. This practice tends to accelerate bank and channel erosion, such as along McDowell Creek, a tributary to the South Santiam. Similar cases of bank erosion are found along the lower reaches of the Calapooia River. This results in high turbidity and sedimentation downstream. Summer and early fall stream temperatures often increase because of reduced shading. Additionally, livestock grazing, such as on Gordon Meadows in the South Santiam drainage basin, causes stream bank erosion.

Chemical pollution may be a problem locally when fertilizers and pesticides wash from farm lands into rivers and streams. Non-point source pollution is more difficult to identify, monitor and remedy. The cumulative effects of various forms of pollution decrease stream and river productivity basin wide. Draining of fields and diverting water for irrigation purposes are other agricultural practices which alter streamflows or water quality which in turn affect fish production.

Residential and Commercial Development

Much of the residential development in the Santiam and Calapooia subbasins has occurred in the floodplain areas of the North and South Santiam and the Calapooia, on the valley floor and in the foothills. Demand for rural homesites is greatest in the scenic foothill areas with close proximity to urban areas (Linn County Planning and Zoning Department 1985). Most residential areas are concentrated in or near the towns and cities listed in Table 4.

Table 4. Incorporated towns and cities in the Santiam and Calapooia subbasins.

Town	County	Population[a]	Location[b]
Idanha	Marion & Linn	289	RM 60 No. Santiam R.
Detroit	Marion	331	RM 56 No. Santiam R.
Gates	Marion & Linn	499	RM 39 No. Santiam R.
Mill City	Marion & Linn	1,555	RM 35 No. Santiam R.
Lyons	Linn	938	RM 27 No. Santiam R.
Stayton	Marion	5,011	RM 17 No. Santiam R.
Jefferson	Marion	1,805	RM 9.5 Santiam R.
Scio	Linn	623	RM 9 Thomas Cr.
Sweet Home	Linn	6,850	RM 34 So. Santiam R.
Lebanon	Linn	0,950	RM 18 So. Santiam R.
Brownsville	Linn	1,281	RM 33 Calapooia R.
Tangent	Linn	556	Lake Cr.
Albany	Linn	29,462	RM 119 Willamette R.

[a] April 1, 1990 census, Center for Population Research and Census, School of Urban and Public Affairs, Portland State University, OR.

[b] RM = river mile

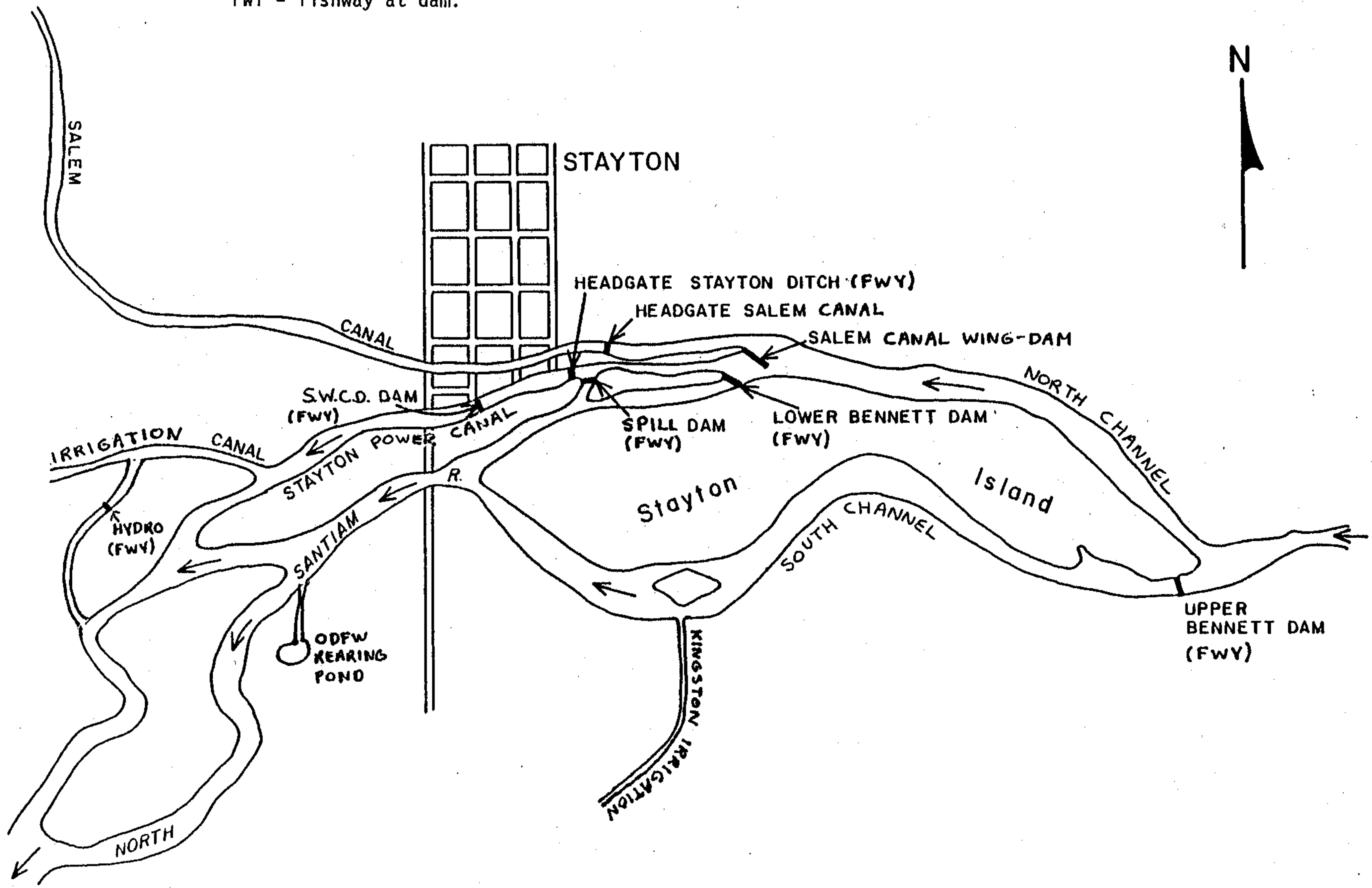
Developers of residential and commercial land remove riparian vegetation, divert water and channelize streams to manage runoff and flows. These impacts are more pronounced in the vicinity of larger towns or municipalities. Pringle and Clark creeks in Salem are examples of streams which have been channelized by municipal development. Fall chinook spawn in Shelton Ditch, which flows into Pringle Creek, yet in most cases channelized streams and ditches such as these cannot support anadromous fish production to any great extent.

Dams and Hydropower Projects

Construction of reservoirs has hindered upstream and downstream migration and reduced production of anadromous salmonids in the Santiam and Calapooia subbasins. Since 1953, Detroit Dam and its re-regulating structure Big Cliff Dam on the North Santiam River have completely blocked anadromous fish passage to important spawning and rearing areas. Migration of adult spring chinook is delayed and survival of smolts is poor because of the cold water released from Detroit Dam.

Upstream migrants encounter a variety of passage problems on the North Santiam at Stayton (Figure 2). During high spring flows, fish can pass through the south channel relatively easily. Flows over the Upper Bennett Dam fishway are adequate for passage. Beginning in early summer, most of the flow is diverted into the north channel and the power canal. Late migrating fish, such as spring chinook and some summer steelhead, must cross a series of fishways and headgates, avoiding unscreened irrigation canals, power canals and ditches. This route is especially difficult during low flow conditions.

Figure 2. Sketch of Stayton diversion area (from Willamette Basin Task Force 1969).
FWY = fishway at dam.



Juveniles migrating downstream encounter similar passage problems. Santiam Water Control District's (SWCD) Water Street Hydroelectric Project (FERC No. 6943) is on a canal off the north channel of the SWCD irrigation system. Juvenile fish screens were installed in 1985. ODFW is currently monitoring smolt migration and success of downstream migrant passage at this facility to determine if year-long screening is a necessary Federal Energy Regulatory Commission (FERC) condition. Although this project is screened, it is next to two other unscreened hydroelectric projects. These projects are not licensed by FERC or are exempt from licensing.

The small Stayton Feed and Seed Hydroelectric Project is located upstream of the Water Street Project. Pacific Power and Light's (PP&L) Stayton Hydroelectric Project, immediately adjacent to the Water Street Hydroelectric Project, is the major hydroelectric facility in the area and uses approximately 760 cubic feet per second (cfs) of water. Tests conducted by the Oregon Game Commission in 1955 and 1959 indicated that there were substantial downstream migrant salmonid losses at the Stayton plant. Currently, ODFW has an agreement with PP&L from March to June to protect the majority of the juvenile outmigrants. However, studies show fish move down the power canal all year. The PP&L plant is under order from the Federal Energy Regulatory Commission to prepare a license application by August 1993. PP&L is consulting with fish and wildlife agencies on fish passage and other environmental study requirements.

A recently completed study of fish migrations in the Stayton Power Canal demonstrated that game fish move downstream in this canal in all weeks of the year (personal communication on 2 January 1991 from E. Smith, ODFW, Springfield, Oregon). Juvenile chinook salmon and steelhead migrate downstream to Upper Bennett Dam where they are either diverted into the north channel towards the Water Street hydroelectric project and the two unscreened projects, or are diverted into the south channel, bypassing the canal system. Although there is a limited, three-month-per year closure at PP&L's Stayton project it is likely that a large number of juvenile fish are subjected to turbine-related mortality as they pass through the unscreened turbine units after the closure has ended.

The Santiam Water Control District is also responsible for adult fishways that are located between the PP&L and the Water Street powerhouses and at the Headgate Dam. The Headgate Dam fishway was completed in 1987.

Stream reaches in the Santiam and Calapooia subbasins protected from further hydroelectric development by the Northwest Power Planning Council are identified in Table 5.

Table 5. Stream reaches in the Santiam and Calapooia subbasins protected for anadromous and resident fish under the Northwest Power Planning Council's hydroelectric planning authority.

Stream	Reach (RM)
Protected for anadromous fish	
Mill Cr.	0-20
Santiam R.	0-12
North Santiam R.	0-40
Smallman Cr.	0-3
Stout Cr.	0-5
Little North Santiam R.	0-16.5
	18-20.5
	23-26
Sinker Cr.	0-4
Elkhorn Cr.	0-8
Evans Cr.	0-4
Cedar Cr.	0-4
Mad Cr.	0-5
South Santiam R.	0-61.5
Thomas Cr.	0-29
Neal Cr.	0-10.5
Ella Cr.	0-4
Crabtree Cr.	0-37
Roaring R.	0-7
South Fork Crabtree Cr.	0-6
Bald Peter Cr.	0-1.5
Hamilton Cr.	0-12.5
McDowell Cr.	0-7
Wiley Cr.	0-17
Jackson Cr.	0-3
Little Wiley Cr.	0-6
Middle Santiam R.	0-37
Gedney Cr.	0-2
Whitcomb Cr.	0-3
Rambaugh Cr.	0-2
Quartzville Cr.	0-18
Yellowstone Cr.	0-4
Packers Gulch	0-1
Canal Cr.	0-8
Elk Cr.	0-4
Bear Cr.	0-4
Pyramid Cr.	0-4.5
Canyon Cr.	0-13
Owl Cr.	0-5
Two Girls Cr.	0-4
Moose Cr.	0-4.5
Trout Cr.	0-4
Little Boulder Cr.	0-1.5
Boulder Cr.	0-2.5
Keith Cr.	0-1.5
Soda Fork	0-6
Harter Cr.	0-3

(continued)

Table 5 continued.

Stream	Reach (RM)
Calapooia R.	0-75
Sodom Ditch	0-6.5
Brush Cr.	0-2
West Fork Brush Cr.	0-5
East Fork Brush Cr.	0-5
Cedar Cr.	0-6
Protected for resident fish	
North Santiam R.	40-49
Breitenbush R.	
Humbug Cr.	0-3.5
East Humbug Cr.	0-5
Marion Cr.	0-7
South Santiam R.	
Middle Santiam R.	
Tally Cr.	0-6

Summer flows in the North Santiam above Stayton are approximately 1,000 cfs. Most of the flow is diverted into the north channel where approximately 900 cfs is appropriated for power and irrigation, leaving juvenile steelhead rearing in the south channel with little flow. The court adjudicated flow requirement for fish passage in the north channel recommended by the Oregon State Game Commission is 50 cfs. There is no flow requirement in that same decree for the south channel.

The Mission Mill Plant in Salem operates a turbine off Mill Creek. The mill race is currently unscreened.

Anadromous fish passage has been a major problem at Foster and Green Peter dams on the South Santiam River. The USACE constructed upstream fish passage facilities at Foster and Green Peter dams and a downstream migrant bypass at Green Peter Dam. Because Foster is a low-head dam, downstream migrants were expected to sound 6-15 meters, depending on the reservoir level, and pass through the turbines or the spill gates. Juvenile spring chinook have passed the turbines and spill gates. However only a few of the steelhead smolts that enter the Foster pool after April successfully migrate from the reservoir during the primary migration period (Wagner and Ingram 1973). ODFW has been negotiating with the USACE to adjust releases from Foster Dam that impact fishing, adult salmonid migration, and fish production below the dam. Loss of anadromous salmonids due to USACE structures is partially mitigated with hatchery fish.

There is a three-week delay in smolt migration for juveniles passing from Green Peter to Foster Reservoir. Inadequate passage at Green Peter Dam has resulted in a drastic reduction of the native winter steelhead above Foster Dam. High flows and cold water discharged from Green Peter Dam delay upstream movements of adults and has thwarted effective collection of adult salmon and steelhead at the upstream-migrant facilities at Green Peter Dam (Buchanan and Wade 1978).

ODFW has completed a 10-year study concerning fish restoration above Foster and Green Peter dams and is currently preparing a final report containing recommendations to the USACE. ODFW is presently considering closing off passage temporarily at Green Peter Dam until passage problems can be resolved.

The Lebanon-Albany Power Canal is an unscreened diversion which diverts water from the South Santiam River at Lebanon to a power plant in the city of Albany.

The Lacomb hydro diversion off Crabtree Creek is operated by the Lacomb irrigation district. The intake to the canal is screened. Water diverted for hydro power is returned to Crabtree Creek. Unused irrigation water is released into Beaver Creek, a tributary of Crabtree Creek.

Adult winter steelhead and spring chinook encounter passage problems between RM 19.5 and RM 28.5 on the Calapooia River (Figure 3). During late winter and early spring high flows, most of the water passes through Sodom Ditch. Migrating winter steelhead use this channel and must pass through a fishway at Sodom Dam. As flows drop, most of the water is channeled into the Calapooia main stem and through Thompson Diversion Ditch. Late migrating spring chinook cannot migrate past the diversion weir near Thompson's Mill. Additionally, unscreened ditches or canals diverting water for irrigation, power generation, and industrial purposes cause mortality and injury to migrating salmonids.

Oregon law requires any person who constructs, operates, or maintains any dam or artificial obstruction on a waterway to provide an adequate fish ladder for upstream and downstream fish passage (ORS 509.605; 498.268). The Habitat Conservation Division will be developing standards, criteria, and procedures for evaluating and resolving fish laddering needs at in-stream obstructions. Fish laddering needs in the Santiam and Calapooia subbasins will then be identified and resolved as part of a coordinated Department effort.

Diversions and Withdrawals

Substantial amounts of water are diverted from the North and South Santiam rivers for municipal, industrial, power generation, and agricultural purposes (Table 6). Values for the Calapooia are overestimates, because available figures include water use in adjacent watersheds.

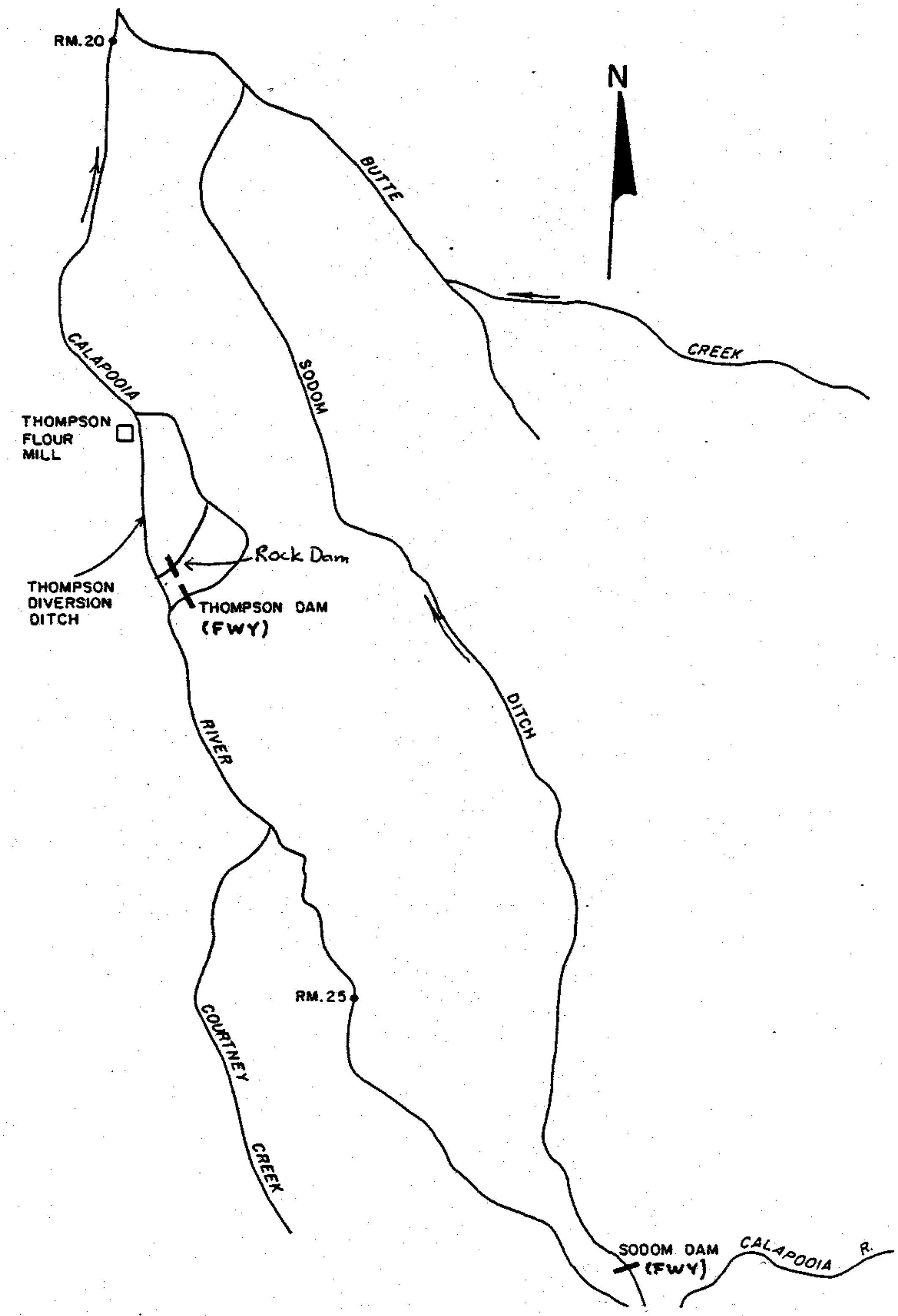


Figure 3 . *Sketch of Sodom diversion area.*(from Willamette Basin Task Force 1969b). FWY = fishway at dam.

Table 6. Surface water withdrawals in the Santiam and Calapooia subbasins, 1985 (1,000 acre ft/yr) (USGS, unpublished data).

Location	Irriga tion	Live-stock	Public	Domestic	Commer-cial	Industrial	Mining	Total
North Santiam	10.84	0.25	26.50	0.04	0.00	4.17	0.02	41.82
South Santiam	5.45	0.13	8.29	0.08	0.01	0.28	0.00	14.24
Calapooia[a]	24.75	0.86	9.28	1.26	0.01	25.58	0.01	61.75

[a] Includes portions of the Willamette and Muddy Creek basins.

Minimum streamflows were established in 1964 and 1983. Oregon Senate Bill 140 (ORS 537.346 and OAR 690-77-050) allowed for conversion of minimum streamflows into in-stream water rights as of February 1, 1989 (Table 7).

Water rights for the Santiam and Calapooia subbasins total 2,930 cfs (Oregon Water Resources Department, unpublished data). This is the potential amount of water that may be withdrawn during a given year. If all water rights were used at the same time, streamflows would be significantly decreased.

Diversion dams and ditches sometime interfere with passage of migrating adult and juvenile salmonids. Adult fish passage is sometimes impeded at the Thompson Ditch diversion dam, Sodom Ditch dam, Upper and Lower Bennett dams, Stayton power canal dam, and Lebanon dam. Thompson Ditch, Sidney Ditch, Stayton power canal, Salem canal and Lebanon-Albany power canal are unscreened diversions that could cause loss of juveniles migrating downstream.

Oregon law requires a diverter to provide and maintain an adequate fish screen at a diversion to prevent fish from leaving the stream (ORS 509.615; 498.248). ODFW's Habitat Conservation Division has completed a summary report identifying fish screening needs at water diversions throughout the state. Screening needs in the Santiam and Calapooia subbasins will be addressed according to their state-wide priority as part of an overall Department fish screening program that is currently being developed.

Table 7. In-stream water rights for the Santiam and Calapooia subbasins.

Stream[a]	Location	Minimum flows (cfs)[b]			Effective
		Natural	Storage	Total	date
Santiam R.	RM 0-1	320	1,570	1,890	6-22-64
Santiam R.	RM 9.6	330	1,570	1,900	6-22-64
No. Santiam	RM 0	430	640	1,070	6-22-64
Stout Cr.	RM 0-3.5				10-18-90
No. Santiam	RM 26.8	580	640	1,220	6-22-64
Rock Cr.	RM 0-6				10-18-90
Mad Cr.	RM 0-headwaters				10-18-90
No. Santiam	RM 45.7	500	640	1,140	6-22-64
No. Santiam	RM 59	345	-	345	6-22-64
Little No. Santiam	RM 2	40	-	40	6-22-64
Little No. Santiam	RM 0-26				10-18-90
So. Santiam	RM 23.3	170	930	1,100	6-22-64
Thomas Cr.	RM 0	20-100	-	20-100	11-03-83
Neal Cr.	RM 0-6			10-18-90	
Crabtree Cr.	RM 0	20-100	-	20-100	11-03-83
Hamilton Cr.	RM 0	3-40	-	3-40	11-03-83
McDowell Cr.	RM 0	3-45	-	3-45	11-03-83
Wiley Cr.	RM 0-1	10	-	10	6-22-64
Wiley Cr.	RM 0-3.5			10-18-90	
Little Wiley Cr.	RM 0-8			10-18-90	
Middle Santiam R.	RM 0.7	110	260	370	6-22-64
So. Santiam R.	RM 48.5	50	-	50	6-22-64
Calapooia R.	RM 3.0	20	340	360	6-22-64
Calapooia R.	RM 45.4	30	340	370	6-22-64

[a] Includes all tributaries above the listed locations.

[b] "Natural" minimum flow stipulations were set by the state Water Resources Board. The "storage" volumes are provided in addition whenever possible from USACE dams located upstream.

Habitat Protection

ODFW has several roles in habitat protection issues. Enforcement authority for fish screens and fish passage was granted ODFW by ORS 509.605 - 509.640. ODFW can apply for in-stream water rights to protect fish habitat and can collect costs of habitat damage from polluters. ODFW has authority under ORS 468.745 to recover both the value of fish and wildlife destroyed by pollution and all costs of restoring production of fish and wildlife including restoration of their habitat. ODFW has written policy and procedures for investigation of fish kills resulting from pollution, as well as draft administrative rules to determine the monetary value of fish losses, which will be presented to the Fish and Wildlife Commission for adoption as an OAR in the near future.

ODFW coordinates with local, state, and federal agencies regarding their habitat protection and management programs. Often this involves making recommendations to avoid impacts from various land and water use practices which conflict with fishery interests, or to provide full habitat compensation. Fish production must compete with other land and water uses such as timber production, irrigation, and hydroelectric power production. Activities which may affect threatened or endangered species must be coordinated with the U.S. Fish and Wildlife Service (USFWS). Activities by other state agencies that may affect threatened or endangered species must be coordinated with ODFW (ORS 496.182). Applications for permits issued by other agencies for land use activities are forwarded to the ODFW for review and comment. ODFW currently has interim policies on screening, fill and removal, and habitat mitigation, which will be before the Fish and Wildlife Commission in the near future. ODFW is a co-equal participant with the NMFS and USFWS in the administration of the Fish and Wildlife Coordination Act.

Fishery managers recognize that habitat degradation and loss is a serious threat to the maintenance of healthy fish populations. Enforcing local, state, and federal laws for protecting fish habitat is essential to sustaining a vital habitat base. Consequently, ODFW must be a consistently strong advocate for the protection and proper management of fish habitat.

Habitat Restoration

ODFW, with the Santiam Flycasters, has installed log sills in Sinker Creek on the Little North Santiam. Fish ladder repair projects are proposed for Elkhorn Falls and Hardrock Falls. In the South Santiam drainage, STEP projects in progress include installing in-stream structures in Ames Creek and Roaring River. A similar project is proposed for Neal Creek. Bank erosion control projects are currently under way in Hamilton and McDowell creeks. Local fishing groups are planting trees and placing trees on banks to prevent further erosion. Fish ladder repair work is proposed for a ladder on Wiley Creek. The high water channel at the mouth of Moose Creek was removed by blasting in the fall of 1987. Additional fish passage projects are proposed for Moose Creek and Soda Fork.

The ODFW and the Albany Steelheaders have planted trees and installed a log gabion on King Creek in the Calapooia basin. They have also planted trees along Washout Creek. Proposed projects include improving passage through the log jam on the North Fork of the Calapooia on Weyerhaeuser land and installing in-stream structures in Potts Creek and the North Fork Calapooia.

Habitat improvement projects sponsored by the Willamette National Forest include revegetation of streams and reservoirs, placement of log sills and gabions in streams, and removing barriers to fish migration (Skeesick and Jones 1988). Projects begun in 1988, but not yet completed in the North Santiam drainage include side channel development for trout on Marion Creek and Blowout Creek. The Forest Service proposes to remove barriers by blasting on the Little North Santiam in the next three to four years. They also propose to revegetate along trout streams in the Little North Santiam and Breitenbush drainages. In 1988 they began planting areas along Elk Creek for cutthroat, rainbow trout, and steelhead habitat enhancement. The USFS removed debris from United States Creek and plans to treat additional reaches on the Calapooia to improve steelhead spawning and rearing.

The BLM has not recently done any habitat enhancement work in the Santiam and Calapooia subbasins. It currently has no plans for such work until completion of its planning efforts in 1990 (personal communication from R. House, Bureau of Land Management, Salem, Oregon).

Policies

Policy 1. The Department shall actively pursue and promote habitat protection and improvement necessary to achieve the objectives for management of the subbasins' fish resources.

Policy 2. The Department shall coordinate with and advise agencies that manage the land and water resources of Willamette subbasins.

Policy 3. Habitat protection shall be emphasized over habitat rehabilitation and enhancement.

Policy 4. Potential losses of fish production from habitat alteration shall be prevented or reduced to the extent possible.

Objectives

Objective 1. Restore, maintain or improve upstream and downstream passage for fish at water diversions, dams, culverts, and other artificial obstacles.

Assumptions and Rationale

1. Adequate fish passage is necessary to prevent injury, delay or loss of fish as a result of any water development project.

Actions

1.1 Restore or improve upstream passage for anadromous species to spawning areas.

a. Monitor the fishways at the SWCD ladder, the headgate ladder, the spill dam ladder, and at Upper and Lower Bennett dams at Stayton, at Lebanon Dam, and at Thompson's Dam, Sodom Dam, and Brownsville Dam bypass channel on the Calapooia. Review hydroelectric licenses for fish passage provisions. Contact the facility operator if fishways are inoperable or in need of repair. Work with facility operators to improve passage if necessary.

b. Work with utilities and agencies to provide deeper water and increased flows at Stayton during upstream migration periods for spring chinook to improve upstream passage.

c. Evaluate potential for fish production above impassable culverts, such as on Mad and Little Rock creeks, and work with landowners to improve passage if appropriate.

d. Determine if log jams in upper reaches of the Calapooia River hinder fish passage and work with land management agencies to improve passage where appropriate.

e. Work with Linn County Soil and Water Conservation District on the Calapooia River Flood Control Project.

1.2 Provide the appropriate ODFW technical fish passage standards and criteria to all state and federal agencies which regulate or have the potential to impact fish passage on streams through their actions.

1.3 Work with the ODFW Fish Passage Coordinator to establish an implementation schedule for subbasin screening projects listed in the ODFW report on fish screening needs (as presented to the 66th Legislature, January 1991).

1.4 Improve downstream passage conditions for juvenile fish.

a. Determine the extent of injuries and mortalities at unscreened irrigation diversions at Mill Creek, Stayton, on Rock Creek, and at Brownsville Dam; screen or use other methods to protect downstream migrants if necessary.

b. Resolve passage problems at Foster and Green Peter dams through continued cooperation with the USACE.

1.5 Survey all culverts within the subbasin for passage problems.

1.6 Make specific recommendations to the responsible agencies or landowners to correct problems at culverts.

Objective 2. Provide necessary in-stream flows for fish production.

Assumptions and Rationale

1. Adequate in-stream flows are necessary for fish passage, spawning, and rearing.

Actions

2.1 Determine necessary flows for fish production.

2.2 Obtain in-stream water rights for:

a. The North Santiam River, south channel at Stayton.

b. Ames Creek, a South Santiam tributary.

c. The reach of the Calapooia River bypassed by Thompson's Mills millrace.

2.3 Obtain more accurate flow measurements at the mouth of the following streams:

a. Minimum stream flow for Thomas Creek is established at the mouth, yet the gauge is located 14-15 miles upstream and may not reflect actual flows at mouth.

b. Minimum stream flow for Crabtree Creek is established at the mouth, gauge is located 8 miles upstream. Water consumption and gravel infiltration occurs between gauge and mouth. Gauge reading does not reflect actual flow at mouth.

2.4 Identify additional areas in the Santiam and Calapooia subbasins in need of in-stream water rights and file necessary applications with the Department of Water Resources.

2.5 Reapply for in-stream water rights where current in-stream water rights are inadequate to protect fish and wildlife uses.

2.6 Coordinate with water users and agencies that regulate in-stream flows.

a. Coordinate with the Santiam Water Control District to provide necessary flows in Mill Creek during fall chinook migration.

b. Work with the USACE to test and implement schedules for releases of water from Detroit, Foster and Green Peter dams that will provide adequate flows for fish production.

c. Coordinate with Pacific Power and Light, the Santiam Water Control District, and the cities of Salem and Stayton and irrigation water users to protect in-stream flows in the north and south channels of the North Santiam River at Stayton for fish passage and survival.

Objective 3. Protect existing stream habitat from degradation associated with timber harvest, road construction, and related activities on forested watersheds.

Assumptions and Rational

1. Land use practices associated with timber harvesting can reduce fish production in forested watersheds.

Actions

3.1 Ensure compliance with state and federal forest management regulations and consideration of ODFW recommendations.

3.2 Monitor riparian protection at timber sales at sites which need riparian vegetation to prevent further in-stream temperature increases, such as in the upper Hamilton, McDowell, and Thomas creek drainages and in the Middle and South Santiam River basins.

3.3 Request that state and federal land management agencies conduct periodic monitoring programs on the success and effectiveness of stream riparian and water quality protection measures.

Objective 4. Protect existing stream habitat in lowland areas from degradation associated with agricultural, residential and commercial development, and other human activities.

Assumptions and Rationale

1. Channel erosion, sedimentation, loss of riparian vegetation, and pollution reduce fish production.

Actions

4.1 Cooperate with other agencies to increase protection of stream habitat.

   a. Work with the Soil Conservation Service, the Department of Agriculture, the Water Resources Department, and the Department of Environmental Quality to identify locations in the Santiam and Calapooia subbasins where agricultural practices reduce fish production. Encourage agricultural land owners to protect riparian habitat, minimize practices which contribute to pollution and sedimentation of in-stream habitat, and to use techniques that conserve water.

b. Identify areas in the Santiam and Calapooia subbasins where in-stream structure and spawning gravel have been altered due to channelization and bank stabilization projects and limit fish production. Coordinate with the DSL, SCS, USACE, and Linn County Soil and Water Conservation District to minimize damage to fish habitat from gravel mining, fill and removal, revetment, erosion control and channelization projects.

c. Identify impacted locations and coordinate with city and county agencies to minimize degradation of riparian and in-stream habitat from urban development projects such as construction of bridges, pipelines, city storm drains, and flood control projects.

d. Encourage municipalities, sewage treatment districts and mill pond owners to acquire specialized equipment and adequately trained personnel so that catastrophic spills of harmful substances are avoided.

e. Investigate fish kills and pursue recovery of monetary damages and restoration of fish and wildlife in pollution affected areas.

Objective 5. Develop subbasin specific knowledge that integrates fish distribution and abundance information, habitat characteristics and potential for improvement, and sensitive watershed areas into the Department's Habitat Database system.

Assumptions and Rationale

1. Better understanding of factors that affect fish distribution and abundance will lead to more effective habitat protection.

2. Computerized information will readily allow access by anyone in ODFW for habitat protection issues.

Actions

5.1 Inventory stream and watershed characteristics that affect fish production.

5.2 Promote increased interagency sharing of inventory information.

5.3 In coordination with USFS, BLM, private landowners, and volunteers, survey streams to determine specific habitat problems and opportunities for habitat protection projects, especially in the Calapooia River, Neal Creek, McDowell Creek, Hamilton Creek, and Little Wiley Creek drainages.

5.4 Ensure that all survey information is entered into the Habitat Database system.

WINTER STEELHEAD

Background and Status

Origin

Winter steelhead are native to the Santiam and Calapooia subbasins. Although upstream reaches of the North and Middle Santiam are essentially lost to natural production because of dams, the Santiam subbasin still provides the majority of winter steelhead production in the Willamette basin.

Loss of natural production due to dams has been partially compensated for by releases of mainly Willamette hatchery stock since 1952 (Howell et al. 1985a). Hatchery summer steelhead are released in the South Santiam as mitigation for loss of winter steelhead in Green Peter Reservoir. Some introductions of Big Creek stock have been made.

Winter steelhead in the South Santiam are currently listed by ODFW as a stock of concern because of the decline in the run due to problems associated with Foster and Green Peter dams. Winter steelhead in the South Santiam should be given a high priority with respect to future population and habitat inventory and monitoring activities in the subbasin.

Life History and Population Characteristics

Distribution

Winter steelhead were historically found in the Little North Santiam, Mad Creek, Rock Creek, and the North Santiam main stem (Fulton 1970). In the South Santiam drainage, spawning areas for winter steelhead were found in Thomas, Crabtree, McDowell, Wiley, Canyon, and Moose creeks and the upper main stem. Spawning areas were also located in Quartzville Creek and the Middle Santiam main stem. In the Calapooia River, winter steelhead spawned in the upper main stem and tributaries such as Potts Creek and the North Fork of the Calapooia.

Presently, distribution in the North Santiam is limited to reaches and tributaries below Big Cliff Dam. Access to the upper reaches of the North Santiam has been eliminated by Big Cliff and Detroit dams since 1953. ODFW has attempted to maintain natural production in the upper South and Middle Santiam above Foster and Green Peter dams. Natural production has declined in the South Santiam above Foster, and no natural production presently occurs in the Middle Santiam above Green Peter Dam.

Winter steelhead continue to spawn and rear in the Calapooia and its uppermost tributaries, although run size has declined from historical levels.

Run Timing

The Minto Dam collection facility on the North Santiam River traps adults from April to May (Table 8). Adult winter steelhead arrive at Foster Dam from February through June. The peak of the run usually occurs in mid-April. Catch records indicate adults are present in the Calapooia River February through May (ODFW 1990b). Hatchery winter steelhead return over a shorter period of time than wild steelhead (personal communication on 8 May 1991 from D. Buchanan, ODFW, Corvallis, Oregon).

Table 8. Winter steelhead trapped at Minto and Foster dams in the Santiam subbasin 1984-1988 (ODFW, unpublished data).

	Minto collection facilities			Foster trap		
		Total fish		Dates trap	Total fish	
Year	Dates trap open	Males	Females	open	Males	Females
1984	April 3-May 2	141	166	April 20-May 2	31	24
1985	March 22-April 29	96	169	Feb. 14-June 30	336	656
1986	March 31-May 6	280	243	Feb. 25-June 24	360	482
1987	April 1-May 18	196	302	Jan. 21-June 25	312	376
1988	April 5-May 3	382	420	Feb. 25-July 5	413	615

Run Size

Total run size of Willamette winter steelhead entering the Santiam and Calapooia subbasins was estimated from Willamette Falls counts (Foster 1990) and steelhead sport catch data (ODFW 1990b) for 1976 to 1988. Yearly counts of fish passing Willamette Falls were multiplied by the proportion of the total upper Willamette sport catch caught in the Santiam and Calapooia subbasins (Table 9). Using this method, the minimum mean run size is 5,740 hatchery and naturally produced steelhead, 59 percent of the total above Willamette Falls run. Approximately 85 percent of the run passing Willamette Falls is considered to be of natural origin (Buchanan et al. 1991), 15 percent of hatchery origin. However actual hatchery fish-to-naturally produced fish ratios of returning adults are unknown.

Clady (1971) reports an annual average of 1,000 steelhead adults collected at Minto Dam from 1952 to 1959. An average of 120 adults was detected by an electronic counter at Elkhorn Falls on the Little North Fork Santiam from 1959 to 1964.

Prior to construction of Foster and Green Peter dams in 1966, an estimated 2,600 native winter steelhead migrated above the Foster Dam site (Buchanan et al. 1984). Two-thirds of these fish were produced in the Middle Santiam, above Green Peter Dam. Inadequate downstream passage at Foster and Green Peter dams and inadequate upstream passage at Green Peter Dam have resulted in a drastic reduction of the native winter steelhead run above Foster Dam. Runs in the South Santiam above Foster Dam have declined from averages of 2,183 naturally produced fish during 1967 to 1971 (21.2 percent of the total run above Willamette Falls) to 823 hatchery and naturally produced fish (1984-1988), 5.8 percent of the run above Willamette Falls. There has been almost no fish passage above Green Peter Dam since 1979.

Table 9. Number of late run hatchery and naturally produced winter steelhead migrating past Willamette Falls and reaching the Santiam and Calapooia subbasins (estimated) and dams (Clady 1971, Howell et al. 1985a, Foster 1990, ODFW 1990b, and unpublished data, ODFW).

Year	Willamette Falls	Santiam/Calapooia[a] No.	Santiam/Calapooia[a] % Will. Falls	Foster Dam No.	Foster Dam % Will. Falls	Green Peter Dam[b] No.	Green Peter Dam[b] % Foster Dam
1967	14,600	--	--	2,731	18.7	--	--
1968	6,400	--	--	1,100	17.2	--	--
1969	8,596	--	--	1,417	16.5	--	--
1970	4,682	--	--	1,413	30.2	--	--
1971	18,314	--	--	4,254	23.2	766	18.0
1972	16,588	--	--	2,153	13.0	289	13.4
1973	11,511	--	--	755	6.6	83	11.0
1974	8,528	--	--	695	8.2	84	12.1
1975	3,034	--	--	354	11.7	20	5.7
1976	5,196	3,532	68.0	302	5.8	25	8.3
1977	8,277	5,380	64.9	503	6.1	92	18.3
1978	8,270	5,706	68.9	488	5.9	96	19.7
1979	5,865	3,871	66.0	149	2.5	0	0
1980	16,142	8,049	50.0	515	3.2	0	0
1981	9,038	4,592	50.9	317	3.5	13	4.1
1982	6,894	3,930	57.0	399	5.8	3	0.8
1983	4,702	2,163	46.0	200	4.3	6	3.0
1984	10,720	5,682	53.0	1,497	14.0	78	5.2
1985	16,043	10,909	67.9	984	6.1	27	2.7
1986	12,776	9,326	72.9	811	6.4	39	4.8
1987	7,630	4,494	58.9	467	6.1	11	2.4
1988	15,007	7,033	46.9	1,028	4.4	--	--
1989	5,361	--	--	222	4.1	--	--
1990	9,222	--	--	271	2.9	--	--

[a] Estimates based on proportion of total upper Willamette sport catch caught in Santiam and Calapooia subbasins.

[b] Green Peter trap not operated after 1987.

Age, Size, and Sex Ratio

Most Willamette stock steelhead spend two years in the ocean prior to returning (Tables 10 and 11).

Table 10. Age composition of North Santiam winter steelhead returning to Minto Dam (DeCew 1969).

Brood Year	Return Year	Age Group	n
1957	1962	3/2	3
1958	1962	2/2	30
1958	1963	3/2	9
1959	1963	2/2	63

Table 11. Age composition of 1977 and 1978 brood winter steelhead returns to Foster Dam (Howell et al. 1985a).

Smolt Year	Return Year	Ocean Age	n	%
1977	1978	1	N/A	N/A
	1979	2	130[a]	77.8
	1980	3	36	21.6
	1981	4	1	0.6
1978	1979	1	9[a]	1.7
	1980	2	452	87.4
	1981	3	54	10.4
	1982	4	2	0.4

[a] Actual sample sizes of 83 2-salt and 6 1-salt returns were expanded for total adult run to Foster trap in 1979.

Average fork lengths of a subsample of 1978 and 1980 hatchery brood winter steelhead adults are given in Table 12.

Table 12. Average fork length (cm) of subsamples of 1978 and 1980 brood year winter steelhead adults (Howell et al. 1985a).

Adults	1978 brood	1980 brood
1-salt male	--	45.0
2-salt male	67.9	69.5
2-salt female	66.2	66.3
3-salt male	81.6	--
3-salt female	77.7	--

Adults collected at Foster Dam had a female-to-male ratio of approximately 2-to-1 (Table 13).

Table 13. Sex ratio of adult winter steelhead returning to Foster Dam, 1985-1987 (M. Wade, ODFW, unpublished data).

Year	No. Females	No. Males	Ratio
1985	237	118	2.0:1.0
1986	208	118	1.8:1.0
1987	141	73	1.9:1.0

The average fork length of 26 adult winter steelhead captured in the South Santiam River during March to May 1966 was 28.8 inches (Clady 1971). No information on weight is available.

Time and Location of Spawning

Spawning occurs during April and May with the peak occurring in late April and early May (Howell et al. 1985a).

Detroit and Big Cliff dams on the North Santiam have blocked access to spawning areas above RM 46.5. Passage problems at Green Peter Dam have limited accessibility to spawning areas in the Middle Santiam and Quartzville Creek. Redd counts from spawning surveys conducted in the Santiam and Calapooia subbasins from 1979 through 1988 are shown in Table 14.

Fecundity of 1982 brood year naturally produced winter steelhead collected at Foster trap averaged 3,500 eggs per female (personal communication from M. Wade, ODFW, Springfield, Oregon). Fecundity estimates of hatchery fish made in 1978 through 1980 and 1984 ranged from 3,640 eggs per female in 1984 to 4,700 eggs per female in 1979 (Howell et al. 1985a). A conservative estimate of 3,500 eggs per female is used at Marion Forks Hatchery for production purposes (personal communication from T. Jones, ODFW, Marion Forks Hatchery, Marion Forks, Oregon).

Table 14. Winter steelhead redds per mile in the Santiam and Calapooia subbasins (J.J. Wetherbee, ODFW, unpublished data).

Location	Year 1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
North Santiam River												
Little North Fork												
Sinker Cr.							39		33		9	0
Elkhorn Cr.									31		14	0
Rock Cr.							45		31	10	44	14
"							68					
Mad Cr.							108	82	60	46	44	88
Little Rock Cr.							23	44	15	8	0	24
South Santiam River												
Thomas Cr.							25		22		14	3
"							10				0	0
Neal Cr.							50		26	20	2	6
"							11				11	
Crabtree Cr.							5		15			
"							67					
Wiley Cr.		40					72	16	18			
"							32	7				5
"											28	
Little Wiley Cr.											7	
Canyon Cr.	25								15			
"									22			
Owl Cr.									7			
Moose Cr.									10			
Soda Fork									3			
Calapooia River												
RM 50.3-51.3									3			
RM 65-71.3											5	
RM 65-72.5												
	1	10	6	8	9		16		16			
RM 72.5-73				56	34							
Potts Cr.				11			5		7	12	6	7
"							7					
North Fk.	15		14	20			25		11	8	11	

Juvenile Life History

Juveniles usually spend two years in fresh water before smolting (Tables 10 and 15) (Howell et al. 1985a). Smolt migration of naturally produced fish in the North Santiam River begins in early spring (DeCew 1969). DeCew (1969) reports that the average length at the end of freshwater growth for 1958 and 1959 broods of North Santiam winter steelhead was 7.2 inches.

Hatchery smolts are released at age 2+ at an average size of five fish per pound from April 7-15 (personal communication from T. Jones, ODFW, Marion Forks Hatchery, Marion Forks, Oregon). Juveniles released in early April above the South Santiam River dams pass Green Peter Dam from mid-April through early May, pass Foster and Lebanon dams late April through mid-May, and pass Willamette

Falls from late April through late May (Buchanan and Wade 1982). Winter steelhead released in the North Santiam River pass Willamette Falls from late April to late May.

Table 15. Freshwater age of winter steelhead trapped at Foster Dam 1979-1982 (Howell et al. 1985a).

Freshwater	1979		1980		1981		1982	
age (yrs.)	n	%	n	%	n	%	n	%
1	0	0	9	2	5	2	0	0
2	57	60	430	89	246	87	180	89
3	38	40	43	9	32	11	19	9
4	0	0	0	0	0	0	4[a]	2

[a] Freshwater age may have been 3 years

Hatchery pre-smolt releases above Foster Dam have not been successful in maintaining the run above Foster and Green Peter dams (Wade et al. 1985).

Hatchery smolts from 1980 through 1986 broods released below Foster Dam yielded an average return rate of 1.7 percent (range 0.13 percent to 2.73 percent) after subtracting 23 percent to 50 percent of the non-migrating smolts that were too small or obviously precocious. Without this adjustment, smolt-to-adult survival would average about 0.9 percent to 1.3 percent.

A smolt production model developed by the Washington Department of Wildlife using reach gradient, area, and flow (GAFM) was employed to provide estimates of habitat carrying capacity. The smolt production estimate for the Calapooia is 20,452 steelhead smolts and for the Santiam 150,544 steelhead smolts.

Hatchery Production

Description of Hatcheries

Marion Forks Hatchery, located on Marion Creek, a tributary of the North Santiam River, is operated by ODFW with funding from the USACE and ODFW. Spring chinook salmon and winter steelhead are produced at the hatchery. Production of winter steelhead at Marion Forks Hatchery mitigates for loss of spawning area above Detroit Dam and supplements the Willamette winter steelhead run in the basin. The mitigation level for the North Santiam River is no more than 84,000 pounds of juvenile chinook and steelhead. Rearing of winter steelhead eggs to smolts requires two years because of cold water and late egg-take. Winter steelhead adults are captured and held until spawning at Minto collection facility near Gates. Steelhead capture and spawning take place from April 15 to May 15. The brood stock is a mixture of naturally produced and hatchery fish.

Willamette winter steelhead returning to the South Santiam River were reared at the former South Santiam Hatchery on Coal Creek from 1926 through 1944. Since then the stock has been infrequently reared in a hatchery (ODFW 1986). There is no current program for propagating the South Santiam stock. An estimated 700 winter steelhead that spawned in areas flooded by Foster and Green Peter reservoirs are mitigated for at the South Santiam Hatchery with summer steelhead. The mitigation level for South Santiam Hatchery is a maximum of 71,000 pounds of juvenile chinook and steelhead.

Supplementation History

Approximately 100,000 Willamette winter steelhead smolts (five fish per pound size) are released each year in April in the Santiam subbasin, mostly in the North Santiam River (Table 16 and Appendix Table A-1). Experimental releases of pre-smolts have also been made in the Middle Santiam and Quartzville Creek as part of a study to restore the native winter steelhead run above Foster and Green Peter dams (Wade et al. 1985).

Table 16. Releases of hatchery winter steelhead in the Santiam subbasin (ODFW, unpublished data).

Release year	Hatchery and stock	Number released		
		Fry	Fingerlings	Smolts
1978	Gnat Cr., Big Cr.			19,076
	Marion Fks., No. Santiam	96,038	23,435	
1979	Roaring R., Big Cr.		12,441	
	Marion Fks., No. Santiam	75,586	29,000	77,744
1980	Roaring R., Big Cr.		58,632	22,090
	Marion Fks., No. Santiam	223,889		117,756
1981	Marion Fks., No. Santiam			142,660
1982	Marion Fks., No. Santiam	103,474	28,130	110,791
	So. Santiam, So. Santiam	23,276		
1983	Marion Fks., No. Santiam	61,150	23,600	151,315
1984	Marion Fks., No. Santiam	49,222	8,337	74,483
	So. Santiam, So. Santiam	8,537		21,064
1985	Roaring R., Klaskanine		8,504	
	Marion Fks., No. Santiam	63,449	47,940	91,853
	So. Santiam, So. Santiam	74,651	8,653	
1986	Marion Fks., No. Santiam		61,097	103,599
	So. Santiam, So. Santiam		14,175	
1987	Marion Fks., No. Santiam			110,634
1988	Marion Fks., No. Santiam			116,745
1989	Marion Fks., No. Santiam			85,490
1990	Marion Fks., No. Santiam			93,442

STEP releases of winter steelhead fry in the Santiam subbasin are given in Table 17.

Table 17. STEP releases of winter steelhead fry in the Santiam subbasin during 1982-1987 (ODFW, unpublished data).

Brood Year	Hatchery and stock	Number released	Release location	Release date
1984	Marion Fks., No. Santiam	8,391	Little North Santiam	July 1984
1985	" "	8,000	Beaver Cr. (Mill Cr.)	June 1985
1985	" "	2,000	Simpson Cr. (Mill Cr.)	June 1985
1986	" "	21,927	Salem Canal	June 1986
1986	" "	1,534	Simpson Cr. (Mill Cr.)	June 1986
1987	" "	24,260	Little North Santiam	June 1987

Angling and Harvest

Sport catch of winter steelhead in the Santiam and Calapooia subbasins has remained fairly constant, averaging 1,970 adults with a range of 542 to 3,396 fish during the 1977-78 through 1988-89 run years (Table 18). Approximately 45 percent of the subbasin harvest is from the North Santiam, 30 percent from the Santiam, and 12 percent from the South Santiam. Only 3 percent of the combined subbasins harvest comes from the Calapooia.

Table 18. Subbasin adult harvest for Willamette winter steelhead (ODFW 1990b).

	Years											
	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Mill Creek	4	0	9	3	9	5	0	0	0	3	0	0
Santiam River	965	395	818	434	340	90	254	446	345	321	859	274
North Santiam River	1,391	437	1,129	918	757	281	681	1,182	1,570	917	1,142	495
Little No. Santiam	139	92	118	93	89	48	35	157	236	161	187	130
South Santiam River	748	57	74	25	30	42	288	552	1,014	578	483	107
Thomas Creek	145	23	102	45	81	24	51	72	27	25	41	29
Crabtree Creek	4	6	51	72	33	45	29	118	140	0	31	11
Calapooia River	0	96	122	48	32	7	20	20	31	36	58	8
Sub-total	3,396	1,106	2,423	1,638	1,371	542	1,358	2,547	3,363	2,041	2,801	1,054

Management Considerations

Willamette winter steelhead are one of the few anadromous fish stocks native to subbasins above Willamette Falls, including the Santiam and Calapooia. The Santiam subbasin contributes significantly to winter steelhead production in the Willamette basin. Access to the upper reaches of the North Santiam has been blocked by Big Cliff and Detroit dams since 1953. Loss of natural production above Detroit Dam has been partially compensated for by releases of hatchery stock in the Santiam subbasin since 1952. Approximately 100,000 Willamette winter steelhead smolts are released each year in the North Santiam River.

Major habitat constraints for winter steelhead production in the North Santiam include passage problems for migrating adults and unscreened diversion ditches, which cause loss of smolts during downstream migration. USACE dams on the North and South Santiam influence sedimentation, flows, temperatures and water quality as well as anadromous fish passage. Since construction of Foster and Green Peter dams, natural production in the upper South Santiam has been seriously reduced and essentially eliminated in the Middle Santiam. Although Green Peter Dam was fitted with fish passage facilities, adults are not attracted to the ladder, possibly due to flows and water temperatures. Smolts migrating out of Green Peter Reservoir are delayed up to two weeks due to the size of the reservoir and the length of the shoreline. Survival of smolts passing through Green Peter Reservoir is very low, apparently due to predation by squawfish and largemouth bass. Smolts must sound in Foster Reservoir to reach passage facilities at the dam, and have not been very successful. Annual returns to Foster and Green Peter dams have averaged 882 and 96 fish, respectively, since 1971 (Buchanan et al. 1991).

Efforts by ODFW to solve production problems on the South Santiam include addressing downstream passage problems of juvenile steelhead, upstream passage problems of adult steelhead, and evaluating rehabilitation of steelhead production above Foster and Green Peter dams (Buchanan et al. 1984). Green Peter Dam and Reservoir have altered anadromous fish habitat and passage so that in-kind, in-place compensation for the loss of at least 1,250 native winter steelhead above Green Peter Reservoir is impossible at this time.

Adult passage is impeded at Thompson's Mill Dam and at Sodom Ditch in the Calapooia River. Unscreened diversions and irrigation ditches cause loss of migrating smolts.

Crabtree, Thomas and Wiley creeks in the South Santiam and the Calapooia River have been managed for natural production of native stock.

The impacts of introduced summer steelhead on production of winter steelhead are unknown. There is the potential for hybridization of Skamania summer steelhead with native Willamette winter steelhead.

Rainbow trout spawn in the spring when hatchery steelhead smolts are released. Some hatchery steelhead smolts are precocious and may spawn with wild trout. The proportion of hatchery releases that are precocious and that contribute to natural production requires monitoring and evaluation. Changes in steelhead hatchery programs may be required in order to meet Wild Fish Management Policy guidelines for trout.

Winter steelhead in the South Santiam are currently listed by ODFW as a stock of concern because of the decline in the run due to problems associated with Foster and Green Peter dams. Winter steelhead in the South Santiam should be given a high priority with respect to future population and habitat inventory and monitoring activities in the subbasin.

Policies

Policy 1. **Winter steelhead in the main stem Santiam River and North Santiam system shall be managed for natural and hatchery production.**

Policy 2. **Winter steelhead in the South Santiam system and Calapooia subbasin shall be managed for natural production. No hatchery-produced winter steelhead shall be released into the South Santiam or Calapooia subbasins.**

Policy 3. **Protection of the run above Foster Dam has priority over harvest in the South Santiam.**

Policy 4. **Protection of the native run in the Calapooia subbasin has priority over harvest.**

Objectives

Objective 1. **Provide an annual minimum escapement of 8,600 naturally produced winter steelhead adults to the Santiam subbasin and an annual average return of 1,200 hatchery adults to the North Santiam.**

Assumptions and Rationale

1. South Santiam winter steelhead have been identified as a stock of concern due to declining numbers, primarily above Foster Dam. Attaining this objective will strengthen winter steelhead populations.

2. The total escapement of winter steelhead to the Santiam subbasin is unknown.

3. The smolt production of the Santiam subbasin using the gradient-area-flow methodology (Washington Department of Wildlife) is estimated as 150,544 smolts. Using an egg-to-smolt survival rate of 1 percent (actual rates are unknown, but typically range from 0.5-1.5%), fecundity of 3,500 eggs per female, and a 1:1 sex ratio, an escapement of at least 8,600 fish would be needed to produce the estimated number of smolts.

4. The mitigation level for the North Santiam is 100,000 smolts to compensate for lost production above Detroit Dam. The current smolt-to-adult survival rate is estimated to be 1.2 percent, which results in a return of 1,200 fish.

5. Releases of precocious hatchery steelhead smolts near areas where spawning of trout occurs may decrease the genetic fitness of trout populations.

6. Habitat quality will be maintained or improved.

7. Unscreened power canals and diversions contribute to smolt mortality.

8. Escapement for the Santiam subbasin can be estimated from counts at hatchery collecting facilities, punch card data, and spawning ground surveys of index streams.

9. Some of these actions could be funded by the USACE and PGE as mitigation for loss of wild winter steelhead above Willamette Falls.

Actions

1.1 Conduct annual spawning surveys to assess population distribution and abundance, as measured by redd counts, the number of miles of production, and an estimate of the number of fish per redd, in the following index stream reaches:

Thomas Creek, RM 30.7-31.7
Neal Creek, RM 3.6-4.4
Crabtree Creek, RM 32.0-33.2
Wiley Creek, RM 11.3-12.4 and RM 15.1-16.4
Mad Creek, RM 0.0-0.5
Rock Creek, RM 0.0-2.0 (for trend information only) and RM 2.4-3.8
Sinker Creek, RM 0.0-0.7
Elkhorn Creek, RM 0.4-1.4

1.2 Conduct an aerial spawning survey of RM 17.0-43.5 of the North Santiam and the Little North Santiam to determine the extent of natural spawning. Using redd counts, the number of miles of production, and an estimate of the number of fish per redd, estimate the escapement to these areas. Extrapolate the escapement for the Santiam subbasin from survey data.

1.3 Inventory tributaries for potential habitat enhancement projects. Document potential projects in a report.

1.4 Continue to monitor returns of winter steelhead to hatchery collection facilities annually.

1.5 Investigate the possibility of rearing North Santiam stock smolts to size in one year instead of two by rearing juveniles at a facility with warmer water than Marion Forks Hatchery, such as Oak Springs Hatchery.

1.6 Continue the current annual release of 100,000 smolts in the North Santiam as mitigation for Detroit Dam.

1.7 Release smolts at all access sites on the North Santiam, making some releases lower in the system.

1.8 Continue to mark all hatchery smolts released in the North Santiam with a different mark for lower river releases. Determine return rates to Minto of fish released lower in the system and of fish released at Minto.

1.9 Investigate the use of acclimation facilities at release sites to improve survival and harvest of hatchery fish.

1.10 Conduct a creel program on the North Santiam in 1992 to determine if lower river releases are harvested at a greater rate than Minto releases and to determine if the harvest objective is met.

1.11 Continue to maintain a late May opening for trout in the Santiam subbasin to protect winter steelhead smolts.

1.12 Minimize the proportion of hatchery steelhead smolts that are precocious and their impact on spawning trout populations. This may be achieved by removal of precocious fish during marking of hatchery steelhead.

1.13 Continue to coordinate shut-down periods and release schedules with hydro projects at Stayton, PP&L, and Albany's Lebanon canal to provide adequate protection.

1.14 Initiate a program to screen the Lebanon-Albany power canal, the PP&L intake at Stayton, the main irrigation canal at Stayton, Sidney ditch, the 19th Street diversion, and Penn Annex lateral.

1.15 Implement habitat protection actions outlined under objectives for Habitat Protection.

Objective 2. Minimize the genetic impacts of hatchery releases on the naturally produced North Santiam stock.

Assumptions and Rationale

1. Hatchery practices and interbreeding of hatchery and naturally produced fish may alter the genetic characteristics of wild populations.

Actions

2.1 Monitor the proportion and timing of naturally produced and hatchery fish taken for spawning at Minto collection facilities.

2.2 Determine the optimum sex ratio, naturally produced component, and size of the spawning population used for hatchery brood stock at Marion Forks Hatchery. In the interim, use a minimum of 20 percent naturally produced fish for brood stock in every generation.

2.3 Collect brood stock at Minto collection facilities from both early and late returns.

2.4 Monitor the proportion of naturally spawning hatchery steelhead in the North Santiam and recommend changes as appropriate if not in compliance with WFMP standards.

Objective 3. Reestablish a winter steelhead run in the North Santiam above Detroit Reservoir.

Assumptions and Rationale

1. The historical distribution of winter steelhead included areas above Detroit Dam.

2. Passage for adults and smolts around Detroit Dam and reservoir can be provided.

3. Providing passage at Detroit Dam would also benefit spring chinook.

4. The run can be monitored at Detroit Dam.

Actions

3.1 Re-negotiate with the USACE to provide winter steelhead access to production areas lost after the construction of Detroit Dam.

3.2 Work with the USACE to establish passage facilities at Detroit Dam.

3.3 Capture winter steelhead adults and pass above Detroit Reservoir.

Objective 4. Increase escapement to 650 winter steelhead in the South Santiam above Foster Dam.

Assumptions and Rationale

1. South Santiam winter steelhead have been identified as a stock of concern due to declining numbers, primarily above Foster Dam.

2. Historically, runs are estimated to have averaged 650 fish (Buchanan et al. 1984). Because of passage problems at Foster Dam, the run declined to an average of 310 adults during 1979-84.

3. The run can continue to be monitored at Foster Dam.

4. Passage conditions at Foster Dam can be improved.

5. South Santiam Hatchery eggs are susceptible to IHN disease which may be contracted through the water supply.

Actions

4.1 Continue to monitor the run of winter steelhead above Foster Dam at Foster Dam.

4.2 Continue to protect natural production in Moose and Canyon creeks with a complete angling closure.

4.3 Protect naturally produced adults by implementing a catch and release only angling regulation in the South Santiam below Foster Dam for unmarked fish.

4.4 Conduct physical and biological surveys in the South Santiam system above Foster Dam, including spawning surveys in Moose, Canyon, and Owl creeks to estimate the percent contribution of these streams to the spawning escapement measured at Foster Dam.

4.5 Identify critical spawning and juvenile rearing areas for native steelhead in the South Santiam River above Foster Dam and other areas in the subbasin. Advocate special protection of these critical areas to the respective landowners.

4.6 Improve downstream passage of winter steelhead smolts at Foster Dam by constructing downstream passage facilities at the dam or trapping smolts above the reservoir and transporting them below the dam. Until this action is implemented or if it fails to increase survival of smolts:

   a. Continue to coordinate with the USACE to hold Foster Reservoir at the 614-foot level from April 15 to May 10 to allow smolts to migrate over spillways.

   b. Use stoplogs at Foster Dam to produce a 300 cfs surface free-fall spill from April 20 to May 10 to improve downstream passage of native steelhead smolts.

4.7 Submit a proposal to the USACE to provide uncontaminated water at South Santiam Hatchery to protect hatchery eggs from IHN disease contracted through water from Foster Reservoir.

Objective 5. Reestablish the winter steelhead run above Green Peter Dam.

Assumptions and Rationale

1. South Santiam winter steelhead have been identified as a stock of concern due to declining numbers, primarily above Foster Dam.

2. Historically, runs above Green Peter Reservoir are estimated to have averaged 1,250 fish (Buchanan et al. 1984).

3. Green Peter Dam was constructed with the intention that winter steelhead production would continue above the reservoir.

4. Winter steelhead production in the Middle Santiam has been essentially eliminated due to passage problems at Green Peter Dam and Reservoir and predation problems in Green Peter Reservoir.

5. Passage conditions at Green Peter can be improved.

6. The run can be monitored at Green Peter Dam.

Actions

5.1 Protect naturally produced adults by implementing a no harvest objective in the South Santiam below Foster Dam for unmarked fish.

5.2 Improve passage of winter steelhead at Green Peter Dam or trap smolts above the reservoir and transport them below the dam and trap adults and transport them above the reservoir. Until this action is implemented or if it fails to reestablish runs, negotiate with the USACE with coordination with NMFS and USFWS to provide in-kind compensation (natural production) for loss of winter steelhead production above Green Peter and Foster dams. Possibilities include:

  a. Identify life history characteristics and habitat needs for native winter steelhead above Foster Dam.

  b. Identify strategies for restoring natural production levels, including potential sites for habitat improvement. Enhance critical areas limiting to native steelhead smolt production.

5.3 Investigate methods to improve upstream passage at Green Peter Dam.

Objective 6. Provide an annual minimum escapement of 1,170 winter steelhead adults to the Calapooia subbasin.

Assumptions and Rationale

1. The current escapement of winter steelhead to the Calapooia subbasin is unknown.

2. Spawning densities in the upper main stem Calapooia and its tributaries averaged 15 redds per mile between RM 50.3 and RM 73 (see Table 14). Using a 1:1 sex ratio, an estimated 700 adults would be needed to account for the spawning density in this reach.

3. The smolt production of the Calapooia subbasin using an alternative method, the gradient-area-flow methodology (Washington Department of Wildlife), is estimated as 20,452 smolts. Using an egg-to-smolt survival rate of 1 percent (actual rates are unknown, but typically range from 0.5-1.5%), fecundity of 3,500 eggs per female, and a 1:1 sex ratio, an escapement of at least 1,170 fish would be needed to produce the estimated number of smolts.

4. Habitat quality will be maintained or improved.

5. Unscreened diversions contribute to smolt mortality.

Actions

6.1 Conduct annual spawning surveys to assess population distribution and abundance as measured by redd counts, the number of miles of production, and an estimate of the number of fish per redd, in the following index stream reaches:

Calapooia River, RM 65.0-72.5 (for trend information only)
North Fork Calapooia River, RM 0.0-1.0
Potts Creek, RM 0.0-1.0

6.2 Inventory streams for potential habitat enhancement projects. Document potential projects in a report.

6.3 Initiate a program to screen the Brownsville irrigation diversion.

6.4 Improve passage at Thompson's Mill Dam on the Calapooia.

6.5 Monitor upstream passage at the Brownsville Dam bypass and at Sodom Dam on the Calapooia and recommend steps to improve passage if needed.

Objective 7. Provide an average annual sport catch of 290 fish (200 natural plus 90 hatchery-produced) in the main stem Santiam and 870 fish (600 natural plus 270 hatchery-produced) in the North Santiam, and provide a catch-and-release fishery in the South Santiam.

Assumptions and Rationale

1. Applying an 8% smolt-to-adult survival to the smolt production estimate of 150,544 smolts for the Santiam subbasin results in a return of 12,044 adults.

2. If the spawning escapement goal of 8,600 adults is met through a return of 12,000 adults to the Santiam subbasin, then 3,400 naturally produced adults would be available for harvest.

3. A harvest rate of 30% would provide a catch of 1,020 naturally produced fish from 3,400 available to the sport fishery.

4. Of the total Santiam sport harvest during 1980-85, 19% occurred in the main stem Santiam, 60% in the North Santiam, and 21% in the South Santiam. Applying these percentages to a total subbasin harvest of 1,020 naturally produced fish results in catches of about 200, 600, and 200 naturally produced fish in the main stem, North, and South Santiam, respectively.

5. Continued hatchery releases of 100,000 smolts should result in a return of 1,200 hatchery adults to the North Santiam. Applying a 30% harvest rate would result in an additional catch of 360 hatchery-produced fish in the main stem Santiam and North Santiam rivers. About 25% of these fish would be harvested in the main stem Santiam, 75% in the North Santiam.

6. Run size can be monitored at Willamette Falls to estimate the size of the Santiam run. The spawning escapement needed for the Willamette basin above Willamette Falls based on an estimated smolt production of 353,620 (gradient-area-flow method) is 10,103 adults.

Actions

7.1 Conduct a random creel check on the Santiam River and lower North and South Santiam rivers during late March and April to provide an estimate of fishing pressure.

7.2 Continue to monitor the harvest of winter steelhead in the subbasin through punch card returns.

Objective 8. Provide a potential average annual harvest of 140 winter steelhead in the Calapooia.

Assumptions and Rationale

1. Applying an 8% smolt-to-adult survival to the smolt production estimate of 20,452 smolts for the Calapooia subbasin results in a return of 1,636 adults.

2. If the spawning escapement goal of 1,170 adults is met through a return of about 1,640 adults to the Calapooia subbasin, then 470 adults would be available for harvest.

3. A harvest rate of 30% would provide a catch of 141 fish from 470 available to the sport fishery.

4. Anglers have limited access below RM 45.5.

5. Protection of the native run has priority over harvest.

Actions

8.1 Continue to monitor the harvest of winter steelhead in the subbasin through punch card returns.

SUMMER STEELHEAD

Background and Status

Origin

Summer steelhead are not native to the Santiam and Calapooia subbasins. Skamania summer steelhead were successfully introduced into the Willamette basin following improvement of fish passage at Willamette Falls in 1971, improved water quality through pollution abatement programs in the 1950s and 1960s, and increased summer flows from releases from dams. Skamania stock was first introduced into the Little North Santiam in 1966 and the South Santiam in 1969 (Buchanan 1975). Releases have also been made in the North Santiam. No releases have been made in the Calapooia River.

Life History and Population Characteristics

Distribution and Abundance

Summer steelhead in the Willamette basin are managed for production and harvest of hatchery fish (OAR 635-500-211). Summer steelhead are not managed for natural production because of the possible negative impacts on the native winter steelhead stock. Sizeable self-sustaining runs of summer steelhead have not developed. However redds have been found in Rock and Mad creeks in the North Santiam and in Hamilton, McDowell, and Wiley creeks in the South Santiam (Table 19).

Table 19. Skamania summer steelhead redds per mile in the Santiam subbasin (J.J. Wetherbee, ODFW, unpublished data).

	Year					
Location	1985	1986	1987	1988	1989	1990
North Santiam R.						
Rock Cr.	2.0	--	--	--	--	--
Mad Cr.	16.0	--	--	--	--	--
South Santiam R.						
Hamilton Cr.	5.8	--	11.8	2.9	--	2.5
McDowell Cr.	18.0	--	10.3	3.2	--	--
Wiley Cr.	8.9	--	3.9	3.6	--	--

Run Timing

Adults return to Foster Dam from April through October with the peak of the returns occurring in June and July (Buchanan et al. 1979).

Run Size

Returns to Minto Dam on the North Santiam and Foster Dam on the South Santiam provide an index of subbasin hatchery run size. These counts underestimate total subbasin hatchery run size as many smolts are released lower in the system and may not return to Minto or Foster dams. These estimates also do not include the proportion of the run harvested. Counts of fish passing Willamette Falls, Minto Dam, Foster Dam, and Green Peter Dam are given in Table 20. Counts from dams in the Santiam subbasin combined with catch data suggest that approximately 61 percent of the Willamette Falls run enters the Santiam subbasin (intra-agency memo dated 12 December 1988 from J.J. Wetherbee, ODFW, Salem, Oregon).

Table 20. Counts of Skamania summer steelhead at Willamette Falls and dams in the Santiam subbasin (Buchanan et al. 1979, Foster 1990, and unpublished data, ODFW).

Run year	Willamette Falls	North Santiam Minto Dam	South Santiam Foster	South Santiam Green Peter[a]
1970	146	--	154	0
1971	2,310	--	2,740	143
1972	690	--	858	20
1973	1,686[b]	20	1,365	57
1974	4,858	77	4,568	438
1975	2,910	375	1,157	16
1976	3,876	810	1,526	39
1977	9,244	1,737	4,809	331
1978	15,172	1,367	4,997	161
1979	7,638	782[c,d]	2,641	2[e]
1980	11,222		2,184	--
1981	15,224		2,429	--
1982	12,571		2,161	--
1983	5,301		1,296	--
1984	25,002		4,930	--
1985	22,223		4,466	--
1986	40,719		5,146	--
1987	23,742		3,908	--
1988	36,940		8,642	--
1989	6,841		1,655	--
1990	23,428		6,569	--

[a] Summer steelhead were not passed above Foster Dam after 1980.
[b] May include 200-plus sockeye salmon.
[c] Counts adjusted for 18% recycling at Minto Dam.
[d] Incomplete counts, through 30 September 1979.
[e] Incomplete counts, through 31 December 1979.
[f] Includes 156 fish removed from potholes below the falls.

Another method of estimating subbasin run size using smolt releases, smolt-to-adult survival rates, and age at return was employed (Table 21). Run size estimates for 1979 to 1988 ranged from 4,688 to

29,920 fish. Run size averaged 15,790 fish during 1979 to 1988. During 1984-88 estimated run size has more than doubled compared to previous years. The estimated percent of the Willamette Falls run entering the Santiam subbasin during 1979-88 was 70 percent to 90 percent.

Table 21. Summer steelhead run size estimates for 1979-88 for the Santiam subbasin based on smolt releases, an estimated smolt-to-adult survival of 7 percent, and age at return as reported by Wade and Buchanan (1983).

Run Year	Estimated Run Size[a]	% Willamette Falls Run Size
1979	6,891	90.2
1980	9,251	82.4
1981	13,378	87.9
1982	11,214	89.2
1983	4,688	88.5
1984	20,765	83.1
1985	19,009	85.5
1986	29,920	73.5
1987	17,002	71.6
1988[b]	25,779	69.8

[a] Age at return 2% 1-salt, 90% 2-salt, 8% 3-salt.

[b] Preliminary data on 1987 smolt releases.

Returns of adult Skamania stock to collection facilities at Foster Dam have fluctuated substantially in the last five years, ranging from 1,043 to 8,926 adults (Table 22). Strong returns to Foster Dam since 1984 have permitted recycling of excess adults through the fishery.

Table 22. Hatchery return size of Skamania summer steelhead at Foster trap (ODFW, unpublished data).

Run Year	Brood Year	Hatchery Return
1983-84	1984	1,043
1984-85	1985	7,899
1985-86	1986	7,357
1986-87	1987	8,926
1987-88	1988	5,090[a]

[a] Preliminary data

Age, Size, and Sex Ratio

Approximately 85 percent of the run returning to Foster Dam are 2-salt fish (Table 23). Releasing smolts at larger sizes to increase survival tends to increase the proportion of 2-salts in the adult return (Wade and Buchanan 1983).

Table 23. Ocean age of adult summer steelhead returning to Foster Dam (Howell et al. 1985a).

Brood	Adult age (%)			
year	1-salt	2-salt	3-salt	4-salt
1969	8.7	72.8	16.3	2.2
1970	7.5	84.4	8.0	0.2
1971	5.2	87.8	6.8	0.1
1972	5.1	85.6	9.3	0.0
1973	11.0	86.7	2.9	0.0
1974	21.1	86.6	2.1	0.0
1975	8.1	88.0	4.2	0.0
1976	2.8	88.9	8.3	0.0
1977	6.1	76.8	17.1	0.0
1978	2.9	94.2	2.9	0.0
1979	1.5	87.6	11.0	0.0
Mean	7.3	85.4	8.1	<0.1

The average length of 1979 and 1981 brood year adult summer steelhead collected at Foster Dam ranged from 56.5 cm to 81.8 cm (Table 24).

Table 24. Average length of adult summer steelhead collected at Foster Dam (Howell et al. 1985a).

Brood year	Sex	Saltwater Age	Length (cm)	n
1981	M&F	1-salt	56.5	50
1979	M	2-salt	70.6	650
1979	F	2-salt	68.0	618
1979	M	3-salt	81.8	50
1979	F	3-salt	78.3	50

Approximately 50 percent of the adult returns of 1984 to 1987 brood year summer steelhead (n=30,315) to Foster Dam were females (ODFW, unpublished data).

Time of Spawning

Skamania summer steelhead adults are spawned from January through early March. Fecundity at South Santiam Hatchery averaged 3,875 eggs per female during 1984 to 1988.

Juvenile Life History

Eggs are incubated at South Santiam Hatchery for approximately six weeks until hatching, usually in mid-April. Alevins are shipped to Roaring River Fish Hatchery for rearing in warmer water until June. Fry are then shipped back to South Santiam Hatchery for rearing until the following April (Howell et al. 1985a). Fingerlings are released in the fall and smolts in April and early May.

Skamania summer steelhead smolts are age 1+ (Howell et al. 1985a) and usually 18 cm to 22 cm long. Smolts migrate past Lebanon Dam on the South Santiam from mid-April until mid-May (Howell et al. 1985a).

Smolt-to-adult survival varies with size at release. Smolts greater than 20 cm fork length return at twice the rate of smolts 18 cm to 20 cm and 10 times the rate of smolts less than 18 cm. Returns to the South Santiam in 1984 through 1986 averaged 7.1 percent. Survival rates in the North Santiam are believed to be less, around 5 percent (intra-agency memo dated 12 December 1988 from J.J. Wetherbee, ODFW, Salem, Oregon).

Hatchery Production

Description of Hatcheries

Two hatcheries in the Santiam subbasin, South Santiam and Roaring River, are currently used for production of Skamania summer steelhead. South Santiam Hatchery has facilities to collect returning adults. Hatchery summer steelhead collected at Foster Dam provide the brood stock for South Santiam and Roaring River hatcheries. Naturally produced fish returning to Foster Dam are recycled through the fishery. South Santiam Hatchery takes fish from the entire run season for brood. Adult fish recycled through the fishery are marked for identification of original time of return.

South Santiam Hatchery incubates summer steelhead eggs, but seasonal turbidity of the water source limits rearing. Eyed eggs are shipped to other hatcheries (Oak Springs and Leaburg) for hatching and rearing. Some of the eyed eggs shipped to Oak Springs Hatchery are hatched and reared to 100 to 200 fish per pound and sent back to South Santiam Hatchery for completion of rearing until release at five fish per pound. Roaring River Hatchery also receives eyed eggs from South Santiam Hatchery and raises them to five fish per pound before release.

Hatchery Releases

Production of Skamania summer steelhead mitigates for loss of native winter steelhead in areas flooded by Foster and Green Peter reservoirs. Summer steelhead extend the steelhead fishery beyond the winter run. The steelhead sport fishery in the subbasin now lasts 9-10 months.

Early adult returns of Skamania stock to the Little North Santiam and North Santiam rivers were poor (Buchanan 1975), possibly due to the combined effects of poor quality smolts and bacterial infections (*Aeromonas salmonicida* and *A. liquefaciens*) associated with high water temperatures in the lower Willamette during smolt outmigration (Buchanan 1975). Presently, low spring flows below Foster Dam on the South Santiam River tend to retard smolt migration.

The recent annual allocation of summer steelhead smolts is 20,000 in the Little North Santiam, 180,000 in the North Santiam, and 160,000 in the South Santiam. These allocations have provided adequate returns to the fishery as well as ample fish for brood stock at South Santiam Hatchery. Releases are made to maximize harvest by the fishery by encouraging adults to hold near fishing areas. Releases in the Little North Santiam are made below RM 17 to minimize potential impacts on naturally produced winter steelhead, which are found primarily above RM 17.

Releases of Skamania summer steelhead in the Santiam subbasin during 1978 to 1986 are listed in Table 25 and Appendix Table B-1. STEP releases of Skamania summer steelhead fry are listed in Table 26. Further STEP releases of summer steelhead will not be made in the subbasin, as required by the Willamette Basin Fish Management Plan (OAR 635-500-211).

Table 25. Releases of Skamania stock summer steelhead in the Santiam subbasin (ODFW, unpublished data).

Release		Number released	
year	Hatchery	Fingerlings	Smolts
1976	Alsea		106,690
	Roaring River		163,560
	South Santiam		192,403
1977	Alsea		106,987
	Roaring River		85,831
	South Santiam	7,191	142,745
1978	Alsea		130,622
	Roaring River	5,986	83,102
1979	Alsea		100,503
	Roaring River	58,824	76,674
	South Santiam	26,638	164,694
1980	Alsea		125,681
	Roaring River	24,770	81,047
	South Santiam		191,165

(continued).

Table 25 continued.

Release year	Hatchery	Number released Fingerlings	Smolts
1981	Alsea		123,883
	Oak Springs		45,157
	Roaring River		81,769
	South Santiam		82,022
1982	Oak Springs		64,998
	Roaring River		76,475
	South Santiam	101,713	139,333
	Trojan Ponds		30,305
1983	Gnat Creek		43,827
	McKenzie		35,269
	Roaring River		72,976
	South Santiam	78,149	260,700
1984	Marion Forks		13,420
	Roaring River		56,030
	South Santiam	25,173	174,785
	Willamette		68,542
1985	McKenzie		41,168
	Roaring River		134,251
	South Santiam	33,406	298,258
1986	McKenzie		39,977
	Roaring River	30,303	114,657
	South Santiam	2,768	252,464
1987	McKenzie		38,622
	Roaring River		71,540
	Willamette		83,048
1988	McKenzie		29,700
	Roaring River		114,187
	South Santiam		201,650
1989	South Santiam		345,432
1990	McKenzie		41,424
	Roaring River		123,712
	South Santiam		195,352

Table 26. STEP releases of South Santiam Hatchery Skamania summer steelhead fry in the Santiam subbasin, 1982-87 (ODFW, unpublished data).

Brood year	Number Released	Release location	Release date
1983	46,261	Scott Cr., So. Santiam	April 1983
1984	25,600	Little North Santiam	May 1984
	26,300	Scott Cr., So. Santiam	May 1984
	1,500	Thomas Cr., So. Santiam	May 1984
1985	35,648	Little North Santiam	April 1985
	26,900	Little North Santiam	May 1985
	14,877	North Santiam	May 1985
1986	18,048	Little North Santiam	March 1986
	18,225	Scott Cr., So. Santiam	April 1986

Angling and Harvest

Of the total Willamette basin sport harvest of summer steelhead during 1975 to 1986, an average of 45.4 percent of the catch came from the Santiam subbasin. Sport catch has generally increased in recent years, yet catch can vary greatly from year to year (Table 27). Sport catch during 1977 to 1988 ranged from 1,601 to 12,089 fish and averaged 7,188 fish. Approximately 50 percent of the subbasin harvest is from the North Santiam, 35 percent from the South Santiam, and 15 percent from the Santiam River. Minimal numbers of fish are caught in Mill and Crabtree creeks.

Harvest of summer steelhead in the Santiam subbasin is subject to general ODFW angling regulations for steelhead.

Table 27. Harvest of summer steelhead in the Santiam subbasin (ODFW 1990b).

	Years											
	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Mill Creek	15	11	0	0	3	4	0	0	0	0	0	0
Santiam River	1,552	1,024	751	836	582	632	201	540	941	779	805	960
North Santiam River	1,641	3,198	1,985	3,144	2,700	2,087	853	4,320	5,033	5,399	3,956	4,365
Little No. Santiam R.	36	104	115	138	92	131	30	257	557	353	237	269
South Santiam River	1,374	4,742	1,293	1,031	1,531	1,648	514	4,147	4,660	4,973	2,982	6,478
Foster Reservoir	33	27	0	0	0	4	0	0	2	6	0	8
Crabtree Creek	12	8	22	0	0	0	3	0	76	36	0	9
Total Subbasin Harvest	4,663	9,114	4,166	5,149	4,908	4,506	1,601	9,264	11,269	11,546	7,980	12,089

Management Considerations

Summer steelhead are not native to the Santiam and Calapooia subbasins. Skamania stock summer steelhead were introduced into the North and South Santiam in the late 1960s. No releases have been made in the Calapooia River. Because of the concern for possible impacts of natural production of summer steelhead on native winter steelhead, summer steelhead in the Willamette basin are managed for production and harvest of hatchery fish. The effects of natural summer steelhead production on native winter steelhead production in the Santiam subbasin are unknown.

Although natural production of summer steelhead has not been monitored, it is considered to be minimal. Estimates of natural production of summer steelhead in rivers and streams of the Santiam subbasin are needed.

Returning adult summer steelhead encounter upstream passage problems at Stayton. Unscreened diversion ditches at Stayton cause loss of smolts during downstream migration.

Releases of summer steelhead smolts are generally made in the main stem of large rivers rather than in small tributaries where winter steelhead spawn. However releases are made in the lower 17 miles of the Little North Santiam, a stream identified in this plan as being managed for natural production of winter steelhead. Releases of summer steelhead in the Little North Santiam could be reallocated elsewhere in the North or South Santiam rivers to minimize the potential negative impact of summer steelhead on natural production of winter steelhead if needed.

Rainbow trout spawn in the spring when hatchery steelhead smolts are released. Some hatchery steelhead smolts are precocious and may spawn with trout. The proportion of hatchery releases that are precocious and that contribute to natural production requires monitoring and evaluation. Changes in steelhead hatchery programs may be required in order to meet Wild Fish Management Policy guidelines for trout.

Policies

Policy 1. **Summer steelhead shall be managed for production and harvest of hatchery fish. The Department shall monitor the run for possible natural production.**

Policy 2. **Summer steelhead smolts shall be released into streams that have suitable adult holding habitat throughout the summer and where adults will provide optimum recreational opportunity.**

Policy 3. **Summer steelhead in the South Santiam River shall be confined to areas below Foster Dam to protect native winter steelhead production in the upper South Santiam.**

Policy 4. **Only smolt-sized fish shall be released to minimize competition with native salmonids.**

Policy 5. **Brood stock shall be collected May through October to maintain broad run-timing while reducing overlap with the run-timing of the native winter steelhead stock.**

Objectives

Objective 1. **Increase the potential average annual sport catch to 700 summer steelhead in the main stem Santiam, 4,500 in the North Santiam, and 5,600 in the South Santiam.**

Assumptions and Rationale

1. The Santiam has a popular summer steelhead fishery. Summer steelhead extend the shorter winter steelhead fishery.

2. The average annual catch during 1984 to 1988 was 805 fish on the main stem Santiam, 4,949 in the North Santiam (including the Little North Santiam), and 4,675 on the South Santiam. In recent years sport catch has generally increased.

3. The proposed harvest levels are the product of applying 7 percent and 5 percent survival rates to current smolt allocations in the South and North Santiam drainages, respectively, and a 50 percent exploitation rate in the fishery.

4. The use of acclimation ponds and releasing smolts lower in the fishery will increase the likelihood that returning adults will hold there longer, increasing their harvest rate.

Actions

1.1 Negotiate with the USACE to provide uncontaminated water at South Santiam Hatchery to protect hatchery eggs from IHN disease contracted through water from Foster Reservoir.

1.2 Provide an annual average return of 9,000 adults to the North Santiam River through the annual release of 200,000 smolts in the North Santiam (which should produce 10,000 adults at a 5 percent return rate).

1.3 Provide an annual average return of 11,200 fish to the South Santiam, including 2,000 fish for broodstock needs, through the annual release of 160,000 smolts in the South Santiam (which should produce 11,200 adults at a 7 percent return rate).

1.4 Consider the use of acclimation ponds to increase returns of adults to the fishery.

1.5 Release smolts throughout the North and South Santiam rivers for better distribution of returning adults for harvest potential.

1.6 Continue to maintain a late May opening for trout in the Santiam streams where summer steelhead smolts are released to protect outmigrant summer steelhead smolts.

1.7 Continue to coordinate release schedules with hydro projects such as Stayton, PP&L, and Albany's Lebanon canal to provide adequate protection of outmigrant smolts.

1.8 Initiate a program to screen all diversions to protect outmigrant smolts.

1.9 Continue to monitor run size with sport catch, collection facility counts, Willamette Falls counts, and the percent of the Willamette Falls run that returns to the Santiam subbasin.

1.10 Implement habitat protection actions outlined under objectives for Habitat Protection.

Objective 2. Continue to maximize harvest of adults in the subbasin.

Assumptions and Rationale

1. Natural spawning by summer steelhead is not desirable because of the potential impact on production of native winter steelhead.

2. Except for meeting brood stock needs at Foster Dam, theoretically all adults could be harvested.

Actions

2.1 Continue recycling adults through the fishery below Foster Dam unless studies show that recycling results in negative impacts on winter steelhead, such as an increase in natural production of summer steelhead.

2.2 Negotiate with the USACE to maintain a minimum release of 800 cfs from Foster Dam June through July to increase harvest of fish in the South Santiam.

Objective 3. Maintain a return of 2,000 adults to Foster Dam to meet brood stock needs.

Assumptions and Rationale

1. Only 1,000 adults are required for brood stock, but the overage allows for mortality and better variety for selection of timing segments. Usually 5,000 adults are handled at Foster collection facilities, but most are recycled into the fishery until brood stock collection is completed.

2. Current hatchery releases of 160,000 smolts in the South Santiam would provide a return of 11,200 fish assuming a 7 percent survival rate.

Actions

3.1 Provide an annual average return of 11,200 fish to the South Santiam, including 2,000 fish for broodstock needs, through the annual release of 160,000 smolts in the South Santiam (which should produce 11,200 adults at a 7 percent return rate).

3.2 Continue to tag adults returning to Foster Dam with a different color for each month to enable selection of brood fish for variety in run timing.

Objective 4. Minimize the potential impact of summer steelhead on native winter steelhead and trout.

Assumptions and Rationale

1. Summer steelhead are known to spawn in some areas in the subbasin, but the success of natural production and its impact on production of winter steelhead is unknown.

2. Releases of precocious hatchery steelhead smolts near areas where spawning of trout occurs may decrease the genetic fitness of trout populations.

Actions

4.1 Conduct spawning surveys on several tributaries during the period when fish are mature.

4.2 Assess juvenile production of summer steelhead in Hamilton Creek and the Little North Santiam.

4.3 Evaluate the experimental releases of groups of sterilized smolts below Foster Dam and their returns.

4.4 Investigate the potential impact of the current summer steelhead hatchery program, including recycling of fish returning to Foster Dam through the fishery, on natural production of winter steelhead in the Santiam subbasin.

4.5 Make any necessary changes in the current hatchery program for summer steelhead to protect the genetic integrity and natural production of winter steelhead in the Santiam subbasin.

4.6 Minimize the proportion of hatchery steelhead smolts that are precocious and their impact on spawning trout populations. This may be accomplished by removal of precocious fish during marking of hatchery steelhead.

4.7 If necessary modify hatchery steelhead programs to minimize their effects on trout populations and to be in compliance with Wild Fish Management Policy guidelines.

COHO SALMON

Background and Status

Origin

Coho are not native to the Willamette River or its tributaries above Willamette Falls, but were widely introduced above the falls in the 1960s following improvements in fish passage conditions (Williams 1983a). Efforts to develop a self-sustaining run above Willamette Falls have been largely unsuccessful.

Life History and Population Characteristics

Distribution

Spawning surveys conducted during 1970-77 documented successful natural spawning in the North and South Santiam rivers, Mill Creek and the Calapooia River (Williams 1983a). Currently, spawning of coho is thought to be confined to Mill Creek and possibly Stout Creek, a tributary to the North Santiam. Returns to Mill Creek may be from fry and pre-smolt releases. Strays from remnant populations from nearby streams are occasionally found in the Santiam River system.

Run Timing

Early run coho adults and jacks pass Willamette Falls from early September through the end of October (Howell et al. 1985b). They probably enter Mill Creek approximately two weeks later.

Age Structure

Coho generally return as 2-year-old jacks and 3-year-old adults.

Hatchery Production

Coho were introduced into the Santiam and Calapooia subbasins as part of the Oregon Fish Commission's program to establish self-sustaining runs above Willamette Falls. Managers initiated releases of fry, fingerlings, yearlings, and adult spawners in the 1950s (Table 28). Coho were released in the North Santiam from 1961 to 1972, in Mill Creek from 1964 to 1970, in the South Santiam from 1957 to 1974, and in the Calapooia from 1961 to 1970 (Williams 1983b). The objective of the releases was to seed as many suitable streams as possible with coho that would use the available rearing capacity (Williams 1983a).

Table 28. Summary of releases of coho in the Santiam and Calapooia subbasins (Williams 1983b; ODFW, unpublished data).

Brood year	Release years	Hatchery	Number released Fry	Fingerlings	Yearlings	Adults
1957	1958	Sandy		44,340		
1958	1959	Sandy		46,000		
1959	1960	Sandy		77,759		
1960	1961	Sandy		100,913		
1961	1962	Bonneville	474,096			
1962	1963	Bonneville	1,234,448			
		Klaskanine	502,444			
1963	1965	Sandy			68,998	
1964	1965	Bonneville	494,728	169,265		
	1964, 65	Cascade	696,850	201,217		1,857
	1965	Klaskanine		50,400		
	1966	Sandy			103,672	
1965	1966	Big Creek	542,587			
	1966	Bonneville	450,000			
	1966	Klaskanine	526,634			
	1966	Oxbow	231,756			
	1965, 66	Sandy	90,000			
1966	1966, 67	Big Creek	444,288			150
	1967	Bonneville	539,015			113
	1966	Cascade				594
	1967	Klaskanine	2,514,124			
	1967	Sandy	315,906	123,900		
1967	1967, 68	Bonneville	744,660			2,219
	1967, 68	Cascade	806,295			2,174
	1968	Klaskanine	521,000			2,160
	1968	Sandy	677,872			1,126
1968	1968, 70	Big Creek			73,920	200
	1968, 69	Bonneville	1,244,607			2,180
	1969, 70	Cascade	519,000		131,992	
	1970	Klaskanine			28,440	
	1969, 70	Sandy	293,618		20,234	
1969	1971	Alsea			15,001	
	1969	Big Creek				540
	1969, 70	Bonneville	806,642			200
	1970, 71	Cascade	391,000		341,553	
	1970	Sandy	824,474			
1970	1972	Alsea			12,320	
	1972	Cascade			330,810	
1971	1973	Bonneville			217,708	
	1973	Cascade			160,957	
"	1971	Sandy				150

continued

Table 28 continued.

Brood year	Release years	Hatchery	Number released: Fry	Fingerlings	Yearlings	Adults
1972	1972, 74	Bonneville			300,421	200
1973	Cascade			99,184		
1972, 74	Sandy				77,905	158
1973	1973	Eagle Creek				363
1974	1976	Cascade			50,960	
1983	--	Cascade	118,754			
1985	--	Oxbow		55,480		

In 1982, the Oregon Fish and Wildlife Commission banned further releases of coho in eastside tributaries of the Willamette upstream of the Santiam River. The commission acted in recognition of concerns about negative interactions between coho and cutthroat trout, or other native species. Releases were authorized for Mill Creek, which currently may have some natural production supplemented by STEP releases (Table 29). Currently no hatchery releases of coho are made in the Santiam or Calapooia subbasins.

Table 29. STEP releases of coho fry in Mill Creek during 1982-1987 (ODFW, unpublished data).

Brood year	Number released	Release location	Release date
1985	27,250	Beaver Creek	March 1986
1986	3,000	Beaver Creek	February 1987
1987	1,000	Mill Creek	February 1988

Angling and Harvest

Sport harvest of coho in the subbasin has declined to minimal levels in recent years (Table 30). Potential harvest of coho in the Santiam and Calapooia subbasins is subject to general Oregon Department of Fish and Wildlife angling regulations for salmon.

Table 30. Santiam subbasin adult harvest for coho (ODFW 1990b).

	Years														
	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Santiam River	14	44	26	9	0	0	0	0	0	0	0	16	0	20	0
North Santiam River	0	0	2	0	3	9	0	0	0	0	8	0	0	8	0
South Santiam River	0	45	10	0	0	0	0	0	0	6	16	46	0	0	0
Total Subbasin Harvest	14	95	38	9	3	9	0	0	0	6	24	62	0	28	0

Management Considerations

Streams in the Santiam and Calapooia subbasins are generally considered to be unsuitable for coho due to habitat constraints and potential competition with other species. Low flows and warm water temperatures in the early fall limit spawning of early run stocks. Coastal stocks released are susceptible to *Ceratomyxa shasta*, a naturally occurring disease organism in the Willamette River.

The Willamette Basin Fish Management Plan (ODFW 1988a) states that STEP hatch-box projects using coho eggs will be phased out in tributaries above Willamette Falls. No further releases of coho will occur in Mill Creek.

Policies

Policy 1. No further releases of coho salmon shall be made in the Santiam and Calapooia subbasins.

SPRING CHINOOK SALMON

Background and Status

Origin

Spring chinook is the only race of salmon native to the Santiam and Calapooia subbasins. The Santiam subbasin has produced approximately 33 percent of the naturally produced spring chinook in the Willamette basin above Willamette Falls (unpublished intra-department memo dated November 22, 1977 from W. Saltzman, ODFW, Portland, Oregon). Currently, the number of naturally produced fish is probably the same, however the percentage has probably decreased due to the increase in numbers of hatchery fish released.

Marking studies of the 1970 brood year indicated that approximately 25 percent of the returns to the Willamette River were naturally produced fish (Bennett 1988). The current percentage of naturally produced fish in the spring chinook run above Willamette Falls is unknown, but is believed to be 5-15 percent (letter dated June 7, 1989 from H. Wagner, ODFW, Portland, Oregon to L. Sowa, Salem, Oregon). Run size appears to be directly tied to the number of hatchery smolts released. Spring chinook adults returning to Foster Dam are primarily hatchery fish, however some spawn in the river and its tributaries downstream.

Willamette River spring chinook are currently listed by ODFW as a stock of concern due to diminished habitat, the small percentage of the total run that is of natural origin, and possible genetic impacts on naturally produced fish from the large hatchery program. Spring chinook in the North and South Santiam should be given a high priority with respect to future management funding and staffing.

Life History and Population Characteristics

Distribution

Spawning ground surveys conducted during 1946 and 1947 indicated that historically the major spring chinook production areas in the North Santiam system occurred in the main stem North Santiam, the Little North Santiam and Breitenbush rivers, Marion Creek and Blowout Creek (Mattson 1948). An estimated 71% of the spring chinook production occurred above Detroit Dam (Mattson 1948). Because passage facilities were not incorporated into Detroit Dam, this production area was lost when the Dam was constructed.

Major spring chinook producing areas in the South Santiam system were the Middle Santiam River, Quartzville Creek, and a 5-mile reach upstream of Cascadia on the South Santiam River. Historically, 85% of the spring chinook production in the South Santiam system occurred above Foster Dam (Mattson 1948). Reservoir mortality and passage problems have contributed to the decline in the runs above Foster Dam. Currently adults are not passed above Foster Dam.

In recent history, access to much of the potential spawning area in the Calapooia River has been blocked by Thompson's Mill and Sodom dams. Additionally, timber harvesting in the watershed has resulted in mass erosion and massive land movements, which have degraded spawning habitat. By the 1970s natural production of spring chinook in the Calapooia was thought to be minimal or non-existent.

Run Timing

Adult spring chinook begin entering the Santiam subbasin in mid-May. The peak of the migration is from late May through early June. Adults reach Minto Dam from late June through mid-October although peak entry into Minto adult collection facility is most often in September (Howell et al. 1985b). Adults arrive at Foster Dam primarily in June and July, but may show as early as late April and as late as mid-October. No information is available for adult time of entry into the Calapooia subbasin.

Run Size

A minimum run size of naturally produced and hatchery spring chinook entering the Santiam subbasin was estimated by adding sport catch and returns to dams and collection facilities (Table 31). This method underestimates run size as few fish return to collection facilities and many are not caught. Minimum run size averaged 5,238 fish from 1971 to 1989 with a range of 1,350 to 11,404 fish.

During 1975-89 the average run size of naturally produced and hatchery spring chinook over Willamette Falls was about 40,000 adults (Foster 1990). If 10% of these fish were of natural origin, then the average run size for naturally produced fish was 4,000 adults. Of the total run of naturally produced fish above Willamette Falls, approximately 50% are believed to return to the McKenzie, 40% to the Santiam subbasin, and 10% to other Willamette tributaries (personal communication on 18 January 1991 from D. Swartz, ODFW, Clackamas, Oregon). Therefore the average naturally produced run of spring chinook into the Santiam subbasin during 1975-89 was about 1,600 fish. Since the run in the South Santiam is believed to be almost exclusively hatchery fish, about 1,600 naturally produced fish returned to the North Santiam, a minimal amount to the South Santiam.

The average minimum hatchery run size during 1986-90 was about 6,800 fish. During 1986-90 an average of 1,061 fish returned to Minto Dam and 5,733 to Foster Dam, the collection sites for Marion Forks and South Santiam hatcheries, respectively.

Run size for the Calapooia subbasin is more difficult to estimate. There are no collection facilities in the subbasin to obtain counts, and no catch has been recorded since 1976 (Bennett 1988). Spawning surveys from 1976 estimated a spawning population of 100 in the main stem (ODFW, unpublished data).

Table 31. Minimum run size of naturally produced and hatchery spring chinook entering the Santiam subbasin and percent of Willamette Falls count (estimated by adding sport catch from the Santiam, North Santiam, and South Santiam and returns to collection facilities, Minto on the North Santiam and Foster Dam on the South Santiam) (Bennett 1988; Foster 1990; ODFW 1990b; and ODFW, unpublished data).

	Sport catch				Collection facility counts[a]			Minimum run	% Will. Falls
Year	Sant.	N. San.	S. San.	Total	Minto	Foster	Total	size	count
1971	--	--	--	1,320	1,731	4,756	6,104	7,424	16.7
1972	--	--	--	597	1,885	1,175	3,060	3,657	14.0
1973	--	--	--	698	1,842	2,735	4,577	5,275	12.6
1974	--	--	--	698	1,041	4,485	5,526	6,224	14.0
1975	278	167	44	489	949	1,798	2,747	3,236	17.0
5-year average								5,163	
1976	53	48	80	181	1,809	966	2,775	2,956	13.3
1977	785	668	283	1,736	558	1,766	2,324	4,060	10.5
1978	103	381	399	883	1,097	2,221	3,318	4,201	9.2
1979	81	153	153	387	166	797	963	1,350	5.3
1980	194	440	219	853	145	947	1,092	1,945	7.4
5-year average								2,902	
1981	98	847	148	1,093	744	2,324	3,098	4,191	14.6
1982	235	1,180	105	1,520	960	267	1,227	2,747	6.1
1983	114	446	167	727	605	1,543	1,707	2,434	8.5
1984	66	558	412	1,036	754	3,019	3,773	4,809	11.4
1985	121	1,028	486	1,635	2,189	3,061	5,250	6,885	20.8
5-year average								4,213	
1986	101	565	959	1,625	1,100	3,885	4,985	6,610	17.7
1987	243	1,804	1,465	3,512	990	6,902	7,892	11,404	21.6
1988	263	1,872	1,802	3,937	1,059	4,107	5,158	9,095	12.9
1989	291	1,767	1,412	3,470	1,149	6,393	7,542	11,012	15.9
1990	--	--	--	--	1,007	7,377	8,384	--	--

Age, Size, and Sex Ratio

Age composition of 12,863 adults returning to Foster Dam from 1964 to 1969 broods was 3.6 percent age-3 fish, 61.8 percent age-4 four, and 34.6 percent age-5 adults (Smith et al. 1987) (Table 32).

Table 32. Age composition of spring chinook adults returning to Foster Dam, 1964-69 brood years (Smith et al. 1987).

Brood Year	Age-3 #	Age-3 %	Age-4 #	Age-4 %	Age-5 #	Age-5 %
1964	12	3	184	47	195	50
1965	28	3	492	53	406	44
1966	23	7	1,030	61	541	32
1967	157	3	4,261	83	705	14
1968	80	6	411	32	810	62
1969	59	2	1,571	46	1,798	52
Total	459	3.6	7,949	61.8	4,455	34.6

The average median fork length of adults measured at Marion Forks Fish Hatchery during 1960 to 1968 was 80.38 cm for males and 85.20 cm for females (Table 33).

Table 33. Median fork length (cm) of spring chinook adults measured at Marion Forks Fish Hatchery, 1960-68 (Wallis and Burck 1961, 1962, 1963; Wallis 1964; Swartz and Wallis 1966; Swartz 1967, 1968a, 1968b).

Year	Median fork length (cm) Males	Median fork length (cm) Females
1960	81.49	87.47
1961	71.61	82.18
1962	74.59	80.86
1963	79.18	86.05
1964	85.62	88.33
1965	88.58	89.28
1966	79.24	83.62
1967	79.38	86.93
1968	83.74	82.09

Female-to-male ratios for returns to Marion Forks and South Santiam hatcheries are provided in Table 34. Ratios range from 1:1.1 to 1:3.

Table 34. Female-to-male ratios of spring chinook returning to hatcheries in the Santiam subbasin, 1979-83 (Howell et al. 1985b).

	Hatchery	
Year	Marion Forks	South Santiam
1979	1:2.7	--
1980	--	--
1981	1:3.0	1:1.1
1982	--	--
1983	1:1.8	1:1.5

Time and Location of Spawning

Spring chinook in the Willamette River system generally spawn from August 25 through October 15 (Mattson 1962). During 1952, fish were taken for spawning as late as November 25 (Mattson 1962).

Presently, spring chinook spawn and rear in Mill Creek, in the Little North Santiam up to Henline Creek, and in the North Santiam River from Stayton up to Minto. In the South Santiam drainage, spawning and rearing occurs in Thomas Creek from Jordan Creek to Hall Creek, in Crabtree Creek from RM 14 to White Rock Creek, and in the South Santiam main stem. Spawning and rearing occurs in the Calapooia River from Holley to Treadwell Creek.

Marion Forks and South Santiam hatchery fish are spawned as early as August and into October, the median date usually falling in the later half of September (Howell et al. 1985b).

Average fecundity of chinook returning to hatcheries during 1978 to 1983 was 4,421 eggs per female at Marion Forks and 4,394 eggs at South Santiam (Howell et al. 1985b).

Juvenile Life History

Naturally produced fish emerge prematurely in the North Santiam. Warm water discharged from Detroit reservoir in the fall shortens the incubation time of spring chinook eggs. Naturally-spawned salmon fry emerge as early as Thanksgiving in the North Santiam River, based on trap catches in Stayton Power Canal. In an experiment on the North Santiam in 1949, naturally produced fish appeared by June 5 (Mattson 1962). Presently, most juveniles are believed to have emerged by March (personal communication from E. Smith, ODFW, Springfield, Oregon). Fry emerge by the end of January at most hatcheries (Howell 1985b).

Hatchery smolt releases in recent broods have concentrated primarily on age-1 fall releases in November and age-2 spring releases in March at both Marion Forks and South Santiam hatcheries. Currently, all Marion Forks smolts are released in March as age-2 emigrants. Fall-released smolts are targeted at 150 mm or larger. Spring releases are fed to achieve an average of nine fish per pound with a uniform length-frequency distribution (personal communication from E. Smith, ODFW, Springfield, Oregon).

Initial studies at Dexter and South Santiam hatcheries indicated that fall releases of smolts will produce substantially more adults and larger adults than spring releases (Smith and Zakel 1980a). More recent results indicate a higher survival rate for March-released smolts, with adult age and size determined by smolt size (Smith et al. 1987). Currently yearling smolt releases are divided between fall and spring liberations. Releases in the South Santiam are made in March and November. Releases in the North Santiam are made only in the spring.

Smolts begin emigration soon after release. Tagged smolts released from Minto on March 18, 1977 were recaptured at Willamette Falls from March 23 through June (Smith and Zakel 1980b). The protracted emigration pattern for Marion Forks smolts may be related to their relatively small size at release. Large chinook smolts emigrate faster than small smolts (Smith et al. 1987).

Smolt-to-adult survival of 1976 to 1980 brood year spring releases from Marion Forks Hatchery averaged 0.68 percent. Survival of 1975 to 1978 brood year hatchery fish from South Santiam Hatchery averaged 0.49 percent for fall releases and 0.51 percent for spring releases (personal communication from E. Smith, ODFW, Springfield).

Hatchery Production

Description of Hatcheries

Hatcheries in the Santiam subbasin that rear spring chinook are Marion Forks and South Santiam hatcheries. Marion Forks Hatchery has operated since 1951 by ODFW with funding from the USACE and ODFW. Spring chinook adults are captured and held until spawning at Minto collection facility near Gates. The Minto collection facility operates during September 15 through October 15. Early returning fish are believed to hold below the trap until the trap opens, and are included in the brood stock. Fish returning to the collection facilities are mixed and randomly selected for spawning. The proportions of naturally produced and hatchery fish spawned are not monitored.

South Santiam Hatchery is also operated by the ODFW with funding from the USACE and ODFW. The original hatchery began operation in 1925, five miles upstream from the present facility. In 1968 the hatchery began operating at its present location near Foster Dam. Hatchery fish are captured for brood stock at Foster Dam. Early, mid, and late-returning fish are selected for brood.

Production of spring chinook at Marion Forks and South Santiam hatcheries during the 1975 to 1985 brood years averaged 0.65 and 0.32 million smolts, respectively. These smolts are released in several subbasins in the Willamette basin, including the Santiam.

Supplementation History

Hatchery releases are derived primarily from native Willamette stock. Experimental releases of 1976 to 1980 brood Carson stock were made from Marion Forks Hatchery, but discontinued due to poor returns to the fisheries.

Hatchery releases are intended to compensate for loss of natural production due to construction of dams on the North and South Santiam rivers. The current mitigation levels are no more than 84,000 pounds of juvenile chinook and steelhead for the North Santiam and a maximum of 71,000 pounds of juvenile chinook and steelhead for the South Santiam. Mean releases of spring chinook smolts for 1981-90 were 493,800 fish for the North Santiam and 734,200 for the South Santiam (Appendix Table C-1).

Green Peter Reservoir was stocked with approximately 2 million fry and fingerlings annually during 1968-75 and 1979-86. Originally this was a successful program. However, sampling of emigration from spring 1985 through fall 1986 indicated that juveniles had low survival in the reservoir, possibly due to increasing predation (unpublished ODFW intra-department memo dated February 17, 1987 from E. Smith, ODFW, Springfield, Oregon). Releasing fewer, but larger fingerlings later did not increase emigration from the 1985 brood.

Managers have stocked pre-smolts, smolts, and adults in the Calapooia River to restore the run. Few returns have been noted, possibly due to continued passage problems, low flows, and limited rearing habitat. However returns have not been adequately monitored and evaluated.

STEP releases of spring chinook fry have occurred in the Little North Santiam, and Hamilton and Crabtree creeks (Table 35). Incubation boxes in the Little North Santiam are operated at Camp Cascade. About 20,000 eggs are allocated to the Camp Cascade program. Future STEP releases will be limited to 500 eggs or less at Camp Cascade for educational purposes.

Table 35. STEP releases of spring chinook fry in the Santiam subbasin during 1983-88 (ODFW, unpublished data).

Brood year	Hatchery and Stock		Number released	Release location	Release date
1983	South Santiam, South Santiam		750	Hamilton Creek	Dec 83
1984	"	"	35,352	Little North Santiam	Jan 85
1985	"	"	21,397	Little North Santiam	Jan 86
1985	"	"	3,929	Crabtree Creek	Jan 86
1986	"	"	19,500	Little North Santiam	Feb 87
1986	"	"	5,082	Crabtree Creek	Jan 87
1987	"	"	8,760	Little North Santiam	Feb 88
1987	"	"	3,900	Crabtree Creek	Jan 88

Angling and Harvest

Spring chinook provide angling opportunities in May, June, and July. Sport catch in the North and South Santiam rivers has generally increased since 1975 (Table 36), perhaps due to increasing angler interest. The average annual sport catch during 1977 to 1989 in the Santiam subbasin was 1,724 fish. Average annual sport catch has been increasing in more recent years. The average annual catch during 1987 to 1989 was 3,640 fish. During 1987-89 the Santiam subbasin had the highest sport catch of spring chinook among Willamette tributaries above Willamette Falls. The 1981 to 1989 average annual catch for the North and South Santiam was 1,119 and 772 fish, respectively.

Sport catch in the Calapooia subbasin prior to 1975 was minimal (Bennett 1988). The average annual catch during 1963 to 1974 was 13 fish with a range of 0 to 34 fish. Since 1977 there has been no recorded catch of spring chinook in the subbasin.

Harvest of Willamette spring chinook in the Santiam subbasin is subject to general Oregon Department of Fish and Wildlife angling regulations for chinook. The sport fishing season has been extended to August 15 in the Santiam subbasin. The Calapooia has been closed to angling for salmon since 1988.

Table 36. Santiam and Calapooia subbasin adult harvest for spring chinook, 1977-89 (ODFW 1990b).

	Years												
	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Santiam River	785	103	81	194	98	235	114	66	121	101	243	263	291
No. Santiam R.	668	381	153	440	847	1,180	446	558	1,028	565	1,804	1,872	1,767
So. Santiam R.	267	393	153	219	145	105	164	409	486	959	1,465	1,794	1,412
Crabtree Cr.	16	6	0	0	3	0	3	3	0	0	0	8	0
Total	1,736	883	387	853	1,093	1,520	727	1,036	1,635	1,625	3,512	3,937	3,470
Calapooia River	0	0	0	0	0	0	0	0	0	0	0	--	--
Total Subbasin Harvest	1,736	883	387	853	1,093	1,520	727	1,036	1,635	1,625	3,512	3,937	3,470

Management Considerations

Dams constructed on the North and South Santiam have blocked access to much of the important adult holding, spawning and rearing habitat in the subbasin. Historically, 71% of the spring chinook production in the North Santiam system occurred above Detroit Dam and 85% of the spring chinook production in the South Santiam system occurred above Foster Dam (Mattson 1948). Changes in natural streamflow patterns and water temperatures below the dams affect fish production in lower reaches of the subbasins (USACE 1988). Cold water discharged from Detroit Dam during early summer causes spring chinook to delay their upstream migration in the North Santiam River several miles downstream from Minto holding facilities. Warm water temperatures in the fall from reservoir draw-down in the North and South Santiam cause early emergence of fry and resulting exposure to winter freshets and juvenile feeding during a nutrient-poor time period. The result of these effects is reduced fry survival.

Since construction of Foster and Green Peter dams, spring chinook production upstream has been seriously reduced. Although the Green Peter Dam passage facilities are viable, working facilities, adults are not attracted to the ladder, possibly due to irregular peaking flows and cold water temperatures. Survival of juvenile spring chinook in Green Peter reservoir is very low, apparently due to predation by squawfish and largemouth bass. Spring chinook have not been passed above Foster Dam to avoid fish disease problems at South Santiam Hatchery, which takes its water from the South Santiam River. Also, until the 1980s, returns of adult spring chinook to Foster Dam were not sufficient to meet hatchery needs. Consequently, no fish were available to pass above the dam.

Upstream and downstream passage is impeded at the Stayton complex on the North Santiam and at Lebanon Dam on the South Santiam. Downstream passage is impeded at the Lebanon-Albany canal on the South Santiam. Small dams on the Calapooia have blocked adult passage, which contributed to the probable elimination of runs and prevents their re-establishment. Unscreened diversions on both the North and South Santiam as well as the Calapooia cause loss of outmigrating smolts.

The extent of natural production occurring in the North Santiam, the Little North Santiam, Crabtree and Thomas creeks, and in the South Santiam below Foster Dam is unknown. Hatchery releases of Skamania summer steelhead and Cape Cod rainbow trout are made in the Little North Santiam. The effects of these hatchery releases on natural production is unknown.

The likelihood of success for re-establishment of spring chinook runs in the Calapooia is unknown.

Willamette River spring chinook are currently listed by ODFW as a stock of concern due to diminished habitat, the small percentage of the total run that is of natural origin, and possible genetic impacts on naturally produced fish from the large hatchery program. The current hatchery program is most likely out of compliance with the Wild Fish Management Policy. Maintaining the current level of hatchery production in the subbasin, which provides for important ocean and in-river fisheries, and coming into compliance with the Wild Fish Management Policy may not be feasible.

Policies

Policy 1. **The Little North Santiam shall be managed for natural production. No hatchery-produced spring chinook salmon shall be released into this stream.**

Policy 2. **The North Santiam above Detroit Dam, the South and Middle Santiam above Foster Dam, and Crabtree and Thomas creeks shall be managed for natural production after reestablishment of runs.**

Policy 3. **The Calapooia subbasin shall be managed for natural production after a run is reestablished.**

Objectives

Objective 1. **Increase natural production of spring chinook salmon in the North Santiam, including the Little North Santiam, and in the South Santiam, including Crabtree and Thomas creeks.**

Assumptions and Rationale

1. Willamette spring chinook have been identified as a stock of concern. This objective addresses some of the problems with the stock.

2. The subbasin supports natural production of spring chinook, although at lower than historic levels.

3. Monitoring the distribution and abundance of populations of spring chinook will provide an indication of their health and adaptiveness.

4. Remnant runs of spring chinook in the Little North Santiam, and Crabtree and Thomas creeks were documented in the 1960s. Currently, little is known about natural production in these and other Santiam system tributaries. Reestablishment of runs may be needed in Thomas and Crabtree creeks.

5. Habitat quality will be maintained or improved.

Actions

1.1 Determine the status, including the population abundance, of naturally produced runs of spring chinook in the North and South Santiam drainages.

   a. Snorkel resting holes in the Little North Santiam and Crabtree and Thomas creeks during the summer to estimate returns of spring chinook.

   b. Conduct spawning surveys in the Little North Santiam and Crabtree and Thomas creeks during late September to estimate natural production.

c. Snorkel the Little North Santiam and Crabtree and Thomas creeks to assess rearing populations.

1.2 Conduct aerial surveys to determine the distribution and number of spawning redds from Stayton to Minto on the North Santiam, in the Little North Santiam, and below Foster Dam on the South Santiam.

1.3 If necessary, rehabilitate runs in Thomas and Crabtree creeks by stocking naturally produced fish from another Willamette tributary system or hatchery smolts for a limited period of time.

1.4 Mark spring chinook hatchery smolts.

1.5 Determine the percent hatchery fish in the run through creel studies, carcass surveys, and returns to Foster and Minto collection facilities.

1.6 Estimate the contribution of hatchery fish to natural production through carcass surveys.

Objective 2. Protect, restore, and enhance spring chinook salmon habitat in the Santiam and Calapooia subbasins.

Assumptions and Rationale

1. Willamette spring chinook have been identified as a stock of concern. This objective addresses some of the problems with the stock.

2. Protection and enhancement of spring chinook populations can be achieved principally through habitat protection and improvement.

3. Warm water temperatures from reservoir draw-down in the North and South Santiam rivers results in reduced survival of spring chinook fry.

4. Unscreened power canals, turbines, and diversions contribute to smolt mortality.

Actions

2.1 Identify sites for habitat improvement.

2.2 Develop habitat improvement plans.

2.3 Implement habitat protection actions outlined under objectives for Habitat Protection.

2.4 Emphasize the need to correct water temperature problems associated with USACE reservoir releases in the North and South Santiam rivers.

2.5 Initiate a program to screen all diversions especially the Lebanon-Albany power canal, Stayton Power Canal, the main irrigation canal at Stayton, the Salem water supply intake at Stayton, Sidney ditch, the 19th Street diversion, and Penn Annex lateral.

2.6 Evaluate upstream passage at Stayton and at Lebanon Dam and recommend steps to improve passage.

Objective 3. Reestablish spring chinook salmon runs in the North Santiam above Detroit Reservoir.

Assumptions and Rationale

1. Willamette spring chinook have been identified as a stock of concern. This objective addresses some of the problems with the stock.

2. Historically, 71% of the spring chinook production in the North Santiam system occurred above Detroit Dam (Mattson 1948). Because passage facilities were not incorporated into Detroit Dam, this production area was lost when the Dam was constructed.

3. Passage for adults and smolts around Detroit Dam and reservoir can be provided.

4. The run can be monitored at Big Cliff Dam.

Actions

3.1 Re-negotiate with the USACE to provide spring chinook access to production areas lost after the construction of Detroit Dam.

3.2 Determine the hatchery-to-naturally produced ratio of spring chinook in the North Santiam run. If there are sufficient naturally produced fish, capture adults and pass above Detroit Reservoir to reestablish natural production in the upper North Santiam, following establishment of passage facilities. If there are insufficient naturally produced fish to use for such purposes in the North Santiam, then consider using naturally produced fish from another suitable stock or hatchery fish to reestablish production.

3.3 Continue to pass spring chinook adults above Detroit Reservoir after reestablishing production.

3.4 Monitor the run in the North Santiam at Big Cliff Dam.

Objective 4. Reestablish spring chinook salmon runs in the South Santiam above Foster and Green Peter dams.

Assumptions and Rationale

1. Willamette spring chinook have been identified as a stock of concern. This objective addresses some of the problems with the stock.

2. Historically, 85% of the spring chinook production in the South Santiam system occurred above Foster Dam (Mattson 1948). Reservoir mortality and passage problems have contributed to the decline in the runs above Foster Dam.

3. Reservoir mortality and passage problems associated with Foster and Green Peter dams can be resolved.

4. Eggs at South Santiam Hatchery are susceptible to IHN and other diseases which can be contracted through the water supply.

5. Disease-free water can be provided for South Santiam Hatchery.

6. The run can be monitored at Foster Dam.

Actions

4.1 Negotiate with the USACE with coordination with NMFS and USFWS to provide in-kind compensation (natural production) for loss of spring chinook production above Green Peter and Foster dams.

4.2 Negotiate with the USACE to provide uncontaminated water at South Santiam Hatchery to protect hatchery eggs and juveniles from IHN and other potential diseases contracted through water from Foster Reservoir.

4.3 Determine the hatchery-to-naturally produced ratio of spring chinook in the South Santiam run. If there are sufficient naturally produced fish, capture adults and pass above Foster Dam to reestablish production in the upper South Santiam. If there are insufficient naturally produced fish to use for such purposes in the South Santiam, then consider using naturally produced fish from another suitable stock or hatchery fish to reestablish a run.

4.4 Continue to pass spring chinook adults above Foster Dam after reestablishing a run.

4.5 Negotiate with the USACE to conduct a study to assess predation by squawfish and largemouth bass on juvenile spring chinook in Green Peter Reservoir and determine methods to reduce predation.

4.6 Investigate methods to improve upstream passage at Green Peter Dam.

4.7 Monitor the run in the South Santiam at Foster Dam.

Objective 5. Reestablish a run of 650 spring chinook salmon in the Calapooia subbasin.

Assumptions and Rationale

1. Willamette spring chinook have been identified as a stock of concern. This objective addresses some of the problems with the stock.

2. A run of spring chinook existed in the Calapooia prior to the 1970s. Spawning surveys in 1976 suggest that the run in the main stem Calapooia was reduced to about 100 fish. Currently, the run in the Calapooia is believed to be minimal or non-existent.

3. Habitat quality will be maintained or improved.

4. Resolving passage problems at Thompson's Mill Dam is necessary for the reestablishment of a spring chinook run.

5. Unscreened diversions contribute to smolt mortality.

6. Based on smolt production estimates, a maximum spawning escapement of about 700 fish is needed to fully seed the habitat. This estimate is based on the estimated spring chinook run in the Willamette basin in 1953, which is the largest run on record consisting of mainly naturally produced fish and the proportion of the historical spawning habitat remaining after construction of dams in the Willamette basin. The residual smolt production capacity is 45,952 for the Calapooia and other minor Willamette tributaries. The spawning escapement needed to produce these smolts was back-calculated using an egg-to-smolt survival rate of 3%, fecundity of 4,400 eggs per female, and a female-to-male ratio of 1:1.

7. The spring chinook run could be monitored at the fish passage facilities at Thompson's Mill Dam, once they are installed.

Actions

5.1 Evaluate stream habitat from Holley to Dollar (RM 46-56) for spring chinook spawning and rearing and adequate temperatures.

5.2 If the results of Action 5.1 confirm that the Calapooia could support a spring chinook run, then request improvement of upstream passage at Thompson's Mill Dam and bypasses.

5.3 Evaluate upstream passage at Brownsville Dam bypass and recommend steps to improve passage if needed.

5.4 Initiate a program to screen the Brownsville irrigation diversion.

5.5 Rehabilitate the Calapooia run by stocking naturally produced fish from another Willamette tributary system or hatchery smolts annually below Dollar for a four- to five-year period.

5.6 Monitor adult returns at Thompson's Mill Dam.

Objective 6. Provide a potential harvest of 200 adults in the main stem Santiam, 1,400 adults in the North Santiam, and 1,300 adults in the South Santiam through the release of hatchery spring chinook salmon.

Assumptions and Rationale

1. Proposed hatchery mitigation levels funded by USACE for spring chinook for 1991 are 63,750 lbs. of smolts for the North Santiam and 37,000 lbs. of smolts for the South Santiam. The level of production at South Santiam is expected to produce a return of 1,400 adults. Additional hatchery production will not be funded by USACE.

2. The average annual sport catch during 1985-89 was 204 fish for the main stem Santiam, 1,407 for the North Santiam, and 1,225 for the South Santiam.

3. Angler interest in spring chinook has increased in recent years.

4. Releases of hatchery smolts downstream closer to the fishery and continued recycling of adults through the South Santiam fishery will contribute to increased harvest.

5. Protection of natural production of spring chinook has priority over harvest in the subbasin.

Actions

6.1 Continue to release about 50,000 pounds of hatchery smolts in the North Santiam and 70,000 pounds of smolts in the South Santiam.

6.2 Monitor the proportion of naturally spawning hatchery fish and recommend changes as appropriate if not in compliance with WFMP standards.

6.3 Investigate the possibility of using acclimation facilities and associated collection facilities to reduce straying of hatchery spring chinook.

6.4 Consider releasing part of the North Santiam smolt allocation below Minto (at Mehama and Stayton) in conjunction with acclimation and collection facilities to maximize adult returns to the fishery.

6.5 Evaluate problems associated with early returning adults at Minto, such as closed holding facilities and poaching potential, and make recommendations to increase harvest of these fish or their use as brood stock.

6.6 Evaluate the effectiveness of increasing harvest by recycling spring chinook adults trapped at Foster collection facilities through the fishery below Foster.

6.7 Conduct stream flow studies using In-stream Flow Incremental Methodology (IFIM) to determine appropriate flows to maximize angler catch.

6.8 Evaluate the effectiveness of redistributing hatchery releases in conjunction with acclimation and collection facilities to maximize adult returns to the South Santiam fishery. In cooperation with the Washington Department of Fisheries, use the proposed otolith method to mark smolts released at Waterloo to determine if these fish return to Foster Dam at the same rate as Foster releases, rather than returning to the South Santiam fishery near Waterloo.

6.9 Continue to monitor the sport harvest of spring chinook in the Santiam subbasin.

Objective 7. Provide an annual average return of 400 and 1,200 hatchery adults to Marion Forks and South Santiam hatcheries, respectively.

Assumptions and Rationale

1. Brood stock needs for Marion Forks and South Santiam hatcheries are 400 and 1,200 spring chinook adults, respectively, assuming a 1:1 sex ratio and 20% pre-spawning mortality.

Actions

7.1 Mark hatchery smolts for determination of percent hatchery fish in the run.

7.2 Incorporate naturally produced fish into the brood stock at Marion Forks and South Santiam hatcheries in every generation.

FALL CHINOOK SALMON

Background and Status

Origin

Fall chinook are not native to the Santiam and Calapooia subbasins. Efforts made in the 1950s to establish a run above Willamette Falls failed because of an inadequate fishway and industrial pollution. Fall chinook were established above Willamette Falls in the late 1960s following improvements in water quality in the Willamette basin and passage facilities at the falls.

The fall chinook run is largely the product of "tule" stock hatchery fish (Howell 1986). Since tules spawn shortly after entering the Willamette River, they are usually dark, have poor quality flesh, and do not bite well. To provide a brighter fish for the sport fishery, later spawning Cowlitz stock from Washington were released experimentally in Mill Creek. Studies in Row River with Cowlitz stock indicated a relatively long freshwater residence, an undesirable trait due to potential competition or predation effects on native fish species. Cowlitz releases were discontinued for this reason and also because the egg supply was not dependable.

Naturally spawning adults are hatchery and wild returns. Wild fish are the progeny of hatchery fish that returned and spawned in the wild. About 28 percent of the runs above Willamette Falls are naturally produced (personal communication from E. Smith, ODFW, Springfield, Oregon).

Life History and Population Characteristics

Distribution

Fall chinook spawn and rear in Mill Creek, Shelton Ditch, the Salem Canal, the main stem Santiam, the North Santiam up to Valentine Creek, and the South Santiam up to Hamilton Creek (Table 37). The Calapooia River was not surveyed as consistently as Mill Creek and Santiam tributaries because natural spawning is thought to be minimal or non-existent due to warm water temperatures, low flows, and the barrier at Thompson's Mill.

Table 37. Spawning surveys of fall chinook in Mill Creek and the Santiam subbasin, 1976-88 (Hansen 1977, 1978; Hansen and Williams 1979; Smith et al. 1982; ODFW, unpublished data).

Location	Spawning redds per mile												
	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Mill Cr.													
RM 0-18.5	75	62	57	14	10	19	3	3	4	--	9	5	12
Shelton Ditch	--	88	77	29	--	93	46	42	101	--	70	20	16
Santiam R.													
RM 0.0-3.0	107	67	43	66	118	37	82	26	--	--	40	42	33
RM 3.0-6.0	117	71	77	68	95	54	137	58	--	--	82	50	33
RM 6.0-10.0	85	57	43	36	52	38	115	58	--	--	59	25	22
RM 10.0-12.0	125	104	56	69	44	99	187	51	--	--	108	46	16
North Santiam R.													
RM 0.0-3.0	50	34	13	12	1	9	--	9	--	--	23	10	1
RM 3.0-11.0	39	43	26	7	4	7	6	7	--	--	8	7	5
RM 11.0-17.0	7	11	3	3	2	3	22	1	--	--	8	7	5
RM 17.0-27.0	1	4	1	1	1	2	1	1	--	--	2	2	1
South Santiam R.													
RM 0.0-7.5	124	122	114	54	28	33	149	57	--	--	48	19	14
RM 7.5-18.0	83	114	108	33	13	12	80	50	--	--	22	7	7
RM 18.0-21.0	18	37	32	2	7	9	99	73	--	--	23	5	3
RM 21.0-38.0	1	5	2	2	5	4	4	2	--	--	3	3	9
Thomas Cr.													
RM 0.0-2.0	--	2	1	0	0	1	1	0	--	--	--	--	--
RM 2.0-12.0	--	2	0	0	0	0	--	--	--	--	--	--	--
Crabtree Cr.													
RM 0.0-4.0	--	7	12	0	0	1	18	7	--	--	--	--	--
RM 4.0-10.0	--	4	17	0	0	--	--	--	--	--	--	--	--
RM 10.0-11.0	--	8	--	--	--	--	--	--	--	--	--	--	--

Run Size and Timing

Run size for Mill Creek and the Santiam and Calapooia subbasins was calculated using Willamette Falls run counts and spawning survey redd counts above Willamette Falls (Table 38). The proportion of above Willamette Falls redds in the subbasin was multiplied by a fish per redd factor. This was computed by dividing the Willamette Falls count by the total number of redds above the falls for the year. Run size was estimated by multiplying the number of redds by the fish-per-redd factor.

Estimated returns to Mill Creek ranged from a low of 678 fish in 1980 to a high of 10,881 fish in 1975. The average run size during 1969 to 1988 was 3,620 adults. Returns to the Santiam subbasin varied from 2,146 to 19,320 adults and averaged 8,136 adults. Spawning surveys were conducted in the Calapooia until 1976. During 1975 and 1976 no redds were found. The 1969 to 1974 average run size estimate is 18 fish; current run size is thought to be minimal or non-existent.

Table 38. Estimated returns of fall chinook to Mill Creek and the Santiam and Calapooia subbasins, 1969-88. The fish-per-red factor is the Willamette Falls count divided by the total number of redds above the falls. Run size is estimated by multiplying the number of redds in the subbasin by the fish-per-red factor.

Year	Will. Falls counts	Redds above Falls	Fish/ redd factor	Mill Creek # redds	Mill Creek Run size	Santiam # Redds	Santiam Run size	Calapooia # Redds	Calapooia Run Size
1969	6,817	982	6.94	--	--	772	5,358	1	7
1970	7,457	2,398	3.11	961	2,989	888	2,762	5	16
1971	4,880	1,382	3.53	600	2,118	608	2,146	1	4
1972	11,614	3,223	3.60	1,354	4,874	672	2,419	0	0
1973	21,861	6,502	3.36	1,992	6,693	1,525	5,124	22	74
1974	33,924	9,597	3.53	1,990	7,025	5,473	19,320	1	4
1975	32,877	8,524	3.86	2,819	10,881	3,938	15,201	0	0
1976	29,269	6,642	4.41	1,656	7,303	3,651	16,101	0	0
1977	25,742	6,739	3.82	1,410	5,386	3,710	14,172	--	--
1978	17,437	6,581	2.65	1,261	3,342	3,165	8,387	--	--
1979	9,905	2,616	3.79	305	1,156	1,588	6,019	--	--
1980	7,760	2,445	3.17	214	678	1,445	4,581	--	--
1981	16,834	2,473	6.81	408	2,779	1,110	7,559	--	--
1982	25,760	6,451	3.99	183	730	1,945	7,761	--	--
1983	13,205	2,832	4.66	173	806	1,906	8,882	--	--
1984	20,060	--	--	377	--	--	--	--	--
1985	29,089	--	--	--	--	--	--	--	--
1986	14,037	2,168	6.47	366	2,368	1,747	11,303	--	--
1987	8,766	1,627	5.39	157	846	916	4,937	--	--
1988	6,867	1,158	5.93	265	1,571	744	4,412	--	--
1989	6,472								
1990	4,490								

Fall chinook first appear in Mill Creek September 10-15. The peak of the run usually occurs during the third week in September.

Time of Spawning

Tule fall chinook and native Willamette spring chinook have substantially overlapping timing of spawning and compete for the same main stem rearing areas.

Fall chinook spawn in Mill Creek in September and October. The proportion of female carcasses sampled during spawning surveys in 1973 and 1978 ranged from 29 percent to 59 percent (Table 39).

Table 39. Sex ratios of fall chinook from Mill Creek and the Santiam system as determined from carcasses recovered during September and October (Hansen and Williams 1979).

Year	Stream	Females No.	Females %	Males No.	Males %
1973	Mill Creek	1,234	39	1,930	61
1978	Mill Creek	164	59	116	41
	Santiam River	32	52	30	48
	North Santiam River	38	59	26	41
	South Santiam River	34	29	83	71

Juvenile Life History

Fall chinook are released as subyearlings from Stayton Pond. The mean size of 1978 to 1984 brood year fish averaged 6.5 grams per fish (Table 40). Fall chinook are trucked out of Stayton Pond during late April through early May.

Table 40. Date of release and size of juvenile fall chinook released from Stayton Pond, 1978-1984 brood (Smith et al. 1985).

Brood year	Date of release	Mean size (g/fish)
1978	05/07-05/29/79	6.8
1979	03/28-06/21/80	5.2
1980	04/28-06/15/81	6.1
1981	04/03-05/21/82	5.2
1982	04/25-05/19/83	5.8
1983	05/08-05/31/84	7.8
1984	05/14-05/31/85	8.6

Hatchery Production

Description of Hatcheries

Eggs to support the Willamette fall chinook program are supplied by Bonneville Hatchery (Howell et al. 1985b). Unfed tule fry from Bonneville Hatchery are reared at Aumsville Pond until mid-February and then shipped to Stayton Pond for final rearing. The Aumsville and Stayton ponds are located east and south of Stayton, respectively, and are satellite facilities of South Santiam hatchery. Only tule fall chinook are reared at these facilities.

Hatchery Releases

Since releases of hatchery fish have continued since the original introductions of fall chinook into the subbasin, it has not been possible to determine if the runs could become self-sustaining. It is apparent, however, that hatchery releases are necessary to maintain adult production at the present levels.

Fry and fingerlings were released in the North and South Santiam and the Calapooia primarily during 1965 to 1968 (Appendix Table D-1). Since then, releases of mostly smolts have been made in Mill Creek and the North and South Santiam. No further releases have been made in the Calapooia since 1968.

Smolts have been released into Mill Creek since 1968. Releases have ranged from 0 to 2,386,835 fish annually. Releases in the Santiam main stem occurred during 1968, 1979-83, and 1987-90. Releases in the main stem and North Santiam rivers during 1987-90 averaged 894,766 smolts annually. Smolts released into the South Santiam averaged 1,368,712 smolts during 1987-90.

Angling and Harvest

Since tule fall chinook spawn shortly after entering the Willamette, they are usually dark, have poor quality flesh, and do not bite well. They have not been a popular sport fish in the Santiam subbasin. The fishery in Mill Creek has been closed since 1972. The Santiam salmon fishery has been closed since 1986. The Calapooia River has been closed to salmon angling year round since 1988.

Small sport fisheries occurred primarily on spawning grounds. The average annual catch during 1978-85 on the main stem Santiam was 134 fish; on the North Santiam, 34 fish; on the Little North Santiam, 2 fish; and on the South Santiam, 176 fish (Table 41). The average total subbasin harvest was 345 fish.

Table 41. Santiam subbasin adult harvest for fall chinook, 1978-89 (ODFW 1990b).

	Years											
	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
Santiam River	88	111	89	154	293	47	89	200	14	5	31	0
North Santiam River	0	42	24	12	63	31	19	79	0	15	0	0
Little North Santiam	--	--	6	6	0	0	0	0	0	0	0	4[a]
South Santiam River	242	144	37	154	257	41	272	263	11	0	4	0
Total Subbasin Harvest	330	297	156	326	613	119	380	542	25	20	35	4

[a] These fish were probably spring chinook.

Management Considerations

Fall chinook are not native to the Santiam and Calapooia subbasins. Although fall chinook are managed for hatchery production, there is some natural production. Fall chinook that spawn in the subbasin are an incentive for water resource managers to provide adequate flows and good water quality during late summer and fall to meet the needs of these fish. This, in turn, provides better water conditions for other species in the subbasin.

Major fish production constraints for fall chinook in Mill Creek include loss of smolts in unscreened diversion ditches and non-game fish predation. Flooding and gravel erosion as well as non-game fish predation are major problems in the lower reaches of the North and South Santiam and the main stem Santiam. Channelization, migration barriers and diversions, streambank degradation and sedimentation problems due to urban and agricultural practices, low flows and high summer temperatures are also problems.

Currently there is no sport fishery in the subbasin. The Mill Creek fishery was closed in 1972 and the Santiam fishery in 1986. However, fall chinook produced in the subbasin contribute to the offshore and Columbia River fisheries. As a result of the United States-Canada Pacific Salmon Treaty, maintaining production of tule stock for harvest in Canadian waters will result in reduced British Columbia harvest of other less abundant or more important Oregon chinook salmon stocks.

The impact of fall chinook on native salmonids, particularly spring chinook and resident trout, in the subbasin is unknown. Juvenile fall chinook have been found to rear in the same reaches as juvenile spring chinook.

Policies

Policy 1. Fall chinook salmon shall not be stocked above Stayton on the North Santiam to avoid impacts on native salmonids.

Objectives

Objective 1. Provide a harvest of fall chinook salmon in ocean and Columbia River fisheries.

Assumptions and Rationale

1. Fall chinook do not contribute to fisheries in the subbasin.

2. Willamette tule fall chinook survive at higher rates than tule stock produced at other hatcheries in the Columbia basin.

3. Establishing a collection facility in the North Santiam River would provide an additional source of eggs and decrease our dependence on adult returns to Bonneville Hatchery.

4. If large numbers return to Stayton, then the facilities will have to be upgraded to handle the greater number of fish.

5. Confining releases to stream reaches adjacent to the Stayton rearing ponds will minimize trucking stress and increase survival of smolts, as well as decrease the costs associated with trucking.

Actions

1.1 Continue to release smolts in Mill Creek.

1.2 Release the smolt allocation for the main stem, North, and South Santiam in the North Santiam at Stayton.

1.3 Initiate a pilot program to investigate the rate of return of adult fall chinook to a collection facility at on the North Santiam at Stayton. If feasible, apply for Restoration and Enhancement (R&E) funding for construction.

1.4 Develop operational plans for fall chinook releases and an adult collection facility at Stayton.

Objective 2. Provide an annual return of at least 4,000 adults to Mill Creek.

Assumptions and Rationale

1. The annual migration and spawning activity of fall chinook in Mill Creek has been popular with Salem residents. It provides a unique opportunity for people to watch salmon within the city limits and has increased public awareness of water quality for the stream.

Actions

2.1 Continue to release smolts in Mill Creek.

2.2 Evaluate upstream passage at the 19th Street Dam and at the state Penitentiary Annex Dam and recommend steps to improve passage on Mill Creek.

2.3 Require screening of Mill Creek diversions, including Pen Annex irrigation lateral and the 19th Street Diversion.

2.4 Implement habitat protection actions outlined under objectives for Habitat Protection.

Objective 3. Monitor the distribution and abundance of spawning populations.

Assumptions and Rationale

1. Information on straying and spawning distribution is necessary to identify areas for habitat protection in Mill Creek and to assess the potential impacts on native salmonids.

Actions

3.1 Continue spawning surveys in Mill Creek and aerial redd counts in the main stem Santiam and the North and South Santiam.

Objective 4. Minimize impacts of fall chinook salmon on native species.

Assumptions and Rationale

1. Fall chinook may compete with native species, particularly spring chinook, in main stem rearing areas.

2. Resident trout are found in some reaches currently stocked with fall chinook.

3. Establishing adult collection facilities on the North Santiam River near the smolt release site will minimize spawning in the wild, thereby reducing the potential for fall chinook impacting production of native fish species.

Actions

4.1 Initiate a pilot program to investigate the rate of return of adult fall chinook to a collection facility at on the North Santiam at Stayton.

4.2 Develop operational plans for fall chinook releases and an adult collection facility at Stayton.

4.3 Determine the distribution of juvenile spring chinook in the North Santiam and evaluate the potential impacts of fall chinook on them.

4.4 Determine the distribution of resident trout populations in the North Santiam and evaluate the potential impacts of fall chinook on them.

SOCKEYE SALMON

Background and Status

Origin

Sockeye salmon are not native to the Santiam and Calapooia subbasins. From July 1966 through September 1968, the Fish Commission of Oregon released sockeye salmon in Willamette basin reservoirs (Lukas and Korn 1968). The purpose of sockeye introductions was to determine the feasibility of producing harvestable numbers by rearing juveniles to smolt size in reservoirs. Studies indicated that Green Peter Reservoir could be used to rear fingerlings to smolt size. Releases of sockeye were made in Green Peter Reservoir in 1967 and 1968.

Life History and Population Characteristics

Adults from 1967 and 1968 releases returned in 1970 and 1971. Approximately 600 fish returned to Foster Dam and less than 200 to Green Peter Dam in 1970 and 1971 (Table 42). The average annual return to Foster Dam during 1977 to 1986 was 312 fish.

Sockeye adults returning to the subbasin were allowed to spawn naturally above Green Peter Reservoir. Natural production continued even though no further hatchery releases were made. Kokanee "smolts" may contribute to the sockeye runs. Adults returning to Foster Dam have been killed since 1984 to prevent exposure of South Santiam Hatchery fish to IHN disease.

Hatchery Production

A total of 143,000 1966-brood Columbia River sockeye, 3.3-3.7 inches long, were released in Green Peter Reservoir on the Middle Santiam in late summer 1967. In 1968, 243,000 Adams River fingerlings from British Columbia were released.

There has been no hatchery production of sockeye, except for kokanee, in the Willamette basin.

Table 42. Estimated escapement of sockeye salmon over Willamette Falls and counts at Foster and Green Peter dams, 1969-87 (Frazier 1988; D. Buchanan, ODFW, unpublished data).

Year	Willamette Falls returns[a]	Foster Dam returns[b]	Green Peter Dam returns[b]
1969	0	40	--
1970	887	636	188
1971	1,070	614	142
1972	0	7	0
1973	26	202	105
1974	21	69	33
1975	1	15	6
1976	575	528	370
1977	151	46	24
1978	16	2	1
1979	16	23	3
1980	3,194	1,835	998
1981	1,521	840	512
1982	3	10	--
1983	120	81	--
1984	663	223[c]	--
1985	70	29[c]	--
1986	69	53[c]	--
1987	69	23[c]	--
1977-86 ave	582	312	308

[a] Willamette Falls counts are sometimes less than Foster Dam counts due to misidentification of sockeye as steelhead.

[b] Three-year old jacks are included in counts.

[c] All fish were killed.

Angling and Harvest

Sport catch of sockeye salmon in Green Peter Reservoir reached a high of 823 fish in 1969, which contributed half of the total sport catch for the year (Table 43). Sockeye adults in later years may have been produced from releases of kokanee. Sockeye, which have residualized as kokanee, together with kokanee from hatchery releases, have continued to provide a sport fishery at Green Peter Reservoir.

Table 43. Sport catch of sockeye salmon from Green Peter Reservoir creel census, 1968-78 (Campbell and Locke 1968, 1969, 1970, 1971; Campbell and Daily 1972, 1973; J.J. Wetherbee, ODFW, unpublished data).

Year	No. of sockeye salmon
1968	54
1969	823
1970	5
1971	0
1972	26
1973	0
1974	0
1975	0
1976	0
1977	0
1978	0

Management Considerations

Sockeye are frequently carriers of IHN viral disease. There has been concern that sockeye returning to the Santiam system might spread the disease to other anadromous stocks, such as spring chinook, and to the South Santiam Hatchery, which takes its water from the South Santiam River. For this reason, beginning in 1984, all adult sockeye trapped at Foster Dam have been killed to terminate the run.

Policies

Policy 1. No further releases of sockeye salmon shall be made in the Santiam subbasin.

TROUT AND WHITEFISH

Background and Status

RAINBOW TROUT

Origin

Rainbow trout are indigenous to the Santiam and Calapooia subbasins. Indigenous populations have been supplemented with hatchery fish in order to meet previous management objectives. Rainbow trout found in the wild may be descendants of local stock, hatchery rainbow trout, or steelhead.

Willamette basin rainbow trout are currently listed by ODFW as a stock of concern due to insufficient information regarding their status. Rainbow trout should be given a high priority with respect to future population and habitat inventory and monitoring activities in the Willamette basin.

Life History and Population Characteristics

Distribution

In the North Santiam above Detroit Dam, rainbow trout occur in the Blowout Creek and Breitenbush River watersheds, Boulder and Marion creeks, and the North Santiam River. Below Detroit Dam, they occur in the Little North Fork including Henline, Cedar, and Gold creeks, Rock Creek and East Fork Rock Creek,and Sardine Creek. Populations in Cedar and Rock creeks are isolated above the falls at RM 2 and 5, respectively. Rainbow trout also occur in the main stem North Santiam below Detroit Dam.

Rainbow trout occur in the South Santiam above Foster Dam in Wolf, Owl, Falls, and Sevenmile creeks. The Wolf Creek population is isolated above the falls at the mouth of the creek. Isolated rainbow trout populations are found in the South Santiam River above the falls at RM 63, however these trout may be descendants of catchable rainbow which were stocked in the past. In the Middle Santiam, they are found in Coal, Bear, and Pyramid creeks. Below Foster Dam, the main stem South Santiam, Neal and Crabtree creeks and Roaring River contain rainbow trout. Isolated populations occur in Neal Creek above the falls at RM 5 and in Crabtree Creek above the falls at RM 34.5. Rainbow trout in Crabtree Creek may be drop-outs from fingerlings stocked in Crabtree Lake. Few resident rainbow occur in the main stem Santiam River.

Rainbow trout occur in the Calapooia River from about RM 45 upstream. Some or all of these trout may be residual winter steelhead.

Both cutthroat and rainbow trout are often present in a watershed. Where they both occur, rainbow are usually found in the warmer, larger main stem and lower tributaries. In the Blowout Creek watershed, rainbow trout are usually not found above minor barriers, indicating they have probably moved up from the main stem or Detroit Reservoir.

Abundance

Occasional population estimates of rainbow trout have been made in the Santiam subbasin during the past 10-15 years. Population estimates of trout were made in Blowout Creek and Quartzville Creek in 1982 (Appendix Tables E-1 and E-2) and in the Middle Santiam in 1979 and 1988-89 (Appendix Tables E-3 and E-4). The limited information available is not adequate for establishing trends in population abundance.

No estimates of population abundance have been made in the Calapooia subbasin.

Adult Age Structure and Size

Age I rainbow in Blowout Creek drainage averaged 4.6 inches in length, age II averaged 6.1 inches, age III averaged 7.3 inches, and age IV averaged 7.2 inches (Appendix Table E-5) (Hunt 1982 and Wetherbee and Hunt 1982). Legal sized fish were mostly age 2. The smallest mature rainbow trout was 4.4 inches long. Rainbow spawn at age 2 or 3.

Time of Spawning and Fecundity

Native rainbow trout spawn in the spring. In Blowout Creek, rainbow spawning extends into May.

Fish are spawned at Roaring River Fish Hatchery from early December through mid-January. Three year old hatchery fish have a fecundity of 7,000-7,500 eggs per female. Four and five year old fish have a fecundity of 9,000-10,000 eggs per female.

Early Juvenile Life History

Eggs begin hatching in early February at Roaring River Hatchery. Hatched eggs are placed in rearing troughs at a size of 4,000/lb. They are reared indoors until they reach a size of about 1,000/lb. In late March or early April they are transferred to concrete rearing ponds outdoors. Shipments of fry and fingerlings to other hatcheries occur in mid-June at a size of 200-300/lb and in late August at a size of 60/lb. Growth is controlled with feeding regimes during the winter and early spring. The largest fish are selected for brood stock and early releases beginning in March.

Yearling trout are raised to a size of 8-10 inches in a year, a size that requires 2-3 years in the wild. One year old catchable trout are released at a size of about 3 fish/lb beginning in March.

Hatchery Production

Description of Hatcheries

Hatchery rainbow trout released in the Santiam and Calapooia subbasins are raised at Leaburg, Roaring River, Willamette, and Wizard Falls fish hatcheries. Descriptions of Leaburg and Willamette hatcheries are found in the McKenzie and Middle Fork Willamette subbasin plans. Wizard Falls Fish Hatchery is outside of the Willamette subbasin. Rearing of rainbow trout at Roaring River Fish Hatchery is described below.

Roaring River Fish Hatchery is operated by ODFW with funding from Oregon state general funds and the Oregon Wildlife Fund. The hatchery has been in operation since 1924. It is located 11 miles southeast of Scio off State Highway 226 near the mouth of Roaring River (RM 1.5), a tributary of Crabtree Creek. The hatchery receives water from Roaring River for its hatchery ponds. Ground water is used to incubate eggs.

Rearing Goals and Practices

Roaring River Fish Hatchery is primarily used to rear winter and summer steelhead, fall rainbow, and to produce rainbow eggs. About one million rainbow are reared annually, of which 230,000 are raised to catchable size (3 fish/lb). Two thousand selected rainbow brood are kept on hand. These brood produce 5 to 7 million eggs annually. Most of these eggs are transferred to other ODFW hatcheries for hatching and rearing.

Until the early 1970s, only Roaring River stock was reared at the hatchery. In January 1967, Cape Cod rainbow eggs were transported from Washington to Roaring River Fish Hatchery. A brood stock was established in 1971 (Kinunen and Moring 1976). Both Roaring River and Cape Cod rainbow were reared from 1971-80. The hatchery switched over entirely to Cape Cod stock during the 1980-81 brood year. Presently, only Cape Cod stock is used at the hatchery. Brood stock is selected from fish rearing at Roaring River Hatchery.

Moring and Buchanan (1978) investigated downstream movement and angler catch of Roaring River and Cape Cod strains of hatchery rainbow yearlings. The Roaring River strain showed a tendency for rapid downstream movement while the Cape Cod strain tended to remain in the planted area longer and were harvested in greater numbers. Based on these results, the Cape Cod strain is considered to be more desirable than Roaring River stock for a catchable trout program. However, later experiments at Green Peter Reservoir found that the Cape Cod strain exhibited more movement than the Roaring River strain.

Fish which attempt to swim out of rearing ponds are culled from the brood stock in an effort to select for fish which do not demonstrate any migratory behavior. The results of this effort are inconclusive.

Hatchery Releases

Releases of hatchery rainbow trout are made in the Santiam and Calapooia subbasins to supplement or provide a sport fishery. Catchable rainbow are stocked in areas where public access is good, recreational use is high, and natural production alone does not provide for a fishery. Fingerlings have been released in the North Santiam River above Detroit Reservoir to make use of available rearing area.

Stocking hatchery fish in areas where natural production of trout exists can either increase or reduce harvest of naturally produced stocks. Hatchery trout are released in the Santiam and Calapooia subbasins in reaches where impact on natural production of trout and steelhead is believed to be minimal. Releases which had been made higher up in the subbasins have been moved to lower reaches to avoid negative impacts on native trout and steelhead.

Streams in the Santiam and Calapooia subbasins have been stocked with hatchery rainbow since the 1920s. Stocking levels during 1979-90 have averaged 131,276 catchable rainbow in the Santiam subbasin, 5,919 in the Calapooia subbasin, and 460 in Mill Creek (Table 44). Current release goals are 130,000 catchable rainbow trout in the Santiam subbasin, 6,000 in the Calapooia, and 500 in Mill Creek. Rainbow trout are released from April through July.

Releases of yearling rainbow trout in the Santiam subbasin are now made in the North Santiam, Breitenbush, Little North Santiam, and South Santiam rivers, and Quartzville, Thomas and Crabtree creeks (Table 45). In the Calapooia River releases are confined to the reach between RM 33 and RM 56 to minimize competition with native winter steelhead and to minimize harvest of juvenile winter steelhead. Since 1988, smaller releases have been made more frequently at sites in an attempt to maximize the proportion of hatchery fish harvested (Table 46).

Table 44. Summary of hatchery releases of catchable rainbow trout in the Santiam and Calapooia subbasins and Mill Creek, 1955-72 and 1979-89 (Oregon State Game Commission 1956-1973 and ODFW, unpublished data).

Release Year	Santiam	Calapooia	Mill Creek
1955	116,516	1,929	1,535
1956	85,540	6,021	1,003
1957	125,566	8,056	5,754
1958	144,041	11,997	1,998
1959	140,991	9,479	5,514
1960	128,121	10,011	1,508
1961	133,750	12,007	1,506
1962	127,477	12,008	1,501
1963	122,503	12,052	1,562
1964	128,964	12,034	1,508
1965	96,254	11,999	1,360
1966	243,930	10,000	1,500
1967	144,007	9,999	2,751
1968	126,965	11,001	1,512
1969	148,740	6,750	1,504
1970	144,429	8,095	1,470
1971	159,223	8,004	1,003
1972	147,029	8,006	1,000
1973-1978		data not available	
1979	117,925	6,000	501
1980	133,502	6,002	500
1981	139,534	6,002	510
1982	139,590	6,038	504
1983	139,677	5,998	498
1984	134,887	6,021	499
1985	132,480	7,997	501
1986	126,257	5,980	509
1987	133,107	5,999	499
1988	127,659	3,000	501
1989	122,446	6,000	499
1990	128,253	5,990	0

Table 45. Locations of current releases of hatchery rainbow trout in the Santiam and Calapooia subbasins.

Stream	Location of release sites	No. of release sites
Mill Cr.	RM 5	1
North Santiam R.	RM 28-35	10
	RM 58.5-77	10
Breitenbush R.	RM 3-14.5	5
Little No. Santiam	RM 0-20	8
South Santiam R.	RM 40-64	10
Quartzville Cr.	RM 6-18	9
Crabtree Cr.	RM 17.5-20	2
Roaring R.	RM 0.5	2-3
Thomas Cr.	RM 9	1
	RM 27-31.5	2
Calapooia R.	RM 33-56	9

Table 46. Catchable rainbow stocking analysis in large streams of the Santiam subbasin, 1987-90[a] (ODFW, unpublished data).

Year	Dates stocked	No. times stocked	Total fish stocked	Fish/ trip	No. sites	Fish/ site
South Santiam R.						
1987	5/22-7/17	5	24,438	5,000	9-10	500
1988	5/13-7/07	6	19,002	3,200	10	320
1989	5/12-7/10	7	22,506	3,200	10	320
1990	5/07-7/20	7	22,000	3,000	10	300
Quartzville Cr.						
1987	5/15-7/10	3	11,998	4,000	7-9	500
1988	5/13-7/07	5	10,008	2,000	8-9	250
1989	5/12-7/03	5	10,019	2,000	9	222
1990	5/07-7/13	6	12,000	2,000	9	222
Breitenbush R.						
1987	5/22-7/22	7	21,004	3,000	3-5	600-1,000
1988	5/26-8/05	9	18,009	2,000	4-5	400
1989	5/26-8/01	10	20,011	2,000	4-5	400
1990	5/21-8/03	9	18,000	2,000	5	400
Little North Fork Santiam R.						
1987	5/29-7/01	4	14,502	3,500	6-7	500+
1988	5/26-7/08	6	12,006	2,000	7	285
1989	5/26-7/11	7	14,010	2,000	6-7	285
1990	5/21-7/20	7	14,000	2,000	7	285
North Santiam R.						
1987	5/22-7/24	8	38,975	5,000	10	500
1988	5/27-8/04	10	34,987	3,500	9-10	350
1989	5/24-7/31	10	35,016	3,500	8-10	437
1990	5/21-8/3	10	34,500	3,500	8	437

[a] 1987 stocking patterns are representative of previous years.

STEP releases of rainbow fry were made in Thomas Creek in 1984 and 1985 to evaluate rearing of rainbow in lower Thomas Creek. About 24,500 fry were released in 1984 and 19,861 in 1985. Currently, there are no plans for STEP releases of rainbow fry in the Santiam and Calapooia subbasins.

Angling and Harvest

Average catch rates for naturally produced and hatchery rainbow trout during 1965-72 in various tributaries in the subbasins are presented in Table 47 (Kinunen 1975). Catch rates were highest in the Little North Santiam (1.92 Rb/angler and 0.91 Rb/hr) and lowest in Crabtree Creek (0.87 Rb/angler and 0.42 Rb/hr).

Table 47. Rainbow trout stocking and angler success for naturally produced and hatchery reared rainbow trout in the Santiam and Calapooia subbasins (modified from Kinunen 1975).

Stream	Ave. no. stocked 1964-1973	Catch rate[a] 1965-1972 Rb/angler	Rb/hr	Approx. date of first release	Ave. no. of times stocked annually
Mill Cr.	1,660			4/25	1
Little No. Santiam	19,050	1.92	0.91	5/10	4
No. Santiam, Sec. I	15,981	1.72	0.84	5/20	3
No. Santiam, Sec. II	37,341			5/20	9
Quartzville Cr.	19,244	1.70	0.92	5/15	3
So. Santiam	22,456	1.20	0.61	4/25	4
Thomas Cr.	1,482			4/25	1
Crabtree Cr.	4,724	0.87	0.42	4/25	2
Calapooia R.	9,389	0.93	0.40	4/25	3

[a] Catch rate based on a minimum of 2 years of data and 100 anglers.

Creel surveys were conducted on the main stem Santiam, North, and South Santiam rivers during 1978 and 1979 to determine the sport catch of steelhead adults and smolts (Buchanan and Wade 1978, Buchanan et al. 1979). Sport catch of naturally produced and hatchery rainbow trout are presented in Tables 48 and 49.

Table 48. Comparison of sport catch on the main stem Santiam and North Santiam rivers and on the South Santiam during March 4-September 30, 1978 (Buchanan and Wade 1978).

Species	Santiam & No. Santiam[a]	So. Santiam[b]
Hatchery Rb trout	8,902	19
Naturally produced Rb trout	1,281	703
Cutthroat trout	344	99

[a] Reaches sampled were from Minto Dam to Mehama (15.5 miles) and from Stayton to the I-5 bridges (27 miles).

[b] Reaches sampled were from Foster Dam to McDowell Creek (10 miles) and from Waterloo to Sanderson's bridge (16 miles).

Table 49. Estimated angling effort and sport catch of trout in the main stem Santiam and North Santiam rivers, from Stayton island to the I-5 bridges, March 4-September 30, 1978 and 1979 (Buchanan et al. 1979).

	1978	1979
Anglers	7,629	5,998
Angler hours	20,340	14,930
Species caught		
Hatchery rainbow trout	0	0
Naturally produced rainbow trout	59	39
Cutthroat trout	30	57

Angler effort and estimated sport catch of rainbow in the South Santiam during part of the open seasons 1975-79 are presented in Table 50. Although angler effort in 1979 was half that of 1978, estimated catch of hatchery rainbow increased and catch of naturally produced rainbow was 70% of the 1978 catch.

Table 50. Estimated angling effort and sport catch of trout in the South Santiam River from the trout season opening through July 4 1975 and 1976, and March 4-September 30 1978 and 1979 (Buchanan and Wade 1978, Buchanan et al. 1979).

	1975[a]	1976[a]	1978[b]	1979[b]
Anglers	---	---	19,489	10,053
Boat angler hours	820	602	---	---
Shore angler hours	6,003	3,006	---	---
Total angler hours	6,823	3,608	51,610	26,807
Species caught				
Hatchery Rb	113	123	15	29
Naturally produced Rb	4	8	372	263
Cutthroat	5	2	15	8

[a] Reach surveyed extended from Foster Dam to Sweet Home boat ramp (4 miles).

[b] Reach surveyed extended from Foster Dam to McDowell Creek (10 miles).

Results of a 1975-76 study suggested that reducing the number of catchable rainbow trout stocked in the South Santiam and Quartzville Creek had no significant effect on the proportion of the fish caught. Reduction in stocking level reduced angler pressure which in turn slightly reduced catch rates (Table 51).

Public access to the Calapooia is restricted primarily to road crossings below RM 33. There is limited angling pressure on tributary streams in the subbasin. An opening-day 1980 count of 108 cars was made on the Calapooia, which was interpreted as adequate fishing pressure (J.J. Wetherbee, ODFW, unpublished data). The harvest of hatchery legal rainbow released in the Calapooia is unknown.

Few creel studies have been done in recent years for sport harvest of rainbow trout in the Santiam subbasin and none have been conducted in the Calapooia subbasin. The information available is not adequate for indicating trends in angling pressure and harvest of naturally produced and hatchery rainbow trout.

Table 51. Plants of catchable rainbow trout, catch rates, and hatchery composition of the catch in Quartzville Creek and in the South Santiam 1975-76 (modified from Moring 1979).

	Stream	
	Quartzville Cr.	So. Santiam R.
No. stocked		
1975	12,995	18,504
1976	9,806	13,804
Percent harvested		
1975	82.5%	82.5%
1976	82.6%	81.8%
Catch per angler		
1975	1.09	0.85
1976	1.07	0.74
Catch per hour		
1975	1.04	1.02
1976	0.77	0.86
Hatchery composition of catch		
1975	92.8%	95.4%
1976	89.3%	87.0%

Daily catch limit for trout is 5 fish. There is no winter season. Canyon and Moose creeks in the South Santiam system are closed to trout angling to protect native winter steelhead. Major streams in the subbasin have a late opening to protect winter steelhead smolts.

Management Considerations

Warm water temperatures in portions of the South Santiam system and competition with steelhead limit production of rainbow trout.

Rainbow trout spawn in the spring when hatchery steelhead smolts are released. Some hatchery steelhead smolts are precocious and may spawn with native trout. The proportion of hatchery releases that are precocious and that contribute to natural production requires monitoring and evaluation. Changes in steelhead hatchery programs may be required in order to meet Wild Fish Management Policy guidelines for trout.

Information needs for improved management of the catchable rainbow program include survival of catchable rainbow after release and the dispersal of catchable trout from stocking sites. The response of angler pressure to varying stocking frequencies needs to be investigated. Angling pressure and catch rates for catchable trout are needed. Measurements of angler pressure and harvest rates of trout at catchable release sites and in unstocked reaches of the same streams are needed.

Willamette basin rainbow trout are currently listed by ODFW as a stock of concern due to insufficient information regarding their status. Rainbow trout should be given a high priority with respect to future population and habitat inventory and monitoring activities in the Willamette basin.

CUTTHROAT TROUT

Origin

Willamette cutthroat trout are classified as the same subspecies as the sea-run coastal variety (Moring 1978). However, anadromous stocks do not occur above Willamette Falls. Instead, cutthroat often migrate shorter distances within streams and rivers, utilizing larger rivers of the Willamette system for accelerated growth (Moring 1978). There are non-migratory populations above Willamette Falls, as well.

Willamette basin cutthroat trout are currently listed by ODFW as a stock of concern due to insufficient information regarding their status. Cutthroat trout should be given a high priority with respect to future population and habitat inventory and monitoring activities in the Willamette basin.

Life History and Population Characteristics

Distribution

Cutthroat trout are found together with rainbow trout in many streams draining the Cascades (Nicholas 1978). An overlapping distribution of rainbow (some of which may have been juvenile winter steelhead) and cutthroat trout has been observed in the Santiam, North Santiam, and South Santiam rivers and in Packer's Gulch, Fish Creek (Little North Santiam), Lewis Creek (South Santiam), Indian Prairie Creek (Thomas Creek), and Cork Boot Creek (E. Brush Creek, Calapooia) (Moring and Youker 1979). Cutthroat are more abundant in headwater and tributary streams than rainbow trout.

Isolated populations of cutthroat trout occur above natural barriers in the North Santiam such as in Opal Creek and Battle Ax Creek in the Little North Santiam system and in Rock Creek above the falls at RM 5. In the South Santiam system above Foster Reservoir, isolated populations occur in the South Santiam River above RM 63, in Soda Fork above the falls at RM 5, in Moose Creek above the falls at RM 5.5, and in Canyon Creek above the falls at RM 10. Isolated populations occur in the Middle Santiam headwaters above RM 31. Below Foster Reservoir, isolated populations of cutthroat occur in McDowell Creek above the falls at RM 5, in Hamilton Creek above the falls at RM 12, in Crabtree Creek above the falls at RM 34.5, in Neal Creek above the falls at RM 5, and in Thomas Creek above the falls at RM 32.

In the Calapooia, isolated populations of cutthroat trout occur above the falls at RM 73 and in the North Fork Calapooia above the falls on the west fork at RM 0.8.

Time of Entry into Subbasin

Migratory cutthroat enter smaller tributaries to spawn in the winter.

Abundance

Population surveys of salmonids in selected Willamette tributaries during the 1970s estimated Big Creek (Little North Santiam drainage) had approximately 262 cutthroat trout per mile while tributaries of the Middle Santiam system had 53-317 cutthroat per mile (Appendix Table E-6). The Blowout Creek system had an average of 1,364 cutthroat trout per mile in a 1980 survey (Appendix Table E-7).

Other estimates of cutthroat trout abundance have been made in Quartzville Creek (Appendix Table E-8), the main stem Santiam River (Appendix Table E-9), Minto Creek (Appendix Table E-10), and Calapooia River tributaries (Appendix Table E-11).

The limited information available for cutthroat trout in the Santiam and Calapooia subbasins is not sufficient to establish trends in population abundance.

Average Adult Age Structure

The age structure of cutthroat in North Santiam tributary streams was 80% age 1 and 20% age 2 (Appendix Table E-12). Cutthroat trout in South Santiam and Calapooia streams were primarily age 2 (41-51 %) and age 1 (32-40 %). Cutthroat trout sampled from large rivers in the Santiam subbasin were mostly age 2 (59.2%) and age 3 (25.8%) (Appendix Table E-13). Larger rivers tended to have a greater percentage of older fish than small streams.

Average Adult Size

Legal sized cutthroat are usually age 1+ in large rivers and 2 in small tributaries due to the greater productivity of large rivers (Moring 1978). In a wild trout inventory of Blowout Creek (Wetherbee and Hunt 1982), the smallest mature female cutthroat was 4.7 inches in length. Age 1 cutthroat in Blowout Creek averaged 4.3 inches, age 2 fish 5.7 inches, age 3 fish 7.0 inches, and age 4 fish 8.1 inches (Appendix Table E-14) (Hunt 1982).

An average of 23-26% of the cutthroat sampled from Minto Creek during 1985-90 were 4.0-5.5 inches long. An average of 23-30% of the fish were 2.4-3.9 inches, 18-21% were 5.6-12.0 inches, and 13-20% were less than 2.4 inches in length (Appendix Table E-15).

Length frequency data of cutthroat trout sampled in Elk Creek in 1982 (Figure 4) indicate a distinct group of fish about 1.2-2.8 inches in length and a second group of fish ranging from 3.5-7.5 inches in length.

Cutthroat trout sampled from the main stem Santiam River had a size range of 5.1-6.3 inches for age 1 fish, 4.7-10.6 inches for age 2 fish, 5.5-12.2 inches for age 3 fish, and 6.3-15.0 inches for age 4 fish (Appendix Table E-16). The average growth rate for cutthroat in the Santiam River was 0.25 inch/month (Moring 1978).

Size range of cutthroat trout electrofished in the Calapooia subbasin was 1.4-7.8 inches (Appendix Table E-11). A ripe cutthroat sampled from Fish Creek was 2 years old and 3.9 inches in length. A ripe cutthroat taken from Hands Creek in the Calapooia subbasin was 6.5 inches long (Moring and Youker

1979).

Age specific length data of cutthroat trout in the Santiam and Calapooia subbasins is summarized in Appendix Table E-17 (Moring and Youker 1979).

Time of Spawning

Cutthroat spawn earlier than rainbow trout, usually during the winter months. In the Willamette basin, cutthroat generally spawn between January and July, later for higher elevations (Nicholas 1978).

Movement and Migration

Movements of cutthroat within Willamette tributaries and migration to and from the main stem Willamette have been observed (Moring et al. undated, Moring 1977). Moring et al. (undated) found that extensive movement occurs primarily in large rivers. Potamodromous cutthroat are residents of larger rivers moving to small tributaries for spawning and immature fish moving from tributaries to forage areas in large rivers.

Adults generally migrate to small tributaries in fall and winter, spawn in late winter or early spring, and then migrate back to larger rivers soon afterward. Cutthroat have been observed to home to small tributaries in two successive years (Nicholas 1978). The degree of straying is unknown. Not all upstream migrants are mature fish on a spawning run (Nicholas 1978).

Movement of cutthroat between the main stem Santiam and North Santiam rivers and within the North Santiam River was studied during 1976-79 (Moring and Youker 1979). The majority of fish tagged were recaptured near the original point of capture, or within 4 miles of that location (Table 52) suggesting that these populations were non-migratory or displayed little migratory behavior.

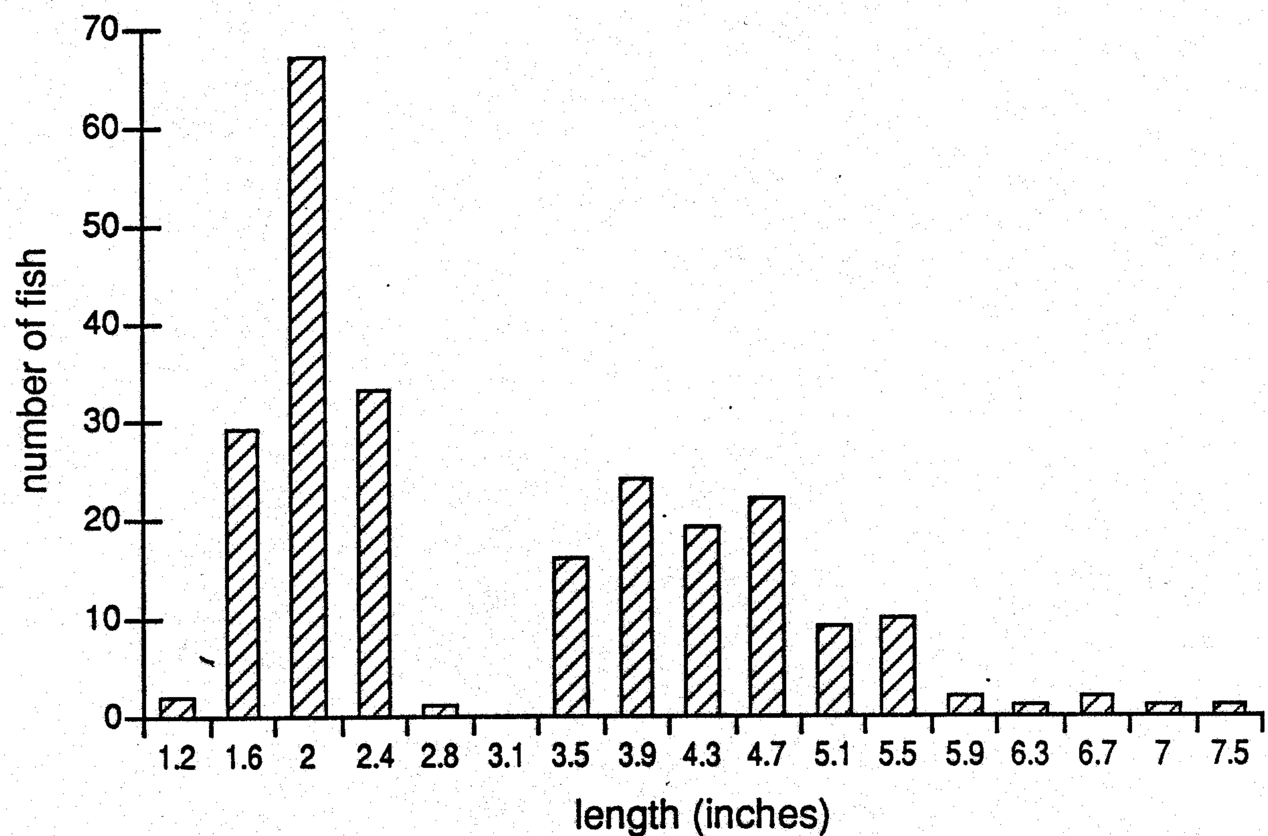


Figure 4. Length frequency of cutthroat trout collected in Elk Creek, RM 2.2 and 2.6, 28 September 1982 (n=240) (unpublished data, J.J. Wetherbee, ODFW).

Table 52. Recaptures of tagged cutthroat trout in the Santiam subbasin, 1976-79 (Moring and Youker 1979).

Stream	No. tags	No. tags recaptured	No. fish >4 miles from capture site	Distance traveled (miles)
Santiam R.	253	36	1	6
No. Santiam R.	21	2	1	4
So. Santiam R.	31	1	0	-
Soda Fork	12	2	0	-

Hatchery Production

There is no hatchery production of cutthroat trout in the Santiam and Calapooia subbasins. No hatchery releases of cutthroat have been made in running waters in the Santiam and Calapooia subbasins.

Angling and Harvest

A comparison of sport catch of trout in the Santiam subbasin during 1978 shows fewer cutthroat were harvested than rainbow (Buchanan and Wade 1978) (Table 48). A total of 344 cutthroat were harvested in the main stem Santiam and North Santiam and 99 cutthroat in the South Santiam. Angling effort and sport catch of cutthroat for the reach from Stayton to the I-5 bridges is shown in Table 49 (Buchanan et al. 1979). Only 30 cutthroat were harvested in this 27 mile reach in 1978 and 57 cutthroat in 1979. Most of the reported sport catch of cutthroat came from the 15.5 mile reach between Minto Dam and Mehama. Creel studies in the South Santiam during part of the open seasons in 1975-79 indicate that few cutthroat were caught between Foster Dam and McDowell Creek (Buchanan and Wade 1978, Buchanan et al. 1979) (Table 50).

Daily catch limit for trout is 5 fish. There is no winter season. Canyon and Moose creeks in the South Santiam system are closed to trout angling to protect native winter steelhead. Major streams in the subbasin have a late opening to protect winter steelhead smolts. The main stem Santiam and the North Santiam below Stayton have a catch and release regulation for cutthroat trout.

Management Considerations

Land use practices such as timber harvesting and road construction have impacted smaller tributaries used by cutthroat. Dams have limited potential migratory movements of cutthroat within the subbasins. Channelization of lower elevation streams and rivers has reduced spawning and rearing habitat for cutthroat trout.

Introductions of anadromous fish in reaches used by cutthroat trout can negatively impact cutthroat production through competition. Nicholas (1978) reports circumstantial evidence of a negative impact from coho salmon and steelhead trout. Cutthroat populations are more abundant in some stream areas above falls which exclude these species. Cutthroat trout production has been found to be lower when coho are present in the same stream reach (Nicholas 1978).

Willamette basin cutthroat trout are currently listed by ODFW as a stock of concern due to insufficient information regarding their status. Cutthroat trout should be given a high priority with respect to future population and habitat inventory and monitoring activities in the Willamette basin.

BROOK TROUT

Origin

Brook trout are not native to the Santiam and Calapooia subbasins. They have been successfully introduced into high lakes in the Santiam subbasin and have become established in a few headwater streams.

Life History and Population Characteristics

Distribution

Brook trout populations occur in Opal Creek in the Little North Santiam drainage, in the North Fork Breitenbush River, and in the Big Meadows area in the headwaters of the North Santiam. Brook trout occur in Holman Creek in the Middle Santiam drainage and in Black Creek and Soda Fork in the South Santiam. Populations in Opal Creek and in the Middle and South Santiam may not be self-sustaining, but consist of drop-outs from high lakes.

Abundance

No population estimates of brook trout in running waters have been made in the Santiam and Calapooia subbasins.

In a wild trout inventory of the Santiam and Calapooia subbasins, brook trout were found in the South Santiam River above Foster Dam and in the North Santiam above Detroit Dam (Table 53) (Ely 1981).

Table 53. Abundance of brook trout sampled during a wild trout inventory in the Santiam and Calapooia subbasins (Ely 1981).

	Length (inches)								
Site	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0
So. Santiam R. above Foster					1				1
No. Santiam R. above Detroit	1	3	1	2					

Size

Brook trout found in the South Santiam River were 6.0 and 8.0 inches in length (Table 53). Brook trout found in the North Santiam River were 4.0-5.5 inches in length.

Time of Spawning

Brook trout spawn in the fall.

Hatchery Production

There is no hatchery production of brook trout in the Santiam and Calapooia subbasins. No releases of hatchery brook trout are made in rivers or streams in the Santiam and Calapooia subbasins.

Angling and Harvest

There is no information concerning harvest of brook trout in the Santiam and Calapooia subbasins. Daily catch limit for trout is 5 fish. There is no winter season.

Management Considerations

Brook trout require streams with gentle gradients and good water quality. The factors which appear to limit brook trout to headwater areas are not understood.

BULL TROUT

Bull trout are currently listed as a species of concern in the Willamette Valley. Bull trout populations in the Willamette valley were never known to be large. Habitat alterations, especially impassible dams and culverts, have adversely impacted bull trout. Historically, bull trout were present in upper portions of the Santiam subbasin (Willamette National Forest 1989). They were last observed in the North Santiam in 1945 and in the South Santiam in 1953. Currently, bull trout are not believed to occur in either the Santiam or Calapooia subbasins. There may be opportunities for reestablishment of the species in the Santiam subbasin in the future.

WHITEFISH

Origin

Whitefish are a member of the trout and salmon family Salmonidae and are native to larger streams in the Willamette basin.

Life History and Population Characteristics

The distribution of whitefish is similar to that of trout. In the Santiam subbasin, whitefish occur in the main stem Santiam River, the North Santiam River, the Little North Fork Santiam, the South Santiam, and Thomas Creek. Whitefish occur in the Calapooia River above Holley (RM 45) (J.J. Wetherbee, ODFW, unpublished data).

Mountain whitefish mature at 3 to 4 years of age and spawn in the fall and early winter (Daily 1971). Length at maturity in most waters is less than 12 inches (ODFW 1987a). A few whitefish caught by anglers in the North Santiam River during the early 1980s were 10-18 inches in length (J.J. Wetherbee, ODFW, unpublished data).

Mountain whitefish have habitat preferences and a diet similar to trout.

Hatchery Production

There is no hatchery production of whitefish.

Angling and Harvest

There is limited information concerning harvest of whitefish in the Santiam subbasin and no information for the Calapooia subbasin (J.J. Wetherbee, ODFW, unpublished data). Records show a few whitefish harvested from the North Santiam River during 1980, 1982, and 1984.

Although whitefish can be caught on natural bait and flies, they are seldom sought by anglers. Whitefish have a potential for increased sport use.

Whitefish may be taken from any water open to salmon, steelhead or trout angling. There is no bag limit.

Management Considerations

Whitefish are underutilized in the sport fishery. It is thought that populations in the Santiam and Calapooia subbasins can support a fishery and provide additional angling diversity.

Policies

Policy 1. Releases of hatchery rainbow trout in the Santiam and Calapooia subbasins shall be confined to the following streams and reaches:

Mill Creek
RM 0-14.5 of the Breitenbush River
RM 0-20 of the Little North Santiam River
RM 28-38 and 58.5-77 of the North Santiam River
RM 40-64 of the South Santiam River
Quartzville Creek
Crabtree Creek
Thomas Creek
RM 0-56 of the Calapooia River

Objectives

Objective 1. Maintain the genetic diversity and adaptiveness of trout and whitefish populations.

Assumptions and Rationale

1. Willamette basin rainbow and cutthroat trout have been identified as stocks of concern. This objective addresses some of the problems with these stocks.

2. Monitoring the distribution and abundance of populations of trout will provide an indication of their health and adaptiveness.

3. Releases of precocious hatchery steelhead smolts near areas where spawning of trout occurs may decrease the genetic fitness of native trout populations.

Actions

1.1 Establish population trends in trout distribution and abundance in selected index streams to be sampled on an annual basis. Possible index streams are Divide Creek above Detroit Reservoir, the upper North Santiam River above Parish Lake Road, RM 35-46 of the North Santiam River, RM 0-27 of the North Santiam River including Marion Creek, Sheep Creek in the upper South Santiam system, and the Calapooia River above the North Fork log jam.

1.2 Verify and document the distribution and upper limits of cutthroat trout in streams.

1.3 Assess the status of cutthroat trout populations of concern in the main stem Santiam and North Santiam below Stayton through electrofishing surveys and scale analysis.

1.4 Assess the migratory patterns of cutthroat trout by conducting a tagging study in the main stem Santiam and the North Santiam below Stayton.

1.5 Minimize the proportion of hatchery steelhead smolts that are precocious and their impact on spawning trout populations. This may be accomplished by removal of precocious fish during marking of hatchery steelhead.

1.6 If necessary modify hatchery steelhead programs to minimize their effects on trout populations and to be in compliance with Wild Fish Management Policy guidelines.

Objective 2. Protect, restore, and enhance trout and whitefish habitat.

Assumptions and Rationale

1. Protection and enhancement of trout and whitefish populations can be achieved principally through habitat protection and improvement.

Actions

2.1 Recommend to the Department of Forestry that they change their policy to provide full riparian protection to all streams containing resident trout populations.

2.2 Identify additional sites for habitat improvement.

2.3 Develop habitat improvement plans.

2.4 Work with volunteers, sporting clubs, landowners and agencies to implement habitat improvement projects in the upper North Santiam River, Blowout Creek, and Marion Creek to create additional pools.

2.5 Implement habitat protection actions outlined under objectives for Habitat Protection.

Objective 3. Provide angling opportunities for trout and whitefish under the Wild Fish management alternative for trout in the following streams and reaches:

North and South forks of the Breitenbush River
Humbug and French creeks in the Breitenbush system
Blowout Creek
RM 0-28 and 35-46 of the North Santiam River
Santiam River
RM 56-73 of the Calapooia River

Assumptions and Rationale

1. The Trout Plan (ODFW 1987a) sets management options for trout, one of which is Wild Fish.

2. Management under this alternative seeks to provide a diversity of angling opportunities including nonconsumptive as well as consumptive use of trout.

3. Special regulations may be necessary to protect stock fitness and life history characteristics and to maintain healthy trout populations with multiple age classes or to provide watchable wildlife only opportunities.

4. Whitefish population levels are adequate to support an increased sport fishery.

5. Many people are not aware of the excellent sporting and eating qualities of whitefish.

Actions

3.1 Evaluate angling pressure and harvest rates on trout through creel studies on key streams such as the North Santiam River below Detroit Dam and the main stem Santiam to determine consumptive use and impacts on native populations.

3.2 Determine the need for additional or modified angling regulations to protect populations of native trout by monitoring the production, harvest, and catch rate of trout.

3.3 Continue to use angling regulations to protect or conserve native trout.

3.4 Publicize information on distinguishing characteristics of whitefish and angling opportunities.

Objective 4. Provide additional angler opportunity and recreation by stocking legal-sized hatchery rainbow trout in the following streams and reaches:

Mill Creek
Breitenbush River
Little North Santiam River
RM 28-38 and 58.5-77 of the North Santiam River
South Santiam River
Quartzville Creek
Crabtree Creek including Roaring River Creek
Thomas Creek
RM 33-56 of the Calapooia River

Assumptions and Rationale

1. The consumptive demand for trout is greater than natural production can provide in accessible streams favored by anglers and close to population centers.

2. Additional angling opportunities can be provided through the release of hatchery rainbow where native trout populations are not sufficient to support a fishery.

3. Over time, releases of catchable rainbow may be moved from running waters to standing waters in the subbasin.

4. The current level of hatchery releases provide harvest rates and returns to the angler which satisfy angler demand.

5. Harvest rate of catchable rainbow is at least 40% of the number released.

Actions

4.1 Continue to release a maximum of 500 catchable rainbow in Mill Creek at RM 5.

4.2 Continue to release a maximum of 130,000 catchable rainbow in the Santiam subbasin at release sites in the following reaches: RM 28-38 and RM 58.5-77 in the North Santiam River, RM 3-14.5 of the Breitenbush River, RM 0-20 of the Little North Santiam, RM 40-64 of the South Santiam River, RM 6-18 of Quartzville Creek, RM 17.5-20 of Crabtree Creek, RM 0.5 of Roaring River, and RM 9 and RM 27-31.5 of Thomas Creek.

4.3 Continue to release a maximum of 6,000 catchable rainbow in the Calapooia River at release sites located in RM 33-56.

4.4 Evaluate current angling pressure and harvest rates through creel studies on key streams such as the Breitenbush, North Santiam, Little North Santiam, South Santiam, and Calapooia rivers and Quartzville Creek. Modify stocking practices to better meet angler demand where necessary.

4.5 If harvest rates fall below 40% then modify stocking practices such as release timing, frequency, and sites to improve harvest rate.

Objective 5. **Provide angling opportunities for trout and whitefish under the basic yield management alternative for trout in those reaches not stocked in the Santiam and Calapooia subbasins.**

Assumptions and Rationale

1. The Trout Plan (ODFW 1987a) sets management options for trout, one of which is Basic Yield.

2. These waters are managed to use their natural productivity to grow trout and whitefish to a harvestable size. Most of the trout available to the angler are either from natural production or from drift of catchable rainbow from hatchery releases made upstream.

3. The fisheries on these waters are of a general, consumptive nature.

4. Other species may be present and may have fishery values equal to or greater than trout.

5. Special regulations may be needed to protect native populations without seriously restricting the major fisheries.

Actions

5.1 While conducting monitoring activities and creel programs designed for other fish species, collect data on the distribution, abundance, fishing pressure, and harvest of trout and whitefish.

Objective 6. **Maximize the harvest of hatchery rainbow trout.**

Assumptions and Rationale

1. Angler catch rate of hatchery rainbow can be increased without increasing release numbers.

2. Increased harvest would minimize the negative effects of hatchery rainbow on native fish.

Actions

6.1 Determine how harvest rates can be increased by modifying stocking schedules, release sites, and release numbers.

6.2 Continue the hatchery rainbow drop out study for another year at Roaring River Hatchery to further evaluate the migration tendency of the Cape Cod stock.

6.3 Continue to use hatchery stock which demonstrates a minimum of migratory behavior.

Objective 7. Minimize the potentially negative effects of hatchery rainbow trout on the production and genetic integrity of native trout, whitefish, and winter steelhead.

Assumptions and Rationale

1. Hatchery fish are released in streams and rivers used by native trout and winter steelhead. Hatchery trout may compete with native fish for food and habitat.

2. The increased angling effort brought about by releases of hatchery trout may increase the harvest of native trout and steelhead.

3. Cape Cod stock is thought to contribute less than 10% to rainbow trout natural production in the Santiam and Calapooia subbasins.

Actions

7.1 Consider marking hatchery trout to enable anglers to distinguish naturally produced from hatchery trout.

7.2 Post signs at popular angling sites informing anglers about differences between native and hatchery trout.

7.3 Continue to document hold over of hatchery rainbow during creel studies and use this information to estimate the contribution of hatchery rainbow to natural production.

7.4 Continue to release Cape Cod stock unless it is estimated that they are contributing more than 10% to natural production.

WARMWATER GAME FISH

Background and Status

Origin

Warmwater game fish are not native to the Santiam and Calapooia subbasins. There is little documentation of introductions of warmwater game fish in the subbasins. Largemouth bass and panfish have existed in standing and running waters in the Willamette basin since the 1800s. Smallmouth bass were successfully introduced into Thomas Creek by ODFW and now provide a fishery in the lower South Santiam system.

Life History and Population Characteristics

Distribution

Largemouth bass, black and white crappie, bluegill, pumpkinseed, brown and yellow bullhead are widely distributed throughout the slower flowing portions of the Santiam, South Santiam, and Calapooia rivers and their tributaries (ODFW 1988a). Bullfrogs are also found in the subbasins. These species are found primarily in sloughs, old channels, and oxbow lakes. Smallmouth bass are primarily stream fish, found in eddies and deeper holes in lower reaches of rivers.

Warmwater game fish found in Mill Creek, the lower Santiam, South Santiam, Thomas and Crabtree creeks, and the Calapooia Rivers and its tributaries are listed in Table 54.

Table 54. Distribution of warmwater game fish in the Santiam and Calapooia subbasins (J.J. Wetherbee, ODFW, unpublished data).

Stream and site	Species[a]									
	SB	LB	Wm	Bg	Pk	WC	BC	BrB	YB	B
Mill Creek		X		X				X		
Santiam R.	X	X		X		X		X		
Talbot Slough			X	X		X	X		X	
South Santiam R.										
RM 0.0-3.5	X	X						X		
Thomas Creek										
RM 0.0-1.0		X								
RM 0.0-4.0		X		X						
RM 0.0-10.0	X							X	X	X
Crabtree Creek	X									
Calapooia R.										
RM 0.0-9.5	X									
RM 0.0-30.0		X		X	X	X				
Oak Cr.										
RM 0.0-15.0	X			X				X		
Lake Cr.										
RM 0.0-4.0		X				X				X
Butte Cr.										
RM 0.0-7.0		X				X				X
Sodom Ditch										
RM 0.0-6.5		X				X				X
Cochran Cr.										
RM 0.0-6.5		X				X				X
Shedd Slough										
RM 0.0-2.0		X				X				X
Walton Slough										
RM 0.0-3.0		X				X				X
Wright Slough										
RM 0.0-1.0		X				X				X

[a] SB = smallmouth bass, LB = largemouth bass, Wm = warmouth bass, Bg = bluegill, Pk = pumpkinseed, WC = white crappie, BC = black crappie, BrB = brown bullhead, YB = yellow bullhead, B = bullhead catfish.

Abundance

The range and numbers of smallmouth bass appear to be slowly increasing in the subbasins. There are no population estimates for warmwater game fish in the Santiam or Calapooia subbasins.

Age structure

The age structure of smallmouth bass sampled in the Santiam River in 1977 was 5.6% age 0+, 44.4% age 1+, 47.2% age 2+, and 2.8% age 3+ (Table 55).

Table 55. Age specific length data for smallmouth bass sampled in the Santiam River, April-June 1977 (n=36) (K. Daily, ODFW, unpublished data).

Age class	N	%	Size range (inches)	Mean length (inches)
0+	2	5.6	2.8-3.6	3.2
1+	16	44.4	4.6-9.1	7.1
2+	17	47.2	8.1-14.1	10.4
3+	1	2.8	13.6	13.6

Average length

Smallmouth bass sampled in the Santiam River in 1977 averaged 3.2 inches in length for age 0+ fish, 7.1 inches for age 1+ fish, 10.4 inches for age 2+ fish, and 13.6 inches for age 3+ fish (Table 55).

Smallmouth bass sampled from Thomas Creek in 1980 ranged in size from 2-11 inches in length (Table 56). The mean length was 4.3 inches (n=82). Age I fish averaged 3.0 inches in length and age II fish 6.9 inches. Samples of smallmouth bass taken in 1987 ranged from 2-15 inches in length (Table 56). The mean length was 6.2 inches. Age I bass averaged 3.3 inches, age II bass 6.7 inches, age III bass 9.3 inches, age IV bass 10.6 inches, age V bass 11.8 inches and age VI bass 12.9 inches (Table 57). These growth rates are moderate in comparison to smallmouth bass growth rates in other Oregon streams (Daily et al. 1990).

Table 56. Size frequency of bass sampled by electrofishing in Thomas Creek, 1980 and 1987 (K. Daily, ODFW, unpublished data).

	No. of fish by one-inch size groups (F.L.)													
Species[a]	2	3	4	5	6	7	8	9	10	11	12	13	14	15
28 May 1980, RM 0-5														
SB	26	24	13	7	3	2	2	1		4				
LB		1												
28 May 1987, RM 0-9														
SB	11	44	9	6	4	6	1	1	2	1	3	2		1

[a] SB = smallmouth bass, LB = largemouth bass.

Table 57. Age specific mean calculated fork length for smallmouth bass collected from Thomas Creek in 1987 (K. Daily, ODFW, unpublished data).

Age	No.	Mean length (in)	Mean calculated length (inches) at age 1	2	3	4	5	6
0+								
1+	7	5.15	4.11					
2+	9	8.50	2.94	7.13				
3+	1	11.69	2.17	6.93	10.39			
4+	3	12.17	3.20	5.67	7.94	10.21		
5+								
6+	2	14.15	3.92	7.10	9.63	10.90	11.79	12.92
Mean fork length			3.27	6.71	9.32	10.55	11.79	12.92
Mean annual increment			3.27	3.44	2.62	1.23	1.24	1.13
Number of fish			22	15	6	5	2	2

A single largemouth bass sampled from Thomas Creek in 1980 was 3.0 inches in length (Table 56).

Warmouth sampled from Talbot Slough in 1967 were 5.0-5.4 inches in length (Table 58). Bluegill were 4.5-5.0 inches in length. White crappie were 4.6-8.8 inches and black crappie 8.3-8.4 inches. Yellow bullhead were 7.2-11.7 inches in length.

Table 58. Size of warmwater game fish sampled by gill net in Talbot Slough, Santiam River, July 19-20, 1967 (K. Daily, ODFW, unpublished data).

Species	N	Size range (inches)	Mean length (inches)
Warmouth bass	3	5.0-5.4	5.1
Bluegill	4	4.5-5.0	4.7
White crappie	65	4.6-8.8	6.9
Black crappie	2	8.3-8.4	8.3
Yellow bullhead	7	7.2-11.7	8.3

Brown bullhead sampled from the lower South Santiam and Santiam rivers in 1978 were 7.6 and 8.4 inches in length (K. Daily, ODFW, unpublished data).

Hatchery Production

Description of Hatcheries

There are no hatcheries or rearing facilities for warmwater game fish in the Santiam and Calapooia subbasins. Hatchery fish are reared at St. Paul rearing ponds (see the Main stem Willamette Plan).

Hatchery Releases

Hatchery produced fish are used primarily to establish populations of warmwater game fish in the wild (ODFW 1987b). Hatchery fish are obtained or reared for specific release programs. Largemouth bass, smallmouth bass, and channel catfish are either purchased or raised. Other species are captured and transplanted.

A single release of 738 channel catfish was made into Talbot Slough on the Santiam River in 1978. Releases of smallmouth bass totaling 3,372 fish were made in lower Thomas Creek in 1973 (Table 59). There are no other records of warmwater game fish releases in streams or rivers in the Santiam or Calapooia subbasins.

Table 59. Releases of warmwater game fish in running waters of the Santiam subbasin (K. Daily, ODFW, unpublished data).

Site	Date	Species[a]	No. & lbs.() released	Size
Talbot Slough	10-13-78	CC	738 (15.0)	4.0 fish/lb
Thomas Creek				
RM 1.5	5-11-73	SB	26 (25)	9-17 in
RM 1.5	9-10-73	SB	1,133 (21.5)	fingerling
	10-3-73	SB	2,213 (29.5)	2.9 in

[a] CC = channel catfish, SB = smallmouth bass.

Angling and Harvest

Harvest of warmwater game fish in flowing waters in the Santiam and Calapooia subbasins occurs mainly in the Santiam River, the lower South Santiam River, and Thomas Creek. Poor access to lower reaches of the Calapooia River limits sport harvest. All species of warmwater game fish are believed to be underutilized in running waters in the Santiam and Calapooia subbasins.

Creel surveys have only been conducted on the Santiam River during 1979 and 1984 (Table 60). Largemouth and smallmouth bass were harvested.

Table 60. Random creel information for warmwater game fish on the main stem Santiam River (J.J. Wetherbee, ODFW, unpublished data).

Year	Species[a]	No. & size () in inches	Total anglers	Hours fished	Fish/ angler	Fish/ hour
1979	LB	1 (12-14)	7	16	0.14	0.06
1984	SB	5 (12-14)	2	7	2.50	0.71

[a] LB = largemouth bass, SB = smallmouth bass.

The bag limit for bass is 5 per day with no more than 3 over 15 inches. There is no bag limit for bluegill, catfish, crappie, other sunfish and yellow perch.

Management Considerations

Cold water temperatures, lack of habitat, and competition with non-game fish constrain production of warm water fish in running waters of the Santiam and Calapooia subbasins.

There is no information concerning the interactions of warmwater game fish and native species in the Santiam and Calapooia subbasins. There is the potential for predation and competition from warmwater species to decrease the production of native fish.

This management plan calls for maintaining or increasing natural production of native winter steelhead and for maintaining natural production of spring chinook in Thomas Creek. The effects of warmwater fish species, in particular smallmouth bass, on winter steelhead and spring chinook in Thomas Creek are unknown. Studies conducted in the Columbia River have shown that smallmouth bass prey on juvenile salmonids (Gray et al. 1982) and may substantially impact their production.

The effects of increasing the abundance of larger smallmouth bass through more intensive management on winter steelhead and spring chinook predation is also unknown. Columbia River studies suggest that larger smallmouth consume slightly more salmonids in number than small bass but substantially more salmonids in terms of biomass since they tend to consume larger, older juvenile salmonids (Connolly and Rieman 1988).

Policies

Policy 1. Management proposals that initiate or expand release programs for warmwater game fish or that alter the distribution of warmwater game fish shall be reviewed and evaluated for potential effects on indigenous fish species.

Objectives

Objective 1. Maintain populations of warmwater game fishes.

Assumptions and Rationale

1. Little is known about warmwater game fish species presence, distribution, abundance, and population characteristics in flowing waters of the Santiam and Calapooia subbasins. Data on warmwater game fish in the Santiam and Calapooia has come from a limited number of stream inventories and creel studies.

2. Monitoring the distribution and abundance of warmwater game fish populations in the subbasins will provide an indication of population status.

3. Protection of existing warmwater populations can be achieved principally through habitat protection.

Actions

1.1 Inventory the Santiam River, RM 0.0-17.0 of the North Santiam, RM 0.0-15.0 of the South Santiam, and RM 0.0-32.0 of the Calapooia River for warmwater game fish population distribution and abundance.

1.2 Assess the distribution and abundance of smallmouth bass and other warmwater game fish in Thomas and Crabtree creeks.

1.3 On priority waters where long-term data sets are necessary to understand population dynamics, carry out routine sampling programs to determine the species composition, distribution, and population structure of warmwater game fish. Possible priority waters include the Santiam and the lower North and South Santiam rivers, Thomas and Crabtree creeks, and the Calapooia River.

1.4 Implement habitat protection actions outlined under objectives for Habitat Protection.

Objective 2. Provide angling opportunities for smallmouth bass in Thomas Creek under quality fish management if feasible.

Assumptions and Rationale

1. Quality fish management provides a better than average opportunity to catch mid- to large-sized fish.

2. Smallmouth bass in Thomas Creek exhibit moderate growth rates.

3. Forage for smallmouth bass is adequate in Thomas Creek.

4. Angling mortality may be controlled through regulations more restrictive than those in general use to prevent overharvest of any size group.

Actions

2.1 Determine the feasibility of Thomas Creek providing a quality smallmouth bass fishery.

2.2 Determine the effects of a change in Thomas Creek smallmouth bass angling regulations on native fish species.

2.3 Evaluate angling pressure, harvest rates of smallmouth bass, and angler satisfaction through creel studies in Thomas Creek.

Objective 3. Provide additional angling opportunities under quality fish management in the subbasins if feasible, such as for smallmouth bass in Thomas Creek.

Assumptions and Rationale

1. Growth rates for Thomas Creek smallmouth bass show potential for providing fish which are larger than average without attempting to produce trophy fish.

2. In addition to Thomas Creek, other running waters may be able to provide a better than average opportunity to catch mid- to large-sized fish.

3. Angler demand may warrant more intensive management of additional warmwater fisheries.

Actions

3.1 Identify additional potential sites in running waters for more intensive management of warmwater game fish.

3.2 Investigate the feasibility of managing identified waters under quality fish management.

Objective 4. Provide a diversity of warmwater angling opportunities in remaining running waters of the subbasins through basic yield management.

Assumptions and Rationale

1. Basic yield management requires little intervention in natural processes affecting production.

2. Running waters will be managed under general statewide regulations for warmwater game fish.

3. Anglers will find variety in species and sizes.

4. Catch rates will be highly variable.

5. Public access limits the warmwater fishery in the Santiam and Calapooia subbasins.

Actions

4.1 Collect data on the distribution, abundance, fishing pressure, and harvest of warmwater game fish.

4.2 Evaluate angling pressure, harvest rates, and angler satisfaction through creel studies on key reaches and streams.

4.3 Improve access by implementing actions outlined under objectives for Access.

Objective 5. Increase public awareness of warmwater angling opportunities in the subbasins.

Assumptions and Rationale

1. The warmwater game fish resource may be underutilized.

2. ODFW's weekly fishing report can be used to provide current information to attract anglers during times of good fishing.

3. Publications can direct people to angling opportunities in specific areas.

Actions

5.1 Provide warmwater fishing information to be included in the weekly fish reports.

5.2 Publish a guide for warmwater game fish in the mid-Willamette Valley.

5.3 Continue to direct anglers to warmwater fishing opportunities in the subbasins when they contact district offices for information.

5.4 Consider involving the public in habitat enhancement projects, sampling studies, and volunteer creel programs.

OREGON CHUB

Background and Status

Origin

The Oregon chub is a small minnow historically recorded only from the Willamette and Umpqua basins in Oregon. The Willamette population is now considered to be genetically discrete from the Umpqua population, which will most likely be classified as separate species (Markle et al. 1990).

Although the Oregon chub is not presently on the federal list of threatened or endangered species, it is on the Federal Register as a category 2 species. Markle and Pearsons (1990) have submitted a petition to list the Oregon chub as an endangered species.

The Oregon chub is currently listed by ODFW as a sensitive species due to the decline in its distribution and abundance in the Willamette Valley. Sensitive species have been granted protection. The Oregon chub should be given a high priority with respect to future management activities in the Willamette basin.

Life History and Population Characteristics

Oregon chub have been found in quiet waters such as sloughs and overflow ponds at low elevations in the Willamette valley (Dimick and Merryfield 1945). They prefer shallow, warm water with depositional substrates having abundant aquatic vegetation (Markle et al. 1990).

Oregon chub have been collected from the South Santiam River (RM 8 and RM 18), the North Santiam River (RM 14.5), and in ponds near Mill Creek (RM 10) (Markle et al. 1990). The most recent sightings have been near Greens Bridge on the North Santiam River (RM 14.5) in 1983 and 1989. Currently, the only Oregon chub population thought to occur in running waters of the Santiam subbasin is in the lower North Santiam River.

The Oregon chub is not known to have occurred in the Calapooia subbasin.

The Oregon chub spawns in the spring and early summer (Markle et al. 1990). Spawning occurs in aquatic vegetation. Fecundity of females taken from Shady Dell Pond in the upper Willamette basin ranged from 147 to 671 (Markle et al. 1990).

Oregon chub feed primarily on zooplankton and midge larvae (Markle et al. 1990).

Hatchery Production

There is no hatchery production of Oregon chub. Fish captured for introductions into new sites may be held for short periods of time in isolated ponds at the St. Paul rearing facilities (see the main stem Willamette plan). It is more likely that they would be transferred directly to re-introduction sites.

Management Considerations

The apparent decline of the Oregon chub in the Willamette valley correlates with the construction of dams and flood control projects. Historically large rivers had braided channels with numerous secondary side channels and wetlands. During winter and spring flooding events, Oregon chub could have been widely dispersed in the flood plain to pond and slough habitats where spawning and juvenile rearing would take place. With recent flood control projects, channelization of rivers and streams, and loss of backwaters, sloughs, and ponds, the dispersal opportunities and available habitat for Oregon chub is now greatly reduced.

Oregon chub may also be vulnerable to predation by introduced fish species such as bass. Introduced warmwater fish are often the dominant inhabitants of quiet waters along lower reaches of the Santiam, North Santiam, South Santiam, and Calapooia rivers. They are probably a major detriment to recolonization, if not the cause of the decline of the Oregon chub in the subbasin.

The Oregon chub is listed by ODFW as a sensitive and protected species due to the decline in its distribution and abundance in the Willamette Valley. A petition has been submitted to list the Oregon chub on the Federal Register as an endangered species.

Objectives

Objective 1. Protect and enhance existing populations of Oregon chub in the Santiam subbasin.

Assumptions and Rationale

1. Oregon chub have been identified by ODFW as a protected species. This objective addresses some of the problems with this species.

2. A small population of Oregon chub may currently exist in the North Santiam River near Greens Bridge (RM 14.5).

3. Additional populations may exist in the subbasin.

4. Protection of critical habitat is necessary to avoid further declines in abundance and distribution.

5. Oregon chub populations may be vulnerable to predation and competition from introduced fish species such as bass.

6. Many of the following actions cannot be accomplished under current levels of funding. If funding continues to be limiting, ODFW will pursue actions according to priority as funds become available.

Actions

1.1 Survey likely habitat in the Santiam subbasin to identify undocumented Oregon chub populations.

1.2 Discourage introduction of fish species that may negatively impact the recovery of Oregon chub populations.

1.3 Identify and implement habitat protection and improvement measures for Oregon chub at Greens Bridge.

1.4 Periodically assess chub population status at Greens Bridge.

1.5 Implement habitat protection measures at additional sites where Oregon chub may be found.

Objective 2. Establish new populations of Oregon chub in isolated waters in the Santiam subbasin where possible.

Assumptions and Rationale

1. Oregon chub have been identified by ODFW as a protected species. This objective addresses some of the problems with this species.

2. A preliminary list of introduction sites prepared by an interagency task force has identified two sites as potentially suitable for introductions of Oregon chub in the subbasin (ODFW et al. 1990). Further investigation and review may identify additional sites.

3. Introductions will be confined to the historic distribution of the Oregon chub.

4. Introductions of Oregon chub will be approved through the ODFW stocking policy review process.

5. If the Oregon chub is added to the federal list of threatened or endangered species, then ODFW will comply with U.S. Fish and Wildlife Service procedures before reintroducing new populations.

6. Many of the following actions cannot be accomplished under current levels of funding. If funding continues to be limiting, ODFW will pursue actions according to priority as funds become available.

Actions

2.1 Evaluate the following potential sites for introductions:

Aumsville Ponds, Mill Creek drainage

2.2 Identify and evaluate other potential sites for introductions in isolated waters in the subbasin.

2.3 Stock Oregon chub in selected, appropriate sites according to Guidelines for Re-introducing Oregon chub into their Historic Range (ODFW et al. 1990).

2.4 Conduct systematic monitoring of introduced populations.

2.5 Develop criteria to define a successful introduction of Oregon chub.

2.6 Determine the causes of unsuccessful introductions.

2.7 Restock sites if warranted.

Objective 3. Promote greater public understanding and appreciation of the status of Oregon chub.

Assumptions and Rationale

1. The status and importance of the Oregon chub is recognized by only a small portion of the general public.

Actions

3.1 Publicize efforts taken and their rationale for protecting and enhancing populations of Oregon chub.

3.2 Educate anglers and angling groups about the status of Oregon chub and the risks of introducing exotic species into potential Oregon chub habitat.

SAND ROLLERS

Background and Status

Origin

The sand roller, *Percopsis transmontana*, a member of the trout-perch family, is native to the Columbia River and its tributaries, including the Willamette. It is currently listed by ODFW as a stock of concern statewide. Populations are suspected of being at low levels, but its exact status is unknown. The sand roller should be given a high priority with respect to future population and habitat inventory and monitoring activities in the Santiam and Calapooia subbasins.

Life History and Population Characteristics

Sand rollers are generally found in low gradient reaches of rivers and streams. During daylight hours they hide among large submergent objects such as root wads and under banks. At night they move out in small schools to feeding areas over sandy substrates (personal communication on 23 October 1990 from P. Reimers, ODFW, Charleston, Oregon). Because of their secretive nature during the day, sand rollers often go uncollected during routine stream sampling. Current records for the subbasins may underestimate their distribution.

Sand rollers have been collected from Mill Creek, the South Santiam River, and the Calapooia River and its tributary Oak Creek (Table 61). They have also been observed in Stout Creek (RM 1) in the North Santiam system and in Hamilton Creek (RM 0-9) in the South Santiam system (personal communication on 28 August 1990 from W. Hunt, ODFW, Salem, Oregon).

Sand rollers collected from the Columbia River ranged in age from 1 to 6 years (Gray and Dauble 1979). Sand rollers usually attain sexual maturity at age II. All fish are mature by age III.

Gravid females were collected from sites in the Columbia River from June through mid-July (Gray and Dauble 1979). Females collected from January through July contained 1,106 to 3,369 eggs. Carlander (1969) reports that a single female contained 4,748 eggs. Spawning occurs in the Columbia River in midsummer when water temperatures range from 57-61º F (Gray and Dauble 1979). Emergent fry were collected in mid-August in the Columbia River. Larger fry were collected in mid-September.

Aquatic insects are the main food of sand rollers. Zooplankton may contribute a greater portion of the diet of immature fish (Gray and Dauble 1979).

Table 61. Records of sand rollers collected from rivers and streams in the Santiam and Calapooia subbasins (D. Markle, Oregon State University, Department of Fisheries and Wildlife, Corvallis, Oregon, unpublished data).

Date	Stream	Site
8-29-40	Mill Creek	At Salem
7-25-53	So. Santiam R.	At Lebanon, RM 18
8-12-55	So. Santiam R.	At Lebanon, RM 18
9-6-57	So. Santiam R.	At Lebanon Dam, RM 21
1968	Thomas Creek	Near Scio, RM 9
8-90	Hamilton Creek	RM 0-9
9-21-82	Oak Cr., Calapooia R.	Near Albany
8-17-83	Calapooia R.	2.5 mi south of Tangent
Undated	Stout Creek	RM 1
Undated	So. Santiam R.	
Undated	Calapooia R.	Near Albany

Management Considerations

Sand rollers may be susceptible to habitat degradation and water diversions found in lower reaches of rivers and streams in the subbasins. Channelization of rivers and streams and removal of riparian vegetation reduces the structural complexity required by sand rollers.

The sand roller is listed by ODFW as a stock of concern statewide. Information is needed concerning its status.

Objectives

Objective 1. Determine the distribution, relative abundance, and habitat use of sand rollers in the Santiam and Calapooia subbasins.

Assumptions and Rationale

1. Determining the distribution and relative abundance of populations of sand rollers will provide an indication of their health.

2. Information on the distribution and habitat use of sand rollers in the subbasins is necessary in order to implement habitat protection actions.

3. Many of the following actions cannot be accomplished under current levels of funding. If funding continues to be limiting, ODFW will pursue actions according to priority as funds become available.

Actions

1.1 While conducting routine inventory for other fish species, collect more detailed data for sand rollers when present.

1.2 Survey rivers and streams of the Santiam and Calapooia subbasins to determine the relative abundance of sand rollers.

1.3 Determine the habitat requirements of sand rollers in the Santiam and Calapooia subbasins.

Objective 2. Protect, restore, and enhance sand rollers habitat.

Assumptions and Rationale

1. Protection and enhancement of sand roller populations can be achieved principally through habitat protection and improvement.

Actions

2.1 Advocate riparian protection for river and stream reaches containing sand rollers.

2.2 Develop habitat improvement plans where needed.

2.3 Work with volunteers, landowners, and agencies to implement habitat improvement projects in stream reaches used by sand rollers.

2.4 Implement habitat protection actions outlined under objectives for Habitat Protection.

CRAYFISH

Background and Status

Origin

Crayfish are the most important freshwater invertebrate to Oregon's fisheries. They provide a small fishery in the lower Calapooia River. They are also important fish forage in the Santiam and Calapooia subbasin.

Life History and Population Characteristics

Three species of crayfish are native to Oregon (Hobbs 1976). These species, their subspecies and intergrades are spread statewide, with overlapping distributions. An introduced species found in the Rogue River is not known to occur in the Willamette or its tributary subbasins, including the Santiam and Calapooia.

Crayfish breed in the summer, with the first egg-bearing females appearing as early as September. Eggs are carried over the winter and hatch late April to late June. The young are attached to the female by a thread-like material for a short time. Size achieved by zero-age crayfish during the first summer is quite variable due to the long period over which eggs hatch. Age determination by the length-frequency method is extremely difficult.

Females mature at about 18-30 months. Fecundity increases with size and perhaps age. There is evidence to suggest that some or perhaps all females do not breed each year.

Hatchery Production

There is no hatchery production of crayfish in the Santiam and Calapooia subbasins. No commercial crayfish culture operations have yet been successful in the state.

Harvest

Crayfish have been fished commercially in Oregon since before 1893 when records were first kept. Markets for bait and for restaurant food dictate the size of landings. Most of the Willamette basin harvest occurs in Multnomah, Clackamas, and Yamhill counties (ODFW, unpublished data). There are no estimates of commercial landings specifically for the Santiam and Calapooia subbasins.

The commercial crayfish season is open from April 1 through October 31. Crayfish may be taken only by crayfish pots or ring nets. Only crayfish 3-5/8 inches or longer in length may be taken. Undersized crayfish must be returned unharmed to the water. Any crayfish caught with eggs attached must be returned unharmed to the water. Gear must be labeled with an identification number issued by ODFW.

Recreational use of the resource is widespread for bait and direct consumption. No license is required to take crayfish. The daily bag limit is 100 per person. The season is open the entire year at all hours. Estimates of sport harvest levels in the Santiam and Calapooia subbasins are unavailable.

Management Considerations

Water pollution, particularly pesticides and some industrial wastes, and flow depletions are the most serious threats to crayfish populations. Local populations may be subject to overharvesting.

Objectives

Objective 1. Assess the population status and commercial harvest of crayfish in the Santiam and Calapooia subbasins.

Assumptions and Rationale

1. Presently, commercial catch information is reported only by date and county.

2. Information should be collected for the most heavily fished waters.

3. Data can be collected at reasonable cost from commercial operators.

Actions

1.1 Conduct biological sampling in key areas to determine size and age composition and relative abundance of crayfish.

1.2 Require commercial harvesters to use a logbook to record effort and catch for all crayfish harvest.

Objective 2. Determine the size and importance of the recreational crayfish harvest in the Santiam and Calapooia subbasins.

Assumptions and Rationale

1. Currently there is no measure of the impact of the recreational harvest or the fishery potential of crayfish.

2. There are no estimates of current harvest or effort.

3. Recreational harvest is widespread and appears to be increasing.

Actions

2.1 While conducting routine stream surveys, collect data to determine size and relative abundance of crayfish.

2.2 Conduct creel studies in key areas to evaluate harvest and effort.

ANGLING ACCESS

Background and Status

The Oregon State Land Board has recommended that the main stem Santiam River, the North Santiam from its mouth to RM 27 near Mehama, and the South Santiam River from its mouth to RM 26.5 above Waterloo be declared navigable based on historical use of the rivers for log drives (Oregon State Land Board 1983). Under this classification streambanks below the ordinary high water mark would be publicly owned and could be used for public angling. The Land Board has recognized that the North Santiam from RM 27 to 40 and the South Santiam from RM 26.5 to 48 show evidence of navigability based on historic use of the rivers for log drives and commercial tourism. The state legislature may exercise its full right to declare these reaches navigable, although in the past only reaches that had navigable use and were also meandered have been recommended.

The main stem Santiam River has boat access at both the I-5 rest area and at Jefferson.

The North Santiam River has adequate access for both boat and bank anglers due to the proximity of the river to Highway 22. The one exception is in the North Santiam just above Stayton, where low flows due to a water diversion dam pose a perpetual boating problem and safety hazard. A new take-out site is needed at or just above Geren Island since the city of Salem has gated the former ramp access site. Additional access would be desirable at the old fish hatchery just below Mehama.

The South Santiam River has more limited bank access than the North Santiam. Highway 20 does not parallel the river closely. Additionally, most of the land along the South Santiam below RM 51 is privately owned. The greatest need for access on the South Santiam is at McDowell Creek Bridge. Currently, there is a small privately owned ramp which is available to the public for a fee. Access to the public could be lost completely.

Nearly all of the land along the Calapooia River is in private ownership. Boat access is limited to sites in Brownsville (RM 32.5) and at McKercher County Park (RM 40.5). Demand for additional access has not been great. However additional access sites would be needed if interest in the warmwater fishery increased. Adequate bank access above Holley (RM 45.5) provides angling opportunities for trout.

Conflicts between anglers and landowners primarily involve trespass, littering, and damage to vegetation. Incentives need to be developed to encourage private landowners to allow public access and to encourage anglers to respect property rights and to minimize disturbance to wildlife.

Policies

Policy 1. **The Department shall seek to provide access for boat and bank angling that will satisfy public need for a variety of angling opportunities and a dispersion of angling effort throughout the subbasin.**

Policy 2. **Acquisition and development of angler access sites shall be consistent with**

guidelines and objectives for management of fish species and habitat.

Objectives

Objective 1. Provide and maintain 2 permanent boat access sites on the main stem Santiam River, 9 permanent sites on the North Santiam River from the mouth up to RM 44, 4 permanent sites on the South Santiam River from the mouth up to RM 33, and at least 1 permanent site on the Calapooia River.

Assumptions and Rationale

1. It is necessary to work with other agencies, public groups, and private landowners to provide and maintain access sites.

2. Existing access sites meet the objective, except for the North Santiam at Stayton and the South Santiam River near the McDowell Creek Bridge site (RM 27.5).

3. Boat anglers primarily use the rivers for day-trips. Consequently, access sites need to be relatively close together.

4. Some boat access sites are poorly maintained or are in need of improved or expanded facilities.

5. ODFW may need to acquire boat access sites currently owned by other parties or agencies in order to assure continued operation of facilities.

6. Many of the following actions cannot be accomplished under current levels of funding. If funding continues to be limiting, ODFW will pursue actions according to priority as funds become available.

Actions

1.1 Work with the Oregon Department of Transportation to improve existing boat access at the I-5 rest area on the main stem Santiam River (RM 6).

1.2 Acquire and improve the Jefferson Boat Ramp on the main stem Santiam (RM 9.5), or acquire and develop a boat access site just to the south.

1.3 Maintain the parking facilities at Greens Bridge on the North Santiam (RM 3).

1.4 Acquire and develop a boat access site on the lower power canal at Stayton on the North Santiam River (RM 15.5).

1.5 Acquire and develop a boat access site at or near the upstream end of Geren Island on the North Santiam River (RM 16.5).

1.6 Work with the State to develop a boat access site behind the old fish hatchery below Mehama on the North Santiam River.

1.7 Work with the Oregon Department of Transportation to expand and develop the parking and toilet facilities at Mehama Bridge on the North Santiam (RM 27).

1.8 Work with Oregon State Parks to improve the launch area and parking facilities at North Santiam State Park on the North Santiam (RM 29).

1.9 Work with Linn County to extend the ramp at Waterloo Park on the South Santiam (RM 23.5).

1.10 Acquire the privately-owned boat access site at McDowell Creek Bridge on the South Santiam (RM 27.5) and improve the ramp and parking facilities.

1.11 Work with the city of Sweet Home to improve the parking facilities at the Pleasant Valley Road on the South Santiam (RM 33).

1.12 Work with the Oregon Department of Transportation to develop a pram slide and parking facilities at the Tangent site on the Calapooia (RM 9.5).

1.13 Acquire and develop a boat access site on the Calapooia River between RM 0 and 9.5.

Objective 2. Increase bank angling access in the subbasins.

Assumptions and Rationale

1. Additional bank angling access would increase angling opportunities.

2. Much of the shoreline along the South Santiam and Calapooia rivers is privately owned.

3. Private landowners often attempt to prevent public access on their property.

Actions

2.1 Identify potential sites for bank angling access on rivers in the Santiam and Calapooia subbasins.

2.2 Acquire additional sites for bank angling where desirable.

2.3 Develop incentives to encourage private landowners to allow public access.

2.4 Develop incentives to encourage anglers to respect property rights and minimize disturbance to wildlife.

PLAN ADOPTION AND REVIEW

The Santiam and Calapooia Plan should not be viewed as the final statement on the management of the fish and fisheries in the subbasin. Planning is a continuing process. As conditions of the resources and desires of the public change and as new information is obtained, the plan must be responsive and evolve as well. Every 2 years public meetings will be held to review progress made in implementing the plan. These meetings are intended to provide an opportunity for the public to comment on management direction and progress. At that time implementation priorities will also be reexamined and adjustments made where necessary. This review will precede the preparation of ODFW's biennial budget, which is submitted to the legislature for funding. The Santiam and Calapooia Plan will be formally reviewed every 5 years. Portions of the plan will be rewritten as needed and presented to a public advisory committee. The final draft will be presented to the Fish and Wildlife Commission for adoption.

Upon adoption by the Oregon Fish and Wildlife Commission, the policies and objectives will become Oregon Administrative Rules. Revision of these rules requires action by the Commission. Emergency changes in administrative rules can be made by the Commission in accordance with the Administrative Procedures Act when needed.

PRIORITY OF ACTIONS

The Santiam and Calapooia Subbasin Fish Management Plan proposes many actions, more than can be completed within existing budgets. Some actions are currently on-going activities of ODFW and only need to be continued or modified. Other actions are new and need funding before they can be implemented. In order to achieve the objectives of this plan within ODFW's budgetary and staff limitations, priorities for funds and effort must be identified.

High priority actions were identified for habitat protection, species or species groups, and access (Table 62). These priorities reflect what ODFW and the citizens advisory committee believe are the most important actions that should be addressed in the Santiam and Calapooia Subbasin Fish Management Plan. The first five actions identified in Table 61 are habitat protection actions which affect more than a single stock or species of fish. The current funding status for each action is indicated. A "yes" in the currently funded column denotes that funding for that action is presently budgeted under existing programs, however current funding may not be adequate. If funding or additional funds are needed, they are noted in the next column.

Table 62. High priority actions in the Santiam and Calapooia Subbasin Fish Management Plan and funding status.

Actions	Currently funded	Remarks on funding status
Reduce the impacts of timber harvest activities on fish production	Yes	Included in base budget
Implement a basin-wide fish screening plan based on the needs identified by HCD as well as those identified in this plan	No	Funding needed
Improve upstream and downstream passage at Stayton on the North Santiam River	No	Operators of facilities required to fund protec-tion devices; funding needed for ODFW staff
Resolve passage problems at Foster, Green Peter, and Detroit dams through continued cooperation with USACE	No	Operators of facilities required to fund protec-tion devices; funding needed for ODFW staff

continued

Table 61 continued.

Actions	Currently funded	Remarks on funding status
Improve passage at Thompson's Mill Dam on the Calapooia River	No	Operators of facilities required to fund protec-tion devices; funding needed for ODFW staff
Increase natural production of winter steelhead in the Santiam and Calapooia	No	Additional funding needed for inventories and habitat enhancement
Protect and enhance the native winter steelhead run above Foster Dam	No	Additional funding needed from USACE to correct passage at Foster Dam
Determine the status of spring chinook populations in the various Santiam subbasin tributaries	No	Additional funding needed for developing technology and seasonal staff for field surveys
Increase natural production of spring chinook in the Santiam subbasin a. Reestablish runs of spring chinook above Foster and Detroit dams b. Increase production in Thomas and Crabtree creeks	No	Partially funded by base budget; additional funding needed for smolt releases and from USACE to correct passage at Green Peter Dam and predation problems in Green Peter Reservoir
Reestablish natural production of spring chinook in the Calapooia subbasin	No	Partially funded by base budget; additional funding needed for smolt releases
Protect and enhance the productivity of native trout	No	Partially funded by base budget; additional funding needed for surveys and habitat improvement
Provide additional angling opportunities for warmwater game fish while protecting populations of native fish species	No	Partially funded by base budget; additional funding needed to publish a warmwater angling guide

continued

Table 61 continued.

Actions	Currently funded	Remarks on funding status
Protect and enhance populations of sensitive species and stocks of concern	No	Additional funding needed for surveys and habitat improvement
Provide and maintain angling access	No	Maintenance of existing sites is funded in the base budget; additional funding needed for acquisition and development of new sites

REFERENCES

Bennett, D.E. 1988. 1987 Willamette River spring chinook salmon run. ODFW, Columbia River Management, Portland, OR. 36 pp.

Buchanan, D.V. 1975. Willamette River steelhead. Columbia River fishery development program, quarterly report. Oregon Department of Fish and Wildlife, Portland, Oregon. 16 pp.

Buchanan, D.V. and M.G. Wade. 1978. Willamette River steelhead. Annual report. Oregon Department of Fish and Wildlife, Research Division.

Buchanan, D.V., R.M. Hooton, M.G. Wade and J.E. McCrae. 1979. Willamette River steelhead. Annual report. Oregon Department of Fish and Wildlife.

Buchanan, D.V. and M.G. Wade. 1982. Restoration of the native winter steelhead run on the South Santiam River above Foster Dam. Annual progress report of the Oregon Department of Fish and Wildlife.

Buchanan, D.V., M.G. Wade, S.P. Trask, B.J. Lee and T.J. Lichatowich. 1984. Restoration of the native winter steelhead run on the South Santiam River above Foster Dam. Oregon Department of Fish and Wildlife annual progress report, Portland, Oregon. 40 pp.

Buchanan, D.V., M.G. Wade and D.L. Higley. 1991. Restoration of the native winter steelhead run on the South Santiam River above Foster Dam - Completion Report. Oregon Department of Fish and Wildlife, Portland, Oregon.

Campbell, C.J. and F.E. Locke, editors. 1968. 1968 annual report, fishery division. Oregon State Game Commission, Portland, Oregon.

Campbell, C.J. and F.E. Locke, editors. 1969. 1969 annual report, fishery division. Oregon State Game Commission, Portland, Oregon.

Campbell, C.J. and F.E. Locke, editors. 1970. 1970 annual report, fishery division. Oregon State Game Commission, Portland, Oregon.

Campbell, C.J. and F.E. Locke, editors. 1971. 1971 annual report, fishery division. Oregon State Game Commission, Portland, Oregon.

Campbell, C.J. and M.K. Daily, editors. 1972. 1972 annual report, fishery division. Oregon State Game Commission, Portland, Oregon.

Campbell, C.J. and M.K. Daily, editors. 1973. 1973 Annual report, fishery division. Oregon State Game Commission, Portland, Oregon.

Carlander, K.D. 1969. Handbook of Freshwater Fishery Biology, Volume I. Iowa State University Press, Ames, Iowa.

Chesney, C.J. 1983. Mass erosion occurrence and debris torrent impacts on some streams in the Willamette National Forest. Oregon State University Master's Thesis. Corvallis, Oregon.

Clady, M.D. 1971. The biology of the winter steelhead of the Willamette River, Oregon. Oregon State Game Commission Progress Memorandum, Fisheries, No. 5, 31 pp.

Columbia Basin Fish and Wildlife Authority. 1990. Integrated system plan for salmon and steelhead production in the Columbia River basin, public review draft. Columbia Basin Fish and Wildlife Authority, Portland, Oregon.

Connolly, P.J. and B.E. Rieman. 1988. Population dynamics of walleye and smallmouth bass and potential predation on salmonid smolts in John Day reservoir. U.S.D.O.E., Bonneville Power Administration. Vol. I, Final Report of Research 1983-86.

Daily, M.K. 1971. The mountain whitefish: a literature review. Univ. Idaho Forest, Wildlife and Range Expt. Station Paper No. 8. 18 pp.

Daily, M.K., R. Perkins and J. Johnson. 1990. Umpqua River smallmouth bass investigation, 1982-88. Oregon Department of Fish and Wildlife Information Report.

DeCew, M.G. 1969. The Marion Forks Hatchery steelhead trout rearing program and life history study of adult steelhead returning to Minto Pond. Fish Commission of Oregon, 24 pp.

Dimick, R.E. and R. Merryfield. 1945. The fishes of the Willamette River system in relation to pollution. Eng. Exp. Sta., Oregon St. Coll., Bull. 20.

Ely, C. 1981. Wild trout inventory, 1979. Oregon Department of Fish and Wildlife. Information Report Series, Fisheries No. 81-6.

Foster, C.A. 1990. Fish passage at Willamette Falls in 1989. ODFW, Columbia River Management Annual Report, 33 pp.

Franklin, J.F. and C.T. Dyrness. 1973. Natural vegetation of Oregon and Washington. USDA Forest Service General Technical Report PNW - 8. 417 pp.

Frazier, P.A. 1988. Fish at Willamette Falls in 1987. ODFW, Columbia River Management Annual Repot, 22 pp.

Fulton, L.A. 1970. Spawning areas and abundance of steelhead trout and coho, sockeye, and chum salmon in the Columbia River Basin - past and present. National Marine Fisheries Service Spec. Sci. Report - Fisheries No. 618.

Gray, G.A., G.M. Sonnevil, H.C. Hansel, C.W. Huntington and D.E. Palmer. 1982. Feeding activity, rate of consumption, daily ration and prey selection of major predators in the John Day pool. U.S.D.O.E., Bonneville Power Administration. Annual Report.

Gray, R.H. and D.D. Dauble. 1979. Biology of the sand roller in the central Columbia River. Trans. Amer. Fish. Soc. 108: 646-649.

Hansen, H.L. 1977. Stock assessment and enhancement of fall salmon species in the Willamette River system. Federal Aid Progress Reports, Fisheries. ODFW, Portland, Oregon.

Hansen, H.L. 1978. Stock assessment and enhancement of fall salmon species in the Willamette River system. Federal Aid Progress Reports, Fisheries. Oregon Department of Fish and Wildlife, Portland, Oregon.

Hansen, H.L. and R.H. Williams. 1979. Stock assessment and enhancement of fall salmon species in the Willamette River system. Annual Progress Report of the Oregon Department of Fish and Wildlife.

Hobbs, Jr., H.H. 1976. Crayfishes (Astacidae) of North and Middle America. U.S.E.P.A. Water Pollution Control Research Series 18050 ELD05/72.

Howell, P.J. 1986. Willamette basin fish management plan: status and progress 1979-85. Oregon Department of Fish and Wildlife, Portland, Oregon.

Howell, P.J., K. Jones, and D. Scarnecchia, L. LaVoy, W. Kendra and D. Ortmann. 1985a. Stock assessment of Columbia River anadromous salmonids. Vol. II: steelhead stock summaries, stock transfer guidelines - information needs. USDOE Bonneville Power Administration, Division of Fish and Wildlife.

Howell, P.J., K. Jones, D. Scarnecchia, L. LaVoy, W. Kendra and D. Ortmann. 1985b. Stock assessment of Columbia River anadromous salmonids. Vol. I: chinook, coho, chum and sockeye salmon stock summaries. USDOE. Bonneville Power Administration, Division of Fish and Wildlife.

Hunt, W.L. 1982. Wild trout inventory, 1980. Oregon Department of Fish and Wildlife. Information Report Series, Fisheries No. 82-1.

Kinunen, W. 1975. A review of rainbow trout stocking and catch statistics in Oregon streams, 1952-1975. Progress memorandum. Oregon Department of Fish and Wildlife, Research Division.

Kinunen, W. and J.R. Moring. 1976. Status and origin of rainbow trout brood stocks in Oregon. Oregon Department of Fish and Wildlife. Information Report Series, Fisheries No. 76-7.

Langridge, R.W. 1987. Soil survey of Linn County area, Oregon. USDA Soil Conservation Service.

Linn County Planning and Zoning Department. 1985. The Linn County comprehensive plan. Linn County, Oregon.

Lukas, G. and L. Korn. 1968. The feasibility of rearing sockeye salmon in reservoirs. Final report. Fish Commission of Oregon, Research Division.

Marion County Planning Department. 1981. Marion County comprehensive land use plan. Marion County, Salem, Oregon.

Markle, D.F. and T.N. Pearsons. 1990. Petition to list the Oregon chub, *Oregonichthys crameri*, as an endangered species. Manuscript. Oregon State University, Corvallis, Oregon.

Markle, D.F., T.N. Pearsons and D.T. Bills. 1990. Natural history of *Oregonichthys* (Pisces: Cyprinidae) with a description of a new species from the Umpqua River of Oregon. Copeia in press.

Mattson, C.R. 1948. Spawning ground studies of Willamette River spring chinook salmon. Fish Commission of Oregon Research Briefs, Portland, Oregon pp. 21-32.

Mattson, C.R. 1962. Early life history of Willamette River spring chinook salmon. Fish Commission or Oregon, Portland, Oregon. 49 pp.

Moring, J.R. 1977. Oregon rainbow and cutthroat trout evaluation. Final report. Oregon Department of Fish and Wildlife, Research Division.

Moring, J.R., ed. 1978. Proceedings of the wild trout--catchable trout symposium, February 15-17, 1978. Oregon Department of Fish and Wildlife, Research Division.

Moring, J.R. 1979. Changes in catch rates following reduction of trout stocking density in Oregon streams. Oregon Department of Fish and Wildlife. Information Report series, Fisheries No. 79-4.

Moring, J.R. and D.V. Buchanan. 1978. Downstream movements and catches of two strains of stocked trout. J. Wildl. Manage. 42(2):329-333.

Moring, J.R. and R.L. Youker. 1979. Oregon rainbow and cutthroat trout evaluation. Final report. Oregon Department of Fish and Wildlife, Research Division.

Moring, J.R., R.L. Youker and R.M. Hooton. Undated. Movement patterns of potamodromous cutthroat trout of the Willamette Valley, Oregon. Oregon Department of Fish and Wildlife, Research Division.

Nicholas, J.W. 1978. A review of literature and unpublished information on cutthroat trout (*Salmo clarki clarki*) of the Willamette watershed. Oregon Department of Fish and Wildlife. Information Report Series, fisheries No. 78-1.

Oregon Department of Environmental Quality. 1978. Oregon statewide assessment of nonpoint source problems, August, 1978. Water Quality Program, Portland, Oregon.

Oregon Department of Fish and Wildlife. 1986. Steelhead management plan 1986-1992. Portland, Oregon.

Oregon Department of Fish and Wildlife. 1987a. Trout plan. ODFW, Portland, Oregon.

Oregon Department of Fish and Wildlife. 1987b. Warmwater game fish management plan. Portland, Oregon.

Oregon Department of Fish and Wildlife. 1988a. Willamette basin fish management plan. Fish Division. Portland, Oregon.

Oregon Department of Fish and Wildlife. 1988b. Comments on the Willamette National Forest draft environmental impact statement and proposed plan. Portland, Oregon.

Oregon Department of Fish and Wildlife. 1990a. Willamette River Subbasin Salmon and Steelhead Plan, Santiam and Calapooia Rivers. Columbia Basin Fish and Wildlife Authority, Portland.

Oregon Department of Fish and Wildlife. 1990b. Oregon salmon and steelhead catch data, 1975-1986. Portland, Oregon.

Oregon Department of Fish and wildlife, Oregon State University Fisheries and Wildlife Department, and Willamette National Forest. 1990. Conservation agreement for the Oregon chub in the Willamette Valley, Oregon. Draft report.

Oregon State Game Commission, Fishery Division. 1956. 1955 fish stockings by watersheds. Portland, Oregon.

Ibid. 1957-1973.

Oregon State Land Board. 1983. Report and recommendation on the navigable waters of Oregon. Division of State Lands, Salem, Oregon.

Oregon Water Resources Department. 1985. Mid-Willamette basin water resources plan update. Salem, Oregon.

Sidle, R., A. Pearce and C. O'Loughlin. 1984. Soil mass movement: influence of natural and management factors. Unpublished manuscript.

Skeesick, D.G. and S.V. Jones. 1988. Draft fish status report. Willamette National Forest. USDA Forest Service.

Smith, E.M. and J.C. Zakel. 1980a. Improving survival of spring chinook smolts from Willamette River hatcheries. Annual progress report. Oregon Department of Fish and Wildlife, Portland, Oregon.

Smith, E.M. and J.C. Zakel. 1980b. Willamette River spring chinook evaluation. Oregon Department of Fish and Wildlife, Portland, Oregon. 53 pp.

Smith, E.M., R.H. Williams and J.C. Zakel. 1982. Willamette River salmon studies. Annual progress report of the Oregon Department of Fish and Wildlife.

Smith, E.M., J.C. Zakel and W.H. Day. 1985. Willamette River salmon studies. Annual progress report of the Oregon Department of Fish and Wildlife. 14 pp.

Smith, E.M., J.C. Zakel, W.H. Day, K. Homolka and M.A. Buckman. 1987. Willamette River salmon studies. Annual progress report. Oregon Department of Fish and Wildlife, Portland, Oregon.

Swanston, D. and F.J. Swanson. 1976. Timber harvesting, mass erosion, and steepland forest geomorphology in the Pacific Northwest. In D. Coates, ed., Geomorphology and engineering. Dowden, Hutchinson, Ross, Inc., Stroudsburg, Pennsylvania.

Swartz, D.F. 1967. Number, size, and age composition of adult salmon and steelhead handled at Fish Commission of Oregon hatcheries in 1965. Fish Commission of Oregon.

Swartz, D.F. 1968a. Number, size and age composition of adult salmon and steelhead handled at Fish Commission of Oregon hatcheries in 1966. Fish Commission of Oregon, Research Division.

Swartz, D.F. 1968b. Number, size, and age composition of adult salmon and steelhead handled at Fish Commission of Oregon hatcheries in 1967. Fish Commission of Oregon, Research Division.

Swartz, D.F. and J. Wallis. 1966. Number, size, and age composition of adult salmon and steelhead handled at Fish Commission of Oregon hatcheries in 1964. Fish Commission of Oregon.

U.S. Army Corps of Engineers. 1988. Willamette system temperature control study - Santiam River subbasin. Phase I report. Portland District, Portland, Oregon.

U.S. Forest Service. 1987a. Draft environmental impact statement, Willamette National Forest. U.S. Forest Service, Pacific Northwest Region, Portland, Oregon.

U.S. Forest Service. 1987b. Proposed land and resource management plan, Willamette National Forest. U.S. Forest Service, Pacific Northwest Region, Portland, Oregon.

Wade, M.G. and D.V. Buchanan. 1983. Development and assessment of steelhead in the Willamette River basin, annual report. Oregon Department of Fish and Wildlife, Portland, Oregon. 18 pp.

Wade, M.G., D.V. Buchanan and S.P. Trask. 1985. Restoration of the native winter steelhead run on the South Santiam above Foster Dam. Oregon Department of Fish and Wildlife annual progress report, Portland, Oregon. 22 pp.

Wagner, E. and P. Ingram. 1973. Evaluation of fish facilities and passage at Foster and Green Peter dams on the South Santiam River drainage in Oregon. Fish Commission of Oregon, Fish Research Project DAWC57-68-C-0013, Final Report, Portland, Oregon.

Wallis, J. 1964. A report on the size and age composition of adult salmon handled at Oregon Fish Commission hatcheries during the 1963-64 spawning season. Oregon Fish Commission.

Wallis, J. and W.A. Burck. 1961. A preliminary report on the size and age composition of adult salmon handled at Oregon Fish Commission hatcheries during the 1960-61 spawning season. Oregon Fish Commission Research Report. Clackamas, Oregon.

Wallis, J. and W.A. Burck. 1963. A report on the size and age composition of adult salmon handled at Oregon Fish Commission hatcheries during the 1962-63 spawning season. Oregon Fish Commission.

Wetherbee, J.J. and W.L. Hunt. 1982. A wild trout inventory of the Blowout Creek system. Oregon Department of Fish and Wildlife. Information Report Series, Fisheries No. 82-2.

Willamette Basin Task Force. 1969. The Willamette basin, comprehensive study of water and related land resources. Appendix D. Fish and Wildlife. Pacific Northwest River Basins Commission.

Willamette National Forest. 1989. Biology of the bull trout, *Salvelinus confluentus*, a literature review. Willamette National Forest, U.S.F.S., Eugene, Oregon.

Williams, L.H. 1972. Soil survey of the Marion County area, Oregon. USDA Soil Conservation Service.

Williams, R. 1983a. Coho salmon in the upper Willamette River, Oregon, Draft. Oregon Department of Fish and Wildlife, Portland, Oregon.

Williams, R. 1983b. Releases of coho salmon into the upper Willamette River, Oregon. Information Report No. 83-3, ODFW, Portland, Oregon.

APPENDICES

APPENDIX A
Winter Steelhead

Table A-1. Releases of hatchery winter steelhead in the Santiam subbasin by release site (ODFW, unpublished data).

Release year	Hatchery and stock	Number released: Fry	Fingerlings	Smolts	Release location
1978	Gnat Cr, Big Cr			19,076	Mill Cr.
	Marion Fks, No Santiam	96,038	23,435		Big Cliff Res.
1979	Roaring R, Big Cr		12,441		Roaring R.
	Marion Fks, No Santiam	75,586	29,000		Big Cliff Res.
	"			77,744	No. Santiam
1980	Roaring R, Big Cr		58,632		Santiam
	"			22,090	Mill Cr.
	Marion Fks, No Santiam			50,420	No. Santiam
	"	"		22,434	Green Peter Res.
	"			13,101	Foster Res.
	"			31,801	So. Santiam
	"		223,889		Thomas Cr.
1981	Marion Fks, No Santiam			62,679	No. Santiam
	"			10,000	Young Lk.
	"			14,943	Green Peter Res.
	"			19,781	Foster Res.
	"			35,257	So. Santiam
1982	Marion Fks, No Santiam	874			Horn Cr.
	"		28,130	39,454	No. Santiam
	"	"		9,752	Walter Wirth Pd.
	"		51,300		Quartzville Cr.
	"		51,300		Mid. Santiam
	"	"		15,174	Green Peter Res.
	"			15,675	Foster Res.
	"			30,736	So. Santiam
	So Santiam, So Santiam	1,748			Horn Cr.
	"	10,764			Quartzville Cr.
	"	10,764			Mid. Santiam
1983	Marion Fks, No Santiam		23,600	99,971	No. Santiam
	"			8,160	Mid. Santiam
	"			9,762	Green Peter Res.
	"	"		16,368	Foster Res.
	"			17,054	So. Santiam
	"		61,150		Crabtree Cr.
1984	Marion Fks, No Santiam		8,337	2,483	Horn Cr.
	"			22,898	No. Santiam
	"	49,222			Quartzville Cr.
1984	Marion Fks, No Santiam			1,999	Mid. Santiam
	"	"		13,014	Green Peter Res.
	"			11,088	Foster Res.
	"			23,001	So. Santiam
	So Santiam, So Santiam			21,064	No. Santiam
	"	"	8,537		Quartzville Cr.

(continued)

Table A-1 continued.

Release year	Hatchery and stock	Number released			Release location
		Fry	Fingerlings	Smolts	
1985	Roaring R, Klaskanine		8,504		Crabtree Cr.
	Marion Fks, No Santiam			3,221	Horn Cr.
	"			45,390	No. Santiam
	"		21,483	271	Quartzville Cr.
	"	"	16,110	281	Mid. Santiam
	"	63,449	10,347	20,200	Green Peter Res.
	"			22,490	So. Santiam
	So Santiam, So Santiam	39,916	8,653		Quartzville Cr.
	"	29,535			Mid. Santiam
	"	5,200			Green Peter Res.
1986	Marion Fks, No Santiam			11,690	Horn Cr.
	"			48,060	No. Santiam
	"	"	20,404		Pyramid Cr.
	"		20,420		Quartzville Cr.
	"		20,273	31,232	Green Peter Res.
	"			12,617	So. Santiam
	So Santiam, So Santiam		14,175		So. Santiam
1987	Marion Fks, No Santiam			110,102	No. Santiam
	"	"		532	Green Peter Res.
1988	Marion Fks, No Santiam			116,745	No. Santiam
1989	Marion Fks, No Santiam			85,490	No. Santiam
1990	Marion Fks, No Santiam			93,442	No. Santiam

APPENDIX B
Summer Steelhead

Table B-1. Releases of Skamania stock hatchery summer steelhead in the Santiam subbasin by release site (ODFW, unpublished data).

Release year	Hatchery	Number released: Fingerlings	Number released: Smolts	Release location
1976	Alsea		106,690	No. Santiam
	Roaring River		163,560	So. Santiam
	South Santiam		40,970	Minto
			41,129	No. Santiam
			110,304	So. Santiam
1977	Alsea		106,987	Santiam
	Roaring River		41,771	No. Santiam
			41,310	So. Santiam
			2,750	Roaring River
	South Santiam	7,191		Sunnyside Pk.Pd.
			19,838	No. Santiam
			122,907	So. Santiam
1978	Alsea		53,324	No. Santiam
			77,298	So. Santiam
	Roaring River	5,986		Roaring River
			41,370	No. Santiam
			41,732	So. Santiam
1979	Alsea		100,503	No. Santiam
	Roaring River	58,824		Santiam
			68,949	So. Santiam
			7,725	Roaring River
	South Santiam	26,638	84,542	No. Santiam
			80,152	So. Santiam
1980	Alsea		85,673	No. Santiam
			40,008	So. Santiam
	Roaring River	18,654		Santiam
			39,995	No. Santiam
			41,052	So. Santiam
		6,116		Roaring River
	South Santiam		93,551	No. Santiam
			97,614	So. Santiam
1981	Alsea		81,665	No. Santiam
			42,218	So. Santiam
	Oak Springs		45,157	No. Santiam
	Roaring River		41,631	No. Santiam
			40,138	So. Santiam
	South Santiam		18,701	No. Santiam
			63,321	So. Santiam
1982	Oak Springs		64,998	No. Santiam
	Roaring River		40,335	No. Santiam
			36,140	So. Santiam
	South Santiam	64,980	30,272	No. Santiam
		36,733	109,061	So. Santiam
	Trojan Ponds		30,305	No. Santiam

(continued)

Table B-1 continued.

Release year	Hatchery	Number released: Fingerlings	Number released: Smolts	Release location
1983	Gnat Creek		43,827	No. Santiam
	McKenzie		35,269	No. Santiam
	Roaring River		17,898	Little No. Santiam
			55,078	No. Santiam
	South Santiam	20,940	134,176	No. Santiam
		57,209	126,524	So. Santiam
1984	Marion Forks		13,420	No. Santiam
	Roaring River		25,736	Little No. Santiam
			30,294	No. Santiam
	South Santiam		35,550	No. Santiam
		25,173	139,235	So. Santiam
	Willamette		68,542	No. Santiam
1985	McKenzie		41,168	No. Santiam
	Roaring River		17,748	Little No. Santiam
			116,503	No. Santiam
	South Santiam	33,406	157,671	No. Santiam
			140,587	So. Santiam
1986	McKenzie		39,977	No. Santiam
	Roaring River	30,303	12,524	Little No. Santiam
			102,133	No. Santiam
	South Santiam	2,768	149,727	So. Santiam
			604	Green Peter Reservoir
1987	McKenzie		38,622	No. Santiam
	Roaring River		20,073	Little No. Santiam
			51,467	No. Santiam
	Willamette		83,048	No. Santiam
			160,043	So. Santiam
1988	McKenzie		29,700	No. Santiam
	Roaring River		22,578	Little No. Santiam
			91,609	No. Santiam
	South Santiam		40,700	No. Santiam
			160,950	So. Santiam
1989	McKenzie		40,091	No. Santiam
	Roaring River		110,051	No. Santiam
	South Santiam		15,181	Little No. Santiam
			20,007	No. Santiam
			160,102	So. Santiam
1990	McKenzie		41,424	No. Santiam
	Roaring River		20,024	Little No. Santiam
			103,688	No. Santiam
	South Santiam		31,625	No. Santiam
			163,727	So. Santiam

APPENDIX C
Spring Chinook

Table C-1. Releases of hatchery spring chinook in the Santiam and Calapooia subbasins (ODFW, unpublished data).

Release year	Hatchery	Number released: Fry	Fingerlings	Smolts	Release location
1958	Marion Forks			51,815	Little No. Santiam
			134,895		North Santiam
	South Santiam		182,657		South Santiam
			19,992		Wiley Creek
			33,705		Quartzville Creek
1959	Marion Forks	512,080	1,615,632		North Santiam
		200,000			Little No. Santiam
	South Santiam		62,967		South Santiam
1960	Marion Forks		1,092,163		North Santiam
	South Santiam		81,925		South Santiam
1961	Marion Forks		1,810,841		North Santiam
	South Santiam		273,140		South Santiam
1962	Marion Forks		1,415,536		North Santiam
	South Santiam			154,118	Middle Santiam
1963	Marion Forks		1,503,305		North Santiam
	South Santiam		157,893		South Santiam
1964	Marion Forks		1,225,857		North Santiam
		747,790			Big Cliff Res.
		1,677,427			Horn Creek
	South Santiam		147,751		Middle Santiam
1965	Marion Forks		1,934,146		North Santiam
			8,644		Horn Creek
1966	Marion Forks	1,212,927	161,884		North Santiam
			32,125		Dry Creek
			36,066		Big Cliff Res.
	South Santiam		147,026		Middle Santiam
1967	Marion Forks		2,108,793		North Santiam
	South Santiam		146,607		Middle Santiam
	Willamette		267,746		South Santiam

(continued)

Table C-1 continued.

Release year	Hatchery	Number released Fry	Fingerlings	Smolts	Release location
1968	Marion Forks		2,408,234	141,912	North Santiam
		312,908			Canal Fork
		596,496			Quartzville Cr.
		88,128			Packers Gulch Cr.
		87,423			Yellowstone Cr.
		602,403			Middle Santiam
	South Santiam		147,781		Middle Santiam
				190,148	Green Peter Res.
				246,450	South Santiam
	Willamette			31,710	South Santiam
1969	Marion Forks		649,276	77,473	North Santiam
			102,521		Quartzville Cr.
		102,000		15,310	South Santiam
	South Santiam	274,010			Green Peter Res.
			53,322	70,955	South Santiam
	Willamette	148,000			Quartz Creek
		220,173			Green Peter Res.
1970	Marion Forks		1,310,299	88,574	Minto Dam
				352,730	North Santiam
		791,302			Quartzville Cr.
		373,877			Packers Gulch Cr.
		384,203			Canal Creek
		2,647,210	15,443		Green Peter Res.
			5,338		South Santiam
	South Santiam	650,840			Green Peter Res.
			214,114	335,176	South Santiam
1971	Marion Forks		346,084	248,066	North Santiam
	South Santiam	1,401,581			Green Peter Res.
				19,865	Foster Res.
				285,451	South Santiam
1972	Marion Forks		1,029,832	73,792	Minto Dam
	South Santiam	463,217			Green Peter Res.
				141,815	South Santiam
	Willamette	2,074,174			Green Peter Res.
1973	Marion Forks		668,907	345,976	Minto Dam
	South Santiam	338,955			Green Peter Res.
				38,469	South Santiam
	Willamette	210,433			Green Peter Res.

(continued)

Table C-1 continued.

Release year	Hatchery	Number released			Release location
		Fry	Fingerlings	Smolts	
1974	Marion Forks		632,143	397,777	Minto Dam
	South Santiam	411,620			Moose Creek
		1,127,996			Green Peter Res.
		152,687	198,632		South Santiam
	Willamette			215,068	Foster Dam
1975	Marion Forks		1,322,053	683,293	Minto Dam
	South Santiam			332,235	South Santiam
	Willamette	1,818,961			Green Peter Res.
1976	Marion Forks			667,117	Minto Dam
			248,050	245,181	North Santiam
	South Santiam			105,363	South Santiam
1977	Marion Forks		100,916	293,760	North Santiam
	South Santiam			199,816	South Santiam
1978	Marion Forks	2,208			Detroit Res.
			340,941	359,182	North Santiam
1979	Marion Forks		961,273		North Santiam
		676,057			Green Peter Res.
	South Santiam			106,821	South Santiam
1980	Marion Forks		881,847		North Santiam
		321,030	74,652		Green Peter Res.
	South Santiam			258,489	South Santiam
1981	Marion Forks		153,567	441,225	North Santiam
	South Santiam			214,532	South Santiam
	Willamette	1,557,634	271,057		Green Peter Res.
				244,506	South Santiam
				3,624	Calapooia River
1982	Marion Forks		187,121	473,021	North Santiam
	South Santiam			237,531	South Santiam
	Willamette	2,258,035			Green Peter Res.
				252,207	South Santiam
	McKenzie	41,540			Green Peter Res.
				25,439	Calapooia River

(continued)

Table C-1 continued.

Release year	Hatchery	Number released			Release location
		Fry	Fingerlings	Smolts	
1983	Marion Forks	153,112			Little No. Santiam
		80,150	427,350	557,255	North Santiam
		151,250			Thomas Creek
		108,228			Middle Santiam
		174,900			Foster Res.
		210,700			South Santiam
	South Santiam			394,280	South Santiam
	Willamette	150,160			Crabtree Creek
		1,999,180			Green Peter Res.
		251,241			South Santiam
		100,094			Calapooia River
	Dexter			161,263	North Santiam
				24,868	Calapooia River
1984	Marion Forks			627,781	North Santiam
		28,421			Horn Creek
	South Santiam			302,738	South Santiam
	Willamette	204,160			Little No. Santiam
		196,014	5,950		Crabtree Creek
		115,994	53,666		Thomas Creek
		1,999,713			Green Peter Res.
		145,517	55,596		South Santiam
		149,845			Calapooia River
	Dexter			172,177	South Santiam
	McKenzie			200,760	South Santiam
1985	Marion Forks			361,377	North Santiam
		13,929			Horn Creek
	South Santiam			279,363	South Santiam
	Willamette	150,478			Thomas Creek
		1,893,430	106,750		Green Peter Res.
		150,322	46,308	94,102	South Santiam
		200,276			Calapooia River
	Dexter			573,446	South Santiam
				20,821	Calapooia River
	Stayton Pond		2,964	5,287	North Santiam
1986	Marion Forks			475,134	North Santiam
	South Santiam			255,864	South Santiam
	Willamette	500,240			Green Peter Res.
		420,200		104,494	South Santiam
	Dexter			515,854	South Santiam

(continued)

Table C-1 continued.

Release year	Hatchery	Number released			Release location
		Fry	Fingerlings	Smolts	
1987	Marion Forks			497,745	North Santiam
				33,316	South Santiam
	South Santiam			74,953	South Santiam
	Willamette			228,216	South Santiam
	Dexter			166,700	South Santiam
1988	Marion Forks			557,671	North Santiam
	South Santiam			166,212	South Santiam
	Willamette			763,645	South Santiam
1989	Marion Forks			496,474	North Santiam
				15,576	South Santiam
	South Santiam			226,656	South Santiam
	Willamette			884,573	South Santiam
1990	Marion Forks			450,352	North Santiam
	South Santiam			246,347	South Santiam
	Willamette			693,993	South Santiam

APPENDIX D
Fall Chinook

Table D-1. Releases of hatchery fall chinook in the Santiam and Calapooia subbasins by release site (ODFW, unpublished data).

Release year	Hatchery	Number released: Fry & Fingerlings	Number released: Smolts	Release location
1965	Bonneville	800,000		South Santiam R.
	Ox Bow	860,790		North Santiam R.
1966	Big Creek	500,187		North Santiam R.
	Cascade	350,000		North Santiam R.
	Ox Bow	499,994		South Santiam R.
1967	Bonneville	500,000		Thomas Creek
		2,000,000		South Santiam R.
		485,000		Calapooia R.
	Cascade	504,432		North Santiam R.
		785,000		Calapooia R.
	Ox Bow	795,000		Little No. Santiam
		408,000		North Santiam R.
		396,000		Stout Creek
1968	Big Creek	114,070		Santiam R.
		257,298		South Santiam R.
	Bonneville	172,572		North Santiam R.
		100,076		Stayton Pond
		511,274		Santiam R.
		495,658		South Santiam R.
	Cascade	521,400		North Santiam R.
		1,254,815		Calapooia R.
	Salem Pond		1,741,317	Mill Creek
1969	Big Creek		246,140	South Santiam R.
	Sandy	48,876		Foster Reservoir
	Salem Pond		1,248,796	Mill Creek
	Stayton Pond		29,459	North Santiam R.
1970	Aumsville Ponds		4,899,780	South Santiam R.
	Salem Pond		380,525	Mill Creek
	Stayton Pond	4,120,074		North Santiam R.
1971	Aumsville Ponds	792,238	4,531,460	North Santiam R.
	Salem Pond	10,080	464,693	Mill Creek
	Stayton Pond		3,737,296	North Santiam R.

(continued)

Table D-1 continued.

Release year	Hatchery	Number released: Fry & Fingerlings	Smolts	Release location
1972	Aumsville Ponds		3,758,318	South Santiam R.
			106,296	Mill Creek
	Salem Pond		867,790	Mill Creek
	Stayton Pond		3,831,618	Stayton Pond
1973	Aumsville Ponds		3,391,307	South Santiam R.
			1,541,660	Mill Creek
	Salem Pond		1,749,294	Mill Creek
	Stayton Pond		4,365,456	North Santiam R.
1974	Aumsville Ponds		2,386,835	Mill Creek
			1,477,388	South Santiam R.
	Stayton Pond		4,019,625	North Santiam R.
			1,512,154	South Santiam R.
1975	Aumsville Ponds		1,409,793	Mill Creek
			3,977,710	North Santiam R.
			2,034,782	Crabtree Creek
1976	Aumsville Ponds		1,170,048	Crabtree Creek
			163,222	South Santiam R.
	Stayton Pond		62,700	Crabtree Creek
			873,561	South Santiam R.
1977	Aumsville-Stayton Pond		259,075	Mill Creek
1979	Stayton Pond		421,353	North Santiam R.
			380,645	Santiam R.
			1,862,860	South Santiam R.
1980	Stayton Pond		263,225	Santiam R.
		71,065	713,655	North Santiam R.
			382,525	Santiam R.
			2,189,665	South Santiam R.
1981	Aumsville-Stayton Pond		393,087	Santiam R.
			1,325,094	North Santiam R.
			1,858,481	South Santiam R.
1982	Stayton Pond		1,368,866	North Santiam R.
			398,020	Santiam R.
			2,300,940	South Santiam R.
1983	Stayton Pond		1,885,821	Mill Creek
			1,460,531	North Santiam R.
			77,507	Santiam R.
			1,851,156	South Santiam R.

(continued)

Table D-1 continued.

Release year	Hatchery	Number released: Fry & Fingerlings	Number released: Smolts	Release location
1984	Stayton Pond		614,118	Mill Creek
			1,197,007	North Santiam R.
			1,404,450	South Santiam R.
1985	Stayton Pond		624,951	Mill Creek
			70,379	North Santiam R.
1986	Stayton Pond		1,021,959	Mill Creek
			1,207,099	North Santiam R.
			813,522	South Santiam R.
1987	Stayton Pond		1,010,995	Mill Creek
			1,137,846	Santiam R.
			1,543,769	South Santiam R.
1988	Stayton Pond		904,387	Mill Creek
			855,508	Santiam R. and North Santiam R.
			1,448,118	South Santiam R.
1989	Stayton Pond		521,371	Mill Creek
			971,932	Santiam R. and North Santiam R.
			1,270,355	South Santiam R.
1990	Stayton Pond		1,002,457	Mill Creek
			613,776	Santiam R. and North Santiam R.
			1,212,604	South Santiam R.

APPENDIX E
Trout

Table E-1. Population estimates of rainbow trout in the Blowout Creek system, 1980 (Wetherbee and Hunt 1982).

Stream	Miles of fish production	No. of trout	Fish per mile
Blowout Cr.	9.5	3,879	408
Beard Cr.	0.9	0	0
Kay Cr.	1.4	24	17
Cliff Cr.	2.1	388	185
Little Cliff Cr.	0.5	0	0
Divide Cr.	2.6	96	37
tributaries	0.5	0	0
Ivy Cr.	2.1	563	268
Lost Cr.	0.5	0	0
Total	20.1	4,950	246

Table E-2. Population estimates of rainbow trout in the Quartzville Creek drainage, 1982 (J.J. Wetherbee, ODFW, unpublished data).

Stream and site	No. of fish	Fish per mile	Density (fish/m^2)
Packer's Gulch			
RM 0.1	7	272	0.02
RM 2.1	6	160	0.01
Canal Creek			
RM 0.1	24	944	0.07
Elk Creek			
RM 0.7	5	112	0.01
RM 0.9	2	64	0.01
RM 1.1	10	160	0.02
RM 2.1	1	32	<0.01
RM 2.2	0	0	0.00
RM 2.6	0	0	0.00

Table E-3. Population estimates of trout in the Middle Santiam drainage, 1979 (unpublished data in letter from P. Bisson to W. Hunt, ODFW, Salem, Oregon).

Site	Reach length (miles)	No.		Fish/mile	
		Ct	Rb/St	Ct	Rb/St
Upper Bear Cr. (old growth)	0.031	65	50	2,092	1,609
Bear Cr. tributary (clear cut)	0.031	57	24	1,835	772
Lower Bear Cr. (old growth)	0.031	31	19	998	612
Mid. Santiam R. near mouth of Bear Cr.	0.057	3	12	53	212
pool nr. mouth of Bear Cr.	0.015	4	10	268	671

Table E-4. Population estimates of trout in the Middle Santiam River, 1988-89 (K. Moore, Oregon State University, unpublished data).

Reach	Fish per mile		Species composition[a]
	fry	adults	
Lower (RM 15-23)	80	192	2/3 Rb, 1/3 Ct
Middle (RM 23-29)	80	368	
Upper (RM 29-36)	240	608	1/3 Rb, 2/3 Ct

[a] Rb = rainbow trout, Ct = cutthroat trout.

Table E-5. Age specific length data for rainbow trout in Blowout Creek, 1980 (Hunt 1982 and Wetherbee and Hunt 1982).

Age class	N	Size range (inches)	Mean length (inches)	Age at legal size
I	40	3.1-5.9	4.6	
II	31	3.9-10.1	6.1	2
III	1	7.3	7.3	
IV	3	6.9-7.5	7.2	

Table E-6. Abundance of cutthroat trout larger than 6 inches in reaches of Santiam subbasin tributaries (Nicholas 1978).

		Abundance of trout			
Stream	Length Year	Fish/ (miles)	Density mile	Sample (fish/m^2)	method
Big Cr. (Little No. Santiam)	1975	0.04	262	---	Rotenone
Elk Cr.	1975	0.06	262	---	Rotenone
	1977[a]	0.02	193	0.019	Shocker
	1977[b]	0.14	72	0.007	Shocker
Galena Cr.	1977	0.11	93	0.012	Shocker
So. Tally Cr.	1975	0.02	317	---	Rotenone
Tally Cr.	1975	0.02	53	---	Rotenone

[a] Above falls.
[b] Below falls.

Table E-7. Population estimate of cutthroat trout in the Blowout Creek system, 1980 (Wetherbee and Hunt 1982).

Stream	Miles of fish production	No. of trout	Fish per mile
Blowout Cr.	9.5	2,630	277
Beard Cr.	0.9	1,724	1,916
Kay Cr.	1.4	1,825	1,304
Cliff Cr.	2.1	1,266	603
Little Cliff Cr.	0.5	585	1,170
Divide Cr.	2.6	4,625	1,779
tributaries	0.5	1,662	3,324
Ivy Cr.	2.1	1,812	863
Lost Cr.	0.5	521	1,042
Total	20.1	16,650	1,364

Table E-8. Cutthroat population estimates in the Quartzville Creek drainage, 1977 and 1982 (M. Montgomery, ODFW, unpublished data and J.J. Wetherbee, ODFW unpublished data).

Stream and site	No. of fish	Fish per mile	Density	
			Fish/m^2	g/m^2
Packer's Gulch[a]				
RM 0.1	0	0	0.00	
RM 2.1	40	1,040	0.10	
Canal Creek[a]				
RM 0.1	2	80	0.01	
Elk Creek[b]	59	230	0.04	1.30
RM 0.7[a]	10	224	0.02	
RM 0.9[a]	26	752	0.11	
RM 1.1[a]	54	832	0.10	
RM 2.1[a]	25	784	0.10	
RM 2.2[a]	128	3,984	0.60	
RM 2.6[a]	153	6,352	1.20	
Galena Creek[b]	71	410	0.08	1.79

[a] From J.J. Wetherbee, ODFW, unpublished data for 1982.
[b] From M. Montgomery, ODFW, unpublished data for 1977.

Table E-9. Modified Schnabel population estimate of legal sized cutthroat trout (>6 inches) in the Santiam River, computed from tag and recapture trips, late March to late June 1976 and 1977 (modified from Moring 1977).

	1976	1977
Reach length surveyed	RM 0.0-6.0	RM 0.0-9.5
Population estimate	316	350
Poisson confidence limits	226-508	235-690
Fish/mile and confidence limits ()	52.9 (37.8-85.1)	36.9 (24.8-72.6)

Table E-10. Density (number/m^2) of cutthroat trout in forested and clear-cut reaches of Minto Creek, Linn County (C. Frissell, Oregon State University, unpublished data).

Year	Stream reach	Reach length (mi)	No. fish	No. fish >6"	Fish/ mile	Fish >6" per mile	Area (m^2)	Density (fish/m^2)
1984[a]	Forested	0.08	36	6	450	6	691	0.05
	Clear-cut	0.08	34	4	425	50	829	0.04
1985[b]	Forested	0.08	51	11	640	135	541	0.09
	Clear-cut	0.09	54	11	600	120	776	0.07
1986[b]	Forested	0.10	99	26	990	220	866	0.11
	Clear-cut	0.12	87	26	725	215	1,046	0.08
1987[b]	Forested	0.10	85	16	850	160	866	0.10
	Clear-cut	0.12	105	27	875	225	1,046	0.10
1988[b]	Forested	0.10	83	18	830	180	866	0.10
	Clear-cut	0.12	87	21	725	175	1,046	0.08
1989[b]	Forested	0.10	88	20	880	200	866	0.10
	Clear-cut	0.12	64	10	980	85	1,046	0.06
1990[b]	Forested	0.10	98	15	980	150	866	0.11
	Clear-cut	0.12	85	30	710	250	1,046	0.08
1985-90 Average:								
	Forested	0.10	84	18	860	180	812	0.10
	Clear-cut	0.12	80	21	770	180	962	0.08

[a] Data from electroshocking surveys.
[b] Data from visual observations supplemented by some electroshocking.

Table E-11. Population estimates of cutthroat trout in the Calapooia subbasin based on electrofishing surveys (J.J. Wetherbee, ODFW, unpublished data).

Stream	Date	Reach length (miles)	No. fish	Size range (inches)
Courtney Cr.	10/29/79	0.006	1	---
Warren Cr.	10/29/79	0.019	1	5.8
West Brush Cr.	9/11/79	0.019	5	4.3-6.8
East Brush Cr.	12/22/78	0.062	3	5.6-7.4
	9/11/79	0.066	44	1.9-7.8
Cork Boot Cr.	8/2/78	0.031	15	2.6-7.4
	12/22/78	0.031	3	6.1-7.3
	9/11/79	0.028	21	2.4-6.4
Bigs Cr.	5/2/78	0.016	1	3.5
Hands Cr.	5/2/78	0.031	11	3.1-6.5
E. Fk. Potts Cr.	9/12/79	0.019	22	<2.8-7.0
W. Fk. Potts Cr.	9/12/79	0.019	9	<2.8-4.0
N. Fk. Calapooia	6/22/79	0.065	7	1.4-5.6
Calapooia R.	6/22/79	0.067	15	5.3
(headwaters)	9/11/79	0.028	3	2.8-6.7

Table E-12. Cutthroat trout population age structure in Santiam and Calapooia subbasin streams (Moring and Youker 1979).

Subbasin and stream	Age at legal size	N	Age 0	1	2	3
North Santiam						
Fish Cr.	unknown	2	0	1	1	0
Rock Cr.	unknown	3	0	3	0	0
Total		5	0	4	1	0
%		--	0	80.0	20.0	0
South Santiam						
Church Cr.	2	4	0	0	3	1
Lewis Cr.	unknown[a]	1	0	0	1	0
Marita Cr.	unknown	1	0	1	0	0
Moose Cr.	2-3	84	0	19	55	10
Morgan Cr.	unknown	1	0	1	0	0
Packer's Gulch	1-2	4	0	1	3	0
Rock Cr.	2	5	0	2	3	0
Sheep Cr.	unknown	1	0	1	0	0
Soda Fk.	2-3[b]	147	0	75	61	11
Toad Cr.	unknown	5	1	1	3	0
Total		254	1	101	130	22
%		--	0.4	39.8	51.2	8.7
Thomas Cr.						
Anderson Cr.	2-3	4	0	0	4	0
Burmester Cr.	2	1	0	0	1	0
Criminal Cr.	2-3	10	1	1	7	1
Hall Cr.	2	3	0	0	3	0
Indian Prairie Cr.	unknown	4	2	2	0	0
Wade Cr.	unknown[a]	22	8	11	3	0
Total		44	11	14	18	1
%		--	25.0	31.8	40.9	2.3
Calapooia River						
Bigs Cr.	unknown	1	0	1	0	0
Cork Boot Cr.	2	14	2	3	7	2
E. Brush Cr.	2-3	2	0	0	1	1
Hands Cr.	2	9	0	5	4	0
Total		26	2	9	12	3
%		--	7.7	34.6	46.2	11.5

[a] Probably age 2.
[b] Primarily age 3.

Table E-13. Comparison of age structure of cutthroat trout populations in large rivers in the Santiam subbasin (Moring and Youker 1979).

River	Age at legal size	N	Age 0	1	2	3	4	5	6
Santiam									
	2	250	0	13	178	43	15	1	0
%			0.0	5.2	71.2	17.2	6.0	0.4	0.0
No. Santiam									
	2	64	0	2	24	29	8	0	1
%			0.0	3.1	37.5	45.3	12.5	0.0	1.6
So. Santiam									
	2	66	0	2	23	26	12	3	0
%			0.0	3.0	34.8	39.4	18.2	4.5	0.0
Total			0	17	225	98	35	4	1
%			0.0	4.5	59.2	25.8	9.2	1.1	0.3

Table E-14. Age specific length data for cutthroat trout in Blowout Creek, 1980 (modified from Hunt 1982).

Age class	N	Size range (inches)	Mean length	Age at legal size
I	58	3.1-6.2	4.3	
II	101	4.1-8.7	5.7	2, 3
III	19	5.9-8.7	7.0	
IV	2	7.4-8.7	8.1	

Table E-15. Size class distribution of cutthroat trout in Minto Creek, Linn County, 1984-89 (C. Frissell, Oregon State University, unpublished data).

Year	Reach	N	No. fish and % () of total by size (in)			
			0-2.3	2.4-3.9	4.0-5.5	5.6-12.0
1984[a]	Forested	36	3 (8)	20 (56)	7 (19)	6 (17)
	Clear-cut	29	0 (0)	11 (38)	14 (48)	4 (14)
1985[b]	Forested	51	9 (18)	17 (33)	14 (27)	11 (22)
	Clear-cut	54	11 (20)	17 (31)	15 (28)	11 (20)
1986[b]	Forested	99	18 (18)	32 (32)	23 (23)	26 (26)
	Clear-cut	85	4 (5)	21 (25)	34 (40)	26 (31)
1987[b]	Forested	118	17 (14)	55 (47)	30 (25)	16 (14)
	Clear-cut	123	20 (16)	48 (39)	28 (23)	27 (22)
1988[b]	Forested	83	11 (13)	27 (33)	27 (33)	18 (22)
	Clear-cut	87	14 (16)	20 (23)	32 (37)	21 (24)
1989[b]	Forested	88	30 (34)	16 (18)	22 (25)	20 (23)
	Clear-cut	64	5 (8)	19 (30)	30 (47)	10 (16)
1990[b]	Forested	98	25 (26)	35 (36)	23 (23)	15 (15)
	Clear-cut	85	12 (14)	26 (31)	17 (20)	30 (35)
1985-90 Average:						
	Forested	90	18 (20)	30 (23)	23 (26)	18 (20)
	Clear-cut	83	11 (13)	25 (30)	26 (31)	21 (25)

[a] Data from electroshocking surveys.
[b] Data from visual observations supplemented by some electroshocking.

Table E-16. Age specific lengths for cutthroat trout from the Santiam River (n=230), 1976-78 (Moring 1978).

Age	Fork length range (inches)
1	5.1-6.3
2	4.7-10.6
3	5.5-12.2
4	6.3-15.0

Table E-17. Age specific length ranges for cutthroat in large rivers and drainage systems of the Santiam and Calapooia subbasins (Moring and Youker 1979).

Stream or drainage	Fork length range (inches) at age					
	1	2	3	4	5	6
Santiam R.	5.1-6.7	4.9-9.6	5.6-12.2	6.5-15.2	11.4	---
No. Santiam R.	4.6-5.1	5.3-11.4	7.1-13.3	11.1-15.7	---	17.7
No. Santiam drainage	4.6-4.8	5.2-8.0	9.8	---	---	---
So. Santiam R.	6.1-7.2	5.4-9.6	8.0-12.2	10.2-12.5	11.7-12.1	---
So. Santiam drainage	2.6-5.4	3.7-7.7	5.9-8.1	---	---	---
Thomas Cr. drainage	4.0-4.4	4.4-7.0	6.8	---	---	---
Calapooia drainage	3.1-4.6	4.4-7.3	5.6-7.3	---	---	---