APPENDIX D: *FISH STOCK STATUS, HABITAT, AND HISTORIC DISTURBANCES*

FISH STOCK STATUS AND TRENDS

INTRODUCTION

This technical memorandum summarizes available information on the fish populations, stock status, and population trends of primarily salmonid fish in the riverine environments of the Chehalis River. Estuarine and salt water species, or saltwater lifestages of anadromous species, will not be addressed.

Information on fish populations and stock status within the Chehalis Basin has generally focused on salmon and trout, and is summarized in three reports developed by the Washington Dept. of Fish & Wildlife and the Western Washington treaty Indian tribes (SASSI, 1993; WDFW 1998a, 1998b). Since these reports summarize available information, stock status and trends will be discussed for chinook, coho, and chum salmon, steelhead trout, bull trout/Dolly Varden, and coastal cutthroat trout. Bull trout and Dolly Varden will be discussed as one species complex, since there is little information for this watershed with which to distinguish them (Table D-1) (WDFW, 1998b).

Table D-2 lists other native fish species, about which little basin-specific population information is known other than their presence in the fish assemblages of the Chehalis Basin, or within forested ecosystems of the Pacific Northwest (Wydoski and Whitney, 1979). In addition, two non-native trout species, brook trout and rainbow trout, have been introduced to some lakes and streams within the watershed. Little is known about their distribution and status, although populations appear to be small (Baxter, 1996; Baitis and Kuzis, 1999). These native and introduced species will not be discussed further.

Definitions used in the stock status reports are as follows:

A "stock" is the fish spawning in a particular lake or stream(s) at a particular season, which fish to a substantial degree do not interbreed with any group spawning in a different place, or in the same place in a different season. Stocks can be comprised of fish of native genetic heritage, non-native heritage, or mixed genetic heritage. Production (reproduction) can be in the wild (natural), supported by hatchery operations (cultured), or sustained by both artificial and natural reduction (composite).

"Critical stocks" are those that have declined in numbers to the point that the stock is in jeopardy of significant loss of in-stock diversity, or in the worst case, extinction.

"Depressed stocks" are those whose production is below expected levels, based on available habitat and natural variations in survival rates, but above the level here permanent damage to the stock is likely. The management intent is to restore these stocks to fishable levels.

"Healthy stocks" covered a wide range of conditions, from robust to those without surplus production for harvest. A healthy listing in this assessment does not mean that managers have no concerns, or that production levels are adequate (SASSI, 1993). It should be noted that, even with positive trends, most anadromous stocks present in the Chehalis Basin are far fewer than their historical numbers, and concerns about declines in fish habitat and fish production are not new (Hiss and Knudsen, 1992; Phinney et al., 1975). Conditions in individual streams will vary; problems and opportunities for restoration will vary as well.

"Escapement" is the number of fish that survive natural and human-caused mortality to spawn. A "run size estimate" is made by combining estimates of fishing harvest and escapement numbers.

STOCKS AND SUBBASINS

Stocks distinguished using genetic analysis are often named for the river(s) they are most commonly found in. In the Chehalis River watershed, fish spawning upstream of the Satsop River to the headwaters are generally grouped as one Chehalis stock, while the Humptulips, Hoquiam, Wishkah, Wynoochee, and Satsop stocks are generally distinguished from one another. This is not always the case, however. For instance, Skookumchuck/Newaukum winter steelhead are distinguished as a separate stock, bull trout/Dolly Varden are distinguished only as the larger "Grays Harbor/Chehalis" stock, and coastal cutthroat trout stocks are distinguished for the "Grays Harbor/Willapa Bay" distribution area. This is a function of the different levels of historic and current information available for different salmonid species.

STOCK STATUS AND POPULATION TRENDS

A total of two spring chinook stocks, seven fall chinook stocks, two chum stocks, seven coho stocks, two summer steelhead stocks, eight winter steelhead stocks, one bull trout/Dolly Varden stock, and two coastal cutthroat stocks have been identified in the Chehalis watershed. No pink salmon or sockeye salmon stocks were identified in this area (SASSI, 1993; WDFW, 1998a, 2000).

Some population trend information is available for some stocks but unknown for others. Trends in population identified by the SASSI report summarize information up to 1992 for most species. Trends in population identified for coastal cutthroat trout were summarized as of 1999, and for bull trout/Dolly Varden up to 1998 (WDFW, 1998, 2000).

Of the thirty-one stocks identified, stocks classed as “healthy” included:

- Chehalis spring chinook,
- Humptulips, Hoquiam, Wishkah, Wynoochee, Satsop and Chehalis fall chinook,
- Humptulips and Chehalis fall chum,
- all seven coho stocks in the watershed, and
- Humptulips, Hoquiam, Wishkah and Wynoochee winter steelhead.

Stocks classed as “depressed” included:

- Satsop summer chinook, and
- Satsop and Skookumchuck/Newaukum winter steelhead.

Stocks classed as “unknown” included: Johns/Elk fall chinook, Humptulips and Chehalis summer steelhead, South Harbor streams winter steelhead, and bull trout/Dolly Varden for the entire Grays Harbor/Chehalis area, and coastal cutthroat trout for both the Humptulips and Chehalis (SASSI, 1993; WDFW, 1998b, 2000).

One stock, Wynoochee spring chinook, was classed as “disputed”. During the development of the SASSI report, disputes arose between biologists. The main issue of dispute was the historical and current presence of six early-timed spring chinook stocks, including one in the Wynoochee River (SASSI, 1993). Nehlsen et al. (1991), using somewhat different criteria than used in SASSI, cited Wynoochee spring chinook as “at a high risk of extinction.”

Some population trend information was identified. A stable or positive population trend was identified for Chehalis spring chinook, all of the fall chinook stocks except Johns/Elk and South Bay tributaries.

Negative trends were identified for Satsop summer chinook, and Satsop and Skookumchuck/ Newaukum winter steelhead. These trends gave rise to the depressed classification for these populations.

Population trends of “unknown” were identified for Johns/Elk and South Bay tributaries fall chinook, Humptulips and Chehalis summer steelhead, South Harbor winter steelhead, Humptulips and Chehalis coastal cutthroat trout, and bull trout/Dolly Varden for the entire basin (SASSI, 1993; WDFW, 1998b, 2000). Wynoochee spring chinook were also identified as “unknown”, but the trend is probably negative, as discussed above.

No population trends were identified for the “healthy” Humptulips and Chehalis fall chum stocks; all seven coho stocks; and Chehalis, Humptulips, Hoquiam, Wishkah, and Wynoochee winter steelhead stocks (SASSI, 1993).

Table D-1. Stock origin, status and production type for salmon and char in the Chehalis watershed. (Sources include: SASSI, 1993; WDFW, 1998, 2000.) Population trends are listed where known, or defined as unknown by investigators.

Stock Name	Stock Origin	Production Type	Stock Status	Population Trend
Spring Chinook (Oncorhynchus tshawytscha)				
Chehalis	Native	Wild	Healthy	Stable or positive[1]
Wynoochee	Native	Wild	Disputed	Unknown
Summer Chinook				
Satsop	Mixed	Wild	Depressed	Negative [2]
Fall Chinook				
Humptulips	Mixed	Wild	Healthy	Positive [3]
Hoquiam	Native	Wild	Healthy	
Wishkah	Native	Composite	Healthy	
Wynoochee	Native	Wild	Healthy	
Satsop	Mixed	Composite	Healthy	
Chehalis	Mixed	Wild	Healthy	
Johns/Elk & S. Bay tributaries	Mixed	Wild	Unknown	Unknown
Fall Chum (O. keta)				
Humptulips	Native	Wild	Healthy	
Chehalis	Native	Wild	Healthy	
Coho (O. kisutch)				
Humptulips	Mixed	Composite	Healthy	
Hoquiam	Mixed	Composite	Healthy	
Wishkah	Mixed	Composite	Healthy	
Wynoochee	Mixed	Composite	Healthy	
Satsop	Mixed	Composite	Healthy	
Chehalis	Mixed	Composite	Healthy	
Johns/Elk & S. Bay tributaries	Mixed	Composite	Healthy	
Summer Steelhead (O. mykiss)				
Humptulips	Native	Wild	Unknown	Unknown [4]
Chehalis	Unknown	Wild	Unknown	Unknown [4]
Winter Steelhead				
Humptulips	Native	Wild	Healthy	
Hoquiam	Native	Wild	Healthy	
Wishkah	Native	Wild	Healthy	
Wynoochee	Mixed	Composite	Healthy	
Satsop	Native	Wild	Depressed	Negative [5]
Chehalis	Native	Wild	Healthy	
Skookumchuck/Newaukum	Mixed	Composite	Depressed	Negative [6]
South Harbor	Native	Wild	Unknown	Unknown[4]
Bull trout / Dolly Varden (Salvelinus confluentus/malma)				
Chehalis / Grays Harbor	Native	Wild	Unknown	Unknown
Coastal Cutthroat Trout (O. clarki clarki)				
Humptulips	Native	Wild	Unknown	Unknown
Chehalis	Native	Wild	Unknown [7]	Unknown

1. Annual escapements prior to 1992 were "hovering around the desired escapement goal of 1400 adults". (SASSI, 1993). In 1991, a positive trend in escapement compared to the 1970-1985 period was identified (Hiss and nudsen, 1993).
2. Stock status rating of depressed based on a long-term negative trend in escapement (SASSI, 1993).
3. In 1991, a positive trend in escapement compared to the 1969-1983 period was identified (Hiss and Knudsen, 1993).
4. Status and trends are unknown, stock comprised of a historically small number of steelhead. (SASSI, 1993)
5. Status is depressed based on chronically low wild spawner escapement (SASSI, 1993).
6. Status is depressed based on chronically low spawner escapement (SASSI, 1993).
7. Status is unknown, but is considered probably similar to the status of coho and winter steelhead, which is "depressed" (Johnson et al., 1999).

Table D-2. Fish species known or suspected to be present in the Chehalis watershed, other than the commonly studied salmonids. (Sources include Hiss and Knudsen, 1993; Wydoski and Whitney, 1979; WARIS/PHS database; Baitis and Kuzis, 1999; Parton et al., 1997).

Fish Species	Scientific name
Native Fish Species	
White sturgeon	Acipenser transmontanus
Green sturgeon	A. medirostris
American shad	Alosa sapidissima
Northern pikeminnow	Ptychocheilus oregonensis
Largescale sucker	Catostomus machrocheilus
Redside shiner	Richardsonius balteatus
Whitefish	Prosopium spp.
Reticulate sculpin	Cottus perplexus
Coast range sculpin	C. aleuticus
Torrent sculpin	C. rhotheus
Riffle sculpin	C. golosus
Prickly sculpin	C. asper
Pacific lamprey	Entosphenus tridendatus
River lamprey	Lampetra ayresi
Western brook lamprey	L. richardsoni
Longnose dace	Rhinichthys cataractae
Speckled dace	R. osculus
Redside shiner	Richardsonius balteatus
Olympic mudminnow	Novumbra hubbsi
Introduced species	
Brook trout	Salvelinus fontinalis
Rainbow trout	Onchorynchus mykiss
Largemouth bass	Micropterus salmoides

IMPACTS OF LAND USE ON HYDROLOGY, STREAM CHANNELS AND FISH HABITAT

INTRODUCTION

This section summarizes potential hydrologic effects, both surface and groundwater, associated with land and water use, and potential affects on fish habitat. These are summarized generally by land use, moving from hydrologic impacts to potential stream channel and fish habitat impacts.

As with most western Washington stream systems, the Chehalis has a land use history focused on timber harvest and agriculture. Many associated activities, such as splash damming and wood removal, have had an affect on hydrologic conditions and resultant channel/habitat conditions. The following sections present general information on the likely affects of land use and associated hydrologic changes within the basin.

For a general discussion of the role of fish habitat in healthy salmon populations, see Smith and Wenger (2000). For more technical discussions about impacts from specific land uses on hydrology and stream channels see Meehan et al.(1991), Beschta et al. (1995), Salo and Cundy (1987), and Dunne and Leopold (1978).

FORESTRY

The legacy

Fish populations and habitats in the Pacific Northwest are strongly affected by both current forest practices and by actions taken as part of past forest practices. Many of those forest practices, which were legal or unregulated at the time, may still have an affect on both current habitat conditions and on fish populations. Past practices included transporting logs using splash dams, stream channelization and removal of woody debris (LWD) (stream cleanouts), removal of riparian vegetation, road and railroad construction in stream channels and flood plains, and the hydrologic impacts discussed above. These actions either removed habitat features (LWD, side channels); increased peak flows, which caused channel downcutting; destabilized streambanks, which caused bank erosion; introduced sediment from bank erosion, road construction, and road failures; increased water temperatures from removal of riparian vegetation; and blocked migration with dams and log storage. Riparian areas that have been damaged or completely removed lower the potential for LWD inputs to the stream in the future, which will limit future habitat complexity until riparian vegetation returns.

The role of these past activities in defining current channel and habitat conditions is not entirely understood. Habitat conditions are likely improved from those of past years, but the combination of past and current activities still affects habitat conditions.

Timber harvest

This land use practice can affect both peak and low flow conditions. Peak flows may increase because less precipitation is intercepted by living trees, and because more snow may accumulate on bare ground. Increases are considered to be most likely at elevations where rain-on-snow precipitation events are likely. Increases in peak flows may affect stream channels (causing channel incision and removal of LWD), even after this potential impact has diminished as regrowth of trees occurs. Low flows have the potential to increase because of less precipitation interception. This could increase summer rearing habitat.

Roads and harvest practices

Peak flows may be affected because roads and drainage ditches reroute subsurface flows to surface runoff, which may enter the stream channel at a faster rate, and at a single point rather than by subsurface runoff. Skid trails also have the potential to route flows this way. Road ditches can extend the stream network, with occasional diversion of flows between basins. While the extent of this in the Chehalis is unknown, it is not uncommon in commercial forest land. Increases in peak flows would be associated with this condition. This could cause channel erosion/incision, and reduced water quality as sediments enter stream channels. Roads also generate sediment from their surface, as well as increasing the likelihood of mass wasting events. Watershed Analyses for forested regions in the headwaters of subbasins in the Chehalis indicate significant quantities of fines associated with roads and road related mass wasting events. These increases could lead to a reduction in the quality of spawning and winter rearing habitat.

AGRICULTURE AND RANGELAND

From a fish habitat perspective, agriculture differs from forestry in many ways. The primary one being that many of the changes in wetlands and stream channels are permanent, and maintained to keep an altered hydrologic condition (more drainage) or riparian changes (no trees). In a forested landscape there is the potential for the altered situation to recover, even though the recovery time may be hundreds of years long.

Drainage manipulation

Drainage manipulation can increase peak flows by delivering storm flows more efficiently to the stream channel. The channel response includes bank or bed erosion. Nearly all of the flood plains in the Chehalis valley have undergone some degree of drainage modification. Drainage modifications may also decrease low flows, and have the potential to lower the water table and reduce groundwater recharge. This reduces low-flow (summer) habitat, and can contribute to higher water temperatures. This also reduces flood storage capacity, which can cause channel incision. Channel complexity is reduced as channel length is shortened. Loss of fish access to wetland and off-channel habitats can reduce winter refuge habitat, as well as summer rearing area.

Crop production

Crop production has the potential to affect low flows as soil is tilled and transpiration rates are altered. Perhaps the most significant land use activity in the middle and lower portions of many subbasins is alteration of riparian vegetation. Coupled with drainage modifications, this contributes to bank erosion, reduces shade and channel complexity, and promotes channel downcutting. As recruitment of structural elements, such as LWD, is limited and channel complexity reduced, habitat value declines. In addition, irrigation water return has the potential to affect water quality (see below). Altered low flows can affect summer rearing habitat quality, and reduce water quality.

Cattle grazing

Cattle grazing has the potential to affect peak flow because compacted soils reduce infiltration and increase stormwater runoff. This has the capacity to cause channel incision. Cattle also remove riparian vegetation and break down streambanks, causing bank erosion, and increased levels of stream sediments. Unstable streambanks can cause channel widening or channel avulsion, reducing the quality of instream habitat due to lowered flows and less in-channel structure.

URBAN

Increases in impervious surface associated with urban landscapes, and the use of stormwater facilities change the timing and increase the magnitude of peak flows, since water is routed quickly to stream channels. Increased magnitude and volume of peak flows can cause bank erosion, channel widening or downward incision, and eventual disconnection of the channel from the former flood plain. Urban land uses also affect riparian corridor integrity where riparian corridors become fragmented, narrow, or disappear. These changes affect stream channels by removing sources of woody debris and shading, and potentially increasing the input of stormwater with degraded water quality (City of Olympia, 1999). As the Chehalis Basin is primarily forested and agricultural land, the impact of urban land uses is limited.

Structural features

In most cases, dams and diversions reduce the magnitude and frequency of high flows. As a result, stream channels downstream of a dam can become narrower as a result. Capture of sediments behind a dam can result in downstream channel erosion and bed armoring. Dams can also block migratory corridors, contributing to dewatering of downstream reaches, and release water with increased temperatures or sediment loads.

Channelization and construction of levees can change peak flow routing, reduce overbank flows, and isolate stream channels from their former flood plains and associated wetlands. The resulting channel constriction can cause downcutting. In addition, loss of connection between main-channel and off-channel or side-channel habitats will reduce rearing area and areas of refuge from high flows. In the Chehalis, bank protection efforts for road and railways have reduced the width of the channel migration zone by controlling meander movement. This can lead to channel erosion elsewhere in the basin as well as affect gravel deposition patterns.

Gravel mining

Gravel mining causes streambed disturbance, removes substrates, potentially changes groundwater interactions with surface waters, and could lower the water table. This removes or disrupts spawning and summer rearing habitats. Mining in the Humptulips, Wynoochee, and Satsop Rivers has altered channel bed elevations and substrate deposition (Collins and Dunne, 1986).

HUMAN WATER USE

Surface water diversions can deplete streamflow by consumptive use; and water used for irrigation can deplete streamflow between the point of diversion and the point of return.

Groundwater pumping had the potential to lower the water table. If groundwater discharge is critical to the maintenance of low stream flows, excessive pumping may affect streamflow. While a number of subbasins have the potential for this impact due to high pumping rates (Scatter Creek, Black River lower Newaukum), quantification of water budget variables has not been undertaken at this level. Areas with high groundwater withdrawal rates also possess the most productive aquifers in the basin.

Return flows have the potential to alter timing of low flows, and to change the surface water/groundwater interaction. They also may contribute to poorer water quality, higher temperatures, and higher sediment levels in the receiving stream.

SUMMARY

There is little doubt that land use activities have influenced basin hydrology and associated channel and fish habitat conditions. The degree to which this has occurred, however, is difficult to determine. In addition, the relative role of each land use activity in each subbasin varies. In general, increased peak flows associated with higher runoff rates and reduced low flows due to more efficient drainage systems are likely the prime hydrologic alterations. These changes, coupled with removal of riparian vegetation, has likely brought about an increase in channel bank and bed erosion throughout the basin. At this level, it is not possible to quantify the direct cause and effect relationship between specific land uses and hydrologic/channel/habitat changes.

Land use impacts on groundwater resources are poorly understood and very difficult to quantify. Alteration of groundwater recharge rates, ditching, and water withdrawals have influenced groundwater movement and availability, but the level of impact is not known

HISTORICAL DISTURBANCES IN THE CHEHALIS WATERSHED

This section follows the summary of impacts from various land use types on fish habitat, and summarizes historic watershed disturbances in the Chehalis watershed. Some topics are covered only briefly to not duplicate other ongoing assessment efforts. In those cases, the reader is referred to other documents for more detail than that presented here. For instance, the important topic of past and present Grays Harbor water quality, research results on the estimated impact on fisheries, and recent water quality improvement efforts are not extensively discussed (see Smith and Wenger, 2000).

"...The history of Chehalis Basin fish runs and habitats is one of pristine productivity, then gross degradation, followed by partial recovery..." (Hiss and Knudsen, 1993).

WILDFIRE & WINDSTORMS

Two of the largest watershed disturbances in the Chehalis watershed, prior to European-American settlement, were wildfire and windstorms. Of these, windstorms were probably a more common occurrence (Agee, 1993). Wildfire return intervals in Sitka-spruce dominated coastal forest are fairly long, on the order of 1,100 years. In other words, Sitka spruce forests rarely burn. In Western hemlock/Douglas-fir forests, which would have covered most of the Chehalis watershed outside of the coastal zones, fire return intervals are between 200 and 750 years, but should more correctly be classified as "episodic" (Agee, 1993). For example, a fire burned the headwaters of the South Fork Newaukum approximately 200 years ago (Weyerhaeuser, 1999). Some evidence exists for burning by humans prior to European-American settlement, especially in lowlands and prairie habitats where burning increases grassland habitats and plants (Agee, 1993).

After European settlement, fires were initially very common as a side effect of use of locomotives and donkey engines during logging, and the process of land clearing. Many of these fires could not be controlled, and were left to burn large tracts of timber (Van Syckle, 1981). Fire suppression was a major concern during both this period and more recent periods of road-based timber harvest. Since approximately 1950, suppression of wildfire has been public policy, so the occurrence of wildfires within the Chehalis watershed has decreased over the last 50 years. The practice of tree planting after harvest began in the early 1940's (Van Syckle, 1981). Slash burning as a management tool prior to tree replanting was used in the 1960's, 1970's, and 1980's, although, it is much less common now.

ESTABLISHMENT OF SETTLEMENTS AND AGRICULTURAL LANDS

River channel conditions prior to European settlement were very different than those seen today. Most low-gradient river channels in Western Washington and Oregon consisted of complexes of river, wetlands, beaver ponds, sloughs, logjams, and side channels, with both standing trees and instream wood very common and plentiful. On a list of rivers with their lower channels completely blocked by drift wood were "...most Grays Harbor rivers, the Chehalis, Black and Satsop Rivers..." (Dept. of Army reports 1875-1899, in Sedell and Luchessa ,1981). The Army Corps of Engineers cleared many streams of logjams and large boulders in the 1880-1905 period in this area.

Draining land for farming began early in the settlement period in Grays Harbor County, from the mid-1800's, and ditching and draining activities by individual landowners were very common in the 1880-1920 period (Van Syckle, 1981; Sedell and Luchessa, 1981). In order to consolidate the main channel, in many rivers, woody debris was not only cleaned out of the stream channel, but was also used to dike off sloughs and side channels. During the 1930's, when the Works Project Administration was active, many stream channels in agricultural areas were cleared of brush (Sedell & Luchessa, 1981).

Actions related to agriculture have been largely undocumented, although their impacts on fish habitat date back to the settlement of Hoquiam in 1857. The process of snagging, or log removal is discussed above. Many streams were diked, which eliminated winter cover and feeding areas, as well as increased channel scouring. Small streams were straightened in order to allow more convenient grazing and farming. Wetlands were drained or filled. These actions have resulted in a loss of habitat and habitat simplification, and are widespread over the agricultural lands in the watershed (Hiss and Knudsen, 1993).

RIPARIAN VEGETATION REMOVAL

One land use practice common on both lands used for timber harvest and agricultural lands was riparian vegetation removal. This was a side effect of (legal) timber harvest practices. Buffer strips of varying widths began to be left during the 1980's, and are now mandated. Therefore, while the historical disturbance was extreme, riparian areas in timber production land use can be considered in recovery from past practices, although, the recovery period may be as long as several hundred years.

This was also a result of agricultural practices, which are ongoing in the watershed. Riparian vegetation removal and degraded conditions have been documented widely throughout the watershed (Wampler et al., 1993 see Appendix D for a summary by subbasin). While this condition can be suspected to be changing for the better, from a fish habitat perspective, on forest lands, it is likely to be remaining a problem in agricultural lands.

In addition, current riparian areas over much of the watershed have been documented to have been removed, or to be in a damaged or degraded state. Resulting bank erosion has also been widely documented (Wampler et al., 1993).

TIMBER HARVESTING

Splash dams for timber transport

Splash dams were used to transport timber to tidewater mills during the 1882-1930 period. There were approximately 100 dams basin-wide. Some dams were built in a series moving downstream, such as those in the Humptulips watershed, and many were used daily. Impacts include: removal of sediments and spawning gravel downstream of dam, migration blockages, destabilized channels, stream cleanouts, and use of regular in-water blasting. Some splash dams in this region were in place for about 20 years, and it is estimated that when in place, splash dams effectively blocked 60 percent of the salmon streams tributary to Grays Harbor (Wendler and Deschamps, 1955).

An additional impact of splash damming was that sloughs, swamps, and low meadows were often blocked off, and wider stream sections had log cribbing added to their banks, to consolidate the main channel. Boulders and logjams were generally removed using dynamite, and small stream channels were often widened as a result of both the flooding from dam operations and erosion of streambed and streambanks by the logs themselves (Sedell and Luchessa, 1981; Van Syckle, 1981). The damage to fish populations as well as to erosion of streambanks was recognized, and splash damming began to be phased out during the 1930's, with many dams finally removed in the 1950's (Wendler and Deschamps, 1955).

Logging railroads and roads

Logging railroads started to be built around 1912 (Simpson Timber and Weyerhaeuser, 1996). A total of 1,095 miles of logging railroad were noted as historically present in Grays Harbor County (Van Syckle, 1981). Because railroad grades were generally restricted to 4% grade or less, they were often laid near or in stream channels. Steams channels were cleaned out and straightened using heavy equipment to protect culverts and trestles. Many railroad grades were eventually converted to road grades, and road networks were extended onto steeper ground (Simpson Timber and Weyerhaeuser, 1996). Stream channels then were at risk of sediment inputs from cut or fill slopes that failed, as well as from road surfaces.

Stream cleanouts for fish passage

Starting in the late 1940’s, and continuing until the 1970's, an additional effort was made in many streams and rivers in Washington and Oregon to remove both instream wood and logging debris. Starting somewhat as a response to damages noted in the splash dam era, these efforts were intended to remove barriers to fish passage (Sedell and Luchessa, 1981).

GRAVEL MINING

Instream gravel mining was most common in the lower reaches of the Chehalis, Humptulips, Satsop, and Wynoochee Rivers, although, it also occurred in many other streams in the watershed. This process started in earnest at the end of the splash dam era, when roads and railroads replaced water transport for logging, and continues today at lowered rates of removal (Hiss and Knusden, 1993). In 1986, it was estimated that in an average year, removal rates (in the four rivers noted above) were 10 times higher than the river's capacity to replenish gravels (Collins and Dunne, 1986). Gravel operations in the Satsop, South Fork Chehalis, Humptulips, and Wynoochee were identified in 1975 to have seriously reduced the available spawning areas for chinook. Operations elsewhere in the Chehalis, particularly in the Newaukum watershed, were felt to have severely affected both chinook and chum populations (Phinney et al., 1975).

DAMS AND DIVERSIONS

The two largest dams in the basin are the Skookumchuck Dam on the Skookumchuck River, and Wynoochee Dam at RM 48 on the Wynoochee River. Skookumchuck Dam was built in 1970, and is a barrier to anadromous fish migration. Steelhead are transported upstream of the dam to spawn (Herger, 1997). Anadromous fish are transported above Wynoochee Reservoir and have access to habitat upstream to Wynoochee Falls (RM 58) (Parton et al., 1997).

WATER QUALITY

This topic is only briefly summarized here. It is discussed in many sources (for example, Chehalis River Council, 1992), and Appendix C of this report.

Low dissolved oxygen levels are identified as a significant problem during warm weather and low flow conditions. The Chehalis River in the "Centralia Reach" and the Black River exhibit stratification, and low dissolved oxygen levels have been observed downstream of Porter (Chehalis River Council, 1992 Pickett, 1994).

While warm summer water temperatures may have been historically present in much of the Chehalis watershed due to low elevations, widespread human activities have removed riparian vegetation and reduced shading levels, thereby contributing to temperature increases (Hiss and Knudsen, 1993).

In addition to direct manipulations of stream channels (diking, ditching, draining), agricultural impacts to fish habitat have included runoff from animal operations and use of agricultural chemicals.

GRAYS HARBOR ESTUARY: HISTORIC AND CURRENT CONDITIONS

This topic is only briefly summarized here. For a more complete discussion, the reader should consult Smith and Wenger (2000), which summarizes research and monitoring changes in industrial discharges during the 1990's.

It has been suspected that water quality in Grays Harbor, particularly in the Inner Harbor, has contributed to poor salmonid population numbers in the past. Suspected or known problems include filling of eelgrass beds in the Inner Harbor (which removed juvenile rearing habitat), industrial discharge from pulp mills, municipal sewage discharge, and non-point source pollution. (Chehalis River Council, 1992). In addition, is it estimated that approximately 30% of the original estuary has been lost to fill (Smith and Wenger, 2000).

FISH HABITAT CONDITIONS SUMMARY

OBJECTIVES

This section presents and summarizes available fish habitat information in the Chehalis Basin. Analyses and conclusions presented are those of the original investigators. See Appendix E for a summary of habitat conditions for each subbasin.

DATA SOURCES

Four of the most important data sources are described below. Other data sources are presented and referenced in the appropriate sections.

Washington stream catalog

This reference, developed in 1975, describes the streams in WRIA 22 and 23, and discusses habitat conditions and problems in a general way (Phinney et al. 1975).

USF&WS/WDFW extensive survey

This report is a resource for ongoing rehabilitation and enhancement activities. The extensive survey identified specific habitat problems in a total of 1,518 stream miles throughout most of the subbasins in the Chehalis watershed upstream of the Humptulips River, and 111 miles of the Chehalis River mainstem. Problems were classified in two ways. A condition noted in a stream reach less than 20 feet long was recorded as a point occurrence, and a situation noted in a reach greater than 20 feet long was recorded as a distance value. Habitat problems were linked to land uses where known (generally harvest practices or agricultural practices), or classed as a situation with unknown causes. Some water quality problems were noted, as well as the presence of beaver dams and water diversions, and in some subbasins, instream woody debris (LWD). Subbasin delineation, and aggregation of data to present results, is similar to, but not always exactly the same as, the subbasin delineation used in this report. Results aggregated by subbasin are presented here as presented by the investigators (Wampler et al., 1993). The data set is archived within a GIS system, and information can easily be extracted for stream reaches of concern in a Level 2 analysis (Hudson, 1993).

The Humptulips, Hoquiam, and Wishkah Rivers and all of the South Bay tributary streams were not included in the extensive survey.

Federal and state watershed analysis reports

Watershed Analysis reports were available for the following subbasins: Chehalis headwaters, Stillman Creek, North Fork and South Fork Newaukum Rivers, West Fork Satsop, Wynoochee, East and West Fork Humptulips, and Wishkah Rivers. These reports are done to assist long-term planning for timber harvest, road, and riparian corridor management on forest lands. Fish habitat and stream channel information is collected by subsampling some stream reaches, and conclusions and recommendations are then drawn for groups of similar stream reaches within the watershed. In some cases, the level of detail of analysis on agricultural lands within the watershed is less than that on forested lands (Raines et al., 1992; Simpson Timber and Weyerhaeuser, 1996; Weyerhaeuser Co., 1994a, 1994b, 1997, 1999; US Forest Service, 1996; Rayonier and US Forest Service, 2000).

Fish habitat concerns identified in these reports were identified at the time of the analysis. One result of watershed analysis is the development of "prescriptions", which are planning, operational, or remedial actions taken by the landowner to address the problems. It should be recognized that conditions may have changed in the watershed as a result of these prescriptions and the original report(s) be consulted for more information.

T/F/W Ambient Monitoring surveys

A few streams in forested portions of the Chehalis watershed have been surveyed as part of a state-wide data gathering project (T/F/W Ambient Monitoring Project, 1991, 1996). Data summaries and analysis of local and regional conditions have not yet been generated from this data set. Thus, no analysis of this data is presented here.

Washington Department of Ecology (WDOE) data collection

The Dept. of Ecology collected water quality information in the mainstem Chehalis River between Porter and Pe Ell, and a number of tributaries (Pickett, 1994) in support of eventual establishment of a total maximum daily load (TMDL) for several water quality parameters. Summer temperature and dissolved oxygen (DO) findings are summarized briefly here, with respect to general salmonid temperature and dissolved oxygen preferences. Because these samples were collected at different times of day, they cannot be described statistically (for example, as a daily maximum). They are, however, an indication of temperature within the daily range of temperatures. Dissolved oxygen (DO) levels measured are discussed with respect to the generally accepted minimum level of 5.0 mg/L for salmonid fish (Bell, 1991). Another important parameter for salmonids, with respect to DO, is the percent of saturation, which is a function of temperature. Water quality information is discussed in further detail in Appendix C.

WDFW culvert database

The Washington State Dept. of Fish and Wildlife, maintains a database of culvert surveys in each WRIA. Culvert information is standardized state-wide (WDFW, 1998a). WDFW also assesses the amount and quality of fish habitat upstream of many culverts in the database, in order to compare habitat gain with the expense of the culvert upgrade. Culvert status classifications include those that are not barriers, those that need repair, those that are fixed, and those that are barriers with insufficient upstream habitat gain to warrant repair.

In April, 2000 the database contained a total of 296 entries for WRIAs 22 and 23, although not all entries refer to culverts that are barriers. Any summary of this information presented at this point would be misleading. Culvert survey information known to have been collected during 1999 by Lewis County and the Washington Dept. of Transportation has not yet been added, since WDFW is still in their quality assurance and habitat assessment process (B. Benson, WDFW, pers. comm., 2000). This database is a “living document”, which can be consulted at a subbasin level as habitat concerns and potential projects are identified, or as part of a Level 2 assessment.

Data Limitations

Problems and situations described in both the USF&WS/WDFW extensive survey and the Watershed Analysis reports are identified as of the date of the survey. Because restoration activities in the Chehalis watershed basin have been ongoing, it should be recognized that some situations may have changed since the survey was done.

SUMMARY OF HABITAT CONDITIONS

While situations vary to some degree between subbasins, some basin-wide patterns are clear. These patterns agree with the conclusions of previous analysts (Hiss and Knudsen 1993, Wampler et al., 1993). As a result of past and present land use practices, stream channels in the Chehalis watershed show a consistent pattern of riparian vegetation removal, shade reduction, and reduction in bank stability leading to erosion and instream sediments. While few measures of existing woody debris levels were found, comparison to historic information and past legal stream cleaning practices point to instream LWD levels to be either non-existent or much lower than historic levels. Information about loss of side channel and wetlands habitats is more anecdotal. However, patterns of timber harvest and agricultural practices have left stream channels in a more simplified state than in pre-settlement periods with less streambank stability, lowered shading levels, and simplified instream habitats with fewer, or no, side- or off-channel habitats available. While summer water temperatures in much of the Chehalis watershed may have been historically high (above preferable for salmonid fish, but sublethal) due to relatively low elevations of many of the stream channels in the basin, riparian vegetation removal, lowered shading levels, and degradation of streambank stability have most likely contributed to increases in the magnitude and range of this problem.

Because of the size of the Chehalis watershed, watershed-wide conclusions are necessarily very general. A more appropriate level of detail is the subbasin level. In some situations, habitat conditions may be in some partial recovery from past damages; this is most likely on forested lands managed under federal or state forest practices where protection of riparian corridors has become the rule during the last few decades. Because little change in protection or restoration of riparian corridors on agricultural lands has occurred in the last few decades, riparian conditions in those land uses rely primarily on the individual landowner’s discretion. In those land uses, riparian and stream habitat conditions will vary widely, and no estimation of the amount of recovery of riparian function can be made at this level.

CHEHALIS RIVER MAINSTEM

This summary covers parts of Subbasins, 4, 10, 13, 19 and 30. It is presented separately here because of the importance of this data summary.

USFWS/WDFW extensive survey

The survey summarized here covered 111 river miles from the mouth to the confluence with the Elk Creek and Crim-Rock Creeks subbasins. The lower mainstem survey included Stevens and Elizabeth Creeks, as well as portions of Peel's, Preachers, and Blue Sloughs. The most important habitat problems identified were: for the "lower mainstem" (mouth to the Black River confluence), stream canopy reduced by agriculture (upstream 3/4 of the lower mainstem, stream canopy reduced by other causes), (downstream 1/4 of lower mainstem), and bank erosion (middle 1/3 of lower mainstem); for the "upper mainstem" (Black River confluence to Elk Creek confluence), stream canopy reduced by agriculture (middle ½ of the upper mainstem), streamside vegetation loss, cause unknown (upstream 1/4 of upper mainstem), and bank vegetation destruction by livestock (middle 1/3 of upper mainstem).

Summary of the most important degradations are given for the entire reach surveyed: reduced tree canopy from agriculture, forest practices and other causes (9 points and 104.1 miles), livestock access (1 point and 7.7 miles), bank vegetation destruction or loss from agriculture and unknown causes (52 points and 22.2 miles), damage from livestock access (7.74 miles), bank erosion (69 points and 24.1 miles), riprap, dumping, and artificial bank protection (65 points and 8.1 miles), and excessive instream sediments (7.4 miles).

In the lower mainstem, beaver dams were noted in Stevens and Elizabeth Creeks. A total of 40 known and suspected water withdrawals were also noted. One waste-water outfall and 7 miscellaneous pollution input sources were noted (Wampler et al., 1993).

Off-channel habitat survey

A 7-mile stretch of the lower Chehalis River floodplain, from the Wynoochee to the Satsop Rivers, was surveyed to identify and inventory off-channel habitats with potential for restoration for juvenile coho overwintering habitat, by reconnecting to the river(s) (Ralph et al., 1994). The lower five miles of the Satsop and Wynoochee Rivers were also surveyed. The large tidal sloughs in the lower 12 miles of the Chehalis mainstem were not evaluated as part of this survey. A total of 28 potential restoration sites were identified. Summaries include general site description, characters of ponded areas, riparian vegetation, aquatic vegetation, inlets and outlets, and restoration and enhancement recommendations (Ralph et al., 1994).

Collins and Dunne (1986) estimate that the rate of gravel removal in the reach between RM 2-11 exceeded the replenishment rate for the three decades prior to 1986, by a factor of 10. Channel downcutting was estimated to be 0.1 foot/year.

WDOE surveyed the mainstem Chehalis River from the Porter Bridge upstream to Pe Ell during 1991 and 1992. Previous studies had documented areas of low dissolved oxygen in the "Centralia Reach" (between the Newaukum and Skookumchuck Rivers). Surveys showed that thermal stratification was present during the summer months in the Centralia Reach, and that deeper waters contained very low, or no, dissolved oxygen (Pickett, 1994). For this study, a total of 45 mainstem sites, between River Mile (RM) 33.8 and RM 108.2, were sampled and are summarized in Table D-3. Summer temperatures were often above the water quality standard of 18 ^{o} C, and in places were found to be 26.6 ^{o}C (Pickett, 1994). While this lower value is tolerated by most salmonid fish, the higher value is above the upper lethal limits of 24.4 - 25.5 ^{o}C for many salmonid species. In addition, low dissolved oxygen levels in some cases are below generally acceptable limits (5 mg/L) (Bell, 1991). In addition, sublethal impacts of warmer summer temperatures can include higher predation success by warmwater species (such as bass) on salmonid juveniles.

Table D-3. Summary of range of water temperatures sampled in the Chehalis River during summer 1991 and 1992 by WDOE. For further information consult the source (Pickett, 1994).

Sampling site (RM)	Temperature range sampled (^oC)	Dissolved oxygen range sampled (mg/L)	Comments
108.2	16.4-17.7	9.4-10.7	@ Pe Ell water intake
106.3	14.4-18.1	9.2-10.8	SR 6 bridge
100.5	15.4-22	8.3-10.6	@ Elk Cr. Rd. nr Doty
97.9	17.8	8.5-10.3	@ Dryad
94.4	18.1-18.2	9.3	Meskill Br.
90.1	18.0-20.12	7.5-9.0	Above Ceres Rd. Br.
90.0	15.8-22.5	7.5-8.8	@ Ceres Rd. Br.
81.0	16.8-20.3	8.1-8.7	@ Adna, SR 6 Br.
77.6	19.9-21.2	7.3-9.1	@ SR 603 Br. nr Claquato
74.9	22.6-23.4	8.2-8.5	Ab. SR 6 Br. nr Chehalis
74.6	16.8-22.3	7.1-8.7	@ SR 6 Br. nr Chehalis
73.6	17.4-25.5	0.5-9.0	
72.5	17.9-25.7	6.9-8.8	Ab Golf Course intake
72.3	17.4-23.4	6.1-9	Blw Golf Course intake
70.7	17.6-25.9	0.1-8.6	North of airport
69.6	17.2-24.4	0.1-8.5	
69.1	13.1-24.4	0.1-8.8	Blw Salzer Cr.
68.6	17.3-24.4	2.6-9.9	
67.5	18.7-26.2	0.1-10.3	@ Mellen St. Br.
64.2	17.1-20.4	6.6-9.3	@ Galvin Rd. Br.
59.9	15.9-23.2	6.9-10.0	Nr Grand Mound (Prather Rd.)
54.2	15.8-21.3	8.3-10.2	@ Independence Br.
44.0	21.4-22.5	8.5-11.5	@ Sickman Ford Br.
33.8	17.3-20.0	7.9-10.6	@ Porter Rd. Br.

SUBBASIN 1. CHEHALIS RIVER HEADWATERS

USFWS/WDFW extensive survey

Two USFWS/WDFW survey summaries lie within this subbasin. A total of 28 stream miles were surveyed in their **"Upper Chehalis"** subbasin, including the upper Chehalis mainstem, upstream of the Rogers Creek confluence, the East and West Forks, Thrash and Cinnabar Creeks. The most important problems identified were: stream canopy and streambank vegetation loss from forest practices (8 points and 13.9 miles) (West Fork, East Fork, and mainstem Chehalis), bank erosion (56 points and 7.8 miles) (Cinnabar Creek, EF Chehalis River), and debris torrent inputs to stream channels (6 points). Few beaver dams were found at the time of the survey. Three water withdrawals were noted (Wampler et al., 1993).

A total of 42 miles were surveyed in their **"Crim-Rock"** subbasin, including the mainstem Chehalis from Rogers Creek downstream to Rainbow Falls, Crim, Big, Rock, and McCormick Creeks. The most important problems identified were: bank erosion (124 points and 19.6 miles) (lower Chehalis, McCormick Creek, Rock Creek, upper Crim Creek), streamside vegetation loss from agriculture and unknown causes (39 points and 12.1 miles) (lower Chehalis River, lower Rock Creek, lower McCormick Creek, mid-Crim Creek), and streamside canopy reduction from forest practices (7 points and 6.3 miles) (Crim Creek, Big Creek, upper Chehalis River). Beaver dams were noted in upper Rock and McCormick Creeks. A total of ten water withdrawals were noted as well as 3 miscellaneous pollution input sources (Wampler et al., 1993).

A portion of this subbasin was included in the **Chehalis Headwaters Watershed Analysis** (Weyerhaeuser Co, 1994). The analysis area included 44,920 acres in the Chehalis River headwaters, upstream of the Town of Pe Ell (Weyerhaeuser Co., 1994). Prior to 1930, splash dams were operated on the mainstem Chehalis above Fisk Falls, and below Crim Creek (Wendler and Deschamps, 1955). Between the 1960's and the 1970's, stream cleaning operations removed LWD from most of the larger streams in this subbasin, except Cinnabar Creek (Weyerhaeuser Co., 1994).

Habitat concerns identified in the watershed analysis include the potential for warm summer temperatures to create adverse conditions for holding spring chinook in the mainstem Chehalis, as well as the potential for legal and illegal fishing to reduce numbers of adult chinook in the same reach, waiting to spawn. Nearly half of the stream channels (47%) had canopy closures lower than that estimated to protect water temperature, including all of the mainstem Chehalis River, and portions of the East Fork, West Fork, and reaches of Crim, Thrash and Cinnabar Creeks. (The lower mainstem is wide enough to limit the degree to which riparian canopy can contribute to thermal reduction.)

Warm summer temperatures also reduce the quality of summer rearing habitat for juvenile fish. Riparian conditions were fairly good over most of the watershed, with mature, dense stands of mixed conifers and hardwoods present over much of the basin. At this time, tree sizes along some of the larger streams are too small to function effectively as LWD, although long-term prospects are good. There is a general lack of in-channel LWD in this subbasin, which limits refuge habitat, holding pool frequency, and depth. This was identified as a problem in areas used by chinook, as well as in areas used by coho and steelhead (Weyerhaeuser Co., 1994).

T/F/W Ambient Monitoring Survey
A stream survey was done in Sage Creek (23.1195) (0.3 miles), Thrash Creek (23.1186) (0.3 miles), Big Creek (23.1179) (0.2 miles), and the mainstem Chehalis River (RM 120.9) (T/F/W Ambient Monitoring, 1996).

SUBBASIN 2. ELK CREEK

USFWS/WDFW extensive survey
A total of 43 stream miles were surveyed in their **"Elk Creek"** subbasin, including the mainstem of Elk Creek and portions of Nine, Seven, Eight, Ludwig, Smith, Swem, Fourth, and Little Elk Creeks. The most important habitat problems identified included: bank erosion (89 points and 27.7 miles) (Elk, Nine, Swem and Smith Creeks), stream canopy reduction from forest practices (6 points and 11.6 miles)(Elk, Smith and Ludwig Creeks), and excessive levels of instream sediments (11 pointsand 9.9 miles) (Ludwig, Eight, upper Nine, and mid-Elk Creeks). Most of the beaver dams noted in the survey were in upper Elk, Smith, and Swem Creeks. A total of 7 water withdrawals and one waster water outfall were noted (Wampler et al., 1993).

WDOE recorded summer temperatures in Elk Creek in the 14 - 17 ^{o}C range, within the preferred range for most salmonid fish (Pickett, 1994; Coutant, 1977). DO levels were good, in the 9.0 - 10.7 mg/L range (Pickett, 1994).

SUBBASIN 3. SOUTH FORK CHEHALIS

USFWS/WDFW extensive survey
A total of 113 stream miles were surveyed in their **"South Fork Chehalis - Stillman"** subbasin, including the mainstem South Fork; Lake, Barney, and Deep Creeks; Beaver, Lost Valley, Halfway, Keller, Slide, Stillman, and Raccoon Creeks; and Cedar, Laughin, Black, Trout, Deer, and Hanlan Creeks. The most important habitat problems identified were: bank erosion (291 points and 55.9 miles) (mid- and upper South Fork, Stillman and Halfway Creeks), streamside vegetation loss or destruction and stream canopy reduction (153 points and 36.6 miles) (mid-and lower South Fork, lower Stillman Creek tributaries, mid-Lake Creek), excessive instream sediments (12 points and 37.2 miles) (northern half of subbasin), and impacts from livestock access to streams (12 points and 23.4 miles) (mid-South Fork, mid-Lake Creek, lower Stillman Creek tributaries). Impacts were seen within both forested and agriculture land uses. Beaver dams were present in low numbers throughout the basin with the exception of Lake Creek, where they were more numerous. A total of 31 known or suspected water withdrawals were noted, as well as 14 miscellaneous pollution input sources (Wampler et al., 1993).

WDOE recorded summer temperatures in the SF Chehalis in the 17 - 20 ^{o}C range. At 20 ^{o}C, some salmonid fish exhibit avoidance behavior, if cooler water is available ("avoidance temperature") (Coutant, 1977). DO levels were good, in the 6.8 - 8.5 range (Pickett, 1994).

For this analysis, we have grouped lower Stillman Creek into Subbasin #4, Upper Chehalis River.

SUBBASIN 4. UPPER CHEHALIS RIVER

This subbasin includes the Chehalis River mainstem, as well as Stearns, Lake, lower Stillman, Bunker, Capps, Absher, Markesian, Dell, Garrett, Prairie, Deep, Van Ornum, Mill, Coal, and Scammon Creeks. Information for the Chehalis River mainstem is presented above. Information for tributary streams is presented here and in other sections. USFWS extensive survey results for Stillman Creek are summarized as part of the South Fork Chehalis subbasin (#3).

USFWS/WDFW extensive survey

Two USFWS/WDFW survey summaries lie within this subbasin. A total of 20 stream miles were surveyed in their **"Stearns"** subbasin, including Stearns and West Fork Strearns Creeks, and several unnamed tributaries. The most important habitat problems identified were: streamside vegetation loss, unknown causes (17.5 miles) (widespread in subbasin), bank erosion (43 points and 11.8 miles) (Stearns Creek, WF Stearns), bank vegetation destruction (48 points and 0.04 mile) (WF Strearns, tributary 0943), and livestock access to stream (3 points and 5.1 miles) (WF Strearns, tributary 0943). Some beaver dams were noted in the subbasin, mostly in the west fork and in two headwater tributaries. Four known or suspected water withdrawals were noted, as well as 1 miscellaneous pollution input source (Wampler et al., 1993).

A total of 47 stream miles were surveyed in their **"Scammon"** subbasin, including portions of Hope, Absher, Copps, Dunn, Marcuson, Dell, Garrett, Bunker, Deep, Van Ornum, Mill, Coal, and Scammon Creeks. The most important habitat problems identified included: streamside vegetation loss, agriculture and unknown causes (46 points and 28.3 miles) (Bunker, Deep, Marcuson, Mill Creeks), livestock access to streams (2 points and 12 miles) (Deep, Marcuson, Bunker and Mill Creeks), and bank erosion (100 points and 22.9 miles) (Bunker, Hope and Deep Creeks) Beaver dams were noted in Bunker, Deep, Garrett, Dell, Marcuson, and Hope Creeks at the time of the surveys. A total of 27 known or suspected water withdrawals and 2 miscellaneous pollution input sources were noted (Wampler et al., 1993).

WDOE recorded summer temperatures in Bunker Creek in the 15 -17.5 ^{o}C range, within the preferred range for most salmonid fish. Temperatures in Stearns Creek were in the 15 - 19 ^{o}C range; the upper end of this range is above salmonid preferred temperatures. Scammon Creek temperatures were recorded as 17.4 ^{o}C (Pickett, 1994; Coutant, 1977). DO levels in Bunker Creek were poor, ranging from 3.3 - 5.4 mg/L. DO levels in Stearns Creek were good, ranging from 6.5 - 7.4 mg/L. DO levels in Scammon Creek were also poor, with one measurement of 5.6 mg/L.

A portion of this subbasin was included in the **Stillman Creek Watershed Analysis (**Weyerhaeuser Co., 1994b). The analysis area included Stillman Creek upstream of the confluence with the South Fork Chehalis. Habitat conditions identified included good spawning habitat in lower Slide, Keller, Halfway, and upper Stillman Creek upstream of Racoon Creek; and less abundant spawning habitats elsewhere. Illegal fishing, especially of holding spring chinook, was also identified as a problem. LWD is in short supply throughout most of the

WAU, contributing to a low pool frequency, although, pool percentages were high. Pool habitat was generally shallow and lacking in overhead cover. Near-term recruitment potentials for LWD were poor to fair. Potential concerns with water temperature exist for 37% of this subbasin, where existing shading is less than desired. The majority of these areas are located in the northern third of the watershed, where land use is agricultural. Lost Creek is known to experience extreme low summer flow problems. In 1972, 1986, and 1990 large floods deposited substantial quantities of logs and debris in jams along the lower portion of the Stillman Creek mainstem (Weyerhaeuser Co., 1994b).

SUBBASINS 5,6,7. SOUTH FORK NEWAUKUM, NORTH FORK NEWAUKUM, NEWAUKUM RIVERS

SFWS/WDFW extensive survey

A total of 125 stream miles were surveyed in their **"Newaukum"** subbasin, including Newaukum Creek; South Fork Newaukum, Lost, Kearney, Beaver, Bernier, and Frase Creeks; the Middle Fork Newaukum; the North Fork Newaukum, Lucas, and Mitchell Creeks. The most important habitat problems identified were: streamside vegetation loss from unknown causes (5 points and 42.9 miles) (Newaukum, NF Newaukum, Lucas Creek, SF Newaukum), bank erosion (302 points and 28.8 miles) (Newaukum, MF Newaukum, NF Newaukum, SF Newaukum), stream canopy reduction and bank vegetation loss from forest practices (28 points and 17.23 miles) (upper NF Newaukum tributaries, Lucas Creek, SF Newaukum tributaries), and bank vegetation reduction and other damage from livestock (78 points and 13.9 miles) (SF Newaukum tributaries, MF Newaukum, lower North Fork Newaukum, Allen Creek). Beaver dams were noted in Lucas Creek, portions of the middle Fork and in some South Fork tributaries, but were not common in other subbasin streams at the time of the survey. A total of 33 known or suspected water withdrawals were noted, as well as 11 miscellaneous pollution input sources (Wampler et al., 1993).

WDOE recorded summer temperatures in the South Fork Newaukum in the 15.8 - 19.1 ^{o}C range, and in the 15.5 - 19.2 ^{o}C range in the North Fork Newaukum. The upper end of this range is above salmonid preferred temperatures (Pickett, 1994; Coutant, 1977). Summer temperatures in the Newaukum River at the mouth were recorded in the 16.6-21.2 ^{o}C range. The upper end of this range is at the upper avoidance temperature reported for salmonid fish (Coutant, 1977). DO levels in both forks and the mainstem of Newaukum Creek were good, ranging from 8.3 - 10.3 mg/L (Pickett, 1994).

A portion of this subbasin was included in the **Upper North Fork and Upper South Fork Newaukum Watershed Analysis** (Weyerhaeuser Co., 1999). Analysis area included: the upper North Fork and upper South Fork Newaukum Rivers (50,235 acres). Lowered amounts of in-channel LWD were noted, primarily due to past management practices. Current shading levels were found to be on target for protection of water temperatures, except for the agricultural areas in the lower North Fork subbasin. Thirteen potential fish passage barriers at culverts were identified, as well as natural passage barriers in steeper sections of the main stems and their tributaries. Lack of in-channel LWD in some stream reaches has produced lowered pool depths and frequency, and lack of cover. Future recruitment potential for LWD was good over much of these basins, and was identified as a problem in 20% of the riparian areas. Pool filling and deposition of fine sediments was noted in some channel types, and much of the watershed has fine sediments delivered from road erosion, and potentially delivered from areas with high hazard ratings for landslides.

SUBBASIN 8. SALZER CREEK

USFWS/WDFW extensive survey

A total of 37 stream miles were surveyed in their **"China- Centralia"** subbasin, including Dillenbaugh, Berwick, Salzer, Coal, and China Creeks. The most important habitat problems identified were: livestock access to stream (2 points and 24 miles) (Salzer, mid-Coal, lower Dillenbaugh, and lower Berwick), stream canopy reduced by agriculture, forest practices, and other causes (3 points and 34.2 miles) (upper China, upper Salzer, lower Dillenbaugh, lower Berwick), excessive streambed sediment (2 points and 16.8 miles) (upper China, Salzer, Coal), streamside vegetation loss or destruction (23 miles) (lower Salzer, Dillenbaugh), and bank vegetation destruction (42 points and 4.5 miles) (Salzer, mid-Coal, mid-Dillenbaugh, lower Berwick). A few beaver dams were noted during the survey, mostly in upper Salzer Creek. Nineteen known or suspected water withdrawals were noted, as well as 2 wastewater outfalls, 9 miscellaneous pollution input sources and one source of suspected poor water quality (Wampler et al., 1993).

WDOE recorded summer temperatures in Dillenbaugh Creek in the 14 - 16 ^{o}C range (at LaBree Road) and in the 17 - 18.6 ^{o} C range (above the mouth and near I-5). This latter temperature is above preferred temperatures, but below avoidance temperatures. Temperatures in Berwick Creek were recorded in the 15 - 16.6 ^{o} C range, and Coal Creek temperatures in the 14 - 16 ^{o}C range. Temperatures in China Creek- 16.1 ^{o}C. These last three measurements are within the salmonid preferred temperature range. Temperatures in Salzer Creek (at Airport Road) were in the 15 - 19.2 ^{o} C range. The upper end of this range is at the upper avoidance temperature reported for salmonid fish (Pickett, 1994; Coutant, 1977).

DO levels in Dillenbaugh Creek at LaBree Road were good (9.3-9.4 mf/L), but were poor both at the mouth and at I-5 (2.1 - 3.1 mg/L). Berwick and Coal Creek DO levels were fair to good (6.3 - 7.9 mg/L and 6.7 - 8.3 mg/L, respectively). China Creek DO levels were good (10.3 mg/L). Salzer Creek DO levels, at Airport Road were very poor (<1 - 6.4 mg/L) (Pickett, 1994).

For this analysis, Coal, Dillenbaugh, and Berwick Creeks are part of Subbasin 10, Chehalis River Middle Reach 1.

SUBBASIN 9. SKOOKUMCHUCK RIVER

USFWS/WDFW extensive survey

A total of 110 stream miles were surveyed in their **"Skookumchuck"** subbasin, including the Skookumchuck River, Hanaford, North and South Hanaford, Packwood, Snyder, Coal, Salmon, Johnson, Thompson, Bloody Run, Baumgard, Plenty, and Eleven Creeks. The most important habitat problems identified were:

stream canopy reduced by agriculture (16 points and 45 miles) (lower ½ of subbasin), livestock access to streams and bank vegetation destruction (103 points and 53.6 miles) (lower ½ of subbasin), excessive instream sediments (11 points and 30 miles) (tributaries in lower ½ of subbasin), and bank erosion (180 points and 20.8 miles) (Thompson, Johnson and Salmon Creeks, upper Hanaford Creek). Beaver dams were fairly uncommon throughout the watershed, and were most common in Packwood, Hanaford, and Thompson Creeks. A total of 23 known or suspected water withdrawals were noted, as well as 15 miscellaneous pollution input sources or suspected sources of poor water quality (Wampler et al., 1993).

Summer temperatures in the Skookumchuck River above Hanaford Creek were recorded in the 14-18.6 ^{o}C range, and in the 17 - 20.4 ^{o}C range at the mouth. Hanaford Creek temperatures were in the 15.5 -19 ^{o}C range. The upper end of this range is above preferred salmonid temperatures and approaches the upper avoidance temperature reported for salmonid fish (Pickett, 1994; Coutant, 1977).

DO levels in the Skookumchuck River, both above Hanaford Creek and at the mouth, were good (8.9 - 11.0 mg/L). Hanaford Creek DO levels were fair to good (5.9-7.3 mg/L) (Pickett, 1994).

A portion of this subbasin was included in the **Upper Skookumchuck Watershed Analysis (**Weyerhaeuser Co., 1997). The analysis area included the area upstream of Skookumchuck Dam, including the reservoir. Most stream channels are fairly high gradient and confined. Rearing areas in the form of lowland areas, beaver ponds, and side channels are not common features in this WAU. Accumulation of fine sediments was rare, and not considered a problem in terms of pool filling or intrusion into redds. Local areas vulnerable to inputs from surface erosion or mass wasting have been mapped. Lack of LWD is common throughout this WAU. Habitat concerns at most life history phases are associated with the lack of LWD. Human-caused barriers included Skookumchuck Dam and culverts. Generally, water temperatures are not considered a problem. Approximately 1/3 of streams in the WAU have shading levels less than desirable: these streams include the lower mainstem and headwaters of the Skookumchuck, and portions of Laramie, Eleven, Three Deer, Drop, and Bigwater Creeks. One splash dam was operated in the past (1/2 mile upstream of the existing Skookumchuck Dam). The channel downstream of that location is now within the reservoir. The construction of Skookumchuck Dam in 1970 eliminated natural access of anadromous fish, and inundated historical spawning habitat for coho and chinook. Populations of steelhead above the dam are maintained by hauling adult fish above the dam (Weyerhaeuser Co., 1997).

SUBBASIN 10. CHEHALIS RIVER MIDDLE REACH 1

USFWS/WDFW extensive survey

A total of 63 stream miles were surveyed in their **"Independence-Lincoln"** subbasin, including portions of Independence, Lincoln, and Wildcat Creeks. The most important habitat problems identified included: livestock access to stream (2 points and 21.3 miles) (lower and mid-Lincoln Creek, independence Creek tributaries), streamside vegetation loss and bank vegetation destruction (60 points and 24.5 miles) (lower Lincoln Creek, Independence Creek and tributaries), bank erosion (112 points and 14.4 miles) (upper Lincoln Creek, Independence Creek tributaries), and excessive instream sediment (2 points and 11.7 miles) (lower Lincoln Creek, Independence Creek tributaries). Beaver dams were fairly widespread in Independence Creek at the time of the survey, only a few dams were noted in Lincoln Creek, mostly in the headwaters. A total of 20 known or suspected water withdrawals and 13 miscellaneous pollution sources were noted (Wampler et al., 1993). WDOE recorded summer temperatures in Lincoln Creek 15 - 19 ^{o}C range. Independence Creek temperatures were recorded in the 13.6- 17 ^{o}C range. Lincoln Creek high temperatures are above preferred salmonid maximums, while Independence Creek temperatures were mostly within the range of salmonid preferred temperatures (Pickett, 1994; Coutant, 1977).

DO levels in Lincoln Creek were poor (3.9-5.6 mg/L). Independence Creek DO levels were also poor (4.1-5.6 mg/L) (Pickett, 1994).

USFWS extensive survey results for Coal, Dillenbaugh, and Berwick Creeks are summarized with Salzer Creek (Subbasin #8).

SUBBASIN 11. BLACK RIVER

USFWS/WDFW extensive survey

A total of 88 stream miles were surveyed in their **"Black"** subbasin, including the Black River, Mima, Waddell, Dempsey, Salmon, Allen, and Beaver Creeks, and Blooms Ditch. The most important habitat problems identified were: livestock access to streams (6 points and 23.9 miles) (Beaver, Dempsey, Mima, and Allen Creeks, Blooms Ditch, and the Black River), streamside canopy reduced by agriculture (2 points and 18 miles) (lower Black River, lower Mima Creek, Beaver Creek, Allen Creek, Dempsey Creek), streamside vegetation loss from unknown causes (1 point and 16.7 miles) (Salmon and Allen Creeks, Blooms Ditch), bank erosion (82 points and 7.2 miles) (Waddell, Salmon and Mima Creeks), and bank destruction by livestock (73 points and 6.2 miles) (Mima Dempsey, Beaver and Allen Creeks, Blooms Ditch, lower Black River). Beaver dams were present throughout the basin, although, somewhat more common in Mima and Waddell Creeks. Twenty-eight known or suspected water withdrawals were noted, as well as 9 miscellaneous pollution input sources (Wampler et al., 1993).

WDOE recorded summer temperatures in the 15 -21 ^{o}C range in the Black River (at Howanut Road Bridge). The upper temperature measured is at salmonid avoidance temperatures, and is at a value where salmonid adult upstream migration has been seen to be blocked by temperature conditions (Coutant, 1977; Bell, 1991). DO levels measured were all in the good range (7.9-12 mg/L) (Pickett, 1994).

A stream survey was done in an unnamed tributary (23.0661) (0.3 miles) (T/F/W Ambient Monitoring, 1996).

SUBBASIN 12. CEDAR CREEK

USFWS/WDFW extensive survey

A total of 38 stream miles were surveyed in their **"Gibson- Cedar"** subbasin, including portions of Gibson, Thurston, Cedar, Shelton, and Sherman Creeks. The most important habitat problems identified were: livestock access to streams (2 points and 2.5 miles) (lower Cedar Creek), streamside vegetation loss from unknown causes (6 points and 2.2 miles) (Cedar, Shelton and Sherman Creeks), bank erosion (52 points and 0.6 miles) (Cedar and Sherman Creeks), and miscellaneous pollution input sources (12 points) (upper Cedar, Sherman, extreme lower Cedar Creek). Beaver dams were present in the subbasin, but not in large numbers during the survey. A total of three known or suspected water withdrawals were noted (Wampler et al., 1993).

WDOE recorded summer temperatures in Cedar Creek in the 14 - 15.6 ^{o}C range, within salmonid preferred temperatures (Pickett, 1994; Coutant, 1977). DO levels is Cedar Creek were good (9.2-10.4 mg/L) (Pickett, 1994).

A stream survey was done in Lost Valley Creek (23.0581) (0.3 miles), and two in Sherman Creek (23.0579)(0.5 miles) (T/F/W Ambient Monitoring, 1996).

SUBBASIN 13: CHEHALIS RIVER - MIDDLE REACH 2

This subbasin contains the mainstem Chehalis between Porter and just upstream of the Prairie Creek confluence, and includes Porter, Rock, Scatter, Prairie, and Garrard Creeks. Information collected in the mainstem Chehalis River is presented in a previous section. This section presents information for the tributary streams.

USFWS/WDFW extensive survey

Three USFWS/WDFW survey summaries lie within this subbasin. A total of 27 stream miles were surveyed in their **"Porter"** subbasin, including Porter, NF and SF Porter, and Marcy Creeks, and two unnamed tributaries. The most important habitat problems identified were: bank vegetation loss from forest practices (1 point and 2.9 miles) (mid-Porter, Marcy, tributary 0548), bank erosion (72 points and 2.6 miles) (Porter Creek, tributaries 0548 and 0547), streamside vegetation loss from unknown causes (2.1 miles) (lower 1/3 of subbasin), and bank vegetation destruction by livestock (23 points and 0.12 miles) (lower Porter Creek, tributary 0547). Beaver dams were not common in this subbasin at the time of the survey. Two water withdrawals were noted, and one miscellaneous pollution input source (Wampler et al., 1993).

A total of 31 stream miles were surveyed in their **"Scatter Creek"**subbasin, including Scatter and Prairie Creeks. The most important habitat problems identified were: stream canopy reduced by agriculture (1 point and 17.6 miles) (Scatter Creek), livestock access to stream (1 point and 11.7 miles) (Scatter Creek, upper Scatter Creek tributary 0719), excessive instream sediments (2 points and 8.5 miles) (mid-Scatter Creek, Prairie Creek), streamside vegetation loss (4 points and 13.2 miles) (Prairie Creek, lower Scatter Creek, tributary 0719), and bank vegetation destruction by livestock (34 points and 3.1 miles) (Scatter Creek). Some beaver dams were noted during the survey, mostly in mid-Scatter Creek. A total of 6 known and suspected water withdrawal were noted, as well as one pollution input source and one suspected source of poor water quality (Wampler et al., 1993).

A total of 53 stream miles were surveyed in their **"Rock-Garrard"** subbasin, including portions of Garrard, Bloomquist, Williams, Rock, and Gaddis Creeks. The most important habitat problems identified included: bank erosion (116 points and 11.5 miles) (upper Garrard, Williams and Gaddis Creeks), livestock access to streams (5 points and 9.4 miles) (Garrard and Williams Creeks), streamside vegetation loss, bank vegetation destruction, and reduced tree canopy (86 points and 8.2 miles) (mid-Rock Creek, upper Williams Creek, Garrard Creek), and excessive instream sediments (5 points and 9.6 miles) (Gaddis and Williams Creeks, SF Garrard Creek). Beaver dams were present in Gaddis and Upper Williams Creeks, as well as in Bloomquist Creek and another small Garrard Creek tributary, at the time of the survey. Twelve water withdrawals and 7 miscellaneous input or suspected pollution inputs were noted (Wampler et al., 1993).

WDOE measured summer temperatures in Scatter Creek in the 15 -21 ^{o}C range. The upper temperature measured is at salmonid avoidance temperatures, and is at a value where salmonid adult upstream migration has been observed to be blocked by temperature conditions (Coutant, 1977; Bell, 1991). Garrard Creek summer temperatures were measured in the 14 - 18.3 ^{o}C range. The higher temperatures observed are above preferred salmonid maximums. Rock Creek temperatures were 14.4- 14.7 ^{o}C, within salmonid preferred temperatures (Pickett, 1994; Coutant, 1977).

Scatter Creek DO levels, measured above the mouth, were good (11.9-14 mg/L), as were DO levels in Garrard Creek (6.4-8.3 mg/L). Rock Creek DO levels were good (8.2-8.4 mg/L) (Pickett, 1994).

WDOE recorded summer temperatures in Porter Creek in the13 - 14 ^{o} C range, within salmonid preferred temperatures (Pickett, 1994; Coutant, 1977). However, these are all morning samples and probably more indicative of mean or minimum temperatures than maximums. DO levels in Porter Creek were also good (9.6-9.7 mg/L) (Pickett, 1994).

Extensive survey results for Independence Creek are summarized with those for Lincoln Creek, in Subbasin #10. Results for Gibson Creek are summarized with Cedar Creek in Subbasin #12.

Thurston Conservation District habitat survey

Thurston Conservation District staff surveyed 4.26 miles of Scatter Creek during 1999, in order to describe fish habitat conditions as part of the development of a Habitat Conservation Plan. Data from that survey may be available by Fall, 2000 (J. Coffing, TCD, pers. comm., 2000).

SUBBASIN 14. CLOQUALLUM CREEK

USFWS/WDFW extensive survey

A total of 94 stream miles were surveyed in their **"Newman - Cloquallum"** subbasin, including Newman, Vance, Cloquallum, Wildcat, Bush, Mox-Chehalis, and Sand Creeks. The most important habitat problems identified were: streamside vegetation loss from unknown causes (1 point and 41.8 miles) (widespread), excessive instream sediments (12 points and 16 miles) (Vance, Sand, Bush and upper Newman Creeks), bank erosion (173 points and 10.5 miles) (Cloquallum, Mox Chehalis and Wildcat Creeks), and bank riprap/artificial protection or dumping (108 points and 2.2 miles) (Wildcat, lower and mid-Cloquallum and Vance Creeks). Beaver dams were present in the basin in moderate numbers at the time of the survey. A total of

22 known and suspected water withdrawals were noted, as well as 2 wastewater outfalls and 22 miscellaneous pollution input sources (Wampler et al., 1993).

Newman and Vance Creeks are grouped in our subbasin 19, below.

SUBBASIN 19. CHEHALIS RIVER LOWER REACH 1

This subbasin includes the mainstem Chehalis River between the Satsop River and Porter Creek, including Workman Delezene, Newman, and Vance Creeks. USFWS extensive survey data for the mainstem Chehalis River is presented above.

USFWS/WDFW extensive survey

A total of 42 stream miles were surveyed in their **"Workman Delezene"** subbasin, including portions of Workman, Delezene, and Eaton Creeks and two unnamed tributary creeks. The most important habitat problems identified included: stream canopy reduction from forest practices (1 point and 23.3 miles) (Workman, Delezene, Eaton Creeks), excessive sediments in streambed (1 point and 16.2 miles) (Workman, mid- and lower Delezene, upper Eaton Creeks), stream canopy reduction from agriculture (9 points and 5.3 miles) (upper Eaton, lower Delezene, lower Workman), and bank erosion (53 points and 0.3 miles) (Workman and Delezene Creeks). Beaver dams were fairly widespread across this subbasin at the time of the survey. A total of 4 known or suspected water withdrawals and 6 known or suspected pollution input sources were also noted (Wampler et al., 1993).

Habitat survey results for Vance and Newman Creeks are summarized with Cloquallum Creek, our Subbasin #14.

SUBBASIN 20. WYNOOCHEE RIVER

USFWS/WDFW extensive survey

A total of 160 stream miles were surveyed in their **"Wynoochee"** subbasin, including the Wynoochee River, Sylvia, Wedekind, Black, Helm, Anderson, Schafer, and Hell Creeks. The most important habitat problems identified were: bank erosion (219 points and 71.65 miles) (major tributaries from Black Creek to Schafer Creek and adjacent reaches of the mainstem Wynoochee), excessive instream sediments (17 points and 3.5 miles) (tributaries in lower 1/3 of basin), stream canopy reduced by forest practices (24 points and 28 miles) (Black, Wedekind and Sylvia Creeks), and beaver dams potentially partially passable (35 points) (tributaries in lower ½ of subbasin). Beaver dams were present throughout the basin at the time of the survey, and present in Black, Sylvia, and Wedekind Creeks in the highest numbers. Fifteen known and suspected water withdrawals were observed, as well as 5 miscellaneous pollution input sources (Wampler et al., 1993).

A portion of this subbasin was included in the **Wynoochee Watershed Analysis** (USFS, 1996). The analysis area included the watershed upstream of Save Creek. The analysts concluded that instream habitats have been simplified through reduced recruitment of LWD, removal of instream LWD, increased inputs of coarse and fine sediments, and road placement in or near stream channels and floodplains.   Streams identified to be in moderate condition with stable or improving trends in habitat quantity and quality included Save Creek, Anderson Creek, Middle Wynoochee River tributaries, Upper Wynoochee, and Wynoochee Lake tributaries.   Streams identified to be in fair to poor condition with unstable or declining trends in habitat quantity and quality: Trout Creek, Harris Creek, Big Creek, West Branch Wynoochee, and the North Fork West Branch Wynoochee (USFS, 1996).

A portion of this subbasin was included in the **Sylvia Creek watershed fish and habitat inventory** (City of Montesano, 1994, 1995).   Sylvia Creek is accessible to anadromous fish for the first 4.7 miles. Resident fish are found upstream of this point. Lower Sylvia Creek was found to have predominantly pool habitat, with qualities that make for good rearing habitat. Little spawning gravels were found, and it was noted that native soils are gravel poor. The report notes that the East Fork /Sylvia Creek has "received protection from logging" for over the last 75 years, although the lower 1 mile was scoured in 1990 during a road fill failure. The West Fork has been logged in the past over a "a substantial portion" of its length (City of Montesano, 1994, 1995).

SUBBASIN 25. HUMPTULIPS RIVER

Fish habitat has been assessed in the East Fork and WF Humptulips Rivers upstream of their confluence as part of the **East/West Humptulips watershed analysis** (Dieu and Martin, 2000; Martin and McConnell, 2000). Spawning gravels were found in adequate amounts in the anadromous zones. Substrate embeddedness was found to be high in O'Brien Creek and the West Fork Humptulips. The relative amount of pool habitat available for summer rearing was high in both upper mainstems and in several tributaries with anadromous fish. Amounts of instream LWD were adequate in many tributaries, especially those upstream of historic splash dam locations. Instream LWD amounts were found to be low in portions of the West Fork and larger portions of the East Fork. Loss of LWD-associated habitat as a result of channel flushing and reduced inputs of LWD was identified to be of concern for the lower portions of the channel network. A reduction in the rate of bank erosion was also identified as a key objective in areas where the river channel is confined by terraces.   Summer water temperatures were determined to cause risk to juvenile steelhead and chinook, especially in the lower reaches of the East and West Forks.

Collins and Dunne (1986) estimated that gravel removal in the Humptulips River between RM 16 and RM 28 between the late 1950's and 1985 caused the river bed to lower, with an estimated rate of 0.1 foot/year. Harvest rates in Grays Harbor County were adjusted after 1986, and the current gravel harvest rate is lower than the rate during that period. Also, WDFW now encourages gravel pit locations to be outside of active stream channels. Current gravel harvest rates, and currently acceptable instream locations, are not known.

A habitat survey was done in Brittain Creek 22.0079) (1.4 mi) and Elwood Creek (22.0079a) (1.6 miles (T/F/W/ Ambient Monitoring, 1991).

SUBBASIN 18. SATSOP RIVER

USFWS/WDFW extensive survey

A total of 246 stream miles were surveyed in their **"Satsop"** subbasin, including the Satsop, WF, MF and EF Satsop and Canyon Rivers, and Decker, Bingham, Cook, and Dry Creeks. The most important habitat problems identified were: bank erosion (428 points and 57 miles) (WF Satsop , MF Satsop, Canyon River, Dry Creek), streamside vegetation loss from unknown causes (2 points and 38.8 miles) (widespread in lower 2/3 of subbasin), stream canopy reduced from forest practices (12 points and 21 miles) (widespread in lower 2/3 of basin), and logjams with the potential to be whole or partial migration blockages (74 points) (upper 1/3 of basin). Beaver dams were present in moderate numbers at the time of the survey. A total of 14 known and suspected water withdrawals were noted, as well as 2 wastewater outfalls and 9 miscellaneous pollution input sources (Wampler et al., 1993).

A portion of the subbasin was included in the **West Satsop Watershed Analysis** (Simpson and Weyerhaeuser, 1996; Baxter, 1996). The analysis area included the West Fork upstream of the confluence. Habitat concerns identified include lower levels of LWD than those present historically. Lower than preferable wood levels were found in the West Fork Satsop, Canyon River, Lower Still Creek, West Satsop Junction, Middle West Fork, Save Creek, Lower Little River, and Lower Upper Canyon River subbasins. Open riparian canopy that might contribute to high water temperatures was noted in the much of the West Fork Satsop mainstem and Canyon River. A potential for gravel scour was noted in the mainstem West Fork Satsop, Canyon River, and lower portion of the Little River. Subbasins where a potential for fine sediment inputs (and little spawning gravel) included tributaries to the west work Satsop, Lower Still Creek, Upper Still Creek, Five Mile Creek, and Seven Mile Creek subbasins (Baxter, 1996).

Collins and Dunne (1986) estimated that, for the 10-20 year period prior to 1986, gravel harvesting removed more gravel than the annual replenishment rate in the Satsop River between RM 1 and RM 3 by a factor of more than 10. Channel downcutting of approximately 0.1 foot/year was estimated.

A stream survey was done in an unnamed West Fork tributary (22.0400) (0.95 miles) (T/F/W Ambient Monitoring, 1991).

SUBBASIN 21. WISHKAH RIVER

A portion of this subbasin was included in the **Wishkah Watershed Analysis.** The analysis area included the subbasin upstream of RM 28.5 (Wishkah Falls is at RM 29.4). Investigators noted that the small tributary streams tended to have good habitat complexity and instream structure. Deciduous-dominated riparian stands in the watershed limit future LWD recruitment. A lack of large instream wood was noted in the main stem Wishkah above the reservoir, and the analysts concluded that habitat conditions were apparently in the process of recovery from past land use actions (Raines et al., 1992). No other information was found for current fish habitat conditions in the Wishkah River watershed.

SUBBASINS 22, 23, 24. MF HOQUIAM, EF HOQUIAM, AND HOQUIAM RIVERS

Historic information found indicated that the Hoquiam River began to be logged early in the settlement period of Grays Harbor County, and records show that 8 splash dams in the basin operated during the 1880-1930 period (Wendler and Deschamps, 1955; Van Syckle, 1981). There is a diversion dam on the WF Hoquiam River, serving as the water supply for the City of Hoquiam. No other information was found about current fish habitat conditions in the Hoquiam River watershed.

SUBBASIN 26. ELK RIVER

Subbasin contains the Elk River, Andrews Creek, and Barlow Creek, as well as Redman, Beardslee, and Mallard Sloughs, and is the southern-most subbasin of the independent South Harbor tributaries. Because of location, the South Harbor tributaries were entered for timber harvest early in the settlement period of the Grays Harbor area (Van Syckle, 1981). No current information on habitat conditions in this subbasin was located.

SUBBASIN 27. JOHNS RIVER

This subbasin contains the Johns River and tributary streams. Five splash dams are reported to have been historically present in the Johns River subbasin, although the dates of building and removal are not known (Fairbairn, 1982). Because of location, the South Harbor tributaries were entered for timber harvest early in the settlement period of Grays Harbor (Van Syckle, 1981). No current information on habitat conditions in this subbasin was located.

SUBBASIN 28. NEWSKAH RIVER

This subbasin contains Newskah River and tributary streams. A total of five splash, pond, or roll dams evidently existed historically on the Newskah River, although no information on the year of building, location, or height is available. All of the dams are reported as out of the river by 1955 (Wendler and Deschamps, 1955). Because of location, the South Harbor tributaries were entered for timber harvest early in the settlement period of Grays Harbor (Van Syckle, 1981). No current information on habitat conditions in this subbasin was located.

In addition, no current information on habitat conditions in O'Leary, Stafford, Indian, Campbell, or Chapin Creeks was located.

SUBBASIN 29. CHARLEY CREEK

One splash dam was reported to have been historically present in Charley Creek, built prior to 1910 and washed out at an unknown date (Fairbairn, 1982). Because of location, the South Harbor tributaries were entered for timber harvest early in the settlement period of Grays Harbor (Van Syckle, 1981). No current information on habitat conditions in this subbasin was located.

A lack of information about habitat conditions in these systems would make it difficult to effectively target enhancement or rehabilitation efforts, should those be desired.

SUBBASIN 30. MAINSTEM CHEHALIS RIVER BELOW MONTESANO

Historical information about channel changes during the 1800's and early 1900's was available, and is summarized in a previous section. Water quality information was available and is summarized Appendix C. Extensive habitat survey information is summarized above.

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