CHAPTER 4. ENVIRONMENTAL CONSEQUENCES

4.1. Effects to Aquatic Resources

This section addresses effects to both the physical and biological components of the aquatic system. Physical characteristics of water quality, quantity and timing are described qualitatively and quantified where applicable and are used to form the basis for fisheries effects determinations. Each section begins with a brief statement that provides the rationale for providing that specific analysis. The introduction also describes the scale of analysis and analytical methods used.

The analysis is conducted at a range of scales to ensure adequate characterization of conditions and effects from the site to the watershed scale (Figure 3-1). Site scale analysis captures the most direct effects of the project, and in this case includes the immediate vicinity of Hemlock Dam and Hemlock Lake. Intermediate-scale effects are analyzed at the reach scale (i.e. lower Trout Creek reach) or the subwatershed scale (Trout Creek subwatershed). The largest scale at which aquatic effects are described in this document is the watershed scale (Wind River watershed) and the furthest downstream point of this scale is the mouth of the Wind River. The aquatics analysis is bounded at the mouth of the Wind River because of the significant change in flow, fish assemblages, and other issues that are encountered once the Wind River flows into the Columbia River.

4.1.1. Water Quality – Temperature

Relationship to Purpose and Need and Significant Issues

As stated in Chapter 1, a part of the primary purpose is to "improve water quality and habitat conditions in Trout Creek in the vicinity of Hemlock Dam". This was identified as a significant issue and the Measurement Methods related to water quality are:

- Predicted peak temperatures
- Predicted temperature effects to fish

Regulatory Framework

Regulatory and legal requirements that direct watershed management include the Clean Water Act (CWA), Section 303, 319, and 404. Federal law requires that streams, rivers, lakes, and estuaries that appear on the 303(d) list be managed to meet water quality standards. A comprehensive approach for protecting water quality includes developing TMDLs (total maximum daily loads) for both point and nonpoint sources.

Lower Columbia River steelhead (as well as other anadromous species, listed in Table 4-7) are listed as Threatened species pursuant to the Endangered Species Act (ESA) of 1973, as amended, 50 CFR 402 (2000). Federal agencies are prohibited from authorizing any action that will result in the destruction or adverse modification of critical habitat. The ESA also requires the USFS to manage for the recovery of Threatened and Endangered species and the ecosystem on which they depend.

Through the Northwest Forest Plan Standards and Guidelines, Forest Service policy also directs that water quality objectives be met. The Aquatic Conservation Strategy (ACS) was incorporated into the Northwest Forest Plan (and thereby amended Forest Plans within the range of the northern spotted owl) to “protect salmon and steelhead habitat on federal lands managed by the Forest Service and Bureau of Land Management within the range of Pacific Ocean anadromy.” The activities proposed by these agencies must not “retard or prevent attainment of” ACS objectives at the fifth-field watershed scale. Specifically, Objective 4 refers to water quality.

4. Maintain and restore water quality necessary to support healthy riparian, aquatic, and wetland ecosystems. Water quality must remain within the range that maintains the biological, physical, and chemical integrity of the system and benefits survival, growth, reproduction, and migration of individuals composing aquatic and riparian communities.

Water temperatures in Trout Creek and in Hemlock Lake are particularly important because of their effect on steelhead that use the Trout Creek watershed. Over the past years of monitoring water temperatures, peak summer temperatures in Hemlock Lake have been found to exceed levels that are lethal to steelhead (USDA 1996). Trout Creek commonly exceeds state water quality standards for temperature and Hemlock Dam is known to affect water temperatures in Hemlock Lake and the lower reaches of Trout Creek. Trout Creek is currently identified as Category 4a on Washington State Department of Ecology’s 2004 Water Quality Assessment (303(d) and 305(b) reports). Category 4a streams are waters that have pollution problems that are covered under an approved Total Maximum Daily Load (TMDL). The approved TMDL that was completed for the Wind River watershed recommends removal of Hemlock Dam as one measure that would improve temperature conditions in Trout Creek (WDOE 2002).

Analysis scale

This effects analysis covers Trout Creek and reaches of the Wind River that lie downstream of Hemlock Dam. The analysis extends to the mouth of the Wind River on the Columbia River. The analysis is bounded there because the significantly larger volumes of water in the Columbia River exert overriding control over water temperatures in that system, and any temperature effect of Hemlock Lake would be entirely overwhelmed by thermal conditions in the Columbia River. The analysis considers the direct, indirect, and cumulative effects of each alternative on peak water temperatures, and focuses on effects occurring from the present through 20 years beyond the implementation of this project.

Methodology

The temperature analysis is conducted by using both an empirical approach based on over a decade of monitoring water temperatures in Trout Creek and the Wind River and by modeling temperature conditions throughout Trout Creek using the Qual2k temperature model (Chapra 2001) and following WDOE (2002).

4.1.1.1. Alternative A – No Action

Summary

Under this alternative, the dam would remain in place. No changes to the structure or operations of the dam or its appurtenances would be planned. There would be no immediate change to the water temperature regimes of Hemlock Lake or lower Trout Creek. The dam would continue to contribute to heating of water in Hemlock Lake and lower Trout Creek, and water temperature standards would continue to be exceeded frequently during the summer months. Fish occupying the reservoir during the summer would continue to be exposed to extended periods of high water *temperatures. The effect of the dam on water temperatures is cumulative with the heating that occurs in the upper watershed as a result of poor riparian shade, wide channels, and the presence of wide, shallow exposed water surfaces in that area. The heating that occurs in the reservoir and lower reaches of Trout Creek would also be cumulative—but working in opposition—to improvements in water temperature that are being sought through active and passive restoration of channels and riparian areas in the upper watershed.*

Direct and Indirect Effects

Reservoir and Lower Trout Creek

Under this alternative, the dam would continue to impound water and expose that water to prolonged periods of direct solar radiation. This would continue to increase water temperatures in the reservoir and in lower Trout Creek during the summer months. The increased temperatures result from the slowing and widening of Trout Creek as it flows through the reservoir reach and are compounded by the shallowing of the reservoir that has occurred over time from sediment buildup. Mid-summer peak temperature peaks in lower Trout Creek would continue to be out of phase with other reaches of Trout Creek or the Wind River (as described in Chapter 3). Peak temperatures would occur in evening hours instead of the late afternoon in lower Trout Creek and diurnal temperature fluctuations would continue to be reduced.

Maximum temperatures within the reservoir have been measured at several degrees higher than temperatures in the upstream reaches of Trout Creek, and average temperature increases through the reservoir are in the range of 2°C. Modeling by the State of Washington (WDOE 2002) indicates that the temperature increases within the reservoir could be as great as 6°C under extreme flow and weather conditions. With the reservoir remaining in place, observed increases in maximum stream temperature would be expected to continue at approximately the same levels.

In the short term, water temperature characteristics of Hemlock Lake or of lower Trout Creek would not change as a result of this alternative being implemented. Peak summertime water temperatures in Trout Creek would continue to exceed the state water quality standards at a relatively high frequency. During periods of high air temperature and low summer streamflow, water temperatures in Hemlock Lake would exceed levels that are lethal to steelhead.

Over time, trees growing along the margins of the reservoir would get taller, providing increased shade to the reservoir. However due to the breadth of the reservoir, the water surface would continue to be largely unshaded during the warmest parts of the day. Sediment would continue to accumulate in the reservoir and on the delta and islands. Overall, the depth of the reservoir would continue to slowly decrease as a result of sediment deposition.

Over the longer term, temperatures in the reservoir may continue to rise slightly as a result of continued buildup of sediment. As the depth and areal extent of the deep pools in the reservoir are reduced by accumulation of sediment, these areas of thermal refugia would also be eliminated or made less effective. However, because the sediment buildup in the reservoir appears to be occurring at a very slow pace, the rate of change in temperature in the reservoir is expected to be small if even perceptible over the next one to two decades. Also, as channels in the upper watershed recover from past disturbances through a combination of active and passive restoration, peak water temperatures throughout Trout Creek should begin to decline. This would be a long term, gradual effect and although it would lead to lower water temperatures throughout Trout Creek, the reservoir itself would continue to be a source of heating to the waters of lower Trout Creek. As upstream temperatures are reduced over time, temperature increases in Hemlock Lake could become greater because currently the temperature increase through the reservoir is partly limited by the extremely high temperatures of Trout Creek as it enters the reservoir and the resultant evaporative cooling effects that occur.

Fish would continue to be exposed to excessively high temperatures in Hemlock Lake and throughout much of lower Trout Creek during mid and late summer months. A small number of deep pools that could offer thermal refugia to fish exist within the reservoir, but due to the limited area of these, any fish seeking them out would likely be forced to share that space with a high density of other fish, and as a result would be exposed to increased competition, stress, and potentially disease. Juvenile fish occupying Hemlock Lake during mid and late summer would be at the greatest risk of exposure to the high temperatures, and the duration of their exposure may be lengthened by difficulties in finding the downstream outlet of the reservoir. Although there has been no documentation of fish mortality related to the high temperatures in Hemlock Lake, laboratory studies have found that steelhead will die if exposed to temperatures similar to those occurring in Hemlock Lake if exposure is continued for an extended period (Bell 1987). Moreover, sub-lethal effects including increased stress, disease, and decreased vigor may be occurring in fish that are exposed to prolonged periods of high temperatures within the reservoir. These effects to fish would be more difficult to detect.

Fish in lower Trout Creek (below Hemlock Dam) would also be exposed to sustained periods of high temperatures because of the lack of nighttime cooling that occurs in that reach. The fish in lower Trout Creek would also continue to be exposed to daily temperature peaks that are out of phase with those occurring elsewhere in the aquatic system. As described elsewhere in this document, temperature peaks in lower Trout Creek occur in the late evening hours instead of during the late afternoon. The effect of this on fish is not known but since the feeding, resting, and migration of steelhead are influenced by both light and temperature, this unusual thermal condition could be detrimental to the fish occupying this reach during the summer period. The combination of excessively high temperatures, lack of diurnal cooling in this lower reach, and the shift in phase for the timing of temperature peaks would provide for decreased oxygen to the fish and therefore increase stress and decrease survival and production potential.

Lower Wind River

Temperatures in the Wind River would not be changed from current conditions as a result of implementing this alternative. The Wind River has a significantly larger flow than Trout Creek in the summer months and temperatures of Trout Creek flows play only a minor role on temperatures of the Wind River. Preliminary results of temperature monitoring in the Wind River indicate that although Trout Creek has higher temperatures than the Wind River, there is no measurable heating of the Wind River by Trout Creek waters. This is in part because the Wind River discharge is that much greater than Trout Creek, but also because the Wind River receives numerous distributed inflows of cooler water through the canyon reach bracketing the mouth of Trout Creek.

Fish occupying the Wind River would not likely be affected by implementing this alternative because of the greater volume of flow there and lower peak temperatures in that larger system.

The onsite and offsite effects are considered long term in that they would persist for as long as the dam remains in place and continues to be operated as it is currently.

Cumulative Effects

Implementing of this alternative would allow for continued heating of Trout Creek as it flows through Hemlock Lake. This contributes to a cumulative increase in temperature that begins in upper Trout Creek and occurs throughout much of the length of Trout Creek. Some of the heating that occurs in Trout Creek comes about naturally without human caused disturbance and some is related to past management activities in upper Trout Creek and the manifestations of those actions. Refer to Table 3-20 for the list of past, ongoing, or reasonably foreseeable future actions that have been considered in the cumulative effects analysis. Some of these action or types of actions have affected or have the potential to affect temperature in Trout Creek or the Wind River.

Heating that occurs in Hemlock Lake is additive to the heating that occurs in the upstream reaches of Trout Creek (Figure 4-2). This contributes to the excessively high temperatures in lower Trout Creek during summer months. The diagram shows that some of the greatest rates of temperature increase in Trout Creek occur in the upper Trout Creek Flats and in the short reach that includes Hemlock Lake.

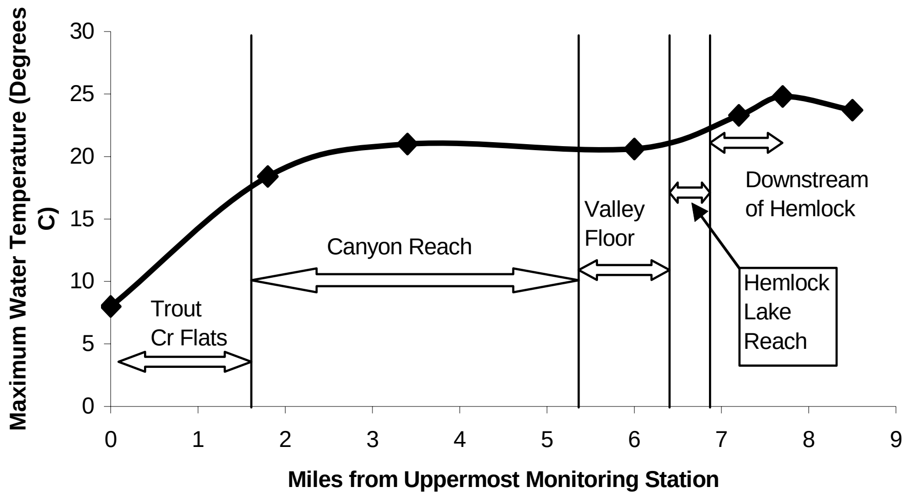

Figure 4-2. Cumulative heating of Trout Creek from headwaters to its mouth. Upstream is to the left, downstream is to the right. Data are from July 23, 2003.

Temperatures in Trout Creek increase from the headwaters to Hemlock Lake (Figure 4-2). The cumulative and incremental effect of Hemlock Dam is clearly evident as it forms the highest peak on the chart. The general trend toward higher temperatures in downstream reaches of Trout Creek is likely to persist over time under any alternative and represents the cumulative effect of natural and management related factors along Trout Creek and its tributaries. Under this alternative, the small cumulative increase in temperature at Hemlock Lake would be expected to persist as well and perhaps to increase over time as sediment levels increase in the lake.

The net cumulative effect of this alternative on steelhead would be a continuation of the increased stress, reduced survival, and lower production potential in both Hemlock lake and in the lower reaches of Trout Creek. This is a long term effect that would continue for as long as the dam is in place. It is not expected to have a measurable effect on survival, growth or migration of federally listed fish at the mouth of the Wind River.

4.1.1.2. Alternative B

Summary

Under this alternative, the dam would be removed and a small pilot channel would be constructed through the area now occupied by the reservoir. Sediments in the reservoir would be eroded downstream as the stream carved a new channel through the reservoir reach. Implementation of this alternative would affect water temperatures both in the immediate vicinity *of Hemlock Lake as well as in downstream reaches of Trout Creek. The magnitude of heating through the reservoir reach would decline to some extent in the short term and to a greater extent over the long term. Because water temperatures in Trout Creek continue to be affected by the cumulative effects of past riparian harvest, road development, and channel modifications in the upper watershed, the decreased heating brought about by implementing this alternative would not bring peak summer temperatures into compliance with state water quality standards. But this alternative would decrease the potential for water temperatures to reach levels that are lethal to steelhead in the reservoir reach and in lower Trout Creek. Also, over longer periods of time, implementing this alternative would work in concert with ongoing efforts to reduce peak temperatures throughout Trout Creek.*

Direct and Indirect Effects

Onsite

Peak water temperatures in Trout Creek currently increase by approximately 1.5 – 2.0°C in the reach now occupied by the reservoir. If the reservoir is removed, peak water temperatures would change in this reach of Trout Creek as a result of the transformation of the reservoir to an active stream.

During the first one-to-three years of active channel development and adjustment there would be little vegetative cover developing immediately adjacent to the water on the newly formed streambanks. The extent of heating that occurs through the reservoir currently would be reduced slightly during this period. The changes would result from the elimination of the broad exposed surface of the reservoir but would be tempered by the fact that the stream still may have very little shading. Water temperatures during this period would continue to increase in a downstream direction through the reservoir reach but the rate of heating would be reduced. The few deep pools within the reservoir that currently provide thermal refugia for fish would probably be lost as the stream creates a new channel and either abandons those pools, incises through them, or just flushes them regularly enough to eliminate any thermal stratification. It is unknown whether similar pockets of cool water would develop in the newly forming channel.

The reduction in peak temperatures within the reach now occupied by the reservoir would improve conditions for fish by reducing their exposure to lethal temperatures and by reducing their exposure and duration of exposure to temperatures that could have sub-lethal effects. This would begin to occur immediately after the project is completed. Because temperatures are already high and approach lethal levels in the reservoir, a reduction of one or two degrees in peak temperature could directly and indirectly benefit Threatened steelhead and aquatic organisms by reducing disease, stress, and competition.

Over longer time periods, thermal conditions for fish within the reach currently occupied by the reservoir would continue to improve as the new channel stabilizes and begins to develop shade.

Offsite

Removal of the dam and reservoir would immediately allow the timing of daily temperature maximums and minimums in lower Trout Creek to shift back in phase with other segments of Trout Creek and the Wind River. Specifically, daily temperature peaks would shift from the late evening hours to the late afternoon. Diurnal temperature swings would be increased as well, to more closely resemble those found in Trout Creek above the reservoir (see Chapter 3). The importance of these changes is that fish in lower Trout Creek would gain some temporal thermal refugia, whereas currently there is limited overnight cooling in that reach.

Following the period of highly active channel re-establishment, streambanks would be planted with a mix of vegetation to provide erosion control, bank stability, shade to the stream, and ultimately to form a new riparian forest along the newly re-formed channel. It is likely that the channel would begin to experience some shade from the planted vegetation over a period of 10 – 20 years after the trees are established. A fully effective riparian canopy would take decades to develop.

Over the long term, the amount of heating that presently occurs in the reservoir reach would be substantially reduced as a result of eliminating the reservoir, establishment of a stable channel form, and development of shade along the edges of the stream. It is likely that State water quality standards would continue to be exceeded in the future because of the condition of channels and riparian areas in the upper watershed and the time required for those systems to recover. However, it is likely that under this alternative there would be significantly fewer days during which temperatures in the Hemlock Lake reach and lower Trout Creek would exceed levels that are lethal to steelhead.

Comparing modeled water temperatures with and without the dam in place provides an estimate of the degree of increase or decrease to be expected through the reservoir reach. The Qual2K water quality model (Chapra 2001, WDOE 2002) was used for this purpose. Model runs under the current scenario (i.e. with the dam in place) predict temperature increases of approximately 1.1°C through the reservoir under average summer temperature conditions. Modeling of temperatures through the same reach in the absence of the dam result in peak water temperature increases of approximately 0.3°C through the reach (Table 4-1).

Table 4-1. Comparison of predicted peak water temperatures in Trout Creek with and without the dam in place.

	Modeled Peak Temperature Upstream of Reservoir	Modeled Peak Temperature Downstream of Reservoir	Change in Peak Water Temperature
Current Condition (Alternative A)	21.7°C	22.8°C	+1.1°C
Dam Removal (Alternatives B,C)	21.7°C	22.0°C	+0.3°C

The modeled results indicate that without the dam there would be a reduction in heating of nearly one degree Celsius during average conditions. During extreme conditions, such as warm summer days with low streamflows, the modeled reduction in heating would be greater. It is also important to note that the model continues to predict an increase in water temperatures through the reach now occupied by the reservoir, so removal of the dam—although it would decrease the amount of heating that occurs through the reservoir reach—is not projected to cause this reach to experience cooling in a downstream direction unless other conditions are also modified through the process.

Implementation of this alternative is not expected to measurably affect peak water temperatures in the Wind River.

The reduction in daily peak temperatures, the improved nighttime cooling, and the shift of temperature peaks from the nighttime to the late afternoon would benefit fish and other aquatic organisms occupying lower Trout Creek. These fish would experience reduced exposure to excessively high temperatures, reduced duration of exposure to high temperatures, and a return of more normal daily thermal regimes. Although difficult to quantify the resultant effects of this on the fish, the steelhead would presumably benefit from reduced stress, improved vigor and feeding success, and ultimately to healthier fish with improved survival.

The improved conditions for fish in lower Trout Creek would occur immediately after project implementation and would be persistent. Over time, the thermal conditions in this reach should continue to improve as upstream channel and riparian conditions improve.

Thermal conditions for fish in the Wind River would not appreciably change under this alternative because the small decrease in water temperatures in Trout Creek would be obscured by the larger flow volumes of the Wind River.

Cumulative Effects

Implementation of this alternative would reduce the heating of Trout Creek that occurs through the reservoir reach. This effect would be cumulative and would act in concert with past, present, and future restoration projects in the upper Trout Creek watershed, including those listed in Table 3-20 as “restoration” projects occurring in Trout Creek. This effect would also be cumulative, although partially offsetting the effects of projects that have caused temperatures to increase in Trout Creek. These include past timber harvest in riparian areas of upper Trout Creek that began in the 1940’s and 1950’s and also includes stream cleanout activities through the 1980’s and road construction that has occurred in the watershed through the past several decades. The net effect of implementing this alternative would be to incrementally reduce the peak temperatures found in Hemlock Lake and lower Trout Creek. Over the long term, the reduction in peak temperatures brought about by this project would be enhanced as upstream restoration activities begin to yield improved water temperatures in upper Trout Creek.

By reducing peak water temperatures in lower Trout Creek, this alternative would increase the amount of oxygen available to fish, reduce stress, and increase survival and fisheries production potential for steelhead using Trout Creek. It is not expected to have a measurable effect on survival, growth, or migration of federally listed fish that temporarily use the mouth of the Wind River.

4.1.1.3. Alternative C

Summary

This alternative proposes to remove the dam, dredge reservoir sediments, and construct a channel through the area now occupied by Hemlock Lake. Sediments removed from the area of the constructed channel would be hauled offsite and stabilized in an upland location. The effects of this alternative on water temperature would be nearly identical to those described for Alternative B except that temperature reductions would occur up to several years sooner under this alternative due to the fact that the streamside vegetation would be established more quickly.

Direct, Indirect and Cumulative Effects

The only substantive difference between Alternatives C and B is that under Alternative C, the period of time and the significance of channel adjustments following dam removal would be reduced because the channel would be constructed in a stable configuration and location. As a result, establishment of riparian vegetation and channel shading may begin to occur up to several years earlier than under Alternative B. All other effects to water temperature would be the same as described for Alternative B.

Under this alternative, water temperature effects to fisheries would be identical to those described for Alternative B, except that shade would be developed slightly sooner in this alternative so longer term improvements in water quality may occur earlier.

4.1.1.4. Alternatives D and E

Summary

Alternatives D and E both propose to leave the dam in place and to dredge sediments from the reservoir to increase depth and decrease heating within the reservoir. Because there is no material difference between the two alternatives in terms of how water is impounded or routed through the reservoir, there is also no difference between the two alternatives in terms of their effects on peak water temperatures. Any deep areas in the reservoir created by dredging are expected to be refilled relatively rapidly by additional sediment deposits from Trout Creek so both alternatives also include periodic re-dredging of the reservoir to maintain depth. In the intervals between dredging, the sluice gate on the dam would be opened annually to route sediments past the dam and to maintain some of the depth in the reservoir that was created by dredging.

Under both alternatives, the deepened reservoir created by dredging is expected to reduce the extent of heating through this reach and increase the areas of thermal refugia for fish occupying the reservoir in the summer months. The extent of the improvement will depend in part on the degree to which water routing through the reservoir is changed after dredging and the period of time it takes for dredged areas to begin refilling with sediment. Immediately after dredging it is likely that the average temperature increase through the reservoir would be reduced to nearly the same extent that it is under Alternatives B and C (i.e. reduced by nearly one degree C). But over the course of just a few years this improvement would be lost as the reservoir again shallowed from deposition of material within the deepened portions of the reservoir. The period over which the reservoir would refill with sediment is unknown but would be expected to occur within five to ten years of the initial dredging.

Direct and Indirect Effects

Onsite

In the short term, dredging the reservoir is expected to cause reductions in the amount of heating that occurs through the reservoir. Modeling of temperature conditions throughout Trout Creek indicates that if the reservoir reach were dredged, peak temperatures would be decreased by approximately one degree Celsius in the Hemlock Lake reach (Figure 4-3). This is approximately the same reduction in heating that would be predicted to occur in the immediate aftermath of implementing Alternatives B or C. However, the persistence of the benefits of dredging is a function of the period of time over which it takes for the dredged areas to refill with sediment. Past USFS studies have suggested that it takes only one or two years for deepened areas to refill. The Bureau of Reclamation (BOR) estimated five to ten years for nearly complete refilling of dredged areas (USDI 2004a). In practice it will likely depend on the weather and types of storms and floods that occur following dredging.

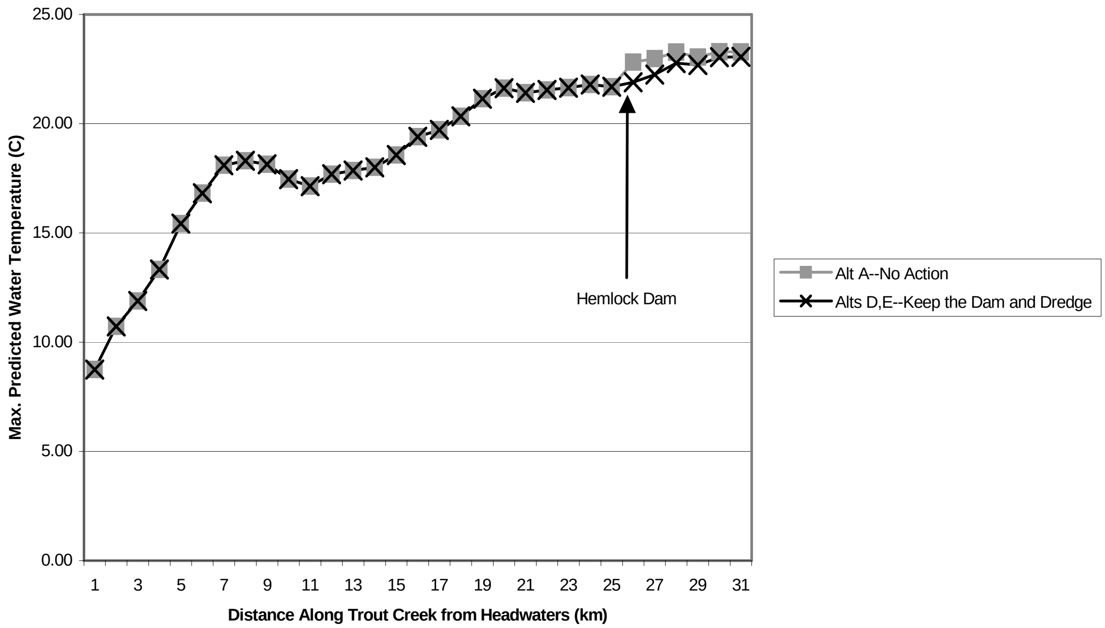

Figure 4-3. Modeled temperature maximums on Trout Creek under Alternative A and Alternatives D and E.

The deep pools that currently exist in the reservoir would be enhanced by the dredging. Thermal refugia provided by these pools is expected to increase simply due to the increased areal extent of the pools that is created through dredging.

In the short term, decreasing water temperature maximums would benefit steelhead in the reservoir by reducing their exposure to high or lethal temperatures and by providing increased areas of thermal refuge within the reservoir. Fish occupying the reservoir would presumably experience reduced disease, stress and competition, and improved vigor. Because the improved fisheries conditions would be directly tied to the increased reservoir depth, the effect would occur immediately after dredging is completed. However, the effect would be reduced annually by sediment deposition occurring within the reservoir, and the associated loss in reservoir depth. The amount of deposition occurring each year would determine how much of the thermal improvement provided by the initial dredging would be lost. The BOR estimates that the dredged reservoir would largely refill within five to ten years of the initial dredging (USDI 2004a) so improved conditions for fisheries would be greatest in the year immediately following dredging but would decline yearly until the next dredging operation occurred.

Offsite

Peak temperatures in lower Trout Creek are expected to be decreased to some extent under this alternative, but because the dam would continue to spill water from the surface of the reservoir, it would continue sending the warmest waters down into lower Trout Creek. Therefore the temperature reduction in lower Trout Creek under this alternative would not be as great as the reduction realized under the dam removal alternatives. In addition, under this alternative the temperature regime in lower Trout Creek would continue to be out of phase with the rest of Trout Creek in that daily temperature peaks would occur in the late evening, and the extent of nighttime cooling would continue to be limited.

Over longer time periods, the dredging would need to be repeated periodically to retain or recapture the temperature benefits of the deepened reservoir. The rate of temperature increase through the reservoir reach differs between the three scenarios (Figure 4-4). The steepest line in the chart indicates the modeled rate of heating through the reservoir under the current condition. The lowest of the lines on the chart shows the modeled rate of heating that occurs immediately following dredging of the reservoir. The intermediate line shows the rate of heating that is predicted to occur after the dredged reservoir has refilled by approximately half the depth that it was initially dredged to.

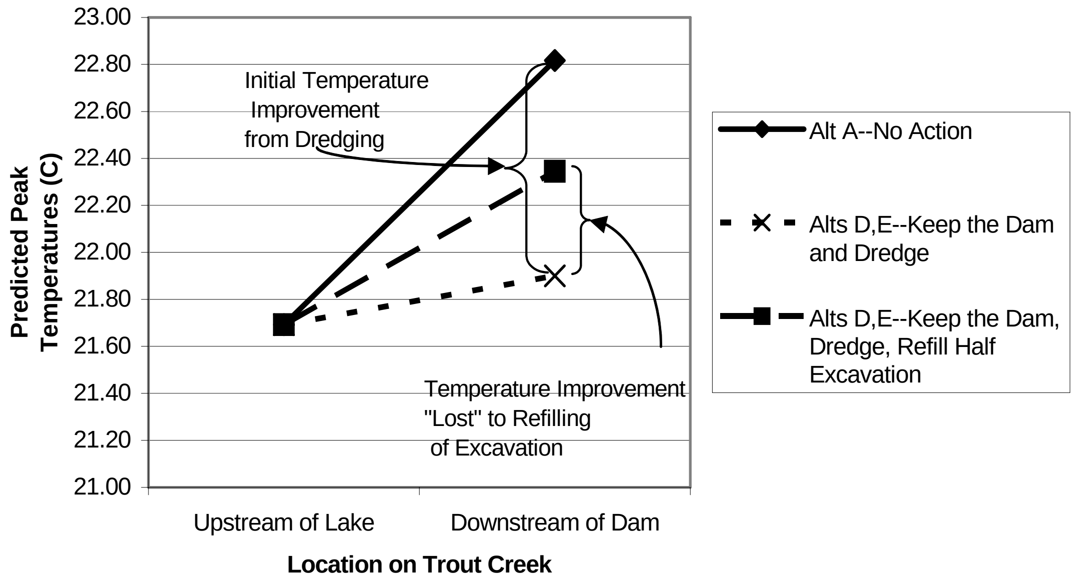

Figure 4-4. Initial improvements in water temperature resulting from dredging, and the amount of improvement that is "lost" when the dredged area of the reservoir refills by half.

The benefits of dredging are closely tied with the processes of sediment deposition and refilling of the dredged areas. As the reservoir refills with sediment, the temperature improvements realized by dredging are lost on a proportional basis. Over longer time periods, the effect of this alternative on water temperatures in the reservoir reach and in lower Trout Creek will depend on the frequency of dredging and the rate at which the reservoir refills with sediment.

Similar to the other alternatives, no measurable effect to water temperatures in the Wind River is expected under this alternative.

Fish occupying the reach downstream of Hemlock Dam would benefit from the reduced peak temperatures brought about by this alternative. However, these fish would continue to be affected by limited nighttime cooling and would continue to experience daily temperature peaks during the late evening hours as described under Alternative A. Although it is not possible to quantify the effects of these alternatives on fish in lower Trout Creek, they are presumed to provide improved conditions relative to the current condition, but would provide less improvement than would occur under Alternatives B or C.

The improved conditions for fish in lower Trout Creek would occur immediately after project implementation and would be reduced annually as the reservoir refills with sediment. After each subsequent dredging (proposed to occur every five to ten years), the improved thermal conditions for fish would return.

Thermal conditions for fish in the Wind River would not appreciably change under these alternatives because the small change in water temperatures in Trout Creek would be diluted and overwhelmed by the larger flow volumes of the Wind River.

Cumulative Effects

Implementation of this alternative would create a series of short term reductions in the heating of Trout Creek that occurs through the reservoir reach, coinciding with dredging efforts. This effect would be cumulative and would act in concert with ongoing, past, and planned restoration projects occurring in the upper Trout Creek watershed, including those listed in Table 3-20 as "restoration" projects. This effect would also be cumulative, although acting in opposition to projects that have caused temperatures to increase in Trout Creek. These include past timber harvest in riparian areas of upper Trout Creek that began in the 1940's and 1950's and also includes stream cleanout activities through the 1980's and road construction that has occurred in the watershed through the past several decades. The net effect of implementing this alternative would be to incrementally reduce the peak temperatures found in Hemlock Lake and lower Trout Creek. Over the short term, the net change in peak temperature in lower Trout Creek would be similar to the levels achieved under Alternative B or C, but as the reservoir refilled with sediment, would reflect conditions more similar to Alternative A. Over the long term, the reduction in peak temperatures brought about by this project is estimated to be less than would be achieved under Alternatives B and C and would be variable, depending on the frequency of re-dredging and the rate at which the dredged reservoir refills with sediment.

Effects to fisheries would similarly fluctuate with the levels of sediment in the reservoir and periods of dredging. Immediately following dredging, the effects would be similar to those described under Alternatives B and C and in subsequent years as sediment refilled the reservoir, effects would shift to reflect those described under Alternative A.

4.1.2. Water Quality—Suspended Sediment

Relationship to Purpose and Need and Significant Issues

As stated in Chapter 1, a part of the primary purpose is to improve water quality and habitat conditions in Trout Creek in the vicinity of Hemlock Dam.

The effect of sediment deposition and increased suspended sediment (turbidity) were included in the significant issue "Sediment release into Trout Creek and Wind River and Effects to Fish". These subjects were analyzed separately. The Measurement Methods related specifically to turbidity are:

- Predicted changes in turbidity in the reservoir and downstream of the dam
- Predicted turbidity effects to fish habitat

Regulatory Framework

Regulatory and legal requirements that direct watershed management include the Clean Water Act (CWA), Section 303, 319, and 404. Federal law requires that streams, rivers, lakes, and estuaries be managed to meet water quality standards. A comprehensive approach for protecting water quality includes developing TMDLs (total maximum daily loads) for both point and nonpoint sources.

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Through the Northwest Forest Plan Standards and Guidelines, Forest Service policy also directs that water quality objectives be met. The Aquatic Conservation Strategy (ACS) was incorporated into the Northwest Forest Plan (and thereby amended Forest Plans within the range of the northern spotted owl) to “protect salmon and steelhead habitat on federal lands managed by the Forest Service and Bureau of Land Management within the range of Pacific Ocean anadromy.” The activities proposed by these agencies must not “retard or prevent attainment of” ACS objectives at the fifth-field watershed scale. Specifically, Objectives 4 and 5 refer to water quality.

4. Maintain and restore water quality necessary to support healthy riparian, aquatic, and wetland ecosystems. Water quality must remain within the range that maintains the biological, physical, and chemical integrity of the system and benefits survival, growth, reproduction, and migration of individuals composing aquatic and riparian communities.

5. Maintain and restore the sediment regime under which aquatic ecosystems evolved. Elements of the sediment regime include the timing, volume, rate, and character of sediment input, storage, and transport.

Turbidity and/or suspended sediment levels are important because they are regulated by the Washington State Department of Ecology under provisions of the Clean Water Act, and because they can affect the health of fish and other aquatic organisms. The amount or concentration of suspended material in the water is determined by measurements of either turbidity or suspended solids. In practice, the measures are not interchangeable and typically not well correlated because turbidity is an optical measure of water clarity and suspended solids is a measure of the weight of sediment carried in the water. State water quality standards are established in units of turbidity, yet fisheries agencies and research findings use suspended solids as the definitive measure of the amount of sediment in the water column. In this report, both terms are used due to the availability of data and the need for some estimate of both.

Analysis Scale

This analysis covers the area including Hemlock Lake and extending downstream to the mouth of the Wind River and including the Columbia River in the immediate vicinity of the mouth of the Wind River. Because water quality is affected by all contributing parts of the drainage area, the cumulative effects portion of this analysis incorporates the entire Wind River watershed as a contributing area. The analysis area is bounded at the downstream end by the Columbia River primarily because of the significantly larger volumes of water there, and the effect of that on diluting and reducing effects of turbidity increases.

Methodology

The analysis is done by a combination of methods. The empirical approach is employed to estimate effects based on past measurements of turbidity on local instream projects. A computational approach is also used to quantitatively estimate suspended sediment levels over a range of flow conditions. Project effects are estimated here based on the range of conditions that are typically seen in Trout Creek and the Wind River. Unusual events such as extreme rainstorms and associated flooding could increase the projected sediment and water quality effects of the project.

4.1.2.1. Existing Conditions

Turbidity levels at any given location on Trout Creek are typically correlated with stream discharge levels and disturbances in riparian areas or aquatic environments. Turbidity levels were measured during the winter of 2002 just downstream of Hemlock Dam and show a close correlation with streamflow levels. Figure 4-5 depicts the turbidity levels in Trout Creek from January through March of 2002 at a site just downstream of the dam. During these months, background turbidity levels were quite low but closely tracked the discharge levels through a range of flows.

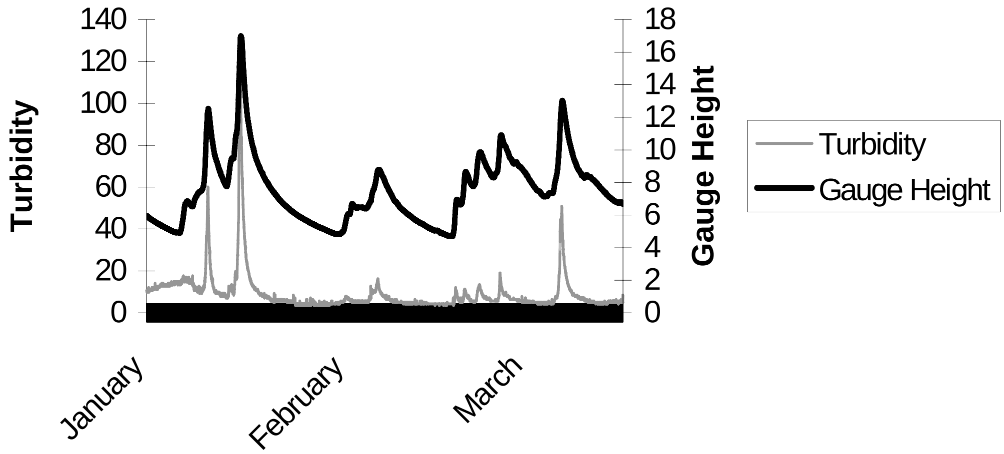

Figure 4-5. Turbidity (NTU's) in Trout Creek and stream gauge height (feet) on the Wind River, January-March, 2002 (USDA 1995–1998, 2002).

In addition to the turbidity changes that occur in Trout Creek from upstream processes, turbidity within the reservoir itself is increased during summer months as a result of swimming and wading activities. During days without any recreational activities, visibility in the water can be up to ten feet or more. Conversely, during periods of high recreational use, and particularly in areas where wading occurs, visibility can be less than a few feet. Although no monitoring has been conducted to evaluate the downstream transmission of these increases in turbidity, it is likely that there would be little evidence of it downstream of the dam. This is primarily because the slow water velocities through the reservoir and the distance between the majority of the recreational activities and the dam allow for settling of the disturbed sediments before water reaches the dam.

4.1.2.2. Alternative A—No Action

Summary

Under this alternative, the dam would remain in place. No changes to the structure or operations of the dam or its appurtenances would be planned. There would be no immediate change to turbidity or suspended sediment levels in Hemlock Lake, Trout Creek, or the Wind River as a result of implementing this alternative. Currently, turbidity and suspended sediment levels in Trout Creek and the Wind River are increased primarily during periods of increased streamflow. In Hemlock Lake, turbidities are also influenced during the summer months by recreational activities within the lake that stir up bottom sediments and cause localized increases in turbidity *within the reservoir. Implementation of this alternative would not cumulatively affect turbidity levels in Trout Creek or the Wind River.*

Direct and Indirect Effects

In the short term, there would be no changes to turbidity or suspended sediment levels in Trout Creek or the Wind River as a result of implementing this alternative. Currently, the dam is highly effective at causing deposition of coarse sediment in the reservoir but does not appear to significantly affect turbidity levels in Trout Creek. Measurements of turbidity from upstream of the reservoir are typically approximately the same as those found immediately below the dam. Since the dam does not appear to appreciably affect turbidity levels in lower Trout Creek, it also would not affect turbidity levels in the Wind River downstream of Trout Creek.

Over the long term, no significant change is foreseen in how the dam influences turbidity in Trout Creek or the Wind River. Within Hemlock Lake, it is likely that the frequency and extent of turbidity increases during summer months would be indexed to levels of public use. If the reservoir becomes more heavily used, it is likely that turbidity levels would increase during the heavy use periods.

Under this alternative fish occupying the reservoir would continue to experience turbidity levels similar to those both upstream and downstream in Trout Creek during the fall through spring period. During the summer months, fish in the reservoir would continue to be exposed to elevated turbidities during periods of high recreational use or they would move to avoid those areas. Increased turbidity levels in the reservoir during times of extensive recreational use may have an indirect short term effect on feeding behavior and respiration of fish.

Because the dam does not have any appreciable effect on downstream turbidity levels, fish in lower Trout Creek and the Wind River would not be affected in any way by turbidity-related effects from this alternative.

Cumulative Effects

Since the dam does not appreciably affect turbidity levels in lower Trout Creek, there are no cumulative effects of this alternative with other restorative or developmental projects in the watershed. Peak turbidity levels that occur in the fall through spring period in Trout Creek are expected to decline over time in response to restoration activities occurring elsewhere in the watershed. This process would be slow, occurring over years and decades and would not be affected by implementing this alternative.

4.1.2.3. Alternative B

Summary

Under this alternative, a pilot channel would be excavated through the reservoir sediments, and the dam would be removed. During all construction activities, Trout Creek flows would be piped around the construction area. When construction of the pilot channel and removal of the dam are complete, Trout Creek would be introduced to the pilot channel and would begin to erode a larger channel and to incise vertically and to expand laterally through the reservoir sediments. Suspended sediment levels in the reservoir reach, in lower Trout Creek, and in the Wind River downstream of the mouth of Trout Creek would be extremely high for a period of from days to weeks, depending on streamflow levels. The turbidities generated under this alternative are likely to be of much greater magnitude and to persist for a greater duration than those from any other single source in the watershed during the fall and winter immediately following project implementation. Turbidity levels occurring as a result of implementing this alternative would exceed state water quality standards for periods of from days to weeks, and could have negative *effects to fish and other organisms. Sediments from implementing this alternative would combine with sediments introduced elsewhere in Trout Creek and in the Wind River watersheds to cumulatively increase the turbidity in Lower Trout Creek and the Wind River. The effect would occur primarily in the first year following project implementation, and in subsequent years would decline significantly.*

Direct and Indirect Effects

Onsite

During project activities, Trout Creek flows would be routed past the construction area in a culvert. Any small remaining pools of water within the reservoir, or areas where water is encountered in the excavation would experience increased suspended sediment levels during the actual excavation and dam removal process. However, because these small pockets of water would not be released downstream, the suspended sediment increases caused by the excavation and dam removal activities would be localized and confined to the work area. Over time, the sediment particles in the water column would be expected to fall out of suspension and deposit in the reservoir area. Downstream reaches of Trout Creek and the Wind River would be relatively unaffected by suspended sediment increases occurring during the construction period.

After dam removal and as Trout Creek is introduced into the pilot channel, suspended sediment levels would increase dramatically within the reservoir reach and in downstream reaches of Trout Creek and the Wind River. This would occur as the stream incises down through the reservoir sediments, and erodes laterally to create a larger channel. At any given flow level, it is expected that the stream would incise down to some base level and to some width that would become relatively stable at that flow. The depth and width of the channel in the quasi-stable condition is dependent on streamflow levels and the material encountered as the stream cuts through the sediments. During the active channel erosion, suspended sediment levels in the reservoir reach and in lower Trout Creek and the Wind River would be high. Once the channel reached the depth and width at which the flow was efficiently conveyed and the bed and banks were at some temporary equilibrium condition, suspended sediment levels would decline until the next larger flow event again began eroding a larger and/or deeper channel (USDI 2004a).

To estimate the magnitude of any increases in suspended sediment levels the BOR modeled erosion rates and suspended sediment concentrations over a range of flow conditions. Their analysis found that if Trout Creek flows were introduced to the pilot channel at a flow of 20 cfs (approximately the annual low flow on Trout Creek), suspended sediment levels in Trout Creek would be elevated to approximately 7,000 mg/L and would remain high for a period of from 20 to 50 days if streamflow levels remained constant (Table 4-2).

Table 4-2. Suspended sediment levels and durations predicted under a range of flow conditions on Trout Creek and the Wind River.

Discharge	Average Concentration—Trout Creek (mg/L)	Average Concentration—Wind River (mg/L)	Duration Max (Days)	Duration Min (Days)
20	7,000	1,200	47	23
200	13,000	2,200	4	2
2,000	20,000	3,300	0.5	0.3

At higher streamflow levels, suspended sediment concentrations increase, but the period of time during which sediment levels remain high is reduced. The duration of the high concentrations is dependent upon streamflow levels because at higher flow levels, it would take less time for the stream to erode a channel that reached some equilibrium condition with respect to channel size and slope. The magnitude and duration of suspended sediment concentrations are both important to evaluating the effect of the project on fish.

Effects to Fish

Fish would be removed from the reservoir area prior to work activities, therefore during dam removal and construction of the pilot channel, there would be minimal effects on fisheries in the project area. Following dam removal, construction of the pilot channel and removal of stream diversion structures, Trout Creek streamflows would be directed into the pilot channel and fish in Trout Creek would be allowed to access the project area from upstream and downstream. Fish entering the project area would be exposed to very high concentrations of suspended sediment as the stream begins incising through the reservoir sediments. Most of the fish that enter the project area immediately after introduction of flows to the pilot channel would be expected to exit the area upstream or downstream in attempting to avoid the sediment. Those that choose not to or are unable to find their way out would be exposed to very high concentrations of suspended sediment for the extent of time that they remain in the project area or in lower Trout Creek. This could cause gill abrasion and possibly suffocation and death for any fish remaining for an extended period of time within these areas.

Steelhead mortality rates of 50% or more have been found in laboratory studies in which the fish were exposed to suspended sediment concentrations of 11,000 mg/L for a continuous 96-hour period (Bash, *et al*. 2001). Under this alternative, suspended sediment concentrations in the project area and lower Trout Creek are generally predicted to occur at lower concentrations for longer periods, or higher concentrations for shorter periods than those summarized in the Bash report. Therefore, we expect that fish exposed to the full magnitude and duration of sediment concentrations predicted under this alternative may have similiarly high rates of mortality. However, the actual exposure time for fish under this alternative would be dependent on the extent to which fish remain in the affected area or move away from the plume, and the extent to which they are able to find refuge within the channel (i.e. at seeps, springs, upwellings, or tributaries). Fish remaining in the immediate area of project activities are less likely to find such refugia than those who move upstream or downstream. The actual number of fish remaining in the area and exposed to extremely high concentrations or extended periods of high sediment concentration is unknown.

Suspended sediments generated from this alternative would indirectly affect fish and other aquatic organisms downstream of the project area. Approximately two-thirds of the adult steelhead immigration into Trout Creek occurs during the months of September – November (WDFW and USFS unpublished data from the Hemlock Adult Trap 1992 – 2003) when suspended sediment effects would be expected to be the greatest. Snorkel surveys by the WDFW and USFS (1999 – 2003) found an average of 145 adult steelhead in the Wind River below the confluence of Trout Creek during that time of year. In addition, approximately 1,480 fry and 170 parr were found in Trout Creek downstream of the dam (Connolly, *et al.* 2001), and 11,000 fry, 7,250 parr, and 10,600 pre-smolts in the Wind River downstream of the Trout Creek confluence during the fall months (C. Cochran per.com. 2004, Connolly, *et al.* 2001).

As described under the previous section, fish in lower Trout Creek or the Wind River that are exposed to the full duration and magnitude of suspended sediment increases that have been predicted under this alternative could potentially be killed by suffocation. The gills of adult and juvenile steelhead, LCR coho, bull trout, whitefish and sculpin could be overwhelmed and clogged by suspended fine sediment and suffocate. Both adult and juvenile steelhead, rainbow trout and whitefish—which are able to escape but have been exposed to the turbidity plume—may also indirectly die as a result of gill abrasion and subsequent infections.

It is expected that the majority of adult steelhead would avoid the turbid water by moving into nearby tributaries or up the mainstem of the Wind River, or would seek refuge in areas of local upwelling or spring inputs that exist along the lower Trout Creek and Wind River canyons. Coho and chinook salmon and bull trout which occasionally use the lower Wind River, would also avoid the turbid water by migrating into the adjacent Columbia River. Escaping fish would nevertheless be exposed to elevated levels of suspended sediment for some period of time, which could cause gill abrasion and indirect mortality. Assuming a run size of 50 fish in Trout Creek, approximately 33 adult steelhead could be affected by elevated suspended sediment concentrations, which could impede their migration into Trout Creek. Juvenile steelhead, sculpin, sub-adult rainbow trout and whitefish would be at the greatest risk of not escaping and would be more likely to be subjected to direct effects and mortality in lower Trout Creek.

Effects to Other Federally Listed Stocks

This alternative has the potential to affect the following federally listed fish species which are found seasonally near the confluence of the Wind River/ Columbia River (RM 152 – 154): Lower Columbia River (LCR), Snake River (SR), Upper Columbia River (UCR), Mid-Columbia River (MCR) steelhead (*Oncorhynchus mykiss*), SR (spring, summer and fall races), UCR spring, LCR chinook salmon (*Oncorhynchus tshawytscha*), Columbia River (CR) chum salmon (*Oncorhynchus keta*), SR sockeye (*Oncorhynchus nerka*) and LCR coho salmon (*Oncorhynchus kisutch*), and bull trout (*Salvelinus confluentus*).

In the short term, increased levels of suspended sediment at the mouth of the Wind River and in the Columbia River (RM 152 – 154) may impact federally listed fish stocks. All of the actions under this alternative would occur with in Trout Creek and Hemlock Reservoir, which is within critical habitat for LCR steelhead. This alternative could also affect critical habitat for LCR chinook in the lower Wind River (RM 2 – RM 0) and has the potential to affect designated critical habitat within the Columbia River between RM 154 – 152.

Most of the fish listed above would not be affected by this alternative because they are not using the habitat near the mouth of the Wind River during the time of the greatest impacts. The effect to those fish actually using the habitat at the time of the impacts would primarily be displacement as the fish move to avoid the turbid waters.

Cumulative Effects

This alternative would cumulatively affect suspended sediment levels in Trout Creek and the Wind River, when the direct and indirect effects of this project combine with the effects of other past, present or future projects in the Wind River watershed.

Existing Cumulative Effects of Other Projects

A listing of the projects or project types most likely to affect or to have affected suspended sediment levels in Trout Creek or the Wind River are listed in Table 3-20. Although specific data is lacking for the effects of each project listed, the sum effect of the past projects and activities in the watershed can be generalized as increasing suspended sediment levels over time in both Trout Creek and the Wind River. This is a result of long term effects of past actions on stream channels, and persistent effects of existing road systems and other developed areas including those used for agriculture, residential, commercial, or recreational uses. The combination of current activities that generate sediment, and those projects or activities that are scheduled to occur, are likely to continue the elevated levels of suspended sediment in streams within the Wind River watershed.

General Trends

A downward trend in suspended sediment is projected over time for streams draining national forest lands as a result of the decrease in logging, road construction, and other developmental projects, and the increase in restoration-related activities. In streams draining non-national forest lands, there is probably not a strong downward trend since development continues to occur and may even be increasing within specific areas. Although these are the general trend projections, the year-to-year or event-by-event variability in suspended sediment levels can be high due to specific projects (such as the reconstruction of Carson Golf Course and other relatively large scale developmental projects), or due to particularly significant floods, landslides, and road failures.

Cumulative Effects of This Alternative

Implementation of this alternative would cause significant short term increases in suspended sediment as described in the preceding analysis of Direct and Indirect Effects. The direct and indirect effects of this project on suspended sediment in Trout Creek and the Wind River would be cumulative and additive to sediment-related effects of logging and developmental projects identified in Table 3-20 and would partially counteract some of the effects of the restorative projects (also listed in Table 3-20). The net cumulative effect would be a very large increase in suspended sediment in lower Trout Creek and the Wind River in the first one to two years following project implementation. During this time period, the effects of this project would probably overwhelm any other source of suspended sediment in the watershed—particularly during the first year following dam removal, and most acutely during the fall months immediately following dam removal. From three to five years after project completion, suspended sediment levels would be significantly lower than in the first year of project implementation, but may still be somewhat elevated. After five years, suspended sediment levels would decline to near background levels in both Trout Creek and the Wind River. Over the long term, suspended sediment levels in Trout Creek and the Wind River would return to approximately the same levels that occur today, and on a similar trend.

4.1.2.4. Alternative C

Summary

Under this alternative the dam would be removed and a channel constructed through the area now occupied by the reservoir. During construction Trout Creek flows would be piped past the work area to minimize sediment introduction during construction. Following construction of the channel and removal of the dam, Trout Creek flows would be introduced to the new channel. During the initial period when Trout Creek is flowing through the new channel, sediment from the channel bottom would be entrained in the flow and suspended sediment levels in the reservoir reach, lower Trout Creek, and the Wind River would be increased.

Because the channel would be constructed to its final form, grade and location, the extent and duration of channel adjustments following construction work would be much lower than under Alternative B. As a result, this alternative would generate much lower levels of fine sediment, and the duration of suspended sediment increases would be significantly lower than described under Alternative B.

Implementation of this alternative would cumulatively increase suspended sediments in Trout Creek and the Wind River, but the increase would only occur over a period of hours before dropping back to near background conditions. At successively higher flows suspended sediment levels would again increase for short periods as the stream continues to erode fine sediments from its bed and banks.

Direct and Indirect Effects

During project activities, Trout Creek flows would be routed past the construction area in a culvert. Any small remaining pools of water within the reservoir, or areas where water is encountered in the excavation would experience increased suspended sediment concentrations during the actual excavation and dam removal process. However, because these small pockets of water would not be released downstream, the increases in suspended sediment caused by the excavation and dam removal activities would be localized and confined to the work area. Over time, the sediment particles in the water column would be expected to fall out of suspension and deposit in the reservoir area. Downstream reaches of Trout Creek and the Wind River would be relatively unaffected by suspended sediment increases occurring during the construction period.

After dam removal and as Trout Creek is introduced into the new channel, suspended sediment levels would increase within the reservoir reach and in downstream reaches of Trout Creek and the Wind River. This would occur as the finer-grained sediments from the newly constructed channel are eroded and entrained in the flow of Trout Creek. Suspended sediment levels would rapidly peak as water is introduced to the new channel but then would recede. Actual peak concentrations are unknown but are expected to be above the range of suspended sediment that would normally occur in Trout Creek during this time of year. Peak levels would be a function of the streamflow levels at the time of rewatering and the size and amount of exposed substrate on the bed of the new channel. Monitoring results from other nearby projects in which channels were severely disturbed or reconstructed suggest that turbidity levels (used here as an indicator of suspended sediment concentrations) would peak immediately following rewatering of the channel and could be measured at hundreds of NTU’s or more in the immediate vicinity of the channel work. This peak would be very short lived, with the rise and fall estimated to occur over a period of hours before returning to near background conditions.

The pulse of suspended sediment from the rewatering would be conveyed downstream through lower Trout Creek and the Wind River. Because of the high gradient of these systems, much of the material suspended in the water column could be expected to remain in suspension as it travels throughout these lower reaches of Trout Creek and the Wind River. However, at each tributary junction or point of increased stream discharge, the flow of Trout Creek would be further diluted, decreasing the suspended sediment concentrations. Dilution effects of the Wind River and other downstream tributaries would reduce suspended sediment concentrations near the mouth of the Wind River to approximately one-tenth of the levels found in Trout Creek below the dam.

Within hours of rewatering, suspended sediment concentrations in lower Trout Creek would return to near pre-project levels. Each successively larger flood that occurs on Trout Creek following dam removal and rewatering of the channel would again increase suspended sediment levels in lower Trout Creek and the Wind River. During these events, suspended sediment levels would be greatest as the flood peak approached, and would return to near background levels as the flood flows subsided.

Effects to Fish

Fish would be removed from the reservoir area prior to work activities, thus during dam removal and construction of the channel there would be minimal effects on fisheries in the project area. Following dam removal, construction of the channel and removal of stream diversion structures, Trout Creek streamflows would be directed into the newly constructed channel and fish in Trout Creek would be allowed to access the project area from upstream and downstream. Fish entering the project area would be exposed to very high concentrations of suspended sediment during the first hours following watering of the channel. Most of the fish that enter the project area immediately after introduction of flows to the newly constructed channel would be expected to exit the area upstream or downstream in attempting to avoid the sediment. Those that choose not to or are unable to find their way out would be exposed to very high concentrations of suspended sediment for a short period of time (up to several hours). This could potentially cause gill abrasion or other serious harm. Because the pulse of high concentrations of sediment is expected to be of very short duration, it is likely that most all fish would simply avoid the plume or swim out of it quickly.

Suspended sediments generated from this alternative could also indirectly affect fish and other aquatic organisms downstream of the project area. Approximately two-thirds of the adult steelhead immigration into Trout Creek occurs during the months of September – November when suspended sediment levels would be the greatest. Snorkel surveys by the WDFW and USFS (1999 – 2003) found an average of 145 adult steelhead in the Wind River below the confluence of Trout Creek during that time of year. In addition, approximately 1,480 fry and 170 parr were found in Trout Creek downstream of the dam (Connolly, *et al.* 2001), and 11,000 fry, 7,250 parr, and 10,600 pre-smolts in the Wind River downstream of the Trout Creek confluence during the fall months (C. Cochran per.com. 2004, Connolly, *et al.* 2001).

It is expected that the majority of adult steelhead in lower Trout Creek and the Wind River would avoid the short term increase in suspended sediment by moving into nearby tributaries, moving up the mainstem of the Wind River, or by seeking refuge in areas of local upwelling or spring inputs that exist along the lower Trout Creek and Wind River canyons. Coho and chinook salmon and bull trout which occasionally use the lower Wind River, would also avoid the turbid water by migrating into the adjacent Columbia River. Escaping fish would nevertheless be exposed to elevated levels of suspended sediment for some period of time. Because the increases in suspended sediment are projected to be relatively short term under this alternative, they are not expected to negatively affect steelhead, adult chinook or juveniles in the Wind River below Trout Creek or at the mouth.

Effects to Other Federally Listed Stocks

As previously discussed, listed stocks of fish temporarily occupy the lower Wind River and/or the Columbia River RM 154 – 152. However fine sediment and turbidity increases generated by this alternative within the lower Wind and Columbia River would be expected to be very low and would occur during the normal high turbidity period (November – February). Any avoidance behavior exhibited by fish would be characterized as “normal” since the turbidities from the Wind River are normally high during this period.

In addition, the levels of sediment and turbidity would be substantially less than what was described in Alternative B and would not be expected to be outside the range of conditions experienced in the lower Wind River or Columbia River. Therefore, increases in turbidity from the project actions would not be expected to affect migration or rearing of listed fish stocks near the mouth of the Wind River.

Cumulative Effects

This project has the potential to cumulatively affect suspended sediment levels in Trout Creek and the Wind River when the direct and indirect effects of this project combine with the effects of other past, present or future projects in the Wind River watershed. The existing effects of other projects in the watershed in terms of suspended sediment, and a characterization of the general trend in suspended sediment levels are provided in the Cumulative Effects analysis for Alternative B.

Implementation of this alternative would cause small and short term increases in suspended sediment as described in the analysis of Direct and Indirect Effects. Those direct and indirect effects would be cumulative and additive to the suspended sediment effects of logging and developmental projects identified in Table 3-20 and would partially counteract some of the effects of the restorative projects listed in the Table. The net effect would be a very small and short term (i.e. one year) increase in suspended sediment in Trout Creek, after which suspended sediment levels would return to approximately the same level and same trend as exists currently. In the Wind River the cumulative effects of this alternative would be reduced due to the larger volume of flow and sediment normally carried by the Wind River.

4.1.2.5. Alternatives D and E

Summary

Both of these alternatives would leave the dam in place but dredge much of the reservoir. The fish ladder would also be reconstructed under Alternative D, but left and repaired under Alternative E. There would be no appreciable difference in effects between these two alternatives in terms of their effects on turbidity or suspended sediment. During the dredging activities Trout Creek flows would be piped past the work area to minimize direct effects of construction on water quality. Similarly, during construction work on the dam and fish ladder, all work would be done in dry conditions by routing Trout Creek around the work area. Following dredging and dam upgrades, operation of the sluice gate would be re-initiated during winter months to coincide sluicing with high streamflows and periods when suspended sediment levels are normally increased in Trout Creek.

Suspended sediment and turbidity levels would increase onsite during project activities, but due to water management onsite, the increases that occur during construction would not be transmitted downstream. After construction activities and during rewatering of the channel suspended sediment levels would increase in lower Trout Creek and the Wind River but would remain high for less than one day. Suspended sediment levels would also be increased during sluicing activities in subsequent winter floods. The extent to which state standards for turbidity would be met during these occurrences is unknown, but would be dependent upon the background conditions at the time, and the effectiveness of the sluicing on increasing the concentration of suspended sediments in lower Trout Creek. Implementation of this alternative would cumulatively increase suspended sediment levels in lower Trout Creek and the Wind River in the short term following construction activities, and over the longer term through annual operation of the sluice gate.

Direct and Indirect Effects

In the near term, suspended sediment concentrations under these alternatives would be far lower in magnitude and of lower duration than for either Alternative B or C. Concentrations would increase under Alternative D primarily during construction of the fish ladder and establishment of the bypass flows of Trout Creek. The increases would result from blasting and excavating associated with the fish ladder construction and also from construction of the coffer dam at the upstream end of the reservoir, installation of the culvert to carry Trout Creek flows and any incidental disturbance associated with the bypass.

During the actual dredging, the main flow of Trout Creek would not be in the work area, thus the only turbid water would be that water that is encountered during excavation. The dam would be used as a temporary settling pond for this water and the embayment on the south side of the reservoir would also be available as a settling area for water pumped out of the excavation. As a result of these measures, suspended sediment levels during construction would be relatively low.

Once Trout Creek flows are returned to the reservoir there would be a brief increase in suspended sediment downstream as any entrained sediments that are not redeposited within the reservoir are routed downstream. The magnitude and duration of this pulse is likely to be small and of short duration.

During winter months, suspended sediment concentrations downstream of the dam would be increased as a result of the re-establishment of sluicing. The degree of increase is not known. However, sluicing would be timed to coincide with periods of high flow and high sediment levels in Trout Creek so that sediment releases paralleled natural processes.

Longer term effects of these alternatives on suspended sediment levels would be similar to those described under Alternative A, except that the result of dredging the reservoir would increase the trap efficiency of the dam. Therefore, downstream suspended sediment concentrations may decrease slightly during non-sluicing periods and during the period of time when the extra depth in the reservoir is retained. As described elsewhere in this document, the full benefit of dredging in terms of deepening the reservoir would only last for a limited period of time, thus any improvement in water quality that occurred as a result of the increased trap efficiency of the dam would be minor and relatively short-lived, coinciding with the persistence of the increased reservoir depths.

Effects to Fish

Fish would be removed from the reservoir area prior to work activities, therefore during reservoir dredging and reconstruction or repair of the fish ladder and other fish passage-related items there would be minimal effects on fisheries in the project area. Following project work, fish and Trout Creek streamflows would again occupy the reservoir. As the reservoir refills with water recently dredged portions of the reservoir are first exposed to the flowing stream and sediments become entrained in the flow. Fish entering the reservoir immediately after project completion could be exposed to increased concentrations of suspended sediment for up to several hours if they remain within the reservoir. However, most of the fish would be expected to exit the area upstream or downstream to avoid the turbid water, or to find areas within the reservoir with relatively clear water. A limited number of juvenile fish could experience gill abrasion and related effects under this alternative. After the first few hours of water introduction to the reservoir, turbidity-related effects to the fish in the reservoir would return to pre-project levels.

As water is reintroduced to the reservoir following project activities, fish downstream of the dam would be exposed to increased concentrations of sediment. This would occur over a period of hours, and due to the relatively low levels of sediment, the limited duration of exposure and the numerous opportunities for avoidance, minimal effects are predicted to occur to the fish in these reaches.

During subsequent periods of high streamflows in Trout Creek, fish in the lower reaches of Trout Creek and the Wind River would be exposed to increased concentrations of suspended sediment when the sluice gate was opened. Since operation of the sluice gate would be limited to the times that the river already had increased concentrations of sediment, the fish would only experience an incremental increase in their exposure, and would not be expected to be harmed by it.

Effects to Other Federally Listed Stocks

Fish temporarily occupying the lower Wind River and/or the Columbia River RM 154 – 152 would be expected to be exposed to very low sediment and turbidity levels except for the annual operation of the sluice gate that would occur during the normal high turbidity period (November – February). Any avoidance behavior exhibited by fish would be characterized as “normal” since the turbidities from the Wind River are normally high during this period.

Periodic dredging would result in levels of sediment and turbidity that would be substantially less than that described for Alternative B or Alternative C and would not be expected to be detectable in the lower Wind River or Columbia River. Therefore increases in turbidity from the project actions would not be expected to affect migration or rearing of listed fish stocks near the mouth of the Wind River.

Cumulative Effects

This project has the potential to cumulatively affect suspended sediment levels in Trout Creek and the Wind River, when the direct and indirect effects of this project combine with the effects of other past, present or future projects in the Wind River watershed. The existing effects of other projects in the watershed in terms of suspended sediment, and a characterization of the general trend in suspended sediment levels in the watershed is provided in the Cumulative Effects analysis for Alternative B.

Implementation of this alternative would cause small and short term increases in suspended sediment as described under the Direct and Indirect Effects analysis. Those direct and indirect effects would be cumulative and additive to the suspended sediment effects of logging and developmental projects identified in Table 3-20 and would partially counteract some of the effects of the restorative projects listed in Table 3-20. The net effect would be a very minor, short term (i.e. less than one month), and repeated (every eight years on average) increase in suspended sediment in Trout Creek, coinciding with periods of dredging and related activities. They would also include increases in suspended sediment levels each winter coinciding with periods of active sluicing. These increases would occur at the frequency of dredging activities and of sluicing activities. Outside of those specific periods, suspended sediment levels in Trout Creek would be at approximately the same level and on the same trajectory as exists currently. In the Wind River, the cumulative effects of this alternative would be nearly imperceptible due to the larger volume of flow and sediment load normally carried by the Wind.

Effects to fish are described under Direct and Indirect Effects.

4.1.3. Sediment Deposition

Relationship to Purpose and Need and Significant Issues

As stated in Chapter 1, a part of the primary purpose is to improve water quality and habitat conditions in Trout Creek in the vicinity of Hemlock Dam. Sediment routing is one aspect of water quality and improving conditions for fish.

Sediment deposition is included in the significant issues “Sediment release into Trout Creek and Wind River and Effects to Fish” and “Downstream Flooding”. The Measurement Methods related to sediment deposition are:

- Predicted sediment deposition timing, location, and thicknesses downstream of the dam
- Predicted effects to fish
- Predicted effects to fish habitat

Regulatory Framework

Regulatory and legal requirements that direct watershed management include the Clean Water Act (CWA), Section 303, 319, and 404. Federal law requires that streams, rivers, lakes, and estuaries be managed to meet water quality standards. A comprehensive approach for protecting water quality includes developing TMDLs (total maximum daily loads) for both point and nonpoint sources.

Lower Columbia River steelhead (as well as other anadromous species, listed in Table 4-7) are listed as Threatened species pursuant to the Endangered Species Act (ESA) of 1973, as Amended, 50 CFR 402 (2000). Federal agencies are prohibited from authorizing any action that will result in the destruction or adverse modification of critical habitat. The ESA also requires the USFS to manage for the recovery of Threatened and Endangered species and the ecosystem on which they depend.

Through the Northwest Forest Plan Standards and Guidelines, Forest Service policy also directs that water quality objectives be met. The Aquatic Conservation Strategy (ACS) was incorporated into the Northwest Forest Plan (and thereby amended Forest Plans within the range of the northern spotted owl) to "protect salmon and steelhead habitat on federal lands managed by the Forest Service and Bureau of Land Management within the range of Pacific Ocean anadromy." The activities proposed by these agencies must not "retard or prevent attainment of" ACS objectives at the fifth-field watershed scale. Specifically, Objectives 3, 4, and 5 refer to sediment routing, deposition, and habitat conditions for aquatic organisms.

3. Maintain and restore the physical integrity of the aquatic system, including shorelines, banks, and bottom configurations.
4. Maintain and restore water quality necessary to support healthy riparian, aquatic, and wetland ecosystems. Water quality must remain within the range that maintains the biological, physical, and chemical integrity of the system and benefits survival, growth, reproduction, and migration of individuals composing aquatic and riparian communities.
5. Maintain and restore the sediment regime under which aquatic ecosystems evolved. Elements of the sediment regime include the timing, volume, rate, and character of sediment input, storage, and transport.

This analysis is provided to evaluate the potential for increased sediment deposition in the project area and downstream reaches of Trout Creek and the Wind River. Deposition of sediment in these areas could affect steelhead as well as other species of fish and other aquatic organisms by burying suitable substrates, eggs or individuals. During project scoping, concerns were also raised about the potential for sediment deposits to affect flooding levels in downstream reaches of Trout Creek and to affect boating access at the mouth of the Wind River. This analysis provides the basis for the fisheries effects analysis and provides a forum for describing the potential effects of sediment deposition on flood levels in Trout Creek and boating at the mouth of the Wind River.

Analysis Scale

The sediment analysis covers the reaches of Trout Creek and the Wind River that lie downstream of Hemlock Dam. The analysis extends to the mouth of the Wind River on the Columbia River. The analysis is bounded there because of the significantly larger volumes of water and sediment in the Columbia River that would overwhelm and obscure any effects from Hemlock Dam removal. The analysis considers the direct, indirect and cumulative effects of each alternative on coarse sediments, and focuses on effects occurring from the present through 20 years beyond the implementation of this project.

Methodology

The sediment analysis is conducted by a combination of methods: 1) analysis of historical air photos; 2) analysis of channel gradients and channel form; and 3) estimates of sediment transport capabilities for Trout Creek and the Wind River. This analysis focuses on the coarser sediments that are more likely to travel as bedload and that would temporarily reside on the channel bottom between periods of movement. Effects of the project alternatives on finer sediments (those sediments that remain suspended in the water column for longer periods of time) are covered under **4.1.2 Water Quality – Suspended Sediments**.

4.1.3.1. Alternative A – No Action

Summary

Under this alternative the dam would remain in place. No changes to the structure or operations of the dam or its appurtenances would be planned. Currently, the dam affects sediment processes within Hemlock Lake and sediment levels in lower Trout Creek and the Wind River. Within the reservoir sediment deposition is increased by the presence of the dam due to the reduced streamflow velocities and the concomitant reduction in stream power. Downstream of the dam, the river is depleted of spawning gravels and larger sediments because a majority of the coarse sediments from upper Trout Creek are deposited and retained in Hemlock Lake. Implementation of this alternative would not change current processes, nor would it immediately change conditions in the reservoir and downstream reaches of Trout Creek or the Wind River. But the continued presence of the dam would cause the existing effects to be extended into the future for the period of time that the dam remains in place. There would be no significant sediment-related cumulative effects of implementing this alternative.

Direct and Indirect Effects

Hemlock Lake

Currently, the dam slows water velocities in Trout Creek causing sediments to deposit within the reservoir and on the delta that has formed at the upstream end of the reservoir. As a result, rates of sediment deposition within the reservoir are higher than in other places in Trout Creek, particularly for sand and larger sized materials. The deposition of large quantities of sands and silts within the reservoir makes that area unsuitable for steelhead spawning and limits the diversity of substrate habitats in the reservoir.

Under this alternative, deposition of sediment and organic material within the reservoir would continue to occur at elevated rates. Erosion and downstream movement of some smaller sediments would continue to occur episodically during larger streamflow events. The total volume of sediment accumulated in the reservoir would be influenced by a combination of streamflow levels, volumes of sediment delivered from upstream, and changes within the reservoir that affect water routing and patterns of deposition. Over the long term, riparian vegetation would continue to develop around the reservoir, stabilizing the upper delta area. The general trend would be toward slow expansion of the bars and delta within the reservoir due to sediment deposition. Over a period of several decades or more, as the reservoir continues to fill in with sediment, the dam would become less effective at trapping sediments behind it and would route more and more material over the dam. This is a very slow process and would not be detectable over the course of the next couple of decades. The BOR (USDI 2004) estimated that at current rates, the delta and bars within the reservoir would continue to grow, reaching the dam crest and completely filling in the reservoir in approximately 240 years.

The continued deposition of sands and silts under this alternative would further bury the coarser materials that provide more diverse and functional substrate for steelhead. Over time, habitat quality for steelhead would continue to decline throughout the reservoir due to the increased proportional area of the reservoir covered by finer sediments.

Trout Creek and the Wind River

Downstream of the dam, lower Trout Creek and the Wind River are indirectly affected by the deposition that occurs within the reservoir because they receive less sediment from upper Trout

Creek than they would receive without the dam in place. The lack of sediment delivery to these lower stream reaches allows for increased hydraulic forces on the streambeds, causing increased erosion of the streambed and banks. The lack of gravel from upstream also leads to very limited areas of gravel or cobble deposition in the channel. These types of deposits are essential for steelhead spawning, hiding and protection during winter floods. In addition, rebuilding of gravel bars and streambanks in the lower reaches is diminished or precluded by the lack of sand, gravel, and cobble replenishment from upstream. Gravel deposits throughout the channel and on bars form important substrates for vegetative development and insect production which provide food for the fish. Continued sequestration of coarse sediments behind Hemlock Dam will affect production potential for steelhead in Trout Creek by limiting aquatic insect production (food for steelhead), reducing hiding cover, and restricting gravels that would provide suitable spawning substrates in lower Trout Creek.

The effects of the dam on sediment processes are most evident in the reservoir and lower Trout Creek. Once Trout Creek joins the Wind River, the restricted sediment supply from Trout Creek is of less consequence throughout most of the Wind River canyon because the Wind River continues to receive sediments from upstream (i.e. non-Trout Creek) sources. Nevertheless, over the 70 years of the dam's life, the restriction of sediments from Trout Creek has to some extent reduced the amount of sediment delivered to the mouth of the Wind River. This effect has actually been beneficial in that the restricted sediment supply from Trout Creek has meant that slightly less sediment is deposited at the mouth of the Wind River. Currently, the mouth of the Wind River is a topic of local concern since rates of sediment deposition there are so high that boating and fishing access are affected and habitat for Eurasion aquatic milfoil, an invasive species, may be increased. The problems at the mouth of the Wind River have been accruing since the construction of Bonneville Dam on the Columbia River which backed water up into the mouth of the Wind River and affected flow rates and patterns of deposition there. Skamania County is currently considering a proposal to dredge the mouth of the Wind River to improve boating access and to reduce the habitat for aquatic milfoil.

Implementation of this alternative would prolong the positive effects of restricted sediment delivery to the mouth of the Wind River. This would be maintained throughout the period that the dam continues to trap and retain sediment.

Cumulative Effects

Land management activities including logging, road construction and stream cleanouts began in the upper portions of the Trout Creek subwatershed as early as the 1950's. These projects led to short and long term increases in sediment delivery to Trout Creek. The riparian logging and stream cleanouts contributed to significant changes in channel conditions in the upper Trout Creek subwatershed which caused increased erosion of channels in Trout Creek and its tributaries. Road systems and the highly disturbed channels have continued to influence sediment levels in Trout Creek over the past several decades. Currently, rates of sediment production in Trout Creek continue to be elevated as a result of these past upstream activities.

More recently, sediment levels in Trout Creek are thought to be decreasing as a result of the active rehabilitation of riparian areas, stream channels and road systems, and the natural regeneration of previously impacted areas. Table 3-20 includes a number of activities that have occurred within the Wind River watershed over the more recent past, and some that may affect sediment introduction to Trout Creek. This alternative would not change the amount of sediment production occurring in the Trout Creek subwatershed but would continue to restrict the downstream movement of this material and in particular, the coarser fraction of the sediment load into lower Trout Creek and the Wind River. As a result, Hemlock Lake would continue to accumulate sediments at elevated, but declining, rates. Lower Trout Creek would continue to be cut off from upstream replenishment of sediments and would continue to experience excessive erosion and limited areas of gravel and cobble deposits which are important to fish and other aquatic organisms. Gravel and cobble inputs from Trout Creek to the Wind River would also continue to be restricted under this alternative.

Assuming the Trout Creek subwatershed produces sediment at similar rates to the rest of the Wind River watershed, sediment yields at the mouth of the Wind River could continue to occur at rates that are roughly 10 to 20% less than they would be by the continued sequestration of Trout Creek sediments behind Hemlock Dam. Recent and ongoing projects on private lands in the lower Wind River watershed (including reconstruction of the Carson Golf Course and expansion of the Carson Hot Springs Resort) are likely to have increased sediment delivery to the lower Wind River. Therefore, although this alternative would continue to restrict Trout Creek sediments from reaching the mouth of the Wind River, the net effect of this project along with other activities in the Wind River watershed may still result in higher sediment loadings at the mouth.

The effects of this alternative on sediment quantity and composition in lower Trout Creek would reduce production potential of steelhead in Trout Creek and the Wind River. This is a long term effect. The effects at the mouth of the Wind River are not expected to measurably affect survival, growth or migration of ESA listed fish at the mouth of the Wind River.

4.1.3.2. Alternative B

Summary

This alternative would remove the dam and allow river processes to create a new channel through the area now occupied by Hemlock Lake. A pilot channel excavated into the existing reservoir bed would direct development of the new channel to what is presumed to be the location of the historic (pre-dam) channel (Figure 4-6). The purpose of this pilot channel would be to shorten the process by which the channel finds its historical (and relatively stable) alignment, thereby reducing the total volume of sediment eroded from the reservoir.

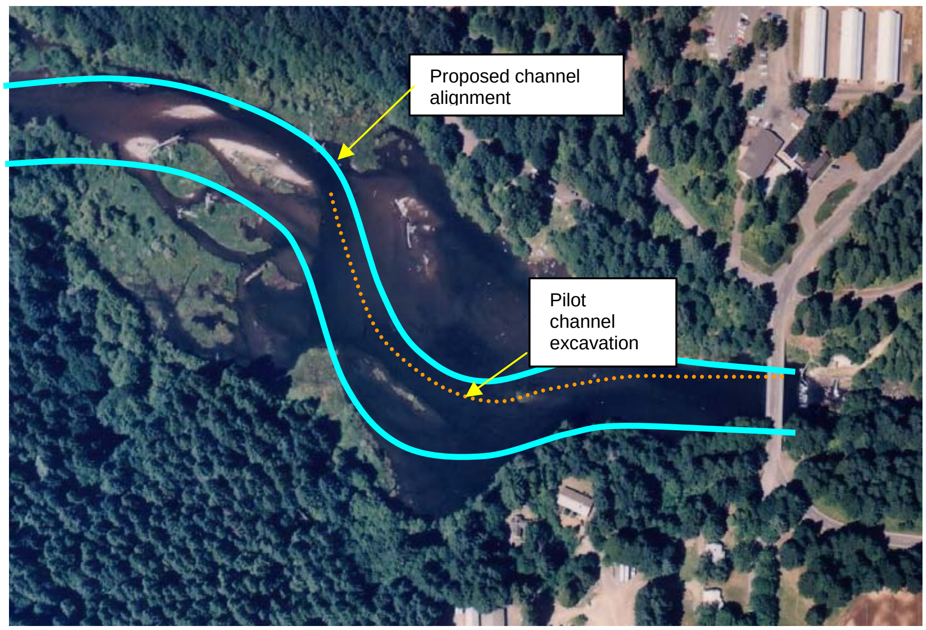

Figure 4-6. Proposed channel alignment and location of the pilot channel.

In the short term, removal of the dam would cause increased erosion in the reservoir, a temporary increase in river bed elevations immediately downstream of Hemlock Dam, and increased deposition of sediment near the mouth of the Wind River. Steelhead spawning would not be affected because the timing of their spawning is offset from the time of most sediment movement, but success of LCR chinook and LCR coho spawning near the mouth of the Wind River and short term quality of critical habitat could be reduced by deposition of fine material over spawning grounds that would occur during the year or two following project completion. Over the long term, the channel through the reservoir would stabilize and provide significantly improved habitat for fish. Fish production in this area would be expected to improve as a result. Downstream of the dam, river bed elevations would return to near current levels, but would have increased levels of spawning gravels, coarse sediment and improved habitat for fish and other aquatic organisms. Sediment accumulation at the mouth of the Wind River would return to near pre-project levels, but would be slightly increased from current levels by resumption of normal sediment routing in Trout Creek. Rates of sediment deposition at the mouth would continue to occur at relatively high rates due to the backwatering caused by Bonneville dam. Spawning success for fish near the mouth would similarly return to pre-project levels.

Direct and Indirect Effects

Onsite

During the initial period following removal of the dam, Trout Creek would incise rapidly through the reservoir sediments. At late summer flows of near 20 cfs, it would take approximately 20 to 50 days for the channel to incise to its base level for that discharge (USDI 2004a). Approximately 7,000 to 14,000 cubic yards of material could be sluiced out during this period and routed downstream. As streamflow levels increase during the fall months, each successively larger flow would further erode the channel bed and banks, increasing the channel dimensions. Over the course of the first year following dam removal, rates of channel erosion would decline. The channel would be expected to reach a relatively stable form within one to three years following project implementation. However, this period would be affected by weather and flow conditions and by the physical conditions encountered during the channel incision and erosion. Once the channel has a grade and location that is relatively stable, bank slopes will continue to work back to stable angles. This process would occur and be influenced by erosion, freeze/thaw activity, and other mechanical forces operating on the banks. During these stream channel evolution processes, critical habitat would be impacted.

The total volume of sediment that would be eroded from the reservoir is dependent upon the pre-dam profile of the channel in the area now occupied by the reservoir and the sequence of channel movements as it finds a stable location and grade. It is estimated that, in total, as much as 38,000 to 60,000 yards of material could be eroded from the reservoir through the channel erosion process (USDI 2004a). As this material is eroded, coarser sediments would be exposed.

Through this process, habitat for steelhead within the reservoir would slowly improve. Over time, the establishment of a free-flowing channel through the area now occupied by the reservoir would expose buried substrates and develop substrate and channel conditions throughout this reach with increased habitat value for spawning, food production, and protection. In the long term, critical habitat in the reservoir would improve.

Direct mortality of aquatic macro invertebrates (aquatic insects) within the project area would also be expected. This impact would extend through the area now occupied by the reservoir and downstream to the mouth of the Wind River. Mortality of macro invertebrates would indirectly limit availability of food and reduce growth of fish. Gersich and Brusven (1981) estimated that full aquatic insect colonization of rock substrates within disturbed areas would take 47 days after turbidity and fine sediment deposition subsides.

Offsite—Lower Trout Creek

Immediately following introduction of flow to the pilot channel, deposition of sediment would begin to occur downstream of the project, from the dam to the mouth of the Wind River. During the first low flow of around 20 cfs, the pools in Trout Creek downstream of Hemlock Dam could all be filled with sand and finer sediments flushed downstream from the reservoir. Sediment deposits in lower Trout Creek and in the Wind River would be temporary due to the high stream power of Trout Creek and the Wind River and the relatively small size of a majority of the sediments in Hemlock Lake. The BOR used an aggradation model to help quantify the predicted effects to Trout Creek (USDI 2004a). The modeling results are presented in detail in the *Sediment Impact Analysis for the Proposed Hemlock Dam Removal Project* (USDI 2004a). Figure 4-7 is an example of one of the scenarios modeled which shows how the depositional peak moves downstream over time at a given flow volume.

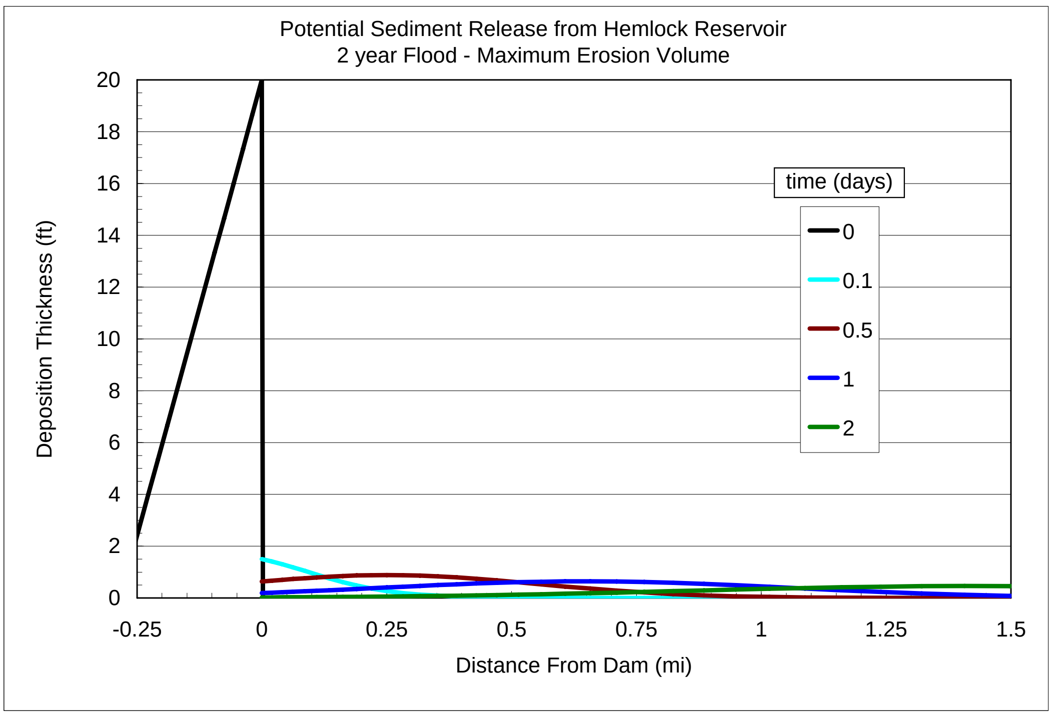

Figure 4-7. Deposition downstream of Hemlock Dam for 2-year flood following dam removal.

Figure 4-7 depicts a scenario in which dam removal is followed immediately by a bankfull streamflow event (approximately two-year recurrence interval). In this modeled scenario, the maximum depth of sediment accumulation is approximately 1.5 feet, and it occurs immediately downstream of the dam, persisting for just a few hours. By the end of one day under this scenario, the sediment peak would have moved over 0.5 miles downstream and the maximum depth of deposited material at that point would be less than one foot. By the end of the second day following dam removal and rewatering of the channel, the sediment peak would have moved about 1.5 miles downstream and would have a maximum depth of well under one foot. Critical habitat would be impacted as the sediment moved through the system.

In general, the modeling effort showed that the largest accumulations of sediment would occur nearest the dam and as the peak moved downstream it would get increasingly smaller. Also, the persistence of sediment deposits in Trout Creek depends on the streamflow levels that occur following implementation of the project. For example, if a large storm immediately follows completion of the project, the peak of sediment deposition in lower Trout Creek could occur and be gone within one day. However, if project completion is followed by an extended period of low streamflows, then the deposition in lower Trout Creek could persist over a longer period, determined by the length of time flows remain low. Under any of the scenarios modeled, the maximum thickness of sediment deposits downstream of the dam was less than 1.5 feet.

Under a range of streamflows typical for fall and winter months on Trout Creek, the sediment deposition peak would be undiscernible in Trout Creek by early spring. Since steelhead spawn in the spring (March – May) and the majority of sediment transport/deposition would be expected to occur between the months of September – February, there would be no short term deposition-related impacts to incubating or emerging steelhead. The BOR found that the predicted change in bed elevation in lower Trout Creek was not large enough to pose any significant risk of flooding to downstream property owners. The predicted thickness of sediment deposits at the mouth of Trout Creek would also not be expected to be large enough to create a passage barrier to fish.

Following the first winter of post-project streamflows, bed elevations in Trout Creek would return to near pre-project levels, with increased levels of sediment in pools and eddy zones due to the reintroduction of spawning gravels and coarser sediments from upstream. The coarse sediments that would begin to occupy this reach would improve fish habitat by establishing or improving isolated pockets of spawning gravel, providing hydraulic roughness and protection for fish during high flows, and creating microhabitats for other aquatic organisms. This coarse substrate would also be subject to downstream transport, but it would have longer residence times in lower Trout Creek and without the dam in place would continue to be replenished from upstream sources.

Since steelhead spawn in the spring (March – May) and the majority of sediment transport/deposition would be expected to occur between the months of September – February, impacts to incubating or emerging steelhead would not expected in the short or long term. The amount of available spawning gravel would be increased in the 1.5 mile reach of Trout Creek immediately below dam and incrementally increased in the canyon reach of the Wind River below the confluence of Trout Creek. Coarse sediment deposition at the Trout Creek fan (at the confluence of the Wind River) would be expected to mimic natural processes and therefore fish migration would not be expected to be affected. In the long term, critical habitat in Trout Creek would improve.

Offsite – Wind River

After Trout Creek enters the Wind River the sediment transport potential increases tremendously due to the increased flow volumes. Because of the large increase in stream power the deposition levels discussed in preceding paragraphs would be further diminished in the Wind River. It is expected that deposition would only be measurable in the channel margins, pools, and slack water areas, where temporary storage would occur (USDI 2004a).

Rough estimates for the total available area for sediment storage in the Wind River canyon vary between 350 yd^3 and 16,000 yd^3 and are described in more detail by the BOR (2004). If 16,000 yd^3 were temporarily stored in the Wind River, some pools and slack water areas may be temporarily filled with sediment. Once the sediment enters the Wind River, because of the large dilution, the deposition in the pools would be expected to be much less. As soon as the first larger flows occur in response to fall rains the pools would start to erode. It is expected that the first bankfull flow to occur after the project would scour the pools of sediment deposits, returning them to near pre-project conditions (*ibid*.).

At the mouth of the Wind River the channel slope decreases dramatically and the transport potential of the river has a corresponding decrease. Most of the sediment eroded from behind Hemlock Dam would eventually reach the mouth of the Wind River. Smaller sediments would reach the mouth of the Wind River relatively quickly and the finest material would pass through the mouth and enter the Columbia River. The BOR (2004) estimates that approximately 50% of the sediment eroded from Hemlock Reservoir would deposit at the mouth of the Wind River upstream of the Highway 14 Bridge (*id.*) This volume of sediment would equate to a thickness of two to three inches of sediment if it were spread uniformly over the entire area of the mouth. It would be difficult to measure a deposition thickness this small. Assuming sediment yields in the Wind River watershed are similar to other western Cascade watersheds (Dunne and Leopold 1978), the volume of sediment potentially eroded from the reservoir would be several times the annual yield for Trout Creek and near the annual sediment yield for the entire Wind River watershed.

Actual deposition patterns within the mouth would be highly variable, depending on the depth and slope of the river, the backwater influence, and the location of flow obstructions. Figure 4-8 shows a plan view of the mouth of the Wind River with bathymetry as recorded in May of 2004 (USDI 2004a).

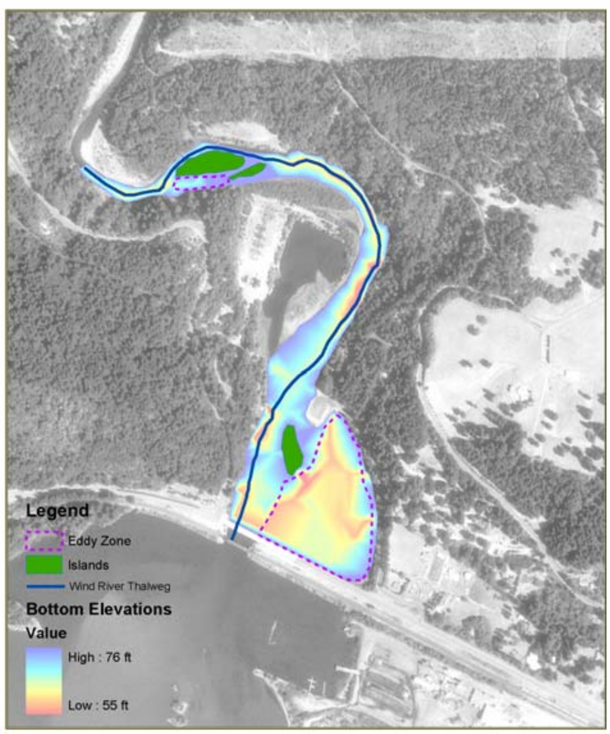

Figure 4-8. Mouth of the Wind River, showing channel thalweg and "eddy zones".

Areas identified on the figure as "eddy zones" are the areas that would be less likely to have sediments flushed through due to their being outside of the more active flowpaths. These areas would accumulate more sediment than other areas around the mouth. It is possible that deposition of sediment in some areas of the mouth could affect boating access, particularly in those areas that are already only marginally accessible by boat due to shallow depths. Increased sediment deposition at the mouth of the Wind River could affect aquatic organisms in that area and could affect spawning redds of fish using the mouth of the river. Fine sediments deposited in the pool tail crest regions where the majority of spawning gravel for LCR chinook and LCR coho exists would be likely to reduce survival of fertilized eggs. The extent of impacts to LCR chinook and LCR coho adults and fertilized eggs at the mouth is unknown. In the short term, critical habitat would be impacted. In the long term, critical habitat in the Wind River would improve.

Cumulative Effects

This project directly and indirectly affects sediment deposition processes from Hemlock Lake to the mouth of the Wind River and increases sediment delivery to both lower Trout Creek and the Wind River. These effects occur over both the short and long term and have the potential to act cumulatively with other projects or processes in the Wind River watershed that influence sediment. Construction-related sediments would cause short term increases to sediment deposition, but over the long term, the re-establishment of sediment routing in lower Trout Creek would provide for more persistent effects to downstream reaches.

Table 3-20 lists the past, present, and foreseeable projects in the Wind River watershed that may contribute to the cumulative effects of this project.

Past logging, road construction, stream cleanouts, and other developmental projects have increased sediment inputs to Trout Creek and the Wind River. These projects occurred over the course of the past several decades but some of the effects continue to be in evidence today. In addition, floods and non-project-related landslides and road failures occur at some non-regular frequency and can cause significant increases to sediment delivery levels. Sediment deposits in Hemlock Lake attest to the volume of sediment that has moved through Trout Creek over the past years.

Over the past ten years, the USFS has focused efforts on projects that are restorative in nature. As a result sediment from national forest lands is presumed to be decreasing from the elevated levels caused by earlier developmental and land management-related activities. At the same time, projects on private and other non-national forest lands continue to be more developmental in nature and include road construction, logging, residential development, and development of facilities related to recreation and tourism. Near the mouth of the Wind River significant development is occurring at the Carson Golf Course and Carson Hot Springs Resort, and the community of Carson is in the process of implementing a stormwater runoff plan. Sediment delivery at the mouth of the Wind River is affected by these activities.

The net result in terms of sediment from the restoration work and developmental activity is unknown and there has been no systematic monitoring of sediment levels within the Wind River system to allow detection of trends in sediment levels.

Because lower Trout Creek and the Wind River downstream of the Trout Creek confluence are high gradient, sediment transport-dominated systems, sediment deposition occurring there is transitory. Cumulative depositional effects would be very limited in those areas. However, at the mouth of the Wind River the sediment transport capability of the Wind River declines dramatically. This is the area where the greatest amount of sediment will deposit for the longest duration and where the potential for cumulative depositional effects would be greatest.

In the short term including the first year following implementation of this alternative, the indirect effects of this project (described previously) would dominate other ongoing sediment deposition occurring at the mouth. The Hemlock Dam project could deliver upwards of 20,000 to 25,000 yards of sediment to the mouth of the Wind River over the first year or two following project implementation. Assuming sediment yields in the Wind River watershed are similar to other western Cascade watersheds, this could represent the equivalent of an entire year’s worth of sediment at the mouth of the Wind River. These sediments would have a negative short term effect on critical habitat. Over the longer term, rates of sediment deposition at the mouth of the Wind River would revert to current levels, except that there would be a persistent increase of approximately 10% due to the resumption of sediment routing past Hemlock Dam.

In the short term, LCR chinook, LCR coho, and other species spawning at the mouth or in other areas of deposition could be affected by implementing this alternative as described above. These impacts to spawning habitat would have a negative short term effect on critical habitat. Steelhead spawning would not likely be affected because their spawing would be temporally offset from periods of maximum deposition and because they typically spawn in areas that would tend to route rather than deposit the finer sediments. The long term increase in coarse sediment delivered to lower Trout Creek would diversify the substrate there, increase hiding cover for juvenile steelhead, and reduce predation. In addition, spawning gravel for steelhead in lower Trout Creek and the Wind River would be increased. The net effect of this alternative is increased production potential for steelhead in both Trout Creek and the Wind River. The increase in coarse sediment delivered to the mouth of the Wind River could also be beneficial to the survival, growth, and migration of federally listed fish occupying that area. In the long term, critical habitat in Wind River watershed would improve.

4.1.3.3. Alternative C

Summary

This alternative would remove the dam, excavate sediments, and construct a channel through the area now occupied by Hemlock Lake. Much of the sediment that has been deposited within the reservoir over time would be removed off site and stabilized in an upland location as part of this project. The downstream sediment deposition effects of this alternative would be minor in comparison to those described under Alternative B. In the short term, there would be an increase in sediment deposition in downstream Trout Creek, the Wind River, and at the mouth of the Wind River that would occur as a result of the erosion of finer materials (sand and smaller sized particles) from the newly constructed channel. This effect would be minimized by constructing the channel to design specifications, and as a result, is only expected to occur in the first year following project implementation.

Over the longer term, sediment deposition in the lower reaches of Trout Creek, the Wind River, and at the mouth of the Wind River will increase simply due to the elimination of the sediment trap that is currently formed by Hemlock Dam. This effect will be persistent and will be evidenced by increased levels of sediment deposits within these channels, providing increased spawning gravels, cover for fish and insects, and protection from increased erosion.In the long term, critical habitat in Trout Creek and the Wind River would improve.

Direct and Indirect Effects

Onsite

Once the new channel has been constructed, the dam has been removed, and Trout Creek has been diverted into the new channel, sand and smaller sediments would be mobilized and transported downstream. It is estimated that up to several inches of sands and silts could be mobilized from the newly constructed channel and routed downstream during the first fall and winter following implementation of this alternative. If an average of three inches of sediment from across the entire area of the reservoir were mobilized, this would amount to approximately 1,100 cubic yards of material that would be available for transport downstream. This would represent less than 20% of the estimated annual sediment production for the Trout Creek watershed. The mobilization of this material would occur immediately following the introduction of water to the channel and would taper off quickly (within hours) until a larger flow volume occurred in the new channel. At each successively higher flow the sediments would again be mobilized, but at each flow stage, the effect would decline within hours. This effect would be expected to occur throughout the first year following project implementation, but would only occur during successively larger flows. Beginning in year two after the project was implemented, the channel is expected to be stabilized to the extent that it would function similar to other nearby reaches of Trout Creek.

Offsite

In the short term, material eroded from the reservoir would quickly move into lower Trout Creek. As described under the previous alternative, the high stream power of both Trout Creek and the Wind River would ensure that much of this material was routed relatively rapidly to the mouth of the Wind River. Where temporary storage of this material did take place within lower Trout Creek and the Wind River, it would occur as relatively thin deposits that were spread through lower energy portions of these reaches. The only measurable deposits within the channel would be likely to occur in the fall months prior to the first substantial streamflow event, and these would be minor. After the first large flood there would likely be very little visible evidence of the sediments in lower Trout Creek or the Wind River. Based on the small amount of sediment depositing in lower Trout Creek and the timing of the deposits, no effects to spawning steelhead are foreseen.

A majority of the material initially eroded from the reservoir would be deposited at the mouth of the Wind River or passed through to the Columbia River. The amount of material that is expected to be eroded from the reservoir and deposited at the mouth is very small and would be nearly imperceptible, as it represents less than two percent of the estimated annual sediment production in the Wind River watershed. Some mortality of Wind River LCR chinook (Tule and Bright) and LCR coho eggs in the lower Wind River could occur due to increased fine sediment deposition, however any effects that were to occur would be short term and expected to impact one cohort.

Sediment deposition would not be expected to be measurable or affect SR spring, summer or fall chinook, UCR spring chinook, SR, UCR or MCR steelhead, SR sockeye and CR chum.

Over time, because increased material would be moved through the reach now occupied by the reservoir, lower Trout Creek and the Wind River would have higher sediment inputs on an annual basis simply because the sediment storage currently afforded by the dam and reservoir would be eliminated. Some of the larger material would be stored temporarily in these downstream reaches forming bed, bar, and channel margin deposits. The increase in substrate within the lower channel reaches would benefit fish by increasing spawning gravels, macro invertebrate production, and food availability and by providing increases in large substrates that are important as hiding cover and physical protection for fish during winter peakflows.

Cumulative Effects

As described under Alternative B, sediment increases from this project would occur in lower Trout Creek and the Wind River over both the short term (project-related sediments) and long term (sediment increases resulting from re-establishment of sediment routing in lower Trout Creek). Sediment inputs to lower Trout Creek and the Wind River as a result of this project would be cumulative with other sediments delivered to those reaches from upstream or adjacent streambank sources. The sediment released as a result of this alternative would increase the total sediment load in lower Trout Creek and in the Wind River downstream of the Trout Creek confluence because sediments would no longer be stored behind the dam. Project-related sediments generated by the dredging and channel construction would consist largely of finer materials and these would only cause a temporary increase in fine sediments downstream.

Sediment loads in Trout Creek are presumed to be decreasing over time as the effects of past logging, nursery practices, and road systems are diminished by revegetation and restoration efforts. This project would provide a long term increase in sediment in downstream Trout Creek as a result of restoring natural sediment routing processes in Trout Creek. In addition, the project would cause a temporary spike in sediment levels in lower Trout Creek associated with project construction activities. This effect would only occur for short periods during the first year following project implementation. It would be most discernible in the fall months prior to the first substantial streamflow event and would occur as thin layers of relatively fine sediment on the channel bottom. Project-related sediment deposits would be mobilized downstream during the first fall freshet and during subsequently larger streamflow events through the first year. Following the first year, downstream reaches of Trout Creek would show no measurable sediment increases as a result of project construction and no cumulative effects except for the increase in sediment that would result from allowing unimpeded sediment routing to resume in lower Trout Creek.

In the Wind River, it is unclear if background sediment production is increasing or decreasing. Restoration of riparian areas, roads, and revegetation of previously harvested national forest lands is expected to effectively reduce sediment production from that area, but ongoing development activities along the Wind River and lower in the watershed may actually be causing increases in sediment production. This project would cause a long term increase in sediment in the reaches of Wind River that lie downstream of the mouth of Trout Creek. The increase would result from restoring sediment routing processes in Trout Creek. In addition, this alternative would cause a temporary increase in fine sediment levels resulting from use of heavy equipment in the stream to remove the dam and construct the new channel. The construction-related sediment would appear as thin layers of relatively fine sediment on the stream bottom, occurring primarily in lower gradient areas and in particular near the mouth of the river. It is estimated that these layers would small and because they are combined with other fine sediments from elsewhere in the watershed, would be nearly imperceptible.

The long term increase in coarse sediment delivered to lower Trout Creek would diversify the substrate there, increase hiding cover for juvenile steelhead, and reduce predation. In addition, spawning gravel for steelhead in lower Trout Creek and the Wind River would be increased. The net effect of this alternative is increased production potential for steelhead in both Trout Creek and the Wind River. The increase in coarse sediment delivered to the mouth of the Wind River could also be beneficial to the survival, growth and migration of federally listed fish species occupying that area.

4.1.3.4. Alternatives D and E

Summary

These alternatives both propose to leave the dam in place, and to repair or replace portions of the facility that provide for fish passage. There is no appreciable difference in the effects of these alternatives on sediment, so their effects analysis is combined here.

Direct and Indirect Effects

Effects of these alternatives would be nearly identical to those described under Alternative A with the following exceptions.

Onsite

Sediment processes within the reservoir would be modified by the initial dredging of the reservoir and by subsequent dredging that would likely occur on intervals of ten years or less to retain adequate depth in the reservoir. Following each dredging effort the reservoir would be deepened. As a result of the deepened reservoir, a greater proportion of the sediments that are delivered to the reservoir would be deposited there (i.e. the trap efficiency of the dam would be increased), and rates of sediment transport past the dam would be reduced. The reduction in sediment transport past the dam would be greatest in the first year following implementation. As the reservoir again refilled with sediments, the rates of deposition behind the dam would decline and the amount of sediment routed over the dam would again increase until the next dredging occurred.

In addition to the dredging that is incorporated in these alternatives, both alternatives would also include re-initiating use of the sluice gate on the dam to annually route sediments. The sluicing would be done during higher flow periods when turbidity levels in the stream are naturally elevated. As the sluice gate is opened, sands, silts, and other materials in the vicinity of the sluice gate would be flushed through the orifice and into lower Trout Creek. The upstream extent of the sluicing effect on sediments within the reservoir is unknown, but the primary deepening effects of the sluicing are expected to be relatively local to the sluice gate orifice. Because a majority of the material to be sluiced is coming from the vicinity of the sluice gate, it is likely to be largely composed of finer grained material, since the coarser materials are typically deposited nearer the upstream end of the reservoir.

When flows would be reintroduced following dredging, fine coats of sediment may be deposited on channel substrate a short distance downstream (approximately one mile) which could directly kill macro invertebrates and indirectly reduce food availability for fish similar to what was described in Alternative C. Operation of the existing sluice gate during high flow conditions would be expected to route primarily sands, silts, small woody material, and organic debris (leaf litter and small branches). Coarse sediment (gravel and cobble) would continue to deposit near the upstream end of the reservoir, and large woody debris (trees and large branches) would be too large to fit through the sluice gate and would continue to be impeded by the dam.

Offsite

Lower Trout Creek and the Wind River would experience effects nearly identical to those described under Alternative A, except that during sluicing activities additional sediments would be routed into and through these reaches. Because the sluicing would be done during periods of naturally high flows, very minor amounts of the sluiced material are likely to deposit in the channels and most would be routed to the mouth of the Wind River. At the mouth of the Wind River the sluiced sediments would constitute an imperceptible increase to the existing sediment loads delivered there.

This alternative would not restore the natural sediment/organic routing as described in Alternatives B or C, therefore the benefits to downstream spawning habitat, hiding cover, organic retention, and macro invertebrate production would be limited and tend to more closely resemble the existing conditions (Alternative A). The finer material (sands and silts) would be deposited predominantly in the lower Wind River. There would be no effect to SR spring, summer or fall chinook, UCR spring chinook, SR, UCR or MCR steelhead, SR sockeye, and CR chum.

Cumulative Effects

These alternatives would have cumulative effects nearly identical to those described for Alternative A except for the increase in downstream sediment movement that would occur during sluicing under these alternatives. The sluiced sediments would increase the sediment load throughout lower Trout Creek and the Wind River. But because the sluiced material would be composed of relatively small-size material, most of the sluiced material would be transported rapidly through the higher gradient reaches to the mouth of the Wind River. The volumes of material routed past the dam during sluicing operations is estimated to be well under ten percent of the annual sediment load of the Wind River so no appreciable change is predicted in the amount of sediments depositing within the channels or at the mouth.

4.1.4. Flooding

This analysis is provided to address concerns raised during scoping about the potential for increased flooding downstream of Hemlock Dam if the dam were to be removed.

Analysis Scale

The area included in this analysis includes Trout Creek downstream of the dam to the Wind River, and the Wind River from the mouth of Trout Creek to the mouth of the Wind River. The analysis is bounded at the confluence of the Wind River with the Columbia River because the discharge in the Columbia River is so much larger than that of Trout Creek that any change in Trout Creek flows would be inconsequential to discharge levels in the Columbia River.

Methodology

The analysis considers the direct, indirect and cumulative effects of each alternative on flooding. It is focused on effects occurring from the present through 20 years beyond the implementation of this project. Analysis of changes in flood potential is conducted by comparing discharge levels in Trout Creek with modeled water storage capacities in the area of Hemlock Lake both with and without the dam in place. Modeling of storage volume capacities was done using HEC-RAS following Barber and Perkins (1999).

4.1.4.1. Alternative A – No Action

Summary

Under this alternative, there would be no planned changes to either the structure or operation of the dam or lake. Implementation of this alternative would not directly or indirectly change the existing hydrology or streamflow regimes in Trout Creek or the Wind River. The range of flow conditions experienced both upstream and downstream of the dam would not be altered except by natural changes and variations in streamflow. Inundation of various portions of the reservoir including the delta, islands, mud flats and wetlands would occur during high flows as it does under the current condition, and during the summer months when the flashboards are in place.

Direct and Indirect Effects

Currently, the presence and operation of Hemlock Dam does not appreciably affect peak streamflow levels in downstream reaches of Trout Creek, because the dam has no flood control capability. The amount of water delivered to the reservoir during winter months is essentially equal to the amount of water leaving the reservoir, except that as water levels rise during flood events, the reservoir area can temporarily store a larger volume of water. This occurs as water depths in the reservoir increase, and as the gently sloping areas surrounding the reservoir become inundated. This increased water storage capacity upstream of the dam occurs only for short periods of time during the rising stages of a flood. The potential increase in storage volume that comes about during these circumstances is relatively small in comparison to the amount of flow that is in Trout Creek at those times. For example, during a bankfull flood (the size that occurs on average every one or two years), the peak volume of water stored behind the dam would be approximately 2.1 million cubic feet. During such an event, Trout Creek would typically discharge approximately 7.8 million cubic feet per hour, so over the course of the entire flood, the proportion of the flood peak that could be stored in the reservoir area would be quite small. As the flood size increases, the proportion of the flood that could be stored in the reservoir area becomes increasingly smaller.

Cumulative Effects

There would be no cumulative effects to streamflow levels as a result of implementing this alternative. As described above, the dam is not used to regulate streamflow levels, so does not have any appreciable effect on streamflow levels upstream or downstream of the project.

4.1.4.2. Alternatives B and C

Summary

Implementation of Alternative B or C would remove the dam and return Trout Creek to a free-flowing stream through the reach now occupied by Hemlock Lake. There is no difference between Alternatives B and C in terms of their effects to streamflow levels or flooding. Removal of the dam would eliminate any water storage capacity now afforded in the reservoir area by the dam. During winter months, there would be no appreciable change to the magnitude or frequency of peak streamflows because the dam has no flood control capabilities. Implementation of either of these alternatives would have no cumulative effects to streamflows in Trout Creek or the Wind River.

Direct and Indirect Effects

Currently during both low and high flows, the dam functions as a run of river dam, in that water storage behind the dam is not manipulated on an event-by-event basis. The dam has no flood control capability. The only manipulation of storage volumes behind the dam is the seasonal installation and removal of the dam flashboards for summer recreational uses.

In the winter, streamflow volumes entering the reservoir generally equal volumes leaving the reservoir, except during the rising limb of floods when the river stage increases and allows inundation of greater areas behind the dam. As water spills out onto flood-prone areas surrounding the reservoir, the volume of water storage is temporarily increased upstream of the dam. However, as described under Alternative A, the storage that comes available through changes in flood stage is not large relative to the discharge volumes in Trout Creek during such events.

Figure 4-9 graphically shows that during a bankfull flood peaking at approximately 2,000 cubic feet per second, the water storage capacity of the reservoir (above the elevation of the dam crest) would be approximately 20% of the hourly discharge, and less than one percent of the total water volume discharged during the flood. Similarly, for the 50-year flood, there would be approximately three million cubic feet of storage essentially lost by removing the dam, and yet Trout Creek discharges approximately 18 million cubic feet ***per hour*** during such an event, quickly obscuring any difference in storage. As a result of the overwhelmingly large volume of water flowing in Trout Creek during floods in comparison with the relatively small volume of water temporarily stored above the dam, dam removal would have no appreciable effect on the timing, magnitude, or frequency of flooding downstream in Trout Creek or the Wind River.

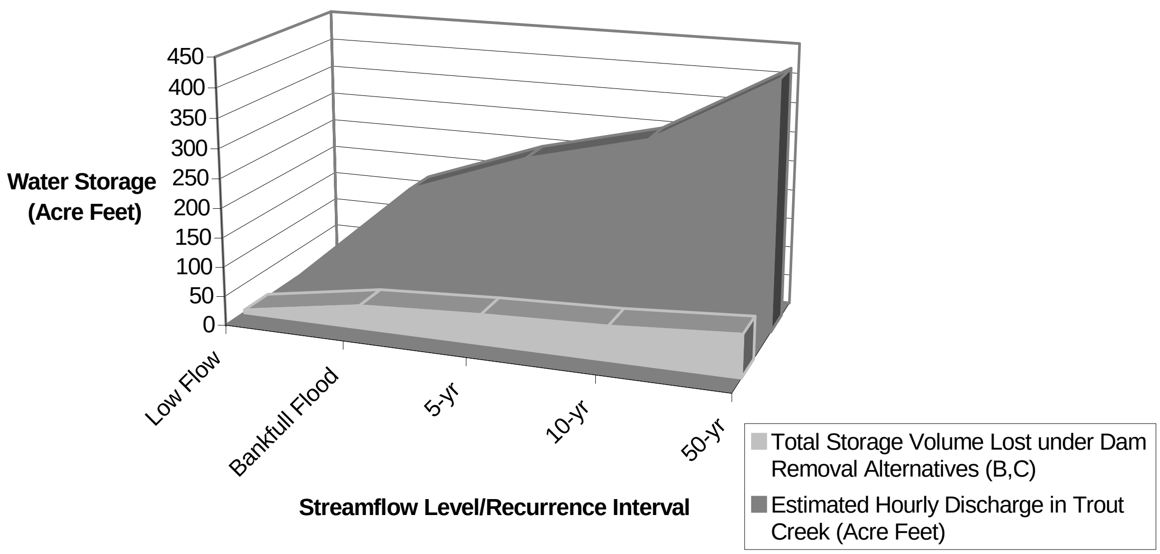

Figure 4-9. Comparison of the total volume of water storage lost under dam removal alternatives, with the hourly discharge volumes in Trout Creek under a range of streamflows.

Cumulative Effects

Implementation of Alternative B or C would cause no appreciable change to peak streamflow levels in Trout Creek or the Wind River, and would also have no cumulative effect on streamflows at any location.

4.1.4.3. Alternatives D and E

Direct and Indirect Effects

Effects of these alternatives would be identical to those described under Alternative A. Dredging of the reservoir would provide a deeper reservoir of water behind the dam, but neither low flows nor high flows would be affected because the reservoir is charged full of water throughout the year.

Cumulative Effects

There would be no change in peak or base streamflow levels under these alternatives and no cumulative effects to streamflows in Trout Creek or the Wind River.

4.1.5. Groundwater

During project scoping, concerns were raised about the potential for dam removal to affect groundwater levels and existing wells in the vicinity of Hemlock Lake.

Analysis scale

Trout Creek, in the vicinity of Hemlock Lake.

Methodology

Lacking significant studies on hydraulic continuity in this area, this analysis relies substantially on existing data and a brief study that was done at the Wind River Nursery in 1986 (Adams 1987). It is supported by direct streamflow measurements taken on Trout Creek during the summer of 2005.

4.1.5.1. Alternative A – No Action

Summary

Under this alternative, there would be no planned changes to either the structure or operation of the dam or lake.

Direct and Indirect Effects

This alternative would not change the existing surface or subsurface hydrology in the vicinity of Hemlock Lake. Streamflow levels in Trout Creek would not be affected, nor would the existing processes of exchange between surface waters in Trout Creek and subsurface waters in the vicinity. The range of depths to groundwater would continue to fluctuate seasonally and from year-to-year in response to precipitation levels and other climatic factors, and water withdrawals that occur in the area over time. Figure 4-10 shows the fluctuations in depth to groundwater over a three-year period at wells located at the Wind River Nursery.

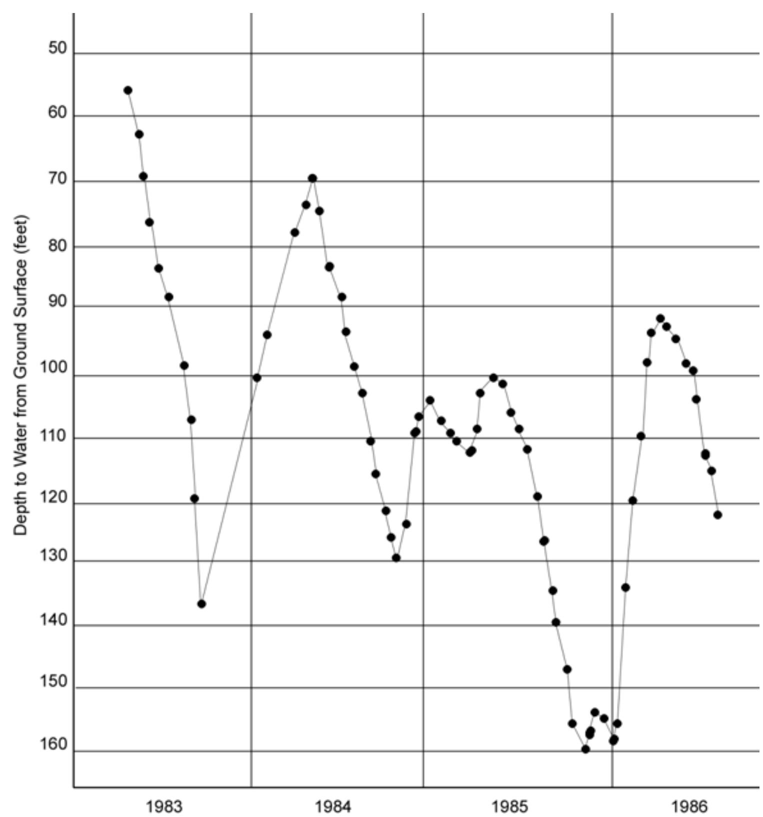

Figure 4-10. Depth to groundwater in OW#2 from 1983 to 1986. (Source: Adams 1987.)

Data plotted in Figure 4-10 is from a Forest Service study completed in the mid-1980's at the Wind River Nursery (Adams 1987). During the study, groundwater levels fluctuated as much as 60 feet or more through the course of a year, and over the three year period varied by about 100 feet. As additional water resource developments occur in the vicinity of Hemlock Lake (i.e. such as those planned as part of the development of the former Wind River Nursery lands), groundwater levels and the range of depths to groundwater may be modified by those changes.

4.1.5.2. Alternatives B and C

Summary

Alternatives B and C would remove the dam and return Trout Creek to a free flowing stream through the reach now occupied by the reservoir. This would restore the pre-dam relationships between flow in Trout Creek and recharge in local aquifers, and could result in changes to water levels in local wells, as the original pre-dam water tables are re-established.

Direct and Indirect Effects

To date, studies have not been done to conclusively determine the extent to which Hemlock Lake contributes to groundwater levels in the area. However, a study completed by the Forest Service in the mid-1980's and more recent streamflow measurements on Trout Creek appear to support the conclusion that Hemlock Lake itself is not likely to be a significant contributor to groundwater, even while surrounding reaches of Trout Creek may be important to groundwater recharge as stated by Adams (1986).

The Adams study conducted in the mid-1980's suggested that Trout Creek could be an important contributor to recharge of the aquifer in the area of the former nursery fields (Adams 1987). This was based on measured streamflow losses in two reaches of Trout Creek during the summer of 1986. The streamflow losses documented in this study were presumed to be lost to infiltration and to provide recharge to the aquifer. There was no direct measure of what portion of the lost streamflow actually reached groundwater known to be accessed by local wells. The reaches of Trout Creek that "lost" flow during the study period included the reach immediately upstream of Hemlock Lake (SG-3 through SG-4), and the reach downstream of Hemlock Dam (SG-5 through SG-6) (Figure 4-11).

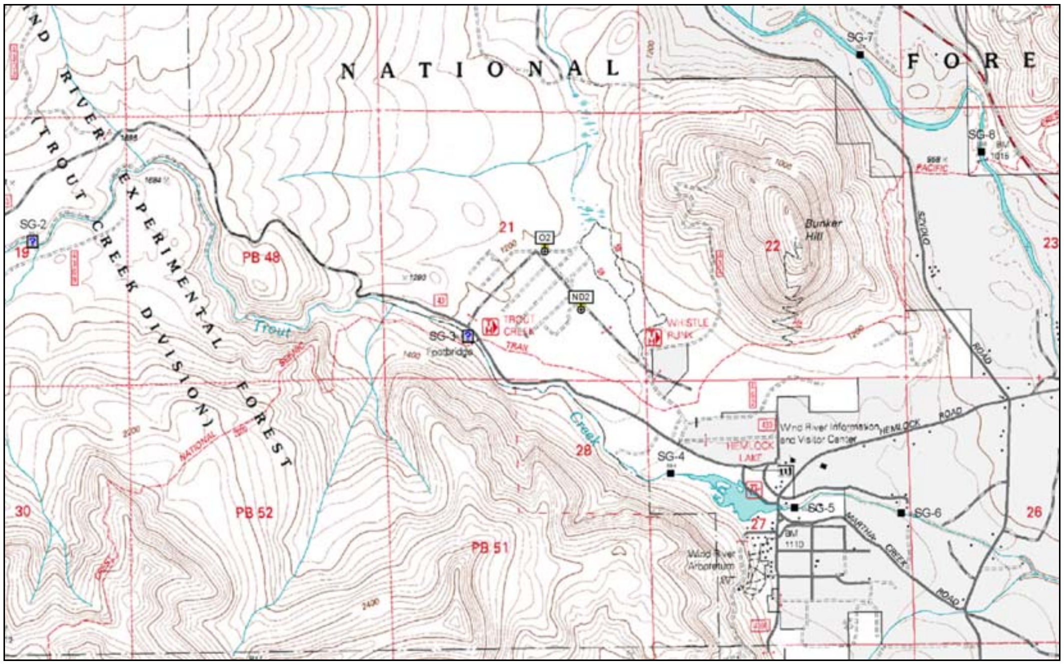

Figure 4-11. Map showing locations of stream gauges used for monitoring stream flow. SG-2 and SG-3 are approximate locations. SG-4 thru 8 are actual locations pulled from the 1986 map. O2 is observation well 2 and ND2 is the nursery domestic well 2.

In the same study, discharge in Trout Creek appeared to increase in the reach that includes Hemlock Lake and Dam (SG-4 through SG-5). This increase in flow was not discussed in the original Adams report, but flow measurements documented in the report showed a consistent increase in the reach that included Hemlock Lake (Table 4-3).

Table 4-3. Summary of the change in streamflow for three reaches of Trout Creek during the summer of 1986. The reaches include one reach upstream of Hemlock Lake, one reach that includes Hemlock Lake, and one reach downstream of Hemlock Dam. Negative values indicate that the stream is losing streamflow in a downstream direction in that reach, and positive values indicate where the stream is gaining flow through the reach. (Data source; Adams 1987)

Streamflow Measurement Dates	Change in Discharge (cfs) in the Reach *Upstream* of Hemlock Lake (SG-3 through SG-4)	Change in Discharge (cfs) in the Reach *Including Hemlock Lake* (SG-4 through SG-5)	Change in Discharge (cfs) in the Reach *Downstream* of Hemlock Dam (SG-5 through SG-6)
7/29/86	-1.5	+3.1	+1.3
8/6/86	-3.9	+3.0	-3.6
8/12/86	-3.0	+3.6	-1.7

With no other major surface water inputs or diversions in this reach, the data suggests that Trout Creek is losing flow in the reaches upstream and downstream of Hemlock Lake, but is actually gaining flow in the reach that includes Hemlock Lake. To provide a more current evaluation of this relationship, the Forest Service measured streamflow in Trout Creek immediately upstream of Hemlock Lake and immediately downstream of Hemlock Dam in the summer of 2005. The data are summarized in Table 4-4.

Table 4-4. Streamflow measurements on Trout Creek immediately upstream of Hemlock Lake and immediately downstream of Hemlock Dam. Measurements taken by Forest Service personnel on July 26, 2005.

Streamflow Measurement Date	Streamflow Measured Upstream of Hemlock Lake (cfs)	Streamflow Measured Downstream of Hemlock Dam (cfs)	Change in Streamflow (Increase) (cfs)
7/26/05	14.2	15.6	+1.4

Streamflows were found to increase by approximately 1.4 cfs in the reach that includes Hemlock Lake in the 2005 effort. Although the increase in discharge was smaller than that found by Adams, the fact that flow increases in this reach was consistent between the two efforts, suggesting that Hemlock Lake may actually be an area that gains water from the subsurface, or at a minimum does not significantly contribute to recharge to the aquifer. Based on these two limited data sets, we would expect no appreciable change to water levels in local wells resulting from implementing this alternative.

Cumulative Effects

This alternative is not likely to have discernable effects on local groundwater levels and no cumulative effects to water levels in local wells.

4.1.5.3. Alternatives D and E

Direct, Indirect and Cumulative Effects

Alternatives D and E call for leaving the dam in place and dredging the reservoir. The effects of these alternatives on groundwater levels would be essentially the same as those described under Alternative A.

4.1.6. Fish Migration

Relationship to Purpose and Need and Significant Issues

As stated in Chapter 1, part of the primary purpose of this project is to improve upstream and downstream passage for all life stages of fish at the Hemlock Dam site.

Barriers to fish migration is a significant issue. The Measurement Methods related to this issue are:

- Upstream migration success

- Downstream migration success
- Impingement potential
- Predation potential
- Harassment potential

Regulatory Framework

Regulatory and legal requirements that direct the maintenance of fish passage include Washington State law (at RCW 77.55).

Lower Columbia River steelhead (as well as other anadromous species, listed in Table 4-7) are listed as Threatened species pursuant to the Endangered Species Act (ESA) of 1973, as Amended, 50 CFR 402 (2000). Federal agencies are prohibited from authorizing any action that will result in the destruction or adverse modification of critical habitat. The ESA also requires the USFS to manage for the recovery of Threatened and Endangered species and the ecosystem on which they depend.

Through the Northwest Forest Plan Standards and Guidelines, Forest Service policy also directs that water quality objectives be met. The Aquatic Conservation Strategy (ACS) was incorporated into the Northwest Forest Plan (and thereby amended Forest Plans within the range of the northern spotted owl) to “protect salmon and steelhead habitat on federal lands managed by the Forest Service and Bureau of Land Management within the range of Pacific Ocean anadromy.” The activities proposed by these agencies must not “retard or prevent attainment of” ACS objectives at the fifth-field watershed scale. Specifically, Objective 2 refers to maintenance of unobstructed pathways to habitat.

2. Maintain and restore spatial and temporal connectivity within and between watersheds. Lateral, longitudinal, and drainage network connections include floodplains, wetlands, upslope areas, headwater tributaries, and intact refugia. These network connections must provide chemically and physically unobstructed routes to areas critical for fulfilling life history requirements of aquatic and riparian-dependent species.

The following analysis summarizes the effects of the dam on fish migration in Trout Creek. This issue is analyzed because fish passage at the dam is one of the primary reasons for undertaking this project, and because there are a number of factors directly or indirectly associated with the dam that affect fish migration. This section includes analysis of the following items: 1) upstream migration; 2) downstream migration; 3) impingement; 4) predation; 5) recreation/harassment. In addition to these factors, the dam also indirectly affects fish through its effects on water temperature, sediment deposition upstream of the dam, and the restriction of downstream transport of sediment and other material at the dam. The effects of the dam on passage and these other factors are often interrelated and complex, but for simplicity, water temperature and sediment effects to fisheries are addressed under separate sections of this report.

Scale of the Analysis

Because this analysis is intended to illustrate the effects of the dam on fish migration, the spatial scale of the analysis is by definition limited to the area in the immediate vicinity of the dam, even though the life history of the fish causes them to be found from upstream reaches of Trout Creek all the way to the Pacific Ocean. Cumulative effects analysis included herein does not attempt to specifically address each migration impediment in the long journey of the fish from the river to the ocean and back, but includes some reference to known significant migration barriers beyond Hemlock Dam.

Migration-Related Factors Analyzed

1) Upstream Migration

The existing ladder which was constructed in 1936 does not meet current NMFS guidelines for adult fish passage (Barber and Perkins 1999). Adult fish passage has been found to be limiting at Hemlock Dam by two engineering studies of the ladder (Orsborn 1987, Barber and Perkins 1999). The studies identified four principal concerns relative to adult fish passage: 1) attraction flow, 2) fish ladder weir configuration, 3) ladder flow and resting water, 4) adult trap design. In addition, USFS videos taken at the fish ladder from 2003 – 2004 indicate that predation or the fear of predation in the fish ladder may also significantly affect fish behavior and passage at the dam. Each of the concerns listed above could potentially affect adult and juvenile steelhead movement past the dam by delaying passage or entirely discouraging upstream migration. These upstream fish passage issues impact Trout Creek critical habitat.

2) Downstream Migration

Downstream movement of fish past Hemlock dam happens throughout the year to some extent, but primarily during smolt outmigration in the spring months (March – June), and during summer periods when large numbers of juveniles enter the reservoir from upstream (Hemlock Adult Trap Data, 1992 – 2004). In addition to the smolts and juveniles moving downstream past the dam, adult steelhead "kelts" descend Trout Creek after spawning (May – June) and must negotiate the dam on their way back out to the ocean.

Downstream migration of fish would be potentially affected both by the delay fish experience in navigating through the reservoir and effects of the dam and ladder on downstream passage. Delay in the reservoir would be a problem only during summer months when streamflows are low. The lack of flow within the reservoir itself and lack of attraction flow to the fish ladder and submerged orifice on the flashboards may make it difficult for juvenile steelhead to find the downstream outlet of the reservoir. The primary concerns with delaying migration during this period would be the length of time that fish are exposed to lethal water temperatures and predators and the increased risk of impingement on flashboards and screened intake.

Fish moving downstream past Hemlock Dam would have two options available to them. They can either go over the dam crest (with or without flashboards) or down the fish ladder. Both of these pathways are known to be used by fish, but the proportion of fish choosing one of these options over the other is unknown. It is possible that the preferred route changes through the year as the hydraulics at the dam crest and entrance to the fish ladder change under changing river flow levels.

Downstream movement through the fish ladder has been observed but not studied. Observations to-date provide no indication that juvenile fish would have difficulty moving downstream through the ladder. However, for those fish going over the dam crest, there would be hazards including: impact of the water surface at high velocities, impact to stationary objects below the dam (dam structures, bedrock or boulders), and impingement of the fish on the dam flashboards or screen as they approach the crest (the potential effects of impingement are discussed in a subsequent section of this report). These downstream fish passage issues impact Trout Creek critical habitat.

3) Impingement

Impingement of fish occurs when water going though a porous object is greater than the fishes' swimming ability to overcome the suction force created by the opening. At Hemlock Dam, there are two primary sources of impingement potential for fish: 1) cracks between flashboards or between flashboards and the dam crest; and 2) the traveling screen that is located at the intake for the Auxiliary Water System (AWS). During routine dam maintenance activities, USFS biologists have over the years observed juvenile steelhead mortality from impingement on these surfaces. This fish passage issue impacts Trout Creek critical habitat.

4) Predation

Increased predation due to migration “bottlenecks” at dams has been well documented. Biologists have observed a variety of piscivorous animals inhabiting Hemlock Lake and feeding in and around the fish passage system. In addition to the direct impacts to fish, increased predation during migration is a source of impact to critical habitat.

5) Recreation/Harassment

Recreational uses of the reservoir can affect fish by harassment and changes to water quality brought on by the recreational uses. The Hemlock Lake recreation site draws approximately 16,000 visitors per year (p. III-42). The majority of the use is from June through September, coinciding in part with the times that numerous juvenile steelhead are present in the reservoir (Connolly and Jezorek 1999). During periods of high water temperature, fish in the reservoir often take refuge in the deepest areas of the reservoir (USDA 2000). These deep areas have been found to have relatively cooler water which appears to provide thermal refuge for fish. Some of these same deep areas are taken advantage of by visitors who want to jump, dive or swim in the reservoir (e.g. from the observation deck and from the rope swing).

4.1.6.1. Alternative A - No Action

Summary

Under this alternative, there would be no planned changes to the structure or operation of Hemlock Dam. Current conditions would continue to persist and existing practices would be maintained. Fish passage at Hemlock Dam would continue to be impeded by the existence of the dam and by the appurtenances associated with the dam that are less than optimal for fish passage. As shown elsewhere in this report, the effects of the dam on habitat and fish passage are responsible for reducing the number of fish returning to Trout Creek by approximately 13 to 23 fish per year depending on analysis method (Rawding 2004). While these are not large numbers in absolute terms, they are significant when viewed in context of the total annual steelhead run in Trout Creek, which has ranged from 8 to 76 fish over the past 10 years. In this light, the dam is potentially responsible for reducing the run by on average 20% to 46% due to its effects on habitat and passage. Cumulatively, the dam is one of a number of factors that affect fish production and survival. These factors are well documented elsewhere, and include habitat conditions in the watershed as well as through the Columbia River and in the Pacific Ocean, passage and predation issues at Bonneville Dam and harvest pressures.

Direct Effects

Upstream Migration

Under this alternative, the effect of the dam and fish ladder on upstream movement of fish would continue at present levels.

Fish Ladder

A number of shortcomings have been identified with the existing ladder, primarily having to do with the size and configuration of the weir pools, the height between pools, and orientation of the ladder (Barber and Perkins 1999). Water passing through the ladder in excess of 4.5 cfs has the potential to give false jumping signals and creates an unsteady flow regime (Orsborn 1987).

Furthermore, the ladder changes from a weir to a slot configuration at the top of the fish ladder. This may result in crowding conditions within the ladder *(ibid.)*.

In recent underwater video photography in the fish ladder, the shortest time for an individual adult steelhead to navigate the fish ladder was 20 minutes. Two other fish were documented as taking two and three hours from bottom to top, and another fish came and went into and out of the fish ladder numerous times, ultimately reaching the top of the ladder and entering the fish trap approximately three weeks after its initial entry into and up the ladder. For undetermined reasons, the ladder may present virtually no difficulty to one fish, but could present a significant delay for another. Because the video study does not allow for tracking of each individual fish (i.e. documentation of the 20-minute migration and three-week migrations were possible only because those particular fish happened to have unique markings/scars that allowed the video viewers to track them through their migration), the data from this study are inadequate to allow determination of the average time for a fish to move past the dam or to evaluate whether the 20-minute migration or the three-week migration is more representative of what most fish experience at the dam.

Once fish reach the top of the ladder, they must enter the trap if they want to successfully pass the dam. Underwater video surveillance of adult steelhead in the fish ladder indicates that the trap causes some hesitation in the continued upstream movement of the fish and may cause some fish to turn around entirely—possibly not completing their journey to upper Trout Creek. Although the underwater video footage has limitations in how individual fish are tracked, there are many more fish "visits" to the entrance to the trap than fish caught in the trap. In general there are 5 to 10 sightings of fish approaching the trap entrance for every fish that is caught in the trap. Most of the fish that initially approach the trap do seem to ultimately enter the trap after multiple approaches. However, some fish have been seen going all the way back down the ladder and leaving the ladder. How many of these fish return and successfully ascend the ladder and enter the trap and how many choose to avoid the trap and find other streams to spawn in is unknown. The average extent of delay that fish experience as they approach and retreat from the trap entrance is also unknown. WDFW has acknowledged the concerns and proposed to modify the trap (letter from D. Rawding 2004).

Fish exiting the fish ladder into the reservoir must pass in front of the dam crest to ascend upstream and are therefore susceptible to fallback (Barber and Perkins 1999). Fallback subjects fish to additional fall mortality and increases migration times as fish relocate the ladder and re-ascend the dam. Fallback of tagged steelhead has been documented at Hemlock Dam, however the percentage or rates of fall back are unknown (WDFW and USFS Hemlock Fish Ladder Adult Trap data, 1992 – 2003). Under this alternative, fish would continue to be exposed to potential fallback which could result in delayed migration, serious injury, and/or increased mortality.

Auxiliary Water Supply

The auxiliary water supply (AWS) that delivers water to the attraction flow chamber at the base of the fish ladder has been identified as a potential problem for upstream migrants in that the flow velocities coming from the pipe far exceed NMFS guidance for such structures (NMFS comments to DEIS on file). Without some form of energy dissipation on the diffuser, fish may continue to be falsely attracted to the diffuser itself instead of toward the entrance to the fish ladder. This condition would continue to influence fish migration at present rates under this alternative.

Operation of the attraction flow may further affect fish passage because the current system requires use of a traveling screen to prevent fish from being sucked into the water intake. Because the screen is not correctly oriented to the flow, debris commonly accumulates on it, resulting in damage or destruction of the motor. Since installation, the screen has been rendered inoperable from two weeks to three months a year. While the screen is disabled, no auxiliary water is provided to the attraction flow chamber and the attraction flow toward the fish ladder is severely diminished. This may confuse fish and delay upstream migration. Under the no action alternative, upstream migration past the dam would be delayed whenever the screen or auxiliary flow is shut off or inoperable.

Downstream Migration

In 1997, a radio telemetry study was done to evaluate the pathways and success of smolts in navigating downstream past the dam during spring flow and high flashboard conditions. The study found that 100% of the smolts chose to go over the central portion of the dam crest on their way downstream, that there was no apparent mortality, and no significant delay at the dam during these high flow flashboard operations (USDA 1997). Figure 4-12 shows the dam with the high flow flashboard configuration which is in operation during smolt migration.

Figure 4-12. 2001 Photograph of Hemlock Dam with the high flow flashboards in place, Skamania County, Washington.

It is reasonable to assume that kelts, parr, fry, and young of the year would have similar success migrating downstream past the dam when flashboards would be installed in such a way as to concentrate spilling water (and fish) over the center portion of the dam and flows would be in the range of 100 – 600 cfs. However, drop mortality could result from fish freefalling over the spillway during low and high flow periods when the fixed object hazards (e.g. bedrock, pipelines) below the dam would be fully exposed, or when flashboards cannot be used to concentrate the spill toward the middle of the channel. For example, in 1995, one dead kelt female steelhead was found below the dam. A subsequent autopsy determined that her back had been broken apparently during the fall over the dam. Traditional operations that negatively influence downstream migrations also impact critical habitat.

A freefall from the top of the dam produces a velocity of 41 feet per second (Barber and Perkins 1999). This rate exceeds the current NMFS drop velocity limitation of 25 feet per second. In addition to the fall velocity itself, approximately 30%of the spillway contains fixed object hazards, which may harm fish if they pass over the spillway toward one side or another of the channel.

Flows of greater than 600 cfs occur on average 65 days per year on Trout Creek, with the majority of those flows occurring in the winter months when juvenile migration would be relatively limited. However, flows exceed 600 cfs on average five days per year during the annual smolt outmigration period of May through June. During these times, smolts, pre-smolts and parr would be at risk of injury and mortality from landing on the fixed object hazards below the dam.

Optimal downstream passage for adults and juveniles can only be sustained during flows of 20 cfs or greater (Barber and Perkins 1999). Summer low flows on Trout Creek are lower than 20 cfs on average 70 days per year. During these periods, optimal conditions for downstream fish passage would be restricted and critical habitat would be impacted. Passage conditions would be severely restricted on an average of 13 days per year when flows drop to less than or equal to eight cfs. Under the no action alternative, these conditions would occur and juvenile steelhead would continue to be affected by low flow passage.

Impingement

When the AWS is operating, flow through the traveling screen can range from 0 – 18 cfs producing an approach velocity of 0 – 0.8 fps at the face of the screen. Current regulatory screening requirements indicate maximum approach velocities of less than 0.4 fps for salmonid fry (USDC 1995b). The existing system can create velocities of more than double the indicated approach velocity (Barber and Perkins 1999).

The risk of juvenile impingement on the traveling screen is high because of the excessive approach velocities, but is further heightened by the lack of sweeping flows (flows that are parallel and adjacent to the screen surface) and excessive screen opening sizes *(ibid.)*. By current NMFS guidelines, the sweeping velocity must be greater than the approach velocity. The existing screen at Hemlock dam is vertical and perpendicular to the flow and as such has no sweeping flows at all. The existing screen has openings of 0.125 inches, exceeding the current 0.094 inch NMFS guidelines by approximately 30%. Maintaining the existing screen opening dimensions would be ineffective at screening juvenile fish (three inches or smaller). This is evidenced by past reports from nursery workers stating that fish and crustaceans that were sucked into the irrigation system had obstructed water sprinkler operations at the former Wind River Nursery (USDA 1996).

Fish would also be prone to being impinged between the cracks in flashboards, particularly during the summer months. The approach velocity at the flashboards is dependent on the hydraulic head on the dam. For example assuming the reservoir is full (4 feet of head on top of the dam) and a crack develops at the base between the boards and the dam crest this would produce an approach velocity of 8.6 fps. A crack just 0.1 feet below the water surface elevation is calculated to produce an approach velocity of 1.75 fps. A layer of impermeable heavy plastic is used to help reduce the risk of impingement on the flashboards. However it would be inevitable that cracks develop producing high velocity jets of water, and increased risk of fish impingement on the flashboards (Figure 4-13).

Figure 4-13. Photograph of Hemlock Dam with low flashboard configuration, Skamania County, Washington.

Indirect Effects

Predation

Under this alternative the dam, fish ladder and reservoir would continue to create conditions that give predators a competitive advantage. Predators would continue to directly and indirectly impede migration, harass and stress fish, inflict serious injury, and/or increase mortality and thereby have an ongoing adverse effect to critical habitat.

Predators including resident rainbow trout, eastern brook trout (*Salvelinus fontinalis*), river otters (*Lutra canadensis*), and mergansers (*Mergus merganser*) have been documented at the reservoir and below the dam. The confinement and concentration of adult and juvenile steelhead below Hemlock Dam and in the fish ladder increases their vulnerability to predation, and the large number of juvenile steelhead that congregate in the reservoir during summer months provides resident rainbow, brook trout, and mergansers with an abundant prey base. In addition, extreme water temperatures in the reservoir may slow prey avoidance reaction and/or concentrate steelhead in cool water pockets, which would increase their vulnerability to predators. USFS biologists have observed mergansers targeting the deep water regions of the reservoir and feeding on juvenile steelhead on numerous occasions. Researchers working on the reservoir during the summer of 2004 documented at least one case of a resident rainbow trout having eaten a juvenile steelhead that had recently been tagged in the reservoir as part of the study (I. Jezorek, pers. com. 2004).

Adult and juvenile steelhead may be most vulnerable to predation when confined within the fish ladder or trap when escape from predators such as otters are difficult. In underwater video footage taken in the fish ladder during the 2003 and 2004 migration periods, otters were observed in the ladder several times.

The presence of otters within the ladder and downstream of the dam may have greater effects on adult steelhead behavior, migration and survival than previously expected. For example, in

October of 2004, four adult steelhead were observed by underwater video cameras in the fish ladder for a period of approximately 12 days. The fish left the site after several appearances of an otter pair in the ladder. As of five months later, only a single fish had returned to the fish ladder. It is unknown whether this fish was one of the four who had previously been in the ladder, or if the five-month absence of these fish indicates that they were caught by the otters or just driven off. In either case, this example shows that at least three or four fish that apparently intended to move upstream in Trout Creek to spawn during the 2005 spawning season may not have followed through, due to the delays at the ladder and harassment or direct predation by otters.

Juvenile steelhead densities within the fish ladder from the same time periods were also affected by the presence of the otters. There was a profound decrease in the relative number and frequency of observations of juveniles following the weeks when otters were in the ladder. While maintaining the video cameras and dam, USFS fisheries personnel have also directly observed the otter pair preying on juvenile steelhead within the reservoir (T. Bair per. com. 2004).

Recreation/Harassment

The direct harassment of fish during such recreational activities would have the potential to stress juvenile fish and drive them away from the thermal refuge in the deeper pools in the reservoir, but may also affect the degree of thermal refuge available in those pockets by mixing the water and destroying any thermal stratification that may be occurring there (see section **4.1.1. Water Quality — Temperature** for a discussion). Moreover, if fish were displaced from the deeper pockets of water, they must then contend with the shallower regions where temperatures are higher and where turbidity levels are increased by visitors who walk or play on the reservoir bottom and stir up the fine sediments of the lakebed.

As human population of Skamania County increases and popularity of the Hemlock Lake Recreation Site continues to increase, the number and frequency of visitors in the reservoir would be expected to increase. At the same time, the reservoir would continue to fill with sediment, reducing the depth and number of deeper pools within the reservoir. The combination of these factors would continue to directly stress juvenile fish in the reservoir, indirectly reducing their options for finding refuge within the reservoir, and crowding fish into remaining areas of refuge, making them more susceptible to predation or disease.

Trout Creek Steelhead Numbers

The number of adult steelhead returning to Trout Creek annually has been monitored at the Hemlock adult trap since 1994. During this period, adult steelhead returns to Trout Creek have been as high as 76 and as low as eight. Under this alternative there is no expected change in the level of effect that the dam has on fish.

Cumulative Effects

Steelhead originating from Trout Creek and returning to spawn there must pass Hemlock Dam and Bonneville Dam in addition to Shipherd Falls. Hemlock and Bonneville Dams are the only two human-built structures of significance that these fish must negotiate in their travel to the ocean and back. Although there is also a fish ladder at Shipherd Falls, native steelhead have historically accessed the Wind River and Trout Creek prior to construction of the ladder, so their use of the ladder at that location is optional. Implementation of this alternative would maintain that condition and these fish would continue to experience the effects of both dams in their migration to the ocean and in their return to Trout Creek. This analysis has been focused on factors within the Wind River watershed because of the array of factors that affect fish once they enter the Columbia River and Pacific Ocean that are beyond our analysis capabilities. Within the Wind River watershed, there are no known cumulative effects of this alternative on fish migration.

4.1.6.2. Alternatives B and C

Summary

These alternatives both remove the dam and restore free-flowing conditions to Trout Creek. There is no appreciable difference in effect on fish migration between the two alternatives since they both immediately restore passage at the Hemlock Dam site and offer long term, unimpeded upstream access. As such their effects are combined here and notations are made where necessary to describe minor differences between the alternative effects. In general, these alternatives eliminate the direct effects of the dam on fish migration and eliminate the indirect effects of the dam on predation and recreational harassment. There are no cumulative effects to fish migration in the Wind River watershed associated with implementing either of these alternatives.

Direct Effects

Removing the dam would allow upstream and downstream passage to occur unimpeded by artificial structures. Upstream migration delays currently resulting from the dam and fish ladder would no longer exist, improving the chances for successful spawning and increased production. Fall or drop mortality for fish moving downstream or for upstream-swimming fish that were once exposed to potentially being swept over the dam would no longer exist. Dam removal would also eliminate potential impingement sources and therefore fish impingement would no longer occur at the site. The net effect of these changes is that fish are more likely to successfully migrate both upstream and downstream through Trout Creek, and success in spawning and surviving their trip to the ocean should be improved, and critical habitat would be benefited.

Indirect Effects

Advantages to predators conferred by the fish ladder and dam would no longer exist. As a result, predation levels at Hemlock are expected to decline from current levels. The magnitude of this effect on actual numbers of fish preyed upon is unknown. The change would be immediate after project implementation and would be persistent over the foreseeable future. Reduced predation would improve the quality of critical habitat.

Recreation within the project area would be expected to continue, however the character and frequency of visits would dramatically change. The effect would be less swimming, less diving, and less area accessible to visitors. Therefore harassment of fish and the effects of increased turbidity from recreational activities would be substantially reduced. The degree of change is dependent in large part on how many people continue to use the site, and how well the site supports continued in-water recreational activities.

Trout Creek Steelhead Numbers

Actual adult steelhead returns to Trout Creek would continue to be influenced by a number of in-watershed and out-of-watershed habitat conditions and other factors that affect survival. Modeling conducted by WDFW (using the Ecosystem Diagnosis and Treatment model or EDT) shows that under the dam removal scenarios, we could expect to see an average of 23 additional steelhead returning to Trout Creek as a result of removing the dam (Rawding 2004). When compared to the numbers of fish that have returned to Trout Creek over the past five years, this equates to an increase of 45% in the size of the Trout Creek steelhead run. When compared against the ten-year average, this would be an increase of 66% in the run size for Trout Creek. These figures are consistent with estimates developed by the USFS for this project (USFS Fisheries Report, Hemlock Dam Analysis File). In a separate analysis, WDFW followed a more “empirical” approach to predicting the effects of dam removal on Trout Creek steelhead, and through this analysis reached a somewhat lower estimate of the predicted increase in returning fish (Rawding 2004). Under the empirical analysis, the numbers of additional fish predicted to return ranged from 10 – 16, which would represent 20 – 31% increases over the average Trout Creek run size of the past five years, and 29 – 46% increases over the average of the past ten years.

The predicted increases in fish returns would be similar under Alternatives B and C, but because of the short term sediment-related effects that occur of Alternative B, the increases in fish returns would probably be delayed for up to several years under that alternative. Alternative C avoids the substantial sediment effects that would occur under Alternative B and would be expected to show a positive response more rapidly.

Cumulative Effects

Steelhead originating from Trout Creek and returning to spawn there must pass Hemlock Dam and Bonneville Dam, in addition to Shipherd Falls. Hemlock and Bonneville Dams are the only two human-built structures of significance that these fish must negotiate in their travel to the ocean and back. Although there is also a fish ladder at Shipherd Falls, native steelhead have historically accessed the Wind River and Trout Creek prior to construction of the ladder, so their use of the ladder at that location is optional. Implementation of either of these alternatives would eliminate one of the two major structures that these fish must negotiate, essentially halving the cumulative effects of those structures on fish passage and survival. This analysis has been focused on factors within the Wind River watershed because of the huge array of factors that affect fish once they enter the Columbia River and Pacific Ocean that are beyond our analysis capabilities. Within the Wind River watershed, there are no known cumulative effects of this alternative on fish migration.

4.1.6.3. Alternative D

Summary

This alternative maintains the existing dam, removes the existing fish ladder and constructs a new ladder that meets current standards and criteria for passage. This alternative would incrementally improve migration at the site by improving the fish passage facilities at the site, and by dredging the reservoir to improve conditions for upstream and downstream migrants.

Direct Effects

Upstream migration

The new fish ladder constructed under this alternative would meet current NMFS guidelines for fish passage and is expected to address the attraction flow, weir configuration, fish crowding and resting condition issues described in Alternative A. Improving conditions in the existing facilities would reduce indirect and direct effects to some degree, and would improve critical habitat.

Downstream migration

Direct and indirect fall or drop mortality associated with the dam would be similar to the existing condition. The construction of a new fish ladder is also expected to improve downstream migration of juvenile fish, and would slightly improve critical habitat.

Impingement

Improvements would be made to the flashboards to eliminate the small gaps that currently exist and pose an impingement threat to juvenile steelhead. In addition, the traveling screen would be modified to provide sweeping flows. Both of these improvements would help reduce the risk of impingement-related mortality, and would benefit critical habitat.

Indirect Effects

Predation

The construction of a new fish ladder under this alternative would be expected to allow fish to more efficiently pass the dam, thereby incrementally reducing the risk of predation. Predation may also be incrementally decreased by the additional depth and hiding cover within the reservoir that would be afforded by the initial dredging and periodic follow-up dredging included in this alternative. These actions would slightly benefit critical habitat. If follow-up dredging is not conducted, the reservoir would be expected to rapidly refill with sediment and incidences of predation within the reservoir would be similar to what was described in Alternative A.

Recreation

In the long term, increased use would be expected as an indirect result of the overall population increase within the Carson / Stevenson area and increased use of the Gifford Pinchot National Forest by the public.

Dredging and increasing the depth of the reservoir would provide fish with additional hiding cover and potentially increased opportunities for thermal refugia. These benefits would be short term and temporary unless periodic dredging occurs as described under these alternatives.

Trout Creek Steelhead Numbers

The number of adult steelhead returning to Trout Creek may be increased under this alternative as a result of improved efficiency of passage at the dam, incremental improvements in water quality, and a reduction in direct effects such as impingement. However, each of these factors would continue to play a role in fish passage, health, and production of steelhead because the dam, fish ladder and reservoir would remain in place. As a result, the increases in steelhead returns to Trout Creek are unknown but expected to be incremental. Although WDFW did not directly model fish returns under this alternative, their empirical analysis illustrated the effect of the reservoir on steelhead production in Trout Creek. Under this alternative, the reservoir remains in place and as a result there would be no improvement or increase in spawning or rearing habitat. Based on the same density dependent assumptions that were used to evaluate the dam removal alternatives, we can conclude that in the best case scenario, the increase in fish returns under this alternative would be estimated at less than half of what was predicted under Alternatives B and C.

Cumulative Effects

Steelhead originating from Trout Creek and returning to spawn there must pass Hemlock Dam and Bonneville Dam in addition to Shipherd Falls. Hemlock and Bonneville Dams are the only two human-built structures of significance that these fish must negotiate in their travel to the ocean and back. Although there is also a fish ladder at Shipherd Falls, native steelhead have historically accessed the Wind River and Trout Creek prior to construction of the ladder, so their use of the ladder at that location is optional. Implementation of this alternative would maintain that condition and these fish would continue to experience the effects of both dams in their migration to the ocean and in their return to Trout Creek. This analysis has been focused on factors within the Wind River watershed because of the array of factors that affect fish once they enter the Columbia River and Pacific Ocean that are beyond our analysis capabilities. Within the Wind River watershed, there are no known cumulative effects of this alternative on fish migration.

4.1.6.4. Alternative E

Summary

This alternative is identical to Alternative D except that under this Alternative the existing fish ladder would be retained and repaired to the extent possible. Effects of this alternative are the same as those described for Alternative D except for two factors which are described here.

Direct and Indirect Effects

Effects of this alternative are nearly identical to those described under Alternative D, with the following exceptions:

Upstream Migration

Maintaining the existing fish ladder and the dam would have very similar effects to fish migration as described by Alternative A. The existing fish ladder would be improved under this alternative, however it would not meet NMFS criteria for fish passage and therefore concerns and deficiencies surrounding the fish ladder weir configuration, fish crowding, and fish resting conditions would not be addressed. These issues would continue to impact critical habitat. The AWS and ladder attraction flow would be improved and would be expected to incrementally reduce direct and indirect effects over Alternative A and would slightly improve critical habitat.

Predation

Potential for predation in and around the fish ladder would continue to be increased as described under Alternative A. In the reservoir, the potential for predation would be the same as described under Alternative D. Increased predation would impact the quality of critical habitat.

4.1.7. Fish Trapping and Monitoring

Potential loss of the ability to trap and count fish (under dam removal scenarios) was identified as an issue by WDFW during scoping for this project. The trap has been in place for over a decade and has served a number of important purposes. In the early 1990’s when WDFW outplanted hatchery steelhead in the Wind River, the trap was used to maintain a genetic reserve of wild steelhead in Trout Creek. Hatchery fish caught at the trap were taken to the Wind River and released, while the wild fish were passed over the dam into upper Trout Creek. The importance of this function of the trap has essentially been eliminated since the late 1990’s when the WDFW stopped planting hatchery fish in the Wind River.

In addition to its function for screening out hatchery fish, the trap has provided an opportunity to collect data on returning adult steelhead, and when combined with smolt data being collected in Trout Creek and elsewhere in the Wind River watershed, this dataset is a valuable and important means of assessing steelhead population dynamics, monitoring restoration effectiveness, and recovery tracking (*ibid*.) As a result of the monitoring being conducted at Hemlock Dam and elsewhere in the watershed, this dataset is one of only six other such high quality datasets on steelhead found on the Pacific Rim (*id*.) Due to the perceived low measurement error, the Governor’s Salmon Recovery Office has designated the Wind River as an intensively monitored watershed (*id*.)

4.1.7.1. Alternative A

Summary

Under the “no action” alternative, no change in the trap or trapping operations would be planned. However, the ability of the FS to continue operation of the trap in its current form could

be affected both by future funding issues and any terms and conditions that are included in a Biological Opinion from National Marine Fisheries Service (NMFS). Currently the trap is funded through a partnership with Bonneville Power Administration. These funds are not guaranteed and may or may not be available for long term trap operations. If this alternative were to be implemented, the trap (along with the other components of the dam) would also need to be evaluated through the consultation process with NMFS and through that processs, operations could be affected by any terms and conditions included in a Biological Opinion.

Direct Effects

Continued operation of the trap would benefit steelhead by allowing greater accuracy in the tracking of populations and by providing data that would allow for evaluation of the effects of in-watershed vs. out-of-watershed factors affecting steelhead. However, unless the trap is modified or replaced, it will continue to reject a proportion of the fish that intend to move upstream past the dam, potentially affecting both the number of fish successfully reaching their spawning grounds and the quality of data collected from this site.

Indirect Effects

The dataset, of which the site at Hemlock Dam is a part, extends from Alaska to northern California. These data would continue to be collected and would contribute to the overall study of migration of steelhead.

Cumulative Effects

There are no known cumulative effects of this alternative on fish counting and enumeration.

4.1.7.2. Alternatives B, C, and D

Summary

These alternatives are similar with respect to the trap because the fish ladder and trap would be removed under each of the three alternatives. As a result, continued enumeration of steelhead in Trout Creek under any of these alternatives would be contingent upon establishment of a new facility or a new method of counting the fish. The USFS has indicated its willingness to consider and permit other options for counting fish and to support the continued monitoring of steelhead. The WDFW has identified potential options for facilities that they would consider as replacements for counting fish at the Hemlock Dam site (Rawding 2004). However, the specifics of any proposed facility construction in Trout Creek are unknown and are outside the scope of this analysis. This would involve an agreement between the USFS and WDFW and financial commitment by the WDFW or other partners.

Direct Effects

Under these alternatives the trap would be removed and counts or estimates of adult fish passage would have to be acquired in some other way. It is possible that the quality of the data would be reduced for some period of time as a new system is put in place—be it a constructed facility or other non-structural means of monitoring. However it is also possible that the quality of data is improved, if a means can be found to count the fish without affecting their migration as the trap now appears to do.

Indirect Effects

Removal of the trap would discontinue operation of a facility that has contributed to a unique and internationally significant monitoring data set (Rawding 2004). It is unknown whether a replacement facility would be constructed or if other methods would be employed to allow continued data collection at this site. In the absence of a replacement strategy, continuation of this dataset would be eliminated and the accuracy of population assessments and tracking of recovery rates for Trout Creek and Wind River fish would be changed.

Cumulative Effects

There are no known cumulative effects of these alternatives on fish counting and enumeration.

4.1.7.3. Alternative E

This alternative would retain and repair the existing fish ladder. The existing trap could remain in place and could be improved or a new trap or other means of counting fish could be constructed at the site, but this would occur as a separate project—it is not included in this alternative design. The effects of this alternative are similar to those described for Alternative A.

4.1.8. Fisheries Effects Common to all Action Alternatives

All action alternatives would require water diversion. The following presents the effects of diverting water for dredging or dam decommissioning.

Heavy machinery used to construct water diversion may disturb fish residing in the immediate vicinity, encouraging up or downstream movement. Initially machinery would have to cross the stream channel above the reservoir to construct the water diversion and fish may be temporarily displaced by equipment. Equipment crossing the stream would generate a short term increase in turbidity which may also cause fish to move up or down stream, and have a minor, short term impact on critical habitat. Direct or indirect mortality would not be expected to occur during water diversion construction.

After the water diversion is constructed, flow would be slowly diverted around the project area. On-site fisheries crews would capture stranded fish with seines and dip nets. After the majority of water is drained from the project area, trained electro-fishing crews would shock isolated pockets of water to extract hiding fish. The capture, transport, and release of federally listed steelhead would cause short term stress and occasional mortality to these fish. Effects of stocking captured fish into a new upstream habitat may lead to competitive interactions with fish residing at the site and in some cases can lead to predation on the disoriented fish being released. Both juvenile and adult stages of steelhead may be subjected to short term stress, but most likely only juveniles would be handled and subject to possible mortality. It is highly unlikely that juvenile and adult chinook salmon (stemming from Carson National Fish Hatchery) would be present in the stream during project activities; therefore these fish would not experience stress or mortality.

Removal of riparian vegetation during temporary access for water diversion and other operations would be expected to be so minimal as to have insignificant effects to floodplain, riparian, and fish habitat functions. The construction of a temporary access trails through the riparian zone to the stream’s edge, in preparation for construction of a diversion dam would incrementally alter riparian vegetation since the majority of equipment would access the project area through the existing boat ramp. These reductions in riparian vegetation will have a slight negative impact on critical habitat.

The dewatered site would temporarily reduce the amount of habitat available to fish, and the diversion structure may temporarily block fish passage. In many cases, the diversion structure would act as a continuation of the barrier presented by the dam; therefore, in such cases the diversion structure would be expected to cause short term impacts to upstream movement of ESA-listed steelhead and short term impacts to critical habitat. Juvenile fish that successfully hide and stay in the reservoir/channel substrate during fish capture and transport efforts would likely suffer mortality upon dewatering.

4.1.9. Endangered Species Act Determinations

Table 4-7. Summary of determinations for ESA listed species by Alternative, Hemlock Dam Fish Passage and Stream Channel Restoration.

Fish Species	Existing Sightings /habitat	Habitat or Species Present	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E
Endangered/Threatened							
Columbia River bull trout	Yes*	Yes*	NE	NLAA	NLAA	NE	NE
Lower Columbia River steelhead trout	Yes	Yes	LAA	LAA	LAA	LAA	LAA
Lower Columbia River steelhead trout Critical habitat	Yes	Yes	LAA	LAA	LAA	LAA	LAA
Lower Columbia River chinook	Yes	Yes	NLAA	LAA	LAA	NLAA	NLAA
Lower Columbia River chinook Critical habitat	Yes	Yes	NLAA	LAA	LAA	NLAA	NLAA
Lower Columbia River coho	Yes*	Yes	NLAA	LAA	LAA	NLAA	NLAA
Middle Columbia River steelhead trout	No*	No*	NE	NLAA	NLAA	NLAA	NLAA
Snake River Spring/Summer chinook	Yes*	Yes*	NE	NLAA	NLAA	NLAA	NLAA
Snake River Fall chinook	Yes*	Yes*	NE	NLAA	NLAA	NLAA	NLAA
Critical Habitat for Snake River chinook	Yes*	Yes*	NE	NLAA	NLAA	NLAA	NLAA
Upper Columbia River Spring chinook	Yes*	Yes*	NE	NLAA	NLAA	NLAA	NLAA
Columbia River chum	No*	No*	NE	NLAA	NLAA	NLAA	NLAA
Snake River sockeye	Yes*	Yes*	NE	NLAA	NLAA	NLAA	NLAA
Critical Habitat for SR sockeye	Yes*	Yes*	NE	NLAA	NLAA	NLAA	NLAA
Proposed, Candidate or Sensitive Species							
Interior Red Band Trout	No	No	NI	NI	NI	NI	NI
Pygmy Whitefish	No	No	NI	NI	NI	NI	NI

*These species are found only in the lower Wind River below Shipherd Falls, and in the Columbia River (RM) 154 – 152, 13-15 river miles below the project area respectively.

NE= No Effect, NLAA = May Affect Not Likely to Adversely Affect; LAA= May Affect Likely to Adversely Affect;.NI = No Impact and NLJ= Not Likely to Jeopardize

Formal consultation has been completed with NMFS on the project described as the preferred alternative and NMFS issued a Biological Opinion on June 1, 2005. This consultation evaluated dam removal effects and the extent of take of listed species in the action area and provided terms and conditions that the USFS must incorporate into the Record of Decision and into the implementation of this project to limit or offset the extent of take.

4.1.10. Magnuson-Stevens Fishery Conservation and Management Act

Essential Fish Habitat (EFH)

The Wind River basin and the Columbia River is designated as Essential Fish Habitat for chinook and coho salmon. chinook and coho salmon EFH in the lower Wind River (RM 10.8 – 0) and Columbia River (RM 154 – 152) may be impacted by fine sediment produced by the action alternatives. Alternatives A, B, D and E are likely to adverse effect (LAA) essential fish habitat in the short term. EFH would be potentially negatively affected for one year by the increase in fine sediment and suspended sediment, which would be delivered to the downstream reaches.

Alternative C may effect but would not likely adversely affect essential fish habitat because the majority of sediment behind the dam would be removed and the long term effects of restoring water temperature regimes, sediment and organic routing and deposition to the lower Wind River would be beneficial to Threatened and Endangered species of fish.

In the long term, Alternatives B and C would restore natural sediment and organic deposition. Deposition would occur north and south of the Highway 14 bridge which is now a consequence and direct result of the construction of Bonneville Dam and backwatering effect of the associated reservoir. In essence, the river is attempting to rebuild its historic fan approximately one mile upstream of the historic confluence. Sediment settling out from the Hemlock Dam project would incrementally contribute to this process and may incrementally decrease the average depth. These effects would be expected to be undetectable in Alternative C.

4.2. Recreation

4.2.1. Visitor Use

Relationship to Purpose and Need and Significant Issues

The loss of recreation opportunities at Hemlock Lake was identified through public comments as a significant issue. Measurement Methods to evaluate visitor use are:

- Predicted change in use (numbers of visitors and types of experiences)

In addition, the Responsible Official directed that certain objectives accompany the primary purpose, including: to continue to support recreational opportunities at the Hemlock site.

The change in population and demographics of Skamania County and the presence or lack of similar recreational opportunities over the next 10 – 15 years was used to evaluate cumulative effects.

Scale of the Anlaysis

Residents of Stabler/Carson represent most of the visitors to the Hemlock Lake site (Chapter 3, p. III-37). Skamania County was therefore chosen as the scope of the cumulative effects analysis. The only foreseeable future action that could affect the amount of visitor use to Hemlock Lake is Skamania County’s development of a day-use, slack-water swimming and boating facility at Rock Creek cove, an inlet of the Columbia River near Stevenson (about 15 miles from Hemlock Lake).

Methodology

For the purposes of this analysis, the increase in population of Skamania County was based on an average decadal trend of between 20 and 25 percent for non-metro recreational counties in the western United States (after Johnson and Beale, 2002). Skamania County is considered to be within reasonable commuting distance of the Portland-Vancouver metropolitan area. Skamania County attracts people seeking a non-urban lifestyle in an area of scenic beauty and close to a variety of outdoor recreational opportunities.

The estimated numbers of groups—or "parties"—who visit Hemlock are a key component in estimating recreational-related expenditures. One way to estimate party counts is to apply an average party size to the total estimated visitor counts. The "Spending Profiles of National Forests" report assessed the average party size recreating on the Gifford Pinchot NF to be 2.5 persons per trip for non-local visitors, and 2.6 for local visitors. Applying these averages to the 16,500 annual visitor estimate for Hemlock Lake, and the assumption that visitation is split 50%/50% between non-local and local visitors, the total number of parties to visit Hemlock annually is 6473 (3,330 non-local and 3,173 local parties). The following assumptions distinguish between local and non-local parties:

Local parties

- Local parties include trips originating from a 30-mile radius of Hemlock, and typically include visitors from Stabler, Carson and Stevenson, Washington.
- Hemlock is their specific destination.

Non-local parties

- Hemlock is a side trip on their visit to the Forest; they would visit this portion of the Forest irrespective of Hemlock Lake.

4.2.1.1. Alternative A – No Action

Direct and Indirect Effects

There would be no change in the facilities offered or the availability of Hemlock Lake Recreation Site for public use. During the summer the lake would continue to offer warm-water wading and swimming opportunities close to the picnic area. Annual sediment deposits would continue to alter the depth of the water and formation of islands. The dam boards would be installed in June and removed in September to maximize the water depth for both fish and visitors. The buoys would remain in place by the bridge to reduce harassment to fish; an additional buoy would be utilized in the deep pool in the southeast portion of the reservoir to further reduce harassment to fish, eliminating one popular swimming hole from public use. Visitor use levels would remain unchanged.

The continued low level presence of USFS personnel on-site would continue to encourage minor law violations such as drug use, minors in possession of alcohol and dogs off-leash.

- 3,173 local parties visit Hemlock annually
- 3,330 non-local parties visit Hemlock annually

Cumulative Effects

Visitor use would most likely increase over time as the population of the Carson/Stevenson area increases. Opportunities for similar lake-oriented recreation, swimming and picnicking may increase within the next decade, however most new developments would not be located within the national forest. The most likely new development would be near Stevenson. Use of the Hemlock Lake site would therefore be mainly from among people living in the closer Carson / Stabler area or by visitors to the national forest.

On peak, hot summer days, site capacity at Hemlock Lake would likely be exceeded at an increased rate over time, resulting in over-crowding of the developed site, and an increase in upstream overflow use. No efforts would be made to manage use when the number of visitors exceeded the maximum recommended “persons-at-one-time” (PAOT) capacity of 105 visitors. Services such as law enforcement and recreation site maintenance would continue at the current level, and possibly decline as USFS budgets decline and the demand for recreational opportunities increase.

4.2.1.2. Alternatives B and C

Direct Effects

The removal of the dam and elimination of the reservoir under both Alternatives B and C would completely change the character of the site and would also completely change the associated recreation opportunities and the numbers and type of user.

The day-use site would remain unchanged, and continue to be the only day-use recreation site on the Mt. Adams District with flush toilets and potable water. The associated opportunities for water-related recreational opportunities in the creek would be downhill and farther away from the existing picnic area. Access to the water would be less convenient for people with limited physical abilities. Use of this site would likely drop considerably without the attraction of the lake, and would be highly dependent on whether or not there are pools in Trout Creek that would provide swimming opportunities.

Once the dam is removed and Trout Creek has stabilized, a trail could be constructed from the developed picnic area to the streamside and depending on the final creek configuration, a few picnic sites could be moved, or new ones established closer to Trout Creek. Development of an off-channel pond has been determined to be a feasible option and would not be precluded by either Alternative B or Alternative C, however the design and the specifications are not sufficiently developed for analysis. If a proposal is developed, it will be analyzed through a separate planning process, resulting in a separate decision. If there are swimming opportunities afforded through channel construction—deep pools—along the trail, it’s expected that the site would receive a fair amount of use, though the USFS does not have sufficient information to accurately predict the magnitude of changes in recreational uses. The overall setting and experiences would be quite different, however, from what they are today.

Without swimming opportunities, most visitors would likely walk the trail but spend relatively little time at Trout Creek compared to current lake use. Some visitors would likely disperse along the stream, as they currently do upstream from the picnic site when the “beach” is crowded. Eventually, the streamside and in-steam conditions would not be too dissimilar from the existing conditions upstream of the day-use area and would provide similar experiences for visitors.

Indirect Effects

A segment of the current users may move to other nearby undeveloped stream-side sites with swimming holes along the Wind River and Trout Creek. These sites already receive a fair amount of use. Additional use could result in “over-use” of these sites, leading to less-than-desirable experiences for all users. Recreation use at these sites would also result in an increase in garbage and human waste, user-created trails causing streambank erosion, and impacts to riparian vegetation. None of these alternative sites offer the experiences that Hemlock Lake offers.

The nearest lake-oriented recreational sites are Goose Lake and Forlorn Lakes. Although the recreational experience of these sites is quite different than Hemlock Lake and they are considerably farther from the Carson / Stabler area (approximately 30 miles) visitor use is expected to increase though not directly as a result of the elimination of Hemlock Lake. Use of all recreational facilities within the national forest is expected to maintain an upward trend.

Public scoping inferred that the improved habitat created by dam removal would elevate returning steelhead numbers sufficiently to allow fishing of wild steelhead on Trout Creek or the Wind River. WDFW maintains a closure on fishing in Trout Creek and a closure on wild steelhead within the Wind River due to the small population size. While dam removal would improve water quality and habitat resulting in a small total increase in the steelhead population, the fishing closures on Trout Creek and the Wind River would most likely remain in effect in the short and near term and not result in an increase in recreational fishing opportunities. WDFW ultimately makes the decision.

- Dam removal would result in a 25 – 75% reduction in local party use (resulting in use by 1,586 – 2,380 local parties, annually)
- Dam removal would result in a 75% reduction in non-local party use (resulting in 793 parties annually)

Cumulative Effects

Demand for all forms of recreation is predicted to increase with the increased population of Skamania County and as people seek recreational opportunities close to urban areas. The elimination of warm-water wading and swimming at Hemlock Lake may compel the development of alternate sites. No additional water-oriented recreation sites are planned for development within the national forest. Use of existing recreational sites with access to water along the Wind River and near lakes would increase within the national forest. These alternate sites would not be as attractive as the Skamania County site at Rock Creek to those displaced by the elimination of Hemlock Lake. Rock Creek represents is closer to the type of recreational experience that was available at Hemlock Lake. For most users of Hemlock Lake, Rock Creek is closer than other lakes on the national forest.

4.2.1.3. Alternatives D and E

Direct and Indirect Effects

Similar to Alternative A, there would be no change in the availability of the Hemlock Lake Recreation Site for public use. Initial dredging would temporarily increase the depth of the reservoir, possibly resulting in lower reservoir temperatures, though any changes would be minimal and short term. Over time, the sediment deposits would alter the depth of the water and formation of islands. The dam boards would be installed in June and removed in September to maximize the water depth for both fish and visitors. The buoys would remain in place by the bridge to reduce harassment to fish; an additional buoy would be utilized in the deep pool in the southeast portion of the reservoir to further reduce harassment to fish.

- 3,173 local parties visit Hemlock annually
- 3,330 non-local parties visit Hemlock annually

Cumulative Effects

The cumulative effects to recreational use from any alternative that results in retention of the dam and the lake would be identical. See Alternative A Cumulative Effects.

4.2.2. Sense of Place: Impacts to Communities and Individuals

The strong attachment that individuals have for Hemlock Lake as a special place is evident from the tone of the numerous letters that were received in response to the proposal to remove the dam during scoping and during the formal comment period for the DEIS. To many people, especially those in the Stabler area, Hemlock Lake represents three essential qualities associated with a sense of place (Ryden 1993): community history, attractive physical landscape, and emotional attachment. This issue recognizes the strong emotional bond that is held by long term residents of Stabler and frequent visitors to Hemlock Lake.

Analysis Scale

Hemlock Lake and recreation area.

Methodology

Surveys to specifically assess sense of place were not specifically conducted for this assessment. Letters and comments received during scoping were used to evaluate the importance of Hemlock Lake as a recreation site. Table 4-8, tabulates the number of scoping comments per the five categories, and notes the city included in the return address (letter or e-mail). The commenter's city of origin is important to understand how communities may be impacted by dam removal. All of the commenters who expressed a long term connection to Hemlock Lake were submitted by people from Stabler and Carson, Washington; and all commenters citing Hemlock Lake as an important recreation facility were from Carson or Stevenson: the common thread is that all commenters in these two categories are from Skamania County. Those expressing support for dam removal with no comments on recreation were submitted from the broadest geographical range: California, Oregon and Washington.

Table 4-8. Tabulation of comments expressed in terms of importance of Hemlock Lake as a recreation site. Comments referenced by city of origin; numbers in parentheses indicate the number of comments received per city/per comment category.

Expressed a Long-Term Connection to Hemlock Lake	Expressed Interest in Hemlock Lake as a Special or Important Place for Recreation	Acknowledged Loss of Current Rec Opportunities and the Need For Alternate Opportunities	Expressed Support for Dam Removal and That Fish Should Not Be Sacrificed for Recreation	Expressed Support For Dam Removal With No Comment On Recreation
Carson, Wa (2)	Carson, WA (1)	Bellingham, WA (1)	Portland, OR (1)	Davis, CA (1)
Stabler, WA (5)	Stevenson, WA (3)	Naselle, WA (1)	Carson, WA (1)	Walnut Creek, CA (1)
		Olympia, WA (1)	Stevenson, WA (1)	Cascade Locks, OR (1)
		Portland, WA (1)	Underwood, WA (1)	Lake Oswego, OR (1)
		Vancouver, WA (1)	Vancouver, WA (1)	Portland, OR (4)
		Yacolt, WA (1)		Amboy, WA (1)
		US Congress (1)		Bothel, WA (1)
				Kirkland, WA (1)
				La Center, WA (1)
				Pullman, WA (1)
				Seattle, WA (3)
				Vancouver, WA (3)
				White Salmon, WA (1)

4.2.2.1. Alternative A

Direct and Indirect Effects

From the letters and comments received, the long term residents of the local communities have formed a strong attachment to Hemlock Lake over decades of use. In addition, members of the Yakama Nation and the Confederated Tribes of the Warm Springs have used the area as a stopping point on the way to huckleberry fields at higher elevations in the Forest, as their ancestors have for millennia. Other users, local and non-local, who have a more recent connection with the site also value the experiences Hemlock Lake offers, and they, too, may have formed emotional bonds with the site. For all of these residents/visitors, these attachments would remain intact with Alternative A.

In spite of their current use of Hemlock Lake for recreation, Tribal representatives for the Yakama Nation (Washines, pers. com. 2001), referring to a concept of “first in time, first in importance" specifically emphasized during discussions with the Forest that from the tribe's perspective, the fish resource in Trout Creek was more important than recreational use of Hemlock Lake and supported removal of Hemlock Dam if it resulted in a benefit to anadromous fish. Retaining the dam would not meet their priority use of the site.

Other respondents who expressed value in the site as a place to remove a dam to restore habitat for the Threatened fishery, may experience a more abstract loss of an opportunity for restoration than a specific desire to transform the Hemlock site.

Cumulative Effects

Future demand for recreational opportunities and changes in the local demographics may alter the emotional connection that Stabler residents have with the Hemlock Lake site. It is likely that the feeling of close-knit community will gradually fade as the population of the local area increases, gradually replacing those with fond memories of enjoying summer days at the lake with neighbors and extended family. Areas such as Stabler with rural, scenic attractions will serve as “bedroom” communities to larger urban areas. The demand for recreational opportunities will bring in more users from more distant locations, gradually diluting the sense of a neighborhood recreational site.

4.2.2.2. Alternatives B and C

Direct and Indirect Effects

It is clear from the scoping letters and comments that the elimination of Hemlock Lake would be a devastating and irreplaceable loss to members of the local communities. This would be true for residents of Stabler and Carson whose comments reflect a long term emotional connection to the area, as well as those from Stevenson, whose comments reflect a strong tie to the specific recreational opportunities provided at the site.

The Hemlock Lake Recreation Site has experienced an increase in use from non-local visitors in recent times. It is not known to what extent these users may have also developed attachments to Hemlock, but it is likely that some have given the unique experiences the lake offers. These users, too, would feel a sense of loss, though not on the same scale as local residents, some of who have experiences with the site that span more than 50 years.

Respondents who support dam removal viewed the site as a place that, as restored, would contribute to the recovery of the threatened fishery. Removal of the dam would fulfill this sense of place. This would be specifically true for the Yakama Nation which views the fisheries resource as more important than recreation. Conversely, members of the Yakama Nation and the

Confederated Tribes of the Warm Springs would now have a site restored to historic conditions to visit on their way to the huckleberry fields.

Cumulative Effects

There are at present no substitutes for Hemlock Lake. If similar lake-related opportunities were developed in the area in the future, the three essential items associated with sense of place, community history, physical landscape appearance, and emotional attachment—would be lacking and the substitute areas would not fulfill the emotional bond that Hemlock Lake provides.

4.2.2.3. Alternatives D and E

The direct, indirect and cumulative effects of retaining the dam and lake under Alternatives D and E would be similar to those identified for Alternative A.

4.3. Cultural Resources

4.3.1. Historic Structures

Relationship to Purpose and Need and Significant Issues

Removal or alternation of the historic fish ladder was identified as a significant issue. The extent of impact will be assessed by the following Measurement Methods:

- Number of historic structures altered or destroyed
- Degree of alteration to historic properties

Regulatory Framework

Under section 106 of the National Historic Preservation Act (NHPA) of 1966, as amended (16 USC § 470 *et seq*.), Federal agencies are to consider the effects of their undertakings (including the expenditure of federal funding and federal projects) on historic resources that are either eligible for listing or are listed on the National Register of Historic Places. Section 110 of the NHPA imposes another obligation on Federal agencies that own or control historic resources. Under this section, Federal agencies must consider historic preservation of historic resources as part of their management responsibilities.

As part of the analysis process, each agency must consult with the State Historic Preservation Office (SHPO) to assure that cultural resources are identified, and to obtain the formal opinion of the Office on each site's significance and the impact of its action upon the site.

4.3.1.1. Alternative A - No Action

This alternative would have no impacts on historic structures.

4.3.1.2. Alternative B

Direct and Indirect effects

This action would result in the destruction of an historic property. This meets the criteria of adverse effect as defined in 36 CFR 800.5. In order to partially mitigate these adverse effects, the fish ladder would be left in place for interpretive purposes. The dam and fish ladder would be documented using the accepted format of the Historic American Building Survey/Historic American Engineering Record (HABS/HAER). Documentation would include structural plans and 35 mm black and white photographs of the dam and fish ladder and its surroundings. Photographs would be labeled according to HABS/HAER standards. Oral history information would also be included as part of the written report, which would be submitted to Washington State Office of Archaeology and Historic Preservation, Advisory Council on Historic Preservation, and National Park Service.

Cumulative Effects

The dam and fish ladder were modified in 1995, with the addition of a concrete wall extending out from the downstream end of the fish ladder, towards the face of the dam. The lowest weir of the fish ladder had its weir wall replaced with a wall and slot. A waterline was installed to transport water to the base of the fish ladder. This consisted of a 24" polyethylene pipe, originating at the concrete enclosure for the traveling screen. A 26" diameter hole was drilled in the enclosure wall downstream of the screen, and the waterline was attached to the upstream face of the dam. Another 26" diameter hole was drilled near the south end of the dam, and the waterline was taken through the dam at this point, where it can spill out over the end of the fish ladder. The traveling screen was also modified. These modifications were determined to have an effect on the dam and fish ladder that was not adverse.

A legislated land conveyance in 2000 resulted in effects to the Wind River Administrative Site Historic District. Prior to the conveyance, this historic district contained 24 historic structures and three historic landscapes. As a result of the conveyance, six historic buildings were transferred out of federal ownership, along with portions of two historic landscapes. The conveyance also included the location of 17 former structures, which were also transferred out of federal ownership.

4.3.1.3. Alternative C

Direct and Indirect effects

This action would result in the destruction of an historic property. This meets the criteria of adverse effect as defined in 36 CFR 800.5. In order to partially mitigate these adverse effects, the fish ladder would be left in place for interpretive purposes. The dam and fish ladder would be documented using the accepted format of the Historic American Building Survey/Historic American Engineering Record (HABS/HAER). Documentation would include structural plans and 35 mm black and white photographs of the dam and fish ladder and its surroundings. Photographs would be labeled according to HABS/HAER standards. Oral history information would also be included as part of the written report, which would be submitted to Washington State Office of Archaeology and Historic Preservation, Advisory Council on Historic Preservation, and National Park Service.

Cumulative Effects

The dam and fish ladder were modified in 1995, with the addition of a concrete wall extending out from the downstream end of the fish ladder, towards the face of the dam. The lowest weir of the fish ladder had its weir wall replaced with a wall and slot. A waterline was installed to transport water to the base of the fish ladder. This consisted of a 24" polyethylene pipe, originating at the concrete enclosure for the traveling screen. A 26" diameter hole was drilled in the enclosure wall downstream of the screen, and the waterline was attached to the upstream face of the dam. Another 26" diameter hole was drilled near the south end of the dam, and the waterline was taken through the dam at this point, where it can spill out over the end of the fish ladder. The traveling screen was also modified. These modifications were determined to have an effect on the dam and fish ladder that was not adverse.

A legislated land conveyance in 2000 resulted in effects to the Wind River Administrative Site Historic District. Prior to the conveyance, this historic district contained 24 historic structures and three historic landscapes. As a result of the conveyance, six historic buildings were transferred out of federal ownership, along with portions of two historic landscapes. The conveyance also included the location of 17 former structures.

4.3.1.4. Alternative D

Direct and Indirect effects

Although the dam would not be proposed for removal under this alternative, modifications to the dam would take place. Some modifications, such as installing a bypass pipe or chute to route fish from the screen to below the dam, could result in effects to this historic property.

Replacement of fish ladder and construction of new ladder would result in an adverse effect to an historic property.

Cumulative Effects

The dam and fish ladder were modified in 1995, with the addition of a concrete wall extending out from the downstream end of the fish ladder, towards the face of the dam. The lowest weir of the fish ladder had its weir wall replaced with a wall and slot. A waterline was installed to transport water to the base of the fish ladder. This consisted of a 24” polyethylene pipe, originating at the concrete enclosure for the traveling screen. A 26” diameter hole was drilled in the enclosure wall downstream of the screen, and the waterline was attached to the upstream face of the dam. Another 26” diameter hole was drilled near the south end of the dam, and the waterline was taken through the dam at this point, where it can spill out over the end of the fish ladder. The traveling screen was also modified. These modifications were determined to have an effect on the dam and fish ladder that was not adverse.

4.3.1.5. Alternative E

Direct and Indirect Effects

Although the dam would not be proposed for removal under this alternative, modifications to the dam would take place. Some modifications, such as installing a bypass pipe or chute to route fish from the screen to below the dam, could result in effects to this historic property. These effects would probably not be adverse. The historic fish ladder would be retained.

Cumulative Effects

The dam and fish ladder were modified in 1995, with the addition of a concrete wall extending out from the downstream end of the fish ladder, towards the face of the dam. The lowest weir of the fish ladder had its weir wall replaced with a wall and slot. A waterline was installed to transport water to the base of the fish ladder. This consisted of a 24” polyethylene pipe, originating at the concrete enclosure for the traveling screen. A 26” diameter hole was drilled in the enclosure wall downstream of the screen, and the waterline was attached to the upstream face of the dam. Another 26” diameter hole was drilled near the south end of the dam, and the waterline was taken through the dam at this point, where it can spill out over the end of the fish ladder. The traveling screen was also modified. These modifications were determined to have an effect on the dam and fish ladder that was not adverse.

4.3.2. Archaeological Sites

Relationship to Purpose and Need and Significant Issues

A significant issue was identifies from the removal of Hemlock Dam and its fish ladder, construction of equipment access routes, dredging of sediments, and streambank restoration activities that could result in direct and indirect impacts to the archaeological remains of the Trout Creek Site, a site that has been determined eligible for listing on the National Register of Historic Places. Dredging of sediments could result in direct impacts to remains of the Wind River Lumber Company's splash dam. The extent of impact would be determined by the following Measurement Method:

- Percentage of archaeological site disturbed

Regulatory Framework

Under section 106 of the National Historic Preservation Act (NHPA) of 1966, as amended (16 USC § 470 *et seq.*), Federal agencies are to consider the effects of their undertakings (including the expenditure of federal funding and federal projects) on historic resources that are either eligible for listing or are listed on the National Register of Historic Places. Section 110 of the NHPA imposes another obligation on Federal agencies that own or control historic resources. Under this section, Federal agencies must consider historic preservation of historic resources as part of their management responsibilities.

As part of the analysis process, each agency must consult with the State Historic Preservation Office (SHPO) to assure that cultural resources are identified, and to obtain the formal opinion of the Office on each site's significance and the impact of its action upon the site.

4.3.2.1. Alternative A - No Action

This alternative would result in no impacts to documented archaeological sites.

4.3.2.2. Alternative B

Direct and Indirect Effects

Heavy equipment needed for dam removal and dredging would impact portions of the Trout Creek archaeological site. Damage to the Trout Creek site as a result of heavy equipment use and access would constitute an adverse effect to the site as defined in 36 CFR 800.5. Three equipment access points have been identified within the boundaries of the site, and although each of these areas has been previously disturbed to some degree, it is likely that further disturbance would occur as a result of this project. These three areas include the existing access road to the pumphouse, the area adjacent to the concrete bridge, and the existing boat launch at the western end of the picnic area. This area equates to 540 m^2, or 0.2% of the site (approximately 180 m^2 of this area has already been modified).

There would be a potential for direct effects to remains of Wind River Lumber Company's splash dam. Although it was replaced by the concrete dam in 1935, portions of the structure have been found intact along the north shoreline, and it is possible that additional portions of the structure remain in the reservoir itself. Dredging activities could result in impacts to these remains.

Rehabilitation and revegetation of the shoreline could result in disturbance of portions of the Trout Creek site which have been inundated since dam construction. Recontouring of the shoreline could result in burial of site deposits.

The dewatering pipe would be buried in the vicinity of the boat launch, and depending on its proximity to the shoreline, could impact currently inundated site deposits.

There is a potential for direct effect to portions of the Wind River Administrative Site Historic District. Historic archaeological remains of the earliest Ranger Station structures were located near what is now the southern approach to the concrete bridge. Depending on depth of disturbance, heavy equipment access along the southern shore could result in impacts to this site.

There is a potential for indirect effects to an archaeological site as a result of dredge material disposal. Material would be disposed of in the Pacific Crest nursery fields, immediately adjacent to the site 45AS221. The dredge disposal material would be placed outside the boundary of site 45SA221, although the presence of heavy equipment and people in the area could result in impacts to the site.

Cumulative Effects

Numerous ground-disturbing activities have occurred within the boundaries of the Trout Creek site. Within the last ten years, new developments at the Hemlock Lake picnic area included construction of barrier-free trails, a viewing deck, a picnic shelter, a boat launch, an information kiosk, a new site sign, and buried concrete piers for picnic tables. This resulted in effects to approximately 31% of the site's area. Removal of modular buildings and subsequent construction of walkways in 1995 resulted in effects to approximately 1% of the site's area. A legislated land conveyance in 1999 resulted in the conveyance of 18% of the site out of federal ownership.

4.3.2.3. Alternative C

Direct and Indirect Effects

Heavy equipment needed for dam removal and dredging would impact portions of the Trout Creek archaeological site. Damage to the Trout Creek site as a result of heavy equipment use and access would constitute an adverse effect to the site as defined in 36 CFR 800.5. Three equipment access points have been identified within the boundaries of the site, and although each of these areas has been previously disturbed to some degree, it is likely that further disturbance would occur as a result of this project. These three areas include the existing access road to the pumphouse, the area adjacent to the concrete bridge, and the existing boat launch at the western end of the picnic area. This area equates to 540 m^2, or 0.2% of the site (approximately 180 m^2 of this area has already been modified, as a result of utilities, etc.).

There is a potential for direct impacts to remains of Wind River Lumber Company's splash dam. Although it was replaced by the concrete dam in 1935, portions of the structure have been found intact along the north shoreline, and it is possible that additional portions of the structure remain in the reservoir itself. Dredging activities could result in impacts to these remains.

Rehabilitation and revegetation of the shoreline could result in disturbance of portions of the Trout Creek site which have been inundated since dam construction. Recontouring of the shoreline could result in burial of site deposits.

The dewatering pipe will be buried in the vicinity of the boat launch, and depending on its proximity to the shoreline, could impact currently inundated site deposits.

There is a potential for direct effect to portions of the Wind River Administrative Site Historic District. Historic archaeological remains of the earliest Ranger Station structures were located near what is now the southern approach to the concrete bridge. Depending on depth of disturbance, heavy equipment access along the southern shore could result in impacts to this site.

There is a potential for indirect effects to an archaeological site as a result of dredge material disposal. Material would be disposed of in the Pacific Crest nursery fields, immediately adjacent to the site 45AS221. The dredge disposal material would be placed outside the boundary of site 45SA221, although the presence of heavy equipment and people in the area could result in impacts to the site.

Cumulative Effects

Numerous ground-disturbing activities have occurred within the boundaries of the Trout Creek site. Within the last ten years, new developments at the Hemlock Lake picnic area included construction of barrier-free trails, a viewing deck, a picnic shelter, a boat launch, an information kiosk, a new site sign, and buried concrete piers for picnic tables. This resulted in effects to approximately 31% of the site's area. Removal of modular buildings and subsequent construction of walkways in 1995 resulted in effects to approximately 1% of the site's area. A legislated land conveyance in 1999 resulted in the conveyance of 18% of the site out of federal ownership.

4.3.2.4. Alternative D

Direct and Indirect Effects

Access for dredging equipment at the boat launch would result in direct effects to the prehistoric component of the Trout Creek site. This area equates to 150 m^2, or 0.05% of the site. Damage to the Trout Creek site as a result of heavy equipment use and access would constitute an adverse effect to the site as defined in 36 CFR 800.5.

There is a potential for direct effects to remains of Wind River Lumber Company's splash dam. Although it was replaced by the concrete dam in 1935, portions of the structure have been found intact along the north shoreline, and it is possible that additional portions of the structure remain in the reservoir itself. Dredging activities could result in impacts to these remains.

There is a potential for indirect effects to an archaeological site as a result of dredge material disposal. Material would be disposed of in the Pacific Crest nursery fields, immediately adjacent to the site 45AS221. The dredge disposal material would be placed outside the boundary of site 45SA221, although the presence of heavy equipment and people in the area could indirectly result in vandalism to the site.

Cumulative Effects

Numerous ground-disturbing activities have occurred within the boundaries of the Trout Creek site. Within the last ten years, new developments at the Hemlock Lake picnic area included construction of barrier-free trails, a viewing deck, a picnic shelter, a boat launch, an information kiosk, a new site sign, and buried concrete piers for picnic tables. This resulted in effects to approximately 31% of the site's area. Removal of modular buildings and subsequent construction of walkways in 1995 resulted in effects to approximately 1% of the site's area. A legislated land conveyance in 1999 resulted in the conveyance of 18% of the site out of federal ownership.

4.3.2.5. Alternative E

Direct and Indirect Effects

Access for dredging equipment at the boat launch would result in direct effects to the prehistoric component of the Trout Creek site. This area equates to 150 m^2, or 0.05% of the site. Damage to the Trout Creek site as a result of heavy equipment use and access would constitute an adverse effect to the site as defined in 36 CFR 800.5.

There is a potential for indirect effects to remains of Wind River Lumber Company's splash dam. Although it was replaced by the concrete dam in 1935, portions of the structure have been found intact along the north shoreline, and it is possible that additional portions of the structure remain in the reservoir itself. Dredging activities could result in impacts to these remains.

There is a potential for indirect effects to an archaeological site as a result of dredge material disposal. Material would be disposed of in the Pacific Crest nursery fields, immediately adjacent to the site 45AS221. The dredge disposal material would be placed outside the boundary of site 45SA221, although the presence of heavy equipment and people in the area could indirectly result in vandalism to the site.

Cumulative Effects

Numerous ground-disturbing activities have occurred within the boundaries of the Trout Creek site. Within the last ten years, new developments at the Hemlock Lake picnic area included construction of barrier-free trails, a viewing deck, a picnic shelter, a boat launch, an information kiosk, a new site sign, and buried concrete piers for picnic tables. This resulted in effects to approximately 31% of the site's area. Removal of modular buildings and subsequent construction of walkways in 1995 resulted in effects to approximately 1% of the site's area. A legislated land conveyance in 1999 resulted in the conveyance of 18% of the site out of federal ownership.

4.4. Threatened and Endangered Wildlife Species

Regulatory Framework

The Endangered Species Act (ESA) of 1973, as amended, 50 CFR 402 (2000) and its implementing regulations prohibit Federal agencies from authorizing any action that will result in the destruction or adverse modification of critical habitat. The ESA also requires the USFS to manage for the recovery of Threatened and Endangered species and the ecosystem on which they depend.

Section 7 of the ESA directs all Federal agencies to use their existing authorities to conserve Threatened and Endangered species and, in consultation with the Service, to ensure that their actions do not jeopardize listed species or destroy or adversely modify critical habitat. Section 7 applies to management of federal lands as well as other federal actions that may affect listed species, such as federal approval of private activities through the issuance of federal permits, licenses, or other actions.

In December, 2004 the USFS requested informal consultation with the U. S. Fish and Wildlife Service (USFWS) for effects to listed wildlife species and resident fish. The USFS determined that this action was "not likely to adversely affect" bald eagle *(Haliaeetus leucocephalus),* northern spotted owl *(Strix occidentalis caurina)* and Columbia River bull trout *(Salvelinus confluentus).* In January 2005 the USFS received concurrence with the USFS effects determinations for these species.

4.4.1. Bald Eagle (Threatened)

4.4.1.1. Alternative A – No Action

The No Action alternative would have no new effect on bald eagles, however the opportunity to increase the available prey base would be lost. The ability for eagles to forage at Hemlock Lake would be maintained in the short term. If the reservoir fills with sediment in the long term, the ability to forage there would be lost.

4.4.1.2. Alternative B

Direct and Indirect Effects

This alternative would return Trout Creek to a free-flowing system that hasn't existed for about 102 years. It is likely that steelhead populations in the creek and in Wind River would increase as more adult fish access spawning habitat above the dam site and more juveniles are able to safely make their way downstream. An increase in the steelhead populations would increase potential prey for bald eagles. Since the steelhead population in the Wind River Watershed is controlled by many different variables beyond the watershed, it is impossible to predict the magnitude of the effect of removing the dam.

Approximately 600 truck loads would be required to move the dredge spoils and 29 truck loads to move the dam materials. Due to the low likelihood of bald eagles being in the area of Hemlock Lake, they are not likely to be disturbed during the process of dismantling the dam and hauling the dam and dredge spoil material to the storage areas.

Because of the negligible potential to disturb bald eagles during the process of dismantling the dam and transporting the spoils material this alternative may affect but is not likely to adversely affect bald eagles.

Cumulative Effects

The beneficial effect of increased prey base is cumulative to other habitat restoration projects that have been planned and accomplished in the Wind River Watershed that have improved spawning and rearing habitat for steelhead. These projects include the Mining Reach and the planned Upper Trout projects.

4.4.1.3. Alternative C

Direct and Indirect Effects

This alternative would have essentially the same effects as Alternative B. The difference is that the number of truck loads of dredge spoils to be moved would be 7,700 to 11,000 dump truck loads. Due to the low likelihood of bald eagles being in the area of Hemlock Lake, they are not likely to be disturbed during the process of dismantling the dam and hauling the dam and dredge spoil material to the storage areas.

Because of the negligible potential to disturb bald eagles during the process of dismantling the dam and transporting the spoils material this alternative may affect but is not likely to adversely affect bald eagles.

Cumulative Effects

Cumulative effects would be the same as with Alternative B.

4.4.1.4. Alternative D

Direct and Indirect Effects

This alternative would improve deficiencies in the dam that make it difficult for fish to pass upstream and downstream. It is possible that these improvements would result in increased numbers of fish in Trout Creek and Wind River that would increase the potential prey base for bald eagles. Since the steelhead population in the Wind River Watershed is controlled by many different variables beyond the watershed, it is impossible to predict the magnitude of the effect of removing the dam.

The reservoir would be dredged and approximately 5,500 truck loads of dredge spoils would transported to the nursery field. Due to the low likelihood of bald eagles being in the area of Hemlock Lake, they are not likely to be disturbed during the process of hauling the dredge spoil material to the storage areas.

Because of the negligible potential to disturb bald eagles during the process of dismantling the dam and transporting the spoils material this alternative may affect but is not likely to adversely affect bald eagles.

Cumulative Effects

If this alternative results in increased steelhead population in Trout Creek, the effects would be cumulative to other habitat restoration projects in the Wind River Drainage, including the Mining Reach and the Upper Trout Creek project.

4.4.1.5. Alternative E

Direct and Indirect Effects

The effects of this alternative would be essentially the same as Alternative D.

Because of the negligible potential to disturb bald eagles during the process of dismantling the dam and transporting the spoils material this alternative may affect but is not likely to adversely affect bald eagles.

4.4.2. Northern Spotted Owl and Northern Spotted Owl Habitat (Threatened)

4.4.2.1. Alternative A – No Action

The No Action Alternative would have no new effects on spotted owl.

4.4.2.2. Alternative B

Direct and Indirect Effects

Implementation of this alternative would not result in any loss of suitable habitat or affect Critical Habitat Unit WA-41. In the long term, the amount of suitable habitat in the project area may increase slightly as the former reservoir is reclaimed, and large trees re-establish on the site.

There is a potential to affect spotted owls due to noise disturbance. Relatively constant noise that would be produced by removal of the dam and dredging the reservoir would be above ambient levels. If explosives are used to demolish the dam, the noise effects could extend out a mile around the work site. The negative effects of noise produced by jackhammers and rock drills would extend out 60 yards and noise produced by heavy equipment would extend out 35 yards from the work site. Since the suitable nesting habitat stand near the dam and reservoir is at least 150 yards from where work would occur, limited operating periods are not required for the use of heavy equipment, or jackhammers and rock drills. In addition, blasting using charges less than 2 pounds would not require a limited operating period. Blasting using more than 2 pounds of explosives however, would be prohibited from March 1 to June 30.

Approximately 600 dump truck loads of dredge spoils would be transported to the old nursery field and dumped. Only a minor amount of suitable habitat that is along the edge of the nursery field is within 35 yards of the field. State permit requirements would require that the dredging and spoil transport take place after June 30, so the work would happen outside of the early nesting period. This would minimize the potential to disturb nesting spotted owls.

Due to the creation of noise above ambient levels in the vicinity of spotted owl habitat, and the negligible potential to disturb spotted owls, this alternative may affect but is not likely to adversely affect spotted owls.

Cumulative Effects

This alternative would not cause a reduction in suitable habitat, for this reason there would be no cumulative effects.

4.4.2.3. Alternative C

Direct and Indirect Effects

Implementation of this alternative would remove the dam, and dredge all sediments from the reservoir. Implementation of this alternative would not result in any loss of suitable habitat or affect Critical Habitat Unit WA-41. The difference from Alternative B is that the number of truck loads of dredge spoils to be moved would be 7,700 to 11,000 dump truck loads. State permit requirements would require that the dredging and spoil transport take place after June 30, so the work would happen outside of the early nesting period. This would minimize the potential to disturb nesting spotted owls.

Due to the creation of noise above ambient levels in the vicinity of spotted owl habitat, and the negligible potential to disturb spotted owls, this alternative may affect but is not likely to adversely affect spotted owls.

Cumulative Effects

This alternative would not cause a reduction in suitable habitat, for this reason there would be no cumulative effects.

4.4.2.4. Alternative D

Direct and Indirect Effects

This alternative would leave the dam in place while dredging sediments from the reservoir bottom. Dredging would require about 5,500 truck loads to transport the material to the storage site. There would be no reduction in suitable habitat, and no affect to Critical Habitat Unit WA-41. State permit requirements would require that the dredging and spoil transport take place after June 30, so the work would happen outside of the early nesting period. This would minimize the potential to disturb nesting spotted owls.

Due to the creation of noise above ambient levels in the vicinity of spotted owl habitat, and the negligible potential to disturb spotted owls, this alternative may affect but is not likely to adversely affect spotted owls.

Cumulative Effects

This alternative would not cause a reduction in suitable habitat, for this reason there would be no cumulative effects.

4.4.2.5. Alternative E

Direct and Indirect Effects

The effects of this alternative would be essentially the same as Alternative D.

State permit requirements would require that the dredging and spoil transport take place after June 30, so the work would happen outside of the early nesting period. This would minimize the potential to disturb nesting spotted owls.

Due to the creation of noise above ambient levels in the vicinity of spotted owl habitat, and the negligible potential to disturb spotted owls, this alternative may affect but is not likely to adversely affect spotted owls.

Cumulative Effects

This alternative would not cause a reduction in suitable habitat, for this reason there would be no cumulative effects.

4.5. Sensitive Wildlife Species

Regulatory Framework

The National Forest Management Act (NFMA) and implementing regulations [36 CFR 219 (1982)] require the Secretary of Agriculture to provide for species viability and diversity of plant and animal communities. The USFS defines Sensitive species as those plant and animal species identified by a regional forester for which population viability is a concern, as evidenced by significant current or predicted downward trends in population numbers or density, or significant current or predicted downward trends in habitat capability that would reduce a species' existing distribution. Regional Foresters shall identify Sensitive species occurring within the region.

4.5.1. Cascade Torrent Salamander, Cope’s Giant Salamander

4.5.1.1. Alternative A – No Action

This alternative would have no new effects on these salamanders. The opportunity to improve connectivity within the Trout Creek sub-watershed would be forgone.

4.5.1.2. Alternative B

Direct and Indirect Effects

Hemlock Lake is not suitable habitat for these species, especially during the warm summer months. Due to the large size of Trout Creek below the dam, it is unlikely that either of these salamander species is a resident there. They may utilize Trout Creek as a corridor to access smaller tributary streams, and removal of the dam would reconnect habitat above and below the dam. In addition, movement of large wood down Trout Creek past the current dam site would improve habitat in the lower portion of Trout Creek. It is unknown how common it is for these species to disperse along Trout Creek, so the beneficial effect could be minor.

With this alternative, the majority of the sediment behind the dam would be allowed to erode downstream. If there were salamanders in the creek below the dam, this flush of sediment would likely cover habitat elements such as cobble at the edge of the water. Due to the low likelihood of these species inhabiting Trout Creek below the dam, this alternative may impact individuals, but would not lead to a trend toward federal listing or a loss of species or population viability.

Cumulative Effects

Sediment produced by other upstream projects would be cumulative to this alternative. The Upper Trout fisheries restoration project would produce minor amounts of sediment. Most of this work will likely be completed before implementing this alternative, so the cumulative effects would be negligible.

4.5.1.3. Alternative C

Direct and Indirect Effects

This alternative would remove the dam and reconnect habitat as in Alternative B. The difference would be that the majority of the accumulated sediment would be removed and stored at an upland site. Since there would be little sediment produced, this alternative would have no impact on these salamanders.

Cumulative Effects

There would be cumulative effects.

4.5.1.4. Alternatives D and E

Direct and Indirect Effects

These alternatives would leave the dam in place so the opportunity to reconnect habitat would be forgone. Annual routing of sediment during high flow periods would simulate natural conditions, and would not affect these species. Since there would be no new effects to these salamanders, these alternatives would have no impact to these species.

Cumulative Effects

There would be no cumulative effects.

4.5.2. Townsend’s Big-Eared Bat

4.5.2.1. Alternative A – No Action

Direct and Indirect Effects

There would be no new impacts with this alternative.

4.5.2.2. Alternatives B and C

Direct and Indirect Effects

These alternatives would return the system to a riverine system. Since this bat forages along forest and stream edges, foraging conditions may be improved as the former reservoir bed revegetates. Since there are no known populations in the area, any improvement would not likely affect this species. These alternatives would have no impact on Townsend's big-eared bat.

Cumulative Effects

There would be no cumulative effects.

4.5.2.3. Alternative D and E

Direct and Indirect Effects

These alternatives would leave the reservoir in place. Since the reservoir surface is probably not a suitable foraging area, the opportunity to improve foraging conditions would be forgone. However, since there are no known populations in the area, these alternatives would have no impact to this species.

Cumulative Effects

There would be no cumulative effects.

4.5.3. Common Loon

4.5.3.1. Alternatives A, B, C, D and E

Based on the low likelihood of loons being present at the reservoir at any time of the year, there would be no impact to this species.

4.5.4. Larch Mountain and Van Dyke's Salamanders

4.5.4.1. Alternatives A, B, C, D, and E

Neither of these species was detected during surveys, so they are not likely to exist in the project area. In addition, the nursery field where dredge material would be deposited is not suitable habitat for these species. For these reasons the project would have no impact on either of these salamanders.

4.5.5. Mollusks

4.5.5.1. Alternatives A, B, C, D, and E

None of these species was detected during surveys, so they are not likely to exist in the project area. In addition, the nursery field where dredge material would be deposited is not suitable habitat for these species. For these reasons the project would have no impact on any of these mollusks.

4.6. Management Indicator Species

Regulatory Framework

Pursuant to National Forest Management Act (NFMA) and it's implementing regulations at 36 CFR 219.19, wildlife habitat shall be managed to maintain existing populations of existing native species by identifying management indicator species whose population changes are believed to indicate the effects of management activities. The Forest Plan identifies species whose population changes may indicate impacts to other species or habitats.

4.6.1. Deer and Elk Biological Winter Range (BWR)

4.6.1.1. Alternatives A, B, C, D, and E

Neither removing the dam nor leaving it in place would affect elk and deer habitat. Covering a portion of the old nursery field with dredge spoils may reduce forage on five to ten acres, however since the field is fenced with an eight-foot mesh fence, no grazing currently occurs there.

4.6.2. Wood Duck

4.6.2.1. Alternative A – No Action

Direct and Indirect Effects

This alternative would result in no new short term impacts to wood ducks. However, continued sediment deposition, reducing the depth of the reservoir would reduce the habitat suitability in the long term. Eventually, the reservoir would not be suitable habitat.

Cumulative Effects

Due to the Riparian Reserve provisions in the Northwest Forest Plan, it is unlikely that additional suitable nesting habitat would be affected by future projects. There would be no cumulative effects with this project.

4.6.2.2. Alternatives B and C

Direct and Indirect Effects

Removal of the dam would likely remove nesting habitat for at least one pair of wood ducks. Suitable habitat would remain in other parts of the District, but it is not known what percent of the population is represented by this one pair. Since wood ducks are not known to nest at Hemlock Lake, the effect of these alternatives would be negligible.

Cumulative Effects

Due to the Riparian Reserve provisions in the Northwest Forest Plan, it is unlikely that additional suitable nesting habitat would be affected by future projects. There would be no cumulative effects with this project.

4.6.2.3. Alternatives D and E

Direct and Indirect Effects

These alternatives would leave the dam in place and contain provisions to route sediment during the high flow periods. Habitat for one breeding pair of wood ducks would be maintained in the long term. However, dewatering the reservoir for one season to accomplish the dredging could displace ducks for that year. Since wood ducks are not known to nest at Hemlock Lake, the effect of these alternatives would be negligible.

Cumulative Effects

There would be no cumulative effects with these alternatives.

4.6.3. Barrow's Goldeneye Duck

4.6.3.1. Alternative A – No Action

Direct and Indirect Effects

This alternative would result in no new short term impacts to Barrow's goldeneye duck. However, continued sediment deposition, reducing the depth of the reservoir would reduce the habitat suitability in the long term. Eventually, the reservoir would not be suitable habitat.

Cumulative Effects

Due to the Riparian Reserve provisions in the Northwest Forest Plan, it is unlikely that additional suitable nesting habitat would be affected by future projects. There would be no cumulative effects with this project.

4.6.3.2. Alternatives B and C

Direct and Indirect Effects

Removal of the dam would remove nesting habitat for about one pair of goldeneye ducks. Suitable habitat would remain in other parts of the District, but it is not known what percent of the population is represented by this one pair.

Cumulative Effects

Due to the Riparian Reserve provisions in the Northwest Forest Plan, it is unlikely that additional suitable nesting habitat would be affected by future projects. There would be no cumulative effects with this project.

4.6.3.3. Alternatives D and E

Direct and Indirect Effects

These alternatives would leave the dam in place and contain provisions to route sediment during the high flow periods. However, dewatering the reservoir for one season to accomplish the dredging could displace ducks for that year. Habitat for one breeding pair of goldeneye ducks would be maintained in the long term.

Cumulative Effects

There would be no cumulative effects with these alternatives.

4.6.4. Osprey

4.6.4.1. Alternative A – No Action

The No Action alternative would have no new effect on ospreys, however the opportunity to increase the available prey base would be lost. The ability for osprey to forage at Hemlock Lake would be maintained in the short term. If the reservoir fills with sediment in the long term, the ability to forage there would be lost.

4.6.4.2. Alternative B

Direct and Indirect Effects

This alternative would return Trout Creek to a free-flowing system that hasn't existed for about 102 years. It is likely that steelhead populations in the creek and in Wind River would increase as more adult fish access spawning habitat above the dam site and more juveniles are able to safely make their way downstream. An increase in the steelhead populations would increase potential prey for osprey. The opportunity to forage in the reservoir would be lost, but these birds could forage in Trout Creek where there is sufficient canopy opening. However, based on observations, the osprey probably forage more in the Wind River.

Since the steelhead population in the Wind River Watershed is controlled by many different variables beyond the watershed, it is impossible to predict the magnitude of the effect of removing the dam.

Approximately 600 truck loads would be required to move the dredge spoils and 29 truck loads to move the dam materials. Due to the low likelihood of osprey being in the area of Hemlock Lake, they are not likely to be disturbed during the process of dismantling the dam and hauling the dam and dredge spoil material to the storage areas. If the nest was occupied, State permit requirements to conduct the dredging and spoil transport after June 30th would minimize the potential to affect nesting ospreys. The expected noise disturbance occurring during the latter part of the nesting season is not likely to cause the adults to abandon the nest.

Cumulative Effects

The beneficial effect of increased prey base is cumulative to other habitat restoration projects that have been planned and accomplished in the Wind River Watershed that have improved spawning and rearing habitat for steelhead. These projects include the Mining Reach and the planned Upper Trout projects.

4.6.4.3. Alternative C

Direct and Indirect Effects

This alternative would have essentially the same effects as Alternative B. The difference is that the number of truck loads of dredge spoils to be moved would be 7,700 to 11,000 dump truck loads. Due to the low likelihood of osprey being in the area of Hemlock Lake, they are not likely to be disturbed during the process of dismantling the dam and hauling the dam and dredge spoil material to the storage areas. If the nest was occupied, State permit requirements to conduct the dredging and spoil transport after June 30th would minimize the potential to affect nesting ospreys. The expected noise disturbance occurring during the latter part of the nesting season is not likely to cause the adults to abandon the nest.

Cumulative Effects

Cumulative effects would be the same as with Alternative B.

4.6.4.4. Alternative D

Direct and Indirect Effects

With this alternative the ability of ospreys to forage at the reservoir would be maintained. However based on past observations, the reservoir is probably not an important foraging area. If improvements to the dam and fish ladder, and annual sediment routing result in more large fish in the Wind River and in Trout Creek, foraging conditions would be improved.

Approximately 5,500 truck loads of dredge spoils would be hauled to the nursery field. Due to the low likelihood of osprey being in the area of Hemlock Lake, they are not likely to be disturbed during the process of dismantling the dam and hauling the dam and dredge spoil material to the storage areas. If the nest was occupied, State permit requirements to conduct the dredging and spoil transport after June 30th would minimize the potential to affect nesting ospreys. The expected noise disturbance occurring during the latter part of the nesting season is not likely to cause the adults to abandon the nest.

Cumulative Effects

Minor improvements to fish habitat and increased ability of fish to pass the dam are cumulative to other habitat improvement projects in the Wind River Watershed.

4.6.4.5. Alternative E

Direct and Indirect Effects

With this alternative the ability of ospreys to forage at the reservoir would be maintained. However based on past observations, the reservoir is probably not an important foraging area. If improvements to the dam and annual sediment routing result in more large fish in the Wind River and in Trout Creek, foraging conditions would be improved.

Approximately 5,500 truck loads of dredge spoils would be hauled to the nursery field. Due to the low likelihood of osprey being in the area of Hemlock Lake, they are not likely to be disturbed during the process of dismantling the dam and hauling the dam and dredge spoil material to the storage areas. If the nest was occupied, State permit requirements to conduct the dredging and spoil transport after June 30th would minimize the potential to affect nesting ospreys. The expected noise disturbance occurring during the latter part of the nesting season is not likely to cause the adults to abandon the nest.

Cumulative Effects

Uncertain benefits to steelhead, and resulting population increases mean that this alternative would have no cumulative effects.

4.7. Neo-Tropical Migratory Birds

Regulatory Framework

The Migratory Bird Treaty Act (50 CFR 10) provides for the protection of migratory birds. It also authorizes the Secretary of the Interior to determine how such birds may be taken, killed, or possessed.

4.7.1.1. Alternative A – No Action

This alternative would have no new impacts on neotropical migrant birds. There would be no cumulative effects.

4.7.1.2. Alternatives B and C

Direct and Indirect Effects

These alternatives would have no effect on nesting habitat for Vaux's swift or pileated woodpecker. Loss of the reservoir surface would reduce foraging area for swallows and swifts in the long term. Without the reservoir, the former reservoir bed will be revegetated and eventually large trees will probably dominate the site. Since the nursery fields in the project area are large open areas where these birds could forage, the loss of the reservoir surface is not significant.

Storing dredge spoils in the old nursery field will temporarily reduce nesting habitat for savannah sparrow, but in the short term, it may provide suitable new nesting habitat for common nighthawk, and spotted sandpipers. These birds nest on the ground in areas with sparse vegetation cover. These effects would probably only last for one to three seasons. Nesting habitat for savannah sparrow is not limited in the area.

Cumulative Effects

If the old nursery fields are eventually reclaimed with trees, loss of foraging habitat for swallows and swifts over the reservoir would be cumulative to loss of other openings in the area.

4.7.1.3. Alternatives D and E

Direct and Indirect Effects

These alternatives would have no effect on nesting habitat for Vaux's swift or pileated woodpecker. Foraging opportunity for swifts and swallows over the reservoir surface would be maintained.

Storing dredge spoils in the old nursery field will temporarily reduce nesting habitat for savannah sparrow, but in the short term, it may provide suitable new nesting habitat for common nighthawk, and spotted sandpipers. These birds nest on the ground in areas with sparse vegetation cover. These effects would probably only last for one to three seasons. Nesting habitat for savannah sparrow is not limited in the area.

Cumulative Effects

Since the reservoir surface would be maintained, there would be no cumulative effects.

4.8. Other Species

4.8.1. Beaver

The loss of a still-water habitat and the effect to beaver populations that are known to be present and active in the Trout Creek area was raised as an issue during scoping.

4.8.1.1. Alternative A – No Action

The No Action alternative would have no new impacts on beavers. There would be no cumulative effects.

4.8.1.2. Alternatives B and C

Direct and Indirect Effects

These alternatives would remove the dam and cause the removal of the accumulated sediment behind the dam. The reservoir would be lost and the gradient of the remaining stream would be increased. Due to the relatively wide floodplain that would remain, the site may still remain suitable for occupation by beavers if they could construct and maintain a dam. Due to the high winter and spring flows however, it is not likely that beavers could reoccupy the site. Removal of the dam would reduce the capability of Trout Creek to support beavers by up to one pair.

Beavers would continue to be able to occupy the Trout Creek flats area, and removal of the dam may facilitate dispersal of beavers into and out of Trout Creek.

Cumulative Effects

These effects would be cumulative to other implemented and future projects that would reduce beaver habitat suitability in Trout Creek. Implementation of timber sales in the sub-basin would follow requirements of the Northwest Forest Plan with regards to Riparian Reserves. These projects are unlikely to affect the quality of beaver habitat. The upper Trout Creek fisheries restoration project would increase large wool levels in the creek and plant hardwood shrubs and trees, improving habitat for beavers as well.

For these reasons, implementing these alternatives would not have a cumulative effect on beavers in the watershed.

4.8.1.3. Alternatives D and E

Direct and Indirect Effects

These alternatives would retain the dam and a result in a deeper reservoir. The capability to support beavers would be maintained. There would be no new effects. The opportunity to improve dispersal ability by removing the dam would be lost.

Beaver habitat could be improved at the reservoir by reducing the amount of canary reedgrass on the western half of the reservoir, and planting deciduous tree and shrub species in this area.

Cumulative Effects

There would be no cumulative effects.

4.9. Botany

4.9.1. Threatened, Endangered & Proposed Plant Species

Regulatory Framework

The Endangered Species Act (ESA) of 1973, as amended, 50 CFR 402 (2000) and its implementing regulations require the USFS to manage for the recovery of Threatened and Endangered species and the ecosystem on which they depend.

Section 7 of the ESA directs all Federal agencies to use their existing authorities to conserve Threatened and Endangered species and, in consultation with the Service, to ensure that their actions do not jeopardize listed species or destroy or adversely modify critical habitat. Section 7 applies to management of federal lands as well as other federal actions that may affect listed species, such as federal approval of private activities through the issuance of federal permits, licenses, or other actions.

4.9.1.1. Alternatives A, B, C, D, and E

At this time there are no federally listed (Proposed, Endangered, Threatened) plant species known to occur on the Forest, however one federally Threatened species (*Howellia aquatilis*) is suspected. *Howellia aquatilis* has an extremely narrow habitat tolerance, generally confined to palustrine emergent wetlands with seasonal drawdown. No such wetland habitats would be impacted by implementing this project. In addition, wetlands to be impacted by this project were surveyed and no Threatened, Endangered, or Proposed species were located. Thus, project Alternatives A, B, C, D, and E would have no effect on federally listed species.

4.9.2. Sensitive Plants

Regulatory Framework

The National Forest Management Act (NFMA) and implementing regulations (36 CFR 219 [1982]) require the Secretary of Agriculture to provide for species viability and diversity of plant and animal communities. The USFS defines Sensitive species as those plant and animal species identified by a regional forester for which population viability is a concern, as evidenced by significant current or predicted downward trends in population numbers or density, or significant current or predicted downward trends in habitat capability that would reduce a species' existing distribution. Regional Foresters shall identify Sensitive species occurring within the region.

4.9.2.1. Alternatives A, B, C, D, and E

There is potential habitat for a number of Sensitive species, including some fungi species that were not specifically targeted during surveys. The actions proposed by this project under project Alternatives A, D & E would be unlikely to impact these species or their habitat, as there would be little to no change to the existing lakeside riparian habitat. Thus, these alternatives will have no impact on Sensitive plant species. Alternatives B and D may alter the hydrologic regime of the hillslope, and would drain some wetland habitat that is currently adjacent to the lakeshore. These alternatives would have more potential to impact habitat for Sensitive species. However, since no Sensitive species suspected to occur within the project area are wetland obligates, impacts, if any, would likely be minor. In addition, wetlands to be impacted by this project were surveyed and no

Sensitive species were located. For this reason, project alternatives B & C may impact (Sensitive species) individuals or habitat, but will not likely contribute to a trend towards federal listing or cause a loss of viability to the population or species.

4.9.3. Invasive Weeds

Regulatory Framework

Washington State mandates control of certain plants that are considered to be highly invasive and a threat to the natural habitat and to state commerce (WAC 16-750). State law at RCW 17.10.140 holds landowners responsible for controlling noxious weeds on their property. The Chief of the USFS has identified invasive weeds as one of the four significant threats to our Nation's forest and rangeland ecosystems.

4.9.3.1. Alternative A

Invasive weed populations would remain or increase slightly in the vicinity of the project area from expansion of established populations. Exposed areas are the most vulnerable to colonization by invasive weeds.

4.9.3.2. Alternative B

Direct and Indirect Effects

Under Alternatives B and C, there would be a substantial amount of newly exposed ground produced when dam is mechanically removed, the reservoir is drained and the stream channel is re-established. These actions would cause a limited amount of new disturbance in and around machinery access points, but would create a substantial amount of newly exposed, stream shore habitat along the re-established channel (area that was previously lake bed). This area would be highly susceptible to noxious weed and invasive plant colonization, particularly since there are already invasive species growing in some areas adjacent to the reservoir.

Cumulative Effects

The current Skamania County Integrated Aquatic Vegetation Management Plan (Pfauth & Sytsma 2004) includes plans to treat aquatic weeds at the Mouth of the Wind River. The confluence of the Wind River and the Columbia River is a drowned river mouth with a surface area of 21.5 acres. Maximum depth of the water in this area is 10 feet, and much of the mouth is constricted by a large sediment bar located between the county boat ramp and the State Route 14 bridge (Pfauth & Sytsma 2004). Surveys conducted at the mouth of the Wind River in 2003 revealed aquatic weed infestations of Eurasian watermilfoil, Coontail, Common waterweed and Nitella species. Goals for treatment at this site (according to the Plan) focus on creating a deeper channel allowing unimpaired boater access between the county boat ramp and the Wind and Columbia River channels. Localized "high intensity" control in this area would achieve this goal without causing a need for treatment of the entire water body; recommended treatments include a combination of physical and chemical techniques. One of the physical techniques recommended includes dredging. According to the report, dredging would create a channel for boats and, in the process, remove significant biomass of aquatic weeds in this area. Regrowth of the weeds would be minimized if the channel is dredged to at least 15 feet in depth.

Implementation of the proposed action would exacerbate sediment build up at the mouth of the Wind River through flushing fine sediments from behind the dam. This would exacerbate the current sedimentation problems analyzed in the Plan and could (depending on the timing of implementation of both the Hemlock Dam project and the County control program) undo dredging efforts by Skamania County by causing rapid re-siltation at the site.

4.9.3.3. Alternative C

Direct and Indirect Effects

Direct and indirect effects would be the same as for Alternative B.

Cumulative Effects

Alternative C would reduce the amount of sediment available to flush down the riparian system (through dredging), but would cause annual pulses of accumulated sediment to be released. This alternative has less potential to exacerbate the sedimentation and aquatic weeds problem at the mouth of the Wind River than Alternative B.

4.9.3.4. Alternatives D and E

Direct and Indirect Effects

Alternatives D and E, because they do not propose to remove the dam, would cause less ground disturbance resulting from mechanical removal of the dam, and would avoid exposing much of the current lake bed to weed invasion.

To control noxious weed colonization and spread under proposed action alternatives, weed-spread prevention and weed eradication activities should be implemented before, during and after project activities (see Chapter 2, Mitigations section).

Cumulative Effects

Alternative D and Alternative E are more difficult to compare to each other (because it is more difficult to estimate the amount and timing of the sediment pulses that will occur, and how deposition rates will compare). Alternatives D and E would probably result in fairly similar levels of sediment deposition, though the use of the sluice gates (an element of alternative D) at times of high streamflows and turbidities may cause more of the flushed sediment to remain suspended longer, resulting in less deposition at the mouth of the Wind River, and more release of sediments into the Columbia River.

4.9.4. Wetlands

Regulatory Framework

Federal (Executive Order 11990, Protection of Wetlands and Section 404 of the Clean Water Act [22 USC § 1344]) and Washington state law (Hydraulic Procedures Act [WAC 220-110] and Shorelines Act [RCW 90.58]) require that there be no net loss of wetlands habitat as a result of actions, and thus any loss of wetlands resulting from this project would need to be mitigated following Washington State Dept of Ecology Wetland Mitigation guidelines.

Wetlands in Washington State are regulated by the Department of Ecology under the State Water Pollution Control Act and Shorelines Management Act. Through Executive Order 89-10 the State has adopted the goal of “no net loss in acreage and function of Washington’s remaining wetlands base”. Wetland acres eliminated under any of the action alternatives would need to be offset by some form of mitigation. The details of any wetland mitigation that results from this project would be identified through the development of a Wetlands Mitigation Plan that would be coordinated with the Department of Ecology.

The potential loss of wetlands was identified during internal scoping for this project, and commented on by the Department of Ecology in comments to the DEIS. A number of wetlands exist around the perimeter of the reservoir. These wetlands range in size and character, and are at least in part dependent upon the existence of the reservoir to provide suitable conditions for the establishment and maintenance of wetland conditions.

This analysis provides an estimate of the quality and quantity of wetlands potentially affected by this project. Data summarized here is taken from a February, 2005 wetlands delineation conducted for the USFS by Ecological Land Services Inc. (ELS), Longview Washington. The analysis scale includes the area in the vicinity of Hemlock Lake, including all wetlands with the potential to be affected by elimination of the reservoir. The determination of the wetland types, area extent, the degree to which they would be affected by this project was made by ELS.

4.9.4.1. Alternatives A, D, and E

Summary

Under these alternatives, the dam would remain in place and the reservoir would continue to exist as it has in the past, with the exception that the depth would be increased as a result of dredging under Alternatives D and E. There would be no direct, indirect or cumulative effects to the existing wetlands under these alternatives.

Direct and Indirect Effects

Existing soils, hydrology and vegetative conditions around the reservoir and in the existing wetlands would not be expected to change over the long term as a result of the selection of any one of these alternatives. In the short term, the reservoir area would be disturbed during dredging activities and other related work under Alternatives B and C. However, access points and work areas would not occur within existing wetlands. As a result, these alternatives would have no direct or indirect effects on wetlands in the short or long term.

Cumulative Effects

There are no known cumulative effects to wetlands resulting from any of these alternatives.

4.9.4.2. Alternatives B and C

Summary

Under these alternatives, the dam would be removed and Trout Creek would be returned to a free-flowing stream. This would indirectly result in a loss of approximately 1.9 acres of wetlands in the immediate vicinity of the reservoir.

Direct and Indirect Effects

As the dam is removed and Trout Creek returns to a free-flowing stream, the elevation of the water surface in the area now occupied by the reservoir would drop well below the levels currently established by the dam. The drop in water levels would affect the frequency and duration of inundation in areas along the shore of what is now Hemlock Lake. The declining water elevations could also affect the amount or disposition of water that now enters the reservoir through side channels that are connected either by surface or subsurface pathways to Trout Creek. In addition to the changes in water levels, the slope and configuration of the ground in areas that now form the banks around the reservoir are likely to change as the stream incises (Alt B) or is excavated (Alt C) through the reservoir sediments.

The combination of changes in hydrology and in ground slope may eliminate the conditions that now contribute to the presence of wetlands around the perimeter of Hemlock Lake. Of the six wetlands identified in Figure 4-14, four are directly influenced by the presence of Hemlock Lake and would likely be adversely affected by the removal of the Lake (ELS 2005). The two wetlands at the western end of the Lake (wetlands D and F) would also be affected by dam removal, but because these wetlands have significant sources of water from upslope, only small portions of them would be affected *(Ibid.)*. It is also possible that as Trout Creek channel is re-established through the reach now occupied by Hemlock Lake that new wetlands could form along the new channel. It is not possible to determine the extent to which this would happen, but if it does occur, the wetlands are most likely to be relatively small due to the expected gradients of Trout Creek and likelihood that much of the new channel would occur in a steep and confined area.

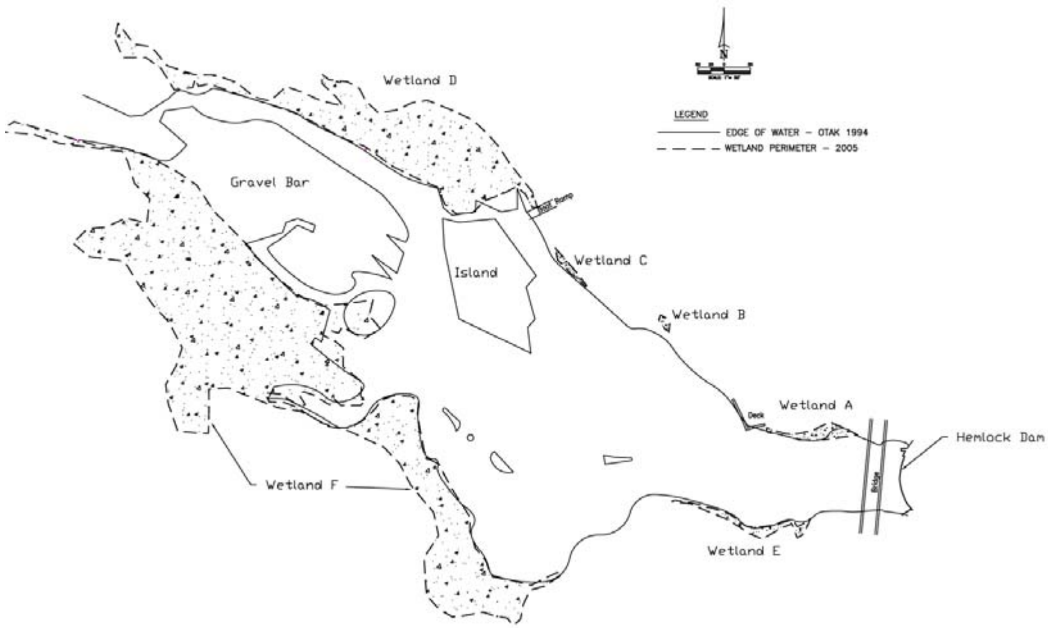

Figure 4-14. Delineation of wetlands in the vicinity of Hemlock Lake.

In total, the wetlands in the immediate vicinity of Hemlock Lake now cover approximately 5.4 acres. Removal of the dam would eliminate or reduce the wetlands in this area by approximately 1.9 acres, leaving approximately 3.5 acres of wetlands that would continue to be supported by water sources not associated with the reservoir. Table 4-9 summarizes the existing wetland types and acreages.

Table 4-9. Wetland types and acreages at Hemlock Lake.

Wetland Identifier	WA State Wetland Rating	Acres	Acreage Predicted to be Eliminated or Changed in Function	Predicted Impact
A	III	0.059	0.059	Convert to upland
B	III	0.008	0.008	Convert to upland
C	III	0.017	0.017	Convert to upland
D	II	1.310	0.44 (estimated)	Partially converted to upland
E	III	0.066	0.066	Convert to upland
F	II	3.959	1.32 (estimated)	Partially converted to upland
Totals		5.419	1.91	

The loss of these wetlands would require the FS to mitigate as described above. The details of any wetland mitigation that results from this project would be identified through the development of a Wetlands Mitigation Plan that would be coordinated with the Washington Department of Ecology.

Cumulative Effects

Significant loss of wetlands has likely occurred over time in the Wind River watershed as a result of development and filling of wetlands. The largest known loss probably occurred as a result of the construction of Bonneville Dam and subsequent backwatering of the entire mouth of the Wind River. Other areas where wetlands are likely to have been lost include areas within the Wind River Nursery, areas throughout the watershed affected by road construction or residential development. The only other contemporary project that is known within the Wind River watershed that involves wetlands is the Wind River Highway Realignment project that is currently being planned by the Federal Highways Administration.

4.10. Economics

4.10.1. Local Economy

Relationship to Purpose and Need and Significant Issues

Public use of the Hemlock recreation site undoubtedly provides economic benefits to the local communities. This was identified as a significant issue since removal of the dam would result in a decrease in use of the site, which in turn may result in a net decrease in recreation-related expenditures due to local and non-local recreationists no longer visiting this portion of the Forest and making purchases associated with recreation activities. The effects are analyzed using the following Measurement Methods:

- Predicted change in expenditures by Hemlock Lake visitors

Regulatory Framework

The National Environmental Policy Act (NEPA) at 40 CFR 1508.15 defines the “human environment” and clarifies that “when an environmental impact statement is prepared and economic or social and natural or physical environmental effects are interrelated, then the environmental impact statement will discuss all of these effects on the human environment."

Analysis Process

The intent of this analysis is to estimate potential changes in the number of recreationists who visit Hemlock and their associated trip expenditures and indirectly, a measure of the economic vitality of local businesses. Because the Gifford Pinchot National Forest lacks data on recreational expenditures associated with visits to Hemlock, this statement utilizes findings from national surveys that analyzed recreation visitor spending on National Forests: The 2000 – 2001 National Visitor Use Monitoring (NVUM) study assessed, in part, party size and expenditures for a variety of items associated with local and non-local day-use recreational trips. A subsequent report entitled "Spending Profiles of National Forest Visitors", based on the 2000 – 2001 NVUM, was prepared for forest and planners and others to use in economic analyses.

Purchases of two common items associated with recreation trips are analyzed—groceries and gas/oil—for local recreationists; only groceries are included for non-local visitors, assuming they would purchase gas irrespective of their side-trip to the Hemlock site. The expenditure values in Table 4-10 were taken from the NVUM spending profiles report and used in this analysis:

Table 4-10. Expenditures, $ per party per day trip

	Local	Non-Local
Groceries	$3.93	$6.20
Gas/Oil	$10.97	-

In the NVUM spending profiles report, each national forest is categorized by visitor spending averages into one of three categories: Above Average, Average or Below Average. While the Gifford Pinchot National Forest is considered an "average spending" Forest, the analysis for this Statement uses the values for a "below average spending" forest due to limited "spending opportunities" in proximity to the site.

It is assumed that there would likely be decreases in trips specifically to Hemlock Lake by both local and non-local users associated with dam removal alternative. There are many unknowns, however, about the existing recreation visitor-use and associated expenditures and even more unknowns about future recreation visitation, making it almost impossible to accurately portray the impacts of the alternatives. For instance, to what extent would the Hemlock site continue to be used for picnics or stream-related recreation activities? Or to what extent would users find substitute places to recreate and still contribute to local businesses through purchases of groceries and gas? In addition, no adjustments are made to reflect possible changes in use over time due to other factors, for example, population increases in the County; or increased traffic through the area as a result of the proposed Wind River Road widening project, etc.

Because there are many unknowns (even the existing condition, or No Action, is an estimate), this analysis assesses a range of potential expenditures, using the assumptions noted below:

4.10.1.1. All Alternatives

- *Local party grocery purchases:* 25 – 100% of visitors purchase groceries specifically for their trip to Hemlock
- *Local party gas and oil purchases:* 25 – 75% of visitors who visit Hemlock purchase gas and oil specifically for their trip to Hemlock
- *Non-local party grocery purchases:* 25 – 100% of visitors purchase groceries specifically for their trip to Hemlock
- Non-local party gas and oil purchases: None of the non-local visitors purchase gas and oil specifically for their trip to Hemlock; they would continue to purchase gas in association with their trip to the Forest

4.10.1.2. Alternatives A, D and E

- 3,173 local parties visit Hemlock annually
- 3,330 non-local parties visit Hemlock annually

4.10.1.3. Alternatives B and C

- Dam removal would result in a 25 – 75% reduction in local party use (resulting in use by 1,586 – 2,380 local parties, annually)
- Dam removal would result in a 75% reduction in non-local party use (resulting in 793 parties annually)

Findings

The economic program, Quicksilver, was used to calculate the expenditures, using the assumptions stated above. Table 4-11 compares the annual expenditures for all of the alternatives. Since it is not known how close these estimates reflect actual expenditures, the dollar figures generated and the comparison between the alternatives should be considered in relative terms, not absolute dollars. And again, it cannot be overstated that there are many, many unknowns and may scenarios that could play out in reality. The findings displayed here are based on the one set of assumptions outlined above.

Table 4-11. Comparison of local expenditures associated with purchases by visitors of Hemlock Lake.

	No Action	Alternatives B & C	Alternatives D & E
Annual Benefit	$17,600 – $61,400	$8,400 – $34,000	$17,600 – $61,400

4.10.1.4. Alternatives A, D and E

Direct and Indirect Effects

For alternatives which retain the dam, the annual visitor expenditures would range between $17,600 and $61,400, utilizing the assumptions stated above.

Cumulative Effects

Past administrative actions to close Forest Service facilities or reduce the organization have significantly affected the role/function that the Hemlock site serves in the local community and Skamania County for employment, visitor services, and general Forest Service “presence.”

Economically, the actions had negative consequences, at least in the short term, for local vendors in particular, and likely for Skamania County in general. An assessment of the overall economic conditions that prevailed after implementing these administrative actions, and the current economic vitality of the area, is beyond the scope of this analysis. But it is certain that employees made purchases at local vendors in association with their employment at Hemlock and the elimination of jobs most likely affected where individuals shopped and how much they spent—and perhaps even where they lived. The loss of to any single local business cannot be determined, but comments received following issuance of the DEIS suggest that the gradual withdrawal of a Forest Service presence has been felt by local businesses.

4.10.1.5. Alternatives B and C

Direct and Indirect Effects

For the two alternatives that remove the dam, the visitor expenditures would be in the range of $8,400 – 34,000. No attempt is made to assess the indirect impacts that these changes would have (i.e. number of jobs).

Cumulative Effects

The removal of Hemlock Dam and associated decreases in expenditures by recreationists at local businesses would contribute to any lasting negative economic consequences associated with past administrative actions affecting the Wind River site.

Effects of Past Administrative Actions Affecting the Wind River Site and Local Communities

Three past administrative actions by the Forest Service in the past ten years have undoubtedly affected the communities within close proximity of Hemlock Lake, particularly the Stabler area: The closure of the Wind River Nursery in 1997; consolidation of the Wind River and Mount Adams Ranger District Ranger Districts and associated location of the District headquarters at Trout Lake, Washington, in 2000; and the cessation of visitor information services at the Hemlock office in 2003. (National and Regional Forest Service budget reductions, policy changes and drastic reductions in timber harvest led to these actions. Office closures and personnel reductions were not unique to the Wind River offices; Forest Service office closures were Regional, even national, in scope—and continue to occur in the present.)

The Wind River Nursery closure in 1997 resulted in the first dramatic loss of jobs at the Hemlock site, eliminating over 300 (most temporary) jobs from its heyday in the 1980s. (Employment opportunities associated with the Nursery had been declining in the years prior to its closure.) The majority of the temporary workers affected were from the Wind River Valley. The subsequent implementation of the District consolidation in 1999/2000 further reduced employment at the site. Most of the permanent employees (approximately 15 – 20) displaced from Hemlock resided in Klickitat or Skamania Counties and commuted to their new duty station in Trout Lake; and in a few cases, to the Gifford Pinchot National Forest headquarters in Vancouver, Washington, or the Mount St. Helens office in Chelatchie Prairie, Washington. Almost all of the few remaining temporary jobs at Hemlock were moved to Trout Lake; affected temporary employees from the Wind River valley had to make the choice of a 50-mile one-way commute or look for other local employment. At the time of this Statement, 16 permanent and a range of five to ten temporary employees worked out of the Wind River Work Center.

The “demotion” of the Wind River District office to a “Work Center” resulted in few tangible administrative or public services that would have been notable to the public or local entities until visitor information services were curtailed at the Hemlock office in 2003 and centralized in Trout

Lake. Closure of the Hemlock office for public services dramatically affected both out-of-area visitors looking for information to enhance their trip to the Forest and local constituents accustomed to the services conveniently provided at the Hemlock office. Individuals now need to travel 50 miles from the Hemlock area to either Trout Lake or Vancouver, Washington, for in-person Gifford Pinchot National Forest visitor information and services. It is very clear from comments that the local communities and Forest visitors are unhappy and inconvenienced with the cessation of visitor information services.

The County has yet to find a tenant for the acquired property it acquired in 2000 following closure of the Wind River Nursery. The nursery fields remain fallow, and the industrial buildings remain vacant. Together, with the vacant Forest Service buildings and reduction in numbers of employees, the administrative site has a quasi-deserted atmosphere.

These past actions have significantly affected the role/function that the Hemlock site serves in the local community and Skamania County for employment, visitor services, and general Forest Service "presence." Economically, the actions had negative consequences, at least in the short term, for local vendors in particular, and likely for Skamania County in general. An assessment of the overall economic conditions that prevailed after implementating these administrative actions, and the current economic vitality of the area, is beyond the scope of this analysis. But it is certain that employees made purchases at local vendors in association with their employment at Hemlock and the elimination of jobs most likely affected where individuals shopped and how much they spent—and perhaps even where they lived.

The tax base of Skamania County is extremely limited, with over 90% of the County in federal ownership or in a tax-exempt status. The loss of a key recreational facility adjacent to federal lands recently conveyed to Skamania County and to the surrounding privately-owned properties could adversely affect property values and further erode the County property tax base.

The removal of Hemlock Dam and a key recreational asset would result in decreases in expenditures by recreationists at local businesses and the potential devaluation of adjacent properties. This would exacerbate negative economic consequences associated with past administrative actions affecting the Wind River site.

4.10.2. Financial Analysis of Forest Service Costs and Revenues

Relationship to Purpose and Need and Significant Issues

The Responsible Official directed that certain objectives accompany the primary purpose, including implementing a cost effective approach to managing the Hemlock site.

Regulatory Framework

The National Forest Management Act (NFMA) requires the Forest Service to develop alternative forest plans that "represent the most cost efficient combination of management practices examined that can meet the objectives established" and "alternatives shall be formulated to facilitate evaluation of the effects on present net value, benefits, and costs." Although this decision would implement and not amend the Forest Plan, the requirement to evaluate economic impacts is stipulated by the National Environmental Policy Act (NEPA) at 40 CFR 1508.15. NEPA defines the "human environment" and clarifies that "when an environmental impact statement is prepared and economic or social and natural or physical environmental effects are interrelated, then the environmental impact statement will discuss all of these effects on the human environment."

This analysis compares the financial costs incurred by the USFS and revenues returned to the USFS over a 20-year period for each alternative. The cost estimates used in this analysis are not highly refined, but represent an appraisal-level evaluation of potential costs. More detailed, design-level costs for each of the alternatives would have been financially impractical for this analysis because of the wide range of alternatives being considered, and the uncertainty about which alternative would be selected for implementation. Once a decision has been reached on which alternative is to be implemented, additional design and cost estimation will be done on the selected alternative. Because the intent of this analysis is to compare the direct financial costs and revenues to the USFS between alternatives, it does not attempt to establish or determine an economic value of the fish, or of the recreational experiences of visitors to the lake.

Analysis Process

Cost estimates developed for each alternative were analyzed using Quicksilver, a project analysis tool developed by the USFS. A 20-year period was used as the planning horizon for the project, and a discount rate of 4% was applied over this period. The length of the planning horizon was selected based primarily on the length of time required to implement the most time-intensive alternative (i.e. dam removal). Because it would likely require several years to complete designs and engineering, to acquire funding, implement the project, and complete follow-up work and monitoring, a 10-year window was considered potentially limiting. Moreover, planning for work associated with the dam that extended beyond 20 years was considered too speculative.

Structural analysis of the dam conducted by Chambers et al. (1992) found the dam to be in good condition, and predicted that it would be functional “for an indefinite period of time”. A more recent structural analysis completed by the US Army Corps of Engineers and QUEST Structures found that the dam withstood modeling of the maximum credible earthquake and probable maximum flood (see discussion elsewhere in this statement). These findings indicate that no time has yet been identified at which point the dam would have to be removed from a stability standpoint, unless changes are found during subsequent inspection and monitoring of the dam. As a result, the costs for dam removal are only shown for Alternatives B and C, which propose to remove the dam under this EIS. It must be noted that if Alternative A, D, or E is selected through this process (i.e. and the dam is retained), there would presumably be some time in the future at which the dam would require significant repair or removal. Any such costs are not included in this analysis.

This financial analysis focuses primarily on costs associated with operations, maintenance, repairs, upgrades, and decommissioning of the dam and its facilities. Revenues from potential user-fee collections are also included for Alternatives D and E to show the overall economic picture (costs and revenue) of managing the dam and recreation site over time over time. The decision to implement fees for the Hemlock Day Use area would not be tied to the decision on the dam; the USFS annually reviews and updates which sites will be fee sites. It is likely that the Hemlock site would become a fee site in the future, whether or not the dam is retained, given the high level of developments provided and the high cost of annual operations and maintenance.

Items Analyzed

Annual Operation and Maintenance Costs

Under each of the alternatives in which the dam remains in place, there are operation and maintenance (O&M) costs associated with maintaining the dam and its appurtenances. The District currently undertakes daily inspections of the dam, fish ladder, and traveling screen to check and clear debris. These are required under Washington State laws for fish passage, and would be continued under all dam retention alternatives. In addition, each spring a series of flashboards are installed across the crest of the dam to provide deeper water in the reservoir through the summer months. These boards are removed in the fall months to avoid having them damaged during winter floods. A fish trap that currently exists at the top of the fish ladder also requires daily visits and maintenance. Costs for maintaining the fish trap are shared with other agencies, but only the USFS portion of these costs is accounted for in this analysis.

In terms of managing the recreational site, there are both daily and annual maintenance requirements. Daily operations include garbage pickup and disposal, restroom cleaning, site checks and law enforcement. Annual maintenance of the facilities includes repair and upkeep of the restrooms, picnic tables, viewing platform, and trail. Costs for all of the items noted above would be incurred under any of the alternatives that retain the dam.

If the dam is removed, all of the dam-related and fish passage O&M costs would be eliminated. Costs for maintaining the recreational facility would continue to be incurred, but as a result of the expected decline in users, the O& M costs for the Hemlock site are predicted to decline under the dam removal alternatives. Because some of the current users of the site may choose to go to other sites on the National Forest if the reservoir is no longer there, an increase in enforcement and maintenance is projected at those sites under dam removal alternatives.

Unscheduled Repairs

In addition to regularly scheduled maintenance, various parts associated with the dam wear out and need repair and/or replacement. In the past five years, approximately $4,900 has been spent on repairs to the: sluice gate shaft, attraction flow screen, motors and gearboxes associated with the traveling screen. The total cost of these repairs was used as an estimate of what could be expected in the future.

Fish Passage Improvements

There are a number of known shortcomings in the existing fish passage system at the dam. These were documented in Barber and Perkins (1999), and are described in the Fisheries section of this report. For alternatives in which the dam remains in place, it is likely that the more significant of the fish passage concerns will need to be rectified by upgrading or improving the existing facility. The specific requirements for improvement are as yet unknown, but expected to arise through the consultation process with NMFS.

For Alternatives D and E, cost estimates were developed for the fish passage improvements that would be most likely to be required. Although these same requirements would likely be imposed under Alternative A, this alternative was analyzed under a true “no action” scenario, and as such includes no improvements to the existing fish passage facilities at the dam. Cost estimates for the fish passage improvements are based on actual costs of other similar projects, or based on past experiences with project work around Hemlock Dam.

Dredging

Dredging of the reservoir is considered at some level under each action alternative. The dredging that would occur under either Alternative B or C would essentially be done as part of re-establishing a channel through the reservoir. Under Alternatives D and E, in which the dam would be retained, the dredging would occur as a means of improving water quality and fish habitat. Recreational uses of the reservoir would also benefit from this dredging. Because of the volume of sediment that is delivered to the reservoir from upstream, dredging of the reservoir under either of the dam retention alternatives would need to be repeated at some frequency to maintain the benefits derived from it. The BOR estimated that the dredged reservoir would refill in a five to ten-year period (USDI 2004a). For this analysis, it was assumed that after initial dredging, follow-up dredging would occur on 8-year intervals to maintain the benefits of the deepened reservoir. However, if sluicing operations are found to be effective at maintaining depth in the reservoir, then dredging frequencies could be reduced and costs would be reduced correspondingly. Dredging cost estimates were developed based on average production rates for heavy equipment, standard costs for equipment and operators, and include costs for management of water during dredging activities.

Dam Removal

Dam removal is considered under both Alternatives B and C. Each of these alternatives includes some level of sediment management associated with removal of the dam. In addition, each of these alternatives would require some level of site rehabilitation following removal, including treatment of invasive weeds, revegetation of the exposed areas that are no longer inundated, tree planting, slope stabilization, and establishment of ground cover on sediments disposed of in the nursery fields.

Alternative C would also include costs for construction of a stream channel through the area now occupied by the reservoir. Under both Alternative B and C, an additional cost was added to account for unforeseen mitigation required during or following project implementation. The types of work this might cover include evaluation of the historic splash dam (if it is found to still be in place just upstream of the dam), dealing with unforeseen issues with sediment or fish passage that may arise, and other unknowns. Estimates of dam removal costs were provided by the BOR (USDI 2004b).

Engineering Costs

For each work item that involves engineering design or contracting, and additional 50% of the project cost was added to the cost estimate for implementation. This increment is based on past USFS and BOR experience with engineering contracts, and would cover: design work, contract preparation and administration, and contingencies associated with the contract (USDI 2004b).

Summary of Findings

Figures 4-15 through 4-17 summarize the findings of this financial analysis. Figure 4-15 summarizes the Present Net Value (PNV) of each alternative. The PNV includes the operations and maintenance (O&M) costs, and capital costs. Figure 4-16 compares O&M costs among the alternatives. The O&M costs are recurring costs that occur daily, annually, or at some other frequency. Figure 4-17 compares the capital costs, which for this analysis are considered to be the one-time costs to improve or remove a facility. Table 4-18 summarizes in tabular form the same data that are shown graphically in Figures 4-15 through 4-17.

Figure 4-15 shows that PNV is negative for every alternative, reflecting the fact that the dam and recreation area cost more money than they generate. In fact there are no revenues returned to the USFS under Alternatives A, B, or C. The relatively small revenue generated under Alternatives D and E reflects the user fee that is likely to be implemented at the Hemlock site in the future.

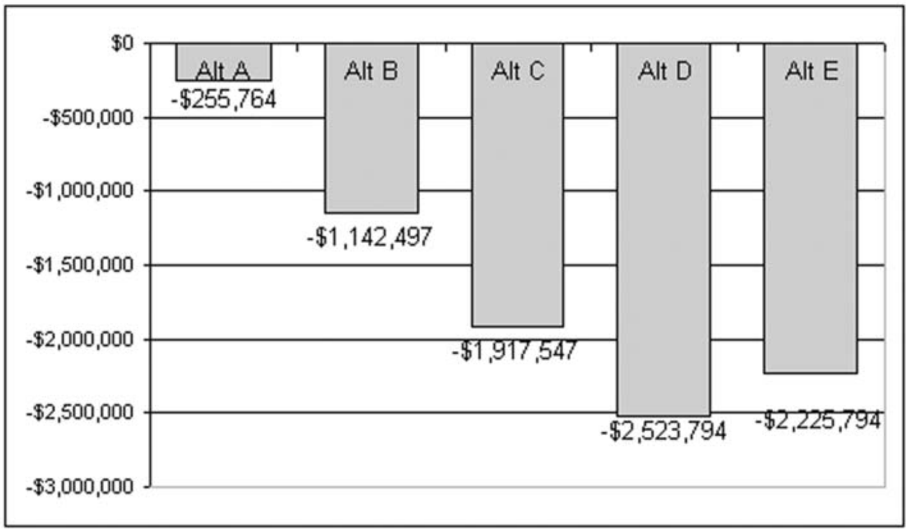

Figure 4-15. Present net value of costs to the USFS for each alternative over a 20-year period.

Alternative A (No Action) has the highest Present Net Value (PNV) among the alternatives, because no action is taken to remedy any of the conditions around the dam and fish passage facilities. Among the action alternatives, the Proposed Action has the highest PNV (lowest cost) at -$1.14 million, and Alternative D (which replaces the fish ladder) has the lowest PNV (and therefore the highest cost) of any alternative at -$2.52 million.

Figure 4-16 summarizes the present value of O&M costs associated with each alternative. Alternative B (Proposed Action) and Alternative C have the lowest O&M costs over the 20-year period at $101,397. The only O&M costs at the Hemlock site that would continue under these alternatives are those for managing the picnic area. Alternatives D and E have significantly higher O&M costs ($1.0 million) due to the maintenance of the dam and fish passage structures, and the periodic dredging of the reservoir.

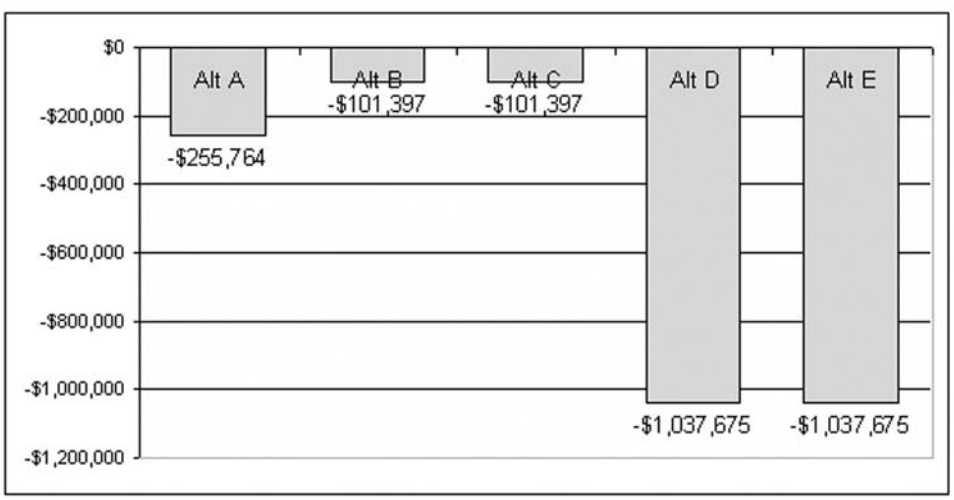

Figure 4-16. Comparison of Operations and Maintenance (O&M) costs for a 20-year period (present values).

Figure 4-17 summarizes the present value of capital[5] costs associated with each alternative. Alternative C, which removes the dam and constructs a new channel through the reservoir deposits, has the highest capital cost at $1.8 million. Alternative B (Proposed Action) has the lowest capital cost of any action alternative, at $1.0 million. The large difference between the two reflects the different sediment management strategies. Capital costs for Alternatives D and E range from $1.7 million to $1.4 million, and reflect costs associated with upgrading the fish passage facilities at the dam, and the initial dredging of the reservoir. These figures do not include removal of the dam, because it is assumed that the dam would not need to be removed within the 20-year period covered by this analysis.

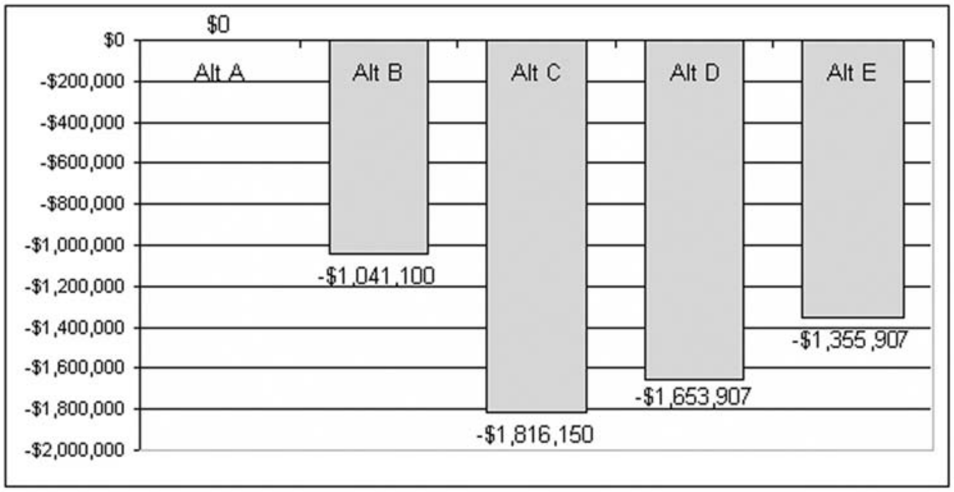

Figure 4-17. Comparison of Capital costs for a 20-year period (present values).

Table 4-12. Summary of the Present Value of all costs and revenues generated at the Hemlock site, and the Present Net Value of each alternative.

	Alt A	Alt B	Alt C	Alt D	Alt E
PV O&M Costs	-$255,764	-$101,397	-$101,397	-$1,037,675[a]	-$1,037,675[a]
PV Capital Costs	$0	-$1,041,100	-$1,816,150	-$1,653,907	-$1,355,907
Present Net Value	-$255,764[b]	-$1,142,497	-$1,917,547	-$2,691,512[b]	-$2,393,572[b]

[a] O&M costs for Alternatives D and E include dredging at 8-year intervals to retain depth in the reservoir (based on analysis of deposition rates by BOR, 2004).

[b] Costs for ultimate removal of the dam or significant repairs to it are not included in the values shown for Alternatives A, D, or E, because these costs are not expected to occur within the 20-year analysis horizon.

[5] "Capital" typically is defined as an asset. Per INFRA, capital improvement costs include the construction, installation, or assembly of a new fixed asset, or the significant alteration, expansion, or extension of an existing fixed asset to accommodate a change of purpose. In this analysis, dam removal is considered a capital (long-term) expense.

4.11. Social

Regulatory Framework

Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," provides that each Federal agency address disproportionately high and adverse human health or environmental effects of its activities on minority and low-income populations. The Executive Order makes clear that its provisions apply fully to programs involving Native Americans.

4.11.1. Economic Effects to Minority and Low-Income Populations

4.11.1.1. Alternative A – No Action

Environmental Justice assesses whether there would be *disproportionate* impacts to minority populations, low-income groups, or tribes. By retaining the dam there would be no disproportionate impacts to these groups who are present in Skamania County and who frequent the lake.

Cumulative Effects

The Hemlock recreation site is one of few free use recreational sites on the south end of the Gifford Pinchot National Forest or along the Columbia River. Continued access to nearby recreational sites is important to low-income families and individuals in Skamania County.

4.11.1.2. Alternatives B and C

Direct and Indirect Effects

The loss of Hemlock Lake would be felt at some level across all economic and racial boundaries due to its unique character. There are no alternative recreation sites conveniently close by that individuals and families of any financial means can go to for similar experiences. But those who do not have the physical or financial means to travel to an off-Forest site (for instance, Lost Lake on the Mount Hood National Forest in the state of Oregon) for a similar lake-related experience would most likely feel the loss of current recreation opportunities to a greater extent than those with the ability to travel some distance and incur greater expenses. As gas prices increase, this disparity would increase. In this general context, low-income individuals, of any race, who frequent Hemlock Lake would likely be affected disproportionately *economically* by the removal of the dam and the associated loss of recreation opportunities afforded at the Hemlock recreation site.

It is not known to what *extent* any of the below-poverty individuals actually utilize the Hemlock Lake site. If the use is proportionate to the presence of these groups/individuals in Skamania County, the "White" individuals below poverty would be affected in the greatest numbers, while populations affected to the greatest percentage would be "American Indian and Alaska Native" individuals below poverty.

The Environmental Justice section in Chapter 3 displayed poverty-by-race for the Wind River and Stevenson CCDs (Census County Divisions). The CCD figures are summarized in Table 4-13, below.

Table 4-13. Low Income Groups/Individuals, by Race, Potentially Affected By Hemlock Dam Removal.

Poverty by Race (Individuals) for Wind River and Stevenson CCCs			
	Wind River CCD	Stevenson CCD	% of County
	Number / %	Number / %	% of County
White	573 / 14%	326 / 21%	10%
Black	0/0	2 / 100	.06%
American Indian And Alaska Native	57 / 37	22 / 28	36%
Other Race	7 / 15	2 / 12	.04%
2 or more races	20 / 21	7 / 11	12%
Hispanic or Latino	56 / 24	2 / 7	15%
White not Hispanic	542 / 14	324 / 21	10%

Cumulative Effects

As stated above, access to alternate recreational sites that afford the same or similar experiences is relatively expensive or inconvenient for low-income people living in the Carson-Stabler area if it means traveling to another state (Mount Hood National Forest), or even to a more distant location on the Gifford Pinchot National Forest. As an economic reality, the national forests can no longer afford to build, operate and maintain such highly developed recreation sites. The possibility for full replacement of the water-related amenities in the Hemlock area (off-channel pond, for instance) would rely on sources of funding other than national forest funds. It is conceivable that user fees would be initiated at the Hemlock Day Use site, whether there was access to water or not, to offset operations and maintenance costs. Alternative locations on the Gifford Pinchot or other national forests would be under similar economic incentive to either begin or continue user fees. State parks and recreation sites charge, or soon will charge user fees. Fees, the cost of travel, food, and supplies would likely discourage low-income families and individuals from pursuing this form of recreation. The nearest equivalent site would be development of Rock Creek cove near Stevenson; now in the early planning stages by Skamania County. Though farther away and in a more urban than forest setting, as envisioned, this site would provide a similar recreational experience. The cost to Skamania County low-income populations would then be similar to their cost to recreate at the Hemlock site.

4.11.1.3. Alternatives D and E

Direct and Indirect Effects

By retaining the dam, there would be no impacts to low-income or minority groups as a whole.

Cumulative Effects

Cumulative effects of either Alternative D or Alternative E would be the same as for Alternative A (no action).

4.12. Short-term Uses and Long-term Productivity

NEPA requires consideration of "the relationship between short term uses of man's environment and the maintenance and enhancement of long term productivity" (40 CFR 1502.16). As declared by the Congress, this includes using all practicable means and measures, including financial and technical assistance, in a manner calculated to foster and promote the general welfare, to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans (National Environmental Policy Act, Section 101). This means that short term uses are those that determine the present quality of life for the public. Timber harvest, recreation, livestock grazing, and some mineral extraction are considered short term uses. Long-term productivity of the land refers to the capability of the land to provide resources such as forage, timber, wildlife habitat and high quality water. Maintaining soil productivity and water quality will assure maintenance of long term productivity.

Each of the alternatives considered in this analysis attempts to incorporate a balance of short-term uses and long-term productivity. In general, Alternatives B and C favor long-term productivity of the Trout Creek system by removing an artificial barrier to the movement of water, wood, sediment, and fish. At the same time, these alternatives retain recreational opportunities at the Hemlock day use site and leave open the option of later consideration of an off-channel recreational pond. Alternatives D and E also include some balance but favor short term uses, specifically recreation. While focused on recreation, these two alternatives also incorporate some habitat and fish passage enhancement which would improve long-term productivity of the Trout Creek system.

4.13. Adverse Effects Which Cannot be Avoided

All alternatives, including the No Action alternative (Alternative A) are likely to adversely affect Lower Columbia River steelhead trout and critical habitat for Lower Columbia River steelhead trout. This species is listed as Threatened species under the Endangered Species Act (1973).

The release of fine sediments and resulting turbidity would result in short term adverse effects to fish and other aquatic species under all alternatives. Mitigation measures presented in Chapter 5 are designed to minimize those effects but some release of sediment is inevitable. By design, Alternative B would result in a much higher degree of impact than the other alternatives. The Responsible Official will take this into account when making a decision.

The nature of the dam removal alternatives (Alternatives B and C) would destroy historic resources, as described in **4.3 Cultural Resources**. Alternative D would remove and Alternative E would modify the historic fish ladder. The dam would be altered under both of the dam retention alternatives. Dam removal and associated actions could expose the remains of the historic splash dam and potentially destroy all or a portion of the remains. Draining the reservoir could expose prehistoric sites that are known to have existed along the shores of Trout Creek. Sediment and/or dam removal actions could damage or destroy portions of these sites.

Any ground-disturbing activity has the potential to spread invasive weed species. Exposure of bare soil from draining the reservoir or from disposal of sediments has the greatest potential to create favorable conditions for invasive species to become established. Mitigation measures have been designed to ensure that these sites are monitored and treated promptly and to ensure that equipment is cleaned of seed sources prior to operating in the national forest.

All alternatives would cause temporary disruption to recreation activities at the Hemlock day-use site due to dam removal and/or dredging and construction activities. Recreational activities associated with Hemlock Lake would be adversely affected during the work period. For the safety of users and to facilitate the heavy equipment, under dam removal alternatives (Alternatives B and C), in-water recreational opportunities would be affected for much longer periods.

4.14. Irreversible and Irretrievable Commitments of Resources

The USFS Environmental Policy and Procedures Handbook (FSH 1909.15) defines irreversible as a loss of future options. It applies primarily to the effects of the use of nonrenewable resources, such as minerals or cultural resources, or to those factors, such as soil productivity that are renewable only over long periods of time.

Irretrievable is defined as the loss of production, harvest, or use of natural resources. For example, some or all of the timber production from an area is lost irretrievably while an area is serving as a winter sports site. The production lost is irretrievable, but the action is not irreversible. If the use changes, it is possible to resume timber production.

The action alternatives have the potential to affect historic and prehistoric resources, as described in 4.3 Cultural Resources. Some of these actions would permanently remove or alter the historic character of the dam, fish ladder, and any remains of the splash dam. Actions which would drain the reservoir and remove accumulated sediments may expose prehistoric sites. Adverse effects to these resources would be irreversible.

Use of the Carson-Guler quarry as a disposal site for concrete and other dam components would represent an irretrievable commitment of resources. As long as the quarry remains active, this site would not be available for production.

Use of the nursery fields for sediment disposal could result in an irretrievable loss of agricultural productivity, however the proposed location of the disposal site does not correspond to fields that had been previously developed and used for nursery production.

4.15. Cumulative Effects

The environmental analysis required under the National Environmental Policy Act (NEPA) is forward-looking, in that it focuses on the potential impacts of the proposed action and alternatives that an agency is considering. Thus, review of past actions is required to the extent that this review informs agency decisionmnaking regarding the proposed action. The Council on Environmental Quality (CEQ) interprets NEPA and CEQ's NEPA regulations on cumulative effects as requiring analysis and a concise description of the identifiable present effects of past actions, to the extent that they are relevant and useful in analyzing whether the reasonably foreseeable effects of the agency proposal for action and its alternatives may have a continuing, additive and significant relationship to those effects. In determining what information would be necessary to perform such analysis, the USFS conducted scoping to determine the relevant issues and identify the past, present, and foreseeable future actions that, together with the proposed action, could result in significant impacts. Agencies are not required to list or analyze the effects of individual past actions unless such information is necessary to describe the cumulative effect of all past actions combined.

When evaluating reasonably foreseeable significant adverse effects on the human environment in an environmental impact statement and there may be incomplete or unavailable information. In this document, cumulative effects have been predicted using the best available scientific information and the professional judgment of the resource specialists.

4.16. Other Required Disclosures

NEPA at 40 CFR 1502.25(a) directs "to the fullest extent possible, agencies shall prepare draft environmental impact statements concurrently with and integrated with…other environmental review laws and executive orders."

The USFS has consulted with NMFS in accordance with the Endangered Species Act implementing regulations for projects affecting Threatened or Endangered anadromous fish species. Disclosure of effects is summarized in **4.1 Effects to Aquatic Resources**. NMFS issued a Biological Opinion based on the preferred alternative (Alternative C) on June 1, 2005.

The analysis area contains areas that are defined as "wetlands". Disclosure of effects to wetlands is summarized in **4.9 Wetlands**. In accordance with federal and state laws, damage to wetlands will be mitigated following Washington State Dept of Ecology Wetland Mitigation guidelines. There will be no effects to floodplains.

During analysis of the proposed project, no unique areas such as parklands were found. There are no Wilderness areas within or adjacent to the project area. There are no Research Natural Areas within or adjacent to the project area. The Wind River is under study as a Recreational River. None of the action alternatives would affect this status.

In review of the effects listed in the Environmental Consequences, there are no known effects on the human environment that are highly uncertain or involve unique or unknown risks. Although local concerns have been raised over certain aspects of the proposed actions, the effects upon the human environment are not likely to be highly controversial to the broader public.

The actions do not threaten a violation of federal, State, or Local law, or requirements imposed for the protection of the environment.

The decision made to implement the proposed action or an alternative action would not set a precedent for other projects.

CHAPTER 5. MITIGATION MEASURES AND MONITORING

5.1. Mitigation

As a part of the design of the alternatives, the USFS is offering the following measures to mitigate for unavoidable effects that could result from project implementation. These measures have been included in the design of the alternatives, as indicated. These measures would eliminate, minimize or reduce impacts of the action alternatives. Site- and design-specific measures will be coordinated with state, local and federal review and permitting agencies during the permit process. Additional mitigation and conservation measures may be prescribed by permitting agencies and will be incorporated into the project design.

	Mitigation	Alternative(s)
Hydrology-1	Trout Creek streamflows will be routed past the work area during all construction activities.	B, C, D, E
Hydrology-2	A coffer dam will be constructed on Trout Creek and at the south embayment of the lake to contain streamflow inputs from Trout Creek and small tribs from the south slopes during construction activities.	B, C, D, E
Hydrology-3	All disturbed areas will be mulched and revegetated using native materials.	B, C, D, E
Hydrology-4	Re-introduction of Trout Creek flows to the channel following work activities will be done as much as possible to coincide with early fall freshets.	B, C, D, E
Hydrology-5	Monitoring of the immediate effects of the removal will be undertaken and continued through the period of active channel incision and adjustment to assess dynamic changes in the channel within the lake or downstream that could affect fish passage, access, or flow paths, and to identify any unexpected situations that require action.	B
Hydrology-6	The sluice gate will be operated annually during periods of high flow to route sediment and to maintain some depth in the lake for improvement of water temperatures. The gate will be opened when flows exceed 1,500 – 2,000 cfs to ensure that sediment releases coincide with periods of adequate stream power to move the sediments. Actual criteria used for triggering opening of the sluice gate will be established in consultation with Department of Ecology and NOAA Fisheries, after development of a turbidity/discharge rating curve.	D, E
Hydrology-7	A Wetlands Mitigation Plan will be developed that describes the mitigations (replacement or rehabilitation) to offset the loss of wetlands as a result of dam removal. This plan will be coordinated with the Washingto Department of Ecology.	B, C
Hydrology-8	Contingency plans will be developed for the selected alternative prior to any construction or implementation activities.	B, C, D, E

	Mitigation	Alternative(s)
To minimize introduction of sediment into the stream channel, the following construction phases and methods will be implemented and represent typical actions required for implementing project activities:		
Fish-1	Equipment used for dam removal and pilot channel construction would typically consist of a mix of the following: back hoe, bulldozer, tractor, grader, dump truck, front-end loader, hydraulic excavator, crane, pumps, pneumatic rock drill, explosives, hydraulic hammers, hydroseeding truck, hand shovels, and rakes.	B, C
Fish-2	Appropriate State of Washington guidelines for timing of in-water work periods for the relevant ESA-listed fish species will be followed. In-water work typically occurs between July 1 and October 1 of a calendar year, except where the potential for greater damage to water quality and fish habitat exists. Work outside this window shall not occur without specific justification and measures implemented to protect summer steelhead. In addition, project activities will typically cease during wet periods, regardless of typical season, that have the potential to generate and deliver sediment to Trout Creek.	B, C, D, E
Fish Handling and Transfer Protocols		
Fish-3	Block nets will be set up at both up and downstream locations and will be left in a secured position to exclude fish from entering the project area. The nets will be secured to the stream channel bed and banks until fish capture and transport activities are complete. If block nets are left in place more than one day, the nets will be monitored on a daily basis to ensure they are secured to the banks and free of organic accumulation.	B, C, D, E
Fish-4	Fish will be collected by hand or dip nets as the area is slowly dewatered. Seining - Seines with mesh < 1mm will be used to ensure entrapment of the residing ESA-listed steelhead. Minnow traps - Traps will be left in place overnight and in conjunction with seining. Electrofishing - Prior to dewatering, electrofishing will only be used where other means of fish capture may not be feasible or effective. The protocol for electrofishing includes the following: - If fish are observed spawning during the in-water work period, electrofishing shall not contact spawning adult fish or active redds. - Only Direct Current (DC) or Pulsed Direct Current (PDC) shall be used. - Conductivity <100 will use voltage ranges from 900 to 1100. Voltage ranges from 500 to 800 will be used for conductivity from 100 to 300. For conductivity values greater than 300, voltages of less than 400 will be used. - Electrofishing will begin with the minimum pulse width then gradually increase to the point where fish are immobilized and captured. - Extreme care will be taken to avoid anode contact with fish. Once stunned, fish will be removed from the water immediately. - If burning (dark bands on the fish indicate injury) occurs, voltage will be reduced and longer recovery times will be afforded.	B, C, D, E
Fish-5	ESA-listed steelhead within the project area will be handled with extreme care and kept in water the maximum extent possible during transfer procedures. A healthy environment for the stressed fish shall be provided; large buckets (five-gallon minimum to prevent overcrowding) and minimal handling of fish. Large fish will be placed in buckets separate from smaller prey-sized fish. Water temperature and the well-being of captured fish will be monitored in buckets. After fish have recovered, fish will be released upstream of the isolated reach in a pool or area that provides cover and flow refuge. A report detailing fish numbers encountered and/or relocated by species and life history stage, condition (e.g. apparently uninjured, injured, dead) shall be prepared and provided to NOAA Fisheries within 7 working days after any relocation activity. However any mortalities of summer steelhead shall be reported immediately to NOAA Fisheries.	B, C, D, E

	Mitigation	Alternative(s)
	Pollution and Erosion Control Plan (PECP) and Supporting Measures	
Fish-6	A Pollution and Erosion Control Plan (PECP) will be developed for this project. The PECP will include methods and measures that minimize erosion and sedimentation associated with the project. The PECP elements will be in place prior to and at all times during the appropriate project phases. The following mitigation measures will assist in the creation of a PECP.	B, C, D, E
Fish-7	All project actions will follow all provisions of the Clean Water Act and provisions for maintenance of water quality standards as described by Washington Dept. of Ecology.	All
Fish-8	The contractor will be required to have a written Spill Prevention Control and Containment Plan (SPCCP), which describes measures to prevent or reduce impacts from potential spills (fuel, hydraulic fluid, etc). The SPCCP shall contain a description of the hazardous materials that will be used, including inventory, storage, handling, and monitoring.	B, C, D, E
Fish-9	Site preparation will be completed in the following manner: - The contractor shall have a written erosion and sedimentation prevention and containment plan for the project and shall have all necessary personnel, supplies and equipment available to ensure that the plan is promptly and effectively implemented. - Flag boundaries of clearing limits associated with site access, staging and stockpile areas to minimize overall disturbance and disturbance to critical vegetation. - Establish staging areas (used for heavy equipment storage, vehicle storage, fueling, servicing, etc) along existing roadways or picnic area beyond the 100-year floodprone area in a location and manner that will preclude erosion into or contamination of the stream or floodplain. - Minimize clearing and grubbing activities, if required for preparation of staging or stockpile areas. Stockpile large wood, trees, riparian vegetation, other vegetation, sand, and topsoil removed for establishment of staging area for site restoration. - Place sediment barriers around disturbed sites where potential erosion may enter the stream directly or through road ditches, which are connected to the stream.	B, C, D, E
Fish-10	Methods to minimize fuel/oil leakage from construction equipment into the stream channel and floodplain include the following: - The contractor shall have a written spill prevention and containment plan for the project and shall have all necessary personnel, supplies and equipment available to ensure that the plan is promptly and effectively implemented. - All equipment used for instream or dam decommissioning work shall be cleaned and leaks repaired prior to arriving at the project. Remove external oil and grease, along with dirt and mud. Inspect all equipment before unloading at site. Thereafter, inspect equipment daily for leaks or accumulations of grease, and fix any identified problems before entering streams or areas that drain directly to streams or wetlands. - Equipment used for in-stream or riparian work shall be fueled and serviced in an established staging area (at least 150’ away from Trout Creek or other water bodies). When not in use, vehicles will be stored in the staging area. - Two oil absorbing floating booms appropriate for the size of the stream shall be available on-site during all phases of construction whenever surface water is present. Place booms in a location that facilitates an immediate response to potential petroleum leakage.	B, C, D, E
Fish-11	Drawdown and/or refill of the lake for any purpose related to this project shall be done in a manner that avoids sudden changes in lake level or stream flow. The frequency and duration of drawdown/refills shall be held	B, C, D, E

	Mitigation	Alternative(s)
	to the absolute minimum necessary to complete the project. The contractor shall prepare a “ramping” schedule that reflects these objectives and this schedule must be approved by NOAA Fisheries before lake level manipulations related to this project occur. To minimize project related sediment introduced into the stream and to help meet state turbidity standards, methods to isolate the in-channel project includes the following: - Divert flow with pumps or structures such as cofferdams constructed with non-erosive devices, such as sandbags, bladder bags, or other means that divert water. - The temporary bypass system may consist of non-erosive techniques, such as a pipe or a plastic-lined channel, both of which must be sized large enough to accommodate the predicted peak flow rate during construction. In cases of channel rerouting, water can be diverted to one side of the existing channel. - Dissipate flow at the outfall of the bypass system to diffuse erosive energy of the flow. Place the outflow in an area that minimizes or prevents damage to riparian vegetation. If the diversion inlet is not screened to allow for downstream passage of fish, place diversion outlet in a location that facilitates safe reentry of fish into the channel. - When necessary, pump water from the de-watered work area to a temporary storage and treatment site or into upland areas and filter through vegetation prior to reentering the stream channel. - Any water intake structure (pump) will have a fish screen installed, operated and maintained in accordance to NMFS fish screen criteria (USDC 1995b) (http://www.nwr.noaa.gov/1hydrop/hydroweb/ferc.htm)	
Fish-12	Slowly re-water the construction site to prevent loss of surface water downstream as the construction site streambed absorbs water and to prevent a sudden increase in stream turbidity. Look downstream during re-watering to prevent stranding of aquatic organisms below the construction site.	B, C, D, E
	Site Restoration	
Fish-13	A revegetation plan will be prepared by the USFS. All disturbed areas shall be rehabilitated and stabilized by seeding and planting with native vegetation. Revegetation would be monitored and maintained for at least three years to ensure a minimum of 80% survival throughout revegetated areas. If survival falls below 80%, additional revegetation would be planted until the threshold for survival is met. All bank stabilization shall be completed and all construction materials, debris, fills, etc shall be removed before the bypass and or cofferdam(s) are removed. - Upon project completion, remove project related waste. Initiate rehabilitation of all disturbed areas in a manner that results in similar or better than pre-work conditions through spreading of stockpiled materials, seeding, and/or planting with native seed mixes or plants. If native stock is not available, use soil-stabilizing vegetation (seed or plants) that does not lead to propagation of exotic species. - Stream channel cross-section and gradient that reflects more natural conditions found up and downstream will be constructed. Large wood and/or boulders may be placed in the reconstructed stream channel and floodplain. - When necessary, access roads, stream channel within the dewatered work area, staging, and stockpile areas will be de-compacted. - In-stream or floodplain restoration material such as large wood and boulders will mimic as much as possible those found in the project vicinity. Such materials may be salvaged from the project site or hauled in from offsite. - Conifers will not be felled in the riparian areas for restoration purposes. Riparian conifers will only be felled for safety. If necessary for safety, trees will be felled toward the stream and leave in place or	B, C, D, E

	Mitigation	Alternative(s)
	place them in the stream channel or floodplain. - Necessary site restoration activities such as mulching will occur within five days of the last construction phase.	

	Mitigation	Alternative(s)
Recreation-1	During dam removal-related activities, the day-use area would be closed to the public, including access to the toilets and potable water.	B, C
Recreation-2	Beaver Group Camp would be available for day-use picnics during the time the Hemlock day-use picnic area is closed to the public due to dam removal-related activities.	B, C

	Mitgation	Alternative(s)
Cultural-1	A plan will be developed to provide for historic documentation of the splash dam if it is encountered during channel excavation or incision. The documentation would be completed prior to removal of the splash dam.	B, C
Cultural -2	If there is a potential to impact archaeological sites are impacted during streambank stabilization activities, additional cultural surveys will be conducted and a report prepared.	B, C, D, E
Cultural -3	Archaeological sites will be avoided in the sediment disposal site.	B, C, D, E
Cultural -4	All heavy equipment access routes will be pre-designated.	B, C, D, E
Cultural -5	The existing fish ladder will be left intact for future interpretive use.	B, C
Cultural -6	Interpretive facilitites will be developed at the site that will convey the history of the dam and fish ladder.	B, C
Cultural -7	The dam and fish ladder will be documented using the accepted format of the Historic American Survey/Historic American Engineering Record (HABS/HAER). Documentation will include structural plans and 35 mm black and white photographs of the dam and fish ladder and surroundings. Photographs will be labeled according to HABS/HAER standards. Oral history information will also be included as part of the written report, which will be submitted to the Washington State Office of Archaeology and Historic Preservation, Advisory Council on Historic Preservation, and the National Park Service.	B, C, D
Cultural-8	Data recovery excavations will be completed in areas proposed for disturbance at the Trout Creek Site, and a final technical report will be submitted to the Washington State Office of Archaeology and Historic Preservation, the Advisory Council on Historic Preservation, and the Yakama Nation (Cultural Resources Program).	B, C, D, E

	Mitigation	Alternative(s)
Wildife-1	Blasting using more than 2 pounds of explosives would be prohibited from March 1 to June 30 to prevent noise disturbance to northern spotted owls.	B, C
Wildlife-2	Seed the dredge spoil pile with palatable forage for elk and deer, and allow ungulate access when forage is established.	B, C, D, E
Wildlife-3	For Alternatives D and E, maintain the lake at a full or near full level for goldeneye ducks from about March 15 to October 31.	D, E

	Mitigation	Alternative(s)
Botany-1	To prevent the introduction of noxious weeds into the project area, all heavy equipment, or other off- road equipment used in the project is to be cleaned to remove soil, seeds, vegetative matter or other debris that could contain seeds. Cleaning shall be done before entering National Forest Lands, and when equipment moves from project sites or areas known to be infested into other areas, infested or otherwise. An inspection will be required to ensure that equipment is clean before work can begin. (Equipment cleaning clause WO-C6.35).	B, C, D, E
Botany-2	To prevent the spread of invasive species that currently exist on the Hemlock lake shore into newly exposed areas: Remove, through hand pulling and/or weed wrenching, all existing noxious weeds and invasive plants, with the exception of reed canary grass (on which this treatment is impossible), before project commencement. This treatment will occur during the season of project commencement, but before the project begins.	B, C, D, E
Botany-3	Remove reed canary grass from areas that are adjacent to newly exposed stream shore. Implement streambank recontouring activities after reed canary grass is removed.	B, C
Botany-4	To safely dispose of reed canary grass, place reed canary grass detritus at the bottom level of silt deposition piles at the Pacific Crest Nursery field.	C, D, E
Botany-5	For two years after completion of project, revisit sites where weeds were located before removal to monitor and control new infestation. In addition, monitor newly exposed stream bank areas and control new weed infestations.	B, C, D, E
Botany-6	Re-vegetate newly exposed areas with: A native seed mix and application prescription developed by the Gifford Pinchot National Forest for the project site. Guidelines for site preparation shall also be followed (see Gifford Pinchot Native Species Policy, 2000). This information will be provided by the Gifford Pinchot National Forest South Zone Botanist prior to project implementation.	B, C, D, E
Botany-7	Plant overstory trees and shrubs in open areas along the lakeshore (see map). Under alternatives D and E (that won't drain the lake), this comprises the existing open areas, primarily located along the south lake shore; under alternatives B and C (that will drain the lake), this includes both existing open areas, as well as what will be, post project implementation, newly exposed stream shore that was previously lake bed. Creating an overstory to shade new stream shore habitat will help prevent establishment and spread of noxious weeds and other invasive plants into this area over time.	B, C, D, E

5.2. Monitoring

5.2.1. Effectiveness Monitoring

Pre- and post-project monitoring will be implemented to establish baseline conditions and monitor effects of the project. Channel cross sections, long profiles, channel substrate, water temperature, turbidity will be monitored at select stations and reaches upstream, in the lake reach, and downstream to the mouth of the Wind River. A monitoring plan will be developed prior project implementation and data will be collected a minimum of one complete year prior to implementation, and for a minimum of five years following the project, dependent upon funding.

The monitoring plan will be developed in coordination with other interested agencies after a decision has been made on the alternative to be selected.

5.2.2. Compliance Monitoring

The compliance with and effectiveness of mitigation measures will be assessed through a review of contract specifications prior to advertisement, contract inspection during project implementation, and monitoring following the completion of each stage of the project.

5.3. Other Plans and Assessments

A number of plans and assessments have been referenced in this document:

A Pollution and Erosion Control Plan (refer to Mitigation Measure Fish-9), a Spill Prevention Plan (Mitigation Measure Fish-10), and a Wetlands Mitigation Plan (Mitigation Measure Hydrology-7) will be developed prior to implementation. These plans will be submitted for review to the Washington Department of Ecology for review for compliance with the Washington State Water Quality Standards and Washington State Wetland Mitigation guidelines.

A Revegetation Plan (Mitigation Measure Fish-13) will be developed to rehabilitate and stabilize newly-constructed streambanks and areas that would be disturbed as a result of removal of the dam and reservoir.

A plan will be developed to provide for historic documentation of the splash dam if it is encountered during channel excavation or incision. The documentation would be completed prior to removal of the splash dam (Mitigation Measure Cultural-1).

The dam and fish ladder will be documented using the accepted format of the Historic American Survey/Historic American Engineering Record (HABS/HAER) (Mitigation Measure Cultural-7).

A final technical report concerning the dam and fish ladder will be submitted to the Washington State Office of Archaeology and Historic Preservation, the Advisory Council on Historic Preservation, and the Yakama Nation (Mitigation Measure Cultural-8).

Changes or additions to the Hemlock recreation site will be designed following implementation. These proposals will be analyzed in a separate site-specific Environmental Assessment in accordance with the National Environmental Policy Act.

The alternative that is selected by the Responsible Official will determine the specifics of these plans and assessments or whether they would be required.

CHAPTER 6. CONSULTATION AND COORDINATION

6.1. Preparers and Contributors

The Forest Service consulted the following individuals, federal, State, and local agencies, tribes and non-Forest Service persons during the development of this environmental assessment:

6.1.1. ID Team Members:

Personnel	Subject Matter Expertise	Agency
Aldo Aguilar	Soils	USFS
Brian Bair	Fisheries	USFS
Jim Chamberlin	Geology/Groundwater	USFS
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Robin DeJong	Engineering	USFS
Cynthia Henchell	NEPA/Writer	USFS
Julie Knutson	Recreation	USFS
Tom Linde	Recreation	USFS
Cheryl Mack	Archaeology	USFS
Benjamin Scott	Engineering	USFS
Andrea Ruchty	Botany	USFS
Mitch Wainwright	Wildlife	USFS

6.1.2. Federal, State, and Local Agencies:

Personnel	Subject Matter Expertise	Agency
Blair Greimann	Hydraulic Engineering	USDI Bureau of Reclamation
Tom Hepler	Civil Engineering	USDI Bureau of Reclamation
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Stephanie Ehinger	Fisheries	NMFS
Bryan Nordlund	Fisheries	NMFS
Greg Pelletier	Water Quality	Washington State Dept. of Ecology
Timothy J. Randle	Hydraulic Engineering	USDI Bureau of Reclamation
Dan Rawding	Fisheries	WDFW

6.1.3. Tribes

Yakama Nation

DISTRIBUTION OF THE ENVIRONMENTAL IMPACT STATEMENT

This environmental impact statement has been distributed to individuals who specifically requested a copy of the document. In addition, copies have been sent to the following Federal agencies, federally recognized tribes, State and local governments, and organizations representing a wide range of views regarding fish passage, water quality, and aquatic habitat and individuals, agencies, organizations, and tribes who provided substantive comments to the DEIS.

Advisory Council on Historic Preservation
American Rivers
Bonneville Power Administration
Clark-Skamania Flyfishers
Columbia River Gorge National Scenic Area
Columbia River Inter-Tribal Fish Commission
Columbia Riverkeeper
Department of Ecology
DSG Associates
Federal Highway Administration
Five Star Nursery
Friends of the Columbia Gorge
Gifford Pinchot Task Force[1]
Norm Haight[1]
High Cascade, Inc.
Arlene Johnson[1]
Kennedy Jenks Consultants
Walt Loehrke [1]
Lower Columbia Fish Enhancement Group
Lower Columbia Fish Recovery Board
Mid Columbia Fish Enhancement Group
Marlyn Misner[1]
National Marine Fisheries Service, Habitat Conservationists Division, Northwest Region
National Oceanic and Atmospheric Agency, Fisheries (National Marine Fisheries Service) [1]
National Oceanic and Atmospheric Agency, Office of Policy and Strategic Planning, NEPA Coordinator
Northwest Ecosystem Alliance
Northwest Environmental Defense Center
Northwest Power Planning Council
Portland District Fish Field Unit
Audrey and David Scott[1]
Skamania County Board of Commissioners[1]
Skamania County Planning Department
Squaxin Island Tribe
Stabler Community Council Executive Committee
Underwood Conservation District
U. S. Army Corps of Engineers, Northwestern Division
U. S. Coast Guard, Environmental Impact Branch, Marine Environmental and Protection Division
U. S. Department of Agriculture, Animal and Plant Health Inspection Service PPD/EAD
U. S. Department of Agriculture, National Agricultural Library

U. S. Department of Agriculture, Natural Resources Conservation Service, National Environmental Coordinator
U. S. Department of Energy, Office of NEPA Policy and Compliance
U. S. Department of the Interior, Director, Office of Environmental Policy and Compliance
U. S. Environmental Protection Agency[1]
U. S. Environmental Protection Agency, Region 10, EIS Review Coordinator
U. S. House of Representatives
Irene Ward[1]
Washington Dam Safety Office
Washington Department of Ecology [1]
Washington Department of Fish and Wildlife[1]
Whitman County Sportsmen Association
Wild Steelhead Coalition
Wind River Resorts
Yakama Nation[1]

[1] Provided substantive comments to the DEIS. Refer to Appendix A for USFS responses.

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