VII. FISHERIES

Changes between the DEIS and the FEIS

See Chapter 2 for a description of the changes in the alternatives that were made since the DEIS was completed. In general, changes in some of the features of the alternatives tended to lessen the predicted impacts as described in the DEIS. This was due to several factors, including: the overall reduction in acres proposed to be treated, which ranged from 377 to 596 acres and the change in logging systems from ground-based methods (skidder or skyline) to helicopter or winter ground-based logging. In addition the temporary road described in the DEIS has been eliminated from the project, further reducing ground disturbance.

The completion of a snowmelt-runoff cycle and the summer thunderstorm season allows us to reassess the impact of the fire upon the aquatic environment. Stream surveys completed during the summer field season have filled some gaps in the habitat inventory data, and recently completed fish population surveys provide a post-fire snapshot of fish population health in the watershed. In general, the impact of the fire upon the aquatic ecosystem has been less severe than expected.

The updated fish and habitat data has been incorporated into the Affected Environment section below, while the effect of changes to project alternatives is evaluated in the Environmental Consequences section.

1. Analysis Area and Information Sources

The fisheries analysis area for this project encompasses a range of spatial scales, which to large degree reflect the status of the bull trout, (*Salvelinus confluentus*), a native charr historically abundant throughout the Columbia River Basin. This analysis area includes the entire Flathead Basin, with the following exceptions. The construction in 1938 of Kerr Dam below Flathead Lake effectively isolated fish populations above the dam from populations in the lower river, which consequently is not included in this analysis. In addition, dams have likewise isolated fish populations in both the South Fork Flathead River and the Swan River, and access to these river systems is no longer available to fish residing in and above Flathead Lake (Weaver and Fraley 1991). The broad-scale analysis area for this project therefore includes the upper Flathead basin, including Flathead Lake, the North and Middle Forks of the Flathead River, and the intervening river channel that connects them.

At a finer resolution, this analysis will focus primarily upon the Big Creek watershed. Big Creek is a fourth order tributary of the North Fork Flathead River, and its principal tributaries include Hallowat, Elelehum, Lookout, Langford, and Skookoleel Creeks, as well as numerous smaller, often unnamed streams. Big Creek flows west to east and joins the North Fork about 10 river miles above the confluence with the Middle Fork. The entire Big Creek watershed spans approximately 77 square miles, or some 52,000 acres. The Moose Fire burned approximately 38%, or nearly 20,000 acres of the watershed.

Information for this analysis has been gathered from a variety of sources. The Flathead National Forest and Montana Department of Fish, Wildlife, and Parks have conducted site-specific fish habitat condition and population status inventories within the watershed for more than twenty years. The Flathead Basin Commission has sponsored several studies that bear either directly or indirectly upon Big Creek and its aquatic resources. The Flathead National Forest completed an *Ecosystem Analysis at the Watershed Scale* (EAWS) study in 1998, which provided a wealth of pre-Moose fire background data concerning Big Creek. Flathead National Forest fisheries biologists and technicians gathered post-fire data on several key fish habitat quality indicators, while Montana Department of Fish, Wildlife, and Parks biologists monitored fish populations and bull trout spawning levels during and after the fire. The Flathead National Forest, in cooperation with the Montana Department of Environmental Quality, has recently completed a watershed restoration plan for Big Creek. This plan, known as a Total Maximum Daily Load, or TMDL, is intended to address problems within the watershed that resulted in Big Creek being listed as water quality-impaired by the state. Forest Service biologists prepared a baseline Biological Assessment (BA) of the status of bull trout in 1998 as required by Section 7 of the Endangered Species Act. Finally, peer-reviewed scientific literature has been used as the primary source of information regarding the life histories and habitat requirements of the aquatic organisms that call Big Creek home, and the effect of natural and human-caused disturbance upon those organisms.

2. Affected Environment

This section describes the current condition of the aquatic environment in the Big Creek watershed, and the principal species that are part of that environment. This assessment is largely based upon pre-Moose Fire data, but the completion of a snowmelt/runoff cycle does allow some description of the post-fire landscape. The probable future effects of the fire on the ecosystem will be discussed in subsequent portions of this section.

Existing Stream Condition

The Big Creek drainage was first entered for large-scale timber management purposes in 1952. The initial harvest activity was in response to an outbreak of spruce bark beetle, which resulted from a large blowdown event in 1949. Most of this early harvest took place in the headwaters of Big Creek and its tributaries, particularly Hallowat, Nicola, and Skookoleel Creeks. By 1975, more than 8000 acres had been harvested within these headwater areas, with the vast majority of the units being either clearcut or seed tree harvest treatments. Many harvest units extended to the stream banks and a significant portion of the riparian canopy was removed. To facilitate these timber operations, roads were constructed throughout the drainage, most prior to the development of Best Management Practice standards. Timber harvest continued during the 1980s but at greatly reduced levels. Timber removal also accompanied the clearing of several ski runs on the north side of Big Mountain Ski Area, located in the uppermost reaches of Big Creek. In total, some 12,000 acres within the watershed have been harvested, and over 200 miles of road have been constructed to facilitate this harvest. The most recent harvest activity involves the removal of Moose Fire hazard trees along main roads, which is discussed in the cumulative effects portion of this section.

The early harvest and road building methods resulted in increased water yields, a greater sediment load in streams, a decrease in large woody debris recruitment, and increased sunlight influencing water temperatures in stream channels. The combined effect of these changes was increased width to depth ratios, elevated water temperatures, increases in peak flows, and a loss of pool habitat and overall habitat complexity. Streams became wider and shallower, and large quantities of rock and soil were eroded from the stream banks and carried downstream. When streambanks are eroded, the particle size of the captured material determines the rate and manner in which it is transported. Small diameter particles move downstream in suspension, while the larger particles, known as bedload, move by rolling, sliding, and bouncing downstream. As stream gradient and discharge decline, the movement of bedload material decreases and the fine particles begin to settle out of the water (Gordon et. al. 1992).

Stream channel stability surveys conducted in Big Creek beginning in the late 1970s revealed increased channel erosion rates and declining fish habitat quality in the headwaters reaches (see table 3-64). As erosion accelerated in the streams, existing pools began to fill with bedload. Fewer big trees falling into streams led to a decline in the total number of pools because large diameter trees are the principal agent of pool formation in forested watersheds (Hauer et al. 1999). Pools are important habitat for both bull trout and westslope cutthroat trout (*Oncorhynchus clarki lewisi*) (Rieman and McIntyre 1993, Liknes and Graham 1988). The loss of habitat complexity associated with low pool frequency has been linked to lower fish diversity (Reeves et. al. 1993) and abundance (Schlosser 1995).

Recognition of the degraded stream conditions in the early 1990s prompted the Forest Service and Montana Department of Fish, Wildlife, and Parks to implement a number of watershed rehabilitation projects. Using helicopters, large wood has been added to several of the headwaters streams in the basin. Areas of active erosion were stabilized with water bars, shrub and tree planting, and placement of coarse woody debris. Reclamation has been completed on 17 miles of roads in upper Big Creek (Big Creek TMDL). These restoration efforts, coupled with natural revegetation, have begun to stabilize the headwaters streams within the basin.

The fine sediment and bedload that was mobilized by erosion in upper Big Creek has gradually migrated downstream. Much of this material has been deposited in the lower gradient reaches of Big Creek below the junction with Hallowat Creek. Recent stream inspections have identified an unstable reach of Big Creek beginning below Elelehum Creek and extending downstream approximately to Lookout Creek. Excessive bedload deposition in this reach has resulted in pool filling and bar formation. Channel braiding has occurred where the deposited bedload created dams and forced the stream to carve new channels.

The new channels themselves contribute additional fine particles and bedload to the stream, exacerbating the sediment imbalance. This downstream progression of channel instability will likely continue until the stream adjusts to the increased sediment load. Fires and past timber harvest in lower Big Creek have retarded channel recovery by reducing the amount of large diameter woody material available to the stream. Stable streams exhibit low rates of bedload movement, and stream energy is instead dissipated primarily by changes in gradient and turbulence associated with pool formation (Beschta and Platts 1986). A stable stream is one at equilibrium, i.e., the amount of sediment entering the stream is roughly equivalent to the amount carried out at the mouth of the stream (Leopold et al. 1964).

Since 1981, McNeil core samples have been taken in Big Creek to determine the percentage of fine sediments (< 6.4mm) in the channel substrate (Table 3-85). Concentrations of fine sediments above 35% within the gravels of spawning redds have been shown to reduce bull trout egg and fry survival (Weaver and Fraley 1991). Elevated sediment levels led the Montana Department of Environmental Quality to declare Big Creek as impaired from a water quality standpoint. The 1990 level of 53.4% fines is the highest ever recorded for any bull trout stream in the Upper Flathead Basin. Preliminary data from 2001 indicate that the percent fines in Big Creek is currently 30% (Tom Weaver, MDFWP, personal communication).

Table 3-85: McNeil Core samples (% fine sediment < 6.4mm) in Lower Big Creek. Data are courtesy of Montana Dept. of Fish, Wildlife, and Parks.

YEAR	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**
%<6.4mm	23.8	32.6	28.2	27.8	28.7	21.6	29.1	40.3	48.4	53.4
YEAR	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**
%<6.4mm	32.9	37.4	37.2	34.5	32.2	30.0	31.1	32.2	33.1	31.4

Fisheries habitat on the Flathead National Forest is primarily protected by the Inland Native Fish Strategy (INFISH), a body of standards and guidelines that amended the Flathead Forest Plan in 1995. INFISH designates the width of buffers, called Riparian Habitat Conservation Areas (RHCA's), around various classes of streams where fisheries concerns receive primary emphasis. INFISH also defines various habitat measurements called Riparian Management Objectives (RMO's), which are based upon similar standards developed for streams in the Pacific Northwest that contain populations of anadromous fish. The INFISH RMO standards were intended to be an interim guideline until appropriate local standards could be developed. Some of the INFISH standards, particularly for width/depth ratio and number of pools, were based upon reference data gathered in streams created by geologic and geomorphic conditions which differ from those that formed streams on the Flathead National Forest. The unconsolidated glacial till that underlies most streams in this area results in higher width/depth ratios and fewer pools than would be found in streams of similar size in the bedrock dominated geology of the Cascades. The following tables (Tables 3-86 and 3-87) display how Big Creek compares to the INFISH RMO parameters. This information is based upon U.S. Forest Service Region 1/Region 4 surveys (Overton et. al. 1996) for a 4-mile reach of upper Big Creek in 1993, 9.1 miles of lower Big Creek in 2002, and 3 contiguous reaches 5 miles in length (Road 316 to ¾ mile above Road 5207) of Hallowat Creek in 1998 (Big Creek EAWS, project record exhibit I-2). The reach in upper Big Creek is outside the Moose Fire boundary, while the Hallowat Creek reach coincides with the fire boundary for much of its length.

Table 3-86: Status of INFISH interim RMOs in Upper Big Creek (INFISH Standard)

Reach #	Length (m)	Mean W (m)	Mean W/D Ratio (< 10)	# LWD/mi (> 20/mi)	# Pools/mi (56/mi)
1	661.4	5.7	13.4	250.6	26.8
2	1,237.1	6.0	18.3	315.8	26.0
3	1,086.7	5.4	18.9	451.6	23.7
4	709.6	5.6	15.8	233.5	9.1
5	759.5	5.0	16.4	182.2	10.6
6	880.3	4.1	17.5	261.4	14.6
7	1,666.1	2.9	17.4	373.7	17.4

During September of 1993, a habitat survey was conducted on 7,000 m of Big Creek upstream of Nicola Creek using R1/R4 methodology (Overton et al.1997). The channel was divided into seven distinct reaches containing A, B, and C channel types. None of the seven reaches complies with INFISH for mean width/depth ratio or for number of pools per mile. All reaches exceeded INFISH standards for pieces of large woody debris per mile. Data was not recorded for temperature. The number of pools per mile needed to meet the RMO is based upon stream width, and decreases as stream width increases.

Table 3-87: Status of INFISH interim RMOs in Lower Big Creek (INFISH Standard)

Reach #	Length (m)	Mean W (m)	Mean W/D Ratio (< 10)	# LWD/mi (> 20/mi)	# Pools/mi (26/mi)
1	3124.8	15.2	38.3	95	6
2	1614.8	11.4	29.6	250	15
3	1330.1	12.2	31.5	156	10
4	341.1	11.6	33.0	1060	24
5	776.9	12.0	28.2	627	15
6	410.9	9.1	27.6	1488	27
7	613.3	11.0	25.8	521	11
8	3214.7	11.4	31.8	311	9
9	3218.7	10.7	35	450	14

A survey was conducted in August of 2002 on lower Big Creek from the mouth to the confluence with Hallowat Creek, a distance of 9.1 miles. The survey broke the stream into nine reaches of varying length, based primarily upon stream gradient. None of the reaches complies with the INFISH standard for width/depth ratio, and only one reach met the standard for pool frequency. All reaches exceeded the standard for LWD.

Table 3-88: Status of INFISH interim RMOs in Hallowat Creek (INFISH Standard)

Reach #	Length (m)	Mean W (m)	Mean W/Max D (m) (<10)	# LWD/mi (>20/mi)	# Pools/mi (56/mi)
1	7,052.7	8.3	34.85	151.5	15.5
2	1,302.2	7.4	37.25	187.8	9.9
3	1,208.9	4.6	27.94	658.7	91.7

In July of 1998, a habitat survey was conducted on 9,563.8 m of Hallowat Creek upstream of its confluence with Big Creek using R1/R4 methodology (Overton et al. 1997). The channel was divided into three distinct reaches, and consisted of B and C channel types. None of the reaches complied with INFISH standards for width/depth ratio. All three reaches comply with INFISH for pieces of LWD per mile. Reach 3 meets the INFISH objective for number of pools per mile, but reaches 1 and 2 do not. The increased abundance of large woody debris in these reaches should gradually move these streams toward attainment of the INFISH RMOs. When the stream encounters these new, large diameter trees, the energy of the flowing water will be dissipated and deflected downwards, scouring out pool habitat. The average depth of the stream should increase as more pools are created, improving the width/depth ratios while increasing habitat complexity.

INFISH also includes a water temperature standard with a maximum daily temperature of 59º F (15º C) in adult holding habitat. Temperature was monitored in Big Creek in the summer of 1979 and a maximum temperature of 15.6 °C was recorded. From 1986 to 1995, temperature was recorded at the Lookout Bridge and the maximum temperature recorded during this time was 13.9 °C. A higher temperature was recorded, but it was determined the recorder was out of the water.

From 1983 to 1995, temperature was recorded during water quality monitoring above Nicola Creek. The maximum recorded was 12.5 °C.

From 1979 to 1981, temperature was recorded during water quality monitoring in upper Big Creek, and a maximum temperature of 12.0 °C was recorded.

From 1979 to 1980, temperature was recorded during water quality monitoring in Big Creek above Hallowat Creek, and a maximum temperature of 8.0 °C was recorded.

In 1987, 1990, and 1991 a continuous temperature recorder was deployed in lower Big Creek from April through October. The maximum temperature recorded during these years was 14.1 °C.

Temperature data gathered by a graduate student researcher in 2000 and 2001 indicated that temperatures in lower Big Creek reached a maximum of 16.46 º C, and the average daily maximum was greater than 15 º C for a period of 17 days during the summer of 2000. The lower reach of Big Creek is used as a migration corridor by bull trout. Temperatures in the spawning and rearing sections did not exceed 14 º C at any time during this recent study.

The Moose Fire may result in slightly higher stream temperatures in the bottom several miles of Big Creek, where the riparian vegetation suffered high mortality. However, the fact that the headwaters and most tributaries of Big Creek are outside the fire will provide protection from higher temperatures in the spawning and rearing reaches of the watershed. If temperatures in the lower migratory corridor rise above 15 º C in summer, the movement of adult male bull trout into the spawning area may be delayed. However, although the daily maximum temperature exceeded 15 º C for seventeen days, the average daily temperature was always below 15 º C. In addition, there are several deep pools in the migratory reach, which should afford migrating bull trout some refugia from high afternoon temperatures.

The Big Creek watershed still supports all native fish and amphibian species believed to have been historically present. Native fish species include the bull trout and the westslope cutthroat trout. Three additional aquatic groups are native and present in Big Creek, one or more species of fish from the genus sculpin (*Cottus sp.*), mountain whitefish (*Prosopium williamsoni*), and tailed frog (*Ascaphus trueii*). Both bull trout and westslope cutthroat trout populations in Big Creek have declined from historic levels. Little is known about the population status of the remaining aquatic vertebrates. There are no populations of non-native fish established in the Big Creek watershed, but there is evidence of low-level genetic introgression between westslope cutthroat and non-native rainbow trout (*O. mykiss*), indicating some mixing of the species (refer to the Big Creek EAWS supporting documentation in the project record).

Photo 3-1: New large woody debris at work in Big Creek

The Moose Fire was a long-duration event that occurred during severe drought conditions. Extreme fire behavior often necessitated flanking tactics working along the edge of the fire, generally from west to east. As safe anchor points were established, fireline construction proceeded along the edge of the fire, with aerial support. On the leading edge of the fire, suppression actions were initially confined to aerial attack using fire retardant and water drops from fixed wing and helicopter aircraft. The effect of these factors is a low amount of suppression-related ground disturbance relative to the large total size of the fire. Suppression activities did occur in several riparian areas within and adjacent to the fire. Hand fire lines were established along several stream channels, particularly Hallowat Creek, reducing riparian vegetation and contributing to soil disturbance. Mechanized equipment was used to construct fire lines, some of which encroached upon riparian areas in lower Big Creek. Care was taken to avoid streams during aerial fire retardant application and no documented fish kills occurred as a result of suppression activities. Fire line rehabilitation was carried out following control of the fire. This should minimize any lingering effects of fire suppression upon aquatic ecosystems in the watershed. Rehabilitation included replacement of organic soil and duff, construction of waterbars, and placement of slash and large woody debris to prevent erosion.

Species Status and Ecology

<u>Bull Trout</u>

Two basic life history forms of bull trout are known to occur: resident and migratory. Resident bull trout spend their entire lives in their natal streams, while migratory bull trout travel downstream as juveniles to rear in larger rivers (fluvial types) or lakes (adfluvial types). The Big Creek bull trout population is an adfluvial migratory group, with juveniles typically moving down to Flathead Lake at age 2-3, and returning at about age 6 to spawn. Bull trout spawning occurs in the fall, and the eggs incubate in the stream gravel until hatching in January (Fraley and Shepard 1989). The alevins remain in the gravel for several more months and emerge as fry in early spring. Unlike many anadromous salmonids, which spawn once and die, bull trout are capable of multi-year spawning (Fraley and Shepard 1989). The historic range of the bull trout stretched from California, where the species is now extinct, to the Yukon Territory of Canada (Hass and McPhail 1991). The decline of bull trout across most of their historic range in the United States resulted in their listing as a threatened species under the Endangered Species Act in 1998.

Several factors have contributed to the decline of bull trout, including the population in Big Creek. Habitat degradation, interaction with exotic species, over-harvest, and fragmentation of habitat by dams and diversions have all been implicated (Rieman and McIntyre 1995). Bull trout are highly sensitive to environmental change (Rieman and McIntyre 1993) and are particularly intolerant of water temperatures above 15º C (Fraley and Shepard 1989). Substrate size and quality, the availability of cover, and stream channel stability are other habitat requirements linked to bull trout abundance (Rieman and McIntyre 1993). As noted above, bull trout embryo and fry survival decreases with increasing fine sediment levels in spawning gravels. Juvenile bull trout are especially dependant upon stable cobble and boulder substrate for daytime cover and over-winter survival (Thurow 1997). Adult bull trout utilize pool habitats and under-cut streambanks, often in conjunction with large woody debris cover (Rieman and McIntyre 1993). Where bull trout coexist with non-native eastern brook trout (*S. fontinalis*), hybridization between the species has resulted in displacement of bull trout (Leary et al. 1993). No populations of brook trout are known to exist in the Big Creek watershed however.

A change in the species composition of Flathead Lake is perhaps the single factor most responsible for the decline of the upper Flathead bull trout subpopulation (McIntyre 1998). Flathead Lake has gone through a major change over the last 2 decades. Opossum shrimp (*Mysis relicta*) first showed up in Flathead Lake in 1981 after being stocked into 3 lakes between 1968 and 1975. These lakes have tributaries that feed into Flathead Lake, allowing the shrimp to migrate down to the lake. Mysis numbers peaked in 1986. Two non-native species, lake trout (*S. namaycush*) and lake whitefish (*Coregonus clupeaformis*) expanded as juveniles benefited from the addition of Mysis to the prey base. The expansion of these species has contributed to the decline of bull trout (McIntyre 1998). The mechanisms for the decline are not well understood since only a few bull trout have shown up in lake trout stomachs, so competition appears likely. This conclusion is substantiated by the fact that bull trout populations remain healthy in Swan Lake and Hungry Horse Reservoir where lake trout are absent. Bull trout in the Flathead system have declined equally in wilderness and managed areas, suggesting that habitat degradation may not be the primary factor in their decline. Lake trout and bull trout competition has been documented elsewhere. Donald and Alger (1993) looked at 34 lakes in the distributional overlap of the species and found that in 28 cases, only one species was present. In the lakes where they were sympatric, lake trout were the dominant species and 3 case histories were documented where lake trout completely displaced bull trout.

Bull trout numbers in Flathead Lake have been estimated based upon redd counts. In 1982, the highest bull trout redd count year, about 13,000 adult bull trout were estimated in Flathead Lake (Weaver 1998). The lowest redd count year was 1996 and adult bull trout were estimated at 916 fish (Weaver 1998). It is important to note that these are gross estimates based on complex assumptions, but these numbers do provide an indication of the precipitous rate of decline the population suffered in less than two decades. Redd counts in the Big Creek drainage have displayed a similar pattern, falling to a low of two in 1993 (Table 3-89). Recent redd count numbers in the Big Creek drainage indicate that the bull trout population may be recovering from the low levels of the early 1990s. Most of the identified bull trout-spawning habitat in Big Creek is located above the fire area, which should help mitigate the impact of the fire upon future spawning (see Map 3-14).

Table 3-89: Redd counts from the index reaches in Big Creek, 1980-2001. Data are courtesy of Montana Dept. of Fish, Wildlife, and Parks.

Year	**1980**	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**
Redds	20	18	41	22	9	9	12	22	19	24	25
Year	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
Redds	24	16	2	11	14	6	13	30	34	32	22*

*** 2001 data are post-Moose Fire**

Hallowat Creek is a major tributary of Big Creek and is a bull trout-spawning stream. Redds in Hallowat Creek are not counted annually, but on an infrequent basis as part of an expanded, basin-wide spawning survey (Table 3-90). About the lower half of the spawning habitat in Hallowat Creek coincides with the fire boundary.

MAP 3-14: Bull Trout Habitat

Table 3-90: Redd counts in Hallowat Creek, 1980-2001. Data are courtesy of Montana Dept. of Fish, Wildlife, and Parks.

Year	1980	1981	1982	1986	1991	1992	1997	2000	2001
Redds	8	14	31	3	27	2	0	32	6*

*** 2001 data are post-Moose Fire**

Juvenile abundance of bull trout is another measure of the population status in Big Creek. Since 1986, biologists with the Montana Department of Fish, Wildlife, and Parks have conducted electrofishing surveys of a 150-meter reach of Big Creek above the bridge at Skookoleel Creek. Estimates of the total population within the reach are calculated from the number captured (Table 3-87).

Table 3-91: Bull trout juvenile abundance estimates for 150 m sample reach of Big Creek. Data are courtesy of Montana Dept. of Fish, Wildlife, and Parks.

Year	1986	1987	1988	1989	1990	1991	1992	1993
Est. #	47	48	67	83	65	47	42	28
Year	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**
Est. #	4	8	13	21	46	38	29	53*

***2001 data are post-Moose Fire**

A crew from the Montana Department of Fish, Wildlife, and Parks sampled segments of Big and Coal Creeks immediately following the fire. Live bull trout representing a variety of age classes were observed in spawning, rearing, and migratory areas of both creeks and their tributaries. No dead bull trout were observed in any stream. The 2002 bull trout juvenile abundance sampling in Big Creek was conducted in early September, and the population estimates derived indicate the population is at its highest level in over a decade (Mark Deleray, MDFWP, personal communication.)

At a broader scale, the status of the entire upper Flathead River subpopulation of bull trout appears to be slowly recovering from the low levels of the early 1990s (Tom Weaver MDFWP personal communication). This rebound in bull trout numbers probably is the result of fishing restrictions, improving habitat conditions, and a new, more favorable equilibrium developing in the greater Flathead Lake ecosystem. Redd counts in most index streams have increased for several years, indicating a higher population of adult bull trout. An exception to this trend is Coal Creek, the next major drainage north of Big Creek. Redd counts in this stream have not recovered, and in 2001 no redds were found in the index reach. This represents the first time since redd surveys began that no redds were located in an index stream. The Moose Fire burned about 27% of the Coal Creek watershed to varying degrees. Fortunately, most of the identified bull trout spawning sites within Coal Creek are above the fire area and should suffer little direct effect. Channel and habitat conditions downstream should be monitored however, to insure that migratory and rearing habitat is available and functioning properly. This project does not propose any significant activity in the Coal Creek watershed.

The Endangered Species Act requires federal agencies, including the Forest Service, to prepare a baseline Biological Assessment for listed species within their jurisdiction. The purpose of this assessment is to determine the status of the species and its habitat. The Flathead National Forest completed the baseline BA for bull trout (USDA Forest Service 2000c) in the North and Middle Forks of the Flathead River in 1998, and updated it in 2000. This BA has been updated in the Biological Assessment recently prepared for this project, and is included below. The BA examined the status of multiple population and habitat parameters and made a determination for each of them regarding their level of function. The categories of function are the following: Functioning Appropriately (FA); Functioning At Risk (FAR), and Functioning At Unacceptable Risk (FUR). Explanations of the individual parameters and their determinations for the Big Creek watershed are listed below, as contained in the 2002 BA, which reflects conditions one year after the Moose Fire.

Updated Environmental Baseline:

Table 3-92 summarizes the updated baseline matrix following the Moose Fire of 2001. Changes to the matrix caused by fire and updated information are highlighted in bold and discussed following the table. Determinations not highlighted are the same as the baseline completed in the year 2000. In some instances, the un-highlighted sections may have changed since the 2000 assessment but the overall determination has not changed.

Table 3- 92: Changes in the environmental baseline matrix in Big Creek drainage from the Moose Fire and recent data (Changes are shown in bold).

Matrix Parameter	Pre-Fire Condition in Big Creek	Current Condition in Big Creek
Subpopulation size	FUR	FUR
Growth and survival	FUR	FUR
Life history diversity and isolation	FAR	FAR
Persistence and genetic integrity	FAR	FAR
Temperature	FA	**FAR**
Sediment	FAR	FAR
Chemical contamination/nutrients	FAR	**FA**
Physical barriers	FA	**FAR**
Substrate embeddedness	FA	FA
LWD	FA	FA
Pool Frequency and quality	FAR	FAR
Large pools	FAR	FAR
Off-channel habitat	FA	FA
Refugia	FA	**FAR**
Width to depth ratio	FAR	FAR
Bank stability	FAR	FAR
Floodplain connectivity	FA	FA
Change in peak/base flows	FUR	FUR
Drainage network increase	FUR	FUR
Road density and location	FAR	**FUR**
Disturbance history	FUR	FUR
RHCAs	FAR	FAR
Disturbance regime	FA	**FUR**
Integration of species and habitat concerns	FUR	FUR

Temperature has changed to FAR from FA based upon a recent survey, which indicated that temperatures in the lower, migratory corridor exceeded 15 º C for a short period in the summer of 2000.

Chemical contaminates has changed from FAR to FA in recognition of the un-polluted water quality in the watershed. There are no known sources of chemical or organic pollution in the watershed.

Physical barriers changed from FA to FUR because of new survey data that located eight fish passage barriers. A separate project, which recently completed consultation, the BMP project, would remove these barriers and return the determination to FA.

Refugia changed from FA to FAR in recognition of continued habitat fragmentation between bull trout subpopulations in the Upper Columbia River Basin, and the degraded habitats found in many of the bull trout streams in the North and Middle Forks of the Flathead River. This determination is also based upon the status of the bull trout population in Coal Creek, the nearest bull trout spawning reach to Big Creek.

Road density changed from FAR to FUR based on surveys that are more recent. The road density parameter will return to FAR if the road decommissioning proposed in this project is implemented.

Disturbance regime changed from FA to FUR because of the size, intensity, and severity of the Moose Fire. The disturbance regime can be considered to be functioning at unacceptable risk due to the amount of past management and recent fire activity, severity, and intensity.

Species Indicators:

1. Subpopulation Size: Functioning at Unacceptable Risk.

Redd count numbers and juvenile abundance estimates show the local population in Big Creek is being maintained at low numbers. Redd counts have occurred in the watershed from 1980 to 2001 (MFWP unpublished data) Redd count data for Hallowat Creek is collected during basin-wide redd count surveys only.

Juvenile bull trout abundance has been estimated in Big Creek from 1986 to 2002 (Deleray et al. 1999 and unpublished MFWP data). Estimates could not be calculated 1994 through 1996 due to too few individuals being captured to allow calculation of number and density estimates (Deleray et al. 1999). The authors reported a declining trend in abundance in Big Creek from peak numbers and densities in 1986 to 1993, but since1997 estimates were similar to previous estimates. The 2001 abundance and density estimates were the highest in over 10 years, and estimates for 2002 are even higher (Mark Deleray, MDFWP, personal communication).

The local population can be considered functioning at unacceptable risk due to several years of low redd counts (1992-1997) and several years of low juvenile estimates (1993-1997). Although redd count numbers 1998 to 2000 are higher than any other year except 1982 it is unknown if this subpopulation can persist following an disturbance event of the magnitude of the Moose Fire. Additionally, indicators included in the matrix (sediment, disturbance history, RHCAs, and disturbance regime) have the potential to affect the subpopulation size.

The decline in the 1990's is likely a result of drought during the 1980's, over harvesting, habitat modification, increased fine sediment levels, and competition with lake trout. Competition is likely an important factor in the decline of bull trout in the North and Middle Forks of the Flathead River, and is discussed in section 3 (Species Descriptions and Habitat Requirements) of this BA. The effects sediment could have on bull trout are discussed in the sediment indicator (number 2 in the habitat indicators) in this section and in the direct, indirect, and cumulative effects section of this BA.

2. Growth and Survival: Functioning at Unacceptable Risk.

Growth and survival of bull trout is functioning at unacceptable risk in the Big Creek drainage. The subpopulation trends and maintenance at low numbers (Deleray et al. 1999) suggest growth and survival of the local population is functioning at less than optimal levels. If a large increase in fine sediment levels is seen following the Moose Fire, growth and survival of eggs and juveniles could be detrimentally affected. These trends, low numbers, and the expected increase in fine sediments from the Moose Fire in spawning and rearing habitats suggest this subpopulation condition may not improve within two generations (5 to 10 years).

3. Life History Diversity and Isolation: Functioning at Risk.

The migratory form is present and no resident form is known to exist. This local subpopulation exists in close proximity to other spawning and rearing groups, but migratory and rearing habitat disturbance has occurred. It is unknown if recolonization would occur if the migratory form were lost. There are numerous streams upstream of Big Creek that are targeted by migratory bull trout for spawning, increasing the probability that strays may enter the watershed and recolonize it. However, recent data from Kanda et al., 2001, suggests that bull trout rarely spawn in streams other than their natal stream.

4. Persistence and Genetic Integrity: Functioning at Risk.

Persistence and genetic integrity is functioning at risk due to the genetic divergence observed among the local bull trout populations within the Upper Flathead River subpopulation. Evidence suggests there is substantial genetic divergence among bull trout populations from different sub-basins in the Flathead (Kanda et al. 2001). The amount of genetic divergence among populations within sub-basins is smaller which suggests there is some gene flow among subpopulations.

The continuing decline in redd count data in Coal Creek, the nearest bull trout spawning stream, increases the risk that the local population will lose connectivity with the greater subpopulation.

No non-native fish species are located in the Big Creek drainage; therefore, the potential for hybridization with brook trout is non-existent.

<u>Habitat Indicators</u>:

1. Temperature: Functioning At Risk

Temperature is functioning at risk in Big Creek. Temperature was monitored in Big Creek in the summer of 1979 and a maximum temperature of 15.6 °C was recorded. From 1986 to 1995, temperature was recorded at the Lookout Bridge and the maximum temperature recorded during this time was 13.9 °C. A higher temperature was recorded, but it was determined the recorder was out of the water.

From 1983 to 1995, temperature was recorded during water quality monitoring above Nicola Creek. The maximum recorded was 12.5 °C.

From 1979 to 1981, temperature was recorded during water quality monitoring in upper Big Creek, and a maximum temperature of 12.0 °C was recorded.

From 1979 to 1980, temperature was recorded during water quality monitoring in Big Creek above Hallowat Creek, and a maximum temperature of 8.0 °C was recorded.

In 1987, 1990, and 1991 a continuous temperature recorder was deployed in lower Big Creek from April through October. The maximum temperature recorded during these years was 14.1 °C.

Temperature data gathered by a graduate student researcher in 2000 and 2001 indicated that temperatures in lower Big Creek reached a maximum of 16.46 º C, and the average daily maximum was greater than 15 º C for a period of 17 days during the summer of 2000. This survey is the basis of the FAR determination. The lower reach of Big Creek is used as a migration corridor by bull trout. Temperatures in the spawning and rearing sections did not exceed 14 º C at any time during this recent study. See Appendix A of this document for the complete temperature data record.

The Moose Fire may result in slightly higher stream temperatures in the bottom several miles of Big Creek, where the riparian vegetation suffered high mortality. However, the fact that the headwaters and most tributaries of Big Creek are outside the fire will provide protection from higher temperatures in the spawning and rearing reaches of the watershed. If temperatures in the lower migratory corridor rise above 15 º C in summer, the movement of adult male bull trout into the spawning area may be delayed. However, although the daily maximum temperature exceeded 15 º C for seventeen days, the average daily temperature was always below 15 º C. In addition, there are several deep pools in the migratory reach that should afford bull trout some refugia from high afternoon temperatures.

2. Sediment: Functioning at Risk.

McNeil core samples have been taken in Big Creek since 1981. Table 3-85 shows the percent of fine sediment (<6.4 mm) found in spawning gravels. The percent of fines has declined substantially since reaching a record high

53.4% in 1990. Core sample data for year 2001 has not been released at the time of this writing, but preliminary indications are that the percent of fine material has further declined to 30% (Tom Weaver, MDFWP, personal communication). Bull trout studies have led to a determination that spawning will be threatened if materials < 6.4 mm exceed 35% of core samples, and impaired if they exceed 40% (Weaver and Fraley 1991). The determination of FAR for sediment is based upon the recent past history in the watershed, which indicates that sediment concentrations are highly variable and sensitive to disturbance.

3. Chemical contamination / Nutrients: Functioning Appropriately.

There is no concern with chemical contamination or nutrient levels; however, Big Creek is on Montana's state 303(d) list of impaired water bodies. The impaired uses that are partially supported are aquatic life support and cold-water fishery. This is primarily caused by past silvicultural practices that have resulted in sedimentation and habitat degradation, areas that are addressed in other sections of the baseline. The Interior Columbia Basin Ecosystem Management Project identified Big Creek as a watershed with high ecological integrity.

4. Physical Barriers: Functioning At Risk

Several culverts may be barriers to bull trout movement in Big Creek. These will be removed in the next two years and the determination of "functioning appropriately" will then apply to watershed.

5. Substrate Embeddedness: Functioning Appropriately.

Flathead National Forest does not measure embeddedness, but percent pool tail surface fines and McNeil Core samples (Table 3-85) can give insight to the level of embeddedness. The proposed action would have detrimental short-term effects (localized sediment increases), but would result in long-term beneficial effects to bull trout (decreased sediment delivery).

Substrate scores calculated by Montana Department of Fish and Wildlife biologists have not indicated levels of embeddedness likely to have a negative impact upon bull trout (Deleray et al. 1999). R1/R4 surveys indicate percent surface fines in pool tails are typically 12%-17%.

6. Large Woody Debris: Functioning Appropriately.

R1/R4 surveys conducted in upper Big Creek and Hallowat Creek indicate pieces of LWD/mi are well above the INFISH objective. This FA determination reflects recent data for the stream, particularly lower Big Creek, which identified abundant LWD in all stream reaches.

A 1979 survey indicated that LWD ranged from low to moderate and was unstable. Some reaches along Big Creek in the headwaters have had significant riparian harvest that reduced the recruitment potential. The 1997 survey showed LWD ranged from 182 to 451 pieces/mi. Although Big Creek far exceeds the INFISH RMO for LWD, past riparian harvest has altered the natural recruitment process. Fire suppression activities in Hallowat Creek cut through LWD jams, which will destabilize them and make pieces easier to flush through the system. In addition, several LWD jams in the stream were burned down to the surface of the water and will be destabilized. It is expected new recruitment of LWD resulting from the fire will offset this loss.

7. Pool Frequency and Quality: Functioning at Risk.

A 1979 survey determined that 4%-15% of the stream was pool habitat. The low availability of pool habitat is likely the result both of basin geology and past management activities. The glacial terraces in the valley bottom are formed of unconsolidated depositional material with high erosion potential. Sediment and channel instability associated with the unstable material fills pools and widens channels. Management actions have exacerbated the situation by increasing water yield (more sediment and channel migration) and reducing large woody debris volumes (fewer pools). Sediment generated by management activities has compounded the effects of natural sediment in the watershed.

1997 R1/R4 surveys show 1 of 10 stream reaches (10%) surveyed in the Big Creek drainage meet the INFISH RMO for number of pools per mile. In general, upper stream reaches in the watershed have more pools per mile, while the lower reaches have fewer pools.

8. Large Pools: Functioning at Unacceptable Risk.

The comprehensive survey of Big Creek conducted in 1979 by biologists from MDFWP classified pools numerically as types 1-5, with type 1 and 2 roughly corresponding to large pools as defined by the bull trout matrix. Pools in these classes comprised 1.5% to 3.2% of all stream habitat in the portion of Big Creek that corresponds to rearing and over-wintering habitat for bull trout. Neither reach of stream surveyed in the upper Big Creek watershed in 1993 and 1997 contains any large pools; however, the three sections of Hallowat Creek surveyed in 1998 contained 0.0 to 10.3 large pools/mile.

9. Off-channel Habitat: Functioning Appropriately.

The comprehensive survey conducted by MDFWP in 1979 identified a low to moderate abundance of side channel habitat. Survey data indicates most of the side-channel habitat is in the form of low velocity braided channel due to LWD jams. There are also several large pond complexes adjacent to Big Creek that are connected by small channels.

10. Refugia: Functioning at Risk.

This habitat parameter refers to the connectivity between populations, and the status of connected populations and their habitat. Refugia for the Upper Flathead subpopulation is considered FAR because of the low total population based upon redd counts and the degree of habitat degradation in the basin. While populations that are more robust exist nearby in the South Fork Flathead River and Swan River, the Upper Flathead subpopulation is isolated from them by dams. Similarly, the Upper Flathead fish no longer are able to travel downstream of Flathead Lake to historic ranges above and including Lake Pend Oreille

11. Average Wetted Width/ Maximum Depth Ratio: Functioning at Risk.

When using width to maximum depth ratio (pools) all stream channel surveyed in the watershed by R1/R4 methods meet the INFISH objective. Based on the 1979 survey, this ratio in lower Big Creek was 8, which would justify a determination of FA. Similarly, mean width to max depth ratio (pool width to depth ratio) in the ten reaches surveyed in upper Big and Hallowat Creeks was 7.8, based upon the more recent (1993, 97, and 98) R1/R4 surveys. However, the determination of FAR is applied because of concern over areas in lower Big Creek, particularly the bull trout migration corridor below Elelehum Creek. Recent surveys and observations indicate this reach has been impacted by excess bedload deposition, resulting in a wider, shallower channel.

12. Streambank Condition: Functioning at Risk.

The R1 Stream Channel Stability Ratings (Pfankuch 1975) for Big Creek completed between 1979 and 1993 were 50 to 102, which range between good condition (39-76) and fair condition (77-114). R1/R4 surveys of Hallowat Creek in 1998 indicate mean bank stability was 92.2 % for the three reaches. Bank stability was not recorded in the 1993 Big Creek survey. There are areas of streambank instability in Big Creek where the stream is laterally eroding the floodplain.

The 1979 surveys used a channel stability rating based upon a 100-point system. The lower reaches earned a rating of 99 (excellent), with stability gradually declining in headwaters reaches to the mid-80s. The lower stability witnessed in the headwaters reaches was likely the result of timber harvest and road building in the upper basin in the period 1950 to 1970.

This instability has since migrated downstream as the bedload mobilized by increased water yield and reduced LWD in the headwaters has been carried down the watershed. Post-fire Pfankuch scores for lower Big Creek indicate that stream stability is only fair.

13. Floodplain Connectivity: Functioning Appropriately.

Big Creek is connected to its floodplain, and off-channel areas are frequently connected, particularly at high flows. There has been no channelization activity in the watershed, and overbank flows occur during high discharge events.

14. Change in Peak/Base Flows: Functioning at Risk.

This parameter is FAR because of water yield increases associated with past silvicultural activities in the drainage. An 18.6% increase in annual water yield due to roading and harvest activities was predicted in a 1991 H2OY model. A greater increase in annual water yield can be expected due to the Moose Fire. There are also visual indicators of bedload movement in several reaches of this stream system.

15. Increases in Drainage Network: Functioning at Unacceptable Risk.

The extensive road network in the watershed, believed to once be in excess of 200 miles, has expanded the drainage network by intercepting ground water and channeling it down roadside ditches. There are also old skid trails that intercept near surface groundwater during the spring snowmelt period. These areas effectively extend the channel network and can change the timing and magnitude of peak flows (MacDonald and Hoffman 1995).

16. Road Density and Location: Functioning at Unacceptable Risk.

There are currently over 170 miles of road in Big Creek with densities as high as 2.9 mi/mi^2 in lower Big Creek. There are some roads located in the valley bottom, but most are located in upslope areas. The upslope roads do have numerous channel crossings, and culvert failure has occurred in the past. Based on road density and location Big Creek is functioning at unacceptable risk.

17. Disturbance History: Functioning at Unacceptable Risk.

The exact percent of Equivalent Clearcut Acres (ECA) is unknown at this time, but it can be assumed greater than 15% of the watershed due to the fire intensity and severity (stand replacement) and past harvest activities. Historic fire records show the Moose Fire is within the natural range of disturbance.

The combination of past management activities (>16,000 acres of harvest, >170 miles of road) in addition with the >20,000 acres of fire within the Big Creek drainage result in a major disturbance history.

18. Riparian Conservation Areas: Functioning at Risk.

Historic timber harvest and road building in the Big Creek watershed had major impacts to riparian areas in the upper basin. There was also some harvest in riparian zones in lower Big Creek. This activity contributed to the destabilization of stream channels by increasing sediment and water yield while reducing LWD recruitment.

The Moose Fire affected riparian areas within the watershed to varying degrees, depending on the fire severity and intensity.

19. Disturbance Regime: Functioning at Unacceptable Risk.

The disturbance regime can be considered to be functioning at unacceptable risk due to the amount of past harvest and recent fire activity and intensity. The severity of the Moose Fire may have been affected by past fire suppression activity in the watershed. Historic fire records show the Moose Fire to be within the range of natural disturbance for this area. Although there has been a favorable increase in bull trout numbers in the last few years it is unknown what effect a natural disturbance event of this magnitude will have upon the local population.

20. Integration of Species and Habitat Conditions: Functioning at Unacceptable Risk.

Despite improvements in several areas, there is no clear indication that the population decline seen in the 1980s and early 1990s has been reversed. Management actions, coupled with natural disturbance events have degraded habitat throughout the non-wilderness range of bull trout in the Upper Flathead. The introduction and proliferation of non-native fish species continues to have a major impact upon bull trout through predation, competition, and hybridization.

Westslope Cutthroat Trout

Westslope cutthroat exhibit the same life history forms as bull trout, and the resident as well as both migratory forms are likely present in the Big Creek watershed (Big Creek EAWS). Cutthroat spawn in the spring when temperatures rise to about 10º C, and fry typically emerge from the spawning beds in late July. Migratory juveniles leave the natal streams at age 2 or 3 and travel downstream as high water levels begin to recede. Westslope cutthroat generally utilize substrate less and pools more than bull trout.

Westslope cutthroat co-existed with bull trout throughout their historic range with the exception of a small area east of the continental divide in the Missouri River drainage (Duff 1996). The similar range of the two species indicates that habitat suitable for bull trout is equally suitable for the westslope. The westslope tended to be more widely distributed throughout this range than the bull trout, possibly because more streams have suitable water levels for spring versus fall spawning, or because the cutthroat tolerate warmer temperatures than bull trout (McIntyre and Rieman 1995). The pattern holds true for the Big Creek watershed. Westslope cutthroat are found in virtually all perennial streams in the drainage, including many where bull trout have never been found.

The population status of the westslope cutthroat is difficult to monitor in part because redd counts are very difficult to obtain for spring-spawning species. Electrofishing surveys conducted in the North Fork Flathead River since 1990 by Montana Department of Fish, Wildlife, and Parks indicated that cutthroat numbers were declining in the river (Deleray et. al. 1999). Catch-and-release regulations for cutthroat in the North Fork were implemented in 1998 in response to the decline. An electrofishing survey of Langford Creek in the summer of 2002 found high numbers of adult and young-of-the-year cutthroat, indicating successful spawning took place despite the impact of the Moose Fire (Brian Marotz, MDFWP, personal communication).

The decline of westslope cutthroat can largely be attributed to the same factors that have impacted bull trout. The cutthroat has been especially affected by the introduction of non-native species, most notably brook and rainbow trout. Brook trout appear to competitively exclude the cutthroat, while rainbow trout hybridize with cutthroat, resulting in a loss of genetically pure populations. One recent study suggests that the rate of genetic introgression between cutthroat and rainbow populations in the North Fork is increasing (Nathaniel Hitt, University of Montana, unpublished data).

Mountain Whitefish, Sculpins and Tailed Frogs

Relatively little is known about the populations of the other aquatic species native to the streams in the Big Creek watershed. All three are likely important prey for adult bull trout (Rieman and McIntyre 1993). One study of sculpin distribution found both slimy sculpins (*Cottus cognatus*) and presumed shorthead sculpins (*C. confusus*) in allopatric populations in the North Fork (Gregg et al. 1995). A more recent study, however, suggests that the second species was not the shorthead sculpin but the common species mottled sculpin (*C. bairdi*) (Baker et al. 1999).

4. Environmental Consequences

The significant issues identified in Chapter 2 related to fisheries are the same as those described in the Hydrology section earlier in this chapter. Issue indicators for those issues are addressed in the Hydrology section. The effects predicted by the hydrology analyses were considered in the fisheries analysis.

The following Effects Indicators were used to focus the fisheries analysis and disclose relevant environmental effects:

- RHCA Buffer Widths (Feet)
- Predicted tons of sediment delivered to streams as a direct result of timber harvest; and tons predicted to be delivered upstream of some portion of the bull trout spawning reaches in Big Creek and Hallowat Creek
- Predicted tons of sediment delivered to streams as a direct result of road decommissioning; and tons predicted to be delivered upstream of some portion of the bull trout spawning reaches in Big Creek and Hallowat Creek
- Qualitative assessment of changes in stream temperature

The Moose Fire has the potential to significantly impact the aquatic ecosystem in Big Creek, particularly lower Big Creek, in both positive and negative ways. Direct fire-related mortality was observed among cutthroat trout, sculpins, and mountain whitefish in Langford Creek. Increased levels of sediment may enter streams until the vegetation recovers. The potential exists for very large pulses of sediment to reach the main stream if debris torrents occur in tributary channels. The loss of riparian canopy may result in incremental temperature increases, particularly in summer months. Water yield will increase and may contribute to further bank erosion and channel instability. On a positive side, the pulse of large woody debris entering the channel should act to stabilize the bedload and accelerate the return to an equilibrium condition. The increased volume of large woody debris should enhance pool formation and increase habitat complexity—the variety of different habitats available to fish at different stages in their life history. Despite significant mortality suffered by the riparian canopy during the Moose Fire, a sufficient number of trees remain alive to insure a future supply of large woody debris. The exact response of streams and fishes to this large fire depends a great deal upon the pattern of precipitation and snowmelt, making precise predictions impossible.

The primary concern in Big Creek, from a fisheries perspective, of the proposed timber salvage and associated road management is increased sedimentation that can further degrade spawning gravels by filling the interstitial spaces with fine material. Increased sediment can also reduce juvenile rearing success and decrease aquatic insect production by causing increased embeddedness of the substrate (Bjornn et al. 1977, Weaver and Fraley 1991, Deleray et al. 1999). Annual monitoring in Big Creek however has not indicated levels of embeddedness likely to threaten juvenile survival (Deleray et al. 1999). The Section 7 Baseline BA concluded that juvenile rearing habitat is in good condition and functioning appropriately. Sediment that enters the system below the spawning reach is therefore less likely to negatively impact the bull trout population.

Bull trout fulfill very specific requirements in their selection of spawning habitat, requirements that make this habitat both limited and subject to degradation (Rieman and McIntyre 1993). Quality spawning sites are often the most spatially restricted habitat component in Flathead River tributaries like Big Creek (Fraley and Shepard 1989). Because of the importance of this habitat, the fine sediments (< 6.4 mm) entering Big Creek and its tributaries above the bull trout spawning reach pose the highest risk to this fish population, regardless of the source of those sediments. Obviously, sediment entering the channel below the spawning reach also has less distance to travel before leaving the watershed. Studies have shown that about 60% of the sediment yield resulting from in-stream activities such as culvert removal is suspended sediment, (see hydrology report in the project record) which ranges up to sand-sized particles (Waters 1995). Virtually all sediment carried in suspension is therefore sufficiently small to impair spawning substrate when it is deposited, as are the finer particles of bedload sediment. Sediments that must travel a greater distance before reaching a stream channel, i.e., sediment entrained by sheet or overland flow, would be comprised of an even higher percentage of fine particles due to the lower waterpower and greater travel distance (friction) involved in transporting these particles (Leopold et al. 1964).

Another important consideration relative to sediment is the timing of entry into the stream network. Most naturally entrained sediment enters on the rising limb of the annual hydrograph, when water is rising and first encountering sediment particles (Brooks et al. 1991). This situation typically occurs during the period of snowmelt in this region, producing the turbid streams and rivers we see during spring high flows. The result of this concurrence is a greater likelihood that sediment captured by streams such as Big Creek would be flushed out of the watershed prior to deposition. Similar sediment yield curves of smaller magnitude can also be produced during rainstorms. Conversely, sediment that enters a stream during low-flow periods is more likely to be deposited before traveling out of the watershed. Confounding this relationship, however, is the sediment capacity of the stream at any given discharge. If sediment exceeds transport capacity, deposition can occur at any discharge, while transport may continue at very low discharge levels if capacity is not exceeded.

Sediment can also have direct negative effects upon fish, by clogging their gills and interfering with respiration. Excessive levels of turbidity can interfere with capture of prey by sight-feeding fish such as trout. Data are scarce regarding the lethal and sub-lethal effects of sediment on trout, making it difficult to predict the direct effects of high sediment levels. Sediment levels above 400 mg/L have been shown to interfere with the ability of fish to feed, while levels above 20,000 mg/L have caused direct mortality (Bozek and Young 1994). Sediment concentrations in watersheds with large deposits of glacial till, such as Big Creek, have likely been quite high during peak flow events since the end of the last glacial age. This suggests that native fish in this region are adapted to high sediment levels of short duration.

Impacts to the function of riparian zones cause concern when activity occurs along the stream channel. When a forest is left intact near streams, trees are available to shade the channel and be recruited into the stream to become sediment traps, control channel erosion, scour pools, and provide cover for fish (Bryant 1983). Riparian vegetation acts to intercept sediment and maintain channel stability. Processes in riparian areas and streams vary within watersheds. In steep, high gradient, non-fish bearing streams, RHCA's would be important in protecting water quality and temperature, preventing surface erosion resulting from rill and gully formation, and providing a source for the recruitment of wood to streams. Farther down in the watershed, vegetation helps store sediment, trees provide stability along the banks, and as trees fall into the stream they would help scour pools and provide cover for rearing fish. Trees that fall into streams also provide a colonization site for aquatic insects, which are often an important food source for fish.

As required by INFISH, RHCAs have been established along all wetlands and stream courses within the project area. These RHCA's create buffer zones around streams and wetlands within which fish habitat protection and enhancement receive primary emphasis. These INFISH buffer zones are designed to perform the following functions: 1) influence the delivery of coarse sediment, organic matter, and woody debris to streams; 2) provide root strength for channel stability; 3) shade the stream; and 4) protect water quality. Studies have shown that buffer widths of between 50-300' have been very effective in controlling the delivery of non-channelized sediment to streams (Waters 1995). INFISH buffers are believed to adequately maintain riparian functions such as sediment control, temperature moderation, and recruitment of large woody debris and other organic material (INFISH EA). Table 3-93 displays the minimum INFISH buffer widths for priority watersheds and the widths proposed under the action alternatives of this project. Buffer widths may be greater than indicated in the table if site-specific conditions indicate that the riparian area is wider than the minimum width. While INFISH does allow harvest to take place within buffers under certain conditions, recent reports have suggested that riparian areas should be off-limits to fire salvage (Beschta et al. 1995), and that is the approach adopted by this project (for further discussion on the Beschta report, please refer to Appendix D). Salvage harvest would not occur within these riparian buffers under any of the action alternatives of this proposal.

Table 3-93: RHCA Buffer Widths (Feet)

Type of RHCA	INFISH Std.	Alt. 2	Alt. 3	Alt. 4	Alt. 5
Fish-bearing stream reaches	300'	300'	300'	300'	300'
Permanently flowing, non-fish stream reaches	150'	150'	150'	300'	150'
Seasonally flowing or intermittent streams	100'	100'	100'	300'	100'
Ponds, lakes, or wetlands > 1 acre	150'	150'	150'	300'	150'
Ponds, lakes, or wetlands < 1 acre	100'	100'	100'	300'	100'
Landslide prone areas	100'	100'	100'	300'	100'

Another fisheries concern normally associated with timber harvest is the effect upon water yield, or the amount of water reaching stream channels. Substantial increases above normal levels can result in channel destabilization and increased rates of erosion. Live trees reduce water yield through evapotranspiration and canopy interception, but dead trees have little effect upon water yield. Increases in water yield are also common following road building, both because road surfaces intercept sub-surface water and channel it to streams more quickly, and because the road surface creates a net loss of vegetation in the watershed. Soil compaction resulting from use of logging equipment also can contribute to increases in water yield, in much the same way that roads do. This proposal does not call for the removal of trees expected to survive the fire or beetles except in the fuel reduction unit in the Big Creek campground. This proposal does not require the construction of any roads, and all salvage logging is designed to minimize soil compaction (see vegetation and soils sections). Water yield will increase in lower Big Creek because of the Moose Fire, and some channel destabilization is likely to result from increased flows. The areas most likely to be affected by water yield increases are primarily in lower Big Creek, downstream of bull trout spawning habitat (see hydrology section).

Direct and Indirect Effects

Alternative 1

This is the "no action" alternative, under which no salvage or road management changes would occur. There would be no direct effects to fish populations if this alternative is selected, but there are potential indirect effects which might occur. The various action alternatives all require the decommissioning of some number of miles of road within the watershed. Road decommissioning includes the removal of culverts and other practices that can contribute sediment to streams. The long-term effect of decommissioning is a reduction in sediment levels as roadways and stream channels revegetate. If this alternative is chosen, the road decommissioning options would not be carried out, and there would be neither a short-term negative impact nor a long-term positive impact to the aquatic environment.

No additional ground disturbance or sediment production related to management activities would occur under this alternative. This alternative would result in less sediment eroding from roads than the action alternatives, since they would not be used for heavy hauling during timber harvest.

The purpose and need that generated this project identified the potential for serious outbreaks of spruce bark beetle and Douglas-fir bark beetle, both within and beyond the boundaries of the Moose Fire. This alternative would not provide any mitigation of bark beetle risk. At-risk Englemann spruce stands in the burned area occur primarily within the RHCA's, where no harvest is scheduled. However, alternative spruce beetle control measures, including trap trees and pheromone traps would be implemented under the action alternatives of this proposal (see vegetation section).

Worst-case analysis indicates that about 340 acres of spruce in the unburned portion of Big Creek watershed are at high risk of beetle infestation. About 150 of these acres are adjacent to streams known to contain bull trout. Much of the remaining high-risk spruce is located along tributary streams which flow into bull trout occupied streams. The effect upon fish populations of extensive mortality among these large riparian trees is unlikely to be negative. Bark beetle epidemics were part of the historic disturbance regime in the northern Rocky Mountains, suggesting that native fish have historically been able to adapt to the phenomenon. The death of large numbers of trees within riparian zones generally should not have catastrophic consequences for fish. Some bank erosion/channel migration may occur in response to increased water yield or diversion by concentrations of large woody debris. Future large woody debris recruitment may be limited, if all or most trees within the riparian area are killed, changing the area to a young-tree forest.

There are approximately 1200 acres of unburned Douglas-fir in the Big Creek watershed considered to be at moderate to high risk of bark beetle infestation over the next several years. These stands are dispersed across a large area and occur primarily as upland stands away from riparian areas. A severe bark beetle epidemic might result in the death of up to 60-80% of this Douglas-fir, but should not have serious impacts to bull trout, particularly their spawning habitat. Small clusters of large diameter Douglas-fir are occasionally found within the riparian corridors in Big Creek, but do not constitute a major portion of the riparian canopy in the upper elevations of the basin, which is dominated by species preferring cool, wet regimes, such as spruce and sub-alpine fir. Any water yield increase associated with beetle-killed Douglas-fir trees should be partially mitigated by the remaining vegetation but may lead to further channel instability.

An additional concern related to bark beetle epidemics is the increased risk of wildfire occurring in the watershed if significant numbers of trees die because of infestation. To the extent that the action alternatives reduce beetle risk and fuel loads, they would help to mitigate this risk. While the fish populations in the watershed certainly experienced large fires and epidemics of bark beetle related mortality in the past, it is unclear whether the depressed contemporary populations are capable of coping with the extremes of these disturbance types. There is also a risk of reburn occurring in the riparian corridor of lower Big Creek, particularly in areas which suffered only low to moderate burn intensity in 2001. However, this risk does not appear to be extremely high in the short-term, as many of the fine fuels will decompose quickly in the moist riparian environment. In the longer term, fuel loadings and the potential for new fires will increase as vegetation matures. The greatest impact of additional fire within the riparian zones of the watershed would likely be a future lack of large woody debris available to the streams, if significant numbers of the remaining live trees should die before the areas burned in 2001 revegetate.

Effects Common to all Action Alternatives

There are four action alternatives included in this proposal, which have in common the use of alternative methods to control populations of spruce and Douglas-fir bark beetles. These methods include the use of pheromone traps to capture beetles, which would be prevented from entering at-risk trees. Trap trees would be employed to attract emerging broods in salvage areas where harvest of Douglas-fir beetle infested trees is delayed. Anti-attractant pheromone may be used to protect high-value stands of live Douglas-fir at risk from beetles. These treatments would be employed on 150 to 300 acres within and adjacent to the fire area, including an area in Dead Horse Creek in the Coal Creek drainage. These methods are discussed in detail in the vegetation section of this document. There should be no direct effect to fish from these alternative beetle treatments.

Indirect effects could result if these treatments are successful in mitigating the severity of bark beetle related tree mortality within the watershed. However, as noted above, there is no clear evidence that such mortality poses a significant threat to fish populations in Big Creek.

The action alternatives of this proposal all include some level of road decommissioning to meet forest plan requirements concerning road density. Roads are the attribute of forest management that contributes the greatest volume of sediment to stream channels (Waters 1995). Road decommissioning typically includes culvert removal, which produces sediment at the removal site that often directly enters the stream. Decommissioning also requires the installation of water bars in the roadway to limit ditch flow, a process that may result in increased sedimentation, particularly if significant precipitation occurs during the excavation of the water bars. Design features such as filter fencing, seeding, and timing removal to occur during low flow periods are only partially successful at controlling sediment generated by decommissioning.

Road decommissioning, particularly culvert removal, is generally viewed as creating short-term harm to fish populations and habitat in exchange for long-term benefits. Culverts have the potential to suffer catastrophic failure if they become plugged with debris or are inadequately sized to accommodate high flows. The sediment generated by culvert failure typically far exceeds that produced by planned removal, particularly on steep slopes where fill depths are greatest (see hydrology section). Improperly installed culverts act as barriers to fish and restrict access to habitat and spawning reaches. Roads that have been decommissioned would “heal” over time and not continue to contribute eroded sediment to streams. The decommissioned roads would reduce the drainage density and water yield, effects which would contribute to channel stability. The miles of road to be decommissioned vary between alternatives and the effects will be considered individually by alternative.

Timber harvest activity, especially those aspects such as road building and tractor skidding that disturb the soil, have also resulted in increased sediment delivery to streams. The contribution from harvest is generally less than that from the associated road network however (Waters 1995). Historic logging practices that included removal of the riparian canopy had other harmful effects upon streams as well, such as increased temperatures and insufficient supply of large woody debris. Modern logging practices that maintain riparian buffer zones have greatly reduced the effects to aquatic communities associated with timber harvest (Newbold et al. 1980, Waters 1995). As with road decommissioning, the potential effect of the various timber harvest scenarios will be considered below for each alternative. Fisheries biologists would participate in monitoring of salvage activities to insure the protection of the aquatic resources in the watershed.

All roads used to facilitate management activities under the action alternatives would be maintained or improved to meet BMP standards, thus minimizing the risk of sedimentation. Even well designed roads can become sediment sources however when they are subjected to heavy usage. As a result, all action alternatives of this proposal would require that dust abatement measures be utilized to minimize the airborne delivery of sediment to streams. In addition, all roads would be monitored during the usage period to identify areas of deterioration and address them before they can become a source of increased sedimentation.

The greatest risk of sedimentation following wildfire arises from the formation of new channels that deliver sediment into the existing channel network. This occurs when excess overland flow leads to the creation of rills and gullies, often during rainstorms. Downed trees help to prevent the development of rills and gullies by slowing the flowing water and dissipating its energy. The RHCA buffers would help protect against channelized sediment, particularly in areas where fire-killed trees have already fallen across the hill. Design features intended to reduce the occurrence of surface erosion would govern the treatment of unmerchantable material within harvest units. The Features Common and Alternatives descriptions in Chapter 2, as well as the soils section of Chapter 3, provide further information regarding harvest methods and erosion control efforts.

Alternatives 2, 3, 4 and 5 propose to carry out fuel reduction work on a parcel of National Forest system land in the Coal Creek drainage adjacent to private property. All applicable BMP and INFISH standards, including RHCA buffers, would be implemented, and this portion of the project should have no measurable effect upon fish and other aquatic resources. The action alternatives would also direct fuel reduction and hazard tree treatment of two additional units, one in the Big Creek campground (not included in Alternative 4), and a second in the vicinity of the Glacier Institute/Big Creek work center. The requisite RHCA buffers would be maintained in these areas and there should be no effect upon fisheries and water quality.

The following discussions of effects pertaining to each action alternative focus primarily on bull trout, currently the only aquatic species located in the project area that is protected under provisions of the Endangered Species Act. Bull trout are widely recognized as a salmonid species that is particularly sensitive to environmental degradation (Rieman and McIntyre 1993, Fraley and Shepard 1989). For this reason, it is generally safe to conclude that processes which favor bull trout populations and habitat also favor other aquatic species, including westslope cutthroat trout. Cutthroat trout tend to be more widely distributed than bull trout throughout their sympatric range (McIntyre and Rieman 1995), and surveys in Big Creek have supported this conclusion. This broad distribution helps to buffer cutthroat populations from disturbance such as wildfire. Cutthroat tend to spawn and rear in headwaters stream reaches, areas that in large part are outside the burned area, and cutthroat use of burned streams following the Yellowstone fires of 1988 did not differ significantly from the use of unburned streams (Reinhart 1991). Redband Trout (*Oncorhynchus* mykiss), a similar species, recolonized severely burned watersheds in Idaho within one year of the fire (Rieman et al. 1997). Juvenile cutthroat were observed by this biologist in Langford Creek in early October, less than one month after the fire swept over the stream.

Redd counts conducted in recent years have indicated that bull trout which spawn in the Big Creek watershed comprise between 5% and 10% of the total spawning population of the North and Middle Forks of the Flathead River. Any significant declines suffered by the Big Creek population could be expected to have a proportional impact on the entire Upper Flathead population as well. Metapopulation theory suggests that individuals from the greater population of a migratory species such as bull trout would recolonize the available habitat if a local population is extirpated (Dunham and Rieman 1999). The metapopulation model postulates that this population strategy insulated a species from the effect of local events such as flood or wildfire. To the extent metapopulation processes apply to bull trout in the Upper Flathead, they would reduce the impact of effects to local populations such as the one in Big Creek. However, the metapopulation theory requires a robust population suitable as a source of individuals to reestablish the local population. The bull trout population in the Upper Flathead is depressed below historic numbers and recolonization from outside an individual watershed may not occur. One recent study found significant genetic differentiation between bull trout in adjacent drainages within the Upper Flathead River, suggesting that individual bull trout faithfully return to their natal stream to spawn with little mixing between watersheds (Kanda and Allendorf 2001). These findings suggest that each local bull trout population should be protected rather than relying upon metapopulation dynamics to restore them following local extinction.

Alternative 2

This alternative proposes to salvage harvest fire-killed trees from 70 units covering 2428 acres. Buffer strips would protect all streams within the harvest units as shown in Table 3-93 above. A variety of logging systems would be employed, including ground, cable, and helicopter methods. Each has different effects on ground disturbance, and potentially therefore on fish populations.

This alternative includes harvest of dead trees from 15 acres within three units located in the Wild and Scenic River corridor of the North Fork of the Flathead River. These units would be ground logged using methods designed to minimize soil disturbance. None of these units drain into Big Creek, and any sediment delivered from these units would go directly into the North Fork of the Flathead, where it would constitute an extremely small percentage of the total sediment load of the river. No sediment from these units has the potential to enter Big Creek or impact the spawning and rearing habitat within the watershed.

Alternative 2 also requires the decommissioning of 57 miles of road within the watershed. The potential sediment yield of this activity has been modeled and is discussed in the hydrology section of this document. The sediment generated above the spawning reaches (see Map 3-14 above) is of greatest concern due to the potential effect of deposition upon egg and fry survival in the spawning gravel. Recent McNeil core data (Table 3-85) indicate that the streambed gravels in the spawning reach contain about 30% fine material, below the level of 35% fines above which spawning would be considered threatened.

The timber harvest scheduled under this alternative presents a low risk of delivering sediment to the stream system. All harvest units are designed to employ logging methods that minimize soil disturbance. The majority of units would be logged using helicopters or cable systems on existing roads. Units scheduled for ground logging systems would require low-impact techniques such as winter logging or use of slash mats and forwarders (see vegetation section). Sediment modeling using the WEPP model predicted 523 tons of sediment would be delivered to streams as a direct result of timber harvest and the associated landings, temporary roads, and other ground disturbing activity (see hydrology section). Of this amount, 79 tons are predicted to be delivered upstream of some portion of the bull trout spawning reaches in Big Creek and Hallowat Creek.

The 510 tons of sediment predicted to result from road decommissioning under this alternative, particularly the 267 tons generated above the spawning reach, are a greater concern for the fisheries. Because the vast majority of this sediment is produced during culvert removals, there is a much greater likelihood that the modeled mass of sediment may be delivered to the streams. The use of BMP's would help to reduce the actual amount of sediment produced. The logistics and cost of a decommissioning project of this magnitude would require that the work be carried out over a period of years, with a minimum of four to five years required to complete the work. This extended time frame would limit the amount of sediment entering the streams in any single year and reduce the risk that carrying capacity would be exceeded and result in deposition within the spawning reach. Finally, by timing the work to occur after peak runoff has taken place (a virtual necessity in the high elevations of the watershed) there would be an opportunity to begin to revegetate disturbed sites before the next high flow cycle begins. The establishment of new vegetation on these sites would help stabilize the soil and reduce erosion.

This volume of sediment is unlikely to have serious direct effects upon fish, such as impairment of respiratory function or interference with sight feeding. Because there are few barriers to fish movement in the watershed, fish would have the opportunity to avoid areas of high disturbance by moving. Less mobile young-of–the-year fish would be most at risk of suffering stress and mortality because of high sediment levels. If stream temperatures rise because of the Moose Fire, thermal stress may compound the effect of elevated sediment loads upon fish. Fish were asphyxiated by sediment in a heavily burned stream in Yellowstone Park following a summer rainstorm two years after the 1988 fires (Bozek and Young 1994). Sediment resulting from culvert removal typically arrives in two pulses (see hydrology section). The first pulse of sediment is short-term, usually lasting less than four hours, and results from the release of material trapped under and immediately adjacent to the pipe. The second pulse of sediment consists of material entrained during subsequent periods of higher flow, when the stream encroaches upon disturbed banks that have not revegetated.

The indirect effect of this sediment that causes the most concern from a fisheries perspective is deposition within spawning gravels resulting in decreased survival of eggs and fry. The precise degree of any deposition is impossible to accurately predict because it is dependant on several factors, most important of which is the precipitation pattern and the resultant volume of stream discharge. Because the decommissioning work would take place over a period of several years, there would be an opportunity to monitor the concentration of fine materials in the core samples and adjust the work schedule if the levels trend upward.

Whatever the short-term negative effects of the road decommissioning might be upon fish in Big Creek, the long-term effects would be beneficial. Sediment delivery would be significantly reduced from the decommissioned roads with the installation of drain dips and, eventually, revegetation. The risk of catastrophic culvert failure with its potential huge pulse of sediment would be eliminated. Barriers to fish passage would be removed, allowing access to additional habitat. Water yield would decrease as roads ceased channeling intercepted ground water to streams. The road density within the watershed would be significantly reduced, and road density was recently found to negatively correlate with bull trout abundance (Dunham and Rieman 1999).

As noted above, forest roads are the single greatest source of anthropogenic sediment in forest streams. Most roads-related sediment occurs during the initial construction of the road, or as a result of drainage problems on poorly designed or maintained roads. This alternative requires no road construction.

Implementation of this alternative may affect bull trout in the local population, but is not considered likely to threaten the existence of either the local or Upper Flathead populations. This determination is based upon the fact that about 50% of bull trout spawning habitat in the watershed is located upstream of the fire boundary, and vegetation in the riparian buffers adjacent to the majority of the remaining spawning habitat suffered low mortality due to the fire. These actions and events likewise will not threaten the continued existence of the Upper Flathead/Flathead Lake bull trout population, 90-95% of which spawns and rears in other watersheds. Similarly, westslope cutthroat trout are widely dispersed throughout the Big Creek watershed and the local population is not at risk of extinction.

Alternative 3

This alternative proposes to salvage harvest fire-killed trees in 63 units totaling 2266 acres of harvest. The reduction in acreage in this alternative from the amount in Alternative 2 results from the elimination of units proposed in inventoried roadless areas. The 15 acres within the Wild and Scenic corridor are likewise retained in this alternative. Modeling using WEPP predicts that this salvage proposal would deliver 426 tons of sediment to streams within the watershed, with 64 tons of this total entering above some portion of the bull trout spawning habitat in Big and Hallowat Creeks.

This alternative proposes the decommissioning of 56 miles of road, 1 mile less than Alternative 2. The WEPP model predicts that 510 tons of sediment would result from this decommissioning, with 267 tons of that total generated upstream of some portion of bull trout spawning habitat. There are approximately 20 miles of road proposed for decommissioning in Alternative 3 that are also displayed as snowmobile routes on the Glacier View Ranger District Snowmobile Access Information Map (prepared January 2002 as a result of the Flathead Winter Recreation Agreement and initially proposed in the Winter Motorized Recreation Amendment – September 2002). These roads are currently open to snowmobile use and would be converted to system winter snowmobile trails. Alternative 3 proposes leaving 10 stream crossing structures in place to accommodate safe and reasonable snowmobile use. There is one site on road 1692, two sites on road 315, and seven sites on the Skookoleel road system 316E and spur roads. The road crosses deeply incised channels at these locations, requiring a crossing structure to insure safe snowmobile use. All other stream-aligned culverts would be removed on these decommissioned roads and snowmobile routes.

The culverts that would remain in place would have one of the following actions taken: 1) They would be appropriately sized to meet INFISH 100 year flow capacity requirements with a maximum fill of 1.5 to 3’ on top of the culvert. The remaining portion of the road prism material above the culvert would be removed from the streamside management zone. Armoring of the upstream and downstream areas of the culvert would occur if the overburden material were made up of fine soil particles in order to minimize any sediment potential if the culvert were to plug; 2) The existing culvert would be removed and an arch pipe would be installed to replace the culvert. The replacement of the overburden material would be the same as just described. The purpose of the arch pipe would be to insure fish passage on larger flatter stream segments. These culverts would be annually monitored for the first two years and then no less than biennially depending on monitoring results (more information on the monitoring plan on culverts left in on decommissioned and bermed roads is described in Appendix E).

The design of these 10 structures greatly reduces the risk to fisheries if they should fail. Sediment modeling indicates that the amount of sediment that would reach a stream if one of these structures fail would be significantly less than the sediment that would result from the failure of a typical road-grade culvert. The regular monitoring of these stream crossings coupled with the design upgrades greatly reduces the risk of failure of these structures. See the hydrology section of the FEIS for further discussion on the risk associated with stream crossing structures in general and these structures in particular.

The effects of this alternative upon the aquatic ecosystem in Big Creek would be similar to Alternative 2, but slightly reduced in magnitude owing to the reduction in harvested acres. It should be remembered that projected sediment delivery tonnage is based upon computer models and likely over-estimates actual sediment delivery (see hydrology section). All mitigation measures required by Alternative 2 would likewise be required by this alternative.

Alternative 4

This alternative would direct harvest on 1793 acres. As in Alternative 3, there would be no harvest in inventoried roadless areas under this alternative. This alternative would eliminate the 15 acres proposed for salvage in the Wild and Scenic River corridor. Additional harvest units would be eliminated to provide a greater level of coarse woody material. The most significant feature of this alternative relative to fish is the designation of a minimum buffer width of 300' on each side of ephemeral stream channels (see Table 3-93). This increased width responds to concern that the standard INFISH buffers may be inadequate for burned landscapes. The loss of vegetation following wildfire increases the likelihood that soil will be eroded during rainstorms, primarily as a result of new channel development.

Soil disturbed during salvage operations would be less likely to reach a stream under this alternative. Total modeled sediment production arising from this harvest scenario is 322 tons, with 22 tons of that total generated upstream of some portion of the bull trout spawning reaches in Big and Hallowat Creeks. This is the least sediment volume predicted to result from timber harvest in any of the action alternatives. This alternative would not allow any logging activity during winter months in order to prevent stress to ungulate populations. This restriction would result in a greater degree of ground disturbance and slightly increased risk of sedimentation, a factor considered in the sediment modeling. Low-impact harvest methods such as the use of slash mats would minimize any increase. As with all discussions of sediment, it is impossible to predict the precise impact. In general, however, where sediment is concerned, less is better and more is worse.

This alternative proposes an expanded decommissioning program totaling 87 miles of road and the removal of approximately 77 culverts. The model projects 657 tons of sediment would be delivered under this alternative, with 355 tons of that total entering above the bull trout spawning reach. This expanded decommissioning project would include the Werner Creek Road # 5261 from the junction with the Hallowat Creek Road #315. This road segment has multiple stream crossings; and is situated close to the channel of Werner Creek for most of its length, increasing the probability that it is a source of sediment to the stream. Approximately 40% of the known bull trout spawning habitat in the watershed is located downstream of the confluence of the two creeks. Decommissioning this road would benefit bull trout in the end; but the number of culverts and proximity to the stream likewise increase the short-term risk of degrading the habitat during the work.

Alternative 4 would provide the greatest long-term benefit to fisheries by further reducing the road miles within the watershed. Fewer roads would reduce drainage density and water yield, which in turn would contribute to greater channel stability in the watershed. The risk of catastrophic road failure arising from culvert washouts would be lowest under this alternative as compared to Alternatives 1,2,3,and 5.

Alternative 5

This alternative proposes the same volume and methodology of timber harvest as Alternative 2. The effects associated with the timber salvage are the same for the two alternatives.

The principal difference between this alternative and 2 is in the road management proposal. This alternative would decommission 56 miles of road within the watershed. Instead of a yearlong closure on the upper Big Creek-Canyon Creek Road #316, Alternative 5 would meet Forest Plan requirements by closing Road #5207 with a berm, thus prohibiting vehicle access to Moose Lake. This might have a small effect on the cutthroat trout population of Moose Lake by reducing fishing pressure, but there is no evidence that over-fishing has harmed the population, so any effect of the road closure would likely be insignificant.

Cumulative Effects

Cumulative Effects Common to all Alternatives

Cumulative effects analysis examines the predicted total impact of the existing condition and any proposed or reasonably foreseeable future activities upon a resource or other value. This part of the analysis will focus upon the probable response of the aquatic ecosystem within Big Creek, Flathead Lake, and the connecting river system, particularly the fish populations, to the proposed action and any additional actions or events that have the potential to affect those populations. The choice of suitable geographic boundaries for the cumulative effects analysis for a migratory species such as bull trout can be challenging. The best scientific data available indicates that bull trout that spawn and rear in Big Creek spend their entire lives between that watershed and Flathead Lake. Bull trout that spawn and rear in other streams that flow into the North and Middle Forks of the Flathead River share some portion of that habitat with the fish of Big Creek, and must be considered in the cumulative effects analysis for the Moose Post-Fire Project. However, our analysis indicates that this project would have no measurable effect on any aquatic resource beyond the confluence of Big Creek and the North Fork Flathead River. Potential sediment increases attributable to this project would not be discernible against the normal background sediment levels in the larger river. For this reason, the primary focus of the cumulative effects analysis for fisheries will be upon the populations in the Big Creek watershed. This emphasis on the local population is consistent with a recent recommendation from the local bull trout recovery coordinator for the US Fish and Wildlife Service (Wade Fredenberg, USFWS, personal communication, March 1, 2002).

Past Actions and Events

The Fire

Clearly, the Moose Fire is the most significant event to impact the Big Creek watershed in many years. The magnitude and severity of the fire are discussed above and in other portions of this document. From a fisheries standpoint however, the fire itself had a relatively small impact. Although there were documented fish kills, post-fire sampling by fisheries crews from Montana Fish, Wildlife, and Parks indicated that all species of fish were present and distributed throughout the stream network. However, the true impact of the fire upon aquatic resources will not be known for several years.

The effect of fire upon streams and their biota is a topic that has received considerable scrutiny in recent years. Numerous studies have documented effects ranging from increased nutrient levels (Spenser and Hauer 1991) to changes is channel stability and habitat complexity (Rieman et al. 1997) and shifts in the invertebrate community composition (Minshall et al. 1989).

Some fire effects are most pronounced during and immediately after the burn, while others are felt over a period of several months or years. The effect of severe wildfire may still be discernible a century after the fire if large woody debris became unavailable to the stream network. Most fire effects diminish in a decade or less with the recovery of vegetation. Fire severity is often reduced in riparian areas due to their higher moisture and lower topography (McMahon and deCalesta 1990, Greswell 1999).

Photo 3-2 New growth along Langford Creek, September 19, 2002

The Moose Fire overall reached or burned across 45% of the identified bull trout spawning habitat in the watershed. The fire will almost certainly result in higher sediment delivery into the stream network in the watershed. The most likely sources of the increased sediment are tributary channels in high severity burn areas and increased runoff from forest roads. Field surveys carried out since the fire indicate that the highest risk of debris torrents comes from an unnamed tributary of Big Creek (referred to as Skookoleel Creek North) approximately 1 mile east of the confluence of Hallowat Creek, and from a series of steep ephemeral channels tributary to and east of Elelehum Creek. At the time of this writing, in late September 2002, these areas have suffered only minor erosion. A burned area emergency rehabilitation (BAER) team implemented several erosion control measures in these areas in an attempt to minimize sedimentation. Skookoleel Creek North enters Big Creek about one mile above the beginning of the identified spawning reach and could contribute fine sediments to this portion of bull trout spawning habitat. The remaining high-risk channels are downstream of the spawning reach and cannot directly impact it, but they may contribute additional material to the destabilized reach of Big Creek, possibly delaying recovery of the channel.

Direct delivery of sediment to streams via sheet, or non-channelized flow, is dependant upon the short-term patterns of precipitation and snowmelt. Most studies have shown that erosion is greatest in the first year following a fire, and declines rapidly as vegetation recovers (see hydrology section). Much of the riparian vegetation in the watershed suffered only low to moderate fire mortality and should limit sedimentation resulting from sheet flow. The riparian vegetation in lower Big Creek experienced high mortality, but any sediment reaching the channel in this area should be flushed from the watershed with little impact to the fish populations. Several old aggregations of large woody debris burned in the lower reaches of Big Creek and may release trapped sediment at high flows. These wood aggregations are below the bull trout spawning reach, and fire-killed trees entering the stream should help to stabilize these areas.

Photo 3-3: Overland or sheet flow on the Moose Fire, April 12, 2002

The potential fire effects extend beyond increases in sediment levels. Stream temperatures may rise as a result of a decrease in the riparian canopy that provides direct shade to the stream. The loss of the upland canopy may also contribute to higher water temperatures if precipitation moving over or through the soil is warmed before reaching a stream channel. Any increases in temperature should be minor and well below levels directly harmful to fish (FNF Post-Fire Assessment). Warmer water temperatures could result in a delay of bull trout spawning, if spawning adults hold in the main river until temperatures drop. There is little that fisheries management can do to mitigate any temperature increase beyond protection of the remaining riparian canopy, but certainly native species have survived similar events in their history. The Flathead National Forest will monitor temperatures in the burned area streams in order to further our understanding of the effect of large fires upon stream temperatures. Mature bull trout have been observed by the fisheries biologist in the spawning reach during September, 2002, indicating that no thermal barrier to migration has developed in Big Creek this year.

Instream recruitment of large woody debris should increase in the short term because of the fire. Observations of the fisheries biologist during the winter following the fire indicate that a large number of trees have already fallen into the stream channels, and many more are likely to do so over the next several years. In addition, a sufficient number of trees remain alive in most of the riparian corridor to insure a continuing supply of large woody debris in coming decades. The most severely burned riparian areas in lower Big Creek should continue to recruit large woody debris from upstream while the forest re-grows. The effect of this pulse of woody debris should be to accelerate the stabilization of the stream channel and increase the habitat complexity, effects that would benefit fish. These benefits should be manifest over a period of five to ten years. There may be instances of channel migration and bank erosion as the stream adjusts to the new wood, but these should be short lived and spatially restricted. Flathead National Forest biologists and technicians would monitor the watershed to identify the development of any potential migration barriers and take action to restore fish passage. Channel erosion would also be monitored to determine if any actions are needed to reduce undesirable impacts.

Fire Suppression

The Moose Fire was a long-duration event that occurred during severe drought conditions. Extreme fire behavior often necessitated flanking tactics working along the edge of the fire, generally from west to east. As safe anchor points were established, fireline construction proceeded along the edge of the fire, with aerial support. On the leading edge of the fire, suppression actions were initially confined to aerial attack using fire retardant and water drops from fixed wing and helicopter aircraft. Both have the potential to affect fisheries resources, albeit in different ways. The effect of these factors is a low amount of suppression-related ground disturbance relative to the large total size of the fire.

Phos-Chek D75R retardant was deployed with air tankers in the Big Creek watershed between August 16, 2001 and August 27, 2001. This retardant formulation has demonstrated low toxicity to fish and aquatic invertebrates (Gaikowski et al. 1996). Phos-Chek D75R contains no sodium ferrocyanide, a component of some fire retardants that can release cyanide under the influence of sunlight. Protocols for the use of retardant restrict application within 300' of streams. Retardant is typically used along ridge tops and upper slopes to take advantage of topography or adjacent to natural firebreaks such as scree slopes. Few fish-bearing streams are located in the upper elevations of a watershed, minimizing the danger of retardant directly harming fish. In order to determine the potential effects of fire suppression activities, records relating to the Moose fire were reviewed, and personnel involved in the Moose fire suppression and BAER actions were consulted. To the best of our knowledge, no fish kills were attributed to the use of aerial fire retardant on the Moose Fire, nor did any significant amount of retardant reach perennial stream channels.

Water withdrawal for fire fighting purposes also has the potential to impact fish. Helicopter buckets drawing water from lakes and streams could accidentally capture fish directly, although one recent study indicates this is extremely unlikely, probably because fish in this region are adapted to avoiding avian predators (Jimenez and Burton 2001). Fire crews were directed to not dip from streams and lakes in adjacent watersheds to prevent the accidental introduction of any non-native species. Dipping by helicopters could frighten fish and may have disturbed bull trout spawning to some degree. A greater threat to fisheries arises when fire crews operating portable pumps use streams directly as a water source. In the case of small streams, the demand from multiple pumps can significantly deplete stream flow. We are not aware of any cases on the Moose Fire where fish were threatened by water withdrawal for fire fighting purposes. Adult bull trout were observed inhabiting a scoured area in Hallowat Creek used by fire trucks for drafting water. Some temporary log impoundments were built in several streams to create pools, but these were only a few inches high and temporary. These impoundments would not have blocked adult bull trout on their spawning migration. We know of no spills of fuel or other chemicals into streams during fire suppression.

Firelines were constructed within RHCA's in several locations, including Hallowat Creek, where several short sections of hand line were constructed across the creek. Some sediment likely entered the creek during the construction of these lines, but the amount would have been very small and impossible to detect. Some logjams were also sawn through to create a fuel break across the stream. The failure of these debris dams would not contribute new sediment to the stream but would cause the redistribution of trapped sediment that could deposit in spawning gravel downstream. However, post-fire observations indicate that many large woody debris pieces have fallen into the stream, and these should stabilize woody aggregations within this channel reach.

About 15 miles of fireline were constructed in the Big Creek watershed. Of this amount, approximately 8 miles were hand line and 7 miles were constructed with mechanized equipment. We know of one mechanized line built within the Big Creek RHCA downstream of the bull trout spawning reach that may have contributed sediment to the stream. During rehabilitation of this line, the stream bank gave way under an excavator and it entered Big Creek. The operator was forced to walk the machine down the creek a short distance before finding a spot where a low bank allowed him to exit the stream. Some additional excavator work occurred near streams to rehabilitate pumping sites. These activities likely all contributed sediment to the streams. All firelines were rehabilitated as soon as fire conditions made it safe to do so. Rehabilitation included replacing disturbed soil, covering the soil with slash and debris, and the construction of waterbars on slopes. Inspection of the rehabilitated lines took place in the fall of 2001, and monitoring continued in 2002 to insure that the firelines are not channeling sediment to the stream network.

Numerous hazard trees were felled and often decked along roads throughout the fire area during and immediately after the fire. These trees were recovered as part of the Moose-Werner Fire Salvage contract discussed below. Some trees were mistakenly removed from within RHCA's, most notably along Langford Creek and in the area of the Skookoleel Bridge over Big Creek. Hazard trees that were felled in RHCA's should have been left in place to promote attainment of INFISH RMO's, and their removal was halted when resource advisors became aware of the situation. Inspection of the affected areas by fisheries biologists indicate that ground disturbance was minimal, and a sufficient volume of large woody debris remains in the RHCA's to provide ample recruitment in these reaches.

The existing road network was also utilized as fireline in parts of the watershed, requiring the removal of vegetation and some soil disturbance, particularly on roads that had been administratively closed for several years. This activity primarily affected the Elelehum Creek drainage and an area in upper Big Creek. Ongoing rehabilitation of these roads includes measures such as culvert cleaning and the installation of drain dips to help prevent sediment from reaching streams. See the hydrology section in the project record for further discussion of the effects of fire suppression on sedimentation.

Historic Timber Harvest

The amount and effect of historic timber harvest was discussed above in the Affected Environment portion of this section (see also the vegetation and hydrology sections). The old harvest units outside the fire boundary have largely stabilized with new vegetation and are no longer believed to be contributing excessive sediment to the stream network. A few areas, such as old skid trails and log landings on sensitive soils continue to deliver sediment through an expanded channel network. These areas are scheduled for additional rehabilitation as part of the Watershed Restoration (TMDL) plan recently submitted to the Montana Department of Environmental Quality by the Flathead National Forest.

Historic harvest units that burned in the Moose Fire are likely to be among the most sensitive to erosive forces in the next several years because they have less coarse woody material available to inhibit the flow of runoff. Many of these areas received erosion control efforts as part of the post-fire BAER work. Problems associated with the road network in these historic harvest units would be addressed under the action alternatives and other road improvement projects discussed above. Most of the historic harvest units that burned in the Moose Fire are located below the spawning reach and cannot contribute additional sediment to the spawning substrate.

The TMDL plan also outlines additional restoration activities that may be carried out in areas impacted by past harvest and road building. These may include tree or shrub planting along streams to stabilize eroding banks, or the addition of more large woody debris in stream reaches where past harvest reduced availability.

BAER Project

In the fall of 2001, the BAER team directed the replacement of seven culverts that were considered at risk of failing because of the anticipated peak flow increases. One culvert was located on the Big Creek Road # 316 approximately 1 mile east of the junction with the Elelehum Road # 5272. The remaining six culverts were located on the Coal Creek Road # 317 and the Dead Horse Creek Road # 1693. Two of these were on ephemeral channels tributary to Langford Creek in the Big Creek watershed. The remaining four culverts are within the Coal Creek drainage. All these culvert replacements probably contributed sediment to the respective stream channel, however, none were located upstream of known bull trout spawning habitat. Some sediment may have reached westslope cutthroat spawning areas in Langford Creek during culvert replacements.

In conjunction with the culvert replacements, large drain dips were constructed in the roads near the culvert sites to act as overflow channels in the event of culvert failure. The drain dips are designed to allow floodwaters to flow across the road prism rather than down the road, thus minimizing erosion of the road surface. In most cases, construction of the drain dips did not contribute measurable amounts of sediment to the streams, as they were some distance removed and down slope of the culvert sites. Many of the channels that received this treatment were dry during the construction period, further reducing the risk of sediment delivery.

The channel of the unnamed creek referred to as "Skookoleel North" was diverted through a ditch to flow into a wetland area next to Big Creek in order to help filter sediment before it reaches the stream. This drainage is thought to be at high risk of suffering significant erosion due to the fire intensity and steep terrain. The stream was not flowing at the time of the excavation and the sediment resulting from this action should be minimal. The BAER actions also included the placement of numerous straw wattles, fiber mats, and loose straw material to help trap sediment and reduce erosion in areas of high burn intensity. These activities would reduce sediment delivery and are beneficial for fish populations.

Big Mountain Expansion EIS

A NEPA decision authorizing the expansion of the Big Mountain ski area was signed in 1995. Most management activities in the Big Creek drainage related to this decision have been completed, including the decommissioning of roads 1668 and 1655B during the summer of 2002. A segment of road 1696 is scheduled for decommissioning by 2005.

There are potentially nine new ski runs planned and approved for construction under this decision affecting a total of approximately 80 acres in the Big Creek watershed. A portion of these runs may be constructed in the next two years. If these ski runs are constructed, there would be a short-term increase in soil erosion and nutrient leaching potential until revegetation occurs. There is a long-term increase in water yield due to the removal of the trees.

The remaining activities that may occur as part of this project are unlikely to generate a measurable response from the aquatic ecosystem in Big Creek. All actions related to this ski area expansion will be monitored by the fisheries biologist to insure compliance with all applicable standards and mitigation measures. See the Hydrology section of this document for further discussion of this project.

Moose-Werner Hazard Tree Removal

The Flathead National Forest authorized the removal of hazard trees affected by the Moose Fire in areas adjacent to heavily traveled roads within the Moose and Werner Peak Fire areas. These were located along the Big Creek Rd # 316, Coal Creek Rd # 317, and short segments of roads 316E, 1693, and 803. Trees that were felled during fire suppression and other hazard trees deemed to threaten public safety were identified for removal. The removal was begun in the winter following the fire and was completed during the following summer.

The proximity of Coal Creek Rd # 317 to Langford Creek necessitated the removal of some trees that were within the RHCA of the stream. This should not impair attainment of the RMO's for the stream, as a large volume of both downed and standing trees remain. All post-fire harvest was carried out during winter conditions so soil disturbance and resulting sedimentation have been minimal. Riparian buffer strips as specified under the Streamside Management Zone law protected all identified streams. The remaining salvage timber was decked along main roads during fire suppression and was hauled during the summer of 2002. No additional equipment operation occurred off the main roads.

Mushroom Harvest

The area of the Moose Fire was the target of both personal use and commercial mushroom pickers seeking Morel mushrooms, which are sprouting in large numbers in the burned area. The effects of this activity were considered in a separate document and determined not likely to effect fisheries (project record V-2). The U.S. Fish and Wildlife Service concurred with this determination in a Biological Opinion. No commercial camping was allowed in the fire area, and all pickers were required to obtain a permit prior to mushroom picking, at which time they were given information concerning fishing regulations and water quality concerns in the fire area.

Ongoing and Reasonably Foreseeable Actions

DNRC Harvest in Coal Creek

The Moose Fire burned nearly 7,000 acres on the Coal Creek State Forest. The Montana Department of Natural Resources and Conservation (DNRC) proposed to salvage harvest merchantable timber from the burned area in two phases. Phase 1 harvest was carried out during the winter months following the Moose Fire. Phase 2 is currently being processed. All the harvest activity in both Phase 1 and 2 take place in either the Coal Creek watershed or face drainages of the North Fork Flathead and would not affect fish populations in the Big Creek watershed. As noted earlier, the bull trout population in Coal Creek is not showing the same improvement in numbers as most other watersheds in the Upper Flathead system. Any further declines in this local population may delay the recovery of the entire Upper Flathead subpopulation. There is also a disjunct bull trout population in Cyclone Lake/Creek that could be affected by this harvest project.

Access to the Coal Creek portion of the salvage area is on the Coal Creek Rd # 317. The first several miles of this road are within the Big Creek watershed and any sediment produced as a result of logging traffic or road maintenance could be delivered to either Langford Creek or Big Creek. The BAER actions included the installation of several new culverts along this portion of the road, along with construction of emergency drain dips. Silt fencing was installed around the road crossing of one stream channel at about milepost 2, and straw mats, coconut mats, and loose straw were used at additional sites to help prevent sediment from entering the channel network. Over 30 new cross drain culverts were installed along the lower section of this road during the summer of 2002 to further improve drainage and reduce sedimentation. The road is closed to heavy hauling during the spring thaw period.

Any sediment entering the stream network from Road # 317 would enter Big Creek near the confluence with the North Fork Flathead, and would be well below the bull trout spawning reach. Westslope cutthroat trout are known to spawn in Langford Creek, and sediment could affect spawning success by filling the interstitial spaces in the substrate, just as in the case of bull trout (Weaver and Fraley 1991). As noted above, numerous young-of-the-year westslope cutthroat trout were observed in Langford Creek this summer, indicating that successful spawning took place in the stream.

The contribution of the road to any sediment delivery should be small however as there is little risk of a significant road failure. Any sediment entering above Mud Lake would be filtered out before reaching the cutthroat spawning reach. Cutthroat trout typically spawn in headwaters stream reaches, and many of these are outside the fire area. This reserve of spawning habitat should adequately buffer the cutthroat population against any impairment of spawning in lower Big Creek resulting from the fire and management activities.

Recreation

The Big Creek watershed is a popular area for recreation (see recreation section). The streams in the watershed have been closed to fishing since 1953, an early recognition of the importance of the basin for bull trout spawning. Moose Lake does receive light fishing pressure, primarily in the months of July and August. Camping is popular in the watershed, both in developed campgrounds near the mouth of Big Creek, and at a small campground at Moose Lake. Camping also occurred prior to the fire at several dispersed sites near Big Creek. The proximity of Big Creek to the Flathead Valley makes it a popular destination for hunters in spring and fall. None of these activities is believed to have affected fish populations in the past, and the level of use will likely decline for several years because of the fire.

There are about 30 miles of developed trails within the area of this proposed project. Approximately 6 miles of this trail network are open to motorized use, with the remainder limited to non-motorized access. A study conducted by the Flathead National Forest demonstrated that this trail network receives very little motorized use (see recreation section). Virtually this entire trail system was severely impacted by the Moose Fire, and restoration of these trails is currently underway. Neither the repair nor the future use of this trail system is likely to affect fish populations or other aquatic resources.

The Big Mountain Ski Resort has facilities including ski runs, a chair lift, and an access road located on Flathead National Forest system land in the headwaters of Big Creek. Past monitoring has identified minor erosion occurring from the road surface and the channel of an ephemeral stream adjacent to one of the ski runs (EAWS and TMDL reports). Winter Sports Inc., the parent corporation of The Big Mountain, has cooperated with the Flathead National Forest to address these problem areas and prevent additional erosion from occurring. The amount of sedimentation attributable to the ski area would be immeasurably small against the background of a normal sediment load within the watershed (see hydrology section) and is unlikely to affect the aquatic ecosystem. The ski runs themselves may slightly affect the timing of runoff and peak flows as a result of the clearing, but the total area of the ski runs is insufficient to have a measurable effect in a large watershed like Big Creek.

BMP Project

The Flathead National Forest is currently conducting a program of road improvement in the Big and Coal Creek watersheds. The goal of this program is to improve 177 miles of existing road to meet BMP standards for drainage. Of this total, 142 miles are within the Big Creek watershed. This program would involve the replacement of 77 culverts that currently do not meet INFISH size requirements or are otherwise deemed at high risk of failure. Seven of these culverts have been identified as barriers to fish passage and their replacement would provide fish access to several miles of habitat for the first time since the original road construction. This work is funded with Moose Fire restoration funds. Approximately 75% of this work was completed during the summer of 2002, with the balance scheduled for next summer.

The analysis for this project predicts that 128 tons of sediment would be delivered to the Big Creek watershed. The total sediment predicted by the model to occur above the bull trout spawning reaches in Big and Hallowat Creek is 81 tons. As is the case with the scheduled road decommissioning discussed above, this road improvement work risks a negative impact upon the aquatic environment and promises a future benefit. The magnitude of the negative effect is dependant upon the timing and location of the improvement work and the pattern of precipitation in the watershed. This project, together with other ongoing and proposed road improvement projects would greatly reduce sedimentation within Big Creek and contribute to the long-term health of fish populations.

The scheduled culvert replacements in Coal Creek are located along a bull trout spawning reach above the confluence with South Coal Creek. This work may harm the Coal Creek population in the short term if sediment is deposited within redds. This risk will be minimized by carrying out the work between May 15 and September 1. The long- term reduction in sediment delivery resulting from this road improvement should contribute to improved spawning conditions and increased recruitment in Coal Creek.

Routine Road Maintenance

Roads within the Big Creek watershed would likely receive some level of routine maintenance on an annual basis. This maintenance would include activities such as road blading, brush cutting, and ditch cleaning on approximately 25 miles of road. All maintenance activities are reviewed and approved by the fisheries biologist prior to implementation. Road maintenance is carried out in compliance with the Road Programmatic Biological Assessment and the accompanying Biological Opinion (see project exhibit U-1). The standards and mitigation measures contained in these documents govern the methods and timing of road maintenance activities in order to protect populations of bull trout. The annual program of road maintenance is therefore unlikely to effect the bull trout population of the Big Creek watershed.

Moose Peak Prescribed Burn

A decision was signed in August 1998 to prescribe burn approximately 2000 acres of grassland/woodland in the Moose Lake area to improve habitat for whitebark pine. This burn has not yet been implemented and may not occur due to consideration of changed conditions in the watershed. This burn would be located in high elevation areas generally above fish habitat. Prescribed burns are typically low intensity fire events, and this burn, if carried out as planned, should have no impact on aquatic resources in the watershed.

Firewood Cutting

The area of the Moose Fire will likely be heavily utilized in future years as a source of personal use firewood because of its proximity to the valley communities. Firewood cutting will be regulated by the existing permit system on the Flathead National Forest, which prohibits firewood cutting within 300 feet of any stream or lake. Compliance with firewood cutting regulations will be further encouraged by additional signage placed in the fire area. Firewood cutting is not expected to affect fish or other aquatic resources, largely because there will be limited areas where open roads allow access within RHCA's.

Weed Control

The Flathead National Forest will conduct an aggressive program of weed control within the Moose Fire area to prevent the establishment and spread of exotic weeds in the newly disturbed forest (see vegetation section). Protocols governing the use of herbicides on Flathead National Forest system lands require compliance with label directions governing the use of each product. Effects of weed control upon fisheries were evaluated in the Flathead National Forest Weed Environmental Assessment (USDA Forest Service 2000a) and no effects are anticipated.

Maintenance of Fuel Reduction Areas

The fuel reduction zones created at the Big Creek Campground, Glacier Institute, and along the private land boundary in lower Coal Creek would be periodically treated by mechanical means (thinning) and/or prescribed burning (low intensity underburning) to maintain the desired condition of low fuel loadings and fire hazard. Treatments may occur every 10-20 years, depending upon stand conditions. Just as the initial fuel reduction activities would not affect fisheries, the periodic maintenance required in these areas would have no effect upon aquatic resources.

Rocky Mountain Research Station Larch Study

The U.S. Forest Service Rocky Mountain Research Station in Missoula, Montana is proposing to conduct a ten year study on the deterioration of fire-killed western larch trees. Five study areas have been identified in the fire area. One of the areas is located approximately ½ mile from the junction of the Big Creek and Coal Creek roads, while the other four areas are located above Mud Lake near the Coal Creek road. The project will involve the felling of approximately 240 fire-killed larch trees in a range of size classes over a ten year period to measure decay rates. No trees will be removed from the sites, and this project would have no effect upon aquatic resources.

Cumulative Effects of Alternative 1

This is the no-action alternative. There may be effects to aquatic resources in Big Creek resulting from past and future events and activities as described in the Cumulative Effects narrative. The most significant effect of past, ongoing, and foreseeable actions is likely to be increased fine sediment levels in the spawning reach substrate. Pool frequency may be reduced if excess sediment deposits in existing pools. Width/depth ratios may increase (worsen) if pools fill or areas of sediment deposition divert streams. The major cause of these changes in the short-term would likely be increased erosion from the burned area. Long-term, deteriorating forest roads and culvert failures are most likely to be the source of increased sediment within the watershed under this alternative. Implementation of Alternative 1 would not cause additional sediment deposition in bull trout spawning habitat resulting from timber salvage and road decommissioning. The risk of sediment deposition resulting from culvert failure would increase under this alternative because culverts would not be removed as part of the road decommissioning proposed under the action alternatives.

The BMP and Big Mountain EIS road improvement projects are likely to proceed and may impact the quality of the bull trout spawning habitat in the watershed. The major impact of these projects is expected to be increased fine sediment levels in the spawning reach resulting from culvert replacements and removals. This could result in reduced spawning success for several years until the excess sediment is flushed from the spawning area. This effect will be reduced by timing work upstream of the spawning reach to occur between May 15 and September 1 each year, when bull trout eggs and fry are not in the gravel. The sediment generated by these projects is not expected to have an effect upon the quality of bull trout rearing habitat, which is currently functioning appropriately in Big Creek. The fisheries biologist would work closely with project crews to insure effects are minimized.

The cumulative effect of all past, ongoing, and foreseeable actions and events, including any associated with this alternative, is not believed to threaten the continued existence of the local bull trout population in the Big Creek watershed. This determination is based upon the fact that about 50% of bull trout spawning habitat in the watershed is located upstream of the fire boundary, and vegetation in the riparian buffers adjacent to the majority of the remaining spawning habitat suffered low mortality due to the fire. These actions and events likewise will not threaten the continued existence of the Upper Flathead/Flathead Lake bull trout population, 90-95% of which spawns and rears in other watersheds. Similarly, westslope cutthroat trout are widely dispersed throughout the Big Creek watershed and the local population is not at risk of extinction as a result of any past, ongoing, or reasonably foreseeable actions.

Cumulative Effects Common to All Action Alternatives

The activities and conditions listed above under the action alternatives and cumulative effects are the most likely past, ongoing, and foreseeable actions that may affect streams and fish within the project area. Increased sedimentation is the greatest concern in Big Creek. See Tables 3-81 thru 3-84 in the Hydrology section for a breakdown of total sediment for each alternative. The fire is overwhelmingly the largest potential contributor of sediment in the first year or two post-fire, after which the reestablishment of vegetation should greatly reduce sediment eroding from the burned lands. The sediment that can potentially be deposited into the bull trout spawning reach poses the greatest risk to the local population. Pool frequency may be reduced if excess sediment deposits in existing pools. Width/depth ratios may increase (worsen) if pools fill or areas of sediment deposition divert streams. Sediment entering below the spawning reach may reduce juvenile rearing habitat, interfere with feeding, and lead to direct mortality of fish at high concentrations. Juvenile habitat is currently functioning appropriately however, and sediment concentrations are not expected to reach levels sufficient to cause direct mortality among juvenile or adult fish in the lower reaches of Big Creek. Localized instances of mortality may occur if debris torrents directly bury fish or create localized concentrations of sediment above lethal levels, but such events may not occur or would be rare.

Bull trout spawning success is the most sensitive and critical population determinate affecting any aquatic species in the Big Creek watershed. The effect of the projected increase in sediment delivery upon spawning success is difficult to predict, primarily because both the amount, and fate, of sediment entering the channels depends in large part on precipitation patterns in coming years. There should be no measurable effect to other components of good fish habitat, such as channel stability, large woody debris recruitment, and stream temperature from any of the action alternatives. This determination is based in part upon the expectation that riparian buffers will protect streams from direct effects of timber harvest, and from the fact that only dead and dying trees will be removed (as has been addressed in Appendix B Post-fire mortality guidelines, it is acknowledged that there may be some trees that are removed that would otherwise live, and some trees that are left that may die). In addition, the effects of road decommissioning and improvement would not affect these habitat features owing to the short length of stream channel affected at road crossings.

Alternatives 2-5 would all increase sediment in the stream channels in the short term and decease sediment in the long term. Both these effects are related more to the road decommissioning activity than to the salvage harvest (see hydrology section). Despite the short-term risk, road decommissioning is the management tool with the greatest potential to improve the health and function of stream habitats by reducing drainage density and sediment yield within the watershed. Sediment delivered by proposed activities would be in addition to increased sediment resulting from the Moose Fire and other past, ongoing, and foreseeable actions as described for Alternative 1. The potential effects of this increased sediment have been discussed, and could include impacts to spawning habitat, juvenile rearing habitat, and channel stability. Water yield should decrease in the long-term as the decommissioned roads reduce the drainage density of the watershed. Other fisheries influences of concern such as stream temperature and large woody debris would not be affected by the action alternatives but would be affected by other past and future actions and events, most notably the fire itself.

The challenge for fisheries biologists is determining the ability of the local fish populations to cope with the cumulative effects of natural events and management activities. Monitoring of population trends and habitat condition is as much retrospective as predictive, but is the best method we have for assessing the status of bull trout. Substantially reduced survival of bull trout embryos, fry, or juveniles would threaten the continued existence of the local population. However, the cumulative effect of all past, ongoing, and foreseeable actions and events, including any associated with individual action alternatives, is not believed to threaten the continued existence of the local bull trout population in the Big Creek watershed. This determination is based upon the fact that about 50% of bull trout spawning habitat in the watershed is located upstream of the fire boundary, and vegetation in the riparian buffers adjacent to the majority of the remaining spawning habitat suffered low mortality due to the fire. The fisheries biologist would closely monitor all management activities to insure compliance with Forest Plan standards and

BMP's. These actions and events likewise will not threaten the continued existence of the Upper Flathead/Flathead Lake bull trout population, 90-95% of which spawns and rears in other watersheds. Similarly, westslope cutthroat trout are widely dispersed throughout the Big Creek watershed and the local population is not believed at risk of extinction because of any past, ongoing, or reasonably foreseeable actions.

Cumulative Effects of Alternative 2

The most significant cumulative effect of this alternative would be increased levels of fine sediment entering the stream network above the amount that would occur as a result of the fire and other past and future actions and events (see hydrology section). Any sediment generated by this alternative would occur over a period of approximately eight years as the salvage harvest and road decommissioning proceed. Sediment produced by this alternative may deposit in spawning and rearing habitat of bull and westslope cutthroat trout. The sediment generated by road decommissioning poses the greatest short-term threat to fish populations, but road decommissioning would begin to benefit streams and fish after several years by reducing peak flows and sediment load. Annual monitoring of the substrate using McNeil core samples is the best tool we have for assessing the condition of the spawning gravels, and substrate scoring provides an assessment of embeddedness. If fine sediment concentrations in the spawning gravel begin to rise, bull trout survival to emergence may be reduced. Increased levels of embeddedness (*lower substrate scores*) may translate to less juvenile rearing habitat and fewer invertebrates available as a food source (Deleray et al. 1999, Allan 1995, Haro and Brusven 1994). Road decommissioning

This alternative should have no effect upon stream temperatures, as no trees expected to live would be harvested in upland sites, nor would any trees be removed from the RHCA's except possibly in the two small fuel reduction units located at the campground and work center. Water yield should not be increased by this alternative because only dead and dying trees would be removed, and no permanent roads would be constructed. Low impact harvest methods should prevent excessive soil compaction, which can increase water yield from a site. Pool frequency may be reduced if excess sediment deposits in existing pools. Width/depth ratios may increase (worsen) if pools fill or areas of sediment deposition divert streams.

This alternative may affect bull trout and cutthroat trout in the Big Creek watershed, but should not threaten the viability of either the local or Upper Flathead populations of the two species. The principal population-limiting factor for bull trout in the Upper Flathead is believed to be the survival rate of fish that migrate to the main river and Flathead Lake, mature, and return to spawn (McIntyre 1998). This alternative should have no measurable effect upon Flathead Lake and little or no effect upon the Flathead River, as Big Creek contributes only about 5% of the total discharge of the North Fork. Recent data indicate that the greatest threat to westslope cutthroat populations is genetic introgression with non-native rainbow trout. This alternative would not contribute to more hybridization between the two species.

Cumulative Effects of Alternative 3

The cumulative effects of this alternative are similar to those for Alternative 2 above, but reduced in magnitude because of the reduction in harvest acres. The sediment predicted to result from implementation of this alternative would be in addition to sediment expected to enter the stream network from all past and likely future actions and events within the watershed (see hydrology section).

This alternative should have no effect upon stream temperatures, as only dead and dying trees would be harvested in upland sites, nor would any trees be removed from the RHCA's except possibly in the two small fuel reduction units located at the campground and work center. Water yield should not be increased by this alternative because no trees expected to survive would be removed, and no permanent roads would be constructed.

This alternative may affect bull trout and cutthroat trout in the Big Creek watershed, but should not threaten the viability of either the local or Upper Flathead populations of the two species. The principal population-limiting factor for bull trout in the Upper Flathead is believed to be the survival rate of fish that migrate to the main river and Flathead Lake, mature, and return to spawn (McIntyre 1998). This alternative should have no measurable effect upon Flathead Lake and little or no effect upon the Flathead River, as Big Creek contributes only about 5% of the total discharge of the North Fork. Recent data indicate that the greatest threat to westslope cutthroat populations is genetic introgression with non-native rainbow trout. This alternative would not contribute to more hybridization between the two species.

Cumulative Effects of Alternative 4

The cumulative effects of this alternative are similar to the other action alternatives but more complex. The expanded RHCA buffer widths on all ephemeral channels would reduce the risk of sediment delivery to the channel network. The prohibition on winter logging, on the other hand, increases the likelihood of soil disturbance in ground harvest units contributing sediment to streams. The expanded road decommissioning proposal would increase the total sediment volume delivered to the watershed, but would not likely increase the annual sediment volume since the additional miles of road would require additional time to decommission. The benefits associated with road decommissioning would likewise be greater with this alternative.

Total modeled sediment yield attributed to timber harvest is lower for this alternative than for the other action alternatives (see Table 3-83). This sediment reduction results primarily from the use of wider riparian buffer strips and a reduction in harvested acres.

As with all action alternatives, Alternative 4 is not considered likely to threaten the continued existence of any fish population, in either the Big Creek watershed or the Upper Flathead basin. This alternative would provide the greatest long-term improvement to fisheries habitat, owing to the greater reduction in road density within the watershed.

Cumulative Effects of Alternative 5

The cumulative effects to fisheries of this alternative would be essentially identical to those of Alternative 2. Harvest units and treatments remain the same. There is one less mile of road scheduled for decommissioning under this alternative, so slightly less short-term harm and long-term benefit would attach to selection of this alternative.

The only difference from a fisheries perspective of this alternative is the closure of the road to Moose Lake. This would result in less fishing activity in the lake and may benefit the westslope cutthroat trout population in the lake. Fishing pressure is not thought to be impacting the fish population at present and this benefit is not likely significant.

4. Regulatory Framework and Consistency

The National Forest Management Act requires the Forest Service to manage lands under its jurisdiction in a manner that insures the maintenance of viable populations of native fish. The Flathead National Forest has recently completed a viability analysis for bull trout and westslope cutthroat trout, which concluded that the populations of both species are currently viable within the Flathead National Forest (see project record exhibit I-6).

The Forest Plan is the primary document that codifies management standards and guidelines governing activity on national forest system lands. Originally adopted in 1986, the Flathead Forest Plan was amended in 1990 (Amendment No.3) to better define the standards for protection of fish populations. Amendment 3 established criteria for assessing the quality of spawning habitat relative to fine sediment concentrations in the gravel of the streambed. A stream would be considered "threatened" when the percentage of fine material exceeds 35% in any given year, while levels of 40% or greater would result in the stream being classed as "impaired".

The Forest Plan was again amended on August 30, 1995, by the Inland Native Fish Strategy (INFISH) (USDA Forest Service 1995). This interim strategy was designed to provide additional protection for existing populations of native trout, outside the range of anadromous fish, on 22 National Forests in the Pacific Northwest, Northern and Intermountain Regions. Implementing this strategy was deemed necessary as these species were at risk due to habitat degradation, introduction of exotic species, loss of migratory forms and over-fishing. As part of this strategy, the Regional Foresters designated a network of priority watersheds.

Priority watersheds are drainages that still contain excellent habitat or assemblages of native fish, provide for metapopulation objectives, or are watersheds that have excellent potential for restoration. Big Creek is a priority watershed. INFISH also established Riparian Management Objectives (RMOs) and Riparian Habitat Conservation Areas (RHCAs). RMOs are habitat parameters that describe good fish habitat. Where site-specific data is available, these RMOs can be adjusted to better describe local stream conditions. These RMOs for stream channel conditions provide the criteria against which attainment or progress toward attainment of riparian goals is measured. RHCAs are portions of watersheds where riparian dependent resources receive primary emphasis. The RHCAs are defined for four categories of stream or water body dependent on flow conditions and presence of fish. The RHCAs are within specific management areas and are subject to standards and guidelines in INFISH in addition to existing standards and guidelines in the Flathead Forest Plan.

The Endangered Species Act (ESA) is responsible for the protection and recovery of listed species such as the bull trout. The bull trout was listed as threatened under ESA in 1998. The recovery plan for bull trout is currently being developed and a draft document is expected soon. Critical habitat delineation is also currently being determined. A stand-alone BA for bull trout would be prepared for the selected alternative in this project as required by section 7 of the ESA. Another native resident of the watershed is the westslope cutthroat trout. The westslope is on the Regional Forester's "sensitive species" list. A Biological Evaluation has been prepared for westslope cutthroat trout that assesses the cumulative effects of all alternatives upon this sensitive species, as per Regional Directive 2670/1950 (August 17, 1995)(project record exhibit I-3).

Sensitive Species Determinations

The Flathead Forest Plan provides specific guidance for the protection of fisheries and other aquatic resources, including the riparian zone around still and flowing water. The planned actions proposed under Alternatives 2-5 comply with all relevant Forest Plan requirements including INFISH. If one of these alternatives is implemented, the fisheries biologist would monitor the activity to insure proper implementation of planned actions.

The Endangered Species Act requires consultation between other federal agencies and the Fish and Wildlife Service when a proposed action is determined likely to affect a listed species. If an action alternative (2-5) is selected for this proposal, a Biological Assessment would be prepared to make an effects determination of the selected alternative upon bull trout. The initial determination for bull trout for all alternatives is *"may affect, likely to adversely affect".* The no action alternative merits this determination primarily because the lack of road decommissioning would maintain a higher road density in the watershed, with its associated chronic sediment delivery and risk of catastrophic culvert failure. The adverse affect attached to Alternative 1 has no corresponding future benefit. Alternatives 2-5 warrant the adverse affect determination largely because of concerns with sedimentation resulting from road decommissioning and timber harvest. The action alternatives would provide a long-term benefit to bull trout because of the road decommissioning.

The Flathead National Forest considers the westslope cutthroat trout a sensitive species and requires a similar effects determination when proposed management activity is likely to affect the species. The basis of the determination comes from the Biological Evaluation of the species status, a separate document located in the project record. The determination for westslope cutthroat trout for all alternatives is *"may impact individuals or habitat, but would not likely contribute to a trend towards federal listing or loss of viability to the population or species."*