APPENDIX II

Summary of natural and man - induced limiting factors of salmonid habitat on Puget Sound and coastal area streams.

NOOKSACK BASIN

The Nooksack River consists of three forks. There are several small independent drainages in the Basin as well. The marine shorelines and esturaries include Drayton Harbor, Birch Bay, Lummi Bay, Bellingham Bay, and Samish Bay. The basin contains 654 streams (1,328 miles).

Limiting Factors - By Streams

- Independent drainages, Strait of Georgia: low flows, pump irrigation withdrawal; occasional debris build-up; extensive channelization.
- Lower Nooksack, Bellingham Area: Water quality in Lower Nooksack and Bellingham Bay; low flows, pumped irrigation withdrawal, channelization, and streamside development, mainly in tributaries.
- Nooksack River, Lynden Area: Extensive gravel excavation; channelization; agricultural pollution; tributaries - channelization, streamside residential development, diversion and pumping of natural low flows.
- Nooksack River, Deming Area: Low glacial temperatures; unstable streambed; disturbance or elimination of gravel due to excavation; tributaries; removal of streamside cover, channelization, urban encroachment.
- South Fork Nooksack, Deming Area: Bank clearing and channel alterations along tributaries; gravel removal from mainstem; low flows.
- South Fork Nooksack, Saxon Area Barrier: Falls at R.M. 25; fish poaching; logging of tributary areas; flash flooding; siltation.
- South Fork Nooksack, Headwaters: Barrier falls at R.M. 25; torrential gradients; extensive logging.
- Nooksack River, Maple Falls Area: Unstable channel; glacial characteristics; barrier preclusions to upstream areas; extensive logging; flash floods; siltation; some gravel removal.
- Middle Fork Nooksack, Kulshan Area: Diversion dam block and low summer flow; occasional channel shifting and gravel removal.
- Nooksack River, Glacier Area: Glacial characteristics (cold and torrential) unstable channel sections; logging of tributary areas; flash flooding.
- Glacier Creek Drainage: Cascades and falls block upstream access; unstable channel in lower area; fish poaching on Thompson Creek.
- Nooksack River, Headwaters: Nooksack Falls a total barrier; steep gradients of tributaries restrict upstream access; glacial characteristics.
- Chuckanut Bay Drainage: Steep gradient restricting access ; removal of stream cover; channelization; water withdrawal; fish poaching, especially in Oyster Creek.

SKAGIT BASIN

The Skagit is the largest basin draining into Puget Sound, consisting of the Skagit, Samish, and at least five other independent stream systems. There are 2,989 identified streams (4,540 linear miles).

Limiting Factors - By Streams

- Lower Samish River: Occasional severe summer low flow; irrigation withdrawal; bank clearance; channelization and diking; gravel excavation near Thomas Creek with silting and sedimentation; runoff contaminated from agricultural sprays, feed lots, silage pits, silos, and septic drainage; e.g. Bob Smith Creek, formerly productive chum salmon stream, now contains badly degraded substrate where eggs no longer survive.
- Friday Creek Drainage: Low summer flows and high water temperatures; flooding; bank stabilization projects; logging; siltation; infestation of "setting" clam larvae at the hatchery.
- Upper Samish River: Low flows; pump irrigation withdrawal; bank clearing; channel alterations; agricultural spraying.
- Lower Skagit River, La Conner Area: Burlington sewage outfall at R.M. 19.5; outfall from food processing plant at R.M. 11; agricultural nonepoint pollution. Sand excavation on lower river resulting in potholes which trap juvenile fish; also, drainage ditches and sloughs; dredging of Swinomish Channel.
- Skagit River, Sedro Woolley Area: Erosion at R.M. 26.5 in Skagit mainstem degrades area below; 80% of flow at Dead Man Slough is now diverted to south channel; Sedro Woolley sewage outfall at R.M. 22.5; diversion from Gillagan Creek to Judy Reservoir drastically reduces summer flows; unstable bedloads in tributaries require gravel dredging in maintaining some channels; low summer flows in all tributaries.
- Nookachamps Creek Drainage: Heavy run off and flooding from precipitous mountain tributaries; diking of farmlands in Nookachamps Valley; fluctuating water levels on Big Lake creates fish passage problems; septic-tank pollution around Big Lake; drainage from silage and manure create heavy algae growths and low DO's in summer months; dewatering of Turner and Mundt Creeks due to diversion to Judy Reservoir.
- Skagit River, Hamilton Area: Reservoir in Jones Creek for Hamilton water supply dries up lower end of creek in summer; logging impairment of tributaries (e.g., culvert passage on Red Cabin Creek, and Alder Creek, log storage areas in lower Muddy Creek) all left-bank tributaries are short-run with limited spawning and rearing areas; garbage and refuse disposal off Skagit River banks.
- Day Creek Drainage: Fluctuations in flow and extensive logging; rapid run-off from steep slopes and flooding; little spawning gravel in upper watershed; extreme summer low flows limit access.
- Skagit River, Concrete area: Severe flow fluctuations due to power generation peaking; heavy siltation from logging activities in tributaries to Grandy Creek; severe erosion on Grandy Creek due to road construction on Baker Lake Road; encroachment by recreation home developments along main river.

- Finney Creek Drainage: Extensive logging and road construction activities have resulted in land slides, silting and erosion, and deposits of logging debris in the stream.
- Lower Baker River: Rainbow trout stocked in Baker Lake increases predation on coho and sockeye fry; extreme lake fluctuations curtail fish use of many lake tributaries, while upper watershed tributaries are precipitous; logging affecting silting and fast run-off; glacial flour creates turbidity in Lake Shannon and, in addition to cold water temperatures, hampers food production.
- Upper Baker River: Precipitous gradients.
- Skagit River, Rockport Area: Major floods from Sauk River subdrainage cause silting and turbidity; violent fluctuations in flow from power generation upstream; logging of cottonwoods on streambank; Jackman Creek particularly impacted by logging.
- Lower Sauk River: Heavy runoff and flooding from glacial flows of Suiattle drainage; precipitous tributaries; Hilt Creek contains many beaver dams and a large land slide, which impedes fish passage; White Creek lacks suitable gravel; extensive logging has aggrevated inherent watershed instability.
- Lower Suiattle River: Steep gradients and impassable cascades on all tributaries; heavy runoffs and low water temperatures; logging and road-building have accelerated runoff and siltation; campgrounds on Buck Creek have encroached on lower stream; slide on Big Creek causing siltation.
- Upper Suiattle River: Rapid glacial melt runoff; glacial flour turbidity; extreme gradients; falls and cascades in tributaries; logging impacts.
- Sauk River, Darrington Area: Extreme flows; extensive logging, flash run-off, erosion; logging of river bottom; siltation, debris, log jams; recreation development encroachment with extensive bank protection; beaver dams on Dan Creek.
- Sauk River, Whitechuck Area: Extreme flows; limited spawning area; precipitous tributaries; road building and logging; rapid snow melt, cold water, flooding, channel scouring.
- Skagit River, Marblemount Area: Flow fluctuations due to power peaking at Ross, Diablo, and Gorge Dams; logging and road building, siltation, accelerated run-off.
- Illabot Creek Drainage: Logging, flash run-offs, erosion; restrictive access in upper steep watershed; channelized section below R.M. 2.0.
- Lower Cascade River: Precipitous tributaries and steep gradients; lack of spawning gravel; extensive logging, erosion, siltation; cold glacial water.
- Upper Cascade River: Erratic streamflows from heavy snow melts; large irregular substrate unsuitable for spawning; precipitous tributaries with cascades and falls; clearcut logging is away from river but adversely influences run-off and debris; falls on north fork impassable.
- Bacon Creek Drainage: Erratic stream flows; unstable gravel; low summer flows; precipitous tributaries.
- Upper Skagit, Newhalem Area: Precipitous tributaries; unsuitable spawning substrate; rapid run-off and heavy flooding.

- Upper Skagit, Ross Lake Area: Adverse changes in river stage from releases from Gorge Dam; migration block.

SAN JUAN BASIN

The San Juan Basin located primarily on Orcas, Lopez and San Juan Islands contains 88 streams (100 miles). One stream on Orcas Island supports anadromous fish. San Juan Island has two such streams over a mile in length. Lopez Island has only two small streams and neither supports anadromous fish.

Limiting Factors - General

- Lack of flow.
- Limited spawning and rearing area.
- Cascades or falls at stream mouths.
- High water temperature.
- Encroachment by summer home developments and retirement communities.

STILLAGUAMISH BASIN

The Stillaguamish Basin consists almost entirely of the Stillaguamish River system, divided nearly equally into north and south forks. The basin contains 457 streams (977 miles).

Limiting Factors - by Streams

- Stillaguamish River, Lower Mainstem: Low summer flows and warm water temperatures; occassional heavy sedimentation; contamination by agricultural spraying; gravel removal.
- Lower Pilchuck Creek: Low summer flows; stream bank erosion associated with road construction and housing developments; removal of vegetation and channelization.
- Upper Pilchuck Creek: 12-15 ft. vertical falls at R.M. 11; logging and road building in upper watershed.
- North Fork Stillaguamish River, Cicero Area: Silt deposition from large land slide upstream; low summer flows; gravel removal; fish poaching.
- Deer Creek Drainage: Flash flooding and heavy silt loading aggravated by extensive clear-cut logging in upper watershed; steep gradient in lower canyon may be partial barrier to pink and chum; silt deposition in lower 2 miles; lack of shade and cover in upper watershed; potholes result in low flows trapping juveniles; precipitous gradient above R.M. 17; logging debris.
- North Fork Stillaguamish, Hazel Area: Sedimentation from major land slide; gravel removal.
- Boulder River Drainage: Series of falls that begin at R.M. 2.9 halt fish migration; gravel removal; channelization; logging.

- North Fork Stillaguamish, Headwaters: Series of falls at R.M. 37.3 prevent migration; adverse impacts from clearcut logging and road construction.
- Squire Creek Drainage: Occasional flash flooding; severe low summer flows; road construction and logging.
- South Fork Stillaguamish, Arlington Area: siltation from a large land slide in upper watershed; steep gradient and cascades in the canyon; flow fluctuations inhibiting migration.
- Jim Creek Drainage Partial migration barrier, particularly at low flows at R.M. 4.3; extensively logged upper slopes, rapid run-off, flooding, scouring, siltation.
- Canyon Creek Drainage: Cascades and falls near R.M. 1.2 are partial migration barrier; two large land slides contribute to heavy downstream siltation; potentially detrimental logging and roadbuilding activities in upper watershed.
- South Fork Stillaguamish, Verlot Area: Massive land slide at R.M. 48.7 causes heavy silt loading; cascades and rapids in the gorge impede migration; potential for debris accumulation within the canyon; detrimental logging and roadbuilding activities; contamination by herbicides and insecticides.
- South Fork Stillaguamish, Headwaters: Lack of nutrients; use of forest herbicides and insecticides; large scale logging-road building.

WHIDBEY-CAMANO BASIN

Most streams are dry in summer. A few, provide limited spawning and rearing flows. Some streams maintain a flow year round. The basin contains 76 independent streams (87 miles).

SNOHOMISH BASIN

The Snohomish River consist of two principal rivers, the Skykomish and the Snoqualmie. In addition, the Basin contains over a dozen small independent streams that flow directly into Puget Sound. Altogether, there are 1,730 rivers and streams (2,718 miles).

Limiting Factors - By Stream

- Snohomish River, lower mainstem: Effluents from wood product industries; extensive log rafting; silt loading from dredging and channelization.
- Pilchuck River, lower mainstem: Gravel removal; flash flooding; low flows.
- Pilchuck River, Granite Falls Area: Low flow; gravel removal.
- Pilchuck River, Headwaters: Diversion Dam at R.M. 26.4 restricts migration; steep gradients and intermittent summer flows in most tributaries; detrimental logging; flash flooding.
- Snohomish-Skykomish River, Monroe Area: Gravel removal; pollution.
- Snoqualmie River, Lower Mainstem: Low summer flow in some tributaries; potential detrimental logging; potential water quality problem because of slow-moving water lacking cover; occasional heavy fish poaching in smaller tributaries.

- Snoqualmie River, Carnation Area: Channelization and diking; gravel removal; siltation from Tolt River slide and gravel operations; tributaries channelized and encroached by residential development.
- Lower Tolt River: Steep gradients, cascades, and falls restrict fish use in some of smaller tributaries; gravel removal; rip-rapping and other flood control block natural overflow channels; logged slopes in upper watershed contribute to flash flooding and silting; Seattle-Tolt Water Reservoir controls flows from south Fork during summer.
- Upper Tolt River: Falls and steep gradient on North and South Fork restricts migration; low flows; siltation from South Fork slide.
- Snoqualmie River, Tolt Area: Snowmelts create severe flooding; I-90 road construction on Snoqualmie Pass Highway results in severe siltation; logging in Griffin Creek headwaters aggravates heavy run-off and unstable channel and bedload; steep gradients and cascades of small tributaries preclude heavy salmon usage.
- Raging River Drainage: Flash flooding associated with steep gradients of upper watershed; streambed scour; lack of gravel; siltation.
- South Fork Snoqualmie River: Snoqualmie Falls block migration upstream habitat potential, never high, depressed further by logging and highway development.
- North Fork Snoqualmie River: Cover removal, streambed siltation, logging debris accumulation; no natural salmon use above Snoqualmie Falls; proposed north fork storage dam. Similar to South Fork Salmon potential limited by natural and man-induced constraints.
- Middle Fork Snoqualmie River: Similar to foregoing.
- Woods Creek Drainage: Low summer flows; beaver dams and log jams on West Fork may restrict migration; impassable falls at R.M. 7.3 East Fork Woods Creek; cascades and falls on steeper tributaries.
- Skykomish River, Sultan Area: Flooding, channel scouring, gravel removal, low summer flows; unstable streambed.
- Sultan River Drainage: Diversion dam block at R.M. 9.7, flooding and prolonged low flows; extensive logging has sometimes created excessive silting; gravel removal.
- Wallace River Drainage: Low summer flows; falls and cascades block migration; water withdrawal.
- Skykomish River, Startup to Forks: Sedimentation; streambed scouring; gravel removal; increased run-off from logging activities; flood control.
- North Fork Skykomish, Headwaters: Precipitous gradient and numerous cascades and falls inhibit salmon use above Goblin Creek.
- South Fork Skykomish, Sunset Falls Area: Logging and road construction; Steep gradients, falls, cascades; three major falls are barriers; only a small portion of the tributaries are accessible.
- South Fork Skykomish, Skykomish Area: Logging, high flows, silt and sands deposition; limited sections of banks sloughing into river; steep gradient.
- Foss River Drainage: Steep gradients.
- Tyee River Drainage: Alpine Falls is total barrier to fish passage; precipitous steepening gradient beyond falls.
- North Fork Skykomish, Index Area: No limitations other than restricted amount of available spawning area; future land clearing or logging could cause problems.

LAKE WASHINGTON BASIN

Rivers and streams that drain into Lake Washington, in turn, drain into Puget Sound via Lake Union and the Salmon Bay waterway. The largest of these streams are the Cedar River and Sammamish Rivers. In addition, there are numerous smaller independent streams. The basin contains 470 streams (700 miles). The Lake Washington Basin is most affected by urbanization.

Limiting Factors - By Streams

- Lake Washington-Sammamish Drainage: Mortality of salmon juveniles at the government locks due to sudden changes in pressure; water quality deterioration at storm drain outfalls and marinas kill fish periodically; contamination by accidental spills of petroleum and chemicals wastes, and siltation from development projects.
- North Lake Washington Drainage: Silt deposition; low summer flows and increased water temperatures affect all streams; encroachment by bank stabilization and stream beautification; poaching and harassment of spawners is serious; impassable falls, fallen trees, or timber slash constitute migration barriers. Road crossings, bridges, culverts restrict migration. Contamination by various waste materials.
- Lower Sammamish River Drainage: Low summer flows; flood damage and siltation from construction developments have completely altered many sections; poaching; the lower six miles of the Sammamish River has been completely dredged, channelized and widened.
- Upper Sammamish River Drainage: The Sammamish above Woodinville represents only a chute to the sea, salmon do, however, spawn in accessible portions of Bear Creek drainage; low summer flows and increased water temperatures typify the lake runoff; storm runoff from farms and developments fowl water quality.
- Issaquah Creek Drainage: The hatchery at Issaquah allows complete control of the numbers of each species passed upstream to spawn naturally; low flows in summer are limiting but compensated for by rearing in Lake Sammamish and Lake Washington; highway construction, laying of gas pipelines, and home developments all have contributed to heavy siltation and water quality problems.
- South Lake Washington Drainages: Mercer Slough, Coal Creek, May Creek and one unnamed. Stream banks have been cleared in developed areas; water quality and supply and general habitat deterioration are limiting in these areas; Kelsey Creek has seasonally lethal water quality; low flow and high temperatures are common in summer; large scale residential developments on May Creek involving storm drains, siltation, road construction and culverts depress water quality; natural vegetation is largely replaced along with increased storm runoff, limits potential.
- Cedar River (Renton Area): Abnormal algae growth is common during the summer months; some stream stretches are artificially contoured or riprapped; streambed quality deteriorates in the lower half due to increasing sand and silt accumulations; low flows during summer are common; occasional contamination with toxic pollutants.

- Cedar River (Maple Valley Area): A pipeline and diversion dam block gravel replenishment from upstream; persistent low flows, and rapid changes in flows from hydroelectric operations; channelization; gravel removal; and bank protection activities.
- Cedar River (Landsburg Area): The pipeline barrier at R.M. 21.4 eliminates upstream migration beyond this point; the diversion dam just upstream also presents a total barrier.
- Cedar River (Headwaters): Downstream barrier at City of Seattle's water diversion structures prevents fish migration into this river segment; subject to detrimental logging and road building activities.

DUWAMISH BASIN

The Duwamish Basin primarily consists of the Green-Duwamish River system. The lower 10 miles of the Green River is known as the Duwamish River and is surrounded by dense industrialization as it drains into Puget Sound in the vicinity of Seattle. A few small independent streams flow directly to Puget Sound. The basin contains 367 streams (643 miles).

Limiting Factors - By Stream

- Lower Duwamish River: The natural channel has been completely altered by the appurtenances of dense civilization; oxygen depletion is critical especially in August and September; a saltwater intrusion wedge, created as a result of dredging, contributes to the oxygen problem; industrial wastes, landfill leachates, domestic sewage, and storm runoff reduce water quality; Miller Creek in Burien has an impassable culvert at R.M. 1.8, with the stream deteriorated from residential and commercial development; cement weir at a sewage plant is a partial blockage of Bow Lake Creek.
- Duwamish River (Kent Area): Flooding, exceeding the capacity of Howard Hanson Reservoir, low summer flows, and water quality are principal limiting factors; removal of stream cover and diking have changed the river profile and the channel in the lower valley; flood control measures, silt deposits, pollution, and the SCS east and west valley pumping stations have adverse affects; the Black River Dam and fish passage facilities (constructed by the SCS in 1971 for flood control) have contributed to fish passage problems.
- Green River (Auburn Area): Heavy siltation on Burns and Crisp Creeks is due to farming and hydraulic projects; Green River has suffered from flood control measures below Burns Creek; the existing flow from Howard Hanson Dam is not sufficient to provide adequate spawning, transportation and rearing.
- Soos Creek Drainage: Gravel excavation; diversion of water.
- Newaukum Creek: Diversion of water for stock watering and irrigation; waste discharges into the stream (City of Enumclaw) contribute to heavy algal growth; detrimental logging impacts in the Grass Mountains.
- Green River (Black Diamond Area): Fish passage facilities are lacking at the Tacoma City diversion or Howard Hanson Dam; the segment in the Green River Gorge provides only limited spawning gravel since little gravel recruitment is possible below the dam.

- Green River (Howard Hanson Reservoir): Fluctuations in discharge below the reservoir; access to the considerable habitat above the dam is blocked due to lack of a fishway.
- Green River (Headwaters): Precipitous gradients.

PUYALLUP BASIN

This Basin contains the Puyallup River and principal tributaries, the White River and the smaller Carbon River, and some small independent drainages. There are 728 rivers and streams (1,287 miles). The Puyallup, Carbon, and White Rivers have a glacial origin.

Limiting Factors - By Streams

- Lower Puyallup: Lowered water quality in the estuary area; siltation resulting from residential development; critical water quality of Commencement Bay, the Puyallup, and Hylebos waterways, from industrial effluents and storm drainage; dams on Clear Creek and Swan Creek block fish passage at certain water stages; the mainstem is contained by channelized banks and extensive levees.
- White River (Auburn Area): Flooding; silt and debris flushed from Mud Mountain Dam and Buckley flume; low summer flows; flood control projects in the lower river; operation of the Lake Tapps-Dieringer Plant Complex causing losses of juveniles through the fish screens in the bypass channel; reduction of stream flows restricting migration.
- White River (Buckley Area): Flushing of silt and debris from the Buckley diversion and Mud Mountain Dam; reservoir level fluctuations; low summer flows; ineffective screening in the Buckley diversion; downstream migration is not possible when water level exceeds 90 feet in Mud Mountain Dam; migration is also delayed at the diversion and at the bypass fish screens, and many fish pass into Lake Tapps (the large rotary screens are only 50% effective and mortalities are 73% for chinook and 34% for coho); heavy silt loads and flushing operations create excessive sedimentation; low flows delay upstream migration; oxygen depletion and heavy slime growth occur in Baise Creek as a result of mill pond for log storage.
- White River-Clearwater area: Glacial conditions and heavy silt load due to logging.
- White River, West Fork Area: Productivity naturally limited by harsh glacial conditions; extensive logging, and roadbuilding have further depressed potential.
- Greenwater River drainage: Steep gradients above Burns Creek; extensive clear-cutting, cover removal, and road construction; siltation; logging debris accumulation; encroachment by summer homes.
- White River, Mt. Rainier - Headwaters: There is little or no access for salmon (natural) in many areas although some chinook and coho spawn in the mainstem.
- Puyallup River, Orting Area: Heavy siltation from logging, glacial flour, cleaning of Puget Sound Power and Light's Electron powerhouse flume; bedload unstability accentuated by various flood control projects and gravel removal.

- Lower Carbon River, Orting Area: Glacial silt; gravel removal; contamination with coal mining wastes in the upper watershed.
- Lower South Prairie Creek: Flood control, gravel removal deposition of coal wastes, bank erosion controls and channel changes have detrimentally alterred lower reaches.
- Upper South Prairie Creek: The dam at R.M. 15.7 lacks fish passage facilities (however, the steep gradient at 15 may preclude salmon passage); boulders, logs and debris jams also limits fish passage; logging with considerable siltation.
- Upper Carbon River: Logging has had detrimental impacts on some smaller tributaries in the past, i.e., debris buildup and siltation; harsh glacial characteristics.
- Puyallup River Electron Area: Much of the channel below R.M. 29 is contained within relatively narrow, artificially contoured, heavily riprapped banks; there is no cover available to fish along area; flushing of reservoirs causes silt deposition below.
- Upper Puyallup River headwaters: Rockslides and debris buildup limit access by salmon; salmon are blocked at the P.S.P.L. diversion; flow fluctuations or prolonged low flows occur below the diversion; logging has reduced streamside cover, caused debris buildup, and increased siltation; occasional gravel removal.

NISQUALLY BASIN

The Nisqually Basin consists of the Nisqually River and McAllister Creek. Identified streams number 331 (715 miles). The Nisqually River begins on the Mt. Rainier, and is seasonally subject to loading of glacial-flour.

Limiting Factors - By Streams

- Nisqually River lower mainstem: Fluctuating flows regulated by upstream impoundments.
- Muck Creek Drainage: Small reservoirs to store water during the dry season, are barriers to fish migration.
- Nisqually River, Yelm Area: Severe flow reductions, or violent sharp fluctuations affecting the 13.5 miles of river between the Centralia powerhouse and diversion.
- Nisqually River, LaGrande Area: Detrimental flow-fluctuation resulting from reservoir operations.
- Tanwax-Ohop Drainage: Extensive cover removal may have adversely impacted these streams in the past.
- Mashel River Drainage: Low natural flows are sometimes compounded by the buildup of logging debris, sporadic fish poaching in the lower half-mile of river.
- Nisqually River, Alder Lake: Logging and siltation; gravel removal; channelization.
- Nisqually River Headwaters: Streamside cover removal and streambed alterations.

TACOMA BASIN

The Tacoma Basin lies between the Puyallup River and the Nisqually River and contains two small independent drainages, Chambers Creek and Sequalitchew Creek with 20 streams (53 miles).

Limiting Factors - General

- Low summer flows and increased water temperatures.
- Debris jams and beaver activity cause scattered blockages.
- Cascades and steep gradients on Sequalitchew Creek.
- Urban and industrialization encroachment.

DESCHUTES BASIN

The Deschutes Basin consists primarily of the Deschutes River system, and a few small independent drainages. There are 143 identified streams (256 miles).

Limiting Factors - By Stream

- Budd Inlet - Capital Lake (independent drainages): High water temperatures, siltation; urban and industrial encroachment.
- Deschutes River, Tumwater area: Siltation; streambed and bank alterations associated with land development and erosion.
- Deschutes River, Lake Lawrence area: Same as foregoing.
- Deschutes River, Headwaters: Deschutes Falls (R.M. 41) is a total block to salmon migration; logging and occasional gravel-removal impact the upstream area.

SHELTON BASIN

The Shelton Basin consists of 11 important salmon streams plus numerous smaller independent watersheds. There are 139 identified streams (240 miles). All of the basin streams are of lowland type issuing from natural springs and/or surface runoff and subject to direct human encroachment.

Limiting Factors - By Stream

- Toten-Eld Inlet, independent drainages: Fish passage in Kennedy and Perry Creeks is limited by natural barriers, to the lower reaches; removal of stream bank cover for agriculture; road construction.
- Mill Creek drainage: Municipal water diversion; residential and industrial encroachment (stream flows through city of Shelton).
- Goldsborough Creek drainage: A diversion dam at R.M. 2.3 is equipped with an adequate fishway; siltation of washwater from gravel removal operations; depressed water quality in the lower stream by storm drainage and effluents from the numerous homes and businesses that line the stream; siting of a Simpson Timber Company processing facility at the immediate mouth.

- Upper Oakland Bay, Independent Drainages: Elevated water temperatures due partially to human encroachment.
- Upper Case Inlet, Independent Drainages: There has been considerable residential development on the lower mile of Sherwood Creek and on Mason Lake; fish poaching is the most serious problem.

KITSAP BASIN

The Kitsap Basin consists of watersheds draining east and south into Puget Sound, and others draining generally west into Hood Canal. The Kitsap Basin provide 665 miles of streams, most of which is accessible to anadromous fish.

Limiting Factors - By Stream

- Coulter-Rocky Creeks: Logging has caused adverse affects in the past; fish poaching is severe; development threatens habitat.
- Carr Inlet, Independent Drainages: Home development encroachment and inaccessibility due to small size.
- Henderson Bay Drainages: Human usurpation; siltation.
- Colvos Passage: Logging and agricultural caused siltation; stream bank cover removal in localized areas; fish poaching.
- Sinclair Inlet, Independent Drainages: City of Bremerton water supply barrier makes all but the lower one mile inaccessible to salmon; human encroachment.
- Dyes Inlet Drainages: Low flows; development water quality impacted by human encroachment; fish poaching.
- North Kitsap Peninsula, Independent Drainages: Streams are small restricting access and space for salmon; siltation.
- Port Gamble - Seabeck, Independent Drainages: Constraints of small stream size.
- Big Beef Creek Drainage: Lethal water temperatures in summer in and below Lake Symington; impoundment usurped and eliminated historic coho spawning and run.
- Dewatto-Anderson Creeks: Occasional poaching.
- Ayres Point, Independent Drainages: Limited habitat; poaching.
- Tahuya River Drainage: Low flows; poaching.
- Union River Drainages: Union River Falls is a barrier to migration above R.M. 6.7; upstream the Bremerton water supply dam is another barrier, low flow in Mission Creek, diversion of Union River flow; fish poaching.

HOOD CANAL BASIN

The Hood Canal Basin consists of the watersheds draining the eastern slopes of the Olympic Mountains to southern Hood Canal. The principal rivers are the Skokomish, Hamma Hamma, Duckabush, and Dosewallips Rivers. There are 557 identified streams (825 miles).

Limiting Factors - By Stream

- Lower Skokomish River, Potlatch Area: Low summer flows; water withdrawal on the North Fork; high winter flows; unstable streambed; reservoir spilling during time of peak discharge.
- South Fork Skokomish, Headwaters: Some removal of streamside cover; low summer flows, possibly intensified by logging effects.
- Lower North Fork Skokomish: Restricted and irregular flow releases from lower Cushman Dam since the 1930's.
- Upper North Fork Skokomish: Inaccessible to anadromous fish due to the presence of two dams downstream.
- Hood Canal Drainages, Hoodsport Area: Low summer flows; steep gradients.
- Hamma Hamma River Drainage: A cascade at R.M. 2.0 restricts fish access; logging.
- Lower Duckabush River: Steep gradient; logging.
- Upper Duckabush River: Inaccessable due to steep gradient and cascades downstream.
- Lower Dosewallips River: Steep gradient.
- Upper Dosewallips River: Blocked by falls downstream.

QUILCENE BASIN

The Quilcene Basin consists of the rivers and independent streams from Quilcene Bay in Hood Canal to Sequim Bay on the Strait of Juan de Fuca. There are 303 identified streams (428 miles).

Limiting Factors - By Stream

- Big Quilcene River: Summer low flows plus water diversion (to City of Port Townsend); steep gradient above R.M. 3; diking and channelization below U.S. Highway 101 bridge.
- Little Quilcene River: Steep gradient; low summer and fall flows; some water withdrawal.
- Upper Dabob Bay, independent drainages: Small size and steep gradient.
- Admiralty Inlet Drainages: Small stream size; extensive removal of stream bank cover; water quality degradation from agricultural wastes, log dumping and storage in Port Townsend Bay at the mouth of Chimicum Creek.
- Port Discovery - Sequim Bay, independent drainages: Natural low flows and barriers; some logging.

ELWHA - DUNGENESS BASIN

The Elwha and Dungeness Rivers are the principal streams in the basin. In addition, thirteen smaller streams flow into the Strait (1,025 miles total).

Limiting Factors - By Stream

- Dungeness River, lower mainstem: Steep gradient limits accessibility; landslides in 1968 and 1969 caused sedimentation of spawning areas and depressed some fish runs.
- Port Angeles, Independent drainages: Steep gradient; encroachment by residential and industrial development; natural low summer flows intensified by development and water diversions.
- Elwha River, Lower Mainstem: The Elwha River contains 44.8 linear miles of stream, but all is inaccessible to anadromous fish except 3.4 miles above the river mouth and below the lower Elwha Dam; the impoundments have eliminated gravel recruitment to the stream below the dam except for some replenishment from tributaries.
- Elwha River, Drainage upstream of Elwha Dams: inaccessible to anadromous fish.

LYRE - HOKO BASIN

The Lyre-Hoko Basin consists of small to medium-sized streams that drain into the western strait of Juan de Fuca; principal among these are the Lyre, Pysht, Clallam, Hoko, and Sekiu Rivers. Most of these have tidal influence extending upstream for several miles. There is a total of 244 streams (495 miles).

Limiting Factors - By Stream

- Lyre River: Low summer flow; siltation; a dam forms a barrier on Salt Creek; steep gradient limit salmonid access to smaller tributaries.
- Twin Rivers: Falls form barriers on both the East and West Twin Rivers; low summer flows; flooding of lower Deep Creek and East Twin River; bank erosion; logging; log jams and steep gradient restrict access.
- Pysht result in channel braiding and shifting during flooding; smaller log jams in the upper watershed restrict fish access.
- Clallam River: An intermittent sand bar at the mouth hinders fish migration; low flows; numerous log jams throughout the watershed; falls block fish access on two tributaries; siltation in the lower river and in several tributaries; the upper watershed streams are threatened by logging and road construction; bank erosion and flooding in the lower 3.5 miles of the Clallam occurs annually.
- Lower Hoko River: Low summer flows; gravel removal; siltation; falls are barriers to fish on two tributaries; flooding on the Little Hoko River; log jams; logging.
- Upper Hoko River: Low summer flows and high water temperature; falls on Herman Creek block upstream fish movement; log and debris jams, and poorly installed culverts on numerous tributaries restrict fish passage.
- Sekiu River: Poor bank cover from the mouth to R.M. 8.8 due to logging; barriers on tributaries restrict access on all but 1.2 miles; numerous log and debris jams; many tributaries have been virtually destroyed by poor road construction and logging.

- Sail River: Low stream flows; log and debris jams; steep gradient.

SOLEDUCK - HOH BASIN

The Soleduck-Hoh Basin includes the streams draining into the Pacific Ocean from the tip of Cape Flattery south to the Hoh River watershed. There are 569 streams (1,355 miles). Stream flows are maintained by high annual precipitation and by summer snowmelt in streams originating in the Olympic Mountains.

Limiting Factors - By Stream

- Waatch River, Makah Indian Reservation Area: Steep gradient; upper Waatch River is inaccessible due to a barrier fall and log jam near R.M. 4.0; summer low flows; some tributaries lack spawning gravel.
- Sooes River: Low summer flow; logging and siltation; man-caused and natural barriers limit access.
- Ozette River: High summer water temperatures; logging and siltation; a falls on Big River blocks fish access to the upper river; log jams on Ozette River likely cause delays in upstream migrations.
- Quillayute River: Low summer flows; barriers, both natural and unnatural, to fish migration.
- West and East Fork Dickey River: Low stream flows; lack of spawning area; logging; beaver dams.
- Bogachiel-Calawah River, Lower Mainstem: Low summer flows; gravel removal; logging and extreme erosion adjacent to Dry Creek; logging of stream banks in some upper tributaries; log and debris jams.
- North and South Fork Calawah River: Low flow; siltation;log and debris jams; barrier falls.
- Bogachiel River, Bear Creek Area: Low stream flow; siltation; log and debris jams; steep gradient in most tributaries.
- Bogachiel River, Headwaters: Low summer flows; impassible falls on the North and South Forks; all tributaries have falls or cascades that block fish near their mouths.
- Soleduck River, Lower Mainstem: Low summer flows; limited spawning habitat.
- Soleduck River, Lake Pleasant Area: Low summer flows; header dams and log jams on tributaries limit access; falls are a barrier on Bear Creek; logging and poor culvert installations.
- Soleduck River, Snider Ranger Station Area: Low tributary summer flows; a falls at R.M. 2.0 on Camp Creek is a barrier to fish migration; falls, cascades, and log jams delay salmon on Goodman Creek; steep gradient in certain tributaries.
- Soleduck River, Headwaters: Falls at R.M. 64.9 block upstream migration; falls at R.M. 8.5 on North Fork Soleduck River blocks fish migration; steep gradient.
- Goodman Creek: Low Summer flows; logging; log and debris jams; falls are a barrier on Falls Creek.
- Hoh River, Lower Mainstem: Unstable streambed; low summer flows; logging.
- Hoh River, Winfield Creek Area: Streambed instability; low summer flows; steep gradient; cascades at the mouth of Maple Creek is a block to fish; falls limit access to two other creeks.

- Hoh River, Hoh Ranger Station Area: Unstable streambed; falls on Owl Creek are a barrier; steep gradient on tributaries; improperly installed culvert on Twin Creek is a barrier to fish migration.
- South Fork Hoh River: Steep gradient; lack suitable spawning habitat in the lower mainstem river.
- Hoh River, Headwaters: Cascades below R.M. 49.0 appear to block further fish; high winter flows; unstable channel; steep gradient in tributaries.

QUEETS - QUINAULT BASIN

The Queets-Quinault Basin contains the watersheds that drain into the Pacific Ocean from Kalalock Creek south to near Grays Harbor. There are 780 streams (1,500 miles). Stream flows are fed by high annual precipitation and snowmelt from the Olympic Mountains.

Limiting Factors - By Stream

- Queets River, Lower Mainstem: Limited access to tributaries; logging; in upper reaches outside of Olympic National Park; log and debris jams are common in several streams.
- Clearwater River, Lower Mainstem: Low summer flows; logging in numerous tributaries.
- Clearwater River, Headwaters: Logging and road construction have seriously damaged habitat in this segment, particularly on the Stequaleho Creek and Solleks River; low stream flow; steep gradient in tributaries; falls block or delay fish migration in certain tributaries.
- Salmon River: Low stream flows; logging caused siltation, log and debris jams, and water quality degradation.
- Queets River, Queets Campground Area: Sedimentation from clay outcroppings exposed in the river; unstable streambed; winter high flows; low summer flows; steep gradient in some tributaries.
- Matheny Creek - Sams River: Undetermined cause appears to restrict fish utilization of Matheny Creek above R.M. 2.7; logging; cascades on Sams River around R.M. 7.0 is a barrier to upstream migration; steep gradient in most tributaries.
- Queets River, Headwaters: Low stream flows; a slide at about R.M. 43.0 appears to block or delay salmon migration; the majority of tributaries have falls or cascades near their mouths that block upstream fish migration.
- Raft River: Logging, denudation of banks, high summer water temperatures, erosion, siltation, logging debris chokes many stream channels (information or natural barriers is not readily available).
- Quinault River, Lower Mainstem: Logging and road construction activity have caused extensive stream habitat damage although more specific information is not readily available.
- Quinault River, Cook Creek - Amanda Park: Low stream flows in many tributaries; detrimental logging and road constructions activities.
- Lake Quinault: Steep gradient in tributaries; low flows in summer in some tributaries; poor road culvert installations on north lake shore tributaries hinder fish migration; high flows cause channel shifting and spawning substrate instability in the river below the mouth of Big Creek.

- Quinault River, Big Creek Area: Unstable streambed downstream of the mouth of North Fork mouth; low flows in certain tributaries; falls or cascades block fish passage at the mouths of most tributaries.
- North Fork Quinault River: Lack of suitable spawning gravel; steep gradient in tributaries; falls block upstream migration at R.M. 12.0; smaller tributaries are generally inaccessible beyond their mouth due to falls and cascades; some unstable streambed reaches downstream of Rustler Creek mouth; cold water temperatures may inhibit growth of juvenile salmon.
- Quinault River, Headwaters: Steep gradient of smaller tributaries; migration is blocked by falls at R.M. 57.0 for salmon, however, steelhead trout are reported reaching further upstream.
- Moclips River: Logging (further information is not readily available).
- Copalis River: Tributaries lack spawning habitat; low stream flows; log and debris jams hinder upstream migration; summer water temperatures are at times too high; independent drainages may have mouths blocked in summer by shifting beach sand.

CHEHALIS BASIN

The Chahalis basin is comprised of all the streams that drain into Grays Harbor or are tributary to the Chehalis River; principal among these being the Chehalis, Humptulips, Hoquiam, Wishkah, Wynoochee, and Satsop Rivers. Several of these rise in the Olympic Mountains. The basin contains some 1,391 streams (3,353 miles).

Limiting Factors - By Stream

- Humptulips River, Lower Mainstem: Low summer flow and insufficient spawning areas; gravel removal.
- Humptulips River, Big Creek Area: Low flows in tributaries; erosion periodically reduces water quality.
- East Fork Humptulips River: Most tributaries have falls or cascades near their mouths that block salmon migration; splash dams used to be present and blocked adults on the East Fork.
- West Fork Humptulips River, Lower Mainstem: Barriers either block or delay anadromous fish in the river gorge and most tributaries; logging impacts.
- West Fork Humptulips River, Headwaters: Cascades at R.M. 45 to 46 block upstream migration; steep gradient.
- Hoquiam River: Municipal water diversions; dams at three locations block or delay fish migration and silt is flushed from the impoundments periodically; falls on the East Fork blocks some species of salmon.
- Chehalis River, Lower Mainstem: Water pollution in Grays Harbor is a major limiting factor for the Chehalis River system; high water temperatures; tributaries have limited spawning habitat.
- Wishkah River, Chehalis River Drainage: Salmon are blocked at R.M. 29.4 by falls while steelhead ascend further upstream; splash dams once blocked significant portions of this watershed; falls block fish on numerous tributaries; downstream of the impassable dam at R.M. 32.3 flows are seasonally limiting; water quality is degraded by development in lower reaches and the Harbor.

- Wynoochee River, Lower Mainstem: Water diversion at R.M. 8.1 periodically delay adult salmon migration; some juveniles are diverted into Lake Aberdeen by an industrial diversion; falls block fish on several streams; gravel removal; siltation; low summer flows.
- Wynoochee River, Carter Creek Area: Marginal spawning habitat; low summer flows; log jams on Carter Creek block or delay salmon.
- Wynoochee River, Headwaters: Both upstream and downstream migrating fish must endure fish passage facilities near R.M. 48.0; falls at R.M. 58.0 block further upstream migration; steep gradient in tributaries; several miles of the river have been inundated by two dams; logging; siltation; and log jams.
- Satsop River: Several dams block or delay salmon migrations; summer low flows; minor gravel removal.
- West Fork Satsop River: Logging; elevated summer water temperatures; some areas suffer from the effects of seasonal flooding and unstable substrate.
- West Fork Satsop River, Headwaters: Several falls block or delay fish migration on the river and tributaries; logging; siltation; streambank denudation; low summer flows; seasonal flooding; streambed instability.
- Middle Fork Satsop River and Decker Creek: Low summer flows; logging; streambank denudation high summer water temperatures; log jams and cascades block or delay migration.
- East Fork Satsop River, Headwaters: Low summer flows in some tributaries; fish passage problems due to dams and other barriers.
- Workman - Delezene Creeks: High summer water temperatures and low flows; restricted rearing area; poor spawning gravel quality; increased predation and competition from other fish due to less then optimum water temperatures.
- Newman Cloquallum Creeks: Newman Creek contains a limited amount of generally poor spawning habitat; barriers on tributaries from log jams and log booms block or delay fish in certain stream areas; industrial and domestic waste pollutions cause extensive fish kills below McCleary in Wildcat Creek.
- Porter Creek: High summer water temperatures; barriers on Porter Creek and tributaries block some salmon from upstream migration; low summer flows in some tributaries; spawning gravel has been degraded in the river and Porter Creek by siltation.
- Gibson - Cedar Creeks: Low summer flows and high water temperatures; barriers block fish use of several tributaries; road construction has degraded spawning habitat in Cedar Creek and Sherman Creek.
- Rock-Garrard Creeks: Low summer flows; siltation, partly agricultural in origin.
- Black River: Low summer flows; some irrigation withdrawal; high summer water temperatures in the lower Black River; Mima Creek suffers from siltation, barriers and diversions.
- Chehalis River - Scatter Creek Area: Low stream flows and high summer water temperatures; siltation; tributaries lack suitable spawning habitat.
- Independence - Lincoln Creeks: Agricultural siltation; high summer water temperatures and low flows; log jams; domestic pollution in tributaries.

- Skookumchuck River, Lower Mainstem: Dams, now removed at R.M. 3.7, 11.5, and 23.8 either blocked or delayed anadromous fish migrations in the past; logging and coal mining in the upper watershed of Hansford Valley resulted in siltation and contamination of spawning habitat; low summer flows particularly in lower Hansford Creek.
- Skookumchuck River - Upper Mainstem: Salmon formerly utilized seven miles of mainstem and one mile of tributary stream above the relatively recently constructed Skookumchuck dam.
- Chehalis River - Centralia Area: Depressed water quality due to residential and industrial encroachment; lack of spawning habitat in some tributaries; low summer flows in some tributaries; agricultural pollution in two creeks has caused fish kills in the past; channelization of some tributaries coupled with denudation of streambanks.
- Newaukum River: Gravel removal; streambed instability; siltation; low summer flows and increased water temperatures; limited spawning and rearing habitat in Allen and Taylor Creeks; barrier to fish migration just upstream of R.M. 1.0 in Taylor Creek.
- North Fork Newaukum River: Seasonal low flow; withdrawal of North Fork water at R.M. 12.5; high water temperatures in the lower north fork; the dam at R.M. 12.5 was a complete barrier upstream migration until 1970; extensive siltation of spawning gravel; low flows in the Middle Fork Newaukum; barriers limit fish access to several miles of tributaries, including the Middle Fork Newaukum.
- South Fork Newaukum River, Lower Mainstem: Gravel removal; unstable streambed; siltation; tributaries have limited amounts of suitable salmon habitat.
- South Fork Newaukum River, Upper Mainstem: Logging; siltation; denudation of streambanks, log jams; falls above R.M. 3.0 are an apparent migration barrier.
- Chehalis River - Mill Bucker Creeks: Low summer flows; limited suitable spawning habitat in some tributaries; a dam on Mill Creek is a block to several miles of good habitat upstream; widespread siltation; some tributaries are blocked to migration by log jams.
- Hope Creeks: Siltation; low summer flows in tributaries; high water temperatures the lower 9 miles of the Chehalis River; elimination of spawning areas in Hope Creek by beaver ponds.
- South Fork Chehalis River, Lower Mainstem: Low summer flows and high water temperatures; tributaries lack spawning habitat; siltation; over-appropriation of water.
- Stillman Creek: Extensive log jams block or delay fish, particularly in the upper watershed; steep gradient; falls block Little Mill Creek; spawning areas in Halfway Creek are silted and compacted.
- South Fork Chehalis River, Upper Mainstem: Logging activities years ago caused siltation of spawning beds that still persists; steep gradient of tributaries renders many inaccessible; falls delay fish migrations at certain times of low flow at several locations.
- Chehalis River - Grim-Rock Creeks: Logging; siltation; dams eliminated original races of salmon prior to 1930's; steep gradient in tributaries; falls block access of several creeks.
- Elk Creek: Only since 1972 has this watershed, above the falls at R.M. 1.5, been accessible to anadromous fish; lacks spawning habitat; logging resulted in siltation and degradation of much of the tributary spawning habitat in the past; falls and log jams block a number of tributary stream miles.

- Upper Chehalis River: Much of the adjacent land has been logged in recent years, and the combined effects of log jams, denuded stream banks, road construction, stream alteration, and siltation have blocked or degraded much of the anadromous fish habitat; falls and cascades render several stream segments inaccessible; natural slides have contributed to some of the siltation problems.
- Charley-Newskah Creeks: Logging impacts similar to foregoing; small tributaries have stream beds consisting primarily of silt and mud; Newskah Creek contains the only significant salmon production and even its upper watershed is blocked by falls at R.M. 6.7; low flows, except in Newskah and Charley Creeks.
- Johns River: Logging; marginal spawning habitat; denudation of stream-banks; high summer water temperatures; siltation.
- Elk River: Limited spawning habitat; former spawning gravel in most tributaries now covered with silt and sand and logging debris.