Historic Steelhead Abundance: Washington NW Coast and Puget Sound

(With Particular Emphasis on the Hoh River)

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Determining Escapement Goals to Rebuild Wild Steelhead Populations:

What Role Should Stock Recruit Analysis Have?

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Acknowledgments

This paper was the vision of Pete Soverel, founder of the Wild Salmon Center. He was concerned that recent Hoh River land purchases made on Washington's Olympic Peninsula (through the coordinated efforts of the Western Rivers Conservancy and Wild Salmon Center with the support of Washington Department of Natural Resources through Section 6 funding under the supervision of the U.S. Fish and Wildlife Service) may ultimately fail to help restore Hoh River steelhead populations back to anything like historic numbers. He felt one reason for this may be the lack of an appropriate history from which to assess the present status of Hoh River steelhead, and for want of that history steelhead managers may not provide sufficient escapement for effective restoration to occur even if all available habitats were returned to a high level of salmon and steelhead productivity. Knowing that Puget Sound steelhead were petitioned for listing with growing evidence its steelhead populations were but small fractions of their former abundance, he felt comparisons with Puget Sound rivers and other Olympic Peninsula rivers may help to fill in historic gaps in the Hoh River historic record.

The resulting Hoh River steelhead history is a work in progress. Over time some of the present gaps may fill with new findings. A number of people provided sources of data to draw from:

Of particular importance were copies of older historic documents provided by Jim Myers, Research Fishery Biologist in the NOAA Conservation Biology Division at the Northwest Fisheries Science Center in Seattle. These included reports from the U.S. Commission of Fish and Fisheries with information on Washington fisheries dating to 1888, somewhat later U.S. Bureau of Fisheries Reports, and the earliest reports of the State of Washington Department of Fisheries and Game. Jim also provided an unpublished analysis of some of that older historic data which was immensely helpful.

Bill Gill, Fish and Wildlife Biologist with the Steelhead Section of the Fish Program of the Washington Department of Fish and Wildlife in Olympia, went to great effort to provide steelhead tribal catch records dating to 1934, sport fishing records to 1947, hatchery smolt release records to the early 1950s, and managed to put together a steelhead database updated to 2004 or 2005 for all of the Puget Sound and North Coast Olympic Peninsula streams.

Nick Gayeski, Resource Analyst for Wild Fish Conservancy in Duvall, provided many connections and pertinent suggestions and authored the detailed section on escapement goals and stock recruitment analysis provided in Part IV and Part V.

Glenn Thackray, Department of Geology at Idaho State University in Pocatello, provided his 1996 PhD dissertation regarding glaciations of the western Olympic Peninsula as well as other papers and geologic maps.

Nate Mantua, with the Climate Impacts Group of the Department of Atmospheric Sciences at the University of Washington, provided copies of several pertinent papers and figures and patient explanations of PDO cycles and their relationship to salmon productivity.

George Pess, Stream Ecologist with NOAA Fisheries at the Northwest Fisheries Science Center in Seattle, provided numerous papers regarding geology, habitat relationships to fish populations, and salmon and steelhead colonization and evolutionary considerations.

Sam Brenkman, Chief Fisheries Biologist for Olympic National Park at Port Angeles, provided a summary of physical characteristics of Olympic Peninsula river basins and the data from snorkel surveys he has led to count steelhead in Olympic National Park.

John McMillan, Salmon Ecologist, and James Starr, Fisheries Biologist, out of the Forks office for the Wild Salmon Center provided much information regarding the extensive snorkel surveys they have done on the Hoh and Quileute river systems and detailed steelhead, salmon, and habitat information regarding those same streams.

Kurt Beardslee, Executive Director of Wild Fish Conservancy in Duvall, provided numerous ring binders filled with steelhead resource material from the Wild Fish Conservancy library.

Xan Augerot, Director of Science for the Wild Salmon Center in Portland, provided much relevant information through her book *Atlas of Pacific Salmon* as well as reviews of the drafts.

And Bill Bakke, Executive Director of the Native Fish Society in Portland, provided many helpful literature suggestions.

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Extended Summary

For want of use of sufficiently long histories, fisheries managers of each new generation have commonly made decisions based on the status of the fishery they inherited when their profession began. A "history begins with me" style of management leads to what has been termed "the shifting baseline syndrome" in which a progressively diminished resource is passed on to each new generation of biologists who come to accommodate and to manage for perpetual resource depletion. The result has been a global fisheries disaster as described by Daniel Pauly (1995) in his paper, Anecdotes and the Shifting Baseline Syndrome of Fisheries, published in *Trends in Ecology and Evolution*.

The purpose of this paper is to provide a more complete historic perspective from which to manage for perpetuation of Hoh River steelhead as but one indicator of a larger ecosystem that will eventually determine the future of all species contained within it. Because of the long lack of using a sufficiently old baseline from which to determine management decisions, some of that Hoh River history is now largely irrecoverable. In its absence, a composite of histories from a number of related sources was drawn from as a means of piecing together the historic gaps from which the status of a functioning salmon and steelhead ecosystem of intertwined species and habitats can begin to occur within the adaptive context of geological and biological time – past, present, and future.

The historic steelhead data used in this paper have come from differing reports from the Commissioner to the United States Commission of Fish and Fisheries (1892, 1898, and 1900); U.S. Bureau of Fisheries reports (1900, 1904, and 1923); the early reports of the Washington State Department of Fisheries and Game's Division of Fisheries (1890-1920, 1928, and 1932); tribal catch compiled by Washington Department of Game from 1934-1978; sport catch and stocking data from Washington Department of Game (1948-1978; and 1962-1984) and Washington Department of Wildlife (1987-1993); 1978-2005 sport catch and tribal fishery records from the Washington Department of Fish and Wildlife historic steelhead database (2006); and the salmon and steelhead stock assessment inventories for Washington (SASSI 1994; and SaSSI 2003). These represent the cumulative records found from differing agencies responsible for fishery management in Washington at differing historic eras.

Much of the available historic information found for steelhead in Washington State has not been used for management purposes for 35 years or more. There are now sometimes doubts among fishery managers regarding its relevance to the present, its authenticity, its accuracy, or how to interpret it as meaningfully useful … if, in fact, it has any usefulness at all. Seldom considered is that older data represent the record of what cutting edge science was 35, 50, 75, 100, and 125 years ago and that the data collected today will similarly be considered outdated and useless 100 years from now unless fishery science learns how to maintain a useful thread of connectiveness over time.

Older data can, and must, be used if fishery resources such as steelhead are to have a long term future. As the case presently is, steelhead in Washington State are being managed for a graduated diminishment to extinction as was found in the development of this Hoh River steelhead history. In fact, one race of steelhead, summer runs, may already be functionally extinct among several steelhead populations on the Olympic Peninsula. This is despite the fact that the summer race of steelhead on these streams often return to those sections of watersheds that are considered pristine in Olympic National Park.

The geologic histories of the river basins of the Olympic Peninsula west coast were found to be particularly complex and none more so than that of the Hoh River Valley where six separate alpine glacial events advanced and retreated between 17,000 and 70,000-110,000 years ago during the Wisconsin glacial era. Differing areas of refugia for salmon and steelhead existed during the Wisconsin period, including areas north of the glacial ice sheet advances and retreats such as the Queen Charlotte Islands. During the Wisconsin glacial events, sea level was much lower than present. The Olympic Peninsula coastline at the mouth of the Hoh River was 22-25 miles offshore 21,000-22,000 years ago, and no glacial advance down the Hoh Valley ever reached closer than 7.5 miles of today's coast leaving a river beyond the glacier terminus that was sometimes as long as it is today.

Although much of the ancient Hoh River valley is now drowned beneath the Pacific, it is known from pollen and beetle records archived in glacial layers that life continuously persisted in the Hoh Valley with conditions that resemble those found in tundra landscapes in Alaska and Russia's Kamchatka Peninsula today. In the case of the Hoh River, there was also a large lake created by a former glacial retreat that persisted for 30,000 years (73,000-43,000 years ago) which could have created a particularly productive salmon and steelhead ecosystem not unlike the more recent history of Lake Quinault or the Situk River system in Alaska.

Whether the Hoh River provided a refugium for salmon and steelhead continuously, or even partially, through the Wisconsin glacial era does not appear to have been considered in the available literature. However, in the absence of investigations to effectively examine the evidence one way or the other, it must remain a consideration. From the information available, it is apparent that science is still on the peripheral edge of understanding the evolutionary sequence of North Pacific Rim salmon and steelhead distribution before, during, and after the Wisconsin era.

Olympic Peninsula human history is also traced from aboriginal colonization of North America via the Bering land bridge that is generally thought to have begun 12,000-15,000 years ago, but which may have begun 50,000-200,000 years ago. Those aboriginal cultures came to be altered through contact with differing agricultural civilizations whose explorations likely began with the Chinese between 1421 and 1423, but perhaps even as early as 499 AD.

Exploitation of what has been termed the "gift economy" of the aboriginal people of North America by the "industrial economy" of modern agricultural civilizations began with the Russian discovery of Alaska in 1741. From that point onward the aboriginal tribes along the North American West Coast were initiated into a 150 year assimilation into the industrial economy. Beaten, brutalized, subjugated, extorted, robbed, assaulted, or more genteelly cajoled or bribed, the initiation of aboriginal peoples into the industrial economy was one of join it or die. On the Olympic Peninsula, the latter became pervasive through sweeping epidemics, dramatic loss of population size, and resulting breakdown of the ability to defend their homelands or to maintain their cultures.

By the late 1800s with the advent of commercial fishing by the Quileute people, it was found that traditional practices had ceased, including abandonment of the fishing society and the first salmon ceremony. By 1900, the original North American gift economy had been fully replaced by the industrial economy no matter what the skin color or ethnic origin of the peoples then sharing the west coast of the Olympic Peninsula and the Hoh River Valley. It was not a matter of choice; it was a matter of the biological reality of adapt or die. There was no remaining place on the North American West Coast to escape to. The Olympic Peninsula was one of the last geographic areas to yield to colonization by agricultural civilization.

The history of this 150 year shift in economies on the North American West Coast was initially driven by the potential for wealth provided by sea otter furs, an animal with the same range around the North Pacific Rim as steelhead. One of their most abundant areas on the West Coast was around Point Grenville near the mouth of the Quinault River. By 1911 sea otters were extinct in Washington. They were thought to be extinct in North America by 1925 until a mother and pup were sighted in Alaska in 1931.   They were reintroduced in Washington in 1969 and 1970. While numbers have slowly risen, their range remains limited primarily to the Olympic Coast National Marine Sanctuary. They remain listed as Endangered in Washington. The sea otter record remains as a lesson to learn from for steelhead management in Washington.

The Wild Salmon Center has focused salmon and steelhead restoration efforts on the Olympic Peninsula into the collection of data that can identify key habitat areas used by salmon and steelhead at varied life history stages and then to coordinate purchases of privately owned land in those areas. To date this has resulted in the purchases of 4,685 acres through the coordinated efforts of the Western Rivers Conservancy, Wild Salmon Center, Washington Department of Natural Resources, and Section 6 funding supervised by the U.S. Fish and Wildlife Service. The Hoh Trust will own and manage the land in perpetuity with a goal to ensure the Hoh River remains a stronghold for salmon and steelhead biodiversity by 1) ensuring that sufficient, functionally connected habitat exists to sustain robust native salmon and steelhead populations, 2) enough salmon make it back to the river basin to maintain healthy, functional ecosystems, and 3) local communities benefit from strong salmon runs and healthy ecosystems.

As indicated by the presently limited distribution of sea otters in Washington State (in a managed marine sanctuary), securing and protecting habitat areas as functioning ecosystems are critical. In the case of such widely ranging animals as anadromous fish, migrations to and from a protected habitat area must be sufficient to allow it to function as a salmon and steelhead driven ecosystem. Habitat purchases made to recreate functioning salmon and steelhead ecosystems are rendered ineffective without sufficient numbers of the key species that drive them.

In the development of the Hoh River steelhead history the following was found:

Comparisons of drainage areas and historic-to-current steelhead population estimates for Washington's Hoh, Stillaguamish, Queets, Quileute, and Quinault rivers (summer runs in red type); Alaska's Situk River; and for the cumulative steelhead populations of Puget Sound streams.

River or region	Drainage area	Historic date	Historic steelhead numbers	Most current steelhead estimate
Hoh	299 sq mi	1953	summer 507-837	~100 (surveys 1994-2005)
		1948-1961	winter 7,938-13,230 (avg)	4,501 (recent 5-yr avg)
Puget Sound	not applicable	1895	327,592-818,980	13,083 (recent 10-yr avg)
Stillaguamish	684 sq mi	1895	60,000-90,000	593 (recent 5-yr avg)
Queets	450 sq mi	1953	summer 1,204-2,007	~100 (recent 10-year estimate)
		1923	winter 48,980-81,633	6,188 (10-yr avg)
Quileute	629 sq mi	1972	summer 1,236-2060	~100-150 (surveys 2002-2005)
		1948-1961	winter 17,614 (avg)	14,568 (1962-2005 avg)
Quinault	434 sq mi	1953	summer 1,268-2,113	<50 (surveys 2005)
		1952	winter 19,000	4,892 (recent 5-year avg)
Situk	77 sq mi	1952	25,000-30,000	12,368 (2004 & 2005 avg)

The percent of the present steelhead population size to a known historic population size for each summer run population was:

- the Hoh River summer run is presently 11.9%-19.7% of that in 1953;
- the Queets River summer run is presently 5.0%-8.3% of that in 1953;
- the Quileute River summer run is presently 4.9%-12.1% of that in 1972;
- the Quinault River summer run is presently 3.9% of that in 1953.

Summer run steelhead populations on the west side of the Olympic Peninsula are clear case examples that alteration, or elimination, of habitat is not always the primary driver toward steelhead extinction. Instead, it can be, and often is, fishery management itself through hatcheries and harvest. This should be anticipated to be the case. A common mantra that has been repeatedly cited as the cause for salmon and steelhead depletions for at least 25 years now is the "four Hs": habitat, hydro, harvest, and hatcheries. On the west side of the Olympic Peninsula there are no hydroelectric dams so fishery problems are limited to the "three Hs": habitat, harvest, and hatcheries. Within the Olympic National Park on the west side of the Olympic Peninsula fishery problems are further limited to the "two Hs": harvest and hatcheries.

The percent of the present steelhead population size to a known historic population size for each winter run population examined was:

- the Hoh River winter run is presently 34%-56% of the 1948-1961 average;
- the Puget Sound winter run is presently 1.6%-4.0% of than in 1895;
- the Stillaguamish River winter run is presently 0.7%-0.9% of that in 1895;
- the Queets River winter run is presently 7.6%-12.6% of that in 1923;
- the Quileute River winter run is presently 82.7% of the 1948-1961 average;
- the Quinault River winter run is presently 25.7% of that in 1952;
- the Situk River fall/spring run is presently 49.5%-41.2% of that in 1952, and the historic low from 1960 to 1980 was 3.3%-6.0% of that in 1952.

Beyond the fact that all of the steelhead populations used for comparison have experienced declines from their historic population sizes, two factors stand out:

- the level of depletion is highest when the historic baseline is oldest;
- summer steelhead have especially high levels of depletion.

As might be anticipated, the closer the available historic baseline is to that time before industrial level exploitation of resources first occurred, the greater has been the measurable level of steelhead depletion since. This is the very reason for the pertinence of developing baselines sufficiently far back in history that they provide a useful background for conservation of steelhead to occur, from which to make management decisions for sustainable populations, and from which to develop steelhead recovery plans when necessary.

For Puget Sound and the Stillaguamish River, 1895 appears to be far enough back to provide an effective historic baseline for winter steelhead. The equivalent date for Olympic Peninsula rivers may be 1923 as shown for the Queets River, the earliest year steelhead harvest information was found there. The Queets winter steelhead pattern fits with those of Puget Sound and Stillaguamish River winter steelhead, but those of the other rivers do not. In this regard, the Queets steelhead history is particularly valuable as a comparative means for developing more appropriate baseline estimates for the other rivers of the Olympic Peninsula's west coast.

In the cases of the Hoh, Quileute, and Quinault winter run steelhead, and for all of the summer steelhead populations examined, no historical points were available from which to create a baseline earlier than the late 1940s, and more commonly the 1950s and 1960s. Because of this limitation, it is probable that these steelhead populations are even more depleted than is indicated.

It is apparent that the Olympic Peninsula summer steelhead populations examined are at the edge of extirpation. The Quinault population may be the most dire, with estimated returns of less than 50 fish for the entire watershed whose spawning destinations are further reduced in their split between the North and East forks – potentially less than 25 fish destined for each. The Clearwater population of the Queets system, and the Sol Duc and Bogachiel populations of the Quileute system, may be similarly low with only 2-3 dozen fish returning to each. In fact, the Quinault, Clearwater, Sol Duc, and Bogachiel populations may already be functionally extinct.

Straying hatchery steelhead have been known to be the greater part of summer steelhead catches in the Hoh, Queets and Quinault since 1979. The combined hatchery and wild catches of summer run steelhead have spiked far above what the wild catches alone historically were. With hatchery steelhead present in such large numbers there is the perpetual dilemma of a mixed stock fishery: if hatchery steelhead are sufficiently harvested to minimize their escapement to the spawning grounds, already depleted wild populations mixed with them will be harvested to extinction. If the hatchery fish are not harvested they will swamp the spawning grounds and also potentially eradicate wild steelhead as distinct genetic populations. In the case of the Olympic Peninsula, both of these mixed stock fishery consequences have been in effect for more than 25 years.

Although the Olympic Peninsula winter steelhead populations examined were not found to be as immediately threatened as the summer steelhead populations, or the winter steelhead populations of Puget Sound or the Stillaguamish River, they are managed under the same assumptions that are leading them to those same ends. This is particularly concerning due to the comparative lack of population growth and human development activities that have occurred on the west side of the Olympic Peninsula, and where most of the watersheds are Olympic National Park, Olympic National Forest, Washington Department of Natural Resources, and Indian reservation lands where it would be anticipated that managers are legally bound to effectively sustain resources for future generations. In the case of steelhead (and salmon) this is not being accomplished.

Because the historic baseline for the Queets River is the oldest for the Olympic Peninsula steelhead populations examined, and because the steelhead histories for all of them have been similar in the years since, its present wild winter steelhead run size average that is 7.6%-12.6% of that in 1923 may similarly represent the level of winter steelhead depletion that has occurred since 1923 on neighboring rivers. For instance, the Hoh River wild winter steelhead population, whose recent 5-year average run size is 4,500 fish, would have been about 35,000-59,000 fish in the early 1920s using the Queets River levels of depletion.

Unless it is recognized that significant steelhead depletion has occurred, there is no reason from which to implement management mechanisms whose goal is recovery rather than sustained depletion. Because of an inappropriate baseline, a management that accommodates continuing steelhead depletion is in effect on the Olympic Peninsula.

Although Olympic Peninsula winter steelhead populations have not yet collapsed to the levels of some other populations in Washington, the life history strategies that were historically characteristic to these populations have been just as radically reshaped by fisheries management. These alterations may critically minimize the ability of these populations to adapt to altered watersheds and to an altering climate, and may deny the potential for recovery.

For each river examined, a major shift in wild winter steelhead run timing was found to have occurred since the 1940s and 1950s with a pattern consistently the same:

- prior to the early 1960s wild winter steelhead returns peaked between December and February;
- wild winter steelhead run timing from the 1980s onward has increasingly shifted to March and April, with elimination of the early run component.

Early run timing is particularly important in order to provide a diversity of spawning time options which may vary from year to year as determined by differing weather and water conditions. Spawning surveys in the 1970s found a wide breadth of wild steelhead spawning time in the Clearwater River (sub-basin to the Queets) prior to hatchery returns. Spawning timing was found to vary with differing flow and water temperature patterns that can vary between tributaries (and to the mainstem), as well as between differing years. Peak spawning time was found to vary as much as 39 days between the warmest year (1978) and coldest year (1975) in the eight years of surveys. Yet river entry time for Queets basin steelhead remained the same all years. Steelhead spawning time in tributaries was found to be more evenly dispersed than in the mainstem, and early spawning was more prevalent in tributaries.

Logging has been pervasive on the Olympic Peninsula outside the National Park boundaries. The conversion of large areas of the Olympic Peninsula river basins from old growth to deciduous trees and immature second growth conifers has resulted in altered tributary hydrologies that are pervasively limited by summer low flows, or flows that go dry. Tributary flow conditions may become further aggravated by global warming, whose symptoms have been found to occur on steelhead spawning grounds in Russia. Although alterations in stream hydrology are known to have occurred, it has seldom been considered how this might relate to steelhead run timing, spawning timing, and emergence timing.

The altered hydrologies that have occurred through clearcut logging on the Olympic Peninsula resemble hydrologic conditions that can naturally occur in more arid climates. In southern Oregon's Rogue River basin steelhead largely depend on tributaries that commonly go dry by June. The habitat has selected for steelhead that spawn early, emerge early, and outmigrate early. As a result the Rogue River is a very productive steelhead system because the wild steelhead population retains a sufficient breadth of life history strategies (including early spawning and emergence) to take advantage of the habitat limitations available.

This is no longer the case on the Olympic Peninsula, nor other areas in Washington. Harvest pressures of 80%-95% have long focused on early returning steelhead in the effort to maximize harvest of hatchery steelhead. This has resulted in harvest of early returning wild steelhead at similarly high levels whose dominant historic return timing was also December through February as found in the historic tribal and sport catch records. A subsequent and pervasive run timing shift in wild winter run steelhead has occurred. Wild winter steelhead that return early have been nearly eliminated. Most wild steelhead now enter the Hoh River in March and April. This is confirmed by more recent sport catch data from throughout Washington rivers.

Steelhead run timing that begins in March or April precludes the ability of steelhead to spawn in January or February. In differing ethnographic studies it was found that the Quileute tribal "calendar" dating to ancient times identified the month of January as the beginning of steelhead spawning and that the spawning habits of certain fish were the most important single factor in determining the course of Quileute history. There had to have been significant reasons why the historic run timing of Washington steelhead was primarily December through February. Early spawning is one obvious consideration. Most early spawning in the Clearwater sub-basin of the Queets was in tributary streams prior to hatchery introductions, and it has been estimated that 75% of winter steelhead that once spawned in Washington's Skagit River Basin used tributary streams.

The available historic evidence indicates:

- most wild winter steelhead in Washington historically returned early (December-February);
- most wild steelhead historically spawned in tributaries;
- early wild steelhead spawning was once of greater importance than presently considered or managed for;
- conditions now favor early steelhead spawning even more than was historically the case;
- but early entry wild winter steelhead have been nearly eliminated.

Given these considerations, it is little wonder that wild winter steelhead populations may now be depleted from historic numbers, if for no other reason than the reshaping of their life history options through modern fishery management. What is worse, the habitat they return to has been altered to create conditions that favor early spawning to an even greater extent than was historically the case due to elimination of old growth forests, subsequently altered tributary hydrologies, and global warming.

Of particular comparative value regarding planning for wild steelhead recovery is the example of Alaska's Situk River near Yakutat. In 1952, despite a river basin size of only 77 sq. mi., 25,000-30,000 steelhead kelts emigrated out of the Situk after spawning as counted at a U.S. Fish and Wildlife Service weir. Yet, just one year later the steelhead population plummeted and was reported nearly non-existent in 1953 and 1954. This was due to the combined effects of attempted steelhead eradication efforts that occurred from 1930 into the 1940s; the initiation of sport fishing harvest in the 1940s; decreased returns of salmon related to an ocean cycle shift and related decrease in nutrients; and several years of record drought conditions that occurred. Steelhead numbers, estimated at 1,000-1,500, remained low for 30 years. Reduced to 3.3%-6.0% of the 1952 steelhead count, the magnitude of Situk steelhead depletion was not unlike that of Olympic Peninsula summer steelhead populations today, or the winter run steelhead of Puget Sound.

When management began to monitor the Situk steelhead population in the 1970s and 1980s, sport fishing was the primary harvest component, although total harvest rates were only in the range of 15%-35%. Despite these seemingly low harvest levels, they were evidently sufficient to keep the population from recovering.

With rising sport fishing pressure through the 1980s, Alaska managers responded with catch and release regulations in 1991 subsequently modified to a ban on bait and an annual limit of two steelhead over 36 inches in length in 1994. However, in effect, it remained a catch and release fishery with minimal harvest.

The Situk steelhead population has responded positively, increasing in increments by doubling each decade since the 1970s from 1,000-1,500; to 3,000; to 6,000; to over 12,000 steelhead in 2004 and 2005. The Alaska steelhead managers could have chosen hatcheries as the primary restoration tool, but did not. Without the added complications of a hatchery program and resulting mixed stock fishery combined with hatchery/wild interactions, the wild population has recovered to within 50% of its historic population size.

Although logging has occurred in the Situk basin and related roads have been built in the lower watershed, habitat remains mostly intact. The entire watershed is in Tongass National Forest and the headwaters are in designated wilderness.

The Situk River represents the potential of what could occur on the Hoh River, and other Olympic Peninsula rivers, if most of the watershed habitat were managed for recovery of an ecosystem driven by historic levels of salmon and steelhead.

The basic components resulting in a continuing Situk River steelhead recovery have been:

- altering steelhead harvest levels to well below those generally determined by MSY (commercial harvest limited to incidental catch during salmon fisheries;

sport catch and release in 1991; no bait & annual sport limit of two over 36" in 1994);

- increased numbers of salmon and nutrients beginning about 1989 (probable result of a PDO cyclic shift in ocean productivity);
- habitat that continues to be intact;
- no hatcheries; no hatchery releases; no hatchery straying (of known consequence).

Another useful example regarding salmon recovery efforts is provided by a comparison of the differences that occurred in management of British Columbia's Fraser River as compared to that which occurred over the same span of time on the Columbia River through U.S. management entities.

In the case of the Fraser River, $21.3 million was spent between 1937 and 1985. The approach taken by the International Pacific Salmon Fisheries Commission on the Fraser River in 1937 focused on stock-by-stock harvest management, habitat, and natural production. It resulted in a successful, sustained recovery program that brought Fraser River sockeye salmon that had been reduced to an average return of 3.3 million fish from 1917 to 1949 up to 5.6 million fish from 1949 to 1982, to 7.8 million fish from 1983 to 1986, and to 10.2 million fish in recent years. In 1990, 22 million sockeye salmon returned to the Fraser River system.

By contrast, over the same period of time the Lower Columbia River Fisheries Development Program increasingly came to focus on building more and larger hatchery facilities and transfers of hatchery stocks from the upper to the lower Columbia to accommodate the perceived realities of dam construction. About $3 billion was spent on Columbia River salmon recovery with an additional $50 million slated for yet more hatcheries and a further $1 billion to improve the passage of juveniles over the dams the hatcheries had helped to justify. Although hatchery advocates indicate that 80% or more of Columbia salmon production is now from hatcheries, the total run size has dropped to 5% of its historic abundance. At the same time, hatcheries were further contributing to the decline of wild salmon, creating a deadly spiral to extinction that managers failed to detect. As a result of Columbia River hatchery production emphasis, wild coho in the lower Columbia River have disappeared, populations of salmon and steelhead in other parts of the basin have become severely depressed, hatchery costs continue to mount, and there have been no tangible results.

The Columbia River may singularly be the greatest, and certainly the most expensive, failure in the history of fish and wildlife restoration that has ever occurred.

In *Rivers Without Salmon: A History of the Pacific Salmon Crisis*, Jim Lichatowich (1999) further indicated:

"Even when faced with the threat of Moran Dam in the 1950s [on the Fraser River], *the Canadians still relied on science and did not allow the hatcheries' promise of a quick fix to lure them into trading away the Fraser's mainstem. The commission's restoration program was based on the latest science, which stressed the importance of the salmon's stock structure and the importance of habitat*.

"On the Columbia, this scientific understanding was ignored…Instead, the Columbia River restoration program invested in a 'conspiracy of optimism,' clinging to the unfounded hope that hatcheries could restore the salmon."

Of the four Olympic Peninsula river basins examined regarding their steelhead histories, the Hoh River appears to have human use and ecosystem attributes from which restoration efforts might most thoroughly and rapidly occur. It has the largest remaining proportion of its basin in Olympic National Park (60%-65%) providing intact habitat; the commitment to hatchery salmon and steelhead has been less intensive; and degraded habitat outside the ONP may be more rapidly recoverable with significantly large land acquisitions already in place that are managed to provide for salmon and steelhead recovery.

The Hoh River may never have been as productive for salmon and steelhead as the neighboring Quinault, Queets and Quileute as determined from early 20th century cannery records. Because the Hoh River is the smallest of the four basins regarding drainage size, smaller salmon and steelhead run sizes would be anticipated. Also, the Hoh is considered the most dynamic coastal river with a perpetually altering river channel which may be a particular constraint on mainstem spawning and rearing productivity. This may trace back to the six glaciations that occurred and the influence the remaining glaciers still have on the Hoh in it origins from Mount Olympus. As a result, tributaries may always have been particularly important.

Given the known shifts that have occurred to steelhead entry timing, the extent of tributary habitat degradation, and the successful Fraser River and Situk River examples to draw from, any realistic potential for Hoh River steelhead recovery must include:

- the provision of sufficient salmon escapement from which to recreate a salmon driven ecosystem of which steelhead are particular benefactors from increased salmon nutrients;
- harvest alterations that will allow the rebuilding of historically dominant wild winter steelhead run timing from December through February without which steelhead may never rise above present levels due to the inability to make use of tributary habitat available to them;
- elimination of hatchery salmon and steelhead releases into the basin to reduce the consequences of mixed stock fisheries and to eliminate the potential for hatchery/wild interactions to occur;
- elimination, or minimization, of hatchery salmon and steelhead released into neighboring river basins in order to significantly reduce hatchery straying into the Hoh basin;
- habitat protection/recovery plans for tributaries on federally and state managed lands;
- strategic acquisitions of private lands as they become available;
- reinvestment of hatchery funding into more beneficial recovery options;
- management driven by sustaining fish diversity and functioning ecosystems, not sustained yield or harvest;
- more effective means of monitoring salmon and steelhead populations;
- assessments of the salmon and steelhead production potential for the entire basin if all available habitat were recovered combined with escapement goals set high enough to accommodate steady increases toward those levels.