Appendix B - Hypothesis for Local Extirpation

Introduction

Impacts to the bull trout population in the Clackamas River have been numerous and sometimes complex since large scale settlement began in the 1840s. The many threats responsible for the rangewide decline in bull trout discussed in Appendix A were also present in the Clackamas River Subbasin. The causes for decline described below on the Clackamas River bull trout population included hydroelectric dams, water diversion dams, timber harvest and forest management practices, conversion and elimination of riparian forest habitat, road building and transportation networks, livestock grazing, agricultural practices including irrigation and chemical applications, mining, residential development and urbanization, harvest of bull trout in the sport and commercial fisheries, fisheries management practices, habitat fragmentation and isolation, and overall water quality degradation.

Premise

The history of deleterious human impacts to anadromous salmonids in the Clackamas River over the last 150 years is parallel to that for bull trout. Most historical documentation of human effects to Clackamas River salmonids focuses on the economically important anadromous stocks; Chinook and coho salmon in particular. Bull trout, or "Dolly Varden" as they were commonly known, appear as footnotes in much of the historical documentation, if mentioned at all. As in many river systems, the presence of bull trout was recognized, but little else was known about them until recent investigations (Dodson and Brun, 2003). In examining the reasons for the decline of bull trout, the historic record and documented observations on other Clackamas River salmonids provide the best clues to what happened to bull trout in this river system. The evidence available indicates anadromous salmonids and bull trout encountered many direct and indirect impacts in the late 19th and early 20th centuries. These impacts were likely detrimental to bull trout, just as they were to the better documented salmon and steelhead populations. Yet, evidence suggests some bull trout persisted, despite major disruptions to their environment, until the 1970s (Murtagh et al. 1992).

A case can be made that increased public access to the upper Clackamas River Subbasin and rapidly expanding fishing pressure beginning in the late 1940s and continuing through the mid-1990s, was the final threat that drove the bull trout into an extinction vortex. The Clackamas River bull trout population, already severely depressed by many anthropogenic pressures, was especially vulnerable when tens of thousands of hatchery reared rainbow trout were stocked in the same rearing habitat during the mid-20th Century. Heavy rainbow trout stocking was followed by intense sport angling pressure accompanied by liberal bag limits (Whitt 1978). Bull trout, known to be exceptionally vulnerable to sport fishing, were subjected to this intense fishing pressure over several decades. In fact, bounty fisheries were offered to eradicate bull trout as reported by Murtagh et al. (1992): "An article in a 1914 edition of the Estacada Progress, a local newspaper, offered a prize for the largest 'dollar-varden' caught on the Clackamas River." Earlier habitat destruction combined with overharvest is probably what finally eliminated bull trout from the Clackamas River.

Background

Commercial Fisheries

Bull trout in the Clackamas River were impacted directly and indirectly by commercial fisheries. Indirectly, bull trout were affected by the loss of large spawning populations of Chinook, coho, and steelhead that were intercepted in the fisheries. The juveniles and smolts from these anadromous fish populations are likely to have constituted a considerable part of the bull trout's prey base. Many bull trout were directly affected when caught in the nets themselves and most likely perished. There is strong evidence that sub-adult and/or adult fluvial bull trout were found historically in the same vicinity as areas of intense commercial fishing operations on the lower Clackamas and Columbia rivers. For instance, Livingston Stone established the first operating fish hatchery in the Columbia River Basin in 1877 at the confluence of Clear Creek and the Clackamas River (Cramer and Associates 2001). It is believed that near this location he secured the Clackamas River "Dolly Varden" (*Salvelinus confluentus*) specimen that is in the National Museum (Smithsonian Inst. 2005) during the winter of 1877-1878. Commercial fisheries in the vicinity were often a problem for the hatchery in securing enough adult Chinook salmon for spawning (Mattson 1950). In 1876, a trap near the mouth of the Clackamas River nearly closed off the entire river to upstream migrating salmon (U.S. Commission of Fish and Fisheries1877, cited in Taylor 1999). In 1877, more than 1,000 drift nets, many reaching 1,200 feet in length, were also being set on the Columbia River (Taylor 1999). In the Columbia River estuary, an area often exploited by the historic commercial fisheries, a recent USFWS review of old State of Oregon seining records for the head of the estuary shows bull trout being caught in seines while apparently foraging at that location (Yoshinaka 2002). Historically, Clackamas River bull trout may have been one of the bull trout populations that utilized the Columbia River estuary. Another historical record indicating heavy commercial fishing activity includes an 1893 report of approximately 12,000 adult spring Chinook salmon harvested by gill-netters in the lower Clackamas River (Smith 1974). By 1908, salmon numbers had declined to such a degree that only five or six commercial fisherman still operated on the Clackamas River itself. Until 1910, there no commercial fishing seasons designated on the Clackamas River (Taylor 1999).

Diversions and Dams

As with commercial fishing, there were direct and indirect effects to bull trout from dams and diversions. Bull trout and their associated prey base of other migratory and non-migratory fish species probably encountered similar threats due to dams and diversions. Likely impacts for bull trout and associated migratory salmonids included partial or complete barriers to migration, delays in migration, fragmentation of habitat, entrainment of fish and associated injury or death, greater exposure to predators, reduction in prey base, and degrading of water quality conditions. Historical records indicate well over 100 years of impacts from dams and diversions in the Clackamas River to fish populations, especially migratory fish.

On the Clackamas River as early as 1890, the State Fish Commission reported that a diversion dam across the Clackamas River near Gladstone impeded the passage of salmon. Although it is unclear from the reports, this dam may have been in existence for several years. Initially, the dam was a partial barrier and a year later became a complete barrier to adult salmon passage after the height was increased. H.D. McGuire, the Oregon Fish and Game Protector, filed a complaint against the mill owner which resulted in the installation of a fish ladder in 1895 (Wallis 1960 and Taylor 1999).

Diversion dams for a variety of purposes existed on many tributaries to the lower Clackamas River from the late 1840s and into the early 1900s. While it is not recorded whether these diversion structures impeded fish passage, most of them were built without fish passage provisions (Cramer and Associates 2001).

The first large hydroelectric facility and diversion dam on the mainstem Clackamas River was completed in 1907, named Cazadero Dam and now called Faraday Dam, which is less than two miles upstream of the town of Estacada (Taylor 1999). When construction began on the facilities in 1902, Oregon's Master Fishwarden had communicated his concerns to the project owners about effects on Chinook salmon. Subsequently, a fish ladder was installed with cooperation of the dam's owners upon completion in 1907. Historical Oregon Department of Fisheries reports indicate that construction of Cazadero Dam was responsible for the failure of the federal egg collecting facility in the upper Clackamas River Subbasin in 1905 and 1906. Thereafter, the state started an experimental egg collection facility at Cazadero Dam in an effort to remedy the problem (Report of the Master Fishwarden 1902, and 1907 and 1908; cited in Smith 1974). Additional impacts to bull trout were likely due to the fish ladder being blocked with a weir in order to capture Chinook salmon to collect eggs for hatchery propagation. Fish may have been allowed to climb the Cazadero fish ladder during some seasons, even though historical reports don't provide much information. Additionally, after several flood events, which threatened the integrity of the dam and the fish ladder, a flood in 1917 damaged the Cazadero fish ladder and a decision was made to not repair or replace it until 1939. During that time, all Chinook salmon were intercepted downstream at River Mill Dam, the second mainstem dam on the Clackamas River located about one mile downstream of the town of Estacada and approximately three miles downstream of the Cazadero Dam site. Construction of the River Mill Dam begun in 1909 and was completed in 1911. Construction of a fish ladder on River Mill Dam was completed in 1912, but the ladder was racked to block fish passage during runs of Chinook salmon in order to collect eggs for fish propagation, thus influencing the decision not to repair the upstream fish ladder at Cazadero Dam. This continued until 1940, when fish passage was restored at Cazadero Dam (Taylor 1999).

The North Fork Dam; the third, furthest upstream, and largest of the Clackamas River dams at 207 feet high; was constructed by Portland General Electric in 1958. North Fork Dam provides upstream and downstream fish passage facilities.

Another diversion dam, the Lake Harriet Dam, on the Oak Grove Fork of the Clackamas River was built in 1924. While upstream of a natural, impassable waterfall on the Oak Grove Fork upstream of historic bull trout occurrence, Lake Harriet Dam likely impacted bull trout habitat in the lower 3.5 miles by diverting the entire river flow, except during high flow spill events. The Oak Grove Fork is a very cold tributary of the Clackamas River, and there are reports of bull trout in this tributary in the 1930s (Carrell 2003).

The early mainstem dams likely had significant impact on the Clackamas River bull trout population both during construction and operation. Upstream fish passage was either not available or not provided until ladders were constructed. These same, early twentieth century fish ladders, also would become damaged and inoperable after large flood events. Intermittently before 1917, and completely after that year for 22 years, all upstream fish passage was blocked at Cazadero Dam on the mainstem Clackamas River until 1939 (Murtagh et al. 1992). The 22 years of complete blockage of upstream fish passage effectively eliminated a large part of the potential food source for bull trout, specifically the large runs of spring Chinook salmon, steelhead, and coho salmon that utilized the upper portion of the subbasin before the early 1900s. Bull trout are a highly migratory, fluvial species in the Willamette River Basin, and were subjected to many of the same suppressing factors as anadromous steelhead and salmon when the dams were built (Buchanan et al. 1997). Early dam construction fragmented habitat and fish populations as they blocked adult migrants from their spawning habitat higher in the subbasin. By the time North Fork Dam was completed in 1958, many of the earlier fish passage problems had been ameliorated. Although fish passage and population connectivity problems still remained, especially for downstream juvenile migrants, naturally reproducing coho salmon and steelhead trout utilized the rebuilt ladders at the dams to build runs in excess of 1,500 fish during the 1950s and 1960s. Although to a lesser extent, spring Chinook salmon also began to re-populate the river above the dams, with runs averaging around 500 fish by the early 1960s (Murtagh et al. 1992).

Water Quality Impacts

In the 1870s, water quality was close to pristine conditions in much of the Clackamas River Subbasin. Much of the subbasin was forested with mature and old growth stands and human population was low and concentrated near the mouth of the Clackamas River. Before settlement, only the occasional large forest fire and rare natural events, such as large floods, volcanic eruptions, and earthquakes, had a negative effect on water quality for bull trout and other salmonids. Water quality changed rapidly in the lower Clackamas in the latter part of the 19th Century, as increasing settlement resulted in land logged for timber and then developed for farming. No regulations inhibited early logging or land clearing. As streambanks and hillsides were stripped of their protective forest cover, instream habitat and water conditions declined. Instream sediment levels increased with the growing area of cleared land. Farmers and others began to divert water out of lower Clackamas River and its tributaries for irrigation and for mill development in the late 1800s. Gravel mining in and adjacent to the lower Clackamas River was also common (Cramer and Associates 2001). By the 1890s, sawdust and other mill byproducts were frequent pollutants in many Oregon streams. Further damage to water quality came from log drives that utilized the Clackamas River and tributaries for moving logs that resulted in scoured stream channels and damaged instream and riparian habitat (Oregon Fish Commission 1889-1890, cited in Taylor 1999).

Although almost no historical records are available, development in the lower portion of the subbasin negatively affected water temperatures in tributaries by the removal of large areas of riparian forest cover along low elevation stream areas. Land clearing; coupled with diversions, irrigation, and subsurface well withdrawals; only exacerbated a decline in water quality for lower elevation Clackamas River tributaries like Clear and Deep creeks. Deteriorating water quality conditions downstream in the lower Willamette River also impacted salmon, steelhead, and other fish including bull trout. By the early 1920s, untreated waste from growing municipalities, pulp and paper mills, and a host of other industries had reached high levels that contaminated the lower Willamette River and Portland Harbor areas. Fisheries authorities were concerned about the pollution impacting migrating salmonids headed for the upper subbasin (Gleeson 1972, cited in Taylor 1999 and Willis et al. 1960).

Hydroelectric dams and reservoirs constructed on the Clackamas River and upstream tributaries may affected water quality. At times, the reservoirs on the Clackamas River produce large algae blooms that sometimes include a noxious blue green algae that would not have concentrated in the historically, free-flowing waters of the river. Reservoirs can also be sinks for nutrients and solar energy. Past, present, and future impacts to Clackamas River fish resources from water quality changes caused by the reservoirs is generally unknown but under investigation by PGE as part of their FERC relicensing procedures.

More than three-quarters of the Clackamas River Subbasin is forested land (Murtagh et al. 1992). The bulk of this forested landscape is in the higher elevations of the middle and upper portions of the subbasin, primarily on National Forest lands with small blocks of Bureau of Land Management land. Substantial amounts of forested land are also held by private industrial forest owners in two tributaries to the Clackamas River; Clear and Eagle creeks. Most of the middle and upper portions of the subbasin were largely untouched by human activities until World War II. At that time and following the war, demand for timber products pushed road construction and timber harvest into many areas previously inaccessible except by trail. Clear-cut logging was the typical method of timber harvest, and removal of streamside vegetation was common (USFS 1994). Loss of streamside shade would have contributed to higher stream temperatures until vegetation could recover. Increased timber harvest led to an expansion of the road system into the middle and upper portions of the subbasin resulting in increased delivery of sediment. Roads generally contribute sediment to streams via road surfaces, cutslopes, and interception of surface and subsurface waters and may destabilize steep slopes depending on road construction methods (USFS and BLM 1995, USFS 1994). The relative impacts of roads, logging, and other human caused disturbances on the land and the effects to water quality can be directly tied to geologic differences in the subbasin.

The two underlying geologies of the Cascades determine how resilient each landscape is to activities such as road building and timber harvesting (Tague and Grant 2004). In watersheds of the Western Cascades, the landscape has undergone the processes of erosion for a longer period than the High Cascades and the rock strata are more deeply weathered, older volcanic rocks. The landscape is generally steep and well dissected by extensive networks of streams that deliver water quickly into the larger streams. Western Cascade streams receive much of their flow via surface and shallow subsurface runoff and generally have higher summer water temperatures. Winter flood runoff in large Willamette River Basin streams (including the Clackamas River) primarily comes from Western Cascade watersheds. High Cascade geology is younger, at higher elevation, less eroded, and usually a much more permeable geology to melting snow and rain. Water is more likely to percolate into this geologic material, rather than flow over it. With water infiltrating into the younger, permeable High Cascade geology, large cold springs fed by deep underground aquifers are common (Duncan 2002). Portions of the subbasin dominated by High Cascades geology (e.g., the upper Clackamas River above the confluence with the Collawash River and most of the Oak Grove Fork) are likely to be less impacted by road building and timber harvesting activities due to greater permeability, lower relief, and lower drainage density. In contrast, portions of the subbasin dominated by Western Cascades geology (i.e., Collawash River, Fish Creek, North Fork Clackamas River, and South Fork Clackamas River) are likely to be more impacted by these same activities. These portions of the subbasin tend to be more sensitive to land management activities.

Road building and logging in the upper portions of the subbasin throughout the 1940s to 1970s impacted fish habitat and populations. Removal of the forest cover to the edge of streams was common throughout the Pacific Northwest during this era (Cederholm et al. 1997, Murtagh et al. 1992). In some cases, tractor logging and skidding occurred directly through small tributaries on harvested blocks of timber in the 1950s and 1960s. Even after tractor logging through small streams was stopped, logging of all timber to the stream's edge was common into the 1980s, via skyline yarder logging (Sue Helgeson, U. S. Forest Service, personal communication, 2005). Until about 1980, removal of large instream wood was also common and thought to be beneficial to fish for fish passage (USDA 1995, Oregon Chapter AFS 1990). Despite these negative impacts to water quality and riparian habitat, by the 1970s native salmon and steelhead populations were still common and were in some cases slowly recovering, although under mounting pressure with expanding hatchery programs and the ensuing sport and commercial fish harvest. During the 1970s, occasional bull trout were still being reported by anglers (Massey and Keeley 1996, cited in Zimmerman 1999, Nordlund 2005).

Fisheries Management and Sport Harvest

Early fisheries management (before 1940) in the Clackamas River Subbasin consisted largely of trapping salmon and steelhead runs to supply eggs to early hatchery operations, the designation of early sport harvest limits and enforcement, and the stocking of high mountain lakes with fingerling trout. Despite the blockage of all Clackamas River salmon and steelhead runs above Cazadero Dam (Faraday) prior to 1940, trout populations were abundant in these same waters and encounters with bull trout were sparse but not unusual. Jiggs Pederson, an early Forest Service employee who worked on trails and roads in the 1920s and 1930s, recalls anglers fishing for trout and bull trout using everything from red huckleberries to live mice floated on small pieces of wood (Pederson 2003, Carrell 2003). Access to much of the upper portion of the subbasin was limited to a few gravel roads or more commonly, foot trails which limited overall sport angling harvest. Gene McMullen, who fished the upper waters on the Collawash and Clackamas rivers in the late 1940s and

early 1950s, recalled with some regret that he and two fellow anglers would come out of the roadless country with weekly limits amounting to 100 trout. This was probably commonplace for the time and era. Gene's understanding was, "that after the road penetrated this country, the fishing steadily declined" (McMullen 1994).

With the advance of the road system into the upper subbasin it was quickly recognized by fisheries authorities that the native trout populations would not meet the demand of a growing human population. It was also recognized that stocking fingerling trout would not provide a good return to the creel in streams. The 1947 annual report of the Oregon Fisheries Division recommended stocking catchable sized rainbow trout based on investigations completed on the Clackamas River (Lockwood 1948). By the 1950s, large numbers of hatchery rainbow trout were being stocked along the roads that paralleled the Clackamas and Collowash rivers. Expanding and sometimes booming human population growth in nearby communities helped fuel demand for fishing. Clackamas County's population grew by 45.7 percent between 1970 and 1980 alone (Oregon Employment Division 1992, cited in USFS 1993). By the 1970s, over 100,000 hatchery catchable trout were being stocked in the Clackamas River and its tributaries on an annual basis (Whitt 1978). The Clackamas River provided one of the largest trout fisheries in Oregon, with more than a quarter million angler days annually, supported by the stocking of tens of thousands of catchable sized, hatchery rainbow trout. This large, hatchery supported fishery also negatively affected steelhead production at the time. A 1988 survey documented nearly 10,000 hatchery and 800 wild steelhead smolts harvested in the fishery along with 1,000 coho smolts (Murtagh et al. 1992). Starting in 1968, an additional hatchery fishery was started in the Clackamas River with the first releases of Skamania/Foster summer steelhead pre-smolts and smolts. These steelhead were particularly popular with anglers because they have a long period of freshwater residency and bite well. This summer steelhead fishery was primarily in the Clackamas River above North Fork Dam, the same areas where bull trout were last reported. By 1979, summer steelhead harvests were averaging over 5,000 fish in the Clackamas River (Murtagh et al. 1992).

Summary and Conclusion

Based on available historical notes and records, the evidence indicates bull trout likely suffered many of the same impacts as did other Clackamas River salmonids (i.e., native spring Chinook salmon). In the 19th Century, spreading settlement with little or no regulations to protect natural resources impacted fish populations, including bull trout. Individual land owners could use the land and water for any purpose with no regulation or restriction. This included fish culture and trapping of Clackamas River salmon runs to collect eggs for hatchery rearing which also impacted salmon, steelhead, and the bull trout found. Since bull trout or "Dolly Varden" as they were known then, were recognized as predators of salmon, fisheries workers probably had a negatively biased view of any bull trout captured with salmon (Adams 1992, Holland 1962, Brown 1992b) and did little to conserve or protect them.

Increasing regulation of commercial and sport fisheries was offset by the construction of mainstem hydroelectric dams and diversions which impeded or blocked upstream and downstream fish passage. Hatchery weirs on fish ladders at the dams also expedited the decline of anadromous salmon runs in the upper portion of the subbasin. These passage barriers also affected migratory bull trout that utilized the lower Clackamas, Willamette, and Columbia rivers. From 1917 to 1939, there was no fish passage and during this period of migratory blockage, bull trout were able to persist in the upper portions of the subbasin without the benefit of a juvenile salmon prey base or access to lower mainstem foraging areas.

Road access into the upper portion of the subbasin was limited at this time, and as early anglers have reported, trout populations were abundant until road access became available. In the 1960s and 1970s, road and highway access expanded which aided in development of a large and popular hatchery trout fishery that may have been the final causative factor that sent the remaining bull trout population into an extinction vortex. The late 1960s stocking and development of a hatchery summer steelhead fishery in the upper subbasin contributed even more angling pressure as hundreds of anglers bait fished every deep hole in the river. Ratliff and Howell (1992) observed that bull trout are aggressive and can be readily caught by lures and bait and thus, are very susceptible to angler pressure. Bull trout can also be more vulnerable in mixed species fisheries because they usually don't sexually mature until they are four to six years old, in contrast to faster maturing species like rainbow trout (Adams 1992). In Oregon's Grand Ronde River Basin, overharvest was considered a limiting factor for bull trout in streams that were being stocked with hatchery, catchable rainbow trout (Buchanan et al. 1997). On the Wenatchee National Forest in Washington, increased fishing pressure was considered a "major contributor" to native bull trout mortality (Brown 1992b). In the Flathead River system in the late 1980s, it was felt that any increase in fishing pressure in any particular area or subbasin could cause a drop in the overall bull trout population in Flathead Lake (Fraley and Shepard 1989). The Metolius River Subbasin in Oregon is considered to be an example where overharvesting of bull trout apparently was one of the major limiting factors for the population. After a catch-and-release fishery was instituted for all trout in the Metolius River in 1983, the bull trout spawning population grew more than ten-fold in nine years (Buchanan et al. 1997). The USFWS documented in 1994, when considering the October 1992 petition to list the bull trout as an endangered species, that overharvest (both legal and illegal) can seriously threaten populations already reduced by other factors (USFWS 1994). Heavy angling pressure and barriers are thought to have caused the ultimate loss of the Clackamas River bull trout population (Don Ratliff, Portland General Electric, personal communication, January 1990).

By the 1980s, angler reports documenting bull trout in the Clackamas River ceased. In the early 1990s as interest and concern for bull trout increased, the first field surveys to locate remnant bull trout began. For over a decade, multiple surveys throughout the subbasin failed to document persistence of a remnant bull trout population. In hindsight, it is ironic that about the time bull trout were finally discerned to be a separate species in 1978, the Clackamas River bull trout was likely extirpated.