CHAPTER 3 AFFECTED ENVIRONMENT

INTRODUCTION

This chapter summarizes the physical, biological, social, and economic environments of the project area. A description of each of the resource topics in this section includes site-specific background data and adjacent environment information that illustrate current resource conditions in and around the project area. The effects area for a particular resource is strongly related to the science of that resource and may not be confined to the boundaries of the project area. For example, the effects area for air quality analysis covers much of northwest Montana.

REGIONAL LOCATION AND SETTING

Glacier National Park (GNP) and the Flathead National Forest (FNF) are in northwest Montana and are bounded to the north by the Canadian provinces of Alberta and British Columbia. The Middle Fork of the Flathead River and Bear Creek originate on National Forest System (NFS) and National Park Service (NPS) lands. The drainages form the boundaries between FNF and GNP lands. The small community of Essex lies 7 miles to the west of the project area. East Glacier lies east of the project area and 11 miles from Marias Pass. There are several small private developments (Snowslip, Summit, and Slippery Bill) east of the project area along US Highway 2.

The Blackfeet Indian Reservation lies to the east of GNP and FNF lands. There are narrow strips of privately owned land in the Middle Fork and Bear Creek drainages. US Highway 2 and the Burlington Northern Santa Fe Railway (BNSF) follow the boundaries of FNF and GNP along the Middle Fork and Bear Creek. The railroad runs from Seattle to Chicago and crosses the project area on a 200-foot wide right-of-way administered by the USFS. The railroad right-of-way and US Highway 2 cross the mountains at Marias Pass (5,213 ft.), the lowest elevation continental divide pass in the Rocky Mountains.

GNP is known as the Crown of the Continent as it has a triple divide draining into three oceans: the Arctic, Atlantic and Pacific. FNF is bordered on the east by the continental divide, which separates the Pacific and Atlantic Oceans. GNP has 1,013,572 acres of breathtaking mountain scenery and pristine glacial lakes. The FNF has 2,351,950 acres of forested land with spectacular mountains shaped by the glacial processes that formed the northern Rocky Mountains. The Livingston Range lies to the northwest, the Lewis Range lies to the northeast and the Flathead Range lies to the southwest of the project area. GNP contains six peaks over 10,000 feet in elevation. The continental divide follows the crest of the Lewis Range to West Flattop Mountain and then crosses to the crest of the Livingston Range. The FNF has several peaks over 8,000 feet in elevation and most of the vegetative cover is dense coniferous forests. The Lewis and Clark National Forest shares the eastern border of the Flathead National Forest and abuts the southeast boundary of Glacier National Park (Map 1-1).

The Crown of the Continent Ecosystem includes GNP, Flathead and Lewis and Clark National Forests (including the Bob Marshall/Great Bear/Scapegoat Wilderness Complex), provincial parks and wilderness areas of Alberta and British Columbia, and portions of the Lolo and Helena National Forests, Blackfeet Indian Reservation, Confederated Salish and

Kootenai tribal lands, and state forest lands. Glacier National Park and the Bob Marshall/Great Bear/Scapegoat Wilderness Complex comprise the relatively undisturbed core of this large ecosystem that supports a large variety of plants and wildlife. While these areas are administered by different agencies, different countries, and different management objectives, they all protect the integrity of the ecosystem. GNP preserves natural and cultural resources and processes for the benefit of this and future generations. FNF conserves natural and cultural resources while providing for the use of identified resources for national consumption and recreation. Privately owned land in John F. Stevens Canyon is used for homesites, tourism-oriented businesses, gravel extraction, and timber production. The Blackfeet Indian Reservation is used for agriculture, timber production, small-scale oil and gas extraction, and ongoing mineral exploration. The Blackfeet Tribe Reservation and the surrounding area are home to the Blackfeet people. Non-consumptive uses of natural and cultural resources in the region continue to sustain the tribe's cultural survival.

National and state forest lands in the region provide timber and livestock grazing. Both the Park and Forest lands provide world class fishing, boating, hiking, backcountry and cross-country skiing. Hunting and snowmobiling are allowed on NFS lands. Bear Creek flows from the west side of the Continental Divide into the Middle Fork of the Flathead River, a designated Wild and Scenic River. The mountains in the Park and Forest are a source of water for millions of people living in the Missouri, Saskatchewan, and Columbia River watersheds.

NATURAL RESOURCES

AVALANCHE PROCESSES

There are several dozen avalanche paths in John F. Stevens Canyon. Only 12 of these avalanche paths pose a threat to the railroad in the project area. Snow avalanches in these paths are a dynamic interaction of weather and mountain terrain. Major terrain factors involved are slope angle, aspect in relationship to wind and sun, elevation, and slope roughness and configuration. Terrain factors are a dominant influence upon where avalanches occur. Precipitation type and rate, temperature, and wind are the weather factors influencing snow stability and dictate the timing of avalanche releases.

Avalanches take two forms: loose snow and slab. A loose snow avalanche involves the cohesionless flow of unconsolidated snow grains or small aggregates of grains. The initial failure occurs at a specific point on the slope when the coefficient of friction between grains at the surface of the snowpack is overcome. Once initiated the movement progresses downslope involving increasing quantities of snow. Since the flow involves only near-surface snow, the quantities of moving snow is typically limited. Dry slides have very little destructive force; however, as their water content increases in periods of rain or thaw their impact force can increase.

In contrast to loose snow slides, slab avalanches fail as a cohesive layer unit. The failing layer can be anywhere from inches thick, up to multiple feet thick. Slab avalanches can even be full depth, failing at the ground surface. Compared with loose snow avalanches, slab releases typically involve larger quantities of snow, achieve higher flow speeds, and typically generate higher impact pressures and destructive potential.

Slab avalanche releases initiate within a region of the slope called the starting zone (Figure 3-1). These origination areas typically exist near the top of peaks and ridges, but can also exist at steep locations further downslope. Starting zones are areas of significant snow accumulation from either precipitation or wind deposit. Starting zones are typically catchment basins or valley wall areas with slope steepness of 30-40 degrees. Examples of catchment basin starting zones are Shed 5 and Shed 11 paths. Examples of valley wall starting zones would be Burnout, Jakes, and Second Slide. Slopes with less than 30 degrees usually will not be starting zones except under conditions where the snow pack is saturated with liquid water.

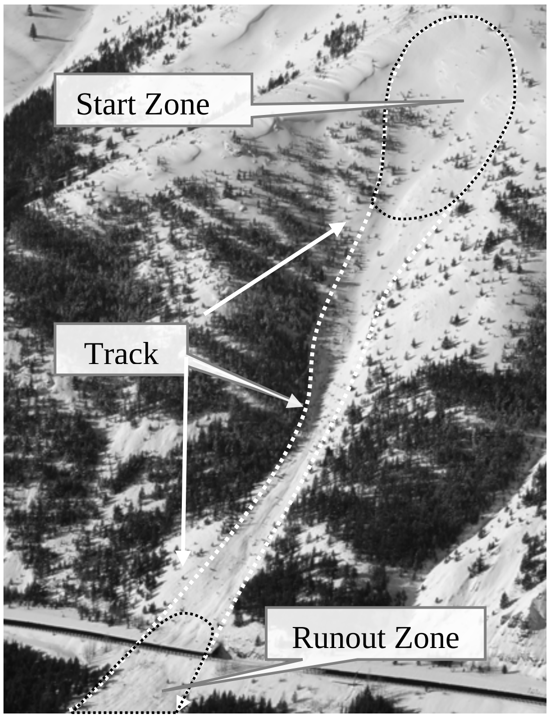


Figure 3-1. Avalanche Path Anatomy.

Once movement begins, the avalanche moves through the avalanche track, often entraining additional snow and gaining momentum and force, finally coming to a stop in the runout zone, a zone of debris deposition. A change in slope angle frequently marks the transition between track and runout zone. In John F. Stevens Canyon, this transition is often at or near the railroad tracks.

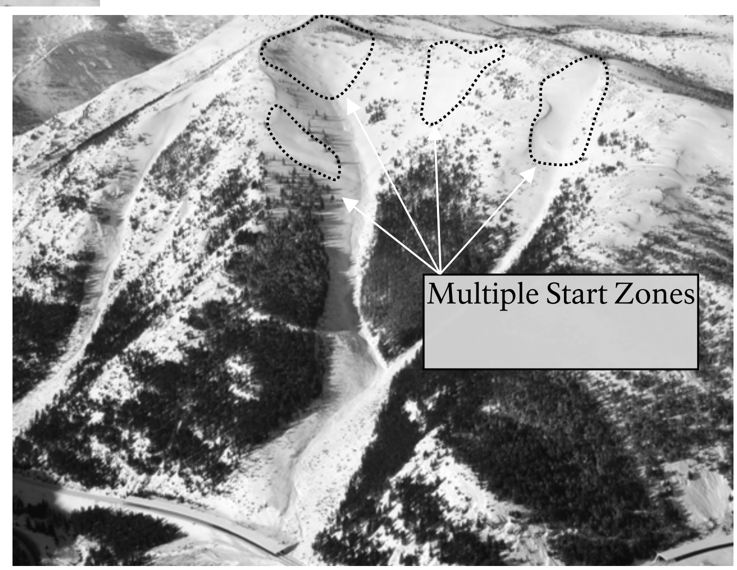


Figure 3-2. Multiple Start Zones.

Many of the avalanche tracks in John F. Stevens Canyon are fed by multiple start zones separated by ridges, rock outcroppings, tree stands, or other features (Figure 3-2). They can release individually or in groups, potentially sending multiple surges into the runout, or under the right conditions, sending a tremendous flow into the valley bottom when several start zones release simultaneously. Starting zones of similar elevation and aspect generally possess similar degrees of snow strengths and stresses.

Avalanche conditions in John F. Stevens Canyon are strongly influenced by its proximity to the continental divide. The canyon is an area where two frontal air masses often collide; warm, moist, maritime air from west of the divide and cool, dry, continental air from the north and east. Since the canyon is located just west of Marias Pass, the westerly flow of Pacific air generally dominates. Periodic surges of cold Arctic air are common however during the winter months. A collision between these two frontal masses often produces dramatic air temperature fluctuations. Thirty degree Fahrenheit fluctuations within a couple of hours occur occasionally. The US record for the most dramatic temperature change in 24-hours occurred at nearby Browning, Montana, on January 23, 1916. An Arctic cold front dropped the temperature from 44F to -56F, a change of 100 degrees. On January 11, 1980, the temperature at the Great Falls International Airport rose from -32F to 15F in seven minutes.

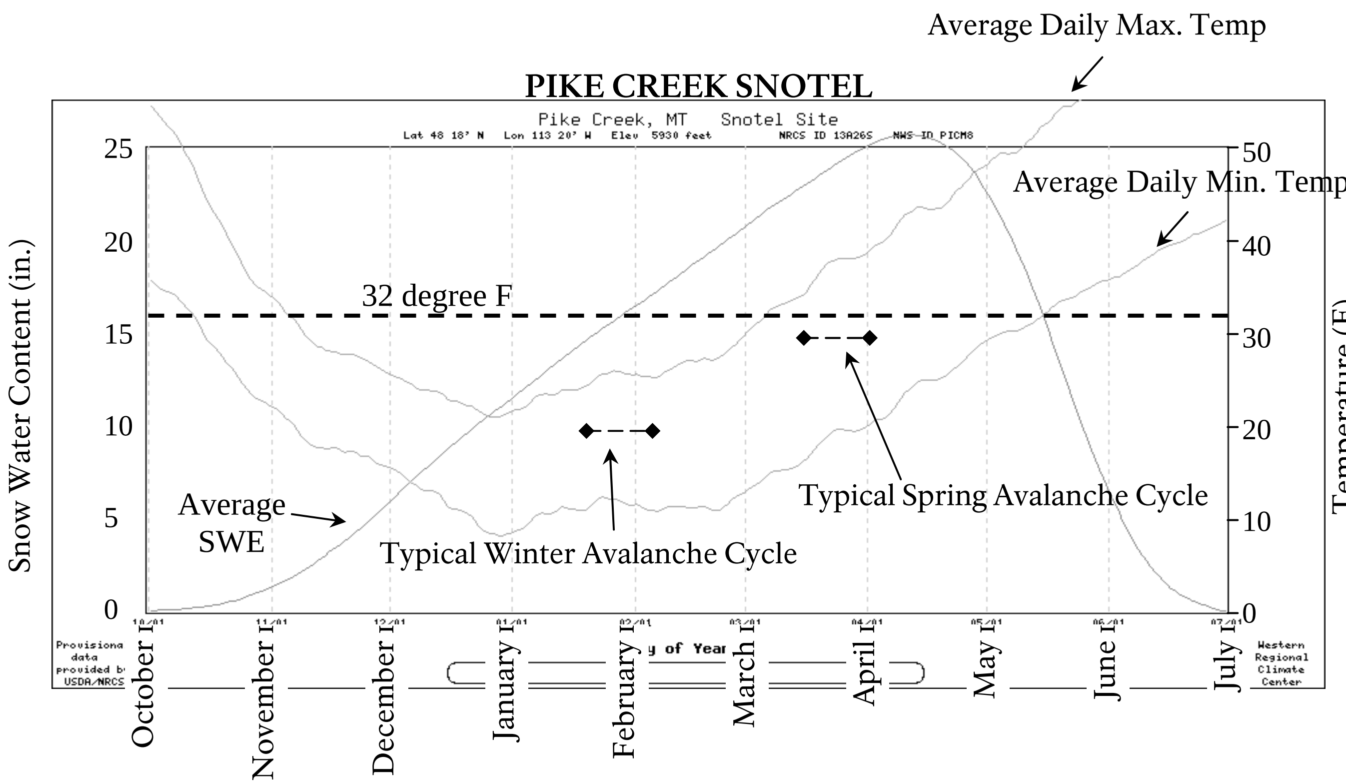


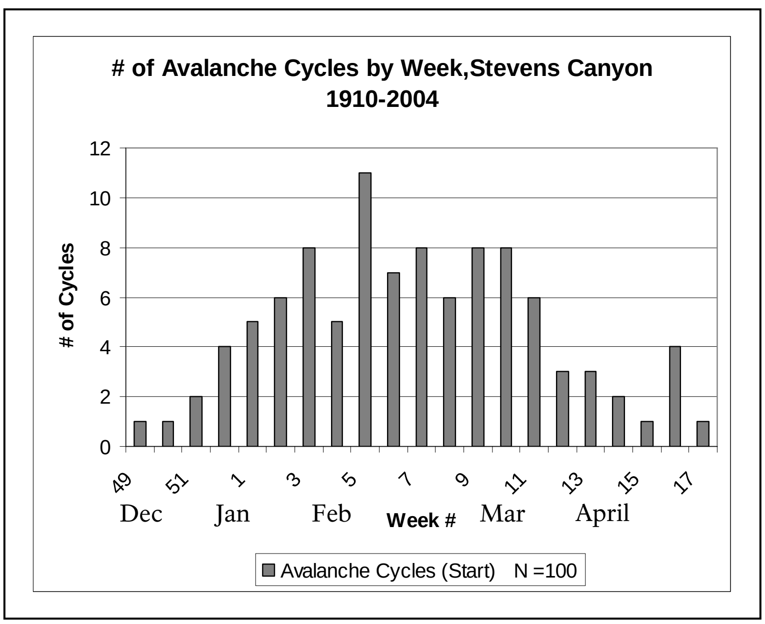
Figure 3-3. Pike Creek Snotel data, showing October to July average daily maximum and minimum temperatures and average accumulated total snow water equivalent (SWE) for the period of record. Winter and spring avalanche cycles may occur anytime between December and April (See figure 3-4).

This 47 degree increase stands as the record for the most rapid temperature change in the US (http://www.wrh.noaa.gov/tfx/tx.php?wfo=tfx&type=html&loc=text&fx=topweather).

Approximately 70% of the yearly precipitation received in the canyon falls in the form of wintertime snow. At nearby Essex, Montana, the twenty-year annual average for snowfall is 198.8 inches. In late January or early February, rain-on-snow events are common, driven by a strong inflow of moist, Pacific air and rapidly warming air temperatures. This "January thaw" or similar weather conditions produce the most significant avalanche cycles in the Canyon.

Periods of avalanche cycle activity are shown in Figure 3-3 with data from Pike Creek Snotel site (http://www/wrcc.dri.edu/cgi-bin/snoMAIN.pl?NOIM8). Pike Creek is located just southeast of Marias Pass on the Lewis and Clark National Forest. In 1979, the Goat Lick Bridge on US Highway 2 was destroyed in one of these avalanche cycles. A typical ingredient in the mid winter events is the presence of a snow cover of cold, deep, weakly bonded, and often unconsolidated snow. This snow may or may not have buried weak layers, however with rapid warming and either the onset of a heavy snow or rainfall, the subsurface weakly bonded snow is unable to support the increasing weight and stress at the snow surface. Figure 4-4 below shows the number of recorded avalanche cycles that have occurred between 1910 and 2004 and when they have occurred during the winter months. Avalanche cycles can occur between December and April depending on snowpack depth and weather conditions. Avalanches do occur in other months but lack the amount of snow necessary to reach the railroad tracks. A peak of avalanche events tends to occur at the end of January and beginning of February.

Figure 3-4. Recorded avalanche cycles by week, John F. Stevens Canyon (Source Blase Reardon, USGS May 2006)



The avalanche paths above the railroad in John F. Stevens Canyon are predominately south facing. Frequent cloud cover and a low sun angle protects these slopes from significant solar warming on winter days; however spring time clearing and a higher seasonal sun angle can produce rapid midday heating in late March, early April. It is this rapid solar warming that precipitates the second most significant avalanche cycles in the canyon. Snow water equivalent (SWE) data from the Pike Creek SNOTEL site show that rain-on-snow events, periods of heavy snow, and differences in temperatures from high to low elevations are also factors in spring avalanche cycles. Table 3-1 gives detailed information concerning statistics of each avalanche path in the project area.

Table 3-1. Avalanche path statistics. (Source *Avalanche Risk Analysis John F. Stevens Canyon, Essex Montana*, Hamre and Overcast 2004)

Path	Starting Zone Elev.	Vertical Fall	Average Avalanche Width	Maximum Path Width at Railroad	Return Frequency[1]	Avalanche Hazard Index (AHI)[2]
Burn Out 4C	5,280 ft.	840 ft.	525 ft.	900 ft.	2 yrs.	11.70
Shed 5	6,100 ft.	1,700 ft.	150 ft.	550 ft.	20 yrs.	6.39
Shed 7	6,760 ft.	2,300 ft.	150 ft.	1,150 ft.	3 yrs.	15.55
Shed 8	6,520 ft.	2,100 ft.	100 ft.	800 ft.	20 yrs.	4.28
Shed 9	6,800 ft.	2,550 ft.	100 ft.	500 ft.	10 yrs.	6.69
Infinity	6,160 ft.	1,900 ft.	277 ft.	400 ft.	10 yrs.	7.17
Jakes	5,680 ft.	1,350 ft.	200 ft.	600 ft.	3 yrs.	8.44
Second Slide	5,800 ft.	1,600 ft.	200 ft.	440 ft.	5 yrs.	9.25
Shed 10	6,800 ft.	2,700 ft.	200 ft.	1,100 ft.	50 yrs.	8.29
Path 1163	7,320 ft.	3,250 ft.	300 ft.	2,112 ft.	5 yrs.	10.75
Shed 10.7	7,180 ft.	3,150 ft.	350 ft.	1,200 ft.	10 yrs.	7.74
Shed 11	6,400 ft.	2,200 ft.	100 ft.	500 ft.	20 yrs.	5.21

[1]Combined frequency from old records, review of tree ring data, and interviews of current railroad personnel

[2] AHI is a calculation of risk based upon encounter probabilities- -Consists of computed values for traffic moving beneath the path, plus values for traffic waiting within the path after being stopped by an avalanche in an adjoining path, avalanche frequency and magnitude within specific paths.

The large-scale avalanche events and return frequencies, defined by debris reaching the tracks, occur sporadically at intervals of 2-5 years. Smaller scale avalanches can occur in the upper reaches of the avalanche paths several times a year, depending on snow levels. Avalanche frequency in the canyon continues to be compiled through historic record research, tree ring data collection, and current recording methods. Although frequency estimates relating to avalanches that have reached the rail have been documented in the avalanche atlas as “frequency from records” or “combined estimated frequency,” established return intervals have not been documented completely enough to derive a specific return interval period for specific avalanche paths or to determine what is or is not “common.”

Commonly the John F. Stevens Canyon mid-winter and springtime avalanche cycles are wet in nature, releasing either slab or loose snow avalanches. The mid-winter slides often originate near mid-elevation (~5,000 – 6,000 ft.) and can involve surges of pulsing flow from multiple start zones. This can produce large, chaotic, debris piles of wet, dense snow. Compared to the mid-winter cycle the spring cycle tends to release at a higher elevation near the upper peaks and ridgetops. Although these spring avalanches frequently involve only near surface layers of snow, they can be full depth, failing at the ground interface and entraining the entire snowpack below the point of initiation. These wet, mid-winter and spring avalanches tend to be comparatively slow in nature, often hanging up in the lower track. Because of their high water content however, they can produce high impact forces.

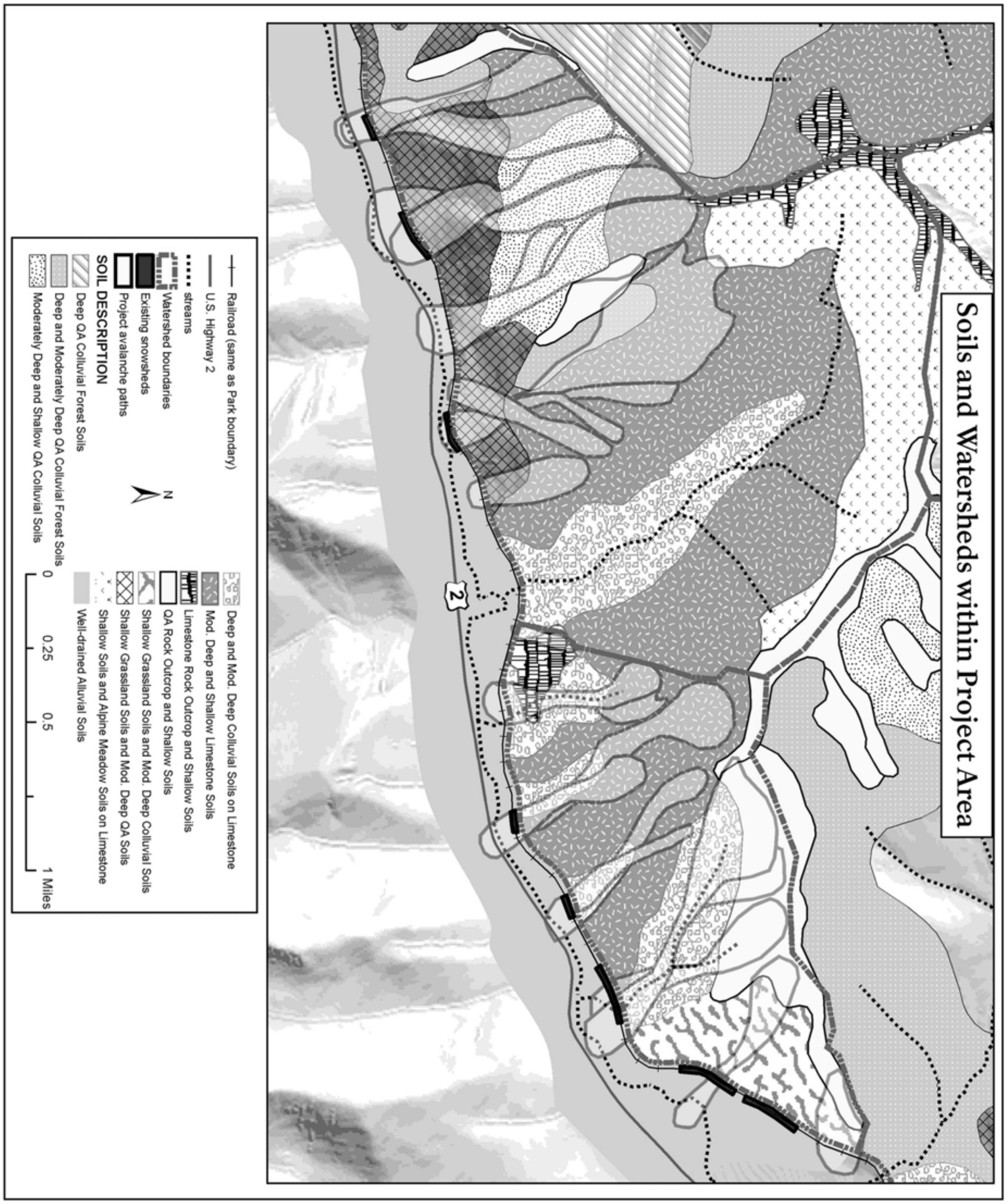
Although the majority of the avalanches in the canyon that reach the rail corridor are wet, there are occasional dry, slab releases that reach the runout zones. The potential for these dry avalanches exists each winter, particularly in January. Dry slab avalanches release high on the slope just beneath the peak and ridgetops and move quickly. An infrequent occurrence in the canyon is the occasional dry slab avalanche that reaches the opposing canyon wall.

WATER RESOURCES

Bear Creek is the major stream, which drains the avalanche paths in the project area. This creek is a tributary to the Middle Fork of the Flathead River that ultimately flows into Flathead Lake.

The two attributes generally used to characterize water resources are water quantity and water quality. Both water quantity and water quality are a result of the geology, landforms, vegetation, climate, and disturbance regimes that characterize an area. Water quantity in mountainous areas is generally characterized by the amount and timing of the surface water flow (streams) and/or subsurface water flow (groundwater). Water quality is characterized by the chemical (e.g. nutrient yield) and physical (e.g. sediment yield) properties of the water. This section describes some of the general weather, geomorphology, stream channel, water flow, and water chemical characteristics found in the project area. Map 3-1 shows the watershed and geology of the project area.

The weather variations for the entire Flathead region are due to the influence of maritime patterns from the Pacific Ocean. The general westerly flow of the lower atmospheric layers common at this latitude of the Pacific Northwest is modified by the mountain complexes of Western Montana and Central Idaho. The high mountains in the Continental Divide, directly east of the Flathead Valley, form an effective barrier against most cold Arctic patterns flowing south on the Great Plains through Canada. The valleys experience many days with dense fog or low stratus cloud layers during the winter months due to the trapping of dense, valley-bottom air by warmer Pacific air moving over the top. Occasionally, during the winter, continental air masses override the maritime air masses causing significant amounts of relatively dry snowfall. The combination of the moist maritime snow and the drier continental snow increases the potential for snow avalanches. Precipitation can vary significantly with season, elevation, and location. The greatest percentage of precipitation falls as snow during winter months. The weather station at Essex, MT (station I.D. 242812) is used to characterize the precipitation of the central portion (John F. Stevens Canyon) of the Middle Fork of the Flathead River Basin. See table 3– 2 for the average monthly air temperatures, precipitation, and snow depths at the Essex, MT weather station.



Map 3-1. Watershed and geology.

Table 3– 2. The average monthly climate data for Essex, Montana (Western Regional Climate Center 2005).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Avg. Max. Temp. (F)	27.2	33.8	40.9	51.1	62.5	73.2	81.1	78.9	64.8	51.4	36.1	28.4	52.6
Avg. Min. Temp. (F)	13.0	16.0	18.8	27.0	33.7	41.2	44.6	43.5	36.5	30.0	22.4	15.8	28.6
Avg. Total Precip. (in)	5.01	3.51	2.79	3.12	2.73	2.83	1.59	1.77	2.98	3.01	4.05	4.51	37.91
Avg. Snow Depth (in.)	36	45	47	27	3	0	0	0	0	0	6	17	15

* Average temperature and precipitation data was for years 1961-1990. The average snow depth data was for years 1951-1970.

Some precipitation occurs every month of the year. Most winter precipitation in the mountains occurs as snow, although some rain-on-snow events are documented. Density of the mountain snow pack increases from about 20% water equivalency in early winter to about 35% in April.

Streamflow increases in April as the snow pack begins to melt. Peak streamflow usually occurs in late May or the month of June. Snowmelt or rainfall does not immediately become surface runoff. Some precipitation percolates through the snowpack into the soil and bedrock to become groundwater, regenerating wet areas, small ponds and perennial streams in lower elevations below the point of infiltration. The slow release of groundwater provides consistent stream baseflow beginning in mid-July and continuing until the fall rains, typically beginning in mid-September.

Figure 3– 5 is a graph of the 1990 May thru September stream flow for the West Fork of Skyland Creek and Skyland Creek above the confluence with the West Fork of Skyland (west of Marias Pass). This graph reflects the typical timing and amount of stream flow for a small watershed in the headwaters area of the Middle Fork of the Flathead River. Note that monitoring data from streams on Forest Service lands close to the project area are used to describe similar conditions found in Glacier National Park that lack existing monitoring data.

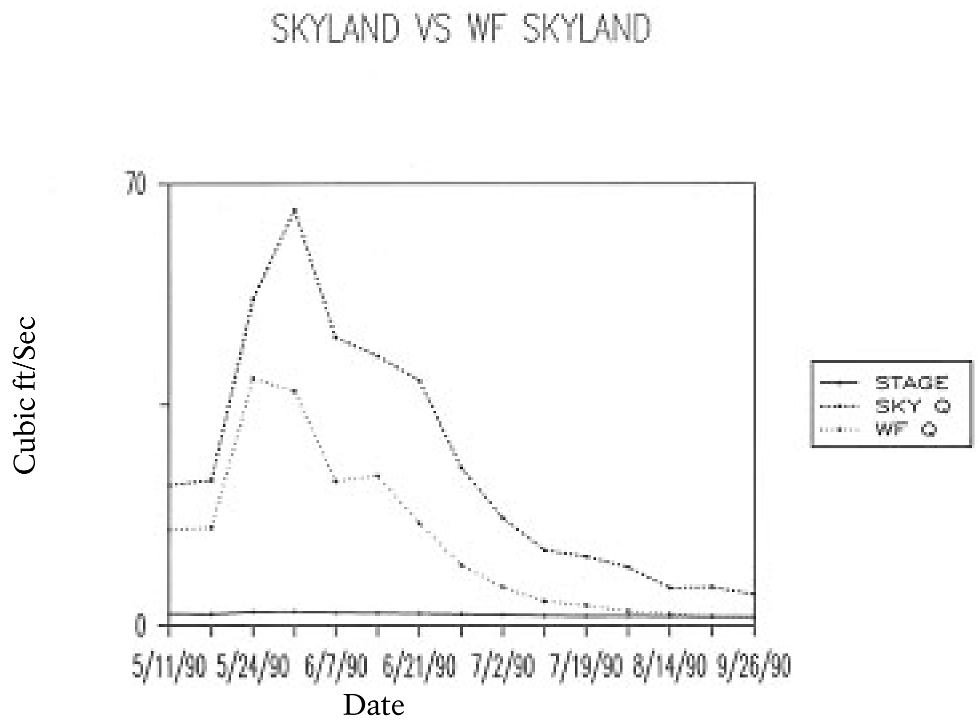


Figure 3-5. Stream flow in cubic feet/second for Skyland Creek and the West Fork of Skyland Creek May through September 1990.

Rain-on-Snow (ROS)

Rain-on-snow hydrologic events are a component of the large avalanche cycles that typically affect the canyon. Rain on snow events in combination with rapid spring snowmelt can cause major flooding, affecting streams and rivers in the project area. The records (1940 – 2004) for the USGS flow gauge on Middle Fork of the Flathead River near West Glacier, Montana (station I.D. 12358500, located approximately 25 air miles from the study area), indicates that a normal spring snowmelt period occurs between May and June. However, one peak flow event occurred on March 2, 1972 that was most likely a ROS. Stations in the South Fork and Middle Fork of the Flathead have recorded approximately three wintertime ROS flooding events during a 50 to 60 year period of record. The highest peak flow recorded for the Middle Fork occurred on June 9, 1964 when a record breaking rainstorm occurred during the spring snowmelt period. This event in the headwaters area of the Middle Fork resulted in a major 200 year flood, which caused significant damage to stream channels, US Highway 2, and the railroad.

Geology/Landforms

The primary underlying bedrock in the project area is Precambrian meta-sedimentary rock including argillites, siltites, quartzites, and limestones. The entire area has undergone glaciation resulting in surficial deposits of alluvium, glacial till, glacial outwash, or glacially scoured bedrock and resultant shallow residual soils.

Climate, geology, and geomorphic processes combine to create various landforms. Landforms and the resultant vegetation are the dominant physical features that affect watershed processes by regulating how and where water flows across the landscape.

Vegetation influences the erosion processes that occur within the landscape. Landforms common in the watershed analysis watersheds are presented in Table 3- 3.

Natural disturbances such as wildfire, blow-down, and snow avalanches remove vegetation and expose bare soil, which in turn increases the potential for nutrients to be released/recycled. Many of the nutrients end up stored in soil and available for plant growth. Some nutrients either in solution or attached to soil particles can end up in streams and ultimately in Flathead Lake. Potential nutrient contribution for each individual landform is rated from low to high in Table 3- 3. The nitrogen yield rating is based on the natural level of nitrogen in the soil, soil permeability and precipitation. The phosphorus yield is based on the natural level of phosphorus in the soil and sediment hazard of the soil type.

Stream Type Characterization

The Rosgen Stream Classification System provides a method for identifying streams according to morphological characteristics (Rosgen 1996). The morphological characteristics include factors such as channel gradient, sinuosity, width/depth ratio, dominant particle size of bed and bank materials, entrenchment of channel, and confinement of channel in valley.

The stream types summarized below are described fully in Rosgen, 1996:

- A-type: streams with gradients 4 to 10% plus, characterized by straight, non-sinuous, cascading reaches with frequently spaced pools;
- B-type: streams with gradients 2% to 4%, moderately steep, usually occupy narrow valleys with gently sloping sides;
- C-type: streams with low gradients < 2% with moderate to high sinuosity and low to moderate confinement.

The streams in the smaller basin tributaries to the Middle Fork of the Flathead River are A stream types in the steeper headwaters areas, and are B stream types in the lower elevations. The Middle Fork of the Flathead River is primarily a C stream type where it occurs in the project area. Table 3– 3 described the common landforms in the project area and their relationship to stream types. The disturbance relationships to these landform classes and the expected nitrogen and phosphorus yields are also displayed in Table 3 – 3. Nutrient yields are discussed further in the environmental consequences section.

Table 3 – 3. Landforms in the Middle Fork avalanche hazard mitigation area, the associated stream type, and the expected nitrogen and phosphorus yield following disturbance.

Landform Class	Most Common Stream Type	Expected Nitrogen Yield After Disturbance	Expected Phosphorus Yield After Disturbance
Valley Bottoms	C	Moderate	High
Breaklands	A	Moderate	High
Steep Alpine Glaciated Lands	B	Moderate	High
Gently to Moderately Sloping Glaciated Lands	A or B	Low	Moderate
Mountain Slopes and Ridges	A	Moderate	Low

Watershed and Stream Channel Current Condition Assessment

Three major characteristics describe the existing condition of a watershed:

- Stream channel condition and stability
- Water quantity (water yield)
- Water quality (sediment yield/nutrient yield)

Streams in this region do not have 100% stable banks due to natural conditions such as channel migration through floodplains, glacial geomorphology that created loose gravel-cobble channels, trees toppling into streams, and the effects of periodic floods. Research shows that land management activities such as timber harvest and associated road construction can reduce bank stability (Overton et al. 1995). Stream bank stability also varies by stream type.

One of the methods used to characterize stream channel stability on the Flathead National Forest is a field survey called a Pfankuch Stream Stability Rating. The Pfankuch stream channel rating was developed to "systemize measurements and evaluations of the resistive capacity of mountain stream channels to the detachment of bed and bank materials and to provide information about the capacity of streams to adjust and recover from potential changes in flow and/or increases in sediment production" (USDA Forest Service 1978). The procedure uses a qualitative measurement with associated mathematical values to reflect stream conditions. The rating is based on 15 categories: 6 related to the channel bottom covered by water yearlong; 5 related to the lower banks covered by water only during spring runoff; and 4 related to the upper banks covered by water only during flood stage. Streams rated *excellent* (<38) or *good* (39 – 76) are less likely to erode during high flow than streams with ratings of *fair* (77 – 114) or *poor* (115 +). Ratings are evaluated at a spot or reach of stream. Each rating represents one point in time and a series of rating must be made over several years to show trends in stream stability. Prime fish habitat is generally found in stream segments with good or fair ratings. Excellent rated segments do not have adequate small gravels for spawning habitat.

Table 3-4 summarizes all the historic Pfankuch Stream Stability Rating done in headwater streams in the Middle Fork of the Flathead River. Most of the stream reaches surveyed were in the *good* class or the upper portion of the *fair* Class. This is typical of the streams in the Flathead National Forest unless a stream reach is significantly affected by a disturbance event such as a flood or a landslide. The streams in the project area are expected to be in this same range of stream stabilities due to similar geomorphology and disturbance regimes.

Table 3- 4. Summarization of Pfankuch stream stability ratings for headwater stream reaches in the Middle Fork of the Flathead River.

Watershed	Number of Surveys	Pfankuch Condition Class
Bear Creek	4 (1981)	2 -good, 2-fair
Bergsicker Creek	2 (1979)	2-good
Challenge Creek	7(1979, 87, 88)	2-good, 5-fair
Dodge Creek	7 (1979,80)	2 good, 5 –fair
Essex Creek	2 (1981)	1-good, 1-fair
Morrison Creek	7 (1980, 81)	7-fair
Nyack Creek	2 (1981)	2-fair
Paola Creek	4 (1981, 90)	1-good, 3-fair
Skyland Creek	16 (1980, 81, 98)	6-good, 10-fair
Twentyfive Mile Creek	3 (1979)	3-fair
WF Skyland Creek	4 (1980)	2-good, 2-fair
WF Dodge Creek	7 (1987)	7- fair

Water Quantity

The amount and timing of water flow from a basin is a major characteristic of a watershed. When forest vegetation is either removed during timber harvest or killed by wildfire there may be increased water yield from that site. A reduction in tree density and canopy cover results in decreased transpiration and canopy interception of rain and snowfall, increasing the amount of precipitation available for runoff. The forest vegetation in snow avalanche paths may be maintained at an early successional stage due to repeated avalanche disturbances. Occasionally a large avalanche event will remove fully developed trees from the sides and run-out areas of the path.

A stream channel develops over time to accommodate the natural variability in flow caused by the disturbance cycles that are operating in that watershed. Streams can accommodate small increases in peak flows without affecting either the stream channels or aquatic organisms. Significant increases in average high flows can cause a variety of channel effects such as widening and deepening, bank and bottom erosion, and sediment deposition on bars or islands. Substantial increases in peak flows generally lead to a subsequent increase in sedimentation. If the amount of water yield increase is too great for stream channel capacity, channel erosion increases proportionately.

The water quantity (water yield) of the project area is within the natural range of variability for each analysis watershed. The major human caused ground disturbing activities in the project area are the historic construction of the railroad and US Highway 2, neither of which has changed the water yield in any significant way. The location of the highway and railroad on the lower elevation alluvial fans with associated lower precipitation, and their water spreading landform characteristics do not influence Bear Creek. Past timber harvest in the Bear Creek headwaters area has slightly increased the background water yield for the basin. The graph in Figure 3– 4 reflects the typical timing and amount of stream flow for a watershed in the headwaters area of the Middle Fork of the Flathead River. This graph is representative of the water flow timing for smaller avalanche path watersheds in the project area; but the amount of flow would be proportionally less due to the smaller size of these watersheds compared to Skyland Creek.

Sediment Yield

The amount of sediment routed to or eroded within a stream channel is frequently used as a measure of overall water quality. Because stream channels have evolved to carry their historic sediment loads, large increases in sediment yielded to a stream may exceed the stream's ability to transport the load (Leopold 1995); as a result, sediment deposition would likely occur in the stream channel, especially in low-gradient sections of a stream, as point bars and mid-channel bars. This leads to a wider, shallower, less stable channel than pre-deposition conditions, and can have a detrimental impact on the fisheries resource by clogging spawning gravels. Increased sedimentation also affects macro-invertebrates and other aquatic organisms. Bank erosion may also be increased, thus adding even more sediment to the load in the stream.

A statistical analysis of the relationship between suspended sediment and stream discharge was completed for samples collected from 1976 through 1986 on the Flathead National Forest (Anderson 1988). Staff conducted a review of the rating curves and regression analysis for the Hungry Horse Ranger District to estimate background sediment carrying capacity for streams similar to those in the project area. Six monitoring stations in five watersheds were included in this estimate. All of these monitoring stations with similar geologic/geomorphic characteristics had similar precipitation regimes and were in close proximity to the project area. Monitoring stations with weak suspended sediment / discharge correlations, few or no statistically significant regression equations, and low suspended sediment concentrations are generally characteristic of stream systems with very limited supplies of sediment. Of the six stations in the Hungry Horse Ranger District, four were in this category. The average background sediment concentrations for the six watersheds range from 0.6 to 2.3 mg/L with an overall average of 1.65 mg/L. The available data are summarized in Table 3-5. Figure 3- 6 displays a graph of sediment yield versus stream discharge for Skyland Creek. This relationship has a correlation coefficient of .9 for measurements taken in 1986 and 1987. The headwater streams in the project area are expected to have similar sediment concentration levels to Twenty-Five Mile Creek, main Skyland Creek, and the West Fork of Skyland Creek. The relationship between stream discharge and sediment yield is also expected to be very similar in the project area watershed.

Table 3-5: The average sediment concentrations for headwater streams in the Middle Fork of the Flathead River.

Stream name	Station I.D.	Sediment concentration (mg/l)	**Sediment Supply Limited**
Challenge	FL6005	2.1	No
Dodge	FL6012	1.7	Yes
Puzzle	FL6007	1.6	No
Twenty Five Mile	FL6008	0.6	Yes
Skyland	FL6009	2.3	Yes
Skyland (West Fork)	FL6010	1.6	Yes

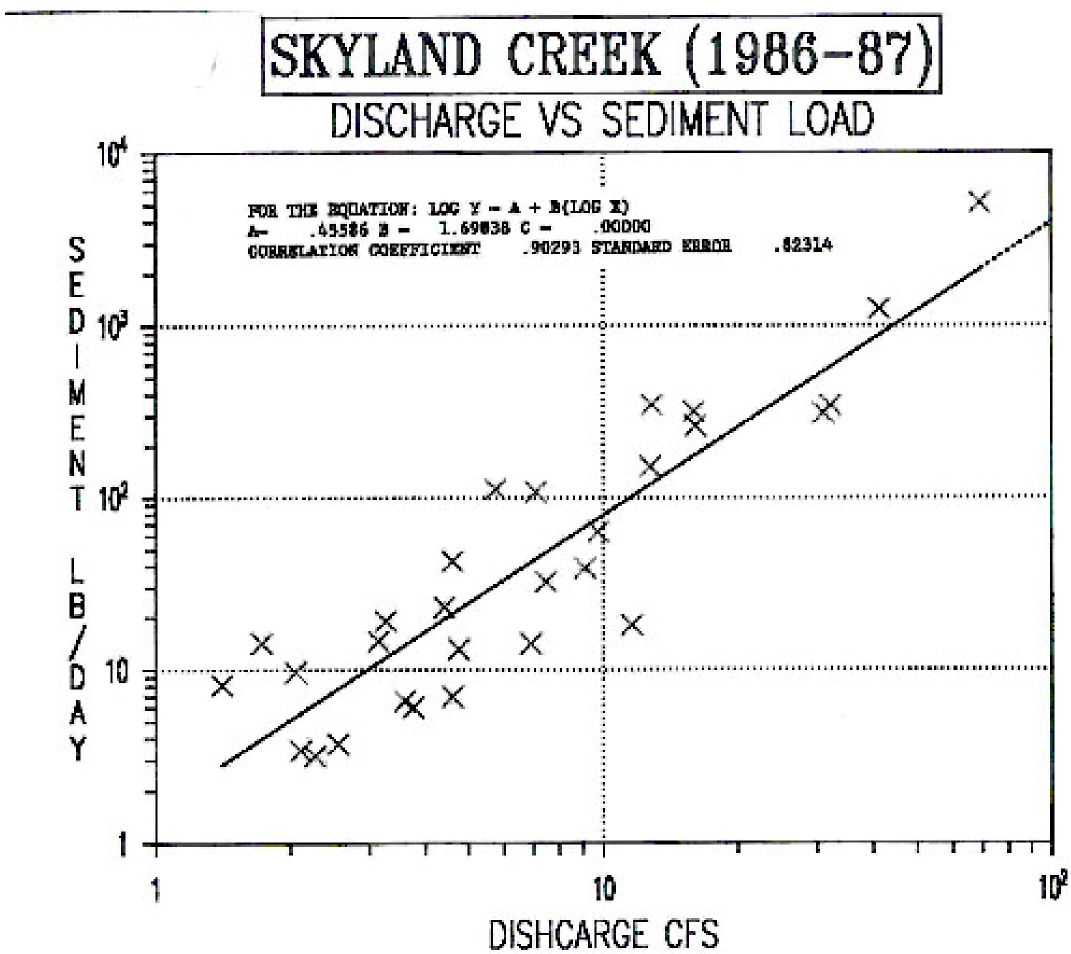


Figure 3-6. A graph of sediment yield versus stream discharge (cubic feet per second) for Skyland Creek of measurements taken in 1986 and 1987.

Changes to sediment yield, especially increases, are usually associated with disturbance within a watershed. Natural disturbances such as wildfire or major snow avalanches in a snow avalanche path can reduce vegetation cover thereby increasing soil erosion and sediment yield. The erosion potential decreases over time as the natural vegetation cover is reestablished over the soil surface. Disturbed sites in this area will rapidly revegetate naturally and once revegetated have little or no potential for soil erosion.

Nutrient Yield

The surface soils in the headwater areas of the Flathead Basin are typically derived from volcanic ash. They tend to have a very high cation exchange capacity, and are naturally low in levels of bicarbonate (Martinson and Basko 1983). The water chemistry data for a long-term water quality monitoring station in the Middle Fork of the Flathead River at Skyland Creek is displayed in Table 3-6. The levels of the various nutrients are typical for the geologic parent materials found in this portion of the Middle Fork of the Flathead River. The analysis watersheds would be expected to have very similar water chemistry characteristics.

There was a total maximum daily load (TMDL) developed for Flathead Lake of which the Middle Fork of the Flathead River is a primary tributary. The Nutrient Management Plan and TMDL for Flathead Lake, Montana (Montana Department of Environmental Quality 2001) identify phosphorus and nitrogen as the primary nutrients of concern in the Flathead Lake basin. Increased algae growth in Flathead Lake because of nutrient increase in the headwater streams is identified as an adverse impact to water quality in the Nutrient Management Plan.

Table 3 – 6. Water chemistry data for Skyland Creek above the confluence with the West Fork of Skyland Creek (monitoring station FL6009).

Parameter (units)	Mean	Number of Samples	Minimum	Maximum
Water temperature –degrees F	42.9-F	145	32	54
Streamflow – cfs	15.5	145	.9	80
Field Conductivity	1.8	148	.2	48
Dissolved Oxygen mg/l	10.0	63	7.6	13.2
pH (lab)	7.9	7	7.3	8.3
NO3 Nitrogen mg/l	.14	5	.03	.48
Total Sulfate mg/l	.26	7	.1	1.0
Potassium mg/l	.42	5	.2	.7
Sodium mg/l	1.7	6	1.0	2.3
Magnesium mg/l	6.7	6	2.6	10
Iron mg/l	6	6	2	10
Total Phosphorous mg/l	.012	25	.005	.021
Manganese mg/l	5.5	6	1	10
Calcium mg/l	37.3	6	16.2	54.2
Suspended Sediment mg/l	2.6	129	.3	13

Studies by research scientists at the Flathead Lake Biological Station have shown a trend of increasing nutrient levels and associated algae growth within Flathead Lake. *The Nutrient Management Plan and Total Maximum Daily Load for Flathead Lake, Montana* was developed to address this trend by the Montana Department of Environmental Quality in 2001. The report identified phosphorus and nitrogen as the primary nutrients of concern in the Flathead Lake basin, including the Middle Fork of the Flathead River. Increased algae growth in Flathead Lake due to nutrient increases in headwater streams is identified as an adverse impact to water quality in the nutrient management plan. The rivers in the Flathead Basin carry a substantial load of biologically inert phosphorus during spring runoff (Ellis and Stanford 1986).

Hydrologists have revealed a strong correlation between the amount of sediment entering Flathead Lake and the amount of available nutrients for algae growth. They have quantified the relationship between increasing stream flow, resulting in increased sediment yield and increased phosphorus yield in Skyland Creek, a headwater stream of the Middle Fork. Figure 3-6 graphically displays the relationship between increased stream flows to increasing sediment yield. Figure 3-7 graphically displays the relationship of increased stream flow to increasing phosphorus yield. Figure 3-8 graphically displays the relationship of increased sediment yield to increasing phosphorus yield. This relationship has a correlation coefficient of .92 for measurements taken in 1986 and 1987. The relationship between stream discharge and sediment yield to phosphorus yield are expected to be very similar in the headwater streams of the analysis watersheds. Therefore, any significant increase in sediment yield of a headwater stream will have a resulting increase in nutrient yield.

Sediment yield increases can be caused by natural disturbances such as floods or major snow avalanches or by man-caused disturbance such as railroad or highway construction. Any mechanism that removes vegetation cover allowing soil erosion/sedimentation to occur increases the potential for increased nutrient yield. Large wet snow avalanches that remove vegetation in a valley bottom/stream channel area result in increased post-avalanche sediment yield and nutrient yield. Refer to Figure 3-7 for a qualitative description of the nitrogen and phosphorus yields after disturbance for the soils found in the project area. Figure 3-8 illustrates that phosphorus increases when sediment increases. However, due to the naturally high sediment load in the Middle Fork of the Flathead River during the spring snowmelt periods and the range of natural variability in nutrient loading any additional nutrients coming from the erosion in an individual avalanche path would be undetectable once the avalanche path stream water was mixed into the waters of the Middle Fork.

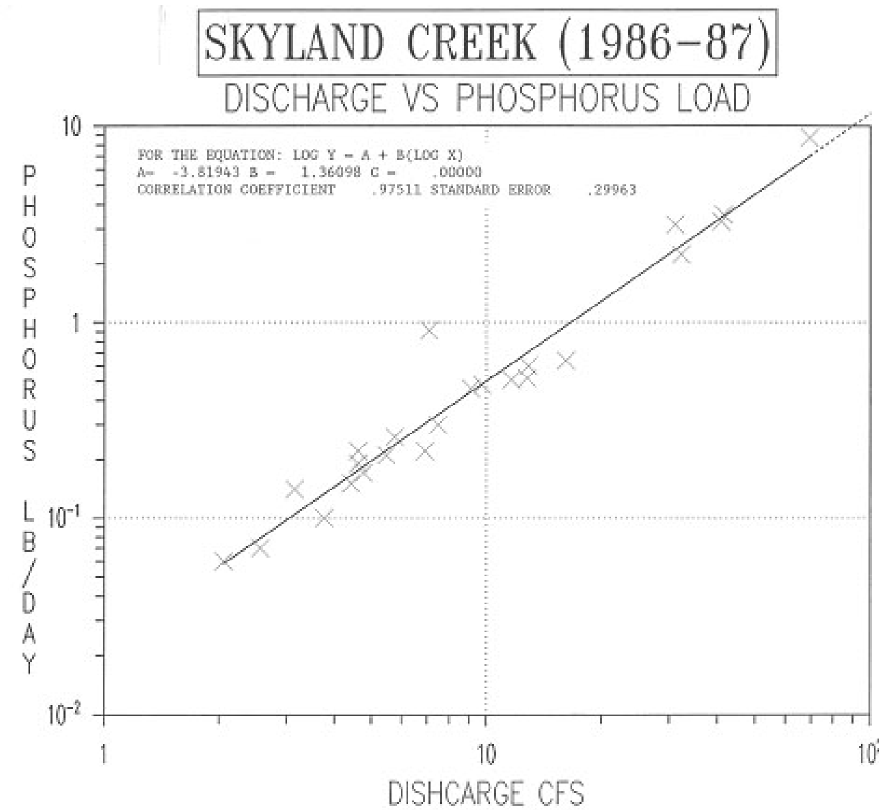


Figure 3-7. Phosphorus yield versus stream discharge (cubic feet per second) for Skyland Creek.

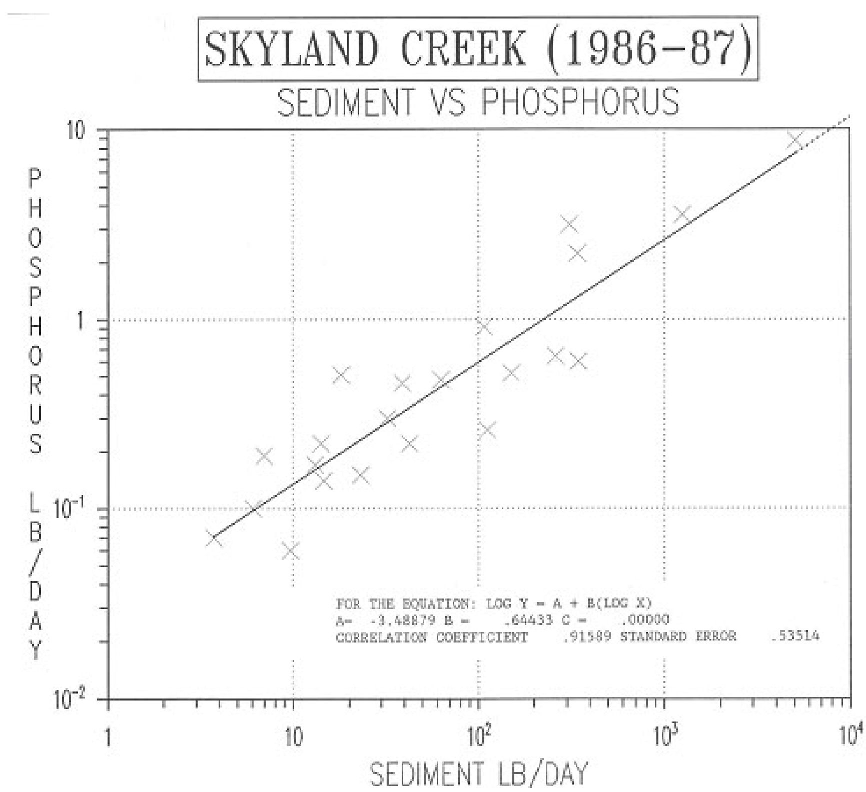


Figure 3-8. Phosphorus yield versus sediment yield for Skyland Creek (1986 and 1987).

AQUATIC SPECIES

The Park and Forest contain the headwaters of three continental watersheds, the Columbia River, Missouri River, and Saskatchewan River drainages. Native fish were typically restricted to the main drainages and those portions of tributary streams that lie below waterfalls and other migration barriers. Many lakes and streams, where historically there were no fish, were stocked at an early date usually with nonnative species. Twenty-four species of fish have been documented in Waterton Lakes and Glacier National Parks, 17 native and seven non-native species. The park provides one of the last strongholds for native westslope cutthroat trout (*Oncorhynchus clarki lewisi*). Several hundred aquatic invertebrate species have been identified in the park, and scientists believe that many aquatic invertebrate and plankton species are yet to be discovered. Researchers have recently documented two amphipod (small crustacean having a laterally compressed body with no carapace) species new to science, the first troglodytes (aquatic cave dwelling insects) to be identified in the Park.

Table 3-7. Fish species known to occur in the Flathead River drainage.

Common Name	Scientific Name	Sensitive Status
Native Fishes		
Westslope cutthroat trout	*Oncorhynchus clarki lewisi*	MSC
Bull trout	*Salvelinus confluentus*	FT, MSC
Mountain whitefish	*Prosopium williamsoni*	
Redside shiner	*Richardsonius balteatus*	
Peamouth	*Mylocheilus caurinus*	
Northern Pikeminnow	*Ptychocheilus oregonensis*	
Longnose sucker	*Catostomus catostomus*	
Largescale sucker	*Catostomus marcrocheilus*	
Slimy sculpin	*Cottus cognatus*	
Shorthead sculpin	*Cottus confusus*	MSC
Non-Native Fishes		
Rainbow trout	*Oncorhyncus mykiss*	
Brook trout	*Salvelinus fontinalis*	
Kokanee	*Oncorhynchus nerka*	
Yellowstone cutthroat trout	*Oncorhynchus clarki bouvieri*	MSC*
Lake whitefish	*Coregonus clupeaformis*	
Lake Trout	*Salvelinus namaycush*	

[a] FT = Federally listed as threatened by the USFWS; MSC = Montana Species of Special Concern as determined by the Montana Natural Heritage Program, * denotes species not native to Flathead River drainage but native and sensitive elsewhere in state.

The Columbia River basin, the area west of the Continental Divide and the area relevant to this project, is characterized as a complex network of unique streams and lakes displaying high water volumes, low productivity, cold temperatures, and high clarity. Table 3-7 shows the species of fish found within the Flathead River corridor ecosystem, there are 10 native and 6 nonnative species of fish. The natural aquatic system and associated indigenous fisheries of the Flathead River system have been dramatically altered in the last century by introductions and invasions of non-native fish such as lake trout, brook trout, and rainbow trout. Although all of the native species are still present in the Flathead River ecosystem, species composition and relative abundance are in most cases quite different from the past.

The Flathead National Forest adopted Flathead Basin Commission recommendations for sediment in 1992 through Implementation Note #10. In short, fine sediments in streams that have greater than 35% fines (<6.4mm) are considered threatened while streams that have greater than 40% fines are considered impaired. McNeil core samples have not been taken in Bear Creek or its tributaries. The 1981 Flathead Fish and Habitat survey measured surface fines. Reach 2 on Bear Creek, located just above the confluence of Giefer Creek, had 48% fines while the highest percentage in the other reaches, including Giefer and Skyland creeks was 16%.

The size range of streambed materials is indicative of fish spawning and incubation habitat. Increased fine sediments reduce pool depth; interstitial spaces needed for invertebrate production, and reduce embryonic survival of fry (Everest et al. 1987, Weaver and Fraley 1991). A McNeil corer (McNeil and Ahnell, 1964) is used to collect streambed samples that are dried and sieve analyzed to determine the particle size distribution, for materials less than 6.5mm in diameter (fines). As part of the Flathead Basin Forest Practices - Water Quality, and Fisheries Cooperative Research Program, Fraley and Weaver established a correlation between the streambed fines and the bull trout survival, in the Flathead River Basin. A statistically significant correlation was identified, that streambed fines greater than 35% resulted in decreased survival of bull trout (Weaver and Fraley 1991). Streams that have greater than 35% fines are considered *threatened* while streams with greater than 40% fines are considered *impaired*.

Bear Creek is a 5th order tributary to the Middle Fork of the Flathead River and is within the project area. All northern tributaries to this creek originate in the Park. US Highway 2 parallels the creek for much of its length. The highway's infringement upon the stream has resulted in stream straightening and reduced large woody debris. The federally-listed bull trout, westslope cutthroat trout, eastern brook trout, mountain whitefish, and sculpins were observed in Bear Creek in 1981. Bull trout are present and spawning beds or redds have been found in Bear Creek (Table 3-8), as well as in nearby Skyland and Giefer creeks. In 1981, Reach 1, which starts upstream of the Middle Fork of the Flathead confluence with Bear Creek to above Tranquil Basin, had very high densities of juvenile bull trout (2.8/100m^2). Densities were also very high (3.4/100m^2) in Skyland Creek.

Table 3-8. Redd counts of bull trout in Bear Creek.

Year	1980	1981	1982	1986	1991	1992	1997	2000
Redd Numbers	9	12	23	21	23	9	2	15

The migratory form of bull trout is present in tributaries, Bear Creek, and the Middle Fork albeit in depressed numbers. No resident forms are known to exist in these streams. Recolonization of this population is unlikely if the migratory form is lost. This subpopulation is in decline and will not improve until measures are taken to alleviate the changes in Flathead Lake.

The effects of non-native fish introductions on the federally listed “threatened” bull trout and “Species of Special Concern” westslope cutthroat trout have been partially described by researchers (Marnell 1988, Fredenberg 2000). The ways in which altered fish communities have affected associated amphibian, aquatic invertebrate, and terrestrial vertebrate populations are not easily described due to the paucity of historic data. There is concern among Park and Forest managers that changes in the abundance of native fish may negatively affect the native predators that depend on them (e.g. bald eagles, river otters, osprey, etc.). Although fish are no longer stocked in the Park’s waters, the introduction and invasion of non-native fish species have seriously compromised the Park’s aquatic systems (Marnell 1988). The potential for hybridization with non-native species is high for native bull trout and westslope cutthroat trout given that brook trout and rainbow trout are present in the watershed. Bull trout and brook trout are known to hybridize although no hybridization between these two species has been verified in the Bear Creek reach. Westslope cutthroat trout and rainbow trout are also known to hybridize and specimens have been collected downstream from Bear Creek in the Middle Fork of the Flathead River. Bear Creek would not be considered as refugia due to the presence of non-native brook trout and bull trout habitat is limited due to the influence of US Highway 2 and the railroad. Protected headwater basins in places like GNP and FNF become increasingly important as refugia for pure genetic stocks of fish as unprotected aquatic and terrestrial habitats become degraded and non-native species hybridization becomes more prevalent.

There are no man made barriers in the watershed that affect upstream migration of bull trout, however, there is a very low pool/riffle ratio which is most likely due to US Highway 2 and the railroad constricting the stream’s natural meander pattern. Pool quality is poor. There are 35 miles of road near Bear Creek with a density of 0.6 mi/mi^2. The riparian area along Bear Creek and parts of Skyland Creek has been severely compromised due to the highway and railroad. This has most likely increased water temperatures and has reduced the amount of large woody debris. At present, there is no chemical contamination in Bear Creek and it is not on the State's 303(d) list of impaired water bodies. Additional information on water conditions, including streambank stability ratings, is included in the “Water Quality” section.

In addition to the ichthyofauna of the lakes and streams, the Park and Forest are also home to many amphibious and aquatic invertebrates, vertebrates, and macroinvertebrates. The Middle Fork area seems to be especially rich in amphibian and reptile species. Long-toed salamanders (*Ambystoma macrodactulum*), tailed frogs (*Ascaphus truei*), boreal toads (*Bufo boreas*), Pacific tree frogs (*Hyla regilla*), Columbia spotted frogs (*Rana luteiventris*), painted turtles (*Chrysemys picta*), western terrestrial garter snakes (*Thamnophis elegans*), and common garter snakes (*Thamnophis sirtalis*) have been observed in the Middle Fork drainage (Marnell 1997).

The introduction of non-native sport fish has been implicated in the decline of several amphibian species in North America. Sport fish introductions have occurred in numerous, formerly fishless lakes in the Park and Forest, but the impact on native amphibians is not well understood due to the lack of historic distribution data (Marnell 1997). The absence of amphibian breeding sites in waters containing fisheries suggests that fish introductions may have locally impacted park amphibian populations (Marnell 1997). In the last ten years, extensive amphibian surveys have been conducted throughout the park’s backcountry by

USGS researchers. Current distributions are fairly well understood, but population status and trends are unknown. Although primary surveys on amphibians and localized studies of macroinvertebrates have been done, comprehensive information on these organisms is not currently available.

GEOLOGY/SOILS

Primary bedrock components in John F. Stevens Canyon are derived of limestone (sedimentary rock high in mineral calcite), quartzite (hardened sandstone) or argillite (hardened mudstone). A variety of soil and mixed soil types occur within the project area. These include rock outcrops, shallow soils, shallow grassland soils, both deep and moderately deep colluvial forest soils (Dutton et al. 2001). Colluvium refers to soil material and/or rock fragments that have moved by creep, slide, or local wash and then been deposited on slopes or at the base of slopes. Both quartzite/argillite bedrock and limestone bedrock derived soils are present for all of the above listed soil types. A summary of soil type characteristics found within the project area is included in Table 3-9. Map 3-1 shows the watershed and soils of the project area.

The riparian zone of Bear Creek consists of a combination of FL2D and NL2A Riparian Landtypes (Sirucek and Bachurski 1995). Landtype FL2D is characterized by somewhat poorly drained soils, generally Typic Endoaquents, under and adjacent to the river channel and moderately well-drained soils, usually Oxyaquic Udifluvents on the banks. The surrounding area typically contains well-drained upland soils that are normally Andic Dystrochrepts. Landtype NL2A is characterized by Aeric Cryaquepts on poorly drained sites, Oxyaquic Cryochrepts on somewhat poorly drained sites, and Andeptic Cryoboralfs on well-drained upland sites (Sirucek and Bachurski 1995).

Table 3-9. Soil types and descriptive characteristics in John F. Stevens Canyon project area (Dutton et al. 2001).

Soil Unit Name	Location	Bedrock Parent Material	Soil Sub-group Classification	Soil Components	Vegetation	Slope Range	% of Area	Erosion Potential	Weed Invasion Potential	Reveg Potential
Rock Outcrop	Mountain tops, ridges, ice-scoured slopes	Quartzite, Argillite/ Meta-sedimentary	Rock	Mostly rock outcrop including cliffs, scoured rock surfaces and limited talus.	Scattered plants in cracks and soil inclusions.	0-100%	1%	Low	Low	Low
Deep Colluvial Forest Soils	Lower to mid-mountain slopes, especially toeslopes	Quartzite, Argillite/ Meta-sedimentary	Typic Dystrocryepts	Deep, well-drained soils with loam or silt loam surface layers high in volcanic ash and very gravelly to extremely gravelly loam or sandy loam subsoils.	Conifer forest ranging from Douglas fir to subalpine fir. Seral vegetation including lodgepole pine, shrubs, forbs, and grasses.	25-60%	3%	High	Medium	Medium
Rock Outcrop and Shallow Soils	Mountain tops, ridges and upper slopes	Quartzite, Argillite/ Meta-sedimentary	Rock, Lithic Dystrocryepts	A complex of rock outcrop and shallow, well-drained, soils with very to extremely gravelly loam or sandy loam textures throughout.	Shallow soil: scattered, mostly alpine forbs, grasses, and shrubs. Conifer krummholz.	0-60%	10%	Low-Medium	Low-Medium	Low
Deep and Moderately Deep Colluvial Forest Soils	Cirque basins and lower glaciated trough walls	Quartzite, Argillite/ Meta-sedimentary	Typic Dystrocryepts	A complex of deep and moderately deep, well-drained soils with loam or silt loam surface layers high in volcanic ash and very gravelly to extremely gravelly loam or sandy loam subsoils.	Subalpine fir, lodgepole pine, spruce, huckleberry, beargrass.	20-50%	5%	Medium-High	Medium	Medium

Soil Unit Name	Location	Bedrock Parent Material	Soil Sub-group Classification	Soil Components	Vegetation	Slope Range	% of Area	Erosion Potential	Weed Invasion Potential	Reveg Potential
Moderately Deep and Shallow Colluvial Soils	Upper mountain slopes and trough walls	Quartzite, Argillite/ Meta-sedimentary	Typic Dystrocryepts, Lithic Dystrocryepts	A complex of moderately deep and shallow, well-drained soils with loam or silt loam surface layers high in volcanic ash and very gravelly to extremely gravelly loam or sandy loam subsoils. Fractured bedrock below.	Subalpine fir, whitebark pine, spruce, lodgepole pine, grouse whortleberry, elk sedge.	25-60%	8%	Low-Medium	Low-Medium	Low-Medium
Shallow Grassland and Moderately Deep Colluvial Soils	Lower elevation mountain slopes on south aspects	Quartzite, Argillite/ Meta-sedimentary	Lithic Haplocryolls, Typic Dystrocryepts	A complex of well-drained, shallow grassland soils and moderately deep colluvial soils. Both have loam or silt loam surface layers and very gravelly to extremely gravelly loam or sandy loam subsoils. Fractured bedrock below.	Shallow soil: grasses and scattered shrubs. Moderately deep soil: Douglas fir, subalpine fir, lodgepole pine, and shrubs such as serviceberry, huckleberry, ceanothus, and spiraea.	35-70%	14%	Medium	Medium	Low-Medium
Rock Outcrop and Shallow Soils on Limestone	Mountain tops, ridges and upper slopes	Limestone/ Meta-sedimentary	Rock, Lithic Eutrocryepts	A complex of rock outcrop and shallow, well-drained soils with very to extremely gravelly loam or sandy loam textures throughout.	Shallow soil: scattered, mostly alpine forbs, grasses, and shrubs. Conifer krummholz.	0-100%	1%	Low-Medium	Low	Low
Deep and Moderately Deep Colluvial Forest Soils on Limestone	Cirque basins and lower glaciated trough walls	Limestone/ Meta-sedimentary	Typic Eutrocryepts, Typic Dystrocryepts	A complex of deep and moderately deep, well-drained soils with loam or silt loam surface layers high in volcanic ash and very gravelly to extremely gravelly loam or sandy loam subsoils.	Subalpine fir, lodgepole pin, spruce, huckleberry, beargrass.	20-50%	10%	Medium-High	Medium	Medium

Soil Unit Name	Location	Bedrock Parent Material	Soil Sub-group Classification	Soil Components	Vegetation	Slope Range	% of Area	Erosion Potential	Weed Invasion Potential	Reveg Potential
Moderately Deep and Shallow Limestone Soils	Upper mountain slopes and trough walls	Limestone/ Meta-sedimentary	Typic Dystrocryepts, Lithic Eutrocryepts	A complex of moderately deep and shallow, well-drained soils with loam or silt loam surface layers high in volcanic ash and very gravelly to extremely gravelly loam or sandy loam subsoils. Fractured bedrock below.	Subalpine fir, whitebark pine, spruce, lodgepole pine, grouse whortleberry, elk sedge.	25-60%	39%	Medium	Low-Medium	Low-Medium
Shallow Grassland and Moderately Deep Colluvial Soils on Limestone	Lower elevation mountain slopes on south aspects with limestone bedrock	Limestone/ Meta-sedimentary	Lithic Haplocryolls, Typic Dystrocryepts	A complex of well-drained, shallow grassland soils and moderately deep colluvial soils. Both have loam or silt loam surface layers and extremely gravelly sandy loam subsoils. Fractured bedrock below.	Shallow soil: grasses and scattered shrubs. Moderately deep soil: Douglas fir, subalpine fir, shrubs such as serviceberry, huckleberry, ceanothus, spiraea, and others.	35-70%	7%	Medium	Medium	Low-Medium
Poorly Drained Stream Terraces and Floodplains	Valley Botteoms	Meta-sedimentary / Limestone	Aeric Cryaquents, Typic Endoaquents	A complex of poorly to somewhat poorly drained deep soils formed in recent alluvium. Organic matter enriched surface layer, gravelly loams and sandy loam subsoils.	Black cottonwood, Red-osier dogwood, Drummond's Willow, and bluejoint reedgrass.	0-5%	1%	Low to Moderat e	High	High

Soil Unit Name	Location	Bedrock Parent Material	Soil Sub-group Classification	Soil Components	Vegetation	Slope Range	% of Area	Erosion Potential	Weed Invasion Potential	Reveg Potential
Moderately Well Drained Stream Terraces	Valley Bottoms	Meta-sedimentary /Limestone	Oxuaquic Cryochrepts, Oxyaquic Udifluvents	A complex of moderately to well drained deep soils formed in recent alluvium or glacial outwash materials. Surface layer is loamy, with very gravelly sandy loam subsoils.	Spruce, subalpine fir, lodgepole pine, clasping-leaved twisted stalk, sweetscented bedstraw and field horsetail.	0-10%	1%	Moderate to High	High	Moderate to High

VEGETATION

The Park and Forest are significant in terms of their diversity of species and habitats because of their location astride the northern-most reach of the Rocky Mountains in the continental U.S., forming a transition area between the intermountain Northwest and the Great Plains. This area is also situated at the southern edge of arctic-boreal influences. Past glaciation has isolated many plant and animal populations, and the varied terrain provides a broad range of micro-climates for a wide variety of plant communities on both the east and west sides of the Continental Divide.

Glacier supports approximately 1,132 species of vascular plants (Lesica 2002), 30 of which are endemic to the northern Rocky Mountains (Lesica 2002), and at least 858 non-vascular plants (DeBolt and McCune 1993; Hermann 1969; Elliott and Moore 1989). Large-scale climatic influences and the variety of environmental conditions in the park foster vegetation diversity. In addition to the large-scale influences, local climate that changes with elevation and proximity to mountain ridges or large bodies of water affects vegetation. Historic occurrence of natural fire has also influenced the ecological diversity of regional flora as it has evolved with various fire regimes. Natural disturbance undoubtedly contributes to and greatly increases both community and landscape heterogeneity. Fire is the most important disturbance in the region through periodic burning and recycling of nutrients and vegetation, but other disturbances include avalanches, landslides, tree-fall, windstorms, floods, glaciation, disease, and insect infestations. Many areas are vegetated with a mosaic of community types representing diverse forest stages and habitats.

Pacific coast and Great Plains plant associations reach their eastern and western limits in this region. Consequently, the geographic location and topographic gradients of the region have fostered and sustained an ecology that includes the plants and animals of a much larger region. Due to the park's geographic location and wide variations in elevation, climate, and soil, four floristic provinces are represented in the region, the Cordilleran (representing flora of both the Cascade Mountains and the Rocky Mountains), Boreal (representing northern flora), Arctic-Alpine, and Great Plains Floristic Provinces (Lesica 2002). Communities in the Middle Fork would be largely representative of Rocky Mountain flora. As the Park and Forest lie along the main chain of the Rocky Mountains in the middle of the western montane province and just southwest of the northern coniferous province, it is not surprising that flora is dominated by species with northern coniferous and western montane distributions. Western montane species are found at all elevations in all habitats, while northern coniferous species are best represented in forests and wetlands, and Arctic-alpine plants are found mainly above treeline. The project area consists of mountain slopes near the Continental Divide, which include habitats ranging from above treeline to river bottom.

The Middle Fork area is densely forested with fire-initiated, even-aged stands of lodgepole pine and western larch covering most of the area (Barrett 1986). The potential climax species in this area are Engelmann spruce and subalpine fir, but frequent fires have limited the distribution of these species, allowing them to be scattered only in the overstory or regenerating in the understory. Douglas fir, black cottonwood, and paper birch are also present throughout the area. Understory vegetation in these lower montane forests includes huckleberry, false huckleberry, buffaloberry, queencup beadlily, Oregon grape, pinegrass, arnica, beargrass, twinflower, and elk sedge. Table 3-10 is a list of plant species and their scientific names in the project area.

Table 3-10. Representative plant species in John F. Stevens Canyon. Bolded species are not native to the park.

COMMON NAME	SCIENTIFIC NAME	COMMON NAME	SCIENTIFIC NAME
Alder	*Alder spp.*	Oregon grape	*Berberis repens*
Arnica	*Arnica spp.*	Oxeye-daisy	*Chrysanthemum leucanthemum*
Arrowleaf groundsel	*Senecio triangularis*	Paper birch	*Betula papyrifera*
Austin's knotweed	*Polygonum douglasii ssp. austiniae*	Peculiar moonwort	*Botrychium paradoxum*
Beaked sedge	*Carex utriculata*	Pinegrass	*Calamagrostis rubescens*
Beargrass	*Xerophyllum tenax*	Prickly swamp currant	*Ribes lacustre*
Black cottonwood	*Populus balsamifera*	Quaking aspen	*Populus tremuloides*
Blue wildrye	*Elymus glaucus*	Queencup beadlily	*Clintonia uniflora*
Blunt-leaved pondweed	*Potamogeton obtusifolius*	Red-osier dogwood	*Cornus sericea*
Bractless hedge-hyssop	*Gratiola ebracteata*	Rocky Mountain maple	*Acer glabrum*
Buckler fern	*Dryopteris cristata*	Scouler willow	*Salix scouleri*
Buffaloberry	*Shepherdia canadensis*	Serviceberry	*Amelanchier alnifolia*
Canada thistle	***Cirsium arvense***	Sharptooth angelica	*Angelica arguta*
Common cattail	*Typha latifolia*	Short-flowered monkeyflower	*Mimulus breviflorus*
Common horsetail	*Equisetum arvense*	Sitka valerian	*Valeriana sitchensis*
Common snowberry	*Symphoricarpos albus*	Slender cottongrass	*Eriophorum gracile*
Cow parsnip	*Heracleum sphondylium*	Slender moonwort	*Botrychium lineare*
Dalmation toadflax	***Linaria dalmatica***	Spalding's catchfly	*Silene spaldingi*
Douglas fir	*Pseudotsuga menziesii*	Spirea	*Spirea spp.*
Drummond's willow	*Salix drummondii*	**Spotted knapweed**	***Centaurea maculosa***
Elderberry	*Sambucus spp.*	Spruce	*Picea spp.*
Elk sedge	*Carex geyeri*	Stinging nettle	*Urtica dioica*
Engelmann spruce	*Picea engelmannii*	**St. Johnswort**	***Hypericum perforatum***
English sundew	*Drosera anglica*	Subalpine fir	*Abies lasiocarpa*
False hellebore	*Veratrum viride*	**Sulfur cinquefoil**	***Potentilla recta***
False huckleberry	*Menziesia ferruginea*	Thimbleberry	*Rubus parviflorus*
Fireweed	*Chamerion angustifolium*	Twinflower	*Linnea borealis*
Green alder	*Alnus viridus*	Twisted stalk	*Streptopus amplexifolius*

Grouse whortleberry	*Vaccinium scoparium*	Water howellia	*Howellia aquatilis*
Horsetail	*Equisetum spp.*	Western larch	*Larix occidentalis*
Huckleberry	*Vaccinium spp.*	western moonwort	*Botrychium hesperium*
Lodgepole pine	*Pinus contorta*	Whitebark pine	*Pinus albicaulis*
Mountain ash	*Sorbus scopulina*	Willow	*Salix spp.*
Orange hawkweed	***Hieracium aurantiacum***	Woodrush	*Luzula spp.*

With increased elevation, the vegetation changes to cooler coniferous forest with an overstory comprised of subalpine fir, Engelmann spruce, lodgepole pine, and occasional Douglas fir and whitebark pine. Common understory species include false huckleberry, huckleberry, grouse whortleberry, spiraea, beargrass, woodrush, arrowleaf groundsel, and Sitka valerian. As you approach treeline, these trees become stunted, forming krummholz forests with more open overstories. Certain areas are dominated by subalpine fir, spruce, and whitebark pine, while others are comprised of stunted lodgepole pine. These treeline communities often have shrubby understories, or large herbaceous meadows interspersed throughout the area. These forests eventually transition to talus slopes, scree slopes, wet meadows, turf communities, and fellfields along upper slopes and ridges that are dominated by alpine forbs, grasses, and sedges.

The impacts of natural avalanches on vegetation have been extensively studied (Major 1977, Butler 1979, Malanson and Butler 1984b, Johnson 1987, Walsh et al. 1994). Snow avalanches move woody debris down-slope by snapping, tipping, trimming, and excavating branches, limbs, and trees. They also injure and scar trees that remain in place (Butler and Malanson 1990, Walsh et al. 2004). Several conifer trees were tilted and uprooted during a major avalanche on the Shed 7 path in February 1979. Conifers had become established along the less-frequent avalanche edges of the path and being relatively inflexible are subject to uprooting by major events, which occur approximately every five to ten years on this path (Butler 1988). At this frequency, mature coniferous trees are precluded from successfully recolonizing the main avalanche path (Johnson 1987). The paths are dominated instead by flexible-stemmed deciduous shrubs and small trees, particularly alder and maple as well as a variety of shrubs, grasses, and forbs (Butler 1979). The proportion of shrub to herbaceous cover is affected by both avalanche frequency and localized site conditions (Malanson and Butler 1984b). Where late-lying snow remains along the inner zone of an avalanche run, the zone will be dominated by herbs, rather than shrubs due to the short growing season (Malanson and Butler 1984b).

Between avalanche events, secondary succession proceeds with herbs, shrubs, and trees establishing and growing along the avalanche paths. Net primary productivity is high in avalanche paths and nitrogen dynamics are improved on sites where the nitrogen-fixing alder dominates (Malanson and Cairns 1995). Plant growth rates are faster than in adjacent forest most likely due to sunlight, nutrient, and moisture availability (Butler and Malanson 1985). Pits and root mounds left after trees tip over create unique microsites that contribute to local biodiversity on the site. Biodiversity is maintained at a higher level in the wake of periodic avalanche events (Malanson and Butler 1986). Snow avalanche paths can also serve as a fuel break, and slow fire spread during fire events, promoting an increased mosaic pattern (Malanson and Butler 1984a). Snow avalanches can also maintain treeline at a lower level than climate alone would limit it to (Walsh et al. 1994). Repeat photography of Stanton Mountain showed a 44 percent infilling of avalanche paths by trees between 1935 and 1998. It is unknown whether this has been caused by climatic changes, a random period of smaller avalanches, or changes in fire frequency. However, as paths fill in with increasingly mature trees, snowpack is provided with greater stability, resulting in smaller and possibly less frequent snow avalanches (Butler and DeChano 2001). The greater stability afforded by mature trees only applies to avalanche paths where mature trees are growing in the start zones. In areas where the start zones are above treeline, avalanches are still able to affect mature trees in the runout zones in lower elevations. Where avalanches leave bare soil behind, the opportunity for exotic plant invasion is increased, especially when this occurs close to source populations along the highway/railroad corridor.

Avalanche paths are usually associated with long, steep ravines, and occur on steep, warm, moist slopes in the subalpine (Butler 1979). They gradually merge into subalpine forest along their margins (Malanson and Butler 1984b). Species commonly found in avalanche paths include green alder, Rocky Mountain maple, spiraea, serviceberry, thimbleberry, Scouler willow, mountain ash, red-osier dogwood, huckleberry, elderberry, beargrass, cow parsnip, fireweed, stinging nettle, false hellebore, sharptooth angelica, and blue wildrye (Lesica 2002, Butler and Malanson 1985). Young subalpine fir, quaking aspen, Engelmann spruce, and occasional Douglas fir may be found regenerating along the margins of avalanche runs (Butler and Malanson 1985). Along the US Highway 2/railroad corridor, common species that occur in potential avalanche run-out paths include black cottonwood, western larch, subalpine fir, Engelmann spruce, lodgepole pine, Douglas fir, paper birch, Scouler willow, Rocky Mountain maple, serviceberry, snowberry, thimbleberry, prickly swamp current, and stinging nettle.

Riparian and riverine wetland vegetation exists along the Middle Fork of the Flathead River, and along streams and creeks. Dominant vegetation includes black cottonwood, Engelmann spruce, paper birch, and quaking aspen in the overstory and willow, alders, red-osier dogwood, Rocky Mountain maple, and horsetail in the understory. No wetlands are known to occur in the project area outside of the river corridor. Typical species found in and adjacent to the riparian areas include beaked sedge, Drummond's willow, black cottonwood, red-osier dogwood, spruce, subalpine fir, twisted stalk, and twinflower (Sirucek and Bachurski 1995).

According to satellite data, vegetative landcover types in the project area include: mesic herbaceous (plants and shrubs that grow in wet areas, including riparian areas or moist meadows – approximately 30%); dry herbaceous, (plants and shrubs that grow in dry areas – approximately 20%); deciduous trees and shrubs (approximately 15%); coniferous forests and dense mesic areas (approximately 15%); coniferous forest and open dry areas (approximately 10%); and barren rock, snow, and ice (approximately 10%).

Glacier National Park and Flathead National Forest have been modified by human activities. Introduced and invasive plants and animals are now a part of regional plant communities. It is estimated that non-native or exotic species comprise about 10% of Glacier's flora (139 species). These non-native species impair natural ecosystems, associated plant and animal communities, and natural processes. Within the project area, the noxious weed, spotted knapweed is found all along the US Highway 2 corridor, while St. Johnswort is present at lower densities. Other noxious weed species with potential to invade within the project area include oxeye daisy, Canada thistle, orange hawkweed, Dalmatian toadflax, and sulfur cinquefoil. Exotic plants that have been intentionally or inadvertently introduced occur in disturbed areas such as roadsides, railways, construction projects, old homesteads, grazed fields, trails, burns, floodplains, and utility sites. The plants in bold in Table 3-10 are non-native to the project area.

WILDLIFE

The region encompassed by the Park and Forest is noted for its abundant wildlife and as a refuge for sensitive and rare species. Habitat for over 300 terrestrial wildlife species, including several threatened or endangered birds and mammals, is found within the Park. Glacier also serves as a protected corridor for wildlife interaction, migration, and genetic exchange between the U.S. and Canada. It is one of the few places in the contiguous 48 states that support natural populations of all indigenous carnivores and most of their prey species. Biological refugia that are large enough to support self-sustaining populations of wide-ranging carnivores such as wolves, grizzly bears, and lynx play a key role in maintaining regional biological diversity and native species. The Bear Creek and Middle Fork corridor form the boundary between the Park and large wilderness areas to the south; thus, the corridor is traversed by many wildlife species despite the presence of the railroad and highway.

Portions of GNP and FNF would be affected by the proposed activities. The wildlife analysis area (WAA) (Map 3-2) was created to define the area of impact for terrestrial wildlife and includes Park and Forest lands in the canyon that would be directly and indirectly affected by alternative actions. However, it is likely that most of the effects on wildlife would occur on species and/or habitat that reside in the Park because artificially triggered avalanches would all occur in the Park's portion of the WAA; impacts on the Forest's portion of the WAA would be primarily from noise generated from blasting. Therefore, a majority of the descriptions and discussions of the affected environment emphasize the wildlife and habitat within the Park's portion of the WAA; though it is understood that individuals of many populations of wildlife move between GNP and FNF lands and that impacts occurring in the Park can affect wildlife use of FNF lands.

John F. Stevens Canyon contains a variety of wildlife habitats though few surveys have been conducted on wildlife in the canyon. Available habitats are described in the "Vegetation" section and the primary types include conifer forest, avalanche paths, riparian, meadows, sidehill shrublands, and rock outcrops. River corridors tend to have a high diversity of wildlife because of the elevated vegetation productivity resulting from water availability, nutrient transport, and alluvial soils. However, the presence of US Highway 2 and the railroad probably make parts of the canyon less suitable to some wildlife species due to continuous disturbance. However, with the exception of grizzly bears, no baseline surveys have been conducted in the project area to confirm this.

Wildlife surveys were conducted in the project area from February 15-April 1, 2005 (Wollenzien 2005) and from January 25-April 8, 2006 (Alban 2006), which encompasses much of the winter period in which avalanche hazard reduction measures may be conducted. Surveys were performed using binoculars and spotting scopes from the highway, and track surveys were conducted when snow and weather conditions permitted. The most common species observed was elk (*Cervus elaphus*) which was observed during 51 of 58 surveys conducted over both years (Table 3-11).

Table 3-11. Wildlife species observed during surveys in project area during winters of 2005 (24 surveys) and 2006 (42 surveys).

Species	No. surveys detected 2005*	No. surveys detected 2006*	Earliest date observed	Latest date observed
Elk	21	38	1/25 (2006)	4/1 (2006)
Mountain goat	8	26	2/25 (2005)	4/8 (2006)
Golden eagle	4	8	2/7 (2006)	3/31 (2006)
Mule deer	2	9***	2/6 (2006)	4/3 (2006)
Whitetail deer	0	3***	3/2 (2006)	4/7 (2006)
Coyote	3**	7	2/16 (2005)	4/8 (2006)
Red squirrel	3**	4**	2/16 (2005)	4/1 (2005/6)
Snowshoe hare	3**	5**	2/16 (2005)	4/1 (2005)
Marten	2**	1**	2/16 (2005)	4/1 (2005)
Canada lynx	1**	2	2/16 (2005)	3/31 (2006)
Mountain lion	0	2**	3/13 (2006)	3/27 (2006)
Wolverine	0	1	3/13 (2006)	3/13 (2006)
Grizzly bear	1**	0	4/1 (2005)	4/1 (2005)
Unidentified mouse	2**	3**	2/16 (2005)	3/27 (2006)
Unidentified vole	1**	2**	2/16 (2005)	2/16 (2005)
Unidentified weasel	1**	0	2/16 (2005)	2/16 (2005)
Unidentified grouse	1**	0	3/22 (2005)	3/22 (2005)

* Includes track surveys as individual surveys (3 in 2005, 5 in 2006).

** Only recorded during track surveys.

*** Not counting track surveys – could not differentiate between mule and whitetail using tracks (deer tracks seen during 2 track surveys).

According to the National Park Service's 2006 Management Policies (NPS 2006), the National Park Service must maintain all components and processes of naturally evolving park unit ecosystems, including the natural abundance, diversity, and ecological integrity of animals and their habitats. The earliest park records suggest that wildlife composition of mammals and birds has changed little since the park was established. The Park has maintained a wildlife observation reporting database (WORF) since 1990, which contains wildlife sightings by employees and visitors from the present back to the 1960s. According to the database, 56 different species (Table 3-7) have been reported in the southern part of the park. All records prior to 2005 are based on incidental or anecdotal observations as no formal surveys or studies to document species occurrence or distribution have been conducted in the area. The list should not be considered a complete list of wildlife species present in the WAA as observations are biased toward the areas frequented by people and the most visible species. For example, there are no records for insects and very few for small rodents in the database, but they are undoubtedly common in the area. The records do confirm the presence of some federally listed threatened and endangered species and species of concern such as grizzly bears, Canada lynx, wolverine, and Harlequin ducks though no trends or use patterns can be extrapolated from the information.

Table 3-12. Statistical estimates of harvests for legally hunted and trapped species within National Forest land adjacent to project area (MFWP Hunting District 141 or 106) or within Flathead County.

Species	Harvest Area*	Years	No. Harvested	Avg. No. Harvested/yr
Elk	HD 141	1999-2003	167	33
Deer (whitetail and mule)	HD 141	2001-2003	140**	47
Mountain goat	HD 141	2001-2004	10	4
Moose	HD 141	2001-2004	17	4
Black bear	HD 106	1996-2002	686	98
Beaver	Flathead County	1996-2002	1929	276
Otter	Flathead County	1996-2002	107	15
Muskrat	Flathead County	1996-2002	5682	812
Mink	Flathead County	1996-2002	707	101
Bobcat	Flathead County	1996-2002	315	45
Marten	Flathead County	1996-2002	2610	373
Weasel	Flathead County	1996-2002	678	97
Wolverine	Flathead County	1996-2002	11	2
Skunk	Flathead County	1996-2002	316	45
Coyote	Flathead County	1996-2002	429	61
Fox	Flathead County	1996-2002	193	28
Raccoon	Flathead County	1996-2002	398	57
Badger	Flathead County	1996-2002	15	2
Lynx	Flathead County	1996-1998***	1	<1

* HD 141 = Hunting District 141.
** Reported as "successful hunters": the number of hunters taking one or more deer.
*** One lynx was harvested in Flathead County in 1996, none in 1997-1998. The lynx season was closed in 1999.

Most wildlife observations were made along US Highway 2 and the Middle Fork of the Flathead River. Mountain goats and elk were the most common species recorded. Several mineral licks occur along the Middle Fork and attract mountain goats and other ungulates from a wide geographic area, especially in spring and early summer. Winter ranges for elk and deer (mule and white-tailed) are located on south-facing slopes in the canyon. Predators such as mountain lions, grizzly bears, and gray wolves are probably attracted to the area because of the large ungulate populations.

Forest land adjacent to the project area is within the Montana Fish, Wildlife, and Parks (MFWP) hunting district 141 for ungulates and hunting district 106 for black bears. Hunters may take elk, deer, mountain goat, moose, and black bear within this area but not mountain lion, antelope, or bighorn sheep. Trappers may legally trap beaver, otter, muskrat, mink, bobcat, marten, weasel, skunk, coyote, fox, raccoon, badger, and wolverine within this part of the Forest. Lynx were trapped in the area through 1996 when eight were harvested. Due to concerns over declining harvest returns, lynx harvest was prohibited in Flathead County in 1997 and statewide starting in 1999. Table 3-12 summarizes harvest statistics for this area (MFWP webpage 2005). During the hunting season, elk and deer near the park boundary seek refuge within GNP boundaries, as hunting is illegal in the park.

Elk are one of the most common ungulate species to use the project area during the winter. They are also important as prey for carnivores such as wolves, which prey almost exclusively upon deer, elk, and moose in the winter. Winter range is often the limiting factor for ungulate populations; thus, maintaining adequate winter ranges for ungulates is important for many species (USFWS 1987).

Elk were reportedly uncommon in the mountainous sections of what is today the Park until the late 1800's (Wasem 1963), but this reported scarcity may be due to the relative lack of observers. Elk present in the Middle Fork section of the Park may be descendants of some migrants originating on the Forest side and from a group of transplanted elk brought from Yellowstone and released in West Glacier in 1912 (Wasem 1963). Approximately 500 elk were reported as having wintered along the slopes of Double and Rampage mountains and in the Park Creek Valley in 1918 (Bailey and Bailey 1918). Large wildfires in 1910 and 1929 in the drainage created substantial browsing habitat for ungulates and by 1939, there were well over 800 individuals wintering along the Middle Fork. Even with extended hunting seasons on Forest land in the early 1940's there was an estimated 1500 elk in the Middle Fork by 1947. With extended hunting seasons, the population in the Middle Fork-Bear Creek drainage was reduced to 800 elk by 1962 (Wasem 1963).

There are several important wintering ranges for elk in the Park, primarily in the North Fork, Middle Fork, and low valleys along the eastern side of the Divide. There is also a wintering range just south of the Park on NFS land in the Spruce Park area. Currently, elk use the Middle Fork drainage year-round. Depending on snow conditions elk can be found along all south facing slopes (including SW and SE facing slopes) of John F. Stevens Canyon during the winter. Steeper slopes tend to accumulate less snow than valley bottoms making travel and foraging easier for ungulates (McDonald 1980).

Table 3-13. Terrestrial wildlife species confirmed present in John F. Stevens Canyon area according to records in the park's WORF database (observations south of UTM 5360000 N) or during winter 2005 wildlife surveys (cited in table as "2005"; Wollenzien 2005).

Common Name	Scientific Name	No. Observations	Sensitive Status[a]
Reptiles			
Western terrestrial garter snake	*Thamnophis elegans*	9	
Common garter snake	*Thamnophis sirtalis*	2	
Birds			
Mallard	*Anas platyrhyncos*	1	
Green-winged teal	*Anas crecca*	2	
Harlequin duck	*Histrionicus histrionicus*	12	MSC, USFS, PIF
Common merganser	*Mergus merganser*	30	
Osprey	*Pandion haliaetus*	4	
Bald eagle	*Haliaeetus leucocephalus*	19	FT, MSC, BEPA
Northern harrier	*Circus cyaneus*	1	
Sharp-shinned hawk	*Accipiter striatus*	1	
Red-tailed hawk	*Buteo jamaicensis*	10	
Golden eagle	*Aquila chrysaetos*	15, (2005)	BEPA
Spotted sandpiper	*Actitis macularia*	8	
Western screech-owl	*Otus kennicottii*	1	
Great horned owl	*Bubo virginianus*	4	
Barred owl	*Strix varia*	2	
Northern saw-whet owl	*Aegolius acadicus*	2	
Belted kingfisher	*Ceryle alcyon*	7	
Three-toed woodpecker	*Picoides tridactylus*	1	
Pileated woodpecker	*Dryocopus pileatus*	11	
Clark's nutcracker	*Nucifraga columbiana*	2	
Common raven	*Corvus corax*	1	
Black-capped chickadee	*Parus atricapillus*	2	
Chestnut-backed chickadee	*Parus rufescens*	1	
Winter wren	*Troglodytes troglodytes*	1	
American dipper	*Cinclus mexicanus*	1	
Mountain bluebird	*Sialia currucoides*	1	
European starling	*Sturnis vulgaris*	1	
Yellow-rumped warbler	*Dendroica coronata*	1	

Common Name	Scientific Name	No. Observations	Sensitive Status[a]
Dark-eyed junco	*Junco hyemalis*	1	
Snow bunting	*Plectrophenax nivalis*	1	
Cassin's finch	*Carpodacus cassinii*	1	
White-winged crossbill	*Loxia leucoptera*	4	
Mammals			
Yellow pine chipmunk	*Eutamias ameonus*	1	
Thirteen-lined ground squirrel	*Spermophilus tridecemlineatus*	1	
Golden-mantled ground squirrel	*Spermophilus lateralis*	2	
Red squirrel	*Tamiasciurus hudsonicus*	2	
Snowshoe hare	*Lepus americanus*	(2005)	
Beaver	*Castor canadensis*	2	
Mule deer	*Odocoileus hemionus*	34, (2005)	
White-tailed deer	*Odocoileus virginianus*	3	
Elk	*Cervus elaphus*	175, (2005)	
Moose	*Alces alces*	7	
Mountain goat	*Oreamnos americanus*	730	
Bighorn sheep	*Ovis canadensis*	1	
Mink	*Mustela vison*	1	
Fisher	*Martes pennanti*	1	MSC, USFS
Marten	*Martes americana*	2, (2005)	
Wolverine	*Gulo gulo*	2	MSC, USFS
Bobcat	*Lynx rufus*	1	
Canada lynx	*Lynx canadensis*	5, (2005)	FT, MSC
Mountain lion	*Puma concolor*	2	
Coyote	*Canis latrans*	14, (2005)	
Gray wolf	*Canis lupus*	2	FE, MSC
Black bear	*Ursus americanus*	17	
Grizzly bear	*Ursus arctos horribilis*	6, (2005)	FT, MSC

[a] FT = Federally listed as threatened by the USFWS; FE = Federally listed as endangered by the USFWS; MSC = Montana Species of Special Concern as determined by the Montana Natural Heritage Program, USFS = listed as sensitive by the USFS; PIF = listed as "Level I priority species" by Montana Partners in Flight; BEPA = Bald Eagle Protection Act.

FEDERALLY THREATENED AND ENDANGERED SPECIES AND SPECIES OF CONCERN

According to the Endangered Species Act of 1973, the term "endangered species" means any species that is in danger of extinction throughout all or a significant part of its range. A threatened species" is any species that is likely to become an endangered species in the foreseeable future throughout all or a significant part of its range. Four species listed as threatened by the Fish and Wildlife Service inhabit the Park and Forest lands: bald eagle, grizzly bear, Canada lynx, and bull trout; the gray wolf is listed as 'endangered'.

Species of concern to the Park and Forest are species that are rare, endemic, disjunct, vulnerable to eradication, or likely to become threatened or endangered if limiting factors are not reversed. A species may also be of concern because of characteristics that make it particularly sensitive to human activities or natural events. The species of concern list for the Park includes species that are listed as "species of special concern" by the Montana Natural Heritage Program, "level one priority species" by Montana Partners in Flight and "sensitive species" by the Forest. Species of Concern confirmed to occur or with potential to occur in the wildlife project area (WAA) are discussed below.

Gray Wolf (Federally Endangered)

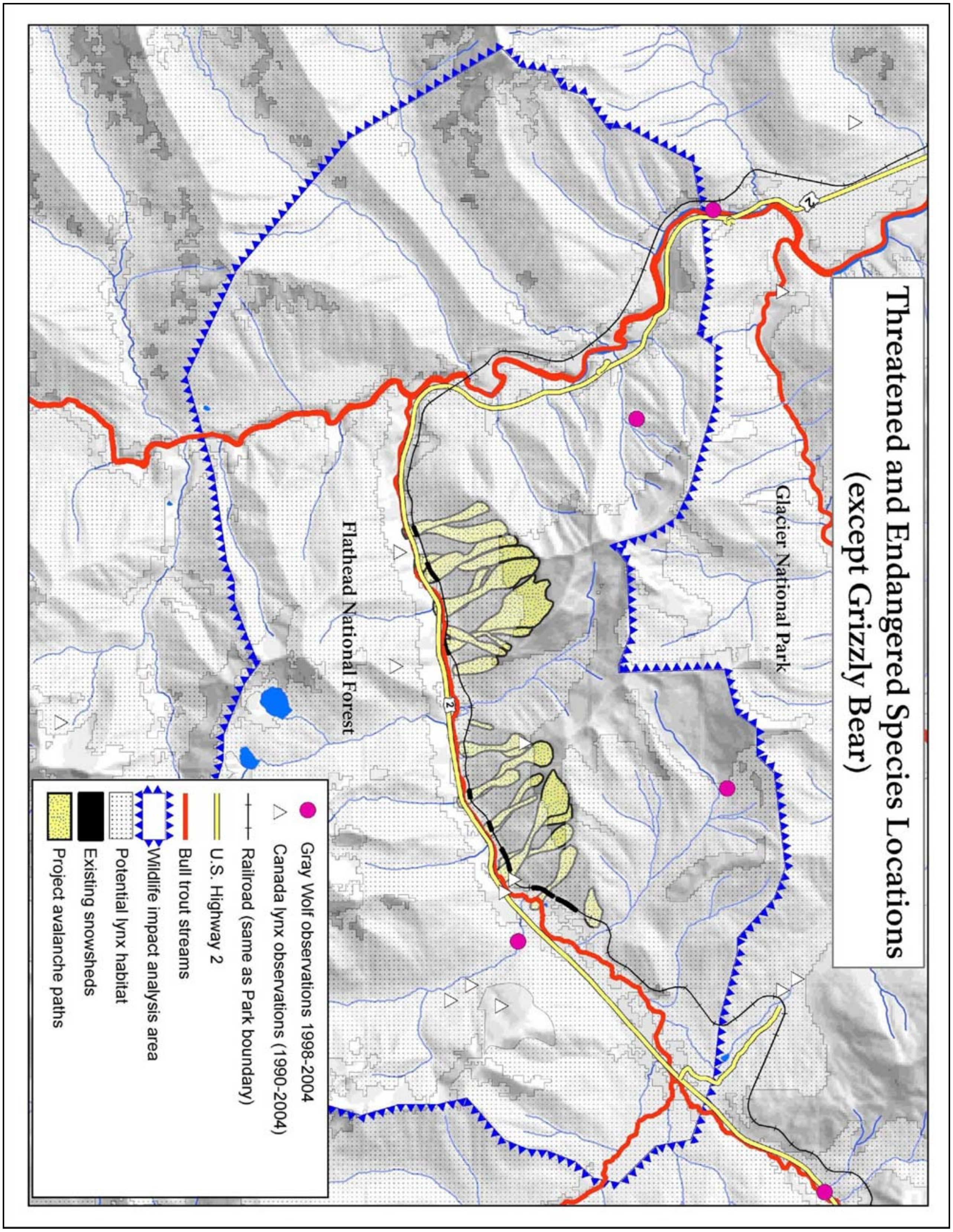
Historically common throughout the Rocky Mountains, gray wolves (*Canis lupus*) were present but greatly reduced by the time Glacier National Park was established in 1910. Until wolves returned to GNP in the 1980s, the park's last known resident wolf pack was removed from the Belly-Waterton River Valleys by a professional Canadian wolfer around 1920. Scattered nomadic pairs and lone wolves were observed throughout the park after 1920, but no resident wolf packs were confirmed (Singer 1975).

By the 1970s, wolf sightings were becoming more frequent in the North Fork of the Flathead River Valley and an effort was made to monitor wolf activity in and around the park. The University of Montana's Wolf Ecology Project was initiated in 1978 with the trapping and radio-collaring of a solitary female wolf (Ream and Mattson 1982). In 1986, the first documented denning of wolves in the western United States in over 50 years occurred in the park (Ream et al. 1991). Wolves have continued to den in the park nearly every year since.

The Park maintains an electronic database of incidental gray wolf observations submitted by park employees, visitors, and researchers and radio telemetry locations of wolves monitored by U.S. Fish and Wildlife Service and park biologists. Sighting records provide occurrence data used by park biologists to describe gray wolf distribution and habitat use patterns in the absence of intensive population level research. Telemetry locations are used to delineate home ranges, identify den and rendezvous sites, and determine pack size and reproductive status. Wolves have been reported in every major drainage in the park in recent years. During the period 1998-2004, there were eight observations in the southern portion of the park some of which involved multiple wolves. Three of these observations were within the WAA. Four of the observations, including one within the WAA, were made between the months of December and April showing winter use of the Middle Fork drainage (Figure 3-2).

The Rocky Mountain Wolf Recovery 2005 Interagency Annual Report (USFWS et al. 2006) recognized four packs using GNP for a large part of their home range, including two packs in the North Fork of the Flathead River and one pack that moved between GNP and Waterton

Map 3-2. Wildlife Observation Database Sightings of Threatened and Endangered Species



Lakes National Park. The fourth pack occupied the southern part of GNP, the Blackfeet Reservation, and the Lewis and Clark National Forest. One of these wolves was killed by a vehicle along US Highway 2 near Marias Pass in December of 2005. An additional two packs occupied Forest Service land south of the park, in the Great Bear Wilderness and Spotted Bear Wilderness.

Gray wolves are wide-ranging and their distribution is tied primarily to that of their principal prey (deer, elk, and moose). Important components of wolf habitat are: 1) a sufficient, year-round prey base of ungulates and alternate prey; 2) suitable and somewhat secluded denning and rendezvous sites; and 3) sufficient space with minimal exposure to humans (USFWS 1987). Low elevation river bottoms that are relatively free from human influence provide important winter range for ungulates and wolves. Wolves are especially sensitive to disturbance from humans at den and rendezvous sites. Pups are born in late March to early May and remain near the den through most of the summer (USFWS 1987). Human activity near den sites can lead to pack displacement or physiological stress perhaps resulting in reproductive failure or pup mortality (Mech et al. 1991). Rendezvous sites are resting and gathering areas occupied by wolf packs during summer and early fall after the natal den is abandoned. Indirectly, wolves support a wide variety of other species; common ravens, eagles, coyotes, wolverines, mountain lions, and bears feed on the remains of animals killed by wolves. As apex predators, wolves also help regulate the populations of their prey ensuring healthy ecosystems and greater biodiversity (Terborgh 1988, Ripple and Beschta 2003, Hebblewhite et al. 2005).

The population dynamics of recolonizing wolves are extremely variable. Inadequate prey densities and a high level of human persecution are the two most important factors that can limit wolf distribution and prevent a complete recovery of wolf populations in the Northern Rocky Mountains (USFWS 1987). GNP's predominantly natural landscape contains some of the most secure and productive wolf habitat in the western part of its range. Despite fluctuating wolf numbers since 1986, the Park's established wolf population continues to serve as a source for natural recolonization in northwest Montana and southern Canada (Boyd-Heger 1997).

Management and recovery of wolves in northwest Montana is directed by the *Northern Rocky Mountain Gray Wolf Recovery Plan* (USFWS 1987). Under this Plan, the criteria for downlisting wolves in the Northern Rocky Mountains to a threatened status would be reached when two of the three recovery areas delineated in the Plan had maintained a minimum of 10 breeding pairs for 3 successive years. A later review of wolf literature by the USFWS concluded that an adequate recovery goal for delisting wolves in the Northern Rocky Mountains would be the maintenance of 300 wolves within 30 packs; 20 packs (200 or more wolves) for 3 years would be sufficient for down-listing to threatened status. These goals were later adopted by the USFWS. There have been over 200 wolves in at least 20 packs since the end of 1997 and at least 300 wolves in a minimum of 30 packs since the end of 2000.

On January 31, 2005, the U.S. District Court in Portland, Oregon, issued a decision that reversed the U.S. Fish and Wildlife Service's April 2003 reclassification of the gray wolf to threatened status. Wolves outside of experimental nonessential areas in Montana, including the project area, are now considered endangered.

Bald Eagle (Federally Threatened)

Bald eagles use portions of GNP on a year-round basis as nesting and wintering residents (Yates 1989), and as seasonal migrants (McClelland et al. 1982, Yates et al. 2001). There are 12 known bald eagle nesting territories in the Park and an additional location on the Forest just outside of the Park near the North Fork of the Flathead River. The closest bald eagle nests to the proposed project area are along Nyack Creek (17 miles to the northwest), at Two Medicine Lake (17 miles to the northeast), and at Hungry Horse Reservoir (12 miles to the west). It is unlikely that bald eagles use the WAA during the breeding season, but they fly over the area during migration and may occasionally feed on carrion in the avalanche chutes in March and April (S. Gniadek, Pers. comm.)

Bald eagles are especially sensitive to human disturbance during the breeding period (Hamann et al. 1999). Productivity of the Park's nesting bald eagle population is lower than productivity documented for the rest of Montana (NPS files), and less than that recommended in the *Pacific States Bald Eagle Recovery Plan* (USFWS 1986) for maintaining viable populations of nesting bald eagles. Reasons for lower productivity in the park may include severe winter and spring weather, deterioration of native fisheries (prey species), and human disturbance near nest and forage sites. Outside of the breeding season, disturbance by humans may cause birds to alter their feeding habits, thereby reducing normal food intake (Hamann et al. 1999). Bald eagle management within the Park is directed by the *Glacier National Park Bald Eagle Operational Plan and Habitat Management Guidelines* (NPS 1999b).

The bald eagle nesting season in the Park extends from early March through late September. Human activity is restricted within 1/4 mile of bald eagle nesting, roosting, and primary foraging areas during specific stages of the nesting cycle if the site has been active within the past five years. Those stages include courtship (late February to mid-April), egg laying and incubation (late March to late May- most sensitive), nestling (mid-May to mid-August), and fledging (early August to late September—the least sensitive period). The potential for nest failure and nestling death due to human disturbance is reduced, but not eliminated, after nestlings reach an age of four weeks (usually early to late June in the park).

Glacier National Park is also within a major bald eagle migration corridor (McClelland et al. 1994, Yates et al. 2001). Some eagles remain to winter in the area, especially along the Middle and North Forks of the Flathead River and near Lake McDonald. Preferred wintering habitat is also usually near open water where fish are available and waterfowl congregate, or near a concentrated food source such as ungulates killed by predators or road accidents. Bald eagle foraging and wintering habitats are found throughout the Park, and are generally associated with large lakes and rivers.

Grizzly Bear (Federally Threatened)

The Park and the Forest are part of the Northern Continental Divide Ecosystem (NCDE) recovery area for the grizzly bear. Population estimates for this ecosystem vary between 549-813 bears (USFWS 1993). (Results from the recent Bear DNA Study are not available yet, so population estimates do not include any new information as a result of that study). The NCDE is especially important for grizzly populations because it adjoins occupied grizzly bear habitat in Canada.

The *Grizzly Bear Recovery Plan* (USFWS 1993), the *Glacier National Park Bear Management Plan* (NPS 2001), and the *Flathead National Forest Land and Resource Management Plan* (USDA Forest Service 1985) provide standards and guidelines for the management of grizzly bears in Glacier National Park and the Flathead National Forest. The plans outline actions required to protect and recover the federally listed grizzly bear. In the NCDE, one of the recovery criteria for a recovered population is the annual number of unduplicated observations of females with cubs-of-the-year averaged over a six-year period. For the Park, the target is 10 females with cubs-of-the-year and 12 for areas outside the Park, including the Flathead National Forest. In 2003, six-year averages were 10 and 8 for the Park and Forest, respectively (USFWS 2004).

The Interagency Grizzly Bear Committee approved the application of the *Interagency Grizzly Bear Guidelines* (IGBG) in 1986 for grizzly bear ecosystems on National Forest, Bureau of Land Management, and National Park lands in Idaho, Montana, Washington and Wyoming. In their Biological Opinion regarding the guidelines, the US Fish and Wildlife Service stated: "It is our opinion that implementation of the Guidelines will promote conservation of the grizzly bear." Five management situations (MS 1-5) were described in the guidelines, each having specific population/habitat conditions and management direction. The proposed project area is designated as MS 1: area necessary for the survival and recovery of the species. In MS 1, management decisions will favor the needs of the grizzly bear when grizzly habitat and other land-use values compete, and grizzly-human conflicts will be resolved in favor of grizzlies. Maintenance and improvement of grizzly bear habitat and grizzly-human conflict minimization will receive the highest management priority in these areas. The guidelines also state that within MS1:

- all special use permits will "specify measures to meet agency grizzly goals and objectives" and "include specific measures to protect and maintain grizzly habitat";
- permits will include "a clause providing for cancellation or temporary cessation of activities if such are needed to resolve a grizzly-human conflict"; and
- permit holders' "full cooperation in meeting grizzly management goals and objectives will be a condition to their receiving and holding approved permits".

Grizzly bear habitat is found throughout the Park and Forest and ranges from the lowest valley bottoms to the summits of the highest peaks. Grizzly bears require large areas of undeveloped habitat (including a mixture of forests, moist meadows, grasslands, and riparian habitats) and have home ranges of 130 to 1,300 square kilometers (Claar et al. 1999). Grizzlies also require a substantial amount of solitude from human interactions (USFWS 1993) and natural habitat that provides connectivity, or travel corridors, between foraging sites.

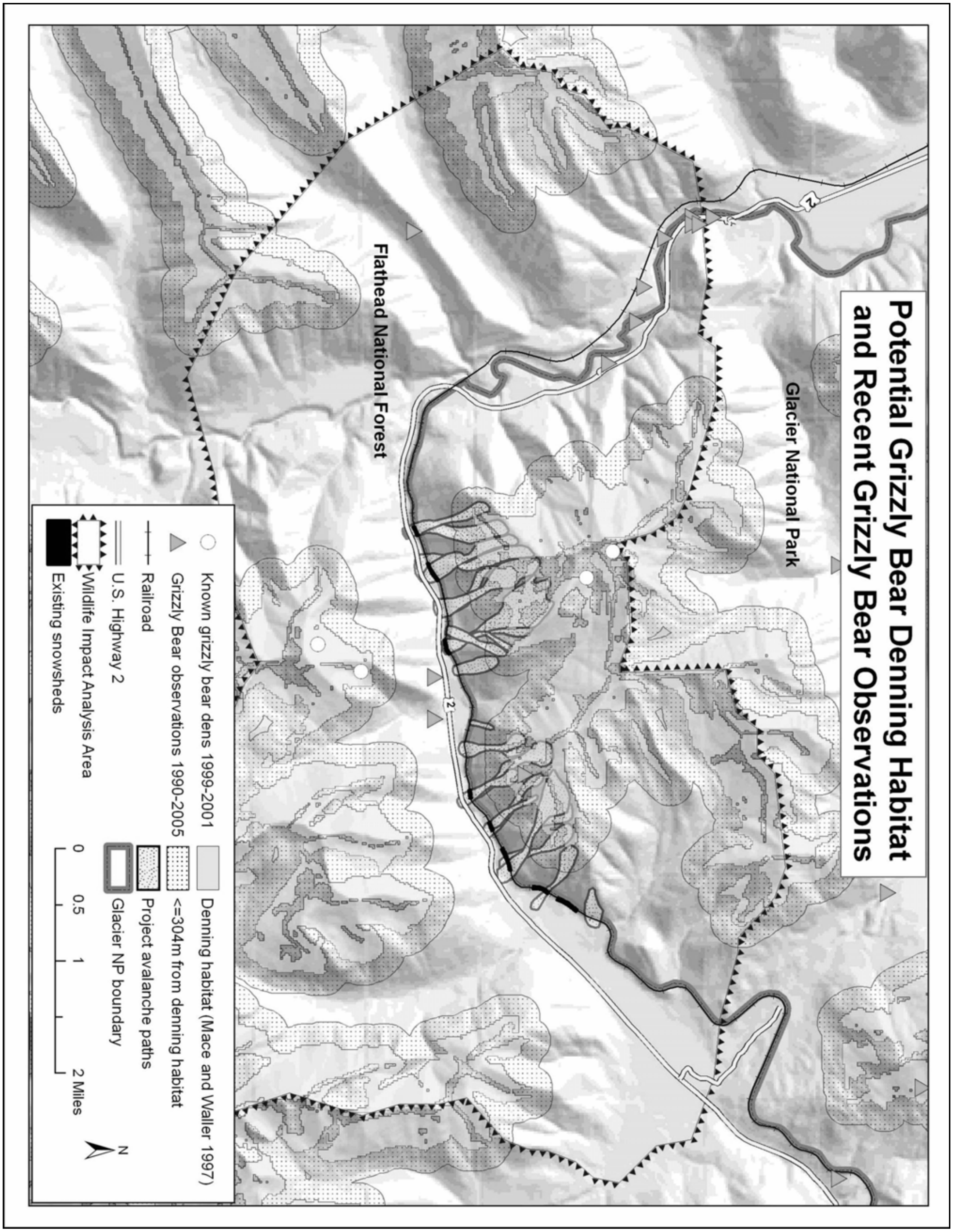
Grizzly bear seasonal movements and habitat use are primarily tied to the availability of different food sources (Waller and Mace 1997). In spring, grizzly bears feed on dead ungulates and early-growing, herbaceous vegetation at lower elevations (Martinka 1972, Waller and Mace 1997). Avalanche paths, especially those on south aspects, provide an important source of herbaceous forage for grizzly bears in the spring and early summer (Zager and Jonkel 1983, Ramcharita 2000, McLellan and Hovey 2001). Waller and Mace (1997) found that grizzly bears used avalanche paths in higher proportions than available during all seasons. Ungulates killed by snowslides are often uncovered in May and June providing a supplemental food source (Martinka 1972). Valley bottom riparian areas are also used frequently in the spring as the snow melts out earlier at lower elevations. Ramcharita (2000) found riparian habitat adjacent to avalanche paths was frequently used by grizzly bears during the spring in British Columbia. The entire length of avalanche paths is used by grizzly bears for foraging, with the start zones being used more frequently than runout zones

(Servheen 1983, Korol 1994, Ramcharita 2000). During the summer, bears move to higher elevations in search of glacier lilies and other roots, berries, and army cutworm moths (*Euxoa auxiliaris*). Bears often concentrate in areas where huckleberries are dense during the late summer and fall.

Bears hibernate in dens away from human disturbance, typically at higher elevations on steep slopes (i.e. > 30 degrees), with deep soils, and where wind and topography cause an accumulation of deep snow (Pearson 1975, Servheen 1981). The denning season in the western portion of the NCDE usually begins in early October, and females may linger near dens until late May. The mean dates for den entry and exit in the nearby Swan Mountains for all age and sex classes were November 5 and April 11, respectively; however, the earliest den entry was October 17 and earliest exit was March 13 (Mace and Waller 1997). Four den sites were confirmed within the WAA while tracking several radio-collared grizzly bears in 1999 and 2000 (Waller unpublished data) (Map 3-3).

Map 3-3 shows the extent of available potential denning habitat in the project area based on findings from Mace and Waller (1997). In this model, potential den habitat was delineated as ≥ 5900 feet in elevation and ≥ 45% slope. Mace and Waller (1997) reported 86% of 78 grizzly bear dens occurred between 5906-6890 feet elevation and 90% of grizzly bear dens occurred at ≥ 45% slope. In addition, two buffer zones around the potential denning habitat are displayed. Some studies suggest vehicle and seismic activity may cause den abandonment within 1000 feet of potential denning habitat. Grizzly bears may have increased heart rates and movement when vehicle and seismic disturbance occurs between 1000-6562 feet of potential denning habitat (Joslin and Youmans 1999). Mace and Waller (1997) routinely observed snowmobile activity within 2 km (6562 feet) of denning grizzly bears and did not observe den abandonment. They cautioned, however, that though den abandonment was not observed, physiological stress could not be discounted.

The bear information management system (BIMS) is an electronic database of incidental grizzly bear observations submitted by park employees and visitors and used in part to inform managers of bear activity. Records are also analyzed by the park wildlife biologist to make annual reports to the USFWS on grizzly bear population trends and management activities (i.e., the number of unduplicated females with cubs of the year, the distribution of family groups across the landscape, and the number of known human-caused mortalities). Map 3-3 shows observations of bears.



Map 3-3. Extent of available potential denning habitat.

Sightings are biased as they reflect the distribution of the people submitting the records. According to the BIMS database, there were 123 bear observations in the WAA between 1968 and 2004: 78 black bear sightings, 36 grizzly, and 9 observations where the species was not determined. Of the grizzly observations, two were in February (same date, same location, probably same bear), one in late April, and 18 in May. The numerous May observations suggest that avalanche paths in this area may be used frequently during the spring for foraging. Grizzly bear tracks were identified in the project area during winter wildlife surveys on April 1, 2005.

Burlington Northern is currently preparing an application for an Incidental Take Permit (ITP) that will include a draft Habitat Conservation Plan (HCP), draft Implementation Agreement, and a draft Environmental Assessment. This application process is separate from this EIS and does not address new avalanche control mitigation proposed in this EIS. The incidental take of grizzly bears would result from the operation and maintenance of the railroad within the Middle Fork Flathead River corridor between Hungry Horse and Browning, Montana. The HCP and its associated Environmental Assessment will clarify the activities in this area associated with the operation and maintenance of the railroad which may affect grizzly bears; evaluate other factors that contribute to human caused mortality of grizzly bears in the corridor; evaluate alternative strategies to minimize the effects of railroad operations on grizzly bears; and, develop an adaptive management framework for grizzly bear conservation in the corridor.

Grizzly bear and train collisions have been documented in the corridor from Browning (29 miles northeast of project area) to Conkelley (approximately 41 miles northwest of project area) since 1976. In that time, 42 grizzly bears have been recorded as killed by trains. The bears are attracted to the tracks for several reasons including: spilled grain, carcasses of other wildlife killed by trains, cattle carcasses, human waste deposited near tracks, and succulent vegetation (sometimes seeded intentionally by humans). (USFWS 2005)

Several spills in the past have resulted in bears being attracted to the railroad tracks. A derailment caused by an avalanche in 1947 punctured a tanker car of syrup, which attracted bears for several weeks afterwards. After three grain spills in John F. Stevens Canyon in the late 1980's eight grizzly bears were killed by passing trains while feeding on the spilled grain. On April 20, 2004, a train transporting corn derailed just northeast of snowshed 10. Twenty-nine cars spilled 2800 tons of corn onto the tracks, the right-of-way, and the slope below the tracks. The tracks were cleared and reopened on April 21. The entire clean-up and restoration continued through November. During clean-up, a contractor was hired to direct bears away from the site and no confirmed deaths of bears occurred, though many were attracted to the site (Hulcher Services Inc. 2004). On August 26, 2005, 3 grain cars spilling approximately 300 tons of corn just east of the Burnout snowshed. Bears were attracted to the site during clean-up.

Canada Lynx (Federally Threatened)

In April 2000, the Canada lynx (*Lynx canadensis*) was listed as a threatened species in the conterminous United States. The USFWS concluded that the population was threatened by human alteration of forests, low numbers as a result of past overexploitation, expansion of the range of competitors, and elevated levels of human access into lynx habitat. Critical Habitat designation was proposed by the USFWS in November 2005. All of Glacier National Park was included in the designation though the USFWS will be evaluating the Park's existing management plans for their adequacy to conserve lynx and could remove the Park from designation in the final ruling on critical habitat. The Flathead National Forest is not included in the proposed designation because the USFWS determined that existing lynx conservation agreements were sufficient to conserve lynx within the Forest.

Lynx habitat is generally described as Rocky Mountain Conifer Forest with a dense undercover of thickets and windfalls. Lynx forage in young conifer forests especially where their primary prey, snowshoe hare (*Lepus americanus*), is abundant. Older forests with a dense understory also provide good foraging habitat, and are often more stable sources of snowshoe hares than younger, transitory forests (Ruediger et al. 2000).Travel corridors are thought to be an important factor in lynx habitat because of the species' large and variable home ranges, generally 5-550 square miles (Ruediger et al. 2000). Travel cover includes contiguous vegetation cover over 6 feet tall (Brittell et al. 1989), and lynx generally do not cross openings greater than 330 feet wide (Koehler 1990). Winter snow conditions may also play a role in the value of lynx habitat. Lynx have a competitive advantage in soft snow during winter months because of their long legs and large feet (Buskirk et al. 2000).

Lynx are most susceptible to disturbance during the denning period and while newborns are developing (May–August) (Claar et al. 1999). The common component of lynx den sites observed in other regions appears to be large amounts of woody debris and minimal human disturbance (Ruediger et al. 2000). Den sites have been documented in older regenerating stands and mature coniferous and mixed-coniferous stands with the requisite component of coarse, woody debris that provides thermal and hiding cover for kittens (Ruediger et al. 2000).

Concurrent with the listing process, a national interagency *Canada Lynx Conservation Assessment and Strategy* (LCAS) was developed to provide a consistent and effective approach to conservation of the species. All federal land management agencies, including the NPS, were participants. The LCAS identifies 17 risk factors that could adversely affect lynx mortality, productivity, and movements (Ruediger et al. 2000). Within GNP, the primary risk factors for lynx are wildland fire management policies that preclude natural disturbance processes, roads and highways, winter recreational trails, habitat degradation by non-native invasive plant species, incidental or illegal shooting and trapping, competition or predation as influenced by human activities, and human developments that degrade and fragment lynx habitat. The U.S. Forest Service and U.S. Bureau of Land Management have entered into conservation agreements with the U.S. Fish and Wildlife Service to consider conservation measures in the LCAS when designing and implementing activities that might affect lynx or their habitat (Ruediger et al. 2000). The National Park Service also considers the recommendations made in the LCAS prior to undertaking any new activities in lynx habitat (Reudiger et al. 2000).

Lynx were considered common throughout the Park during the early 1900s (Bailey and Bailey 1918). Reported lynx sightings declined after the 1960s, but have increased in recent years, possibly due to increased interest in the species (Park files). Map 3-2 shows potential lynx habitat within the WAA created using GIS map layers of mesic conifer forest above 4,000 feet elevation. This should be considered an approximation and undoubtedly includes some non-lynx habitat and excludes some areas used by lynx.

Starting in 1994, systematic, winter track surveys for lynx and other forest carnivores were conducted by GNP wildlife technicians (NPS files). Lynx were detected in many drainages throughout the park including the St. Mary, Two Medicine, McDonald, and Many Glacier Valleys although no estimates of population numbers were made. Winter distribution and habitat use by lynx was analyzed using track survey data and GIS from 1998-2001 (Hahr 2001, NPS files). Surveys in 2002 detected lynx in drainages of the Middle Fork of the Flathead River (Buhler et al. 2002). Winter track surveys in 2002-2003 did not detect any lynx in the Middle Fork drainage including along Ole Creek (Edmonds et al. 2003). A February 16, 2005 snow track survey in the project area recorded lynx tracks and a scat above snowshed 7 in the project area (Wollenzein 2005). During winter wildlife surveys in 2006 (Alban 2006), a pair of lynx was observed together at the carcass of an elk killed by an avalanche. The pair was seen several times between March 22 and April 3 between Jake's and Second Slide avalanche paths. They were also heard calling back and forth which could be a sign of breeding behavior. Lynx detections have also occurred on the Forest's portion of the Middle Fork in the following nearby tributaries: Skyland Creek, Essex Creek, and Dickey Creek.

The WORF database contains three additional observations within the wildlife project area (Map 3-2). One observation was in April of 2001 near the base of the Shed 7 avalanche path. A second sighting, also from April 2001, was approximately 2.5 miles southeast of the project area. An older sighting, from February 1971, was approximately one mile north of the project area along the highway.

Bull Trout (Federally Threatened)

Bull trout in the Upper Columbia River Basin, the area of this EIS, has been accorded "threatened" status by the U.S. Fish and Wildlife Service under the provisions of the Endangered Species Act. The Flathead River system contains a significant amount of stream and lake habitat for bull trout.

Bull trout exhibit three distinct life-history forms—resident, fluvial, and adfluvial. Resident bull trout spend their entire lives in small tributaries, whereas fluvial and adfluvial forms hatch in small tributary streams then migrate into larger rivers (fluvial) or lakes (adfluvial). Only the adfluvial form of bull trout is present in the project area. Spawning occurs between late August and early November (USFWS 1998). Eggs and fry typically over-winter in spawning streams until the following spring. Specific habitat requirements of bull trout include abundant cover for adult fish during spawning, low levels of fine sediment in the incubation environment, cold summer water temperatures and channel stability for juveniles, and open migration routes between seasonally important habitats (USFWS 1998).

Bull trout have experienced significant population declines and local extirpations throughout their historic range (USFWS 1998). Threats to the viability of bull trout populations include: over-harvest by anglers; population fragmentation resulting from blocked migration routes; competition and hybridization with introduced, non-native fish species such as lake trout (*Salvelinus namaycush*) and brook trout (*Salvelinus fontinalis*); and human-caused modifications of the aquatic environment (Mogen and Kaeding 2000). Because of its protective status, bull trout cannot be kept if caught in the Park or Flathead River and its tributaries. Likewise, selected bull trout spawning streams along the Middle Fork within the park are closed to fishing year round.

The primary threat to bull trout persistence west of the Continental Divide in the Flathead River system is the invasion of non-native lake trout into bull trout habitat. Historic records do not indicate that lake trout were ever stocked in the Flathead drainage within the park, but the species became established in most of the park's larger lakes, including Lake McDonald, through immigration from downstream sources as early as 1959 (Fredenberg 2000). When non-native lake trout are introduced into a natural system dominated by bull trout, lake trout usually displace bull trout through competition and predation (Donald and Alger 1993). Systematic fish surveys conducted by the USFWS in 2000 to assess the population status of bull trout in lakes on the park's west side, found that bull trout populations have experienced steep declines. Large increases in lake trout numbers were also noted for most lakes and the Flathead River system. The report concludes that most of the bull trout populations in the Park's lakes "are currently at high risk of extirpation" due to displacement by lake trout. The report recommends the restoration of bull trout in compromised lakes, possibly through a lake trout eradication program, and the protection of still pristine lake systems from future lake trout invasion (Fredenberg 2000).

Evidence suggests that there is substantial genetic divergence among bull trout populations from different sub-basins in the Flathead (Kanda et al. 1997). The amount of genetic divergence among populations within sub-basins is smaller which suggests that there is some gene flow among subpopulations. Competition/predation is occurring with lake trout in Flathead Lake and all 12 members on a panel of fishery experts responded that there is a greater than 70% probability that this interaction is preventing a recovery goal of maintaining 1980's bull trout populations for at least 15 years (McIntyre 1998). Therefore, the probability of this population persisting is low and is functioning at an unacceptable risk.

Plant Species

No federally listed threatened or endangered plants have been identified in Glacier National Park at this time. The park may have habitat for the federally threatened water howellia (*Howellia aquatilis*), which is found in northwestern Montana wetlands. Water howellia requires a combination of very particular habitat and weather patterns before it can germinate. Water howellia has not been discovered in park wetlands that have been surveyed. Spalding's catchfly (*Silene spaldingi*) has recently been listed by the Fish and Wildlife Service as a threatened species. This species occurs in western Montana; however, no potential habitat for the species has been identified in Glacier National Park.

The Fish and Wildlife Service lists the slender moonwort (*Botrychium lineare*), a plant species found in Glacier National Park, as a candidate species. The Montana Natural Heritage Program ranks the slender moonwort as a G1/S1 species, meaning that both on a global and state level, the plant is "critically imperiled because of extreme rarity (five or fewer occurrences or very few remaining individuals), or because of some factor of its biology making it especially vulnerable to extinction." Slender moonwort grows in open meadows, under trees, roadside ditches, and on limestone cliffs at higher elevations. It has been found in early successional habitats in the Many Glacier, Going-to-the-Sun Road, and Belly River areas.

Species Of Concern In Wildlife Project Area

Tables 3-8 and 3-9 identified species (other than federally-listed species) recognized as sensitive by the Montana Natural Heritage Program, U.S. Forest Service, or Montana Partners in Flight. Additional sensitive species undoubtedly use John F. Stevens Canyon but have not been recorded in the database. Sensitive wildlife species confirmed to be present or that could occur based upon the habitat present in the Canyon are described below.

No populations of plant species on Montana's Species of Concern list are known to occur within the project area. Within five miles outside the project area, there are populations of short-flowered monkeyflower, Austin's knotweed, bractless hedge-hyssop, peculiar moonwort, and the moss, *Ditrichium ambiguum*. Other rare plant populations known to occur within the Middle Fork area are slender cottongrass, English sundew, buckler fern, western moonwort, blunt-leaved pondweed, and mosses *Paraleucobryum longifolium* and *Tayloria norvegica*.

Harlequin Duck (*Histrionicus histrionicus*)

Harlequin ducks winter in coastal areas and migrate inland during spring to mountain streams and rivers where they can breed and nest away from human disturbance (Clarkson 1994). Harlequin ducks are common from spring to fall in fast-flowing water (streams and rivers) and less frequently on lakes. Productivity is highly variable. Recreational boating, sport fishing and other human activities have been shown to displace harlequin ducks, especially during nesting and brood rearing periods (Clarkson 1994). Harlequin duck declines have been documented throughout the western populations, including in Montana, where there are approximately 110 pairs (Genter 1993). Upper McDonald Creek in GNP, with about 25 pairs, is considered the most critical harlequin breeding stream in Montana (Ashley 1998). In addition to the McDonald Valley, harlequin pairs and/or broods have also been documented in the Two Medicine, Many Glacier, St. Mary, and Middle Fork drainages (GNP files). Surveys conducted in 1998 near Essex on the Middle Fork and its adjoining creeks resulted in observations of juvenile harlequins within the drainage. Exact breeding locations could not be determined but pairs did use the Middle Fork for feeding, resting, and traveling during the breeding season (Ashley 1998). A pair of harlequins was also observed in 1994 along Bear Creek (NPS files).

Golden Eagle (*Aquila chrysaetos*)

Golden eagles are common in open areas of the park from spring to fall. They nest in cliffs (and possibly trees) throughout the park including the McDonald, North Fork, Middle Fork, St. Mary, Two Medicine, Waterton, and Many Glacier drainages (Park files). A golden eagle nest was located in 2000 in the WAA on Snowslip Mountain. This nest has not been monitored so its recent status is unknown. However, a pair of golden eagles was observed on multiple dates in this area during winter wildlife surveys in 2006 (Alban 2006). Productivity for golden eagles in Montana has been low and may be declining (Joslin and Youmans 1999). Golden eagles may be disturbed during the nesting season by humans, resulting in lowered productivity due to disruption of courtship activities, over-exposure of eggs or young birds to weather, and premature fledging of juveniles. Direct mortality of juveniles due to starvation or predation is also possible if adults are displaced from the area and regular nest attendance does not occur (Fyfe and Olendorff 1976). The nesting season for golden eagles in Montana begins in March or April. Golden eagle migration through the Park has been documented as thousands of eagles travel north to nesting areas in spring and south to wintering areas in autumn (Yates et al. 1994, Yates et al. 2001). Golden eagles will feed on carrion in avalanche chutes during migration or nesting periods.

Fisher (*Martes pennanti*)

Fishers are residents of coniferous forests and riparian areas. Breeding in the WAA is probable, especially on the Forest portion, but the population status and trends are unknown. Due to a lack of fishers being trapped from 1920-1960 and the belief that they were probably extirpated from northwest Montana, several translocations of fisher from other areas occurred in the recent past. From 1959 to 1962, 75 fishers from British Columbia were introduced into western Montana and Idaho. Another 110 fishers from Minnesota and Wisconsin were relocated into northwest Montana between 1989 and 1991. However, population numbers remain low and genetic data suggests that some fishers native to Montana were still present prior to the translocations (USFS 1994, Vinkey 2003). Fishers inhabit moist coniferous forests and prefer mature stands with abundant small mammal prey. They generally frequent drainage bottoms, lower slopes, and riparian areas (USFS 1994). Fishers have been documented on both sides of the Continental Divide in the Park, including the St. Mary, McDonald, Two Medicine and Many Glacier drainages (Park files); and in the Forest in all three drainages of the Flathead River. No observations of fisher tracks were made in the Middle Fork drainage during surveys in the winter of 2002-2003.

Wolverine (*Gulo gulo*)

The wolverine is a rare resident of coniferous forests and alpine meadows on both sides of the Continental Divide. Breeding has been documented, but population status and trends are unknown. Wolverine were apparently extirpated from Montana by 1920 due to over-harvest, but recovered through dispersal from Canada into Glacier National Park (Newby and Wright 1955). Wolverines appear to require large, isolated tracts of wilderness supporting a diverse prey base. They utilize a range of habitats including alpine areas, mature forest, ecotonal areas, and riparian areas. Wolverines exhibit a distinct seasonal elevational pattern moving to lower elevations during the winter where they search for carrion in ungulate winter ranges. A limiting factor to wolverine distribution may be the availability of suitable denning habitat. Wolverines appear to require remote alpine cirques for denning and are especially sensitive to human disturbance during courtship, denning and rearing of young (Copeland 1996). Removal of large predators such as wolves and mountain lions from an ecosystem can reduce the amount of carrion available to wolverine. The wolverine has twice been petitioned for listing under the Endangered Species Act (1995 and 2000), and in both instances the USFWS determined that there was insufficient scientific evidence to warrant listing. It is considered sensitive by the US Forest Service and "potentially at risk" by the Montana Natural Heritage program.

The park is considered to have very high quality wolverine habitat due to its extensive alpine areas, rugged topography, remoteness, and diverse ungulate populations. Wolverines have been detected across elevational gradients in most park drainages with sightings concentrated in the Two Medicine, St. Mary, McDonald, and Many Glacier drainages (Yates 1994, Hahr et al. 1999, Hahr et al. 2000). An on-going wolverine study within Glacier National Park was started in 2003 and has resulted in the capture of 22 wolverines. Some of the wolverines were instrumented with GPS collars and over 3,000 telemetry locations have been recorded. Trapping sites were concentrated on the east side of the park and as far south as Two Medicine. Male home ranges averaged 496 km^2 and female home ranges averaged 141 km^2. One individual male traveled over 200 km from the east side of the park to the northwestern corner of Montana. Though, no telemetry locations were recorded in the WAA during this study, track surveys conducted during the winters of 2002-2003 twice detected wolverine tracks in the Middle Fork drainage including a February observation between Fielding and Ole Creek (in the WAA). An observation of a wolverine within the project area just west of snowshed 11 was made during winter wildlife surveys in March 2006 (Alban

2006). The Park's wildlife observation (WORF) database contains two wolverine observations within the WAA, one in 1970 and the other from an unknown year.

Westslope Cutthroat Trout (*Oncorhynchus clarki lewisi*)

In 2000, the U.S. Fish and Wildlife Service considered the westslope cutthroat trout for possible listing under the Endangered Species Act, and the decision was made not to list the species. The fish are native to all major drainages within the park, but they are common in the North Fork and Middle Fork of the Flathead River, which remains one of the last strongholds for genetically pure westslope cutthroat in the United States (Marnell 1988). Introductions of non-indigenous sport fish have compromised about 84% of the historical range of the native cutthroat trout in the Park (Marnell 1988). Despite repeated invasions and introductions of non-native salmonids and the associated genetic contamination of some native populations, many lakes in the Park still contain secure populations of westslope cutthroat trout (Marnell 1988). Seventeen lakes in the park contain pure genetic stocks of native westslope cutthroat trout. The remaining fish-bearing lakes contain non-indigenous fish or hybrids that are mostly the introduced Yellowstone cutthroat trout, brook trout, or rainbow trout (*Oncorhynchus mykiss*). Selected spawning streams (along the Middle Fork of the Flathead River and within the Park) are closed to fishing to protect cutthroat spawning areas.

Shorthead Sculpin (*Cottus confusus*)

Shorthead sculpins live in a few streams in the Columbia River drainage. Their habitat ranges from small to large, cold, clear streams to large rivers and deep lakes. Very little is known about the distribution and status of this species in the park.

Species of Concern Potentially in Wildlife Project Area

Boreal Toad (*Bufo boreas*)

This species is a Montana "species of special concern" and listed as "sensitive" by the USFS. Boreal toads are mainly terrestrial and very mobile, and consequently sometimes difficult to detect during field surveys. Adults may also show a seasonal shift to nocturnal behavior or take refuge from hot, dry conditions by burrowing in the ground litter or inside rodent holes. Serious declines of this species throughout portions of its southern range are cause for concern for its status in other regions. Boreal toads were found in most of the major drainages in the park, except portions of the North and Middle Fork, Flathead River drainages. Breeding populations of boreal toads do not often live near predatory fish populations (Marnell 1997). There is a large breeding population of boreal toads in the vicinity of the Two Medicine developed area, and a large migration of young boreal toads was observed in the North Fork in the summer of 2002. Thus, it is probable that the boreal toad occurs within the WAA.

Townsend's Big-eared Bat (*Corynorhinus townsendii*)

This species is a Montana Species of Special Concern and listed as sensitive by the USFS. Townsend's big-eared bats depend on caves and cave-like structures for nursery colonies, day roosts, and hibernacula. This species is a forest generalist within the subalpine, montane woodland, shrubland, and riparian community groups (Nagorsen and Brigham 1993).

Because of their restrictive habitat requirements, Townsends' big-eared bats have a patchy distribution. Alteration and disturbance of roost structures, exposure to pesticides, changes in insect prey populations, and shooting are the main threats to Townsends' big-eared bat populations in western North America (Wisdom et al. 2000). Although no recent records exist for this species in the park, there are records from adjacent lands in Flathead, Glacier and Lincoln Counties and in British Columbia, Canada. There is also a record of the species collected in 1874 from Waterton Lakes National Park. Since the specimen was collected during an international boundary survey, it was quite likely collected in or very near what later became Glacier National Park. Occurrence of this species in the Park has not been verified, in large part because bat surveys have never been conducted; therefore, it is unknown whether this species occurs within the WAA.

Peregrine Falcon (*Falco peregrinus*)

The USFWS removed the peregrine falcon from the list of threatened and endangered species in 1999. Although no longer endangered, peregrine falcons, their eggs, parts, and nests will continue to be protected from unauthorized killing, possession, transportation, and importation by the Migratory Bird Treaty Act (1918). This species is also considered a Montana Species of Concern and is listed as sensitive by the USFS. The species will continue to be monitored across the nation for the next 13 years to provide data on at least two generations of peregrines and to ensure that the bird is doing well after being delisted. Peregrine falcons are rare in the park, though sightings are reported nearly every year, occasionally during the nesting season. There have been no recorded peregrine nests in the Park and only one on the Forest, located in the Crane Mountain area near Flathead Lake. Surveys of potential peregrine falcon nesting habitat in the Park began in 1989 and were completed in 1991. Peregrine falcon habitat has been documented in many areas of the park (Yates et al. 1991) but the southern part of the park has not been examined.

Northern Goshawk (*Accipiter gentilis*)

This species is a Montana Species of Special Concern and listed as Sensitive by the USFS. Northern goshawks inhabit forested areas in the area, especially mature to old-growth coniferous and mixed forests, from spring to fall. Adult goshawks generally remain on their territories throughout the year, although they may shift to lower elevations in the fall. Goshawks require large nest trees in dense stands to support their bulky nest structures, and prefer to forage in small openings or dense stands with relatively open understories (Hayward 1983). Goshawks have been observed throughout the park, but only a handful of nests have been documented. Goshawk surveys have been conducted in the St. Mary Valley only. Many sightings have occurred in the McDonald, St. Mary and Many Glacier drainages (GNP files). Habitat for this species within the WAA is probably limited because of the relative lack of open mature forest on the slopes.

Black-backed Woodpecker (*Picoides arcticus*)

This species is a Montana Species of Special Concern, listed as Sensitive by the USFS, and a Level One Priority Species by the Montana Partners in Flight. Black-backed woodpeckers are rare residents of mature to old-growth subalpine, montane, and lower montane forests and riparian woodlands, especially beetle-infested forests (Caton 1996). This species is almost exclusively found in post-burn habitats created by stand-replacement and mixed severity wildfires. They may remain in these stands for five years after a fire with peak densities in years two to four post-fire (Dixon and Saab 2000). Black-backed woodpeckers excavate cavities for nesting in live trees with heart-rot or recently killed trees (Wisdom et al. 2000). This species' habitat may be declining within the region due to the decline of mature forests and the altered frequency of stand-replacing fires (Wisdom et al. 2000). Black-backed woodpeckers have been documented in recently burned areas of the North Fork and McDonald drainages (GNP files). Nesting has been documented, but population trend is unknown. It is unlikely that this species is currently present within the WAA because of the lack of recent forest fires in the area. However, future burns could attract individuals to the area.

Olive-sided Flycatcher (*Nattallornis borealis*)

This species is a Montana Species of Concern and a level one priority species of Montana Partners in Flight. Olive-sided flycatchers breed in forested areas of North America and winter in Central and South America. This species is found in recently burned conifer forest and seems to persist at least 15 years after a fire. It is less dependent on burned forest than the black-backed woodpecker, occurring in mature forest edge habitat throughout the park. They are a contrast species using mature coniferous forests for nesting and forest openings for foraging. They are uncommon from spring to fall in conifer forests, bogs, and recently burned forest. Nesting has been documented but population trend is unknown. Breeding bird survey data for the interior Columbia River Basin indicate populations have declined between 1966 and 1994 (Wisdom et al. 2000). They have been documented in the St. Mary, McDonald, Many Glacier and North Fork drainages (GNP files). It is unknown whether this species occurs within the WAA.

Northern Hawk Owl (*Surnia ulula*)

This species is a Montana Species of Concern. It is a rare resident and migrant in recently burned forest. Nesting occurs in large diameter snags and has been documented in the North Fork Valley (Gniadek et al., in prep.), but population trend is unknown (GNP files). It is unknown whether this species occurs within the WAA. There is no recently burned forest in the WAA, however; that may change with future wildfire activity.

Black Swift (*Cypseloides niger*)

This species is a Montana Species of Concern. Black swifts are rare in spring and summer in northwest Montana. They forage over forests and in open areas near their nesting sites, which may be located behind or next to waterfalls and wet cliffs (Michael 1927, Knorr 1961, Foerster and Collins 1990). Black swifts have been documented in the McDonald, St. Mary, and North Fork drainages with nesting documented in the McDonald Valley (GNP files). It is unknown whether this species occurs within the WAA.

White-tailed Ptarmigan (*Lagopus leucurus*)

This species is a Montana Species of Concern. This bird is common year-round in a variety of vegetation types in alpine areas of the Park. They have a completely white plumage in the winter making them inconspicuous and difficult to inventory. It is unknown whether this species occurs within the WAA.

Brown Creeper (*Certhia americana*)

This species is a level one priority species of Montana Partners in Flight. It is common year-round in mature coniferous forest east and west of the Continental Divide. Based on known habitat requirements, it is unlikely that this species occurs within the WAA.

Lewis's Woodpecker (*Melanerpes lewis*)

This species is a Montana Species of Concern. It is uncommon in spring and summer on both sides of the Continental Divide. Habitat types near the project site that Lewis's woodpeckers may occur in include burned coniferous forests and open riparian woodland (particularly cottonwood). It is unknown whether this species occurs within the WAA. There is no recently burned forest in the WAA, however; that may change with future wildfire activity.

AIR QUALITY

Glacier National Park is classified as a mandatory Class I area under section 162(a) of the Clean Air Act. The Clean Air Act gives the federal land manager and the park manager the responsibility for protecting air quality and related values, including visibility, vegetation, wildlife, soils, water quality, cultural resources, recreational resources and public health, from adverse air pollution impacts. Glacier is located in two air quality control regions: the Missoula Intrastate region west of the Continental Divide and the Great Falls Intrastate region east of the divide. The Missoula region is maintaining all national air quality standards except for fine particulate matter (PM10), and the Great Falls region is maintaining all standards except for carbon monoxide in the city of Great Falls. However, there are no major metropolitan areas within 125 miles of Glacier, and regional smog typical of highly populated areas with high vehicle use is absent. The International Air Quality Advisory Board's *Special Report on Transboundary Air Quality Issues* (1998) reported that visibility in the area is being affected by wildfires, prescribed fires, and industrial emissions from sources in the northern states and Canadian provinces on the boundary.

Air quality is considered good in Glacier National Park. Visibility is occasionally impaired by airborne particulate matter, including smoke from both natural and manmade fires and dust from unpaved roads. Sulfuric compounds, including sulfur dioxide and ammonium sulfate from industrial emissions, can also contribute to local haze. When inversions occur, visibility problems in the park can be more severe.

The annual visibility levels at Glacier National Park are approximately 84 kilometers, which is less than typical in the Central Rocky Mountains but greater than many eastern sites. Impaired visibility results from concentrations of fine particles suspended in the ambient air. Sampling performed in GNP from 1992 -1995 (Sisler 1996) found fine aerosol (i.e. sulfates, nitrates, organics, light-absorbing carbon, and fine soil particles) and coarse aerosol (i.e. larger dust particles) concentrations averaged 5.5 ug/m^3 each. There were no strong seasonal variations except for nitrate, which showed a strong winter peak, and coarse mass, which also peaked in the winter. Organics are by far the largest contributor to fine particle mass (58.4%) followed by sulfate (17.9%), soil (10.4%), light-absorbing carbon (7.7%), and nitrate (5.6%). The organic and soot particles originate from vegetative burning and urban sources; sulfates and nitrates originate from sources of sulfur dioxide and nitrogen oxides, such as power plants; and coarse mass and soils come from wind blown dust.

Sulfate and nitrate ion concentrations in precipitation measured at Glacier National Park are comparable on average to other sites in the northwestern United States but are very low compared to most sites in the eastern United States. In 2004, Glacier reported a sulfate ion concentration of 0.3 milligrams per liter (mg/L) and a nitrate ion concentration of 0.4 mg/L (National Atmospheric Deposition Program 2004).

The annual maximum 1-year ozone levels at Glacier National Park are lower than those measured at most of the other monitoring sites in the National Park System. Between 2002 and 2004, Glacier's annual highest daily 8-hour average maximum ozone concentration was 56 parts per billion (ppb). Glacier had no violations of the EPA standard of 85 ppb. Glacier's peak ozone levels are comparable to those measured at other national park system sites in the Pacific Northwest but are significantly lower than those measured in national parks system sites in southern California and in the northeast and east-central United States. In addition, Glacier's ozone levels are well below the U.S. Environmental Protection Agency (EPA) 8-hour average ozone standard designed to protect human health (NPS Air Resources Division 2004).

Winter inversions cause local increases in carbon monoxide at Kalispell, 32 miles south of West Glacier. Most of Flathead County's 70,000 residents live within 15 miles of Kalispell, the largest city in northwestern Montana. Emissions from automobiles and wood-burning stoves combined with winter meteorological conditions, cause seasonal increases in carbon monoxide (NPS 1998). Smoke and dust particulate can degrade regional air quality during the dry, hot summer months.

Sources of pollutants surrounding Glacier National Park west of the Continental Divide include industrialized areas south and west of the park and the rapid population expansion and building in the Flathead Valley. East of the Continental Divide, energy producing facilities along the east front, primarily north of the U.S. border, contribute to air quality pollutants due to a primarily northern air flow. Sources in Montana are under the authority of the state of Montana, which works closely with the Park on air quality issues. The United States and Canada are considering a variety of regional air quality management frameworks for managing this transboundary air quality issue. Air quality issues are the same throughout all of the Park's geographic areas within the park. Flathead National Forest shares the same air quality issues and sources of pollution as the Park.

NATURAL SOUND

An important part of the mission of the National Park Service is the preservation of natural "soundscapes" associated with national parks. Natural soundscapes are the unspoiled sounds of nature. Natural soundscapes are a significant resource and have intrinsic value as a part of the unique environment of Glacier National Park. Natural quiet is one of the central values of designated or proposed wilderness. The sounds of wind, water, falling snow, animals and other natural phenomena are present throughout the project area. In the winter months, the occasional, loud rumble of avalanches drowns out all other noises. Wildlife behavior is affected by unnatural sound and disturbance.

Human activities in the project area generate artificial noise that varies depending on time, season, and location. The greatest source of artificial noise near the project area is from train and road traffic. Elevated noise levels are concentrated around highway improvement projects, train operations, recreational areas, campgrounds, and private property. Airplane and helicopter overflights are heard periodically. Erratic gunshots from fall hunting on NFS lands can be heard in FNF and along the south boundary of GNP. Sounds during the winter months are softened by deep snow in the canyon. During the winter months, snowmobile traffic and snow removal machinery can be heard from pullouts and roads adjacent to the highway.

The regular noise associated with the highway and snowmobile trails quickly subsides as one moves further from developed areas. While sound may carry to the upper elevations of the steep canyon walls, sound dissipates quickly within the snowy, forested Park or Forest roadless areas. The low frequency sound of train traffic can carry up to 20 miles during the winter months.

Future development and activity outside the project area may contribute to changes in the natural soundscape. Resource extraction, logging, maintenance operations, and increased recreational activity are activities and operations that will change the ability to appreciate natural quiet in John F. Stevens Canyon.

CULTURAL RESOURCES

HISTORIC BUILDINGS, STRUCTURES, and CULTURAL LANDSCAPES

The Forest Service and National Park Service are required to comply with the National Historic Preservation Act of 1966 (NHPA) [Public Law 89-665], as amended. Section 106 of the NHPA states that Federal agencies with direct or indirect jurisdiction over Federal, federally assisted, or federally licensed undertakings afford the Advisory Council on Historic Preservation (ACHP) a reasonable opportunity for comment on such undertakings that affect properties included in or eligible for inclusion in the National Register of Historic Places (NRHP) prior to the agency's approval of any such undertaking [36 CFR 800.1]. Historic properties are identified by a cultural resource inventory and are determined as either eligible or not eligible for the National Register. Eligibility is reviewed, and concurrence given, by the Montana State Historic Preservation Office (SHPO). The undertaking's effects on historic properties are then assessed, and ways to avoid, minimize, or mitigate any adverse effects evaluated. This process takes place prior to any decisions that might restrict an agency's subsequent consideration of alternatives to avoid, minimize, or mitigate the undertaking's adverse effects on historic properties. The Forest participates in the Region One Programmatic Agreement (R1PA) with the Montana SHPO and the Advisory Council that provides for a more efficient process for conducting cultural resource inventories and meeting Section 106 compliance. Under the PA, if there are no eligible properties affected by the undertaking either through project redesign or because there are no properties located within the undertaking, then the undertaking is included in an annual report to Montana SHPO and compliance is completed without project consultation. However, if an eligible property is affected by the proposed undertaking, then compliance is completed in the standard way with consultation with the SHPO. Glacier National Park has a similar Programmatic Agreement and annual reporting requirements with the Advisory Council and the Montana SHPO. However, the Park's Agreement includes specified actions that may be undertaken without SHPO review, but subsequently reported annually to the SHPO.

The Flathead and Lewis and Clarke Forest Reserves were created Feb 22, 1897 and included lands in the Middle Fork (including all of what is now Glacier National Park). Glacier National Park was carved out of the east half of the forest reserve in 1910. The first road into the project area was a tote road built to support railroad construction and was maintained by locals after construction was finished. Construction of US Highway 2 along the historic tote route through the project area started in 1920 but was not completed until 1930.

Probably the single most important historic event for the project area is the construction of the Great Northern Railway through the canyon. The then named St. Paul, Minneapolis, and Manitoba Railway was based in Minnesota and for its first three decades was focused on building tracks to serve the growing farming communities in that state and into eastern North Dakota. By 1886 the railroad terminated in Minot, North Dakota with plans to continue building west into Montana to take advantage of the growing mines in and around Butte. Expansion further westward would depend on finding a viable route across the Rocky Mountains, Cascade Mountains, and on to Puget Sound. James J. Hill created a new company, the Great Northern Railway in 1889, to finance and manage the westward extension of the railroad.

The new company sought a direct route west from the Missouri River that would decrease the distance, open up new territory, and avoid the Northern Pacific Railway territory in central Montana. John Stevens and C. F. Haskell Both men explored and formally surveyed Marias Pass, the lowest pass across the Rocky Mountains, in the winter of 1889-90. This pass allowed the Great Northern Railway to build the railroad through what was later called John F. Stevens Canyon.

Construction of the westward extension of the Great Northern Railroad shifted into high gear once the route was finally located. In the spring of 1890, survey crews located the exact route of the roadbed and constructed tote roads for hauling supplies. Actual railroad construction started the following year with crews working from east and west. The summit was reached from the east by the fall of '91 and on December 31, 1891 the route was completed to Kalispell (platted in 1891 to be the division point for the new railroad). Construction west from Kalispell continued through 1892 and the last spike completing the line across the continent was driven at Scenic, Washington on January 6, 1893.

Construction supplies were hauled into the project area over primitive tote roads. Eastside crews came out of Havre and west side crews came up from Demersville. Work camps were located every so many miles along the canyon with special, triple-decker rolling bunkhouse and kitchen cars used by crews for living and eating. Crews worked on four bridges that took more than a year to complete crossing Two Medicine River, Cutbank Creek, the Middle Fork at Java (Nimrod), and the Middle Fork at Coram. Tunnels were blasted through the rock at Pinnacle, Kootenai Creek, and West Glacier. Crews laid the tracks and then constructed sidings, stations, snowsheds, and other structures. The steep avalanche paths to the north of the new railroad were an obstacle for the railroad from its inception. Photographic evidence indicates that the railroad was originally a single track through the project area and that there were earlier and less substantial snow shed structures that were replaced by the more substantial timber structures that exist currently.

A second track had been added to the railroad in the project area by the time the earliest existing snowsheds were constructed between 1912-1913. The existing snowsheds are massive timber and concrete structures that span both tracks and vary in length from 380 feet to 1,100 feet. Shed 7/7A was extended in 1919 and again in 1941. Sheds 10.5 and 11 were both constructed in 1923 and shed 4C was burned at some point in time. All are open-faced structures with concrete retaining walls on the upslope side and open timber-work sides and timber roof. The sheds are 36 feet wide and slope from 18 feet high at the face to 25 feet high at the back. There is a set of timber supports the length of each shed between the tracks. These are long, linear structures constructed with massive timber materials and are the defining characteristics when evaluating them for listing on the National Register of Historic Places.

Table 3-14. Existing snowshed lengths and avalanche path widths.

Shed	Existing Length (feet)	Additional Extension Needed	Avalanche Path Width (feet)	Comments and Date Built
Shed 4C (Burnout)	n/a	900' (Burned shed needs to be rebuilt	900'	This snowshed was burned and only the concrete retaining wall remains
Shed 4D	1,100'	None needed	1,100'	Built 1912 -1913
Shed 5	380'	100'	550'	Built 1912-1913
Shed 6	820'	None needed	800'	Built 1912-1913. Sheds 5 and 6 combined- date unknown
Shed 7/7A	1000'	150'	1,150'	Built 1913, extended in 1919 and 1941
Shed 8	650'	100'	800'	Built 1912-1913
Shed 9	400'	100'	500'	Built 1912
Shed 10	500'	350'	1,100	Built 1913 with 12' wide extension built onto full length of shed unknown date
Shed 10.7	670'	550'	1,200'	Built 1923
Shed 11	400'	150'	500'	Built 1923

The snow sheds and the entire railroad through the canyon have been recorded and evaluated as site 24FH350. The railroad itself has been evaluated elsewhere in Flathead County as eligible (Mt Department of Transportation, 1987; Federal Energy Commission, 2002, 2004; Lewis and Clark National Forest, 2004: all consensus determinations of eligibility) for listing on the National Register of Historic Places under criterion A through D for its association with events significant in local, regional, and national history. The snowsheds are both contributing elements of the historic railroad grade and are independently eligible for listing in the National Register under Criterion C for their architectural qualities. The coming of the Great Northern Railway was responsible for the existence of Kalispell and integral to the development of the Flathead Valley and northwest Montana. Its role in the history of the Northwest is no less crucial and beyond the scope of this document but the Great Northern Railway is locally, regionally, and nationally significant.

SOCIAL AND ECONOMIC RESOURCES

Socioeconomic Environment

Overview of Socioeconomic Environment

The choice of methods for mitigating avalanche risks to rail operations along the southern boundary of Glacier NP has the potential for impacting the socioeconomic environment on several very different scales. In the narrowest sense, the actions taken would occur within a short (approximately 6 mile) section of canyon surrounded primarily by federal lands. The actions chosen, however, would also have implications on a regional scale for BNSF and Amtrak operations outside of the John F. Stevens Canyon avalanche area. Additionally, large construction projects associated with mitigation of avalanche danger could affect local area economies.

The potential affected socioeconomic environment for this analysis includes effects to BNSF that are associated with avalanche control measures (direct cost of control), costs to BNSF of delays and damage due to avalanche hazard, costs and benefits to markets served by BNSF, Amtrak, travelers of US Highway 2 due to alternative methods of mitigation, and potential benefits to local economies due to BNSF expenditures for avalanche control.

BNSF Operation

Burlington Northern Sate Fe Corporation is a publicly-held corporation that, through its subsidiaries, provides rail transportation services in North America. BNSF has approximately 40,000 full-time employees. For the years 2002, 2003, and 2004, BNSF reported total annual revenues of between approximately nine and eleven billion dollars, and annual net income ranging between 760 and 816 million dollars.[1]

Within northern Montana, John F. Stevens Canyon, along the southern and western boundaries of Glacier NP, is a major transportation corridor. In addition to the BNSF Railroad lines, US Highway 2 winds through this canyon. The BNSF line through the canyon was built originally in 1891, and a second set of tracks was added in 1910 (Reardon et al. 2004). Currently the two BNSF tracks allow for simultaneous east and west train traffic. The average BNSF trains are approximately 6,300 feet in length. Over the last six months, an average of between 38 and 42 trains per day have passed through the canyon. This freight traffic has increased by approximately 35% over the last 4 years (personal communication, Lane Ross, BNSF).

In addition to the BNSF freight trains moving through the canyon during winter months, two Amtrak passenger trains (an eastbound morning train and a westbound evening train) pass over the tracks each day (Schedule published online at Amtrak.com).

BNSF Avalanche Safety Program

The potential for avalanches within the John Stevens Canyon area has necessitated that BNSF make choices between the risk of avalanche damage or delay and any costs that risk might entail, and costs associated with avalanche forecasting and mitigation. In essence, the implicit tradeoff is between preventative control costs on the one hand and costs associated with damage and delays on the other.

[1] Financial data from http://finance.yahoo.com/q/is?s=BNI&annual accessed on 2/14/06.

Not long after the rail lines through the canyon were built, avalanches were frequent enough that the Railroad built a series of protective snowsheds. These sheds, now in some cases approaching 100 years old, still provide significant protection from winter slides. However, some sheds have been destroyed by fire, or avalanche paths have widened rendering incomplete protection in several shed locations. Due to natural reforestation, some sheds, or portions of them, are no longer within slide paths.

Currently, BNSF augments existing snowshed protection with a warning system of signal wires (Table 3-15). These wires are tripped when a slide occurs in an unprotected location signaling trains to reduce their speeds and be prepared to stop in the event of an obstruction on the tracks.

Table 3-15. Snowshed and signal wire lengths currently in use within John F. Stevens Canyon. Source: compiled from Hamre and Overcast (2004).

Avalanche Path Protected	Path Width	Length of Signal Fence	Length of Snowshed
Burnout	900	750	-
Shed 4D	1100	-	1100
Shed 5	550	-	380
Shed 6	800	-	820
Shed 7	1150	100	1000
Shed 8	800	-	650
Shed 9	500	-	400
Jakes	600	600	-
Second Slide	440	440	-
Shed 10	1100	350	500
Path 1163	2112	2140	-
Shed 10.7	1200	550	670
Shed 11	500	-	400

BNSF reports that in 2004 costs associated with avalanche detection and avalanche debris removal within the canyon included approximately $340,000 for plowing, $5,000 for signal fence installation and repair, and $100,000 for contract services (Table 3- 16)[2].

[2] Information on 2004 BNSF costs related to avalanche detection and snow removal from personal communication, Mark Boyer, Manager of Maintenance Planning, BNSF, Havre, MT. Nov. 23, 2005.

Table 3-16. Estimated annual BNSF costs associated with avalanche prediction and detection in John F. Stevens Canyon.

Category of cost	Estimated annual cost
Costs of signal wire repair/replacement	$5,000
Costs for snowshed maintenance	$40,000[a]
Costs for snow removal	$340,000
Contract services	$100,000
Total	$485,000
[a] estimate from Hamre and Overcast (2004).	

BNSF Goods Transport Between Seattle and Chicago

Table 3-17 details the average daily transport of goods through Essex, MT for the period between November 2004 and April 2005. As the table shows, over 40% of the freight along this route during winter months is intermodal, transported by truck and train. An additional 20% are grain trains (either full or returning empty). Anther 12% consists of BNSF work and helper trains. Additional trains carry autos (5%), and passengers (Amtrak at 5% of daily use). It should be noted that 17.3% of use is intermodal traffic for priority UPS shipments.

Table 3-17. Average daily mix of trains through Essex, MT: November 2004 through April 2005. **Source: BNSF (August 18, 2005)**

Type of Train	Average number per day	Percent of daily traffic
Amtrak	2	5.0%
Bare table intermodal	0.7	1.8%
Grain	4.1	10.3%
High priority manifest	2.4	6.0%
Helper	4.3	10.8%
Normal priority manifest	3.4	8.5%
Premium intermodal	1.4	3.5%
Guaranteed intermodal	0.4	1.0%
Double stack intermodal	7.9	19.8%
Other unit train	0.2	0.5%
Auto train	2	5.0%
Work train	0.6	1.5%
Empty grain train	3.7	9.3%
High priority intermodal UPS	6.9	17.3%
Total Trains	40	100.0%

Transportation of hazardous materials by rail during periods of high avalanche danger within the John Stevens Canyon is of particular concern. Hazardous materials include any substance that could result in environmental contamination, if leaked. Table 3-18 lists the most common hazardous materials carried by the railroad and the number of loaded railcars of hazardous substances that traveled through John Stevens Canyon during the yearlong period from July 1, 2004 to June 30, 2005. By far, the largest class of hazardous cargo is designated as "freight-all-Kinds Hazardous Materials" (nearly 90% of all hazardous material cars). These are rail cars loaded with containers or trailers that contain a mix of hazardous and non-hazardous materials.

Table 3-18. Major classes and amounts of hazardous cargo carried by railcars in John F. Stevens Canyon: July 2004-June 2005.[a] Source: Edward Chapman, Director of Hazardous Materials, BNSF.

Description Of Car Contents	Number of Loaded Cars	Percent Of Cars With Hazardous Loads
Freight-all-Kinds -Hazardous Materials	40,287	79.77%
Elevated Temperature Liquid	2,059	4.08%
Diesel Fuel	1,918	3.80%
Propane	1,159	2.29%
Liquefied Petroleum Gas	889	1.76%
Flammable Liquid	709	1.40%
Alcohols	397	0.79%
Pentanes	336	0.67%
Ammonia- Anhydrous	268	0.53%
Carbon Dioxide- Refrigerated Liquid	221	0.44%
Sodium	138	0.27%
Hydrogen Peroxide- Aqueous Solutions- Inhibited	101	0.20%
Total Hazardous Loaded Railcars[b]	50,506	

[a] Data provided for substances with 100 cars or more per year shipped along route.

[b] Total includes substances with less than 100 cars per year shipped.

BNSF ACCIDENTS, DERAILMENTS, AND DELAYS

History of Avalanche Delays and Damage

The motivation for analyzing potential impacts associated with alternative methods of avalanche control within John Stevens Canyon is to mitigate some of the damage and delay costs associated with past avalanche events in the canyon. Reardon and Fagre (2005), and Hamre and Overcast (2004) examined the history of avalanche events within the canyon.

Data was compiled by Reardon and Fagre (2005) on the significant avalanche events (or cycles) during the 28 year reporting period from 1977-2004. During this period, there were seven significant events, which resulted in reported damage or delays to railroad operations (Table 3-19). These avalanche cycles spanned between one and four days in length.

The 7 avalanche cycles disturbing railroad operations that were seen over this 28 year period have an estimated average closure time per event of 39.6 hours including both BNSF and Amtrak operations. This estimate is likely an overstatement of actual delay impacts on BNSF operations as the calculation includes a 48 hour delay of only Amtrak traffic in 2003. There were no lengthy avalanche disruptions in 21 of the 28 recorded years between 1977-2004. The average disruption/delay per year is 7.1 hours.

Table 3-19. Historic record of lengthy avalanche caused rail delays and damage.
Source: Reardon and Fagre, 2005.

Date of Avalanche Peak	Days with recorded slides	Hours BNSF interrupted
2-12-1979	2	60
1-23-1982	2	unknown
2-8-1996	2	7
12-30-1996	3	18-72[b]
3-11-2002	1	Short
3-11-2003	4	48 Amtrak
1-28-2004	2	29
Average per major event	2.3	39.6[a]
Average per year (all 28 years)	-	7.1

[a] Data only used for the 79, 96, 03, and 04 events. Use of the 2003 48 hour Amtrak closure may overstate impacts on BNSF operations. Additionally, inclusion of the indeterminate "short" 2002 closure would likely reduce the average closure per event.

History of accidents and delays (Reardon)

[b] One-way traffic only for 72 hours.

Several factors complicate the use of historical events in estimating an average level of rail traffic disruption for use in comparisons involving new avalanche control programs. The primary problem involves the incomplete nature of record keeping associated with disruptions in rail traffic within the canyon. Additionally, snow removal methods have allowed faster clearing of tracks in recent years than in the past (pers. comm., B. Reardon, USGS).

In addition to the lengthy delays and substantial damage due to past avalanche events within John Stevens Canyon, trains routinely encounter short delays during winter months. These routine delays are not included in the avalanche caused delay Table 3-19.These delays are due to the need to reduce speed to a level where they are able to stop within one-half their range of vision. BNSF representatives estimate that during the prime winter season between January 10th and March 17th approximately 20 percent of the trains traveling through the canyon face an average 20 minute delay/slowdown due to avalanche concerns. BNSF further estimates that for 5 percent of the trains running during winter months, the delays result in additional costs due to the need to switch in fresh crews. (Personal Communication, Lane Ross, BNSF. August 4, 2005).

Economic Cost to BNSF from Avalanches and Avalanche Danger

The need for avalanche prediction, protection, and control measures within John Stevens Canyon arises from real risk associated with rail-avalanche accidents. Historic delays and accidents in the canyon have imposed very real costs on BNSF and Amtrak. These costs include costs of damaged trains, costs of clearing avalanche debris, and costs associated with closures and delays due to avalanches.

Evaluating the potential costs and benefits of the alternatives presented in Chapter 4, Environmental Consequences requires first that estimates of current, unmitigated costs associated with avalanche danger in the canyon be estimated. Table 3-20 shows the major classes of costs faced by BNSF and Amtrak associated with avalanche risk in John Stevens Canyon. Some of these costs, such as those associated with avalanche detection systems or snowshed maintenance can reasonably be expected to continue.

Table 3-20. Categories of costs associated with avalanches and avalanche danger

Cost category	Description
Delays or travel restrictions	Costs associated with delayed transport of goods due to avalanche-caused track closure or excessive avalanche risk. Costs may include increased personnel costs as well as increased train operation costs and costs associated with late delivery of freight.
Train or Rail damage	Costs associated with accidents involving trains and avalanches. Costs include damaged rail cars, injury or death to rail workers, and damage to tracks or roadbed.
Snow / Debris Removal	Costs associated with plowing and removal of avalanche snow and debris that has blocked the rail line
Avalanche prediction, detection and protection systems	Costs associated with detecting avalanches (signal wires) and building and maintaining snowsheds

Costs associated with rail delays

Estimation of the baseline level of costs incurred by BNSF due to short delays or restrictions is necessarily based on assumptions of average levels of avalanche danger over the winter. As noted above, BNSF estimates that during the January 10 through March 17 prime winter avalanche season approximately 20 percent of trains face a short delay averaging 20 minutes, and 5 percent face additional costs from delays associated with the need to bring in fresh crews. Table 3-19details estimation of annual costs to BNSF arising from these short delays associated with avalanche danger.

Table 3-21 outlines the estimation of direct costs to BNSF associated with these relatively short winter delays. Based on current winter train traffic levels and information on delay costs provided by BNSF (Personal Communication, Lane Ross, BNSF). Aug. 4, 2005), they estimated that direct costs to BNSF associated with minor winter delays are in the range of $340,000 per winter.

Table 3-21. Estimated annual cost associated with short delays and travel restrictions due to avalanche danger. Source: Personal Communication, Lane Ross, BNSF. Aug. 4, 2005.

Winter season trains per day	38
Days during Winter season	66
Total Winter season trains	2,508
Percent of trains facing a short delay averaging 20 minutes	20%
Number of trains facing short delays	502
Costs associated with short delays[a]	$100,400
Percent of trains facing additional costs due to need for fresh crews	5%
Number of trains facing additional costs	125
Costs associated with delays necessitating fresh train crews[b]	$237,500
Total estimated costs due to short delays or restrictions	$337,900

[a] Delays of trains are estimated to cost $600/hour
[b] Estimated to cost an additional $1900 per train.

Costs associated with lengthy avalanche risk and accidents

The primary goal of all precautionary measures taken by BNSF regarding winter operations through John Stevens Canyon is avoidance of avalanche-related rail accidents, such as occurred in the 2004-05 winter. The measure of the effectiveness of any avalanche risk mitigation measures undertaken by the railroad is the degree that potential accidents are avoided. A cost/benefit analysis of an avalanche mitigation measures package would compare the dollar cost of those measures to the benefit gained in reduced costs associated with avalanche risk. Two estimates were derived in developing the baseline level of risk (and associated costs) of avalanche-related rail accidents within the canyon.

The first estimate, shown in Table 3-20, is based on assessments of risk and costs presented by Hamre and Overcast (2004). While the estimates below are presented as annual averages, implicit in these estimates is the understanding that accidents involving avalanches and railcars within the canyon are very infrequent. Many years can pass without accidents. Hamre and Overcast (2004) estimated the frequency of various types of rail cars being hit by an avalanche within the canyon. These estimates are based on train frequency and the length of time each type of car is exposed to avalanche danger during the winter season. Table 3-20 shows that Hamre and Overcast (2004) estimate that on average 2.75 freight cars would be struck by avalanches each year. On the other end of the spectrum, it is estimated that a mini dozer (a small bulldozer) would be hit approximately every 350 years. Multiplying the estimated annual frequency of accidents for each type of rail car by the estimated cost associated with each type of car being hit yields an estimated annual cost associated with the current unmitigated avalanche risk within the canyon.

Added to this estimated annual cost of damage and injury is the additional estimated cost to BNSF due to delays on the line. The estimate of $25,000 per year is based on an average annual delay due to avalanche closures of 7.1 hours (Table 3-19) and the recognition that with each passing hour another train from each direction is likely affected and delayed.

Table 3-22 shows an estimated total annual cost associated with substantial damage and delays from avalanches within the canyon of approximately $1.6 million dollars. As noted above, this estimate represents an annual average, while actual yearly costs may range from zero in many years to $25,000,000 or more for a very bad accident.

Table 3-22. Estimated hypothetical costs associated with avalanche related derailments / accidents. Source: Derived from Hamre and Overcast (2004).

Class of Rail Car	**Cost per Accident**[a]	**Estimated cars hit / year**[b]	**Average Estimated Cost per year**
Freight Car	100,000	2.752	275,000
Locomotive	3,000,000	0.15	450,000
Passenger car	25,000,000	0.035	872,000
Mini Dozer	2,000,000	0.003	6,000
Total Estimated annual Cost of accident damage and injury			1,603,000
Estimated delay cost of an annual average 7.1 hour delay due to avalanches[c]			25,000
Total estimated annual costs to BNSF from major avalanche events			1,628,000

[a] Loss to equipment and life costs from Hamre and Overcast (2004) pp. 42-43.

[b] Encounter probability estimates from Hamre and Overcast (Figure 3.4, pg. 44)

[c] Based on an annual average delay of 7.1 hours from major slides (Table 3.17)

Hamre and Overcast note that their computed encounter probabilities (estimated railcars hit per year) are somewhat higher than shown by accidents that have actually occurred. They suggest that the actual accident rate is lower than their predicted accident rate because of closures forced on the line by avalanche events (Hamre and Overcast 2004 p.43). As an alternative estimate of average annual risk/cost associated with avalanche-related rail accidents in the canyon, a second baseline cost estimate is presented in Table 3-21. This second estimate of baseline risk (and associated cost) is based on actual rail accidents that have occurred within the canyon due to avalanche danger.

Over the 28 year period from 1977 to 2004, there have been one major and several minor avalanche-related rail accidents. (Personal Comm. Blase Reardon, USGS, W. Glacier Aug 22, 2005). The largest accident occurred in 2004 when an empty freight train was stopped within the canyon by one avalanche and was hit by another avalanche while it was stopped. This accident resulted in the loss of 15 grain cars (Hamre and Overcast 2004 at p.1).

In addition to the 2004 incident, a locomotive was damaged in 2003 when it was struck by avalanche debris. In addition to the 2003 and 2004 rail incidents, several avalanche-caused accidents involving vehicles on US Highway 2 also occurred during this period. In the winter of 1996-97, a BNSF train was stuck in avalanche debris near snowshed 4c.

Table 3-23 shows the calculation of average costs associated with rail/avalanche accidents during the 28 year period. On average, there has been less than $100,000 in rail damage per year due to avalanches during this period. It must be noted that the estimates of average annual avalanche-related accident costs shown in Table 3-23 are based on available information on accident costs. No comprehensive source of avalanche caused train and rail damage was available for this analysis. Estimates are therefore based on public records (such as news accounts) and communication with current and former BNSF employees. To the extent that incidents of avalanche-related train damage have been missed in this analysis, the associated cost estimates will be underestimated.

Table 3-23. Estimated costs associated with avalanche related derailments / accidents: Based on 1979-2004 accident records. Based on conversations with Blase Reardon, USGS, August 22, 2005.

Date	Incident	Estimated incident cost	Average annual cost
2003	Locomotive damaged by avalanche debris	2,500[a]	
2004	15 empty grain cars destroyed	1,500,000[b]	
Average annual cost 1979-2004		--	54,000
annual	Estimated delay cost of average 7.1 hour delay	--	25,000
Total average annual cost		--	79,000

[a] Personal Comm. Mark Boyer, BNSF.

[b] Based on Hamre and Overcast (2004) estimate of value of typical rail car ($100,000)

Comparison of the estimated average annual rail costs associated with avalanches in John Stevens Canyon show a wide range between the hypothetical cost estimate based on avalanche encounter probabilities of $1.6 million and the estimate of $79,000 per year based on the historical accident record. The large difference between these two estimates likely arises from two sources. The high end estimate (based on Hamre and Overcast, 2004) assumes that train traffic does not react to avalanche danger. That is, the trains keep running and the tracks are immediately cleared of snow and debris. In actuality, slides may often block the tracks during high danger periods stopping rail traffic and thus eliminating or reducing risk during the periods of the highest likelihood of accident. A second source of the large range in the estimates is that cost estimates at the high end are largely driven by low probability events. For instance, over one-half of the estimated $1.6 million in annual costs is associated with accidents involving Amtrak passenger cars. Hamre and Overcast note (p. 44) that the most likely scenario is that several passenger cars would be hit at once by an avalanche roughly every 100 years. Therefore, the likelihood is relatively low that this type of accident (and its associated costs) would be contained within our 28 year period of record.

While the range of estimated annual costs associated with avalanche/rail accidents in the canyon is very wide, it does provide two points for comparison. One based on recent observed accident rates, and the other based on high-end estimates of risk and exposure to avalanche danger.

Total Estimated Current Costs Associated Avalanche Risk

Table 3-24 summarizes the current level of costs associated with avalanche danger faced by BNSF and Amtrak within the John Stevens Canyon. The total estimated annual average cost to BNSF associated with avalanche risk ranges from approximately $900,000 to $2.45 million.

Table 3-24. Current estimates of costs and risk associated with rail travel through avalanche zones of John F. Stevens Canyon.

	Estimated Annual Cost	
Cost/ Risk category	**Low**	**High**
Estimated Costs of Minor Train Delays or Travel restrictions	337,900	337,900
Estimated Risk/Cost of Avalanche caused Train or Rail damage	79,000	1,628,000
Cost Snow / Debris Removal	340,000	340,000
Cost Snowshed maintenance	40,000	40,000
Cost Avalanche prediction/detection systems	105,000	105,000
Total Estimated Cost	901,900	2,450,900

Recreational Use of Winter Trails

Table 3-25 shows a 10 year series of winter trail use estimates for the three specific trails, which would be closed during use of artillery. Visitor logs for the Fielding trailhead are unreliable because the sign-in register is difficult to find and many people bypass it. Rangers in the area estimate that the register logs for the Autumn Creek trail provide good estimates for the Fielding trailhead (Pers. comm. K. Johnson, August 16, 2005). Table 3-25 shows approximately 800 to 1,000 winter trips are made on the potentially affected trails in a typical winter season.

Table 3-25. Estimated winter trail use for Ole Creek, Scalplock, and Fielding trails: 1995-2004.

Year	Ole Creek and Scalplock Individual Winter Trips	Fielding Trailhead Individual Winter Trips[a]
1995	217	548
1996	109	450
1997	116	374
1998	152	485
1999	263	573
2000	342	793
2001	383	658
2002	212	406[b]
2003	212	549
2004	212	601

[a] Fielding use estimated as equal to Autumn Creek trail use.

[b] January data missing.

US Highway 2 Winter Traffic Levels

Table 3-26 below shows the average daily traffic at the West Browning traffic counter for January through March in the years 2000 though 2004. Overall, an average of approximately 1,150 vehicles per day crosses this counter during these winter months.

Table 3-26. Average daily January-March traffic at MDT West Browning traffic counter.

Year	West of Browning Traffic (counter A-36)
2000	1170
2001	1139
2002	1037
2003	1201
2004	1195
5-year average	1148

REGIONAL AND LOCAL COMMUNITIES

The affected socioeconomic region is defined as the two-county area of Flathead, and Glacier Counties. The BNSF rail-line passes through these two primary counties on its approaches to Marias Pass and the John Stevens Canyon. This section discusses economic, employment and demographic characteristics for this two-county area.

Economy

The foundation of the regional economy is mainly based on tourism, agriculture and regional trade. Tourism is a large part of the regional economy and has dramatically increased during the last several years, as this region has become one of Montana's leading tourist destinations.

Production of agricultural goods, including hay, wheat, barley, some hardy fruits and livestock, has been a traditional base of the local economy. Kalispell is approximately 32 miles from the park's entrance at West Glacier. Kalispell has become the main trade center for northwest Montana and is important to regional economic activity. Flathead County has a diverse economic structure, while Glacier County has more concentrated economic sectors. In addition to a wide range of recreational opportunities and tourism related businesses, Flathead County has a variety of manufacturers, a concentration of professional services serving the region, growing numbers of second-home residents and a developing focus on visual and performing arts. Tourism and agriculture are the main drivers of the economy of Glacier County.

Employment

Employment by economic sector for Flathead and Glacier Counties is shown in Table 3-27 and 3-28. Most jobs related to the tourism and recreation industry are in the retail trade and services sectors of a county's economy. Average annual unemployment in the two-county area is 5.7%. This is somewhat higher than the state average of 4.4%, mostly because of the seasonal character of the local economy. Due to the large tourism basis of the local economy, employment varies seasonally in the three-county area (www.bls.gov).

Table 3-27. Total full and part-time employment by industry (2003): Flathead and Glacier Counties.

Economic Industry	Flathead County	Glacier County
Farm	1,124	538
Agriculture[a]	946	(D)[b]
Mining	299	141
Construction	5,250	266
Manufacturing	3,519	29
Transportation, Communications & Utilities	2,194	233
Wholesale	1,020	109
Retail	7,178	571
Finance, Insurance & Real Estate	4,733	(D)[b]
Services	21,853	1,379
Government	4,832	2,232

[a]Includes Agriculture, Forestry and Fishing

Source: Regional Economic Information System, U.S. Bureau of Labor Statistics

[b](D) Information not disclosed due to small number of reporting entities.

Table 3-28. Labor force and unemployment statistics for Flathead and Glacier Counties: 2004. Source: www.bls.gov . Accessed Aug 2, 2005.

Statistic	Flathead County	Glacier County
Labor Force	41,868	5,942
Total Employees	39,625	5,466
Total Unemployed	2,243	476
Unemployment Rate	5.4%	8.0%
Montana Unemployment Rate	4.4%	

Population and Income

In terms of population, Flathead and Glacier Counties show two distinct patterns in recent years. Table 3-29 shows that Flathead County has seen a robust population growth of 25.8% over the 1990 to 2000 period while Glacier County grew less than half as quickly (a 9.3% population growth over the decade). In terms of per capita income, Flathead County was $25,406 in 2003 while Glacier County per capita income was $18,549 in that year.

Table 3-29. Population and personal income characteristics, Flathead and Glacier Counties. Source: www.bea.gov/bea/regional Accessed Aug. 1, 2005.

Statistic	Flathead	Glacier	Montana
Population (2003)	79,485	13,250	917,621
Population change 1990-2000	25.8%	9.3%	12.9%
Per capita personal income (2003)	$25,981	$18,549	$25,406
Population per square mile	14.6	4.4	6.2

Sources of Personal Income in Key Industries

The two primary industries that may be affected by actions covered under this EIS are rail transportation, heavy and civil engineering construction. The link to rail transportation is clear, and construction may be impacted to the extent new snowsheds are built by BNSF. Table 3-30 shows 2003 personal income in Flathead and Glacier Counties attributable to these two industries.

Table 3-30. Key industry sources of personal income in 2003, Flathead and Glacier Counties. Source: www.bea.gov/bea/regional/reis Accessed July 28, 2005.

Industry	Flathead	Glacier
Rail Transportation	26,177,000	1,361,000
Heavy and Civil Engineering Construction	27,989,000	(D)
Total County Personal Income	2,064,848,000	246,288,000
(D) information not disclosed due to small number of reporting entities.		

HEALTH AND SAFETY

Natural avalanche processes have posed a safety risk to the railroad and US Highway 2 in John F. Stevens Canyon since the transportation corridor was established. Forest fires in the early 1900's removed trees and vegetation providing anchor points for snow laden avalanche paths. Avalanche hazard increased in areas with starting zones below timberline. BNSF built several snowsheds beginning in the early 1900's to reduce avalanche risk to trains and personnel. The snowsheds effectively protected trains and employees in avalanche paths that posed the greatest risks. Since that time, vegetation in specific avalanche paths has successfully regenerated. Several avalanche paths that were protected by snowsheds have become wider than the snowshed protected zone, leaving vulnerable areas at the snowshed openings. There are currently 8 snowsheds in the project area protecting 4,820 feet of railroad tracks.

There have been 81 historic reports of avalanche incidents that interrupted train or vehicle traffic in the canyon between 1910 and 2004 (Reardon et al. 2004). Several avalanche caused accidents have affected the railroad and highway since 1929. Avalanche reports were compiled by Blase Reardon in a paper called *Natural Avalanches and Transportation: A Case*

Study From Glacier National Park, Montana, USA. Three men were killed when a mail train was derailed and rolled downslope March 4, 1929 (Kalispell Weekly News 1979). A 1947 derailment of a syrup tanker car resulted in bears feeding on the spill for weeks (Glacier National Park 1947). Two railroad workers were buried by avalanche and rescued in 1950 (Hungry Horse News, January 27, 1950). The Goat Lick Bridge on US Highway 2 was removed by large wet avalanches in February 1979 (Martinelli 1984). In 1997, a railroad worker was hit by an avalanche while driving a truck on US Highway 2 (Reardon et al. 2004).

The current safety issues have evolved from stricter state and federal employee safety guidelines, BNSF's lower tolerance for risk factors, and greater risk exposure due to more train traffic. BNSF employees are held to guidelines and risk management laws under National Institute of Occupational Safety and Health (NIOSH) and Occupational Safety and Health Administration (OSHA) that protect employees from identified hazardous working conditions. The request for avalanche hazard mitigation measures on NPS lands originated from an avalanche cycle in 2004 that compromised worker safety and derailed a train.

After the 2004 avalanche collision and train derailment, BNSF contracted with Chugach Adventure Guides, an avalanche hazard reduction company, to compile an avalanche risk analysis of the John F. Stevens Canyon area. Dave Hamre and Mike Overcast of Chugach Adventure Guides compiled the avalanche atlas. The avalanche hazard index (AHI) provides a standardized, well-accepted tool to compare avalanche hazards in different locations with site-specific variables. The variables that are inserted into several equations are based on formulas in *The Avalanche Hazard Index* by Peter Schaerer. The hazard index is a function of past avalanche path magnitudes, avalanche path width, past frequency of avalanche occurrence, relative timing of adjacent avalanches, and length of traffic exposure in the area. The hazard index of each avalanche path posing risk to a transportation corridor is compiled to generate an overall avalanche hazard index for a given traffic corridor. The total AHI for the railroad in the project area is 110.45, a sum of the individual values for each path. Table 3-1 lists the AHI values for each avalanche path in the project area. It is noteworthy that an increase in railroad traffic will increase the AHI for the whole canyon. The AHI is not a static number, but it increases with greater numbers of trains or length of trains and decreases with less train traffic and shorter trains.

A compilation of 22 years of historic avalanche records beginning in 1910 from the National Park Service (NPS), Montana Department of Transportation (MDT), and BNSF provides past frequency and magnitude of the avalanche paths within the activity area. The historic record is provided in Appendix B of this document. The *Avalanche Risk Analysis John F. Stevens Canyon Essex, Montana* states that the historic record is not consistent after 1932 and the recorded information is intermittent. The report states that there is simply not enough reliable information for hazard analysis in records kept after 1932. A fire in 1910 swept through the canyon, removing vegetation. Some of the avalanche risk has been reduced by vegetation regeneration anchoring snow in previously hazardous avalanche paths. Approximately 200 tree ring cores were taken from most of the avalanche paths to determine avalanche periodicity. Tree core results were combined with old records, topography, and current vegetative cover to derive avalanche frequency and magnitude. The report states, "there are inherent inaccuracies in combining these methods to derive these important parameters." Therefore, the avalanche hazard index values in Table 3-1 may be different if the analysis were to be prepared with current avalanche information and mitigation measures implemented by BNSF.

The hazard analysis provides recommendations for avalanche risk reduction and BNSF has developed a full avalanche forecasting and training program. BNSF has hired an Avalanche Safety Director (ASD) who manages the avalanche safety program and updates the Avalanche Safety Operations Plan (Appendix C). The ASD conducts avalanche forecasting, non-explosive stability testing, and weather monitoring. The ASD provides avalanche safety and rescue training for all personnel working in the project area. The ASD evaluates the avalanche hazard level and recommends restrictions on the railroad during high avalanche risk periods. Railroad hazard operations involve restricting traffic on one or both tracks along the railroad during periods of high avalanche potential.

The hazard analysis examined the risk to certain types of employees and found that signalmen have the highest exposure to avalanche hazard as they frequently fix signal wire in the avalanche paths during or after avalanche activity occurs. The ASD has reduced avalanche exposure for these employees by allowing signalmen to work on signal fencing only when conditions are safe and ensuring rescue personnel are present. Increased avalanche safety training and awareness may change the behavior of BNSF employees, reducing the possibility for injury or death.

Table 3-31 provides a comparison of the AHI for the railroad in John F. Stevens Canyon (mitigated by existing snowsheds) with unmitigated AHI values for other transportation corridors in North America where avalanche hazard reduction is conducted. This is not an exhaustive list of hazardous travel corridors; it is merely a method of comparing the John F. Stevens railroad corridor hazard with that of other travel corridors. Explosive use by various methods (artillery, GasEx, helicopter delivery, handcharges, Avalauncher) is used on all of these travel corridors.

Table 3-31. Comparison of transportation corridor avalanche hazard indices (Compiled from AES, 2004)

Transportation Corridor	Unmitigated AHI	Explosive Use	Structural Mitigation
Rogers Pass, BC	1004	X	X
Red Mountain Pass, CO	335	X	X
East Lynn, AK	205	X	X
John F. Stevens Canyon (Railroad Corridor), MT	111		X
Coal Bank/ Molas, CO	109	X	
West Lynn, AK	100	X	X
Berthoud Pass, CO	93	X	
Coquihalla, BC	90	X	X
Loveland Pass, CO	80	X	
Wolf Creek Pass, CO	54	X	X
Silverton-Gladstone, CO	49	X	
Teton Pass, WY	47	X	
Lizard Head Pass, CO	39	X	

Montana Department of Transportation provides safety for travelers on US Highway 2 through the 511 Montana Road Reports. Occasional closures of the highway occur when weather conditions warrant. MDT closes US Highway 2 if hazardous weather or avalanche conditions develop. The operations plan for this closure is at the following website http://www.mdt.mt.gov/publications/docs/manuals/mmanual/chapt8c.pdf.

Winter recreational visitors to Glacier National Park and the Flathead National Forest and surrounding wilderness areas are encouraged to use proper equipment and to use resources such as the Glacier Country Avalanche Center for updated information as to avalanche conditions and activity. Park rangers provide current information on snow conditions to backcountry overnight travelers and to day use visitors when requested. Visitors to wilderness areas are responsible for their own safety and risk avoidance is one of the tenets of wilderness travel.

WILDERNESS

Glacier National Park completed a study and environmental impact statement in 1973 to comply with the 1964 Wilderness Act. That document, subjected to public review, recommended that over 90% of the park should be designated as wilderness. President Nixon forwarded that recommendation to Congress on June 13, 1974. A bill was subsequently introduced to designate the land as wilderness. That bill was never enacted, but since that time, the lands have been defined as recommended wilderness and managed as designated wilderness by the NPS. NPS policy requires management of proposed or recommended wilderness as designated wilderness until the land is either formally designated or formally rejected by Congress. Until that time, all the area identified as recommended wilderness will continue to be managed as wilderness. Amendments to the wilderness recommendation of 1974 were made in 1984 and 1994 that made minor adjustments to the original proposal and increased the amount of proposed wilderness to 95% of the park's total area (NPS 1999). Wilderness in Glacier National Park is defined as lands that are essentially undeveloped or are natural in character and lie at least 250 feet from established roadways and development zones (Map 1)

The Great Bear Wilderness area lies south of the project area and comprises 286,700 acres of the Flathead National Forest. The wilderness was designated in 1978. The Great Bear Wilderness, along with the Bob Marshall Wilderness and Scapegoat Wilderness, make up the 1.5 million acre Bob Marshall Wilderness Complex.

The Wilderness Act of 1964 provides the foundation for the management of both the proposed NPS and designated NFS wilderness areas. The general wilderness guidelines promote natural processes and allow humans only as temporary visitors. No motorized travel or tools are permitted in wilderness areas. Visitors are encouraged to comply with "leave no trace" practices that minimize human impact on resources. Federal land managers are required to manage wilderness by determining if an activity contributes to the management of wilderness and therefore is appropriate and if the activity utilizes the minimum tool for project implementation. For example, the use of motorized tools, helicopter flights or the installation of structures or equipment must undergo a vigorous minimum tool analysis and review before they would be authorized to proceed.

Public law 88-577 established a national wilderness preservation system and describes wilderness with the following language:

> A wilderness … is…an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain. An area of wilderness is further defined to mean… an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions and which: 1) generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable; 2) has outstanding opportunities for solitude or a primitive and unconfined type of recreation; 3) has at least 5,000 acres or land or is of sufficient size as to make practicable its preservation and use in an unimpaired conditions; and 4) may also contain ecological, geological, or other features of scientific, educational, scenic or historical value.

Recommended wilderness in Glacier National Park includes the area north of the NPS boundary (edge of the railroad right-of-way) in John F. Stevens Canyon. The project area within Glacier lies within recommended wilderness (Map 1) The Great Bear Wilderness boundary lies mid-slope on the south side of the canyon. Wilderness areas near the project area are affected visibly and audibly by highway traffic, railroad traffic and some private development. There is evidence of development from high elevation vantage points along the canyon walls. As one moves away from the railroad and road corridors, the wilderness values that they come to expect within designated or proposed wilderness are maintained.

VISUAL RESOURCES

Both US Highway 2 and the railroad traverse through approximately 47 miles of the John F. Stevens Canyon (hereafter in this section will be called the canyon). The canyon offers a tremendous variety of scenery viewing related opportunities: driving for pleasure, wildlife viewing, hiking, floating, fishing, hunting (only on the National Forest side of the canyon), and winter sports of snow shoeing, cross-country skiing, and snowmobiling (on the National Forest side of the canyon). Most of the canyon is a scenic, narrow, travel corridor with landscapes of green forested mountainsides, recently burned areas, and rugged, snow-covered mountains rising in the distance. The Congressionally designated Wild and Scenic Middle Fork of the Flathead River braids its way through the western portion of the canyon. Vehicle and train passengers will observe deep green pools and shallow whitewater riffles along this portion of the canyon. Wildlife such as elk, deer, moose, and bears are commonly visible as part of the scenery along the travel corridor. The western-most boundary of the canyon is located at West Glacier, the main western entrance to the interior of Glacier National Park, and the eastern-most boundary of the canyon is located on the Continental Divide at Marias Pass.

Several thousand vehicles per day are estimated to travel on US Highway 2 through the canyon during the summer months and about half that amount during the winter months. US Highway 2 provides the northern-most access across the State of Montana and connects the east and west sides of the Rocky Mountains. US Highway 2 is also used often by summer visitors to Glacier National Park to access a different portion of the Park instead of traveling over the Going-to-the Sun Highway in the interior of the Park. Various tourism commissions, community members, and the Forest Service have recently designated the John F. Stevens Canyon as part of a larger 400-mile loop called the Northern Continental Divide Scenic Loop.

Amtrak provides passenger service along the railroad between Chicago/Minneapolis/St. Paul and Seattle/Portland via northern Montana. Amtrak operates a daily west bound train in the canyon during the early evening hours as well as a daily east-bound train traveling during the early morning daylight hours. Each train is capable of carrying up to 275 passengers.

The project area or the area that would be affected by the proposed alternatives includes a 6-mile stretch of the canyon where Bear Creek enters from Glacier National Park and flows into the Middle Fork Flathead River. There are currently 9 snowsheds, which total a little over a mile in length (about 5900 feet) within the project area. All of these snowsheds are located on the north side of US Highway 2. The existing railroad alignment and the majority of snowsheds are visible from numerous locations along US Highway 2. Snowsheds and portions of the highway can also be viewed by railway passengers. Only one snowshed (on the south side of US Highway 2 across from the Walton Ranger Station) is located outside the project area. Snowsheds were built over several decades starting in the early 1900s and have been intermittently extended or connected. The railroad and snowsheds are considered by some as a scenic and historic feature of the landscape. This is the only place in the United States where a group of historic railroad snowsheds is visible from a highway corridor.

Private property development within the project area consists of widely scattered family ranches, summer cabins, guest accommodations, and recreational facilities. Most sheds are not directly viewable to adjacent landowners other than the Burn Out shed (Shed 4C). This shed was consumed by a previous fire and all that remains is the cement wall above the tracks.

The Devil Creek Campground, a Forest-Service run campground, is located within the project area. It is operated during the summer, approximately from Memorial Day weekend in May to Labor Day weekend in September.

The following photos in Figure 3-9 show the critical viewpoints in the project area based upon the ability for one to see the train tracks and snowsheds from the US Highway 2 corridor – these viewpoints will be used to assess the effects of the various avalanche hazard reduction alternatives:

Figure 3-9. Synopsis of Viewpoints from US Highway 2

Viewpoint #1 - View of Burn Out (4C) concrete snowshed (Shed 4C)

Viewpoint #2 – View of Snowsheds 5 and 6 on the left and Snowshed 4D on the right

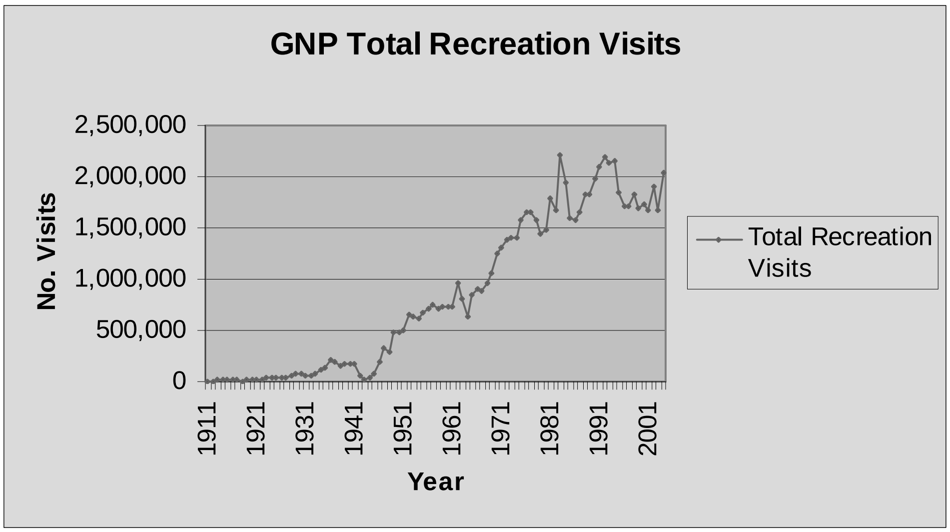
Viewpoint #3 - Shed 9

Viewpoint #4 - Shed 8

PUBLIC USE AND EXPERIENCE

In the past ten years, Glacier National Park visitation has ranged between 1.7 and 2.1 million. The highest recorded visitation was 2,204,131 for 1983. Visitation has fluctuated over the years but the number of visitors has steadily increased since the park opened in 1911. The Flathead National Forest does not have formal seasonal visitor use records; however, the Forest provides recreational activities and destinations over a huge area for thousands of Montana residents and out-of-state visitors per year. Figure 3-10 illustrates the annual Glacier National Park visitation levels since the park was created in 1911.

Figure 3-10. Annual Glacier National Park recreational visits 1911-2004.



During the winter months, the public can access the Going to the Sun Road from the west entrance as far as Lake McDonald Lodge and from the East Entrance to Rising Sun. US Highway 2 allows automobile access to winter recreation areas in John F. Stevens Canyon and the mountains along the continental divide. Recreation activities such as backcountry skiing, cross country skiing and snowshoeing are popular for winter visitors on NPS and NFS lands. Snowmobiling on groomed tracks is permitted on NFS lands south of the project area. Snowmobiling is not permitted in GNP.

Winter recreational use along the US Highway 2 corridor has increased over the past decade. Winter use statistics from businesses that provide guided trips in the park in the Middle Fork and Bear Creek areas have shown an 87% increase in guided visitor trips into the backcountry from 1993 to 2004 near the project area (Table 3-32). The commercial trips in the table are from Autumn Creek, Ole Creek, Scalplock, Marias Pass, Fielding, and 3 Bears Lake trail destinations. The commercial use from 1993 through 2005 was through Izaac Walton Inn and Glacier Park Ski Tours. Additionally, in the winter of 2002/03, Big Mountain Resort received a commercial use permit to guide ski trips in Glacier National Park.

Table 3-32. Commercial business winter use statistics - individual winter trips

Year	December	January	February	March	April	Year Total
1992/93	N/A	41	37	36	0	114
1993/94	9	25	31	35	4	104
1994/95	23	57	33	0	0	113
1995/96	12	34	59	39	0	144
1996/97	32	29	54	78	9	202
1997/98	8	48	63	49	3	171
1998/99	84	55	97	136	0	372
1999/00	22	59	59	49	13	202
2000/01	28	32	122	47	3	232
2001/02	24	43	92	44	6	209
2002/03	7	62	80	38	6	193
2003/04	61	38	107	46	8	260
2004/05	36	2	98	66	3	205

Trail registers at the Walton Ranger Station, Fielding trailhead, and Autumn Creek trailhead show steady use of winter trails from 1995 to 2004 (Table 3-33). According to the 1999-2004 State of the Backcountry Reports for Glacier National Park, registration numbers from the Fielding trailhead are not an accurate representation of the use of that area. Many winter recreationists bypass the trailhead to use a shortcut across private property and do not sign the register. The actual winter use numbers for the Fielding trailhead are probably close to those of Autumn Creek. Backcountry skiers recreate regularly on Elk Mountain, Shields Mountain, and Snowslip Mountain.

Table 3-33. Winter trailhead registrations per year

Year	Walton Ranger Station Trailhead [1]	Fielding Trailhead[2]	Autumn Creek Trailhead[3]	West Lakes District Total Use[4]
1995	217	41	548	3226
1996	109	No data	450	2467
1997	116	No data	374	2444
1998	152	No data	485	2802
1999	263	No data	573	3478
2000	342	40	793	3478
2001	383	40	658	3569
2002	212	45	406 *	3275
2003	212	52	549	3751
2004	212	52	601	3947

*missing January data

[1]Walton Ranger Station Register: Ole Creek, Scalplock Lookout Trail, Park Creek

[2]Fielding Trailhead: Shields Mountain, Elk Mountain, Ole Creek

[3]Autumn Creek: Autumn Creek, Three Bears Lake, Little Dog, Blacktail Hills, Lubec, Up Trail, East Glacier

[4]West Lakes District: Polebridge Entrance, Logging Creek, Kintla Lake, Quarter Circle Bridge, Camas Road (north), Camas Entrance, Going to the Sun Road (head of Lake McDonald), Sperry Trailhead, Walton Ranger Station, Fielding Trailhead, Autumn Creek Trail (Marias Pass)

The John F. Stevens Canyon area offers world-class backcountry and crosscountry skiing, snowshoeing and snowmobiling to visitors and area residents. The spectacular scenery, arduous terrain, and possibilities for solitude in a natural setting draw people to this area. An increase in popularity in these recreational activities is evidenced by magazine articles, stores catering to backcountry users, and publications touting destinations for skiing and snowmobiling. The increased use at trailheads during the winter months is a good indication of the popularity of these areas for winter recreation. Throughout the year, wildlife viewing from pullouts along US Highway 2 is a popular activity, including in the project area.

Historic records show that traffic on this section of US Highway 2 has increased substantially since 1982. Based on information collected at Montana Department of Transportation permanent traffic counters, annual average vehicles per day (vpd) west of Browning at station A-36 increased from 1,480 vpd in 1982 to 1,916 in 2004. This data shows that traffic has steadily increased 29% in volume over the past 22 years in this location. Annual average daily traffic volumes at Station A-60, west of Hungry Horse increased from 3,549 vpd in 1982 to 6,629 vpd in 2002 representing an 87% increase over the past 20 years. Existing traffic volume data for US 2 was reviewed and used to develop estimates of current and future winter traffic volumes. Winter traffic volumes are lower than summer traffic volumes. Table 3-34 illustrates daily traffic averages for January, February, and March at traffic recorders A-36 and A-60. US

Highway 2 is occasionally closed for hours or days due to severe weather during these months. Highway numbers reflect closures.

Table 3-34. US Highway 2 winter (January, February, March) traffic average daily use and future projections

Year	West of Browning Traffic Counter A-36	West of Hungry Horse Traffic Counter A-60
1999	1064	3995
2000	1170 (10.0%)	4046 (1.3%)
2001	1139 (-2.6%)	4066 (0.5%)
2002	1037 (-9.0%)	4075 (0.3%)
2003	1201 (15.8%)	4114 (1.0%)
2004	1195 (0.0%)	No data- construction
2010 Forecast	1338 (2%/year)*	4360 (1%/year)
2020 Forecast	1606 (2%/year)*	4800 (1%/year)
2030 Forecast	1927 (2%/year)*	5280 (1%/year)
*assumed growth is the percent increase over the previous five years		

A 2001 visitor use survey in Glacier National Park found that visitors came to the park for a variety of reasons. Viewing the scenery was the primary reason 63 % of visitors visited the park; 16 % wanted recreational activities such as hiking, boating, biking and camping; 5% wanted to experience a change from their "normal routine"; 4% wanted to enjoy socializing with family or friends; 3% came to view wildlife; 2% came to take photographs; and 7% cited other reasons for visiting the park (MK Centennial 2001b). This survey was conducted in the summer months, however, winter visitors are assumed to have the same reasons for their visit to the park.

Visitation and public use is affected by many seasonal variables. Forest fires, decreased snowpack, and climatic anomalies such as rain or drought affect visitation from a natural standpoint. Economic changes, gas prices and national security contribute to human caused national visitation trends. These factors make it difficult to define all of the variables affecting northwest Montana visitation in a given year.