8.0 OZETTE LAKE SOCKEYE SALMON ESU

8.1 BACKGROUND

8.1.1 Description of the ESU

The Ozette Lake sockeye salmon ESU includes all naturally spawned sockeye salmon residing below impassable natural barriers (e.g., long-standing, natural waterfalls) in Ozette Lake and its tributaries. Ozette Lake is located within Olympic National Park on the northwest corner of Washington State (*Table* 8.1). Sockeye salmon stock reared at the Makah Tribe's Umbrella Creek Hatchery were considered part of the ESU, but were not considered essential for recovery of the ESU. In its 1999 listing decision, NOAA Fisheries determined that it was not necessary under the ESA (64 FR 14528, March 25, 1999) to consider the progeny of intentional hatchery-wild or wild-wild crosses produced through the Makah Tribal hatchery program. However, once the hatchery fish return and spawn in the wild, their progeny become listed.

Sockeye salmon in the Ozette Lake basin make up a unique ESU and are genetically distinct from all other sockeye populations on the Washington coast and in Puget Sound. The extant natural beach-spawning population spawns at two primary locations along eastern and western lakeshore areas at the southern end of the lake: Olsen's Beach, located on the lake's eastern shore north of Siwash Creek, and Allen's Bay Beach, located on the lake's western shore (Makah 2000; Jacobs *et al.* 1996). Gustafson *et al.* (1997) reported differences in allozyme genetic data among the Allen's and Olsen's beach-spawning aggregations. However, the differences between years at the same given spawning location were also found to be as great as the differences between beaches, suggesting that the aggregations may be a single population, with the genetic differences observed reflecting natural variation within the lake population. Mature adult sockeye salmon in Ozette Lake have also been reported near the south shore of Baby Island at the southern end of the lake, in Erickson's Bay (Gustafson *et al.* 1997), and on the beach north of Umbrella Creek (Jacobs *et al.* 1996). Historically, it is likely that sockeye salmon also spawned in tributaries to Ozette Lake, potentially including Big River, Umbrella Creek, and Crooked Creek and in the Ozette River (Jacobs *et al.* 1996; Dlugokenski *et al.* 1981). A supplementation program operated by the Makah Tribe has established a naturally spawning sockeye salmon aggregation derived directly from the beach-spawning population in Umbrella Creek. Adult returns from juvenile sockeye released through the Tribal program are also expected to spawn naturally in Big River beginning in 2004. These hatchery sockeye salmon aggregations are now derived from sockeye salmon adults returning to Umbrella Creek and are considered isolated from the natural beach-spawning population.

8.1.2 Status of the ESU

In its most recent review of the ESA status of the Ozette Lake sockeye salmon ESU, the majority of BRT members found that the ESU remains "likely to become endangered" in status (NMFS 2003a). General VSP parameter findings, as per NMFS (2000), for the naturally spawning populations within the ESU were provided in the updated BRT status review document. In summary, the BRT found moderately high risks for the sockeye salmon ESU in all VSP

elements.

The extent to which sockeye spawned historically in tributaries to the lake is controversial (Gustafson *et al*. 1997), but it is clear that multiple beach-spawning aggregations of sockeye occurred historically and that genetically distinct kokanee currently spawn in large numbers in all surveyed lake tributaries except Umbrella Creek and Big River (NMFS 2003a). The two remaining beach-spawning aggregations are probably fewer than the number of aggregations that occurred historically, but there is insufficient evidence to determine how many sub-populations there might once have been.

The BRT expressed concern regarding the inability to fully assess risks to the ESU because of the lack of reliable population status data prior to 1997 (NMFS 2003a). The BRT was further concerned that the overall abundance is low for a population that represents an entire ESU and may be substantially below historical levels (NMFS 2003a). The BRT was also concerned about reports that habitat degradation in the lake has resulted in the loss of numerous sites suitable for beach spawners. Uncertainty regarding the significance of harbor seal and otter predation on beach spawner sockeye abundance was an additional concern.

The Puget Sound Technical Recovery Team (TRT) has not yet completed reviews to identify populations within the Ozette Lake sockeye salmon ESU and population abundance, diversity, spatial structure, and productivity levels necessary for ESU viability. Based on preliminary analyses, the TRT considers the Ozette Lake sockeye salmon ESU to be composed of one historical population, with substantial sub-structuring of individuals into multiple spawning aggregations (K. Currens, NWIFC, pers. comm., December 2003).

8.2 ASSESSMENT OF HATCHERY PROGRAMS

8.2.1 Ozette Lake Sockeye Program

8.2.1.1 Broodstock/Program History. There is currently one hatchery broodstock, and it is isolated from the lone natural sockeye salmon population that constitutes this ESU (Table 8.1). The Umbrella Creek Hatchery broodstock is used to sustain hatchery programs that are creating adult sockeye salmon spawning aggregations in Umbrella Creek and Big River. There are no hatchery broodstocks that are integrated with the natural Ozette Lake sockeye salmon population.

Table 8.1. Independent extant Ozette Lake sockeye salmon populations preliminarily delineated by the Puget Sound TRT and their relationship to Ozette Lake sockeye hatchery populations.

Independent Population [1]	Within ESU Hatchery Populations [2]	Out of ESU Hatchery Populations [3]
Ozette Lake	(1) Umbrella Creek Hatchery (2) Big River Egg Boxes	None

[1] The independent sockeye chinook salmon population preliminarily delineated by NMFS (2003) for the Ozette Lake sockeye salmon ESU.

[2] In ESU hatchery-origin sockeye salmon populations located within the geographic boundaries of the Ozette Lake sockeye salmon ESU.

[3] Out of ESU hatchery-origin sockeye salmon populations located within the geographic boundaries of the Ozette Lake sockeye salmon ESU.

The hatchery broodstock propagated through the Makah Tribe's Umbrella Creek and Big River hatchery programs was derived from the natural beach-spawning population. However, the design of the two hatchery programs operating within the ESU is to isolate hatchery adult returns from the natural-origin beach-spawning population in Ozette Lake by creating separate spawning aggregations in Ozette Lake tributaries (Makah 2000). The separate tributary-spawning aggregation now returning to Umbrella Creek is used as the broodsource for the two hatchery programs (Table 8.2). The programs are isolated from the natural beach-spawning population, because no adult sockeye salmon from the natural population are used as broodstock for artificial propagation, and straying of hatchery fish to beach-spawning sockeye spawning beaches appears negligible (Makah 2000; NMFS 2003b). There are no hatchery programs operating within the ESU that use fish collected from multiple areas or streams for broodstock.

Table 8.2. Ozette Lake sockeye salmon hatchery propagation inventory. ESU, natural population integration, and production status for sockeye salmon hatchery programs located within the geographical boundaries of the Ozette Lake sockeye salmon ESU.

ESU Name	Program Type & Purpose	ESU Status	Program Description	Program Size (Max. release/yr)	Years in Operation
Ozette Lake Sockeye	Isolated Conservation/ Introduction	In	Unfed and Fed fry	Umbrella Ck 80,000 Big River 135,800	21 4

8.2.1.2 Similarity between Hatchery-origin and Natural-origin Fish. There is no genetic evidence that sockeye salmon produced in the hatchery programs have diverged from the natural sockeye salmon genotype. Through 2000, the hatchery program relied on the collection of broodstock directly from the natural, beach-spawning sockeye salmon aggregation. Given that the tributary sockeye salmon population is only one generation removed from the donor natural population, there is a very low likelihood that genetic divergence has occurred as a result of the artificial propagation program.

Allozyme analyses indicate that the hatchery and natural beach-spawning sockeye populations are genetically indistinguishable (Makah 2002). Again, given that the program only recently transitioned from collection of the natural beach-spawning sockeye salmon population for use as hatchery broodstock, there is a very low likelihood that genetic divergence has occurred as a result of the artificial propagation program.

Hatchery-origin and natural-origin sockeye salmon in the ESU share identical life history characteristics for the majority of the sockeye salmon life cycle, including natural rearing from fry to two-year smolt size in Ozette Lake, emigration seaward as smolts from Ozette Lake via the Ozette River, rearing for two years from smolt to adult size in Northeast Pacific marine waters, migration into the Ozette River and Ozette Lake in the spring and early summer as maturing four-year-old adults, and holding through maturity in Ozette Lake for 4 to 6 months prior to spawning in the winter months (Jacobs *et al*. 1996; Makah 2000).

Differences in life history characteristics are that the hatchery-origin fish return to an Ozette Lake tributary to spawn rather than to beaches in the lake. Other differences are that adult sockeye collected from Umbrella Creek for the hatchery program are artificially spawned, and hatchery adults that are not used as broodstock spawn naturally in the tributaries rather than in Ozette Lake. Eggs are artificially fertilized and incubated in a hatchery under controlled conditions, and a proportion of juvenile sockeye are fed an artificial diet prior to their release and emigration into Ozette Lake.

8.2.1.3 Program Design. The Umbrella Creek and Big River hatchery programs are seeding natural habitat in Ozette Lake tributaries, using juveniles and adults for natural production purposes. The objective of the hatchery programs is to establish self-sustaining sockeye salmon aggregations in the tributaries where sockeye salmon spawning had not been observed for decades. The programs are also designed to isolate sockeye production from the natural, beach-spawning sockeye salmon population in Ozette Lake. Also, the historical presence of sockeye salmon spawning in Ozette Lake tributaries is uncertain and controversial. There is scientific evidence indicating that the Umbrella Creek hatchery program has led to the return of adult sockeye salmon that are the progeny of naturally spawning hatchery-origin fish in the tributary (Makah 2000). Adult returns to Umbrella Creek have ranged from 44 (1995) to 312 (1999) fish and exceeded 2,500 adult sockeye salmon in 2000 (M. Crewson, Makah Tribe, pers. comm.). In 1999, 37.2 percent of the total adult escapement to Umbrella Creek was estimated to be the progeny of naturally spawning hatchery adults produced by the Umbrella Creek Hatchery program (Makah 2000).

The Umbrella Creek Hatchery program appears to be successful in isolating hatchery-origin sockeye salmon adult spawning and juvenile production from the natural beach-spawning population. Mark recovery data indicate that the tributary hatchery program is not leading to straying of hatchery-origin sockeye salmon adults into beach-spawning areas used by the natural population. More than 200 adult carcasses were sampled on Ozette Lake beaches in 2000, and no marked hatchery-origin sockeye adults were observed (MFM unpublished data). Similarly in 1999, when 400 adult spawners returned to Umbrella Creek, no straying was observed to lake beaches (0 of 121 lake spawners sampled were marked with an adipose fin clip). The intent of the hatchery program is to limit hatchery-origin sockeye salmon straying to 1 percent or less of the lake-spawning population or to levels below natural levels identified through analyses of DNA markers (Makah 2000).

BMPs are applied in implementation of the hatchery programs, consistent with those recommended by NOAA Fisheries. Potential negative effects on natural-origin sockeye salmon are limited by applying risk avoidance measures that lower the probability of an unwanted event occurring and by applying measures that will help minimize the loss of fish should some unanticipated event occur. Specific measures implemented to minimize adverse genetic, ecological, and demographic effects on listed fish are included within the Makah Tribe's hatchery plan (Makah 2000) describing hatchery fish production, monitoring and evaluation, and research components. For example, to minimize genetic risks, the proposed tributary hatchery programs will be evaluated after 12 years, or three sockeye salmon generations, per release site. Measures applied to minimize the risk of tributary hatchery-origin sockeye salmon spawner straying to beach-spawning areas include imprinting hatchery fish to tributary return locations

through on-site incubation, rearing, and release. Broodstock selection, collection, mating, juvenile fish rearing, and fish release measures applied through the programs are designed to minimize the risk of within- and among-population diversity loss to the donor tributary-returning population destined for natural spawning and to the artificially propagated sockeye salmon population produced for release into Umbrella Creek and Big River. Restricting hatchery sockeye salmon releases to the fry stage complies with conservation hatchery protocols, which call for the production of hatchery fish of the same life stage as natural-origin species that they may encounter in order to limit competitive effects.

All hatchery-origin sockeye salmon juveniles produced in the Umbrella Creek and Big River hatchery programs are marked through application of thermally induced otolith banding, and for fed fry above one gram size, an adipose fin clip (Makah 2000).

8.2.1.4 Program Performance. Mark recovery surveys for otolith-marked and adipose fin-clipped hatchery-origin sockeye salmon adults in 1999 and 2000 indicate that stray rates for hatchery fish have been very low and perhaps nonexistent (NMFS 2003b).

Hatchery sockeye salmon fry-to-adult survival rate estimates for fish produced by the programs are not yet available. The program survival rate goal is 0.6 percent (Makah 2000). Applying an estimated fry-to-returning-adult survival rate of 0.6 percent to the total fry releases at the two locations beginning in 2004, 480 adult hatchery-origin sockeye salmon may return to Umbrella Creek and 798 adults may return to Big River each year as a result of tributary hatchery program juvenile sockeye releases. Additional natural-origin adult fish will return to the tributaries concurrently with these first-generation hatchery-origin adult sockeye. Actual hatchery fry-to-adult survival rates will be determined by otolith marking all hatchery-origin sockeye eyed eggs to allow for their differentiation from natural-origin fish upon return as adults to natural spawning areas. Spawning ground surveys conducted throughout the annual sockeye salmon return period will be used to enumerate spawners and collect information regarding fish origin (via observation of live fish for fin clip marks and carcass and broodstock sampling for otoliths) and age class composition (scale and/or otolith sampling of broodstock and carcasses). Abundance and mark recovery information will be used to estimate total tributary escapements and first generation hatchery- and natural-origin sockeye proportions of the total. Spawner surveys and mark recovery programs in adjacent non-supplemented tributaries and in lake spawning areas will be used to estimate hatchery-origin sockeye salmon stray rates. Spawner escapement estimates for hatchery-origin fish will be applied to appropriate broodyear fry release numbers to estimate fry-to-adult survival rates. Natural-origin spawner escapement estimates will be compared with contributing broodyear counts of naturally spawning fish to estimate spawner-to-spawner replacement rates.

The tributary sockeye hatchery programs are designed to colonize Ozette Lake tributaries with self-sustaining sockeye populations. Preliminary data indicate that the Umbrella Creek Hatchery program has been successful in producing natural-origin adult sockeye returns, although the long-term success of the program in creating self-sustaining populations is still uncertain. Peak adult sockeye salmon observations in Umbrella Creek in 1995 were 19 fish per mile. Peak counts in 1999 were 138 adults per mile (Makah 2000). Of the 138 spawners per mile observed in Umbrella Creek in 1999, it is estimated that 37.2 percent (52/138) were natural-origin recruits,

yielding an adult replacement rate of 2.7 (Table 8.3, from Makah 2000). For comparison, Foerster (1968) reported a 28-year (1921-48) average adult return-per-spawner rate of 1.8 for Karluk Lake, Alaska wild-origin sockeye salmon. Roos (1991) estimated that Fraser River sockeye salmon exhibit an average return-per-spawner rate of 4.4. The estimated population abundance trend for the natural Ozette Lake beach-spawning population appears to be flat or slightly increasing (greater than 1.0) (NMFS 2003a).

Table 8.3. Peak adult sockeye salmon counts from Umbrella Creek (RM 2.5 to 4.8) (Makah 2000).

Return Year	Hatchery Releases[1]	Adult Sockeye	Distance (miles)	Peak Fish/Mile	Peak Number NOR/Mile
1995	48,186[2]	44	2.26	19	n/a
1996	No Release	79	2.26	35	35
1997	39,040[3]	135	2.26	60	n/a
1998	44,411[3]	96	2.26	42[5]	n/a
1999	45,220[4]	312	2.26	138	52

[1] Hatchery releases correspond to return years, not release years, which were 3 years prior to adult returns.
[2] 48,186 fingerlings were the combined lake and creek releases of which 7,645 were released into Umbrella Creek.
[3] Lake release only.
[4] All fish were released into Umbrella Creek.
5 Surveys did not include the peak spawn timing due to excessive turbidity.

The Umbrella Creek and Big River sockeye salmon hatchery programs are designed to be terminated after 12 years, or three sockeye salmon generations, commensurate with achievement of natural-origin recruit return objectives to the target tributaries. Continuation of the programs through their 12-year limit of operation is very certain, given the restoration intent of the programs and their alignment with the Lake Ozette Sockeye Salmon resource management plan (Makah 2000), which is the Co-managers' lone population assessment and sockeye salmon recovery initiative for the ESU. The programs are supported and funded by several sources, including the Makah Tribe, the Bureau of Indian Affairs, and the USFWS. Both hatchery programs are approved under the ESA and NEPA for a 12-year duration of operation (NMFS 2003a; 2003b), and all other state permits needed for their continued operation are in hand.

Neither of the hatchery programs operating in the Ozette Lake watershed block or hinder juvenile or adult migration or distribution. Broodstock is collected from Umbrella Creek, using a run-of-the-river weir and trap that allows for handling of all sockeye salmon returning to the tributary. The weir is removed from beach-spawning areas used by the natural sockeye salmon population in Ozette Lake, and does not affect that population's migration or distribution. There are monitoring and evaluation programs implemented as part of the resource management plan for the Ozette Lake watershed that lead to temporary migration delay and blockage of natural-origin sockeye salmon. An adult fish-counting weir at the mouth of the Ozette River is operated by the Makah Tribe as a means to enumerate sockeye salmon adults entering Ozette Lake each year. A small proportion of the total number of natural and hatchery-origin juvenile sockeye salmon emigrating from Ozette Lake each year may be collected, examined, and released during smolt emigration trapping operations in the Ozette River (NMFS 2003b).

The Umbrella Creek and Big River hatchery programs are isolated from natural sockeye salmon spawning, rearing, and migration areas. No effects to natural-origin beach-spawning sockeye

salmon are likely as a result of hatchery operations, including entrainment or removal of natural sockeye as a result of hatchery screening.

8.2.1.5 VSP Assessment. Following is a summarized assessment of VSP parameter effects of the two sockeye hatchery programs active within the ESU.

Abundance - Data indicate that the Umbrella Creek Hatchery program is increasing the abundance of naturally spawning sockeye salmon and natural-origin fish within the ESU (NMFS 2003b; Makah 2000). However, the abundance status of the natural beach-spawning population, which was the extant population at the time of listing and remains the focus of recovery for this ESU, will not be directly enhanced as a result of the two programs, which are designed to be isolated.

The sockeye salmon hatchery program has resulted in an increase in natural spawning abundances in the ESU. Adult returns to Ozette Lake tributaries were zero prior to initiation of the tributary hatchery programs. Adult returns to Umbrella Creek have now ranged from 44 (1995) to 312 (1999) fish, and exceeded 2,500 adult sockeye salmon in 2000 (M. Crewson, Makah Tribe, pers. comm.). Assuming fry-to-adult survival rates at goal levels, the hatchery program in Big River could lead to additional annual adult returns of approximately 800 sockeye salmon, beginning in 2004.

Naturally spawning returns to Umbrella Creek (and beginning in 2004, to Big River) resulting from hatchery juvenile sockeye releases are creating natural-origin sockeye adult returns to the tributaries. Of the 138 sockeye salmon spawners-per-mile observed in Umbrella Creek in 1999, the Makah Tribe estimates that 37.2 percent were natural-origin fish, yielding an estimated adult replacement rate for natural spawners of 2.7 (Makah 2000). Although evidenced by only one year of data, the advent of a large number of natural-origin sockeye may indicate that life history traits of the original donor lake-spawning sockeye stocks are compatible with, and may have adapted to, Ozette Lake tributary habitat conditions. Based on available tributary spawning habitat, the abundance of listed fish in the ESU is expected to increase if self-sustaining populations are established at full habitat-seeding levels in the tributaries as a result of the proposed hatchery program. Results for 1999 indicate that natural-origin tributary spawners established through the hatchery program have the potential to become self-sustaining. However, determinations of whether self-sustaining sockeye aggregations have been successfully established in the tributaries must rely on stock recruitment data collected through the HGMP over several sockeye generations.

Productivity - Because reliable data do not currently exist on historical abundance and distribution, spawner/recruit or smolt-per-adult functions for use in evaluating stock-specific population growth rates and estimating the productivity of Ozette Lake sockeye salmon have not been developed. The productivity of the natural beach-spawning population will not be directly enhanced as a result of the two isolated hatchery programs. Data collected in 1999 indicate that adult hatchery-origin sockeye salmon that spawned naturally in Umbrella Creek in 1995 had an adult replacement rate of 2.7 (Table 8.1, from Makah 2000). This tributary spawner-to-adult return rate compares favorably to flat or slightly increasing replacement rates evident in recent years for the listed beach-spawning population.

Natural origin sockeye resulting from the tributary colonization program may contribute to the overall productivity of the listed ESU by using tributary spawning habitat that is not being colonized naturally by the beach-spawning population. Productivity of the tributary-spawning populations (measured as egressing fry/fingerlings per year) may increase until suitable habitat in Umbrella Creek and Big Creek (the two tributaries targeted for hatchery release) is fully colonized and if resultant sockeye broods become more adapted to the tributary environments. If productivity conditions in Ozette Lake are not limiting at current lake spawner juvenile fish production levels (as suggested by Beauchamp *et al*. 1995), natural-origin juvenile fish entering the lake from the tributaries will lead to increased smolt numbers and, if ocean conditions are not limiting, increased natural-origin sockeye adult returns.

Spatial Structure - The spatial structure of the beach-spawning population is not being enhanced by these isolated hatchery programs, which are designed to return sockeye salmon to Ozette Lake tributaries, where spawning has been absent for decades. An intent of the hatchery programs is to expand spatial distribution of natural sockeye salmon production within the ESU by establishing self-sustaining sockeye salmon populations (originally derived from the listed lake-spawning populations) in Ozette Lake tributaries. This is accomplished through annual hatchery sockeye salmon fry releases and allowing the majority of sockeye salmon adults returning each year to the tributaries to spawn naturally. Whether the creation of tributary sockeye returns represents reestablishment of historical spatial use patterns for Ozette Lake sockeye salmon is uncertain. Adult fish needed for hatchery broodstock are no longer removed from the natural beach-spawning population, which helps safeguard their spatial distribution. Also, the hatchery programs are operated to limit and monitor straying of hatchery-origin sockeye to beach-spawning areas to preserve spatial structure of the natural beach-spawning population. Hatchery-origin sockeye produced through the HGMP are imprinted to, and released within, two Ozette Lake tributaries. Available data indicate that adult returns resulting from tributary releases have a low tendency to stray to lake spawning areas. No straying to lake beaches was observed for either the 1999 or 2000 adult return years.

Diversity - Ozette Lake sockeye salmon diversity may potentially benefit from the hatchery programs. The primary purpose of the hatchery programs is to create self-sustaining sockeye salmon populations in Ozette Lake tributaries where past sockeye salmon spawning and production may have occurred and where kokanee populations are very small. If successful, the tributary stocking program may extend the range of Ozette Lake sockeye salmon within its native watershed, which may increase the diversity of life history traits and sockeye behavior and potentially the genetic characteristics of sockeye salmon included in the ESU. These changes may provide resilience to the tributary-spawning component of the ESU, perhaps allowing the aggregation to endure man-caused or natural catastrophic factors affecting the survival of the core, listed beach-spawning population. Measures are applied to retain the diversity of natural beach-spawning population and of the propagated and natural populations in the tributaries (Makah 2000, NMFS 2003a). No sockeye are removed from beach-spawning areas for use as broodstock; only sockeye returning to Umbrella Creek that were introduced by the hatchery program are collected and spawned to sustain the hatchery program. The program is limited to a 12-year duration as a measure to decrease the likelihood for loss of within-population diversity that may potentially occur as an outcome of artificial propagation. Allozyme analyses indicate

that the hatchery and natural beach-spawning sockeye populations are genetically indistinguishable (2002 data from K. Currens, NWIFC). Also, available data indicate that returning adults resulting from tributary hatchery program sockeye releases have a low tendency to stray to lake spawning areas (Makah 2000), and genetic introgression by the hatchery-origin sockeye salmon is not a substantial concern.

8.3 CONCLUSION

Existing Status: Threatened
BRT Finding: Threatened
Recommendation: Threatened

8.3.1. ESU Overview

8.3.1.1 History of Populations. The Ozette Lake sockeye salmon ESU is currently composed of one historical population, with substantial sub-structuring of individuals into multiple spawning aggregations (NMFS 2003a).

The extant natural beach-spawning population spawns at two primary locations along eastern and western lakeshore areas at the southern end of Ozette Lake: Olsen's Beach, located on the lake's eastern shore north of Siwash Creek, and Allen's Bay Beach, located on the lake's western shore (MFM 2000; Jacobs *et al.* 1996). Historically, it is likely that sockeye salmon spawned in other beach areas in Ozette Lake. The population may also have spawned in tributaries to Ozette Lake, potentially including Big River, Umbrella Creek, and Crooked Creek, and in the Ozette River, but sockeye salmon had been absent from lake tributaries for decades. Recently, a hatchery supplementation program has established a naturally spawning sockeye salmon aggregation derived directly from the beach-spawning population in Umbrella Creek. Adult returns from juvenile sockeye released through the same hatchery program are also expected to spawn naturally in Big River beginning in 2004. These hatchery sockeye salmon aggregations are derived from returning sockeye salmon adults established in Umbrella Creek.

8.3.1.2 Association between Natural Populations and Artificial Propagation

Natural populations "with minimal genetic contribution from hatchery fish"

The natural beach-spawning Ozette Lake sockeye salmon population is likely to be subject to minimal or less genetic influence from hatchery-origin fish. The hatchery programs designed to establish naturally spawning aggregations in Ozette Lake tributaries have a substantial genetic influence on the natural populations resulting from naturally spawning hatchery fish.

Natural[a] populations "that are stable or increasing, are spawning in the wild, and have adequate spawning and rearing habitat" [b]

None. The natural beach-spawning Ozette Lake sockeye salmon population is spawning in the wild with low or no hatchery influence. Also, although incomplete, available data do indicate that the natural population is stable or increasing in abundance. Analyses of trends using population size estimates through 1998 indicate that the short-term (10-year) trend has improved from a decline of 9.9 percent per year to a relatively low 2 percent annual increase. The long-term trend remained slightly downward (-2 percent) (NMFS 2003a). However, the natural population does not have adequate spawning and rearing habitat. Anthropogenic factors have considerably altered critical habitat and also played an important role in the decline of the ESU. These factors have likely reduced the natural sockeye salmon population's resiliency to such natural factors for decline as drought and poor ocean conditions. Factors contributing to the decline of the ESU include the cumulative effects of intensive land-use practices during the last century and continuing presently, particularly timber harvest, agriculture, and associated stream-clearing and road-building (Dlugokenski *et al.* 1981; MFM 2000; Gustafson *et al.* 1997). Cumulative land-use effects are an important factor limiting the productivity of naturally-produced sockeye salmon within the lake and its tributaries.

Mixed (Integrated Programs[c])

The hatchery sockeye salmon aggregation introduced in Umbrella Creek includes first-generation hatchery-origin adults and returning adult fish that are the progeny of naturally spawning hatchery-origin fish. The hatchery aggregation is not integrated with the beach-spawning population.

Hatchery (Isolated[d])

Umbrella Creek Hatchery and Big River Hatchery populations return to tributaries where sockeye have been absent for decades. Neither program uses natural-origin beach spawners as broodstock, instead relying on adult returns to the tributaries.

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[a] See HLP for definition of natural, mixed and hatchery populations

[b] HLP Point 3

[c] Integrated programs follow practices designed to promote and protect genetic diversity and only use fish from the same local population for broodstock (both natural-origin fish, whenever possible, and hatchery-origin fish derived from the same local population and included in the ESU). Programs operated to protect genetic diversity in the absence of natural-origin fish (e.g., captive broodstock programs and the reintroduction of fish into vacant habitat) are considered "integrated".

[d] Isolated programs do not follow practices designed to promote or protect genetic diversity. Fish that are reproductively isolated are more likely to diverge genetically from natural populations included in the ESU and to be excluded themselves from the ESU.

Hatchery fish stray rates to beach-spawning areas are very low. In addition to minimal or no genetic exchange between the hatchery tributary and beach-spawning aggregations, the hatchery programs apply appropriate measures to isolate the tributary fish from the natural beach-spawning fish.

8.3.2. Summary of ESU Viability:

8.3.2.1 Abundance. Table 8.4 summarizes recent-year abundance information for the extant population within the ESU, including (as available) the estimated total number of naturally spawning fish, and the number of within ESU hatchery-origin fish contributing to total natural spawning escapement. Estimated natural-origin returns and the total number of natural spawners (i.e., the combination of natural-origin and hatchery-origin sockeye salmon included in the ESU) appears to have increased since 1999 when the ESU was originally listed under the ESA as threatened. Recovery goals for the ESU have not yet been developed, but available information indicates that the total naturally spawning population is currently well below historical abundance levels (NMFS 2003a). Hatchery-origin adult returns to Umbrella Creek as a result of the Umbrella Creek Hatchery program have led to the establishment of natural spawning in a tributary where no sockeye salmon had been observed for two decades.

The hatchery programs are isolated by design and are, given current stray rate analyses results, unlikely to benefit the abundance of the natural-origin beach-spawning sockeye salmon population. The hatchery program is increasing the abundance of natural-origin sockeye salmon produced in Umbrella Creek through successful natural spawning by hatchery-origin adults. Both hatchery programs are designed to terminate after 12 years, so the programs cannot be relied on to sustain natural-origin sockeye salmon abundances in future years.

8.3.2.2 Productivity. Given very low stray rates to beach-spawning areas, naturally spawning sockeye salmon originating from the hatchery programs are unlikely to benefit the productivity of the natural beach-spawning population. The programs are designed to isolate hatchery adult fish from the natural beach-spawning population, reducing the risk of adverse affects on their productivity. Under the current program, no sockeye salmon are collected from the natural beach-spawning population for use as broodstock, reducing the risk of productivity loss for the natural population. Adult returns resulting from Umbrella Creek program have led to sockeye salmon spawning in a watershed where sockeye salmon production (and productivity) has been absent for decades.

The hatchery programs are self-sustaining by virtue of the establishment of sufficient adult sockeye salmon returns to Umbrella Creek to meet annual broodstock collection needs. Adult return abundances to the creek indicate that fry-to-adult survival rates are exceeding the 0.6 percent goal for the program in recent years, although data are incomplete. Available data indicate that this hatchery program has led to the production of natural-origin returns to Umbrella Creek that are the progeny of naturally spawning hatchery fish. Naturally spawning hatchery-origin sockeye preliminarily appear to be reproducing at a level demonstrated for healthy natural-origin sockeye populations.

Table 8.4. Estimated number of natural-origin sockeye salmon included in the Ozette Lake sockeye salmon ESU escaping to spawning grounds and the estimated number of hatchery-origin sockeye salmon included in the ESU escaping to spawning grounds and returning to hatcheries.

	Ozette Lake				
	Natural-origin escapement	Hatchery-origin escapement		Total escapement	
	Beach	Trib hatchery-origin	Trib natural origin		
1974	N/A	0	0	N/A	
1975	N/A	0	0	N/A	
1976	N/A	0	0	N/A	
1977	N/A	0	0	N/A	
1978	1,690	0	0	1,690	
1979	N/A	0	0	N/A	
1980	N/A	0	0	N/A	
1981	350	0	0	350	
1982	2,123	0	0	2,123	
1983	N/A	0	0	N/A	
1984	502	0	0	502	
1985	N/A	0	0	N/A	
1986	N/A	N/A	0	N/A	
1987	N/A	N/A	0	N/A	
1988	N/A	N/A	0	3,599	
1989	N/A	N/A	0	603	
1990	N/A	N/A	N/A	385	
1991	N/A	N/A	N/A	684	
1992	N/A	N/A	N/A	2,548	
1993	N/A	N/A	N/A	N/A	
1994	N/A	N/A	N/A	585	
1995	N/A	N/A	44	N/A	
1996	1699	79	0	1,778	
1997	998	N/A	135	1,133	
1998	1310	N/A	96	1,406	
1999	1676	149	251	2,076	
2000	1293	N/A	3106	4,399	2/
2001	591	N/A	3525	4,116	3/
Recovery Abundance Goal 1/				N/A	
All Years					
Arithmetic Means				1,749	
1999-2001					
Arithmetic Means	1,261	114	1,186	2,485	
% Beach Natural				51%	
% Trib Natural				N/A	
% Trib Hatchery				48%	

Notes: Total escapement data from NMFS 2003 BRT sockeye status review document.

1/ Interim recovery abundance goal for natural-origin fish from WDFW and PNPTT 2003.

2/ Beach spawner escapement estimate includes an unknown number of natural-origin fish returning to Umbrella Creek.
3/ Tributary hatchery escapement estimate includes an unknown number of natural-origin sockeye produced in the tributary.

8.3.2.3 Spatial Structure. The hatchery programs isolate production to tributaries that have not been used by the beach-spawning sockeye salmon for spawning or rearing. Given the low stray rates for hatchery-origin sockeye salmon and the risk minimization protocols that have been applied, the hatchery programs are unlikely to affect or benefit spatial structure of the beach-spawning aggregation within Ozette Lake. However, the hatchery programs are likely to benefit the spatial structure of the aggregate sockeye salmon population within the ESU. The tributary colonization programs are leading to range extensions for sockeye salmon that were confined to beach-spawning areas prior to natural spawning by adult hatchery-origin sockeye returning to the tributaries. The hatchery programs employ broodstock collection methods and operate hatchery water intake structures in a manner that does not block or hinder access by migrating natural salmon populations to natural spawning areas. The broodstock collection weir on Umbrella Creek is operated to seed the upstream area with naturally spawning sockeye by passing all adult fish not needed for use as broodstock.

8.3.2.4. Diversity. Sockeye salmon diversity may potentially benefit from the programs. The primary purpose of the hatchery program is to create self-sustaining sockeye salmon populations in Ozette Lake tributaries where past sockeye salmon spawning and production may have occurred and where kokanee populations are very small. If successful, the tributary stocking program may extend the range of Ozette Lake sockeye salmon within its native watershed, which may increase the diversity of life history traits and sockeye behavior and potentially the genetic characteristics of sockeye salmon included in the ESU. These changes may provide resilience to the tributary-spawning component of the ESU, perhaps allowing the aggregation to endure man-caused or natural catastrophic factors affecting the survival of the core, listed beach-spawning population. Establishment of sockeye salmon populations in the tributaries may be considered a genetic reserve for the natural beach-spawning population. Sockeye salmon returns established through the hatchery program in the tributaries originated from the listed beach-spawning population and are only one generation removed (for use in artificial propagation) from that population. By spreading sockeye production to an alternative spawning area within the basin, establishment and maintenance of tributary aggregations decrease the risk that Ozette Lake sockeye salmon would be lost due to natural or man-caused catastrophic events affecting the beach-spawning sockeye salmon population or the productivity of the beach environment. Appropriate measures are applied to retain the diversity of the natural beach-spawning population and of the propagated and natural populations in the tributaries (Makah 2000, NMFS 2003). No sockeye are removed from beach-spawning areas for use as broodstock; only sockeye returning to Umbrella Creek that were introduced by the hatchery program are collected and spawned to sustain the hatchery program. The program is limited to a 12-year duration as a measure to decrease the likelihood for loss of within-population diversity that may potentially occur as an outcome of artificial propagation. Available data indicate that adult returns resulting from tributary hatchery program sockeye releases have a low tendency to stray to lake spawning areas (Makah 2000).

8.3.3. Artificial Propagation Record

8.3.3.1 Experience with Integrated Programs. The Umbrella Creek Hatchery program has been operated for 21 years. Big River Hatchery has been in operation for four years. Each program is limited to twelve years of operation, commencing in 2003.

8.3.3.2 Are Integrated Programs Self-Sustaining. The hatchery programs are isolated and are wholly self-sustaining through collection of broodstock from adult hatchery and natural-origin sockeye salmon returns established in Umbrella Creek. Smolt-to-adult survival rates in recent years appear to be above the goal of 0.6 percent, given adult return abundances to Umbrella Creek.

8.3.3.3 Certainty that Integrated Programs will Continue to Operate. The Makah Tribal hatchery programs have fairly stable funding sources and are very certain to continue in accordance with resource management agreements and strategies. The programs operate under the Lake Ozette Sockeye Salmon resource management plan, a management framework written by the Makah Tribe and approved by WDFW to establish tributary spawning aggregations and implement research, monitoring, and evaluation programs to improve scientific understanding of Ozette Lake sockeye salmon population status, life history, and factors affecting their survival and productivity. The programs are also included as agreed strategies under the *U.S.* v. *Washington* fishery management framework. In accordance with approved risk minimization strategies for implementing the hatchery programs, they will be terminated after 12 years of operation. The resource management plan was submitted to NOAA Fisheries in 2000 by the Makah Tribe and WDFW for an evaluation and determination of whether the plan addressed criteria under the ESA 4(d) Rule Limit 6, allowing for activities conducted under the plan to be excepted from take prohibitions for listed Ozette Lake sockeye salmon defined in Section 9 of the ESA. NOAA Fisheries evaluated the plan and determined that it adequately addressed all of the criteria specified in Limit 6 in July 2003. The hatchery programs have operated under the approved plan since that time.

8.3.4. Summary of Overall Extinction Risk Faced by the ESU

The Ozette Lake sockeye salmon hatchery programs appear to have benefited three of four VSP attributes for the ESU. The abundance of naturally spawning sockeye salmon has been increased by the programs, as evidenced by the establishment of adult returns in Umbrella Creek. The programs are unlikely to contribute to the abundance of natural-origin fish produced in beach-spawning areas, but naturally spawning hatchery-origin sockeye are leading to the production of natural-origin adult fish in Umbrella Creek. The programs are also unlikely to benefit or affect natural beach-spawning sockeye salmon productivity, but naturally spawning hatchery fish in Umbrella Creek appear to be enhancing overall productivity in the ESU boundaries. Fry releases through the program in Umbrella Creek have returned adult spawners above replacement levels, as evidenced by establishment of adult returns in Umbrella Creek that are sufficient to meet broodstock collection needs and seed natural habitat. ESU spatial structure has been enhanced through reintroduction of spawners in tributaries that have been vacant for decades. Genetic diversity of the beach-spawning population is being safeguarded from hatchery effects coincident with operation of the hatchery programs through application of appropriate hatchery protocols. ESU diversity has benefited through creation of genetic reserves through establishment of tributary spawning aggregations originally derived from the beach-spawning population. However, given the intent to terminate each hatchery program after 12 years, the viability of natural populations and extinction risk to the ESU will shortly depend entirely on performance of natural-origin populations in their available habitat.

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