Table 3.18 Minimum and maximum percent of landbase in each subwatershed that lies in each of the five DNR defined rain-on-snow zones in each of the fifth-field watersheds in the analysis area.

	Snow			Rain	
	Highland	dominated	Rain-on-snow	dominated	Lowland
Lower M. F.	9.0-9.5	24-28	24-40	22-43	0-0
Upper M. F.	13-100	11-35	0-37	0-30	0-0
Taylor	18-71	21-52	8-40	0-14	0-0
Pratt (NF lands)	22-75	18-33	3-46	0-7	0-0
Pratt (non-NF lands)	11	19	16	46	7

Impacts of Timber Harvest Practices on Flows and Trend Analyses

Concern over severe flooding in western Washington in November 1990 resulted in the initiation of a study which attempted to statistically test whether timber harvest practices in several basins (including the Snoqualmie River) has increased the magnitude of the peak of floods (Connelly et al. 1993). It also led toward the development of a dispersed physically-based model which would link and help to explain the physical mechanisms that might cause changes in runoff production as the result of forest harvesting, and to predict those changes (Connelly et al. 1993, Wigmosta et al. 1994). The Snoqualmie River Basin was chosen as the pilot study of this second model and work on it is ongoing. The first version of this physically-based model is now available for general use but was not utilized in this analysis because of date requirements and time limitations. The statistical model, which has already been applied to the Snoqualmie Basin, is discussed below.

Nine basins were chosen to statistically test whether forest harvest practices have affected peak flows, including the Skykomish, Snoqualmie, and North Fork of the Stillaguamish. The results of this study, which involved three separate analyses, showed that a significant trend in increasing peak flows could only be demonstrated in the North Fork Stillaguamish; none could be shown in the Snoqualmie. The analyses included investigations of whether trends in climate were responsible for any changes in peak flows. The authors cautioned, however, that this study was limited because the results could be obscured by random variability, and that the statistical methods used did not allow the causes of trends to be determined.

Connelly et al. (1993) questioned why no statistically significant trends appeared for the Snoqualmie, although they had for the North Fork Stillaguamish, since the percentage of total harvest was greater in the Snoqualmie Basin. The trends in harvest histories by elevation are

also quite similar for each basin. He stated that it did not seem likely that an increase in Snoqualmie River floods had simply not been detected in the tests because: a) one of the analyses actually found an uptrend (weakly significant) in the peak residual series, which suggested that the climate-corrected direction of trends in peak flows in catchment was down, rather than up, and b) an approximate analysis of the minimum detectable difference in an analysis of residual series after trends due to climate is removed was considerably smaller than the change in flood peaks predicted for a change in harvested area. These tests were applied to the entire Snoqualmie Basin, which does not mean that a statistically significant trend could not be demonstrated for the Middle Fork Snoqualmie watershed if the same analyses were run for it in isolation.

Connelly et al. (1993) states that the seemingly counter-intuitive behavior of these two basins can only be explained by applying a more physically-based approach. Such an approach would account for the location of the harvested areas, and the surface and subsurface routing of precipitation and snowmelt during extreme floods. This latter approach was discussed above, and could be used in the future to predict the effects of future land management scenarios on peak flows in the Middle Fork Snoqualmie. It would also allow for the improvement of existing flood hazard plans for the lower reaches of the Middle Fork Snoqualmie that are incorporated into the Draft King County Flood Hazard Reduction Plan (King County 1990), and ongoing floodplain planning by King County and the City of North Bend.

In response to concerns about past and potential future flooding in King County, the Surface Water Management division of King County (King County 1990) conducted a literature review of the effects of forest harvesting on: snowpack accumulation and rate and volume of snowmelt, and the flow response in tributary and river basins. In addition, this study examined flow gauge records in a single basin to see if a statistically significant trend in the magnitude of peak flows could be linked to the percent of the basin which had been harvested. The Snoqualmie River Basin was chosen because it has good long-term gauge data, some subbasins have been heavily harvested, and because it is King County's largest basin. The rationale for this latter point was based on research (Christner and Harr *in* King County 1990) that suggests that forest harvest has a diminishing importance with increasing basin size. The thought was, therefore, that if an effect could be statistically demonstrated in a large basin, then smaller basins with similar harvest histories (such as examining the Middle Fork Snoqualmie alone) could reasonably be assumed to have also been affected to some degree.

The King County study (1990) looked for any trends in the flow records of the gauges at Carnation on the Snoqualmie River, at Fall City on the Raging River, and at North Bend on the South Fork Snoqualmie; they did not review the flows at the Tanner gauge site on the Middle Fork Snoqualmie. The limitations of this study were great, since it was essentially an attempt at graphically interpreting trends in gauge flow data which are affected by a number of confounding covariables. The authors' interpretation of their results was limited; regressions appeared to indicate that peak flows have been increasing over time in the Snoqualmie River and in the South Fork of the Snoqualmie. They did, however, assert that "while the limited data available do not entirely rule out a cyclic climate change, the most plausible explanation for the observed trends appears to be that basin hydrology has changed over time," and that flows "may be related to forest harvest."

There have also been attempts to assess whether any trends in low flows (versus changes in peak flows--discussed above) have occurred over time in the Snoqualmie Basin (e.g., Kresch 1994, Pacific Groundwater Group 1995, Pentec 1996). The Initial Watershed Assessment (IWA) for the Snohomish Basin (Pacific Groundwater Group 1995) that was commissioned by the Washington Department of Ecology that was discussed earlier regarding minimum instream flows required by Ecology, also analyzed streamflow trends relative to annual precipitation trends at Snoqualmie Falls. Those findings are summarized as follows:

Analysis of total annual trends at seven gauges within the Snohomish Basin showed declining streamflow (normalized to precipitation) on the Snoqualmie, Snohomish, and Tolt Rivers. Normalized streamflow trends could reflect changes due to land use activities or water withdrawals. The apparent streamflow declines are too large to be explained by allocated withdrawals alone, and may be partly related to limitations inherent in the analysis. The data shows considerable scatter, and conclusions should be drawn with caution (Pacific Groundwater Group 1995 *in* Pentec 1996).

The apparent declines in low summer flows in these rivers, including the Middle Fork Snoqualmie, that were observed in this study were questioned in a critique of it commissioned by the City of Everett (Burges 1996). That critique stressed that some of the methods and assumptions made were questionable, therefore, the results may be in error (Burges 1996 *in* Pentec 1996). An additional study of low flow trends was, therefore, conducted for the Draft Snohomish River Basin Conditions and Issues Report (Pentec 1996) using a linear regression statistical model developed by Kresch (1994). This study examined flow data from 12 gauge stations in the Snohomish Basin, including all the long-term stations in the Snoqualmie Basin, (including the Middle Fork Snoqualmie gauge at Tanner). This study showed that low summer flows at all 12 sites have been consistently lower since 1980 than the long-term norm.

There are several long-term flow gauges in the Snohomish River Basin in which little or no water withdrawal (diversion) has occurred; data from these gauges were used as baselines for assessing flow trends in streams from which water was withdrawn (Pentec 1996). Time series analysis was used to look for trends. Flow data at gauge stations on the Snoqualmie River and all three forks of the Snoqualmie were among those studied. Time series on the Snoqualmie River at both Carnation and Snoqualmie (which has significant water withdrawals) were compared against time series of the Middle, North, and South Forks of the Snoqualmie (which do not have significant water withdrawals). The trend analysis had mixed results in comparing flows in the Snoqualmie at Snoqualmie to flows in the forks of the Snoqualmie. Overall, results indicated that 7-day low summer flows in the Snoqualmie River at Snoqualmie have been reduced, and in some years greatly reduced, compared to 7-day low summer flows in in the Middle, South, and North Forks. This indicates that low summer flows in the Middle Fork Snoqualmie are not decreasing proportionally as greatly as they are in the Snoqualmie River.

The Washington State Forest Practices Board (1994) watershed analysis manual contains a module for estimating changes in a hydrologic regime, particularly changes in peak flows due to past timber harvest management activities. This module was not applied to the analysis area because of low confidence in its sensitivity ratings due to module limitations. In lieu of applying this method, a model which describes patterns of vegetation disturbance (e.g.,

openings in the canopy due to fire, timber harvest, roading, etc.), and their possible impacts on flow regimes, is presented in the following section.

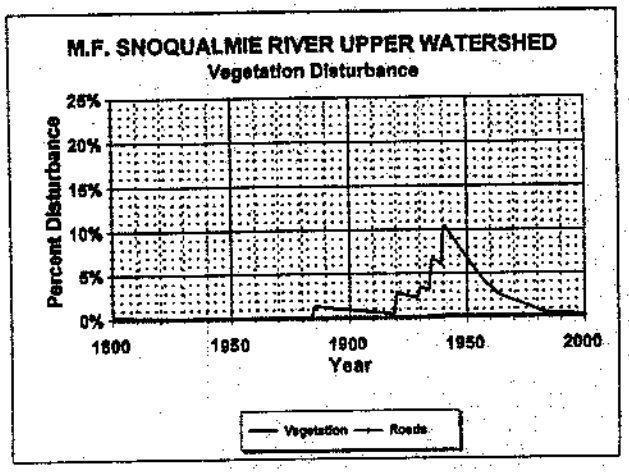
Vegetation Disturbance Model

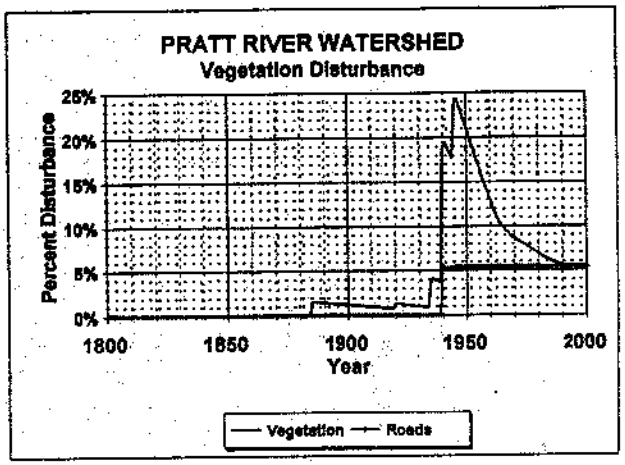
Removal of the forest canopy causes changes in both the amount of precipitation that reaches the ground and the rates of melting snowpacks. These factors influence the magnitude and timing of both peak flows and low summer baseflows in the analysis area. A model was developed on the Mount Baker-Snoqualmie National Forest which basically displays estimates of the percent of forest canopy openings in fifth-field National Forest System watersheds and sixth-field subwatersheds. The results of this model serve to describe the extent of canopy disturbance due to timber harvest, roads, powerlines, railroads, and natural and man-caused fires. Following each disturbance event, forest vegetation remains in a disturbed or "hydrologically immature" state until (if) it reaches a 70% crown closure, when the model assumes that the stand is "hydrologically recovered." The results of this analysis are summarized below. Refer to Appendix C for further discussion, including model assumptions.

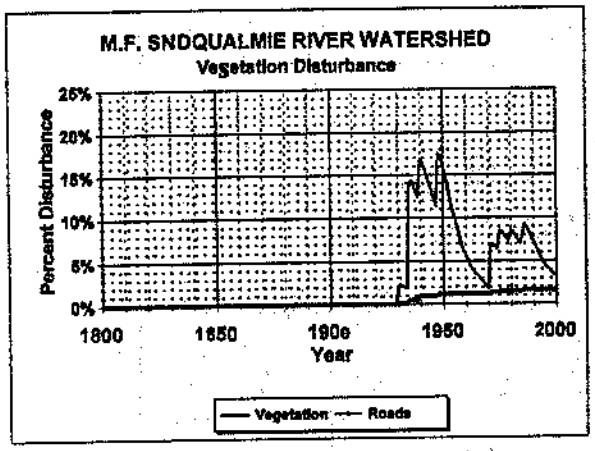
The overall percent of vegetation disturbance in each of the four fifth-field watersheds in the analysis area is presented in Figures 3.41 through 3.44. Estimates are shown over time beginning in the year 1800 and continuing through the present. In each fifth-field watershed there was estimated to be virtually no canopy disturbance before 1930-1940. Levels rose very sharply in this period and peaked between 11 and 24 percent (the upper Middle Fork Snoqualmie and Pratt River Watersheds, respectively) around 1950 in each watershed. Levels thereafter dropped fairly steadily in each watershed to the present time, except in the lower Middle Fork Snoqualmie (off Forest Service lands) where levels rose again in the 1970's and 1980's, before beginning to drop again over about the last ten years. Current levels in each fifth-field watershed vary from about 5-6 percent in both the Pratt and Taylor River watersheds, to virtually 0 percent in the upper Middle Fork Snoqualmie.

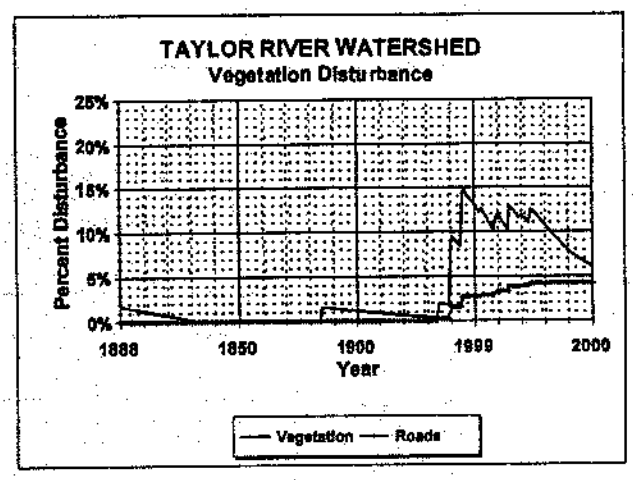
It was not possible to plot disturbance levels on a more site specific subwatershed scale in the upper and lower Middle Fork Snoqualmie fifth-field watersheds, but it was in the Pratt and Taylor River watersheds (Figures 3.45 and 3.46). The greatest estimated canopy disturbance in this century occurred in the Taylor River. Levels were plotted in each of the subwatersheds which had disturbance estimates of 10 percent or greater. In the Pratt River watershed, subwatersheds B and A reached levels of 23 to 30 percent, respectively, around 1950, but have dropped to 0 percent at present. In the Taylor River watershed, subwatersheds E, A, and B reached levels of 20-40 percent between 1950 and 1975 (40 percent in subwatershed B in 1975). Current levels in subwatersheds A and B are about 12 percent, but nearly zero in subwatershed E.

Figures 3.41-3.44 Percent of vegetation disturbance in each of the fifth-field watersheds since over the last 200 years.

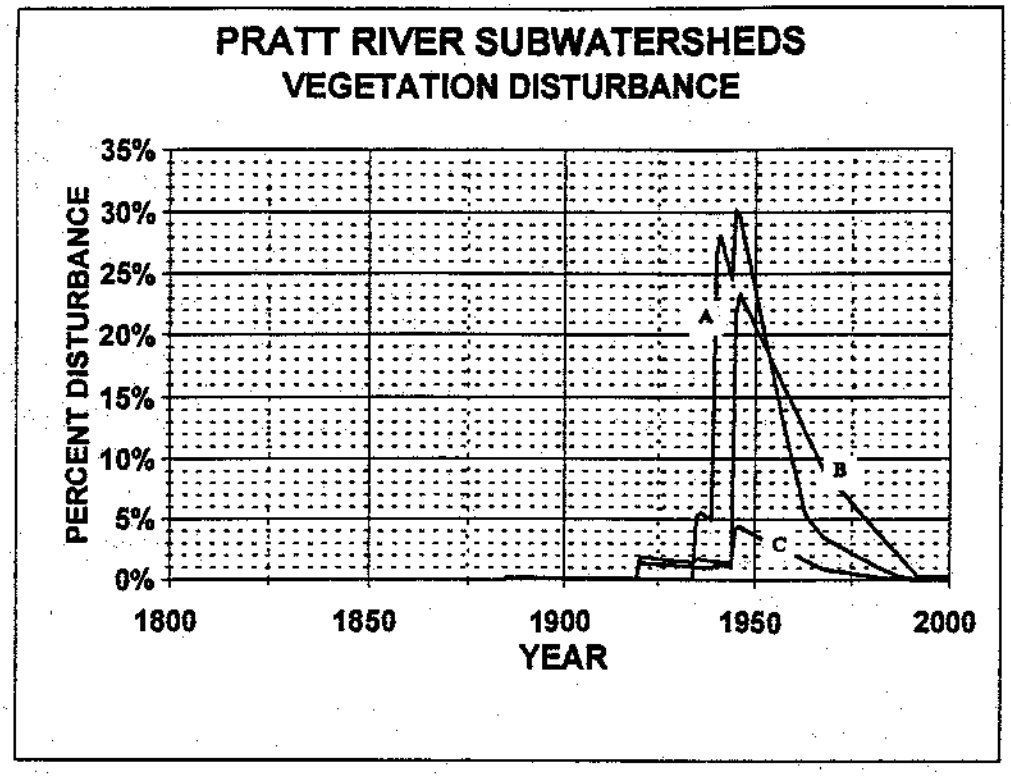


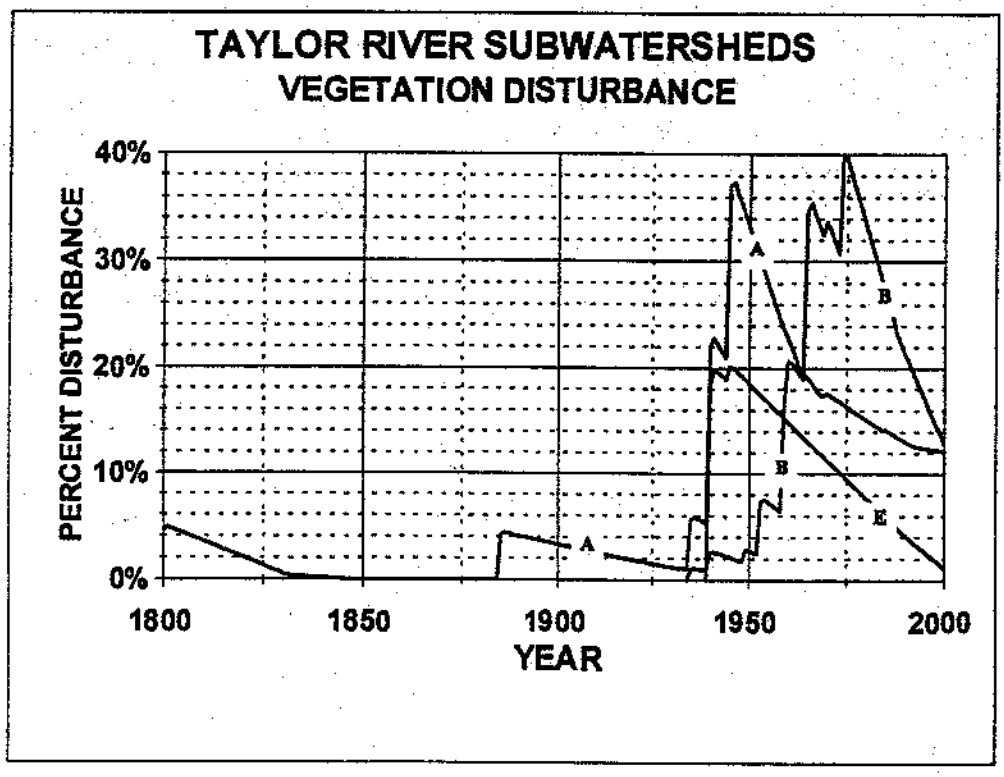






Figures 3.45 and 3.46 Percent of vegetation disturbance in those subwatersheds of the Pratt and Taylor Watersheds which have appreciable levels of disturbance.





The results of this modeling effort indicate that most or all of the subwatersheds in each of the fifth-field watersheds in the analysis area currently have timber stands with at least 70 percent closed canopy structure. Our model, therefore, estimates that there should currently be little impact to the annual pattern of snowfall accumulation and snowmelt because of man-caused or fire-related openings to the timber canopy. This was not the case over some periods in different subwatersheds throughout the analysis area between about 1940 and 1980 when up to 40 percent of a subwatershed was "hydrologically immature." This condition potentially resulted in much larger peak flow events in some subwatersheds (listed above), with resultant impacts to channel morphology such as widening or incision. Overall, current disturbance levels appear to be approximating the levels that existed early in this century before significant logging began, which was a period when no major forest fires had occurred in the area for at least 150 years.

Water and Air Quality

Acid Precipitation

Due to concern about potential acidification of sensitive waters in the Cascades due to acidic precipitation, some monitoring of rainfall and snowfall has been conducted by both the U.S. Environmental Protection Agency (EPA), and the Washington State Department of Ecology (Ecology). Most of this work began in the mid 1980's, and some is still being conducted. Present levels of acid deposition in the Cascades are below those which have resulted in acidification of lake systems in eastern North America. It is not, however, known what levels are great enough to begin degrading water quality in the sensitive waters of the Cascade Mountains that have relatively low acid neutralizing capacity. Most of the alpine lakes in the Central Cascades (including some of the lakes in the analysis area) are among these sensitive waters (Rashin 1989, Duncan 1991). All the studies found through a literature search have included monitoring of sulfate, nitrate, and hydrogen ion levels. Nitrate and sulfate ions can result in acidic deposition through either a long-range transport transformation in the atmosphere to a dilute form of acidic rainwater, or they can accumulate in snow packs and release pulses of low pH snowmelt in the spring.

Approximately 80% of the normal annual precipitation at Snoqualmie Pass falls from October through April (NOAA 1983-89 *in* Rashin 1989), the vast majority as snow. May through September rains are also very important inputs into lakes, however, because average monthly concentrations of sulfates in rainwater during those months was 1.7 to 4.0 times greater than those during the winter (NADP 1989 *in* Rashin 1989). Generally, rainfall seems to be more effective in washing out sulfate, nitrate, and ammonium than snow. The winter precipitation (from 1983 to 1990) falling at monitoring sites at Snoqualmie Pass, Stevens Pass, and Mount Rainier (Paradise) have been less concentrated in ammonium, sulfate, nitrate and strong acid than the rainfall collected at stations in the Puget Sound Basin (Duncan et al. 1991). This is due to the fact that these sites are both snow dominated and that they are further from the emission sources.

The estimated wet deposition load of ions critical to contributing to acidification showed no annual trends at the Snoqualmie Pass monitoring site through its short history of 1983 to 1990. Levels were, however, higher at Snoqualmie for almost all variables than they were at either Stevens or Mount Rainier in 1990 when monitoring was conducted at all three sites. Table 3.19 below shows the volume weighted average deposition rates for each of those stations for critical ions in 1990.

Table 3.19 Estimated deposition load of critical ions for 1990 at three stations in the western Cascades of Washington.

	Loading (kg/hectare-year)		
	LOCATION		
Species	Stevens Pass	Snoqualmie Pass	Mt.Rainier (Paradise)
SO_4 (S)	2.54	3.51	2.96
SO_4 (SO_4)	7.62	10.54	8.88
NO_3 (N)	0.94	1.41	1.45
NH_4 (N)	0.30	0.30	0.19
H	1.55	2.32	0.27

[as modified from Duncan, 1991]

Duncan et al. (1991) cites S and SO_4 levels of 6.7 and 20.0 kg/hectare-year, respectively, as being critical (essentially threshold) levels for aquatic receptors. Eilers et al. (1994), however, proposed a lower critical load level based on lake chemistry data available within National Parks in Washington and Oregon and results of more detailed studies elsewhere. Eilers recommends an interim sulfur deposition guideline of about 3 kg S/hectare-year and 9 kg SO_4/hectare-year, below which sensitive resources will be protected from adverse effects. The highest S levels recorded at Snoqualmie Pass during 1983 to 1990 was an average loading of 3.51 kg/hectare-year in 1990. Both the S and SO_4 loadings that year were estimated to be about one-half that of the critical levels proposed by Duncan et al. (1991), but exceed the levels proposed by Eilers et al. (1994). In addition, Duncan cautions that there is some error in how his estimates were calculated, and that levels at Snoqualmie need to be verified by continued monitoring.

Eilers et al. (1994) describes what his recommendation for maximum S loading is predicated on. His assumptions are quoted below:

"The recommended S loading will not necessarily protect all sensitive aquatic resources at all times. This recommended loading is adequate for protecting at least 95% of the resources

from chronic acidification, but it may not be adequate for long-term protection of the most sensitive resources. The recommended S loading may not protect aquatic resources from episodic acidification from either S or N deposition. Episodic acidification will precede chronic acidification in many of the systems, particularly in view of the importance of snow to the hydrologic budgets of the alpine lakes. The recommended S loading does not address possible accumulation of N in low temperature lakes that remain ice covered for most of the year."

In addition to the cautions above, Eilers et al. (1994) states that the guidelines for N loading are even more problematic than for S loading. He found no evidence that chronic N accumulation has occurred in lakes within the region, and what little information that has been collected suggests that episodic acidification from NO_3 in probably not occurring. As an interim guideline he suggests a value of 5 kg N/hectare-year for the protection of aquatic resources against chronic acidification, although the level may have to be even lower to protect resources from episodic acidification. Eilers et al. (1994) also states that the most important form of N and S deposition to forests in the region may be acidic components in fog, especially in higher elevation sites. Therefore, although snowfall is the largest contributor in volume at the higher elevations within the analysis area, it is not the only input that needs to be considered.

Further discussion of existing research and data on acidic precipitation in Western Washington can be found in the South Fork Snoqualmie Watershed Analysis (Mount Baker-Snoqualmie National Forest 1995). That analysis also summarizes some of the indicators and thresholds that have been adopted for use in assessing risks and possible impacts; some of that discussion also appears below in the section on lake water quality.

Ozone Levels

Ozone is another potential pollutant of concern for the watershed, although probably not as great an issue as it is in the neighboring South Fork Snoqualmie watershed. It may be the most important air quality influence on vegetation in the basin due to expanding urban areas and the I-90 corridor. Areas of the Cascade Range east of Puget Sound are subject to episodes of high ozone concentration during periods of atmospheric stability. The effect of these episodes is poorly quantified but may produce substantial stress and affect the health of trees (Hogsett et al. 1989 *in* Peterson et al. 1992). Average 24-hour ozone concentrations at levels higher than 80 ppb occur in Washington Cascades during the summer months (Eilers et al. 1994), which are high enough to be of concern. Eilers et al. (1994) states that the National Ambient Air Quality Standard values based on extreme ozone concentration are considered inadequate for protecting vegetation from injury. He believes that the cumulative nature of ozone effects suggests a more conservative standard may be appropriate, and recommends using a new air quality indicator (SUM60) which sums all hourly concentrations equal and above 60 ppb.

No studies of ozone levels were found to date for locations near the analysis area so future monitoring would be necessary to describe the spatial and temporal patterns of ozone

exposure. Exposure of plants to elevated levels of ozone can produce several quantifiable effects, including visible injury, reduced photosynthetic capacity, increased respiration, premature leaf senescence, and reduced growth (Peterson et al. 1987, Reich and Amundson 1985 *in* Peterson et al. 1992). The most immediate effect of elevated ozone on vegetation may be one or more of the following: foliar injury, decreased leaf longevity, reduced carbon gain of foliage, and reduced plant growth (Peterson et al. 1992).

Lake Water Quality

The water quality of some of the lakes in the Washington Cascades differs relatively little from the water chemistry of current atmospheric deposition. It appears that lake water quality is closely linked to the chemistry of the deposition, and that there is a strong basis of concern that the long-term integrity of lakes in the Cascades could be affected if atmospheric deposition contains pollutants (Peterson et al. 1992). Deposited sulfate, nitrate, and ammonium in the form of rainfall, snowfall, or dry deposition all have the ability to acidify surface waters. Sulfate deposition is usually associated with long-term chronic effects, while nitrate and ammonium are often associated with episodic acidification due to rapid releases of nitrogen during snowmelt.

Acidification of surface waters contributes to increased mobilization and availability of aluminum which can be toxic to aquatic life. The toxic effects of acidification on biotic communities in surface waters is attributed to the combined increase of hydrogen ion (H^+) and aluminum concentration in the presence of low calcium concentrations (Baker et al. 1990 *in* Peterson et al. 1992). The ability of a body of water to neutralize acidic inputs and avoid these toxic effects is basically dependent on the concentrations of basic cations such as calcium (Ca^+) and the concentration of weak organic acids. Alkaline waters (those with higher concentrations of base cations) can neutralize incoming acids, largely through increased weathering (Brakke et al. 1990 *in* Peterson 1992), while organic acids have a strong buffering capability which resists further acidification due to the presence of organic carbon. Nearly all of the surface waters in the Cascades have low levels of dissolved organic carbon, and any inherent acid neutralizing capability is due to the presence of base cations (Peterson et al. 1992). Many also have low concentrations of base cations and are therefore sensitive to any acidic inputs.

The largest comprehensive quantitative assessment of water quality in the Washington and Oregon Cascades was conducted as part of EPA's Western Lakes Survey (Eilers et al. 1987, Landers et al. 1987) which sampled 159 lakes in the region out of an estimated total of 1,371 lakes larger than 1 hectare in surface area. During the EPA study two lakes were sampled within the analysis area--Tuscohatchie and Spider. Neither lake was acidified, but Spider had low acid neutralizing capacity. The Pacific Northwest region was one of five regions in the western United States surveyed. These regions were chosen because they represent areas containing the majority of lakes that are considered to be at risk as a result of acidic deposition. The other study regions were areas of the northern Rockies, southern Rockies, central Rockies, and the Sierra Nevadas. As a population, lakes in the Washington and

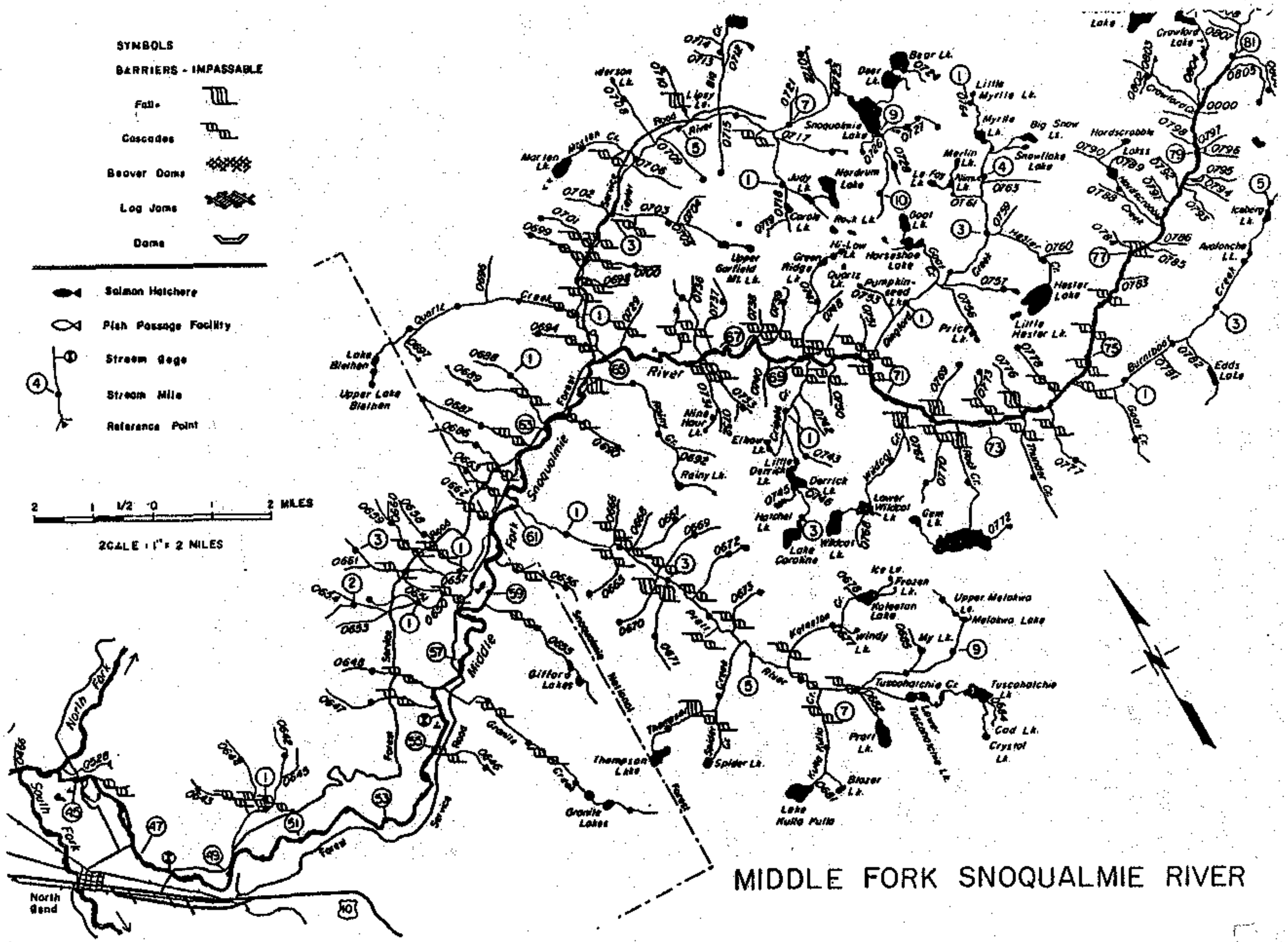
Oregon Cascades, and the Puget Sound lowlands are among the most dilute (contain the lowest concentrations of dissolved minerals, including the base cations) in the United States. The low acid neutralizing capacity of Cascade lakes is second only to the inability of lakes in the Sierra Nevadas to buffer acidic inputs (Landers et al. 1987). Individual Cascade lakes are the most dilute aquatic systems anywhere (Eilers et al. 1990 *in* Peterson et al. 1992). This issue is important across the Mount Baker-Snoqualmie National Forest, and is continuing to be studied by Forest staff and other researchers.

The assessment of the sensitivity of lakes to inputs of pollutants is not conducted solely on the basis of water chemistry. Surveys of the populations of aquatic indicator species are also in use and being developed (Plafkin et al. 1989, Karr 1986, Karr 1994, Kerans and Karr 1994). The methods developed in some of the survey techniques have been applied in the Washington Cascades, but do not yet have results specific to the analysis area (Fore and Karr 1994, Plotnikoff 1992, Plotnikoff 1994).

A guideline for setting limits of acceptable change in surface waters has been suggested for lakes in the Cascades by the U.S. Forest Service (Peterson et al. 1992). This guideline lists suggested taxonomic groups of aquatic organisms (aquatic insects, amphibians, plankton, fish, mosses, and aquatic plants) that should be investigated for sensitive indicators of stress for atmospheric pollutants along with characteristics to check. This guideline also lists suggested value ranges for nine water chemistry variables for four categories of water quality, along with explanations for the rationale used. Recommended levels for the variables are expressed as percentage changes from background levels. Baseline levels have not been determined for any of the lakes in the analysis area, however, so lake quality can not be assessed using them until a monitoring program has been established. This topic is further discussed in the South Fork Snoqualmie Watershed Analysis (Mount Baker-Snoqualmie National Forest 1995) which includes a listing and description of the sensitive biologic and chemical indicators available for use.

The only water quality data which was found for lakes in the analysis area were synoptic or seasonal surveys which did not allow for analysis of long-term trends. There have been several different lake studies undertaken which included one or more of the lakes in the analysis area, including work by researchers at Central Washington University and the University of Washington (e.g., Duncan 1991; Smayda 1986 and Spyradakis et al. 1990, respectively). Some work has also been conducted by the USGS (Bortleson et al. 1976, Dethier et al. 1979), along with the EPA study mentioned earlier (Eilers et al. 1987, Landers et al. 1987). The location of most of the lakes in the analysis area is shown in Figure 3.47, along with most perennial streams, river miles, and locations of some of the barriers to fish migration.

Figure 3.47 Map of the analysis area showing stream miles, lakes, most perennial streams, and many of the impassable migration barriers (source--Williams et al. 1975).



The most extensive lake quality survey of lakes in the area was conducted by the Washington State Department of Fish and Wildlife (WDFW) (Pfeifer 1997). This ongoing study has sampled only a few water quality variables, and sampling methods vary somewhat from those used in other known studies. The WDFW study includes some replicate sampling of lakes and, therefore, allows for some degree of comparison with earlier sampling, including work conducted by other the other studies mentioned above. Attempts at such comparisons were not possible in this analysis effort. Data from the WDFW lake studies (Pfeifer 1997) are included as Appendix C.

The water quality data displayed in Appendix C, along with data from the other studies referred to above, indicates that most of the lakes in the Middle Fork Snoqualmie analysis area generally have both low concentrations of nutrients, and very low acid neutralizing capacity. Primary and secondary production of algal and plankton communities varies greatly, and an effort is underway by the WDFW to determine what physical and chemical variables determine lake productivity (Pfeifer, personal communication 1996). Low acid neutralizing capacities make many lakes susceptible to acidification in the coming decades from current levels of acid deposition.

The single site where the data indicated that pH may limit the size and health of the aquatic community (at least trout), is Quartz Lake, where pH readings varied from 4.5-6.0 in the 17 samples taken from 1984-1986. These low pH levels may be a result of the quartz mining which has occurred and continues to occur between Quartz and Green Ridge Lakes. It may also be due to natural sources or a combination of the two. Contamination by toxics is thought to be very low to nonexistent in nearly all lakes. The single known exception is Williams Lake. In a joint study by the WDFW and the Forest Service (Pfeifer and Peacock 1987), copper concentrations in Williams Lake were found to be at toxic levels. These high levels prevent a sustainable fish community and no fish currently exist in the lake. It is still to be determined whether the copper input to the lake is natural, from past up-drainage mining activity (no mining currently occurs), or a combination of the two. The Forest Service has not conducted a survey of abandoned mine sites within the analysis area. Such surveys have been conducted at some mine sites elsewhere on the Forest.

Stream Water Quality

All of the streams and rivers within the analysis area are listed by the State of Washington as Class AA waterbodies. The general characteristics of Class AA ("extraordinary") waters are defined in the State water quality standards (Chapter 173-201A WAC 1992) as generally characterized as markedly and uniformly exceeding the requirements of all, or substantially all uses. A brief summary of surface water quality standards and enabling legislation is given in Appendix C.

The Middle Fork of the Snoqualmie River is on the Washington State Department of Ecology's 303(d) list of those waters which do not meet these State water standards for water

temperature, which is one of several variables that are included in those standards (Ecology 1996). This does not indicate that all other variables meet standards in all the waterbodies in the analysis area; it only means that no data has been presented to Ecology that demonstrated (within given data quality requirements) that a stream or lake was not meeting standards for one or more other variables. The true situation throughout most of the analysis area is largely unknown, because so little water sampling has been conducted. The 303(d) list includes those waters which do not meet threshold standards for bacteria, temperature, pH, total dissolved gas, oxygen, and toxic, radioactive, or deleterious compounds. It also includes those segments which do not meet the narrative criteria of other variables such as nutrient and sediment loads, which do not have specific threshold levels defined.

The 1980 water year (October 1 to September 30) was the only period when the USGS monitored water temperature at its discharge station at Tanner; this was the only temperature data they have ever collected in the analysis area. During this study there were 21 days when the maximum daily temperature exceeded the maximum temperature allowed in in the State water quality standards for the area (16° C), including one period of 13 consecutive days. If these high temperatures had been due to man-caused conditions, these records would have resulted in the listing of the river on the 303(d) list under present law. The Middle Fork Snoqualmie River is included on the proposed 1996 303(d) list for water temperature because of high temperature readings observed by Ecology and the Puget Power Company during limited sampling conducted in the 1990s (Joy, personal communication 1997).

Baseline studies of the water quality in the Snoqualmie River have been conducted by Ecology (e.g., Joy et al. 1991), as well as a study of the total allowable maximum daily load of permitted pollutant emissions into the Snoqualmie River (Joy 1994). The only known quantitative data for a site within the analysis area was collected at a monitoring site which was located near the mouth of the Middle Fork Snoqualmie River. Monthly samples were collected at this site by the Washington State Department of Ecology (Ecology) between June 17 and September 16, 1991. The four samples that were taken were analyzed for nutrient concentrations, turbidity, water temperature, conductivity, dissolved oxygen, suspended sediment, pH, and fecal coliform. It did not include samples to check whether State standards were being met for total dissolved gas, and toxic, radioactive, or deleterious materials. The four pH readings ranged from 6.4 to 6.8, hence all were very near the minimum allowable level State standard of 6.5. The sample that was taken in August did not meet the State standard for temperature or dissolved oxygen. In addition, the sample taken in September had relatively high fecal coliform levels (100 organisms/100 ml); standards state that no more than 10 percent of samples can exceed 100 organisms per 100 ml of water. This very limited sampling did not result in additional variables being listed on the 303(d) list, and the results are indicative of relatively high water quality. Four samples are not sufficient to make any conclusive statements, however, and they indicate that further monitoring of temperature, dissolved oxygen, pH, and fecal coliform is merited to determine true background levels.

The impacts of the current levels of extensive dispersed camping that exists in the analysis area have not been assessed. In many areas this dispersed camping likely results in periodic bacterial contamination from human waste. Trash associated with camping, and the

widespread illegal dumping that occurs, also likely result in frequent site contamination from hydrocarbons and various toxic wastes. These pollutants may occasionally result in localized stress or death of local or downstream aquatic organisms. The potential risk to human health is probably a greater issue; it would be difficult to quantify risks and impacts.

The sediment load carried by the Pratt and Middle Fork Snoqualmie Rivers is an issue because of the possible deleterious impacts on the aquatic community. The glacial lakebed history of the lower valley of the Middle Fork Snoqualmie left clay and soft sediment deposits which can be chronic contributors of fine sediments to the mainstem (Pfeifer, personal communication 1997). In addition, there is a large mass failure on the Pratt River about 0.5 mile upstream from its mouth, which contributes large amounts of fine, blue clays into the Pratt, which are transported downstream into the Middle Fork Snoqualmie. There have been frequent, high turbidity loads observed (visually assessed only) in the lower Pratt for about the last decade (Pfeifer, personal communication 1997). The high turbidity concentrations that often occur in the lower Pratt and in the mainstem of the Middle Fork Snoqualmie may suppress both primary (i.e., algal) and secondary (i.e., invertebrate and fisheries) production. Unfortunately, there has never been a sediment budget conducted for the Middle Fork Snoqualmie watershed, although there have been budgets estimated for the neighboring South Fork Snoqualmie watershed; these are summarized in the South Fork Snoqualmie Watershed Analysis (Mt. Baker-Snoqualmie National Forest 1995).

Suspended sediments often represent about 90 percent of the total sediment load in western Washington streams, with bedload comprising the remainder (Dunne and Leopold 1978). The studies conducted on the South Fork Snoqualmie River found that bedload represented 6-10 percent (Booth 1991, Dunne 1984) of the total load. The South and Middle Forks of the Snoqualmie River are both dominated by granitics and volcanics, and are otherwise similar in topography and vegetation, so it is likely that the relative makeup of the sediment load in the Middle Fork is similar to these estimates for the South Fork. Total loads may vary greatly, however, due to differences in land use and hydrologic regimes.

The only ongoing mining in the analysis area is mining for quartz crystals. There are approximately twenty active claims in the upper watershed above Taylor Creek; these are largely concentrated near Quartz Lake and between Goldmeyer Hot Springs and Hardscrabble Creek. There are also a few other claims located in the lower portions of the analysis area. These quartz mining operations generally use only small explosive charges to access crystal deposits. The problems associated with the mine tailings of large ore operations (e.g., acid mine drainage, etc.) should generally be much less of a problem near these sites. There is, however, a known case where a body of water near quartz mining currently has low pH readings (Quartz Lake), although the cause has not been determined. Early in this century copper mining occurred in the upper watershed near Dutch Miller and other locations. There has not been a survey of water quality near these abandoned mine sites.

Lake, Pond, and Wetland Habitats and Fisheries

The number and diversity of lakes and ponds in the analysis area is among the greatest on the Forest. Information on which species are present is available from the Washington State Department of Fish and Wildlife (WDFW) for most of the 152 lakes and ponds located within the Pratt, Taylor, and upper and lower Middle Fork Snoqualmie Watersheds (Pfeifer 1997). Some qualitative information is also available from Trail Blazers, Inc. Data is limited to the game fish which have been introduced. In the analysis area only various stock of rainbow (*Oncorhynchus mykiss*) and cutthroat (*Oncorhynchus clarki*) trout have been introduced, and are often the only species present. Other species which may be present in some lakes include mountain whitefish (*Prosopium williamsoni*), eastern brook trout (*Salvelinus frontinalis*), and sculpins (*Cottus sp.*).

Quantitative data on population sizes and biomass are not available for any of the lakes in the analysis area. It is likely that the vast majority of the lakes in the analysis area historically did not support fish populations before stocking activies began early in this century (Pfeifer, personal communication 1997). Much of this stocking was conducted informally by the Forest Service, fishing clubs, and individual citizens before the establishment of the Washington State Department of Game (WSDG) in 1933 (it consolidated with the Washington State Department of Wildlife in the late 1980s to become WDFW). Early management by the WSDG consisted of intermittent stocking of streams and lakes with hatchery stocks of eyed eggs, fry, or fingerling cutthroat, rainbow, or eastern brook trout. Stocking of rainbows and cutthroats in streams took place annually, virtually without exception until 1983 when it was discontinued. Stocking of eastern brook trout was generally discontinued in both lakes and streams about 20 years earlier. Stocking of some lakes with rainbow and/or cutthroat trout remains active today (Appendix C-4).

Approximately 57% of the lakes in the analysis area (86 of the 152) are known to currently not have naturally reproducing stocks; any fishery in these lakes is totally dependent on restocking by the WDFW and volunteer organizations like Trail Blazers, Inc., which carry out planting approved by the WDFW. Only 26 lakes (17%) have good to high levels of natural reproduction, while 27 lakes (18%) have low to poor levels (Pfeifer 1997). About 60 lakes (39%) have been stocked or restocked with cutthroat or rainbow trout within the last several years; approximately an additional 27 lakes had also been stocked in the past.

The tables in Appendix C-4 list and describe the lakes within the Pratt, Taylor, and Middle Fork Snoqualmie watersheds. The total of 83 lakes in the Middle Fork Snoqualmie, 41 lakes in the Taylor, and 28 lakes in the Pratt watersheds represent an estimated combined surface area of about 1642 acres. The average lake size over the entire analysis area is about 10.8 acres, but only 35 lakes (23%) are over 10 acres in size. These largest 35 lakes represent about 80% (1312 acres) of the total lake area; the remaining 117 lakes less than 10 acres average only 2.8 acres. The largest ten lakes in the area are: Snow (159.5 acres), Snoqualmie (126.4 acres), Hester (66.6 acres), Kulla Kulla (60.1 acres), Nordrum (60 acres), Caroline (59.6 acres), Upper Tuscohatchie (58.3 acres), Upper Wildcat (53.7), Bear (49 acres), and Thompson (47.2 acres). These large lakes are distributed among all three watersheds at elevations varying from 3225 feet (Snoqualmie Lake) to 4740 feet (Caroline), and comprise

about 45% of the total lake surface. The highest, fairly large lake in the entire analysis area occurs in the upper Middle Fork Snoqualmie watershed at 5700 feet (Chain Lakes, 3.5 acres).

There are no wildlife guilds directly dependent upon forested wetlands and wet meadows; however, both are important habitat components for many guilds, and therefore, species (Figure 1.8 Riparian Reserves). Wetlands serve a variety of important functions as wildlife habitat. Many species are associated with the wetland edge of a lake or pond. There are an estimated 80 acres of wet meadows, 2699 acres of shrubby wetlands that constitute primarily avalanche chutes, and 1284 acres of hardwood wetlands. The total 4063 acres of all wetlands is larger than any other basin of a similar size on the Forest, as reflected in the very high diversity ratings described earlier. In combination with the high numbers of ponds and lakes, there are optimum levels of wetlands available for wildlife. Field reports indicate that, with the exception of a few large lakes within easy hiking distance to the public, such as Snow Lake, the majority of lakeshores are in good condition (Sobieralski, personal communication 1996). The exceptions have had their shorelines trampled by hikers and fishermen, reducing the amount of native vegetation and downed logs available. Of the 54 sensitive plant species known or suspected to occur in the analysis area, 60 percent are considered to be associated with wetlands.

Stream Channels

Stream channel condition and morphology reflect the input of water, sediment, and wood to the stream channel, relative to the ability of the channel to either transport or store these inputs (Sullivan et al. 1987). The channel's ability to transport these inputs is dependent upon the location and timing of the inputs as influenced by the channel and watershed characteristics of slope gradients, geology, landforms, structural controls, and historical disturbances.

The analysis area is dominated by steep gradient (>20%), tributary sediment "source" channels with a relatively small number of lower gradient depositional zones (0-2%) as the tributaries enter the valley floor, including portions of the mainstem Middle Fork (Figure 3.48).

Each of the fifth-field watersheds was analyzed for sediment transport capability based entirely on stream gradient data (Figures 3.49 through 3.52). The categories are as follows: >20% Source, 4-20% Transport, 2-4% Response, and <2% Depositional. These categories were developed based upon existing stream channel classification systems by D. Montgomery and J. Buffington (1993) and D. Rosgen (1994).

Figure 3.49 Relative abundance of stream gradient classes within the lower Middle Fork Snoqualmie River fifth field watershed within the Mt. Baker-Snoqualmie National Forest boundary.

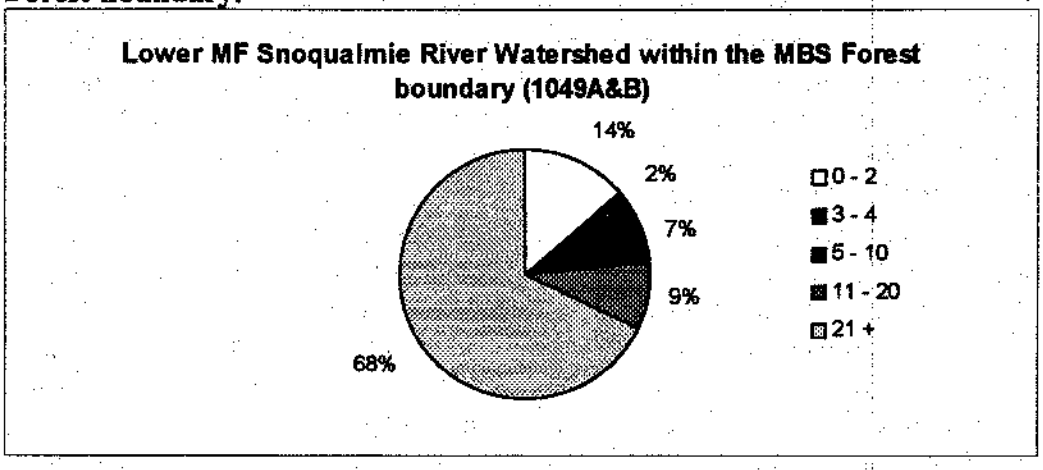


Figure 3.50 Relative abundance of stream gradient classes within the Pratt River fifth field watershed including the lower Middle Fork Snoqualmie River outside the Mt. Baker-Snoqualmie National Forest boundary.

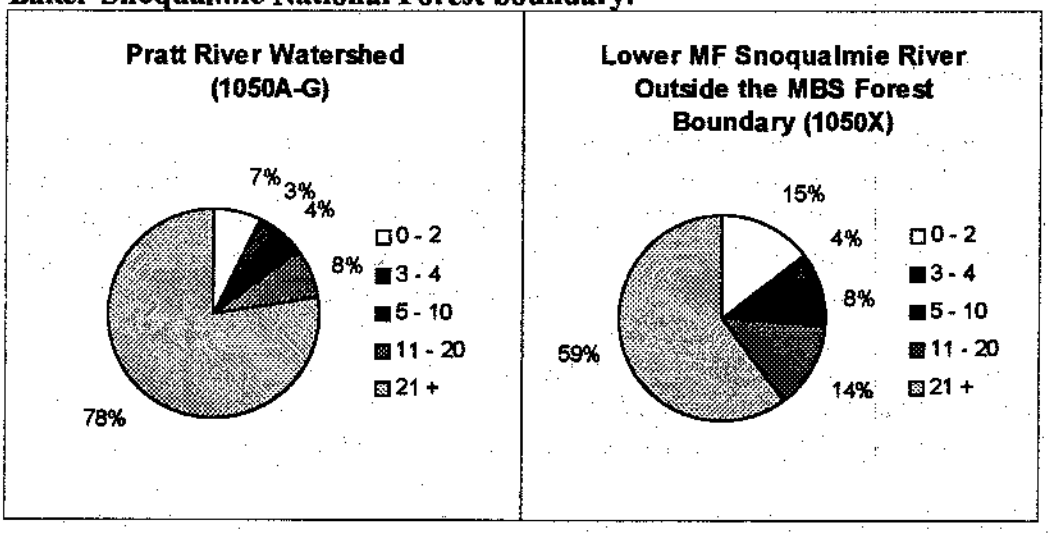


Figure 3.51 Relative abundance of stream gradient classes within the upper Middle Fork Snoqualmie River fifth field watershed.

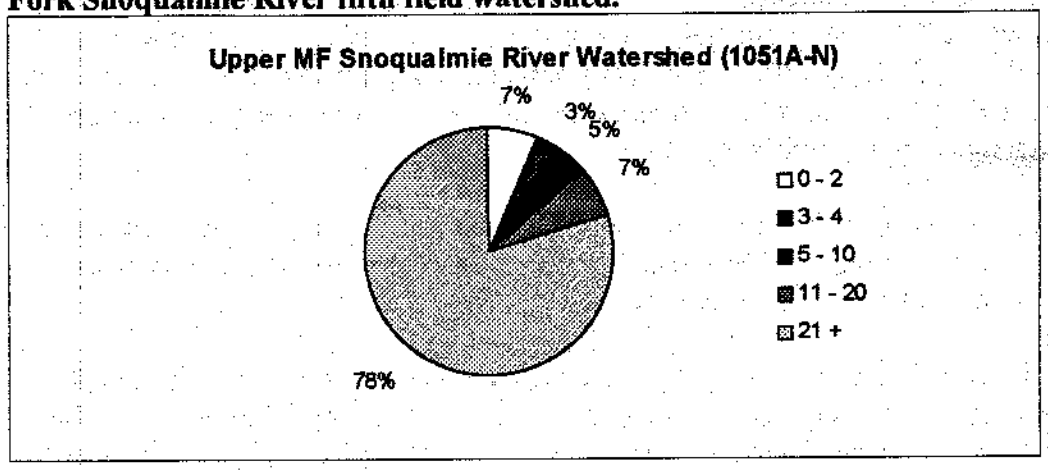
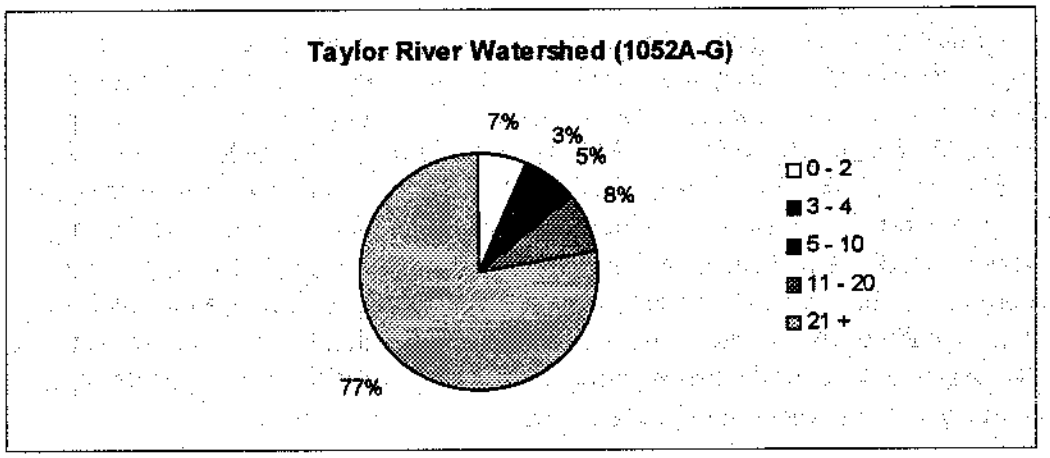


Figure 3.52 Relative abundance of stream gradient classes within the Taylor River fifth field watershed.



The lower Middle Fork Snoqualmie River fifth-field watershed, within the Forest boundary (1049A&B), is comprised largely of source channels (approximately 68%). Transport reaches amount to approximately 16% of the total stream miles within this fifth field watershed, while response reaches represent only approximately 2%. Depositional areas comprise approximately 14% of the total and are found primarily in the Middle Fork Snoqualmie mainstem.

The Pratt River (1050A-N), is also dominated by source reaches (approximately 78%), while the remainder is composed of 12% transport channels, 3% response channels, and 7% depositional channels. The lower Middle Fork Snoqualmie River outside the Forest boundary (1050X) is graphed separately from the Pratt River to show its unique character being composed of approximately 59% source reaches, 22% transport reaches, 4% response reaches, and 15% depositional reaches. In this case, combining the Pratt and the lower Middle Fork outside the Forest boundary would have masked the obvious differences in their gradient distributions.

The upper Middle Fork Snoqualmie River fifth-field watershed contains approximately 78% source reaches, 12% transport reaches, 3% response reaches, and 10% depositional reaches. The Taylor River fifth-field watershed is nearly identical in proportions to the upper Middle Fork Snoqualmie differing only by a percentage point for source reaches (approximately 77%) and transport reaches (approximately 13%).

"Channel stability is the ability of a stream or river to transport the flows and sediment of its watershed in such a manner that the dimension, pattern and profile of the river is maintained without either aggrading nor degrading" (Rosgen 1996).

Channel stability within the analysis area was assessed using three methods. First, areas of insufficient vegetative bank cover were determined using a GIS map of the riparian vegetation structure classes within the watershed. Second, Pfankuch channel stability indices were analyzed from past stream surveys of some representative tributary and mainstem reaches. Third, changes in active channel widths over time for a few representative mainstem response reaches within the watershed were analyzed using aerial photographs.

Upon review of the Riparian Vegetation Structure Class Map, riparian corridors which are either non-forested or have shrubs and/or seedlings are relatively rare and closely associated with high elevation ephemeral streams within avalanche chutes (Figure 3.53). Riparian reserves composed of sapling/pole (1" to 9" dbh) are found mostly in the lower Middle Fork below its confluence with the Pratt River. Sapling/pole sections of riparian reserves are also found in the upper Pratt River, the lower Taylor River, lower Quartz Creek, and the upper Middle Fork Snoqualmie River mainstem below Goldmeyer Hotsprings. Immature stands (9" to 21" dbh) are found for the most part along the mainstems of the Taylor, Pratt, and upper Middle Fork Snoqualmie Rivers. Most mature stands are confined to tributary streams within the Forest boundary, with sporadic groves along the mainstems of the Taylor, Pratt, upper Middle Fork Snoqualmie Rivers, and Quartz Creek.

Approximately 14% of the stream miles within the analysis area have sapling/pole sized stands. These stands have inadequate root development to adequately stabilize stream banks or provide quality large woody debris (LWD) for sediment storage and energy dissipation. The majority of these stands are outside of the Forest boundary.

Pfankuch (1975) channel stability ratings were conducted as part of four separate USFS Level II stream surveys conducted within the analysis area (Table 3.20). The channel stability rating performed on two reaches of Quartz Creek in early August of 1990 resulted in scores of 94 and 69. The reach with the score of 69 was considered to have good channel stability, while the reach scored as a 94 was considered to have fair channel stability. Four reaches of the Taylor River were assessed in September of 1992 and received scores ranging from 75 (good stability) to 86 (fair stability). Channel stability ratings performed on four reaches of the Pratt River in September of 1992 resulted in scores ranging from 62 (good stability) to 79 (fair stability). An aerial reconnaissance video (8/96) clearly showed a large earth slump that was, and still is, actively contributing fine sediment (blue clays) to the Pratt River approximately 1/2

mile above its confluence with the Middle Fork. This sediment source greatly increases the overall turbidity of the mainstem downstream of the Pratt River. Three reaches within the mainstem of the river were rated in mid-August of 1996, and resulted in scores of 91 (fair stability), 118 (poor stability), and 124 (poor stability). The fair stability score was from the upper reach surveyed from approximately river mile 80 to river mile 81. The 1996 stability survey indicates that the mainstem has poor channel stability overall. This is particularly true in some stretches from its confluence with Burntboot Creek down to the Forest boundary at river mile 60.

Table 3.20 Pfankuch channel stability ratings for the Middle Fork Snoqualmie River and selected tributaries.

Stream Name	# of Reaches	Survey Date	Location	Range of Scores	Rating
Quartz Creek	2	8/2/90	RMs 0.0-3.0	69 - 94	Good/Fair
Taylor River	4	9/10/92	RMs 0.0-6.7	75 - 86	Good/Fair
Pratt River	4	9/17/92	RMs 0.0-6.7	62 - 79	Good/Fair
MF Snoqualmie River	3	8/20/96	RMs 60.0-81.0	91 - 124	Fair/Poor

Reach score of: <38 = Excellent, 39-76 = Good, 77-114 = Fair, >115 = Poor.

The Pfankuch channel stability rating index was developed prior to stream classification systems. Therefore, the stability rating used for past USFS Level II surveys uses an average stability index, regardless of stream type. Different types of streams typically have different channel stabilities, and should have separate channel stability ratings associated with them.

Rosgen's (1996) stream classification system has adjusted the Pfankuch stability ratings to each individual stream type. The reason this is done is to reflect the naturally inherent and differing value ranges for each stream type (Rosgen 1996). The Level II stream surveys presently provide Pfankuch channel stability indices for entire reaches. These reaches are then given a Level I Rosgen stream type (A-F). This level of stream typing is not detailed enough to properly relate channel stability with a particular stream type. A Level II Rosgen typing (A1-6, B1-6, C1-...) should be conducted to establish reach breaks for associated Pfankuch channel stability indices. This would greatly increase the sensitivity of interpretations of stability ratings (Rosgen 1996).

Forest Service 1:12,000 aerial photos from 1992 were compared with 1:12,000 aerial photos from 1962 and Army Corps orthoquads from 1942 to locate areas of active channel widening. Time constraints allowed analysis of only the mainstem Middle Fork Snoqualmie and Pratt Rivers. One obvious site of channel instability was observed from approximately river mile 71 to 74.5 along the upper Middle Fork mainstem. This stretch of the Middle Fork was railroad logged in the late 1930's and the 1942 orthoquad shows a fairly well confined channel with clearcuts bordering it on either side with some riparian vegetation still intact. The 1962 and 1992 photos, however, show significant channel braiding and widening in the same reach. Thunder Creek, a left bank tributary to the Middle Fork mainstem (RM 73.5), experienced a major debris avalanche between 1942 and 1962, which introduced large amounts of sediment to the mainstem. Along with the above events, the frequency of large flood events seems to have increased significantly in the last two decades in this region.

Table 3.21 shows some rough measurements of sinuosity and average active channel width for each photo series of this section of the mainstem. These measurements seem to indicate that sinuosity has decreased and average active channel width has greatly increased since 1942. It appears that the combination of past large scale timber harvest, excessive sediment introduction, and increased flood frequencies have resulted in long-term channel instability within this section of the upper Middle Fork Snoqualmie River.

A section of the Pratt River from approximately river mile 2.0 to a point just above Thompson Creek at approximately river mile 5.0 was also analyzed using the same aerial photo series and orthoquads. Table 3.21 also displays the results of rough measurements of sinuosity and average active channel width for the Pratt. These measurements seem to indicate that the Pratt River mainstem has become somewhat narrower and confined since 1942. Sinuosity did not appear to change significantly over the last 45 years. An intensive and extensive aerial photo analysis of the entire analysis area should be conducted in the near future using state-of-the-art analytical stereoplotter technology to more accurately assess the effects of past and present human activities on stream channels within the drainage.

Table 3.21 Comparison of sinuosity and change in average active channel width (Wac) for the mainstem Middle Fork Snoqualmie and Pratt Rivers from 1942 to 1992, using USFS 1:12,000 aerial photos (1962 and 1992) and Army Corps of Engineers 1:20,000 orthoquads (1942).

	MF Snoqualmie		Pratt	
Photo Date	Sinuosity	Wac*	Sinuosity	Wac*
1942**	1.13	60	1.10	90
1962	1.00	120	1.11	60
1992	1.03	160	1.12	50

*Average active channel width in feet.
**Army Corps of Engineers 1:20,000 orthoquads

Large Woody Debris Recruitment

Within the analysis area there are approximately 360 stream miles which have either shrubs/seedlings or are non-forested and approximately 155 stream miles of sapling/pole riparian areas (Table 3.22). Most of the small or non-forested areas are located along the shores of high-mountain lakes or along perennial non-fish bearing and intermittent streams in avalanche chutes. However, a few areas were found along the banks of the Middle Fork Snoqualmie River near the city of North Bend. With no trees along the banks, no new debris will be available to replace large old pieces in the river as they decay (Bisson et al. 1987). These open areas can, through increased primary production, increase samonid fry production in the summer, but poor cover can reduce survival over winter. These effects are typically greater in smaller streams than in larger rivers (Murphy and Hall 1981).

Table 3.22 Relative abundances of vegetation structure classes within analysis area (SNF = small or non-forested, SAP = sapling/pole stands, IMM = immature stands, and MAT = mature stands).

Structure Class	Total Stream Miles	%
SNF	360.47	0.33
SAP	155.23	0.14
IMM	186.10	0.17
MAT	389.79	0.36
	1091.60	

There are several miles of riparian areas that are composed of sapling/pole stands. These trees typically range from 5 to 20 years of age and 1" to 9" dbh. These trees will not provide quality LWD or shading to the aquatic system for decades, but will reduce bank erosion. Immature and mature stands make up the remaining approximately 575 stream miles of riparian area vegetation within the analysis area. These stands are presently providing quality LWD to the aquatic system as well as stream shading.

Instream Habitat

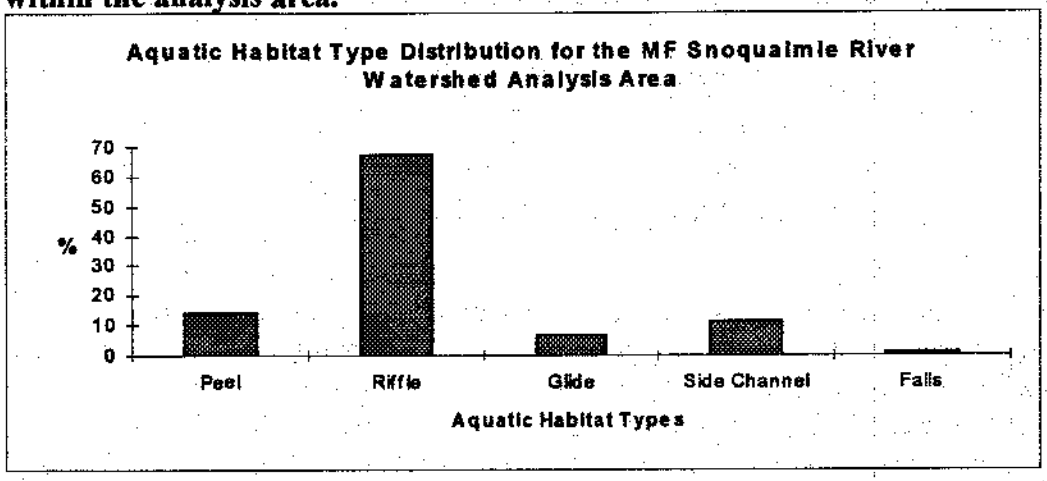
Forest Service instream habitat surveys have been conducted on the mainstem of the river, its two major tributaries, and six of its lesser tributaries (Table 3.23). These surveys collected information on aquatic habitat type distribution, pools/mile, dominant/subdominant substrate type, and relative abundance of LWD. There will be a brief discussion of each of these topics in the following paragraphs.

Table 3.23 Forest Service stream surveys conducted within the analysis area. Mod Level II indicates that a MBS modified Level II stream survey was performed in place of the more intensive R6 Level II survey.

Stream Name	Date Surveyed	Total Miles Surveyed	Survey Type
Quartz	8/2/90	3	Level II
MF Snoqualmie	8/27/90	7	Level II
Taylor	9/10/92	6.7	Level II
Pratt	9/17/92	6.7	Level II
Rainy	10/13/93	2.8	Mod Level II
Dingford	10/19/93	4.5	Mod Level II
Wildcat	10/20/93	1.6	Mod Level II
Bumboot	10/20/93	3.1	Mod Level II
Cripple	10/21/93	1	Mod Level II
MF Snoqualmie	8/9/96	12	Level II

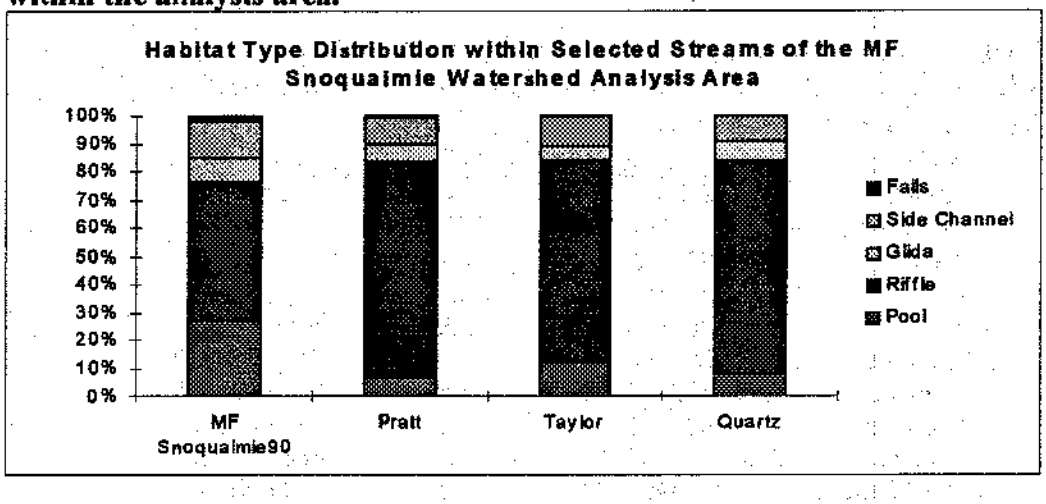
According to past Level II stream survey results, the aquatic habitat within the analysis area appears to be dominated by riffles (approximately 67%), with lesser amounts of pools (approximately 14%) and side channels (approximately 11%) (Figure 3.54). Glides (approximately 7%) and falls (approximately 1%) were also observed. This information seems to support suggestions that the river is pool habitat limited, particularly from Mine Creek Campground to the Taylor River confluence on the mainstem (Pfeifer, personal communication 1996).

Figure 3.54 Aquatic habitat type distribution for some selected rivers and streams within the analysis area.



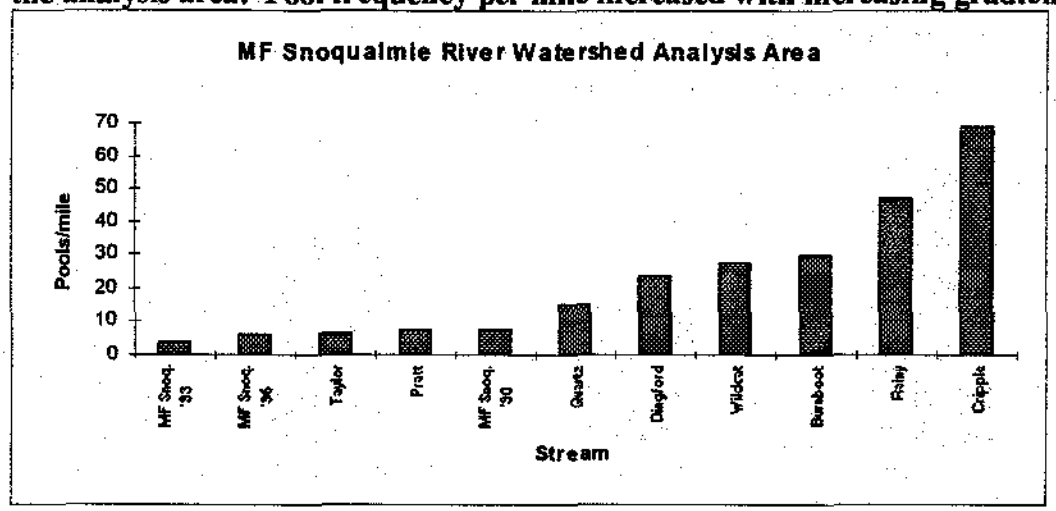
A look at each individual stream surveyed seems to indicate that the tributaries to the mainstem have an even lower abundance of pool and glide habitat available to the aquatic community (Figure 3.55). The average proportion of riffles within these tributaries is approximately 75% of their existing aquatic habitat compared to only 48% of the mainstem being riffles. Part of this could be due to the tributaries, particularly Quartz Creek, having a higher average gradient than the mainstem.

Figure 3.55 Aquatic habitat type distribution for selected individual rivers and streams within the analysis area.



A comparison of the number of pools observed per mile of stream seemed to indicate that pool frequency does increase with increasing gradient as the streams move from a meandering pool:riffle type to a straightened step pool and cascade:pool type (Figure 3.56). At present not enough data exists within this watershed to accurately assess whether or not these pool frequencies are within the range of natural variability.

Figure 3.56 Relative distribution of pools per mile for various rivers and streams within the analysis area. Pool frequency per mile increased with increasing gradient.



A similar study of the number of pools per mile was conducted by the WDFW for the North Fork, Middle Fork, and South Fork Snoqualmie, and the North Fork Tolt rivers (Jackson and Jackson 1993) (Figure 3.57). This study showed a lower frequency of pools per mile for the Middle Fork (approximately 4.0 pools/mile) than the Forest Service 1990 (approximately 8.0 pools/mile) and 1996 (approximately 6.0 pools/mile) aquatic habitat surveys (Figure 3.58). Both the North Fork and the Middle Fork appeared to have fewer pools/mile than either the South Fork or the North Fork Tolt Rivers in 1993. However, when trout densities for these rivers were compared (discussed in a later section), they did not appear to correlate to the frequency of pools/mile. The differences in pools/mile observed for the Middle Fork from 1990, 1993, and 1996 could be due to differences in survey methodology, variable location of surveys, and/or observer error. The average number of pools/mile for the Middle Fork seems to be around 6.0 according to these observations.

Figure 3.57 Comparison of the number of pools per mile for rivers sampled by the WDFW (Jackson and Jackson 1993).

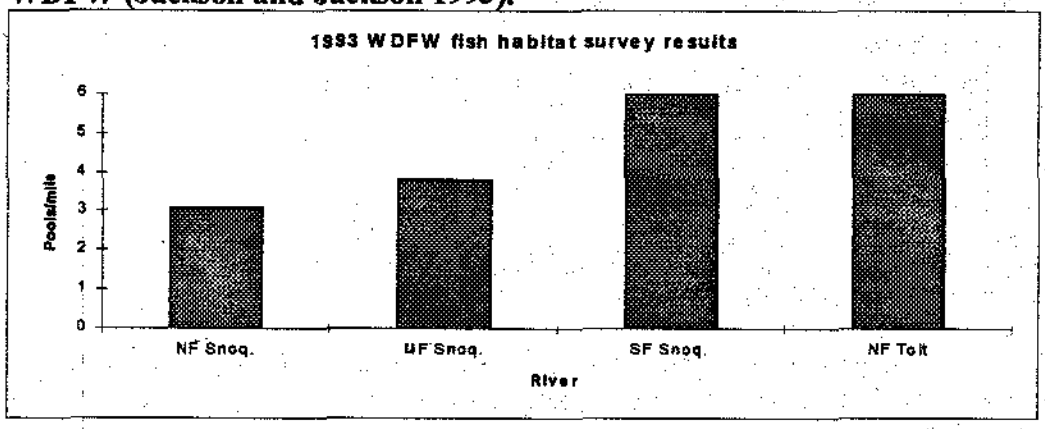
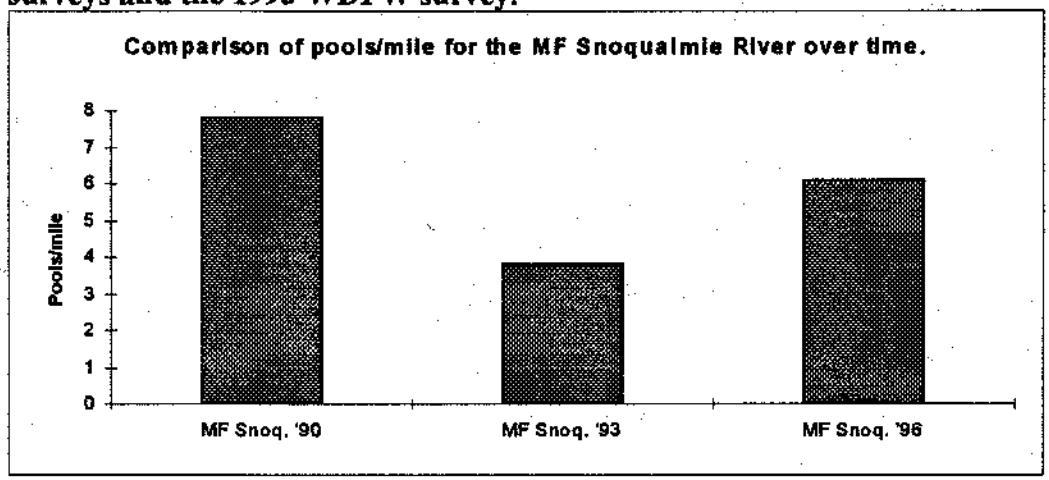


Figure 3.58 Comparison of the number of pools per mile for representative reaches of the Middle Fork Snoqualmie River from the 1990 and 1996 USFS Level II stream surveys and the 1993 WDFW survey.



The dominant stream bed substrate type within the mainstem MF, according to the 1996 Level II stream survey from approximately river mile 61 to 65, was observed to be cobble (2.5"-10.0") with gravel (0.08"-2.5") as the subdominant substrate (USDA Forest Service 1996). From approximately river mile 67.5 to 74.5 the dominant bed substrate was cobble with gravel and boulders (10.0"- 160") being the subdominant types. The upper Middle Fork Snoqualmie River from approximately river mile 80 to 81 had boulders as its dominant bed substrate with cobble and bedrock being the subdominant types. The 1990 Level II survey conducted in nearly the same reaches recorded similar dominant and subdominant bed substrate types (USDA Forest Service 1990).

Three tributaries to the Middle Fork Snoqualmie River were also surveyed for dominant and subdominant stream bed substrate types and will not be discussed in this narrative, but the results are summarized in Table 3.24 by reach.

Table 3.24 Summary of results of past USFS Level II stream surveys on three MF Snoqualmie River tributaries.

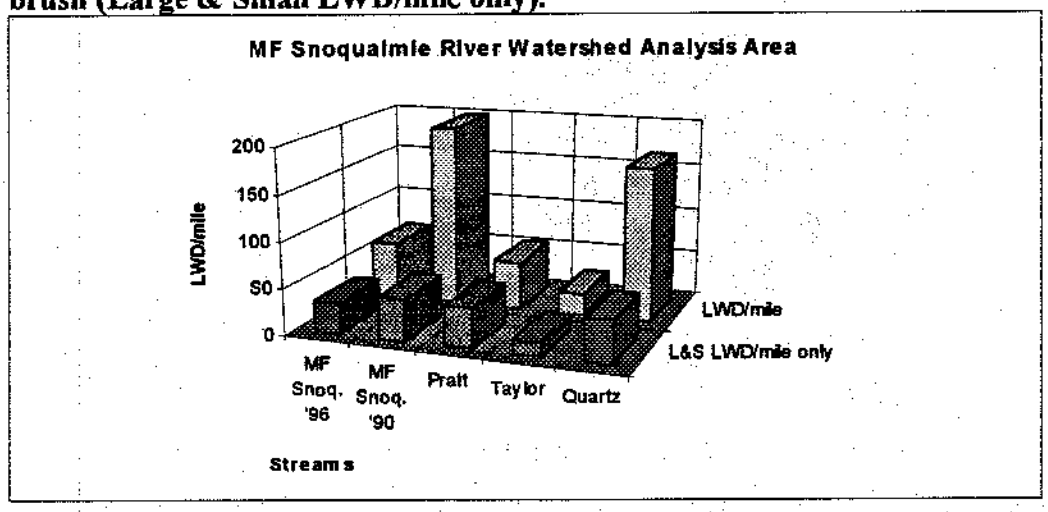
Stream Name	Survey Date	Reach 1	Reach 2	Reach 3	Reach 4
Pratt River	9/17/92	CO/GR	CO/LB	CO/LB	CO/SB
Taylor River	9/10/92	GR/CO	CO/SB	CO/SB	CO/GR
Quartz Creek	8/2/90	SB/LB	BR/SB	n/a	n/a

GR = gravel (0.08-2.5in), CO = cobble (2.5-10in), SB = small boulder (10-40in), LB = large boulder (>40in), BR = bedrock (source - 1996 USFS R6 Stream Survey Handbook).

Figure 3.59 shows the average LWD/mile observed within the bankfull channel of the river and a few of its tributaries. When the brush-sized LWD (dbh>12", length>25') was factored out, the large and small LWD combined showed more similarity in LWD frequency between systems. The only exception was the Taylor River which had much less large, small, and total LWD/mile compared to the other three drainages. There was not enough time during this analysis to determine why the Taylor River has less woody debris. Large amounts of

additional LWD were observed along the outer edge of the bankfull channel of the mainstem by stream surveyors last August (Sean Ebnet, personal communication 1997). It is believed that this debris was left outside the bankfull channel when last year's flood waters receded. Perhaps some of this debris was in the bankfull channel during the 1990 survey resulting in the higher LWD/mile figures that year. Observations made recently indicate that the 1990 and 1995 flood events have contributed large amounts of LWD to the mainstem Middle Fork from Dingford Creek to Burntboot Creek and caused substantial channel shifting (Pfeifer, personal communication 1996). No information was found that would indicate that stream cleanout operations, removal of inchannel LWD to reduce flood hazards, have ever been conducted within the analysis area on federally managed lands.

Figure 3.59 Large woody debris (LWD) per mile for some selected rivers and streams within the analysis area. LWD per mile is given with brush (LWD/mile) and without brush (Large & Small LWD/mile only).



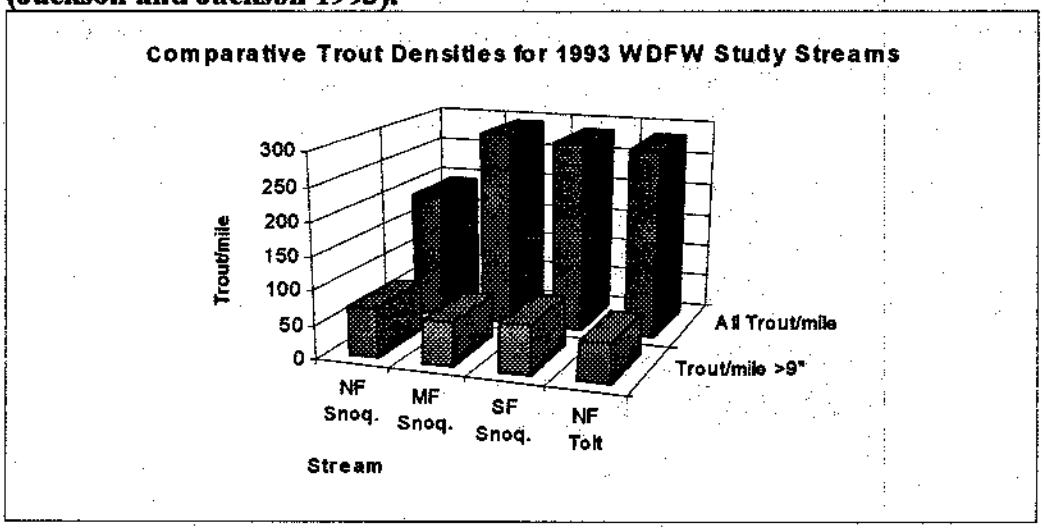
Aquatic Species

Past state and federal aquatic surveys within the analysis area have documented the presence of resident populations of rainbow trout (*Oncorhynchus mykiss*), cutthroat trout (*Oncorhynchus clarki*), eastern brook trout (*Salvelinus fontinalis*), mountain whitefish (*Prosopium williamsoni*), various species of sculpin (*Cottus sp.*), and largemouth bass (*Micropterus salmoides*) (Pfeifer 1985) (USFS 1990).

The eastern brook trout population is introduced, but the rainbow and cutthroat populations may be native. Both rainbow and cutthroat trout were stocked in the analysis area as early as 1933 and as late as 1983. Brook trout stocking began in 1940, but ceased in 1963. Some unsanctioned group recently introduced largemouth bass to a small buttonhook-shaped pond in the lower Middle Fork floodplain. Exposure of this typically warm water fish species to the lake could have an adverse affect on its existing indigenous flora and fauna. Hopefully better public education about the hazards of non-native fish species introduction will stop unsanctioned fish stocking.

Hook-and-line surveys conducted in 1981 and 1984 showed cutthroat to be the dominant trout species within the analysis area (Pfeifer 1985). Trout growth in all the Snoqualmie forks appears to be below average. However, Pfeifer (personal communication 1996) did not recall that the fish from the Middle Fork were slower-growing than the other forks' populations. In Jackson and Jackson (1993), the Middle Fork was found to be slightly more productive (number of trout/mile) than the North Fork and South Fork Snoqualmie, and North Fork Tolt Rivers (Figure 3.60). However, this river receives the greatest fishing effort. As a result it also has the lowest average density of trout greater than 23 cm per mile.

Figure 3.60 Comparative trout densities (total # of trout per mile and # of trout per mile >9" in length) for 1993 WDFW study streams in the Snoqualmie River Watershed (Jackson and Jackson 1993).



The entire analysis area has been managed with "Catch and Release," Selective Fishery Regulations since 1986, as part of the WDFW "Basic Stream Management Strategy" (Jackson and Jackson 1993). A hook-and-line CPUE study performed by Pfeifer (1990) was compared to studies performed in the South Fork to assess the effectiveness of the catch-and-release regulation. Length frequencies of the two populations were similar but catch rates and catch success did improve, particularly in the Middle Fork. However, in the 1990 survey, more large cutthroat trout (over 34 cm in length) were caught more than 1/4 mile from common river access points than were caught near the access points, indicating lack of angler compliance. It has been suggested that poor compliance with the regulations is probably a major factor in the failure of the regulations to restore the historic abundance of older trout in these streams (Wright 1991), and compliance levels estimated by local Wildlife Agents in 1989 and 1990 ranged from 50% to 77% (Pfeifer 1990).

Whitefish and any sculpin populations within the analysis area are definitely native. No efforts have been made to identify specific sculpin species. Pfeifer (personal communication 1996) suggested that it would be worthwhile to sample the lower-valley wetlands and oxbows for possible native minnow species.

There are a total of about 572 miles of perennial streams which are known to support fish within the analysis area, and are thought to provide the majority of potential habitat among the estimated 1,747 total stream miles within the watershed (Table 3.25). The majority of these 572 miles of known fish bearing sections are located within the lower gradient, lower elevation reaches of the Upper Middle Fork, which is the largest fifth field watershed in the analysis area. There are approximately 912 miles of intermittent streams in the analysis area, and they are by far the most abundant stream type present (~ 52%). Again, the majority of this stream class, approximately 73%, is represented within the Upper Middle Fork. This class does not distinguish fish bearing from non-fish bearing intermittent streams, so fish presence/absence should be verified through field reconnaissance.

Table 3.25 Stream classification of streams within the analysis area by fifth-field watershed.

5th Field Watershed	Total Acreage	Stream Class* (in stream miles)				
		Perennial Fish Bearing Miles	Perennial Non-Fish Bearing Miles	Intermittent Miles	Unknown Miles	Total Miles
Upper MF Snoqualmie	43,617	455	3	662	0	1,120
Lower MF Snoqualmie	6,590	10	17	29	6	62
Taylor	19,323	25	83	84	1	193
Pratt**	39,949	82	85	138	67	372
Analysis Area Total	109,479	572	187	912	75	1,747

* Note: DNR and USFS R6 stream classes were combined to construct this table.

** Note: Of the total acreage within the Pratt fifth field watershed (39,949) the Pratt River itself comprises approximately 17,946 acres while the lower Middle Fork outside the MBS Forest boundary makes up the remaining 22,003 acres.

The stream classification system used to produce these totals was developed by combining the DNR stream typing system with the Forest Service-R6 stream classification system. These are presently our best estimates of the stream types represented and their relative proportion in the analysis area. However, recent investigation of previously typed streams on State lands has resulted in retyping of as much as 60% of the streams surveyed. Therefore, it is important that stream classification be verified by periodic field reconnaissance.

Human Dimension

Prehistory

Very little research has been conducted in the upriver and mountain regions of western Washington. The data base is incomplete; the gaps are filled with information about cultural traits extrapolated from other areas.

The way in which people used and inhabited the foothills and mountains of the western Cascades was influenced by people from eastern Washington and the coastal region. As the distance from the coast increases, the sites and artifacts look more like those found in eastern Washington. Whether this indicates that the people using the Cascades were culturally distinct from those using the coast is open to question. The differences that developed between the

maritime orientations and those found inland could represent parts of a settlement and subsistence system that included both environments. Further research focusing on the contact zones, such as the inland prairies of the Puget trough, will continue to shed light on this question (Hollenbeck 1978).

Early settlement was by small groups occupying open campsites dispersed along river terraces and lake edges for short term use such as hunting, gathering, and lithic material procurement. Occupation of the upland areas increased about 4,000 years ago and continued into the early historic period (Miss and Burns 1989).

Groups probably ventured into the high country during the warmer months to take advantage of plant and animal resources. Their forays may have taken them to specific places close to the mountain passes, or even across the mountains, to meet and trade with people from the east side. However, in immediate post-glacial times, climatic extremes may have limited both the extent and routes of travel.

Two prehistoric archaeological sites have been found within the analysis area; however, no large scale systematic survey has been conducted. In the adjacent areas, sites have been found in the vicinity of the Alpine Lakes to the north, at Chester Morse Lake in the Cedar River watershed, and near Hyak. These sites indicate that the area was occupied over a period of eight millennia.

Ethnography

The people who lived in the upriver territory of the present Mt. Baker-Snoqualmie National Forest in the middle 1800's belonged to the Salish language group. They spoke two distinct but mutually intelligible Salishan languages: Nooksack (Lhechelesem) and Puget Salish (Lushootseed). In Nooksack country, the Lhechelesem language has been largely or wholly replaced by another Salishan language, Halkomeken, or by Lushootseed. In addition, several dialects of these languages were spoken. The groups most closely associated with the upriver and forested territory of the Mt. Baker-Snoqualmie National Forest are, from north to south: the Nooksack, the Upper Skagit, the Sauk-Suiattle, the Stillaguamish, the Skykomish, the Snoqualmie, the Muckleshoot, and the Puyallup. They are generally distinguished geographically by drainage basin. Among these groups, there were close similarities in political organization, lifestyle, and religious beliefs. Kinship ties, shared subsistence areas, dynamic trade networks and topographic continuity linked groups and provided a basis for sustained relationships.

The analysis area was the province of the ancestors of the present-day Snoqualmie Indian group. Variously called Snoquel-ol-mi, Snoqualmie, etc., they consisted of those people who made their permanent homes along the Snoqualmie River and its tributaries. Most villages were located downstream of Snoqualmie Falls, which formed a natural barrier for migratory fish; however, one village site is said to have been between the South and Middle Forks of the Snoqualmie River, and another was one mile below North Bend.

The village site at North Bend had a number of "removable houses," which may indicate that it was a temporary or summer village. Temporary dwellings may have been constructed of a conical frame with cattail mats for siding. These may have been placed alongside permanent cedar plank houses as village populations grew for certain seasons or purposes.

The upriver and mountainous environment of the Snoqualmie Indians provided deer, elk, mountain goat, bear, beaver, grouse, huckleberries, blackberries, elderberries and salmonberries, to name just a few of the food resources. The diet was rounded out by a variety of resources available from the valley, lacustrine and marine environments. The Snoqualmie men were known as excellent hunters, as were other upriver Indians of western Washington. Hunting trips lasted two or three weeks and were frequent throughout the year except during the prime fishing periods.

Berrying and hunting trips were probably combined, at least to some extent. Indian women gathered berries in July at the lowland elevations, and in August and September family groups made special trips into the mountains. The Snoqualmie group periodically set fire to their favored gathering areas to promote berry growth.

Because the Snoqualmie were closely influenced and frequently related to the Yakima Indians, it is likely that the folded cedar bark basket used by the Yakima for berry picking was used in this area. Such baskets were made on-site. Berries were dried and packed home for winter stores. Indians built fires under wood-framed processing racks to facilitate drying. Another drying method used reflected heat from a trench-fire; the berries were spread out on a mat that faced the fire at about a 45 degree angle.

Other wildlife and plants were taken closer to the villages and camps, downstream of the watershed analysis area. The Snoqualmie valley had many natural prairies popular for plant gathering activities. The prairies also produced large quantities of potatoes after they were introduced by Europeans. These became a trade item in later years.

Travel routes and trade networks were well established between the Yakima and Snoqualmie and between the Wenatchi and Snoqualmie. The Snoqualmie Pass trail followed the general route of the South Fork Snoqualmie River. It was considered the "foot trail" across the Cascades; and after the introduction of horses in the mid-1800's, it was used less often than the horse trail across Yakima Pass.

Euroamerican Contact

Subsequent to the Donation Land Act of 1850, European settlement of the western territories quickly took place. Under the Act, as amended to include Washington Territory in 1853, every white male settler who resided upon and cultivated land for four consecutive years was entitled to a quarter of a section if single, and a half of a section (320 acres) if married. By 1855, 1,018 claims had been taken in Washington, scattered widely over the territory.

Governor Isaac L. Stevens was directed by the President of the United States to treat with all the Indians of western Washington. Stevens was to unite the Indians into tribes for the purpose of negotiating a treaty and to make provisions to remove them to reservations located away from the centers of white population, and for the most part, away from the traditional lands and resources of the Cascade province. The Snoqualmie were assigned to the Tulalip Reservation near the mouth of the Snohomish River. The location of the reservation was not well suited for the inland oriented tribe, and one Snoqualmie leader made several pleas for the establishment of a reserve on the prairies in the vicinity of Snoqualmie Falls. Some Snoqualmie Indians apparently moved down to the Tulalip Reservation and were absorbed into the Tulalip Tribes while others returned to their traditional upriver territory, or never moved. A group of Snoqualmie Indians has united and are attempting to gain recognition from the federal government as an autonomous tribe.

Transportation, mining, logging, recreation, and Forest Service administration were the primary historic themes that affected the analysis area. The proximity to the coast affected the development of transportation routes that connected resources with effective import, export, and distribution markets.

Properties Historic

Within the Middle Fork Snoqualmie River watershed, 11 properties are listed in the Forest Heritage Resource data base. All are associated with the historic period of use. Most sites represent historic transportation developments, with mining, logging, CCC and administrative themes also represented. The majority of sites have been located through the historic records. It is likely that more sites will be discovered as heritage resource inventories are conducted in the watershed.

Roads

In addition to the county roads, there are National Forest system roads and numerous privately owned roads within the Forest boundary. Past management practices by landowners have resulted in an extensive road system within the lower portion of the watershed outside the National Forest boundary. Originally developed and used for timber harvest, these roads are now used by the public to access the watershed for recreation purposes. Figure 3.61 Roaded and Unroaded Lands shows which areas of the analysis area currently have roads or do not.

The development of this road system over the last 60 years has resulted in a current open road density of approximately 0.91 miles of road per square mile, for all ownerships. National Forest land consists of an open road density of .30 miles per square mile, while private land has an open road density of 3.35 miles per square mile. Surfacing can vary from crushed gravel to native material. Drainage is accommodated either by outsloping the road surface or by building the roads with ditches and using culverts to accommodate drainage of runoff or providing for stream crossings.

Early access up the Middle Fork of the Snoqualmie River was served by the construction of roads for mining interests around the turn of the century and then logging access which began in earnest in the 1920's.

Within the analysis area there are approximately 168 miles of existing roads. The following table (Table 3.26) gives a breakdown of these roads by ownership.

Table 3.26 Road Ownership in the Analysis Area.

National Forest System Roads	32.4 miles
National Forest Non-System Routes	0.3
State and Private Roads	127.1
County Roads	8.5

The 32.4 miles of National Forest system road are currently distributed into maintenance levels as shown in Table 3.27 below.

Table 3.27 National Forest System Road Maintenance Levels.

Level 1 (Closed--In storage)	7.4 miles
Level 2 (Open--Mtc. for High Clearance Vehicles)	19.9
Level 3-5 (Open--Mtc. for Passenger Cars)	5.1

Most of the roads on National Forest lands were constructed initially for timber harvest activities, with roads along the valley floor being constructed first as early as the 1930's and 1940's. By the 1970's, the roads being constructed for timber harvest were being built in the steeper terrain of the watershed. Although originally built for timber access, in most cases, a large portion of the road system has served multiple forest management access objectives. Included in these objectives are public access for dispersed camping, hunting, fishing, wildlife and scenic viewing, berry picking, and trailhead access to both wilderness and non-wilderness areas.

Railroads

Over 36 miles of logging railroad were completed and used in the Middle Fork Snoqualmie River area. These rail lines went from Edgewick to the Taylor River with one spur line reaching up the Pratt River valley and another going as far as Goldmeyer Hot Springs. This line was owned, operated and maintained by the North Bend Timber Company with right-of-way grants from both the Pacific States Lumber Company and the Snoqualmie Falls Lumber Company.

Logging

The North Bend Logging Company began as W.C. Weeks' shingle mill in North Bend around 1890; over the next 20 years, several camps connected by railroad and telephone line were established (Figure 3.62 Historic Timber Harvest). Weeks and his partner R. Webb Vinnedge reached maximum production at their mills around 1905-1910. At about that time, the South Fork Lumber Company stepped in with some healthy competition, with their mill located just three miles upriver from North Bend.

Camps and equipment were moved around and set up temporarily where there was timber to be cut. In 1919, the District Ranger reported on two logging operations in his District: the North Bend Logging Company finishing up at Rockdale (just east end of North Bend), and the Skagit Boom and Logging Company.

By the early 1920's, logging operations in the Middle Fork Snoqualmie River area were in high gear. Camp #15 outside of Edgewick was fully operational and Camp Brown (built in 1927), further upriver, became a pivotal point for logging operations in this area. From 1931 to 1936, approximately 3300 acres of timber was harvested on National Forest lands using narrow gauge railroad. Beginning in 1953 and continuing through 1993, approximately 1700 acres of timber on National Forest lands was harvested using a cable and skyline system. Timber harvesting on private lands during this time period amounted to about 8000 acres. The total acreage harvested over a 60+ year period amounted to approximately 14,275 acres (out of nearly 97,000 acres of forested land).

In the more recent past, the area supported up to five sawmills which were the main contributors to the economy of the analysis area and its surrounding environs. The last mill in the North Bend area closed in the late 1980's, making the Weyerhaeuser mill in the town of Snoqualmie the last vestige of a once dominant industry.

Mining

Considerable development occurred in 1896 at the Dutch Miller and Bahoster property located at the extreme head of the Middle Fork in what was known at the time as the Burns Mining District (Dubois 1906). By 1901, these mines had produced several small shipments for the smelter, returned $37.65 per ton after smelt costs, principally in copper. Patents on these claims date from 1908. This mine was reached from Seattle via the Great Northern Railway line to the Foss Creek Station on the Skykomish River, a four-hour ride. From the station to the mines took an additional eight hours; the first five miles to Crystal Cabin (a 20 by 30-foot log cabin located at 4,895 feet) by horse, and by foot trail for one mile "over a glacier and through Crystal Pass (which rises 900 feet in one half mile and has an elevation of 5,895 feet at the highest point) which brings you to Dutch Miller Cabin" (DuBois 1906). Mr. DuBois, a mining engineer for the Washington State Division of Mines and Geology, visited the mines in 1906 and reported a cabin and a blacksmith's shop "in the floor [of which] a shaft has been sunk on a 61 degree incline to the south" (1906). It appears that the camp, consisting of a cabin and numerous tents, was located around the mill site down along the Skykomish River.

The expense of removing ore from the Dutch Miller was great. Within a few years, the main access to the mine had switched from the Skykomish River to the Middle Fork of the Snoqualmie River (Treen 1916), and almost 30 years later, a mine-to-market road was proposed (Melrose 1941). By that time, the Sunset Highway had reached North Bend and a road branched off up the Middle Fork to Goldmeyer Hot Springs. From that point, eleven miles of trail came within one mile of the mine; the last mile was an untrailed, rugged section, not easily negotiated (Carither 1942). The proposed mine-to-market road was never completed.

Today, there are approximately 20 active mining claims in the analysis area. Of these, two are currently going through the patent process. Many other claims over the years have become inactive due to many different factors. The material most frequently mined in this area is quartz crystals.

Forest Service Administration

The Pacific Forest Reserve was set aside in 1893, closed to settlement and resource use. In 1897, the Mt. Rainier Forest Reserve was designated with a new mandate; mining, agriculture and timber uses were allowed on suitable lands within the Reserve. In 1899 the Mt. Rainier National Park was established from part of the Mt. Rainier Forest Reserve and in 1904 an additional portion of the Reserve was transferred to the Park. The Forest Reserve was transferred from the Department of the Interior to the Department of Agriculture in 1905 and subsequently designated the Washington National Forest and the Rainier National Forest. On June 18, 1908, the Washington National Forest was divided into two Forests: the Washington National Forest, from the international border to the Skagit River; and the Snoqualmie National Forest, from the Skagit River to the Green River. In 1973, Forest officials decided to merge the Mt. Baker (previously the Washington National Forest) with the Snoqualmie National Forest. At that time, the Snoqualmie gave up administration of the Naches and Tieton Districts to the Wenatchee National Forest.

The Lester District, which encompassed the Snoqualmie River and the Green River watersheds, was headquartered originally at Lester. The main administrative offices were later moved to Denny Creek. In addition, there was a guard station at Taylor River in the analysis area. After the closure of the Sunset Highway the Forest Supervisor proposed that the headquarters be moved to North Bend. The CCC established a camp at North Bend and built the North Bend Ranger Station in 1936. Today, the North Bend Ranger Station administers approximately 87,000 acres of the analysis area. The main office is located in North Bend and still utilizes the same buildings that were built by the CCC in the mid 1930's.

Current American Indian Uses

An inventory of Native American religious use, practices, localities and resources on the Mt. Baker-Snoqualmie National Forest was conducted in 1981 (Blukis, Onat and Hollenbeck 1981). Although the knowledge of many religious sites and resources is private, the inventory

does identify several localities in the Middle Fork Snoqualmie watershed that hold religious or spiritual significance for the Duwamish and Snoqualmie Indian communities. Qualities and resources of concern include, but are not limited to, purity, privacy, and cedar.

Culturally significant localities that have been identified in the watershed may have been used by Indian individuals and their families for long periods of time. In some cases, special knowledge of these locations may have been passed from generation to generation. However, there is some indication that as land use privileges are lost on state and private lands, religious and cultural use of National Forest lands is increasing. The Forest Plan Information Needs section refers specifically to a need to recognize the changing patterns of cultural and religious use on the Forest.

Community/Economics

Within the analysis area, there is only one population center: the community of North Bend. This area has a permanent population base of approximately 3,000 people. In addition, there is a large unincorporated population outside the city limits which is dependent upon North Bend for goods and services.

The economy of the watershed has changed from a timber-dependent situation to a very diverse pattern. Until as recently as the late 1970's, this area was dependent on wood products. Most people are now employed in other industries or jobs, which reflects a change in the overall economics of the area. Most of the people associated with the wood products industry are employed either by the Weyerhaeuser Company in the town of Snoqualmie or with some of the still remaining small logging companies such as Littlejohn and Anderson. Such businesses as Nintendo of North Bend and Ski Lifts Inc. at Snoqualmie Pass employ a smaller segment of the local population.

The majority of the adult working population derive their livelihood from outside the area. Most individuals are employed in Issaquah, Bellevue, Renton and Seattle, working in various professional and technical jobs. This in turn makes the North Bend area a "bedroom community" for the Puget Sound basin. This trend will probably continue into the future as population figures show an increase of 400,000 new residents in the state of Washington by the year 2000.

Recreation

Current Recreation Demand

The Middle Fork Snoqualmie River valley is one of the closest valleys in the Mt. Baker-Snoqualmie National Forest to the Seattle/Bellevue Metro area. Because of its proximity and ease of access (I-90) it may also receive some of the heaviest use. Recreation use occurs throughout the valley from the town of North Bend to the headwaters of the Middle Fork and associated subwatersheds. Formal and informal trails connect the Middle Fork Road to destinations throughout the Alpine Lakes Wilderness Area (Figure 3.63 Roads and Trails).

Recreation activities pursued within the Middle Fork Snoqualmie Valley include driving, picnicking, fishing, whitewater kayaking, sightseeing, photography, backpacking, climbing, rockhounding, car camping, dayhiking, horseback riding, mountain biking, swimming, rafting, hunting, trapping, off-road driving and motorcycling. The actual number of users is high; however, there has not been a formal vehicle or head count done. Traffic counts last taken 5-10 years ago indicated that approximately 65,000 vehicles are entering the National Forest on FS Rd. #56 annually. The majority of the activities take place within ¼ mile of the road system and the Taylor and Middle Fork Rivers. Backcountry use tends to fall into the low use category with only three primary destinations (Snow Lake, Snoqualmie Lake and Melakwa Lake) falling into the higher use categories (MBS Land and Management Plan, Appendix E, Pg. E-12).

Use in the Snow Lake and Gem Lake area must be taken into consideration when examining this watershed. Even though the access is from the South Fork of the Snoqualmie, most of the users are spending their day in the Snow Lake basin which drains into Rock Creek and the Middle Fork. Snow Lake currently receives the highest recreation use of any wilderness, backcountry, and many front country sites on the Forest. Approximately 25,000 hikers registered at the Alpental trailhead in 1995. In past years when electric eyes were placed at the Alpental trailhead and at the entry into the Snow Lake Basin the number indicated that 50% of the hikers were actually entering the Basin. The other 50% were turning around before crossing the second electric eye and were not dropping down into the lake basin.

Goldmeyer Hot Springs is located at the confluence of the Middle Fork and Burntboot Creek. Many recreationists are entering the valley and searching for the hot springs. Ten to twenty vehicles are often parked in the parking areas used to access the springs. Many users are regulars and are members of the corporation that owns the property. These users and their clients have formed and participated in a great amount of public input concerning the management of the Middle Fork area. This somewhat local interest has spurred other user groups in the Seattle area to become more interested and active in the decision-making process concerning the Middle Fork.

Developed Recreation

Trailheads: There are four formal USFS maintained trailheads located above the National Forest boundary, eight informal parking areas, and four areas used by miners and their visitors. This does not include a large number of dispersed use sites located all along the river. Only one of these trailheads has outhouses to properly deal with human waste. A list of trailheads and parking areas follows in Table 3.28.

Table 3.28 District Count of Commonly Used Parking Areas in the Middle Fork

TYPE OF TRAILHEAD	LOCATION	NUMBER OF PARKING AREAS	NUMBER OF VEHICLES	NUMBER OF OUTHOUSES
Formal		4		
	Middle Fork		50 Cars15 truck and trailer (stock)	2
	Snoqualmie Lake		15 Cars	0
	Dingford Creek		10 Cars	0
	Dutch Miller Gap		25 Cars	0
Informal		8		
	Granite Creek			0
	CCC Road		5 Cars	0
	Pratt River		4 Cars	0
	Garfield Mtn		10 Cars (Pvt. Prop.)	0
	Wildcat Creek		5 - 10 Cars	0
	Rock Creek		3 Cars	0
	Thunder Creek		3 Cars	0
	Goldmeyer Hot Springs		10-15 Cars	0
	Hardscrabble Lake		10-15 Cars	0
Mining		4		
	Quartz Creek		10 Cars	0
	Green Ridge Lake		5 Cars	0
	5pruce Claim		5 Cars	0
	Mill Site		2 Cars	0

Campgrounds: Two developed campgrounds have existed in the Middle Fork. Mine Creek Campground located on Department of Natural Resources property at MP 3.0 has been closed for approximately five years. The closure was due to budget cuts and law enforcement problems. The second campground was on the east side of the Taylor River at its confluence with the Middle Fork Snoqualmie River. The Taylor River Campground was closed as a developed site in the mid-1980's . The closure was due to budget cuts and vandalism problems. A flood in the late 1970's greatly affected the campground. Several campsites were eliminated and outhouses relocated. Constant vandalism and the lack of a budget to replace outhouses and picnic tables caused the District to simply close the campground. A gate was installed which was later vandalized. High water from the Middle Fork partially washed out the spur road becoming a more effective vehicle closure.

The site is now used as a dispersed campsite by individuals that are able to walk in. Users park at the gate or at the washout and walk the remaining ¼ mile into the old campground. Before the campground was closed to vehicular access many of the campsites were denuded of vegetation and some erosion was occurring. Lower use has allowed vegetation to regrow in most of the campsites. Now soil erosion and vegetation damage that is occurring is related to a small number of 4-wheel drive vehicles that occasionally enter the area.

Goldmeyer Hot Springs: The Hot Springs, located along Burntboot Creek, has been used by recreationists for almost 100 years. The property was originally owned by the Northern Pacific Railroad and is still private property. The property is managed by Northwest Wilderness Programs as a retreat site. It is open to the public by reservation and a daily fee. There is currently no official right-of-way for a parking lot, road use, trails, or any bridges to access this retreat site. Parking takes place on National Forest land on the north shoreline of the Middle Fork Snoqualmie River. Visitors park at this location and wade the river or use blown-down

trees when they are available. The more reliable access is via the Middle Fork Trail #1003 from Dingford Creek or Taylor River.

Parking occurs in two locations. The first is a wide spot in Rd. #56 at the junction with the spur road to an old parking lot. Many user trails have developed running directly from the road down to the river bank. A naturally blown-down tree is used as a footlog. The second parking area is on the north shore of the river directly across from the access trail to the Hot Springs property. An old vehicle ford was used to access an inn and campsites on the property. Again, because of the lack of a formal access system of trails and bridges, many user trails have developed causing vegetation damage and soil erosion. From 1960 and into the 1980's several large old growth trees growing along the river bank were dropped by users for footlogs.

To get a handle on the management of their land the owner's family formed Northwest Wilderness Programs as a non-profit corporation. Reservations are currently required, a fee is charged, and a caretaker is usually on site. Vandalism has dropped significantly since the caretaker has been living on the property. The area is cleaner, and other law enforcement problems have dropped.

Dispersed Recreation

Front Country (Non-Wilderness): The Middle Fork of the Snoqualmie River is one of the closest natural areas to the Seattle Metropolitan area. The entire roaded portion of the river is used for day use and weekend camping. Recreationists using the river in this way are engaged in a wide variety of activities including day hiking, fishing, hunting, rafting, kayaking, picnicking, target shooting, climbing, mountain biking, photography, and simply driving for pleasure. Approximately 82 dispersed campsites are located along the river and along Rd. #56. These were inventoried through the Code-a-Site program in the mid 1970's. All of the sites are accessed by short user-built roadways and trails. Most sites still exist and are full during the summer. Full dispersed sites were also the norm when a campground existed in the valley.

Unfortunately the lower portion of the river, from North Bend to the Taylor River, has a reputation for a lack of Forest Service and law enforcement presence. Vandalism, irresponsible shooting, garbage dumping, vehicle abandonment, and the use of 4-wheel drive vehicles off the road are some of the types of incidents that have been reported. The upper portion of the road from Taylor River to the Dutch Miller Gap Trailhead has a much lower level of problems.

In spite of its reputation approximately 65,000 vehicles travel Rd. #56 during the course of a year (District RIM Data 1970's-1980's).

Backcountry (Alpine Lakes Wilderness Area): 82,294 Acres in the Middle Fork drainage became protected from future development when the Alpine Lakes Wilderness Area was created in 1976. The wilderness boundary wraps around the roaded portion of the Middle

Fork Snoqualmie River approximately 1/2 mile from the road on most trails. The distance does vary somewhat.

Historically this area was used by American Indians, trappers, and miners. Today the backcountry is primarily used by backpackers, day hikers, climbers, anglers, and miners. Horses were the primary mode of transportation for all, including the District Ranger. Horse use has dropped significantly to only a few horses per year on trails. Backpackers, climbers, and anglers constitute the great majority of trail users today. Trail use in this part of the Wilderness Area generally falls into a "Low" use category of 0-500 users per year, per trail (MBS Land and Resource Management Plan, Pg. E-12). Since 1995 non-regulatory entry permits have been required for entry throughout the Alpine Lakes Wilderness Area. Use numbers were generated using 1995 permits. At this time the permit system is new and the rate of non-compliance has not been calculated. At some time in the future regulated or limited use permits may go into effect within the Wilderness Area. The implementation plan for this is outlined in the "*Alpine Lakes Wilderness Area, Recreation Use Study, 1993.*" The plan to limit access is currently on hold due to lack of funding and the development of the *Fee Use Demonstration* project being conducted nationwide.

Trails: The earliest records regarding trails in the Middle Fork date back to the early 1900's. Around 1914 the Middle Fork Trail was part of the main forest transportation system that linked the White River drainage to the Darrington area. The District Ranger lived at the Taylor River guard station during the summer and patrolled the area on horseback. Railroad logging and the development of roads eliminated the need to administer most of the Middle Fork via horseback and many sections of trail fell into disrepair or were abandoned altogether. The road replaced most of the main trail creating easier public access to side trails. Many of the major drainages had foot and horse trails connecting the valley bottom to the high lakes.

Today only four formal trail systems provide regular access to the backcountry. They are: Rock Creek Trail #1013, Dutch Miller Gap Trail #1030, Dingford Creek Trail #1005, and the Snoqualmie Lake Trail #1002. The newly reconstructed Middle Fork Trail #1003 connects all of these, essentially recreating the system as it existed 90 years ago.

Access to the Pratt River Trail #1035 was located on private land on which a hiker-only cable suspension bridge existed. This foot bridge washed out in 1975 and has never been replaced. Thompson Lake Trail #1009 access is also located on private land. Therefore, these two trails do not get as much use as the others.

Middle Fork trails are in demand by the public. Low elevation, the opportunity to hike and camp in old growth forests, and access from Seattle (less than a one-hour drive) combine to make this area an attractive destination for almost four seasons.

A complete inventory of trails and their management guidelines is located in Appendix D. Existing trail miles listed in the inventory may differ from those generated through GIS. Each of these trails was measured on the ground using a cyclometer and therefore is much more

accurate than GIS generated numbers. The following table is a summary of the trail miles located in the Middle Fork of the Snoqualmie. Proposed miles are estimates.

Table 3.29 Summary of Trail Miles

Watershed	1049 Lower Middle Fork	1050x Private Lands	1050 Pratt River	1051 Upper Middle Fork	1052 Taylor River	TOTAL
Wilderness	0.0	0.0	20.9	21.2	8.6	**50.7**
Non-Wilderness	0.0	0.0	11.0	16.1	14.1	**41.2**
Total Existing	0.0	0.0	28.1	42.1	21.7	**91.9**
Adequate	0.0	0.0	12.1	23.6	8.2	**43.9**
Inadequate	0.0	0.0	16.0	18.5	13.5	**48.0**
Proposed	6.0	25.0	24.5	14.6	1.0	**71.1**

Management guidelines outlined in the Inventory are in compliance with the Mt. Baker-Snoqualmie National Forest Plan (FEIS 1991), the Alpine Lakes Area Land Management Plan (FEIS 1981), and the Alpine Lakes Area Recreation Use Study (1993). An update to Appendix E and Appendix H were both done in 1996 to bring all trails into compliance with the various management plans that are in effect.

Winter Recreation

The Middle Fork is lightly used for snowshoeing, cross-country skiing, and snowmobiling. The road is not plowed and tends to get icy several miles below where the snow would be considered good for these pursuits. This tends to limit access from November through April. The snow does vary from year to year causing access and use to vary and be unpredictable. The Middle Fork Trail from Taylor River upstream to Dingford Creek will be accessible to hikers throughout the winter months during most years. Low elevation trails are in demand by the general hiking public.

Water Sports

The Middle Fork valley is a popular destination for recreationists pursuing a variety of water sports. The river has been open only to catch and release fishing since 1986, and has become popular with flyfishers.

Whitewater kayaking and rafting occur mostly on the lower stretches of the Middle Fork Snoqualmie River. Put-ins exist all along the Middle Fork below the Taylor River confluence. A common take-out point is at the concrete bridge well below the Forest boundary. Kayaking and rafting generally occur during high water periods in the spring. Dates vary from year to year depending on when snow melt occurs.

Hunting

Hunting for deer, elk, and black bear occurs between August and December each year. Historically the Pratt River was a popular destination for elk hunters. A cable suspension bridge located on private property washed out in 1975. Since this time very few hunters access the Pratt. Most hunting now takes place along the roads and is mostly day use.

Recreation Special Uses

Currently there are no Recreation Special Use Permits active within the Middle Fork valley. Occasionally permits have been issued to small Outfitter Guides providing day trips and transportation to trailheads for tourists.

CHAPTER 4 - FUTURE TRENDS

Vegetation Patterns

Seral Stages

The rates at which stands reach the next seral stage depend on many conditions such as elevation and environmental zone. The patches of early seral stands located near Quartz Mountain in the silver fir zone will move into mid seral stages in the next 10 to 25 years and then into the late seral, single story stage in approximately 250 years.

In approximately 120 to 130 years the mid seral western hemlock stands in the Pratt, Taylor and Upper Middle Fork Watersheds that were logged in the 1930's and 1940's will begin to show single-storied late successional characteristics. The mid seral silver fir stands in these watersheds will take longer to show these characteristics, approximately 250 years or longer.

Barring large scale natural disturbance, such as fire, the amount of late successional stand characteristics on National Forest lands within the watershed will increase and the amount of early-seral stand characteristics will decrease due to the land allocations within the analysis area and the minimal timber harvest anticipated. State and private lands outside the National Forest boundary are expected to be logged while in the mid seral stage, thereby returning these stands to early seral stages and preventing the stands from moving into late successional stages.

Timber Harvest

With the advent of the Mt. Baker-Snoqualmie National Forest Land and Resource Management Plan (1990), the timber management emphasis changed from regeneration harvest in old-growth to intermediate treatments in immature stands, primarily with commercial thinnings. As the political and scientific controversy surrounding management of spotted owl/old growth habitats intensified, National Forest Plans were amended via the Northwest Forest Plan Record of Decision (ROD, 1994).

Given the current direction, vegetation management activities that produce timber commodities will take place on a variety of land allocations and under a range of stand conditions. The Forest Plan as amended by the ROD identified a number of Management Allocations (MAs) in the Middle Fork Snoqualmie River area where vegetation management would occur. In MA 17 Timber Emphasis, timber commodity production is a primary objective. In a variety of other management allocations (e.g., MA 14 Deer/Elk Winter Range, MA 2A Scenic Viewshed Foreground, and GF General Forest, Alpine Lakes Management Plan), timber commodity production is but one of multiple objectives. And in yet other management allocations, timber commodity production is not one of the objectives but rather a byproduct of meeting other objectives (e.g., Late Successional Reserves and Riparian Reserves).

Only a small portion of the Middle Fork Snoqualmie River Watershed analysis area is available for vegetation management in allocations where commodity production is one of the primary objectives. There are a number of immature stands in the LSR (less than 80 years) and in Riparian Reserves where vegetation management could occur in order to meet those allocations' objectives. The current emphasis in all these immature stands is precommercial and commercial thinnings (including small openings) where the thinning prescription would vary considerably, from lighter thinnings in LSRs and Riparian Reserves (10-30% basal area reduction) to the more traditional thinnings in MA 14 or MA 17 (40-50% basal area reduction).

Timber harvest on state and private lands is expected to continue using short rotations of 50-60 years. Roads on state and private lands will be maintained if they are mainline roads; however, many of these roads will have short term use and may not be maintained.

Fire

Fire occurrence is expected to decline on National Forest lands with the continued low levels of forest harvest activity. Large burning events have occurred in approximately 200-year intervals since the year 1300 and it has been nearly 300 years since the last of these events. Because global climate and weather patterns are complex and not necessarily cyclical, we cannot use this data to predict any specific fire events in the future. Also, logging much of the low elevation forests earlier in the century may have affected the natural fire cycle by removing fuels. Small lightning and human caused fires will continue to occur, but with modern prevention and suppression technology, the large catastrophic human caused fires are not expected. Only fires burning under the most severe fire weather conditions will result in catastrophic resource loss or impacts.

Plant Communities and Species of Concern

Whether recreation activities increase over time or remain at current levels, fragile plant communities including wetlands at the edge of lakes and ponds could be at risk and some loss of vegetation is inevitable, but negative effects are preventable with controlled management of recreational activities.

Trends for individual species are hard to predict because of the lack of surveys. However, if trends favor the growth of late successional vegetation and protection of riparian areas, then Sensitive and Survey and Manage plants should benefit. Threats to fringed pinesap include habitat loss through removal of host conifers, disturbance of soil, competition with other vegetation, herbivores (deer, elk, rodents, and slugs are known to browse the plants), and trampling. Threats to unknown populations could increase with silviculture treatments such as commercial thinning. This species is expected to be delisted by the state of Washington because of the high number of sightings in the state. Threats to boreal bedstraw include habitat loss due to changes in hydrology (since it grows in areas with a shallow water table) such as trail building, habitat loss due to changes in light intensity such as thinning, and trampling. Trampling could be a threat to Alaska harebell in rocky, alpine zones. Plant surveys and

mitigation measures would occur prior to any ground disturbance on National Forest lands thus reducing increased threat to these species.

Noxious weed populations and introductions of new weeds are expected to increase with continued forest industrial activity and whether recreation activities increase over time or remain at current levels. This can be mitigated through inclusion of contract provisions in harvest contracts that require only clean, weed-free equipment and materials to be used. However, this is not appropriate for recreational users or on private lands. If current infestations are not controlled, the level of effort and economic cost will be greater as populations increase in size.

Terrestrial Habitats and Species

Species of Concern

Threatened or Endangered Species

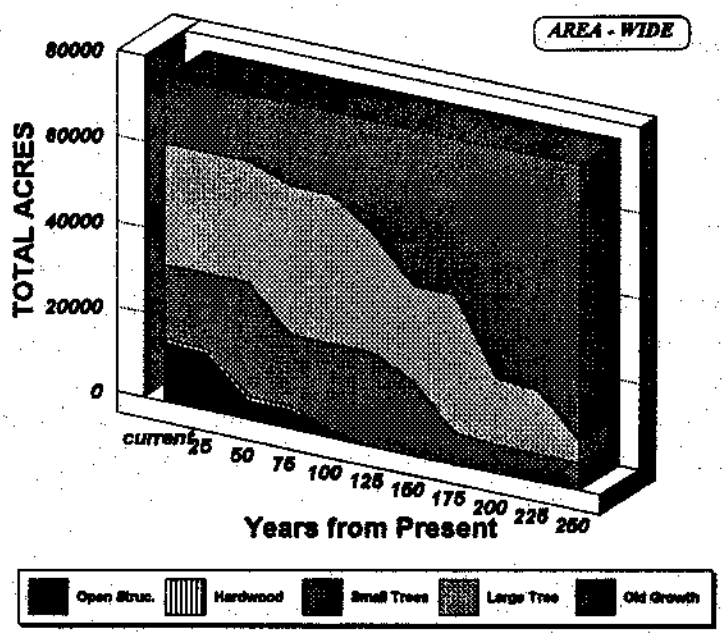
Bald Eagle: Limiting factors for the analysis area are the lack of anadramous fisheries, high recreation disturbance along shorelines of rivers and lakes, and snow cover along high elevation lakes. Other than a catch and release fishery of cutthroat trout, no other plans are foreseen to stock the streams in the future with any anadramous fishery. There are waterfowl using all streams that could provide a sufficient prey base. Some white-water rafting and kayaking occurs, mostly along the mainstem, but is not predicted to increase in great amounts in the future. Stable or potentially increasing recreation use of all major rivers along the shoreline is predicted, making disturbance of waterfowl nesting and potential nesting of bald eagles a possibility. In the future, the analysis area will continue to offer limited opportunities for nesting bald eagles, although occasional scattered sightings may still be noted from wintering and summering birds nesting along the mainstem Snoqualmie River.

Spotted Owl: Although all eight spotted owl territories are below "threshold," no logging of mature and old growth nesting and foraging habitat is expected within the LSR, Dispersed Recreation, LSOG, Scenic River, Mature and Old Growth allocations under the Forest Plan. Removal of suitable owl habitat within territories already below "threshold" is not likely to occur. Some thinning of dispersal habitat may occur which could enhance a multi-layered stand condition and accelerate achieving old growth conditions sooner with the correct prescriptions. No thinning is proposed at this time within the Pratt River drainage where the CHU occurs. Over time, with lack of logging, old growth conditions will increase in size and quality, which will benefit a variety of old growth dependent species, including the spotted owl (Figure 4-1). Increased recreation may increase disturbance to nest sites, although increases are predicted to be minor. If increased recreation use is confined to existing, well-defined sites and trails the area disturbed will remain the same and increased harassment of nest sites would not be expected even if the number of recreationists increases. If additional trails are proposed, surveys to update nest locations may be needed. Eventually more owls could fill suitable habitat niches as the amount of old growth increases, assuming the total area disturbed

remains the same. Existing owl pairs may eventually have enough suitable habitat to be above "threshold" levels.

Marbled Murrelet: The occupied marbled murrelet site near Goldmeyer Hot Springs will become an "unmapped LSR," as directed by the Forest Plan (C-9). See Figure 4-2 for the boundary of the occupied site outlined as directed in the Forest Plan (C-10). Suitable habitat is likely to increase over time as shown in Figure 4-1. It is likely that the number of murrelet nesting pairs could increase as old growth increases, assuming stable or increasing recreation is confined to the same areas as discussed under "Spotted Owls" above. If recreation is not confined to existing disturbance zones, surveys may be needed to determine where additional marbled murrelets are nesting depending on the location of the proposed recreational activity.

Figure 4.1 Estimated Changes in Vegetation Structure over Time.



Peregrine Falcon: The biggest limiting factor for increasing the number of peregrine falcon nesting pairs in this analysis area is lack of suitable nesting sites that are snow free in March, which is the nest site selection period. Although there are many suitable cliff faces within the analysis area, it is unlikely that nesting will occur since these potential sites are not snow free until June or July. Future trends indicate that peregrine falcons are not likely to begin occupying sites in this analysis area, regardless of any human activities planned for the future. No potential nesting habitat is located on private land, therefore future opportunities for peregrines will not exist on private land.

Grizzly Bear and Gray Wolf: Although the open road and trail density for the analysis area is currently higher than the recommended 1.00 miles per square mile, suitable habitat for both these species is primarily located on National Forest lands, as private land will continue to be roaded and logged in the future. The open road and trail density on just National Forest lands

is 0.79 miles per square mile with an HAI of 0.47 that indicates the appropriate amount of security habitat is available in this analysis area on National Forest lands according to the Grizzly Bear Recovery Plan. Private land west of the National Forest boundary is not expected to be managed for grizzly bears (IGBC 1986). Therefore, trends toward a stable or greater number of recreationalists using the analysis area could reduce the amount of security habitat below what is recommended by the Recovery Plan, unless no new roads or trails are built and increased use is limited to those areas already in use. Security habitat is important for both species, and if the correct amount of security habitat is retained for grizzly bear, gray wolves should also benefit. Figure 4-3 displays a map of Bear Management Unit #01 with subunits and proposed management recommendations by subunit referred to as "Management Situation Areas."

Species of Concern (C2), Sensitive Species, Survey and Manage, Management Indicator Species, or Species of Concern

Cascades, Red-Legged, Spotted, and Tailed Frog, and Van Dyke's Salamander: Since these species inhabit either streams or ponds, all activities on National Forest lands will have to meet the aquatic conservation strategy and Riparian Reserve standards and guidelines in order to proceed. These guidelines, if implemented, should be adequate to protect all future aquatic breeding sites on National Forest lands, regardless of the activities proposed. Continued stocking of lakes with non-native fish, combined with UV radiation, may be a threat in the future for Cascade frog and other amphibians, as these practices are not expected to cease. Surveys in the future should be able to determine the extent of populations. Upland populations away from the Riparian Reserves would benefit from surveys, as these areas may not be protected otherwise. If dispersed recreation is allowed to continue unchecked as is presently occurring, and riparian reserve standards and guidelines are not implemented, populations of these species may be jeopardized. Habitat for these species on private lands is expected to decline.

Larch Mtn. Salamander and Mountain Goat: Future activities on National Forest lands that are proposed within talus slopes, or cliffs, or within old growth adjacent to cliffs, such as mining or road building, will need to incorporate surveys to search for these species, as well as activities within old growth that are ground disturbing in nature. These searches should be sufficient to uncover any individuals that may occur. There are no limiting factors for these species if activities are not proposed in these areas, no recreation use consisting of rock climbing or spelunking is proposed, and the Mountain Goat Management Area allocation is retained. Habitat for these species on private lands is expected to decline, as logging and road building continue.

Common Loon, and Lynx: Although both these species could occur within this analysis area, suitable habitat is presently not available and is not predicted to increase or become available in the future. Therefore, future trends for these species are not expected to change over time.

Olive-sided Flycatcher, Vaux's Swift, and Pileated Woodpecker: Habitat for these species should increase over time, as late-successional habitat increases and the large snag component increases. Since future logging proposals on National Forest lands are primarily thinning of younger stands, future trends for these species should improve. Habitat for these species on private lands is expected to decline, as logging continues without leaving snags and no large tree component is expected to be retained.

Goshawk, Wolverine, Marten, and Fisher: Over time, as the amount of old growth increases on National Forest lands, suitable habitat is expected to increase for goshawk, marten, and fisher. If existing and projected increases in recreation use are confined to existing trails and facilities, the amount of security habitat available for these species is likely to be sufficient to allow for expansion or improvement of nesting or denning territories, as all of these species are negatively affected by human disturbance. Road and trail densities are presently at acceptable levels. If new roads or trails are proposed, careful evaluation will be needed as potentially marten, wolverine, and fisher populations could be compromised while an increase in the amount of suitable habitat is expected. Habitat for these species on private lands is expected to continue to remain low or decline as open road levels remain high and no old growth component is retained.

Townsend's Big-Eared Bat, Hoary Bat, Silver-Haired Bat, Long-Eared Myotis, Long-Legged Myotis, Yuma Myotis: These species of bats all use unique features for roosting and hibernacula, in association with older stands, and on National Forest lands these areas will need surveys prior to projects proceeding. Recreational use of caves and cliffs will need to be limited where potential roosting and hibernacula are found after field searches. If all potential hibernacula and roosting sites are surveyed prior to project implementation, future trends for any of these species, combined with increasing snag levels, should be improved. Habitat for these species on private lands is expected to decline as no snags will be retained and high disturbance of any potential roosting/hibernacula is expected.

Harlequin Duck: Increased uncontrolled dispersed recreation use may limit the ability of this duck to nest alongside rivers undisturbed. Over time, as young stands grow into older stands, increased amounts of quality nesting habitat should be available. If recreation use is controlled, an increase in the numbers of successful nesting pairs can be expected.

Elk: Thermal cover is limited on private land and will continue to be so, increasing the emphasis of the winter range areas on National Forest lands. Road densities are at acceptable levels, although if increases in road densities are expected, elk condition and numbers may be negatively affected. Foraging opportunities will continue to be provided on private land, although little long term thermal or hiding cover would be available.

Wildlife Species and Habitat Diversity

Diversity levels, in terms of species richness, can be expected to remain high as current conditions are expected to be maintained or improved over time due to the following factors.

A. The amount and high quality of wetland, lake and pond habitat is expected to remain the same.

B. Riparian reserves on National Forest lands are expected to remain in the same condition or improve over time, in accordance with the Forest Plan, as 1) roads are closed where needed to meet the aquatic conservation strategy objectives, 2) dispersed recreation sites that are causing resource damage will be rehabilitated, and 3) the old growth component will increase over time as extensive logging of riparian reserves will cease and restoration will occur.

C. An increase in late-successional habitat is expected as stands mature in all the components that emphasize no harvest of this habitat type.

D. Snag levels, especially in the large snag component, are expected to increase over time as old growth increases and decadence is once again a part of the function of the younger stands.

E. Unique habitats are expected to receive greater protection under the Forest Plan, and those species needing cliffs, talus, caves, bridges, wetlands, ponds, and other unique features will be provided for.

Exceptions to this are:

Road and trail densities may increase depending on the extent of proposed recreation increases. If road and trail densities increase unchecked or without careful planning, negative effects to security habitat would be expected. As the human influence zone increases, security habitat decreases and the carrying capacity of the analysis area to support grizzly bear and gray wolf populations would decline. Prey species utilization of the analysis area would also be negatively affected, and potential denning would be compromised.

High mountain lakes are expected to continue to be stocked with non-native fish unchecked, and UV radiation is expected to continue. Protection of habitat is expected to improve with rehabilitation of lakes that have had heavy impacts from people, but without the reversal of the previous two factors just mentioned, it is unknown if populations will stabilize.

Recreation, Roads and Trails

Currently, it is predicted that human use of this analysis area will either remain stable or increase. If recreation use increases significantly, it would be expected that many species and their habitats could be detrimentally affected. Proposals consisting of managing increased recreation would alleviate the majority of any disturbance created.

Fragmentation that reduces habitat capability below optimum levels is expected to be reduced over time as young stands on National Forest lands grow into older stands. Naturally occurring fragmentation is expected to remain constant which should continue to provide high diversity for those species needing edge. If increases in recreation occur in an uncontrolled manner, fragmentation of core habitat by human disturbance will reduce security habitat,

effectively reducing the size of core habitat. If future recreation acitivities are controlled, connectivity should improve for species such as fisher as old growth increases over time. Other species are already provided for in this analysis area, with near optimum arrangement of stands in juxtaposition with potential barriers such as roads. Habitat for low-mobility, old growth obligate species should increase over time on National Forest lands as stands mature.

Hillslope Processes

Erosion processes will continue to modify the landscape within the Middle Fork Snoqualmie River watershed and influence other biological and physical processes. The most significant erosion occurrences will continue to be associated with natural events. Slope failures associated with the deep lacustrine deposits in the lower watershed will continue to be a very significant contributor of sediment. The magnitude of sediment contribution originating from avalanche chutes is not well understood but is considered to be a significant sediment source in the Middle Fork and will continue to be so. A widespread wildfire would accelerate the frequency and distribution of erosion processes (both surface soil and mass wasting) due to the loss of soil cover, loss of root strength, and alteration of hillslope and stream channel hydrology.

Management's influence of soil erosion processes is expected to remain close to current levels within the foreseeable future. Road densities on National Forest lands are very low within the watershed (ranging from a low of approximately 0.02 mi./sq. mi. in the Pratt River to approximately 0.66 mi./sq. mi. in the Lower Middle Fork). Road densities outside the National Forest boundary in the lower watershed are considerably higher. The average road density for the analysis area is 0.91 miles per square mile. Several roads in the Quartz Creek drainage are currently inaccessible for maintenance. An increased rate of erosion is possible along the remaining roads due to the current trend of reduced budgets for road maintenance. The lack of clearcut timber harvest in recent years (and for the foreseeable future) on National Forest lands will reduce the quantity of sediment originating from this surface erosion source.

Forest Service Road 56 will continue to be periodically closed due to debris on the road or failure of the road prism. Sections of this road exist within naturally occurring unstable soils that will continue to erode and move downslope, particularly within locations where the river is eroding the toeslopes of unstable soil material. Other sections of the road exist within the depositional fan of debris avalanche chutes and/or dissected slopes.

Increased recreational use in the analysis area would likely result in increased vegetation and soil disturbance within the riparian areas of the Middle Fork and its major tributaries. Increased sedimentation would occur as a result of this disturbance but the significance of this sediment source in relation to other contributions is uncertain. A comprehensive inventory of current and anticipated future dispersed recreational use sites is needed in order to evaluate the potential effects of this activity. The negative impact to the aesthetic quality of the environment resulting from vegetation disturbance, soil erosion, and garbage disposal may actually be a more significant concern than the actual contribution of sediment or alteration in site productivity.

Hydrologic Processes

Flow Regime

Peak Flows

The ability to predict future trends in both the magnitude, duration, and timing of both peak and low flows is limited because flow data is only available at one location (the Tanner gauge on the mainstem Middle Fork Snoqualmie) within the entire analysis area. There have been several studies which attempted to investigate past trends in either peak high flows or summer baseflows at various locations within the Snoqualmie Basin. Most of these studies (see discussion in Chapter 3) did not look individually at flows within the Middle Fork Snoqualmie River, however, so some assumptions about flows in the analysis area have to made on the basis of the results of studies that estimated trends for other watersheds within the Snoqualmie Basin. The observations made below are based on the 25 years of flow data at the Tanner gauge station, the overall indications coming from the studies that were reviewed in this analysis and discussed earlier, and probable future land use.

It appears that large storm flows, specifically peak annual flows, have increased in frequency in the last decade relative to storm flows in the 1960's and 70's. The limited period of record (1962-present) does not indicate an increase in the magnitude of these flows, but four of the eight largest annual peaks on record since 1962 have occurred in the last ten years. This single fact is certainly not conclusive alone, but it does simply illustrate the conclusions of other trend analysis studies within the Snoqualmie Basin that indicate there has been an increase in the frequency of large storm flows. Neither these later studies nor this watershed analysis could determine whether this apparent increase has been a result of random annual weather patterns, a definite climatic trend, a response to land management actions which altered the hydrologic regime, or a combination of two or more of these factors.

Vegetation Disturbance

The vegetation disturbance model presented earlier showed that almost all of the subwatersheds in the analysis area have been relatively steadily maturing and hydrologically recovering since the 1940's and 1950's when up to about 40 percent of some subwatersheds were logged, roaded, or recently burned. There are now only two subwatersheds in the entire analysis area that currently do not meet the Forest Plan standard of a 12 percent level of vegetation disturbance. The lower Taylor and Quartz Creek (52A and 52B) subwatersheds of the Taylor River fifth-field watershed currently have about 12.5-13.0 percent of their areas disturbed (i.e., areas with less than 70 percent crown closure due to roads, harvest, fires). Conditions should continue to improve in these areas as stands grow back, however, and both these subwatersheds should meet this standard within several years.

Vegetation disturbance levels, as expressed in this model, have not directly related to either storm or summer baseflow hydrographs, which is not at all surprising due to the numerous other factors that influence streamflow. The apparent increase in frequency of large storm flows over the last decade

should be ameliorated to some degree by maturing forest stands, as they certainly have been in the last decade, but random weather patterns or genuine shifts in the climate could easily offset these effects. The positive hydrologic influence of maturing forest stands should continue to reduce peak flows to some degree for at least another ten years in general across the analysis area; additional incremental benefits should decrease after that time. The largest annual peak flows on record are estimated to be 15-20 year events (about 30,000 cfs discharge) based on the entire 25-year period of record. It appears that, on average, they now occur more frequently than that. There is no evidence that this trend will reverse, and large destabilizing floods should be expected to continue to happen up to several times each decade.

Low Flows

Evidence from past studies on any trends over time in the magnitudes or durations of low summer baseflows is mixed. Overall, however, most efforts indicate that very low summer flows have occurred more frequently and that discharges have decreased somewhat in magnitude in the last decade. If this is true, and if one assumes that storm flows have been increasing in frequency over the same period (which appears to be the case), this trend seems to support the hypothesis that some of this change is due to land management, and is not solely due to random fluctuations in weather patterns. The hydrologic regime of the mainstem of the Middle Fork Snoqualmie River appears to be becoming flashier, with both more large storm flows and more numerous low summer baseflows.

The continuing maturation of coniferous stands throughout the analysis area should help to store snowpack longer into the spring and early summer months, and allow more water to recharge the ground water table and be available to feed channels in the summer and early fall. The incremental benefits of this process should decrease over the next few decades. Snowpack retention in a fully mature or old growth forest stand can actually be less than in a horizontally more diverse stand that has numerous small openings, however, so the trend does not necessarily continue in one direction with time. A relatively young stand which has 70 percent crown closure and is therefore considered "hydrologically mature" in the Mount Baker-Snoqualmie National Forest vegetation disturbance model, may actually retain more snowpack on the ground than an older stand with 70 percent crown closure. It could also retain less, depending on the horizontal and vertical diversity of the stand. More snow may be ablated directly from the canopy of the older trees. The relatively large, strong branches of mature and old-growth trees intercept much of the snowfall, and never allow it to reach the ground. In contrast, drooping branches of younger trees drop most of their snow in high winds. This snow accumulates in small openings on the ground between the young trees, where it is largely sheltered from direct solar radiation and warm winds.

There is no evidence to indicate that the current patterns of relatively frequent, low summer baseflows will not continue over at least the upcoming few decades. Current summer and fall low flows in the mainstem of the Middle Fork Snoqualmie do not always meet the preferred target flows set for it by the Washington State Department of Ecology (Ecology); that will likely continue to be the case. Baseflow levels can increasingly limit the health and size of aquatic populations in some cases, even if discharge is not decreasing. This is the case where channels have widened or large volumes of alluvium have deposited, such is the case in reaches of the mainstem of the Middle Fork Snoqualmie,

and is likely the case near the mouths of some of its tributaries (review of aerial photos has only been conducted on selected reaches of the mainstem to date).

Consumptive Water Withdrawals

There are presently several proposals to withdraw groundwater from the deeper aquifers near the confluence of the Middle and South Forks of the Snoqualmie River (King County 1996 *in* Pentec 1996). The current status of the groundwater resources in the Snoqualmie Basin, and to some degree their interaction with surface streams, has been studied at various locations in the Snoqualmie Basin. Past and ongoing studies are reviewed in the Draft Snohomish River Basin Issues and Conditions Report (Pentec 1996). Most of these studies have focused on the Snoqualmie River Valley (i.e., the mainstem of the Snoqualmie River), since it forms the largest aquifer system in the entire Snohomish Basin. The interactions between surface and groundwaters is not as well studied in the Middle Fork Snoqualmie River watershed, but low summer baseflows are very dependent on groundwater inputs.

All of the current surface water and groundwater consumptive water withdrawals that occur in the Snoqualmie Basin are located near or downstream of the city of North Bend. There are no known withdrawals within the Middle Fork Snoqualmie River watershed analysis area. Several cities withdraw water from surrounding basins. All of these cities project increased water needs in the upcoming decades and are looking for additional sources. The city of North Bend and other municipalities are considering the possibility of withdrawing surface and/or sub-surface waters from the Middle Fork Snoqualmie watershed analysis area in the future. Consumptive withdrawals would alter the hydrologic regime to some degree, and could potentially reduce the quality and quantity of instream and riparian habitat in some areas in the summer and early fall.

Water and Air Quality

Air Quality

In the 1980's a relatively extensive network of acid deposition monitoring stations existed in western Washington, including sites at Snoqualmie and Stevens Pass, as well as at Paradise on Mount Rainier. Most of these sites were discontinued by 1990, including the stations at Stevens Pass and Snoqualmie Pass. The wet deposition loads of ions critical to acidification were monitored at Snoqualmie Pass from 1983 to 1990 (Duncan et al. 1991). This period of record was not long enough to discern long-term trends, but it did show that deposition levels were higher at Snoqualmie Pass than they were at either Stevens Pass or Mount Rainier. The highest average sulfur loading recorded at Snoqualmie Pass was observed in the final year of the study (3.51 kg/hectare-year in 1990). This level was higher than the maximum allowed under proposed standards (Eilers et al. 1994). Deposition of sulfur oxides in the analysis area should decrease after 2001, when new scrubbers are added to reduce emissions from the Centralia Power Mill. This mill currently has the second largest sulfur emissions in the western United States. Nitrogen oxide emissions, however, are projected to continue to rise as population and urbanization increase. Overall acidic deposition rates in the analysis area could increase in the upcoming decades due to these emissions.

Other past or ongoing studies of air quality in the Snohomish Basin include investigations of ozone and particulate levels. Areas of the Cascade Range east of the Puget Sound lowlands, including the Snoqualmie Basin, are subject to episodes of high ozone concentration, especially during the summer. The effects of these episodes are poorly quantified, but they may produce substantial stress and affect the health of trees and other vegetation. There are no known studies within the analysis area, so a quantitative trend analysis is not possible. It is likely, however, that ozone levels will increase somewhat over the long-term, as they have in most locations near the analysis area where ozone has been monitored. Recent studies in Mount Rainier National Park have shown that average ozone levels appear to increase with increasing elevation (Bachman, personal communication 1997); this is a new finding. It is possible, therefore, that ozone levels in the higher elevation areas of the Middle Fork Snoqualmie are actually somewhat greater than at some monitoring sites in neighboring Puget Sound lowlands, and will increase further as ozone levels continue to rise in urbanized Puget Sound.

Lake Water Quality

Water quality should remain stable over the next decade in virtually all, if not all lakes in the analysis area. There are currently two lakes which have known water quality problems, and current conditions are expected to continue into the foreseeable future unless remediative actions are taken. Williams Lake is currently biologically dead because of toxic levels of copper. Quartz Lake is somewhat acidic (pH readings of 4.5 to 6.0); these levels are low enough to stress fish. The source of contamination in either lake may be man-caused from nearby mining, or natural causes, or a combination of the two.

Other than Quartz Lake, there are currently no lakes with pH levels low enough to stress aquatic populations, but many of the lakes in the area will always continue to remain extremely vulnerable to acidic deposition. Qualitative and limited quantitative data on these lakes indicate that many of them have low to very low acid neutralizing capacity. There is some data on seasonal and short-term trends for lakes in the watershed and surrounding area, but no long-term trend information is yet available. A study of selected lakes in the Cascades in 1996, including Nordrum Lake in the Taylor River watershed, collected lake bottom sediment. Its goal was to calibrate how lake pH levels relate to the occurrence of various plankton species. This information will then be used to estimate what pH lake levels have been historically by examining cores of lake bottom sediment. This very long-term trend information will enable investigators to determine background levels and could help to predict future trends. The initial results of this study will be available in 1997.

The limited quantitative data available indicates that most of the lakes in the analysis area are relatively dilute, clear oligotrophic systems with high water quality. Most of the lakes in the area have been sampled at least once for variables such as pH, temperature, and conductivity. Those results did not raise concerns, but other variables remain unsampled. Seasonal norms have not been determined in any lakes, nor have long-term trends. It is likely that almost all of the lakes in the area are currently healthy because of low risks from site contamination sources, and the trend should remain stable. There is some risk of bacterial contamination in those lakes that have high recreational use (see discussion of recreation in Chapter 3). These risks would increase if trail access to lakes was improved, and reduced if hiking times were increased. The greatest known potential threat to lake water quality in the analysis area future will continue to be from acidic deposition.

Stream Water Quality

There has been only limited monitoring of stream water quality within the analysis area, and that has occurred solely in the lower reaches of the mainstem of the Middle Fork Snoqualmie River. That data, along with quantitative and qualitative data on upstream aquatic and upland communities, indicates that water quality is probably not currently limiting biologic production or diversity in most locations.

Water temperatures and dissolved oxygen concentrations should continue at current levels, or improve somewhat in most locations in the future on streams located within Forest boundaries. This is due to the increases in canopy cover that will be provided by maturing riparian communities as they recover from past timber harvests. Suspended and bedload sediment levels may also decrease in many stream reaches in the upper watershed. Surface erosion and mass failures should deliver less sediment to channels as young timber stands mature. This will not be true, however, if flood events become more frequent and/or larger in magnitude due to climatic changes. High turbidity levels will probably continue to limit algal, invertebrate, and fish productivity in the lower Pratt River. This will also occur during high flow periods in the lower reaches of the mainstem of the Middle Fork Snoqualmie River. There are large, chronic sources of sediment being delivered to these reaches, and this will continue to be true for many decades, if not centuries.

If total recreational demand continues to rise, demand for dispersed recreation is likely to rise with it. The negative impacts of dispersed recreation on river water quality within Forest lands will increase if current control practices are continued. If access is further limited and/or control increased, bacterial and chemical inputs into channels should decrease overall.

Mining for quartz crystals will continue to occur within the analysis area, especially in the upper watershed near Quartz Lake, Goldmeyer, and Hardscrabble Creeks. These relatively small operations are generally not thought to cause serious water contamination, but any suspected sites (such as the area around Quartz Lake) should be studied to determine trends.

Conditions in many areas outside the Forest boundary will likely remain stable or deteriorate as many timbered subwatersheds become more urbanized. Existing riparian buffers should largely be maintained on private lands, as prescribed in the State Forest Practices Act, but much of the upland community will likely be converted to urban land use. This will result in more overland flow, and the potential for greater surface erosion and more frequent mass failures. More sediment will be delivered to stream channels, resulting in higher suspended and bedload sediment loads in some stream reaches. Urbanization will also increase the risk of point source contamination, as well as nonpoint inputs of pesticides, herbicides, hydrocarbons, and other pollutants.

Aquatic Habitats and Species

Lake Communities

No species of fish or invertebrate that currently appears on Federal or Washington State lists of threatened or endangered species are documented to occur in the lakes of the analysis area, nor does

any species appear on the Regional Forester's Survey and Manage List. The resident fish species which do currently occur in the lakes of the watershed are almost all introduced species, as virtually all the lakes were fishless before formal and informal stocking efforts began after the turn of the century. In addition, most of the lakes which do now support fish do not have self-maintaining, naturally reproducing populations, and would die out without further stocking efforts by the WDFW and its cooperators. None of the current species [predominantly rainbow and cutthroat trout, along with fewer numbers of eastern brook trout (a char), and some mountain whitefish and sculpins], are likely to be listed as threatened or endangered in the foreseeable future.

If current stocking activities continue, fish population sizes and health are likely to continue at current levels for at least a decade. Over longer time periods, however, they may be negatively impacted by recreational fishing pressure or by acidification of lake waters by acidic deposition. If trail access to lakes remains similar to current conditions, recreational fishing pressures will increase unless limits are reduced by the WDFW. In addition, degradation of the riparian lakeshores will also increase unless lakeshore access is limited, and more hardened campsites are created. Many of the lakes in the analysis area probably have low to very low capacities to buffer acidic inputs, so would be at risk if acidic deposition rates increase. Some of these lakes may already be at risk due to current deposition rates, since only a few lakes have had their acid neutralizing capacity (ANC) measured; ANC is similar to, but not identical to alkalinity.

If access to lakes is reduced by requiring longer or more difficult hikes or more tedious approaches, thereby reducing fishing pressure and harvest levels, negative impacts to some lake communities may result. This could occur in low-productivity lakes where an excessively large, unchecked fish population would overgraze the invertebrate or amphibian community. Native fish populations in high alpine lakes are usually limited by a combination of available spawning habitat, predation, and general habitat quality and quantity. Those lakes with the healthiest populations of large-sized fish are limited by one or more or these factors so that large, dense populations of stunted fish do not result. Fishing pressure currently represents the greatest limiting factor in some lakes in the analysis area. Most or all of the lakes in the analysis area are thought to have been fishless before stocking efforts began in this century. Potential future reduced fish harvests might contribute to excess fish density conditions in the following lakes: Big Snow, Snoqualmie, South Snoqualmie Lake Pot, Marten, Carole, Judy, Green Ridge, Upper Garfield, Derrick, Myrtle, Nimue, Upper Hardscrabble, Lower Hardscrabble (Pfeifer 1997).

Unless lakes become acidified in the future, the current zooplankton and phytoplankton communities should persist. The composition of these communities has not been surveyed, but anecdotal information from the WDFW (Pfeifer 1996) indicates that they are probably relatively healthy and diverse. The current state of the lake amphibian community is virtually unknown. Although the presence of some amphibian species has been noted in several lakes, no population or diversity estimates have been made, nor any estimate of the effects that the introduction of fish has had on the health and size of the amphibian populations. Most of the lakes which now support fish have been stocked for several decades. It seems likely, therefore, that competition with, and predation by fish species over that period should have resulted in a new amphibian community which should persist over time if stocking activities remain similar.

Stream Channels

The analysis area is dominated by high gradient "source" tributaries. These tributaries contribute large quantities of both coarse and fine sediment to the mainstem channels below. These lower sections are dominated by sapling/pole and immature riparian stands. In areas containing glaciolacustrine deposits, this has resulted in stream channel instability (e.g., the mainstem of the Middle Fork below Burntboot Creek). These areas will continue to change as the rivers move toward a new equilibrium state, but will improve over the long term. As the magnitude of peakflows and sediment delivery decrease over time, the disturbed channel segments will begin to establish stable meander patterns in the new elevated flood plain.

The section of the upper Middle Fork Snoqualmie River from RM 71 to 74.5 will remain in a disturbed state for the foreseeable future, resulting in chronic damage to FS road 56. The channel section of the Pratt River from approximately river mile 2.0 to approximately river mile 5.0 appears to be slowly recovering from railroad logging in the late 1930's. This trend is expected to continue in the Taylor River as well. The riparian canopy cover can be expected to improve faster within the tributaries than on the mainstem, given the much broader width of the mainstem river. The natural earth slump along the bank of the lower Pratt River will continue to contribute fine blue clay sediment to the mainstem Middle Fork in the future. As the bank is worn down the contribution should lessen over time until it revegetates and stabilizes or shifts further into the channel. There are no plans to attempt to artificially stabilize the bank due to high costs and low probability of beneficial results of such action.

Large Woody Debris Recruitment

Future LWD recruitment will remain poor in the lower Middle Fork near North Bend due to continued timber harvest and land conversion. Over time, the sapling pole and immature riparian areas will become mature (more than 21" dbh) stands greatly increasing bank stability, canopy cover, instream nutrient loading, pool formation, and energy dissipation. Recruitment in riparian areas within the MBS Forest boundary will continue to improve in all subwatersheds, except in the disturbed portion of the Middle Fork mainstem from RM 71 to 74.5.

Instream Habitat

As the riparian vegetation associated with rivers and streams within the analysis area begins reaching maturity in the future, aquatic habitat type composition will move from dominantly riffle habitat to a more equal distribution of both pool and riffle habitat. Therefore, the frequency of pools per mile is expected to increase over time as well. Mainstem aquatic habitat is expected to improve more slowly than tributary habitat, due to greater channel instability and the younger riparian vegetation currently in the mainstem reaches. As second growth riparian stands mature, they may choke off primary production in some stream sections resulting in a reduced carrying capacity. Riparian thinning may speed up the development of the patchy/open canopy old growth conditions in second growth stands over the next 50 -100 years (Sedell and Swanson 1984), which would improve aquatic system carrying capacity.

Stream bed substrate types will most likely remain the same as not, with periodic redistribution during high flows. As bank erosion decreases over time (50+ years), embeddedness of the bed substrate of the Middle Fork mainstem and some of its tributaries will decrease.

Overall amounts of LWD per mile will likely remain the same or decrease slightly in the future as riparian vegetation matures and is recruited as small and large LWD in the lower elevation channels within the analysis area. These larger riparian stands will be less susceptible to being uprooted during high flows than the existing sapling/pole and immature stands, possibly resulting in a lower LWD recruitment frequency over time. However, future LWD recruited to the channels will be of higher quality than what exists today and will most likely increase fish cover, pool formation, channel stability, and energy dissipation.

Aquatic Species

Trout populations will be expected to continue to increase as the Middle Fork system's aquatic habitat complexity (e.g., quality pools, substrate, and LWD) and food abundance increases over the next 50+ years. However, angler non-compliance with WDFW fishing regulations in the analysis area could continue to artificially suppress trout population growth, especially older "trophy" size trout, through overfishing. If recreational use remains constant within the analysis area, the existing trout population would be expected to remain the same or slightly increase, with larger adult trout still being underrepresented. With increased recreational use of the Middle Fork drainage in the future, trout populations would be expected to remain the same or decrease slightly, with adult trout being further reduced in numbers. Greater measures will have to be taken to enforce fishing regulation compliance, to sustain a viable trout fishery, regardless of future recreational trends within the analysis area.

Human Dimension

Population

The population adjacent to the analysis area continues to grow. From 1980 to 1990 the population of Washington State grew by an estimated 730,000 people, an increase of nearly 18%. Over this same period, King, Pierce and Snohomish Counties showed a combined increase of nearly 466,000 people, or a 22% increase in growth (Appendix D-1 Population Data). This trend is expected to continue for at least the near future.

Economics

The economy of the area adjacent to the analysis area will probably continue to diversify in the future, changing from a timber/agriculture based economy to one based on service and light industries. Grocery stores, gas stations, and retail outlets are likely to increase dramatically to service the increasing local population and to provide services to people visiting the local area.

An important component of the local economy will continue to be based on commuting to jobs outside the local area.

Even if the lumber and wood products industry stabilizes, it will continue to employ fewer workers as mills become automated. Some commercial timber will continue to be sold and harvested in this analysis area. Special forest products will continue to contribute directly and indirectly to the economics of local communities. The availability of personal use Christmas trees from federal lands will diminish as plantations outgrow Christmas tree height.

Recreation

The demand for day use recreational opportunities is projected to increase in Washington State. This is a general trend identified in the Washington State Parks and Recreation Commission Survey, 1990. Individuals surveyed indicated that they wanted more base camp facilities (campground and dispersed sites) with access to trails, water, beaches, and interpretive sites nearby. This is a trend away from the long distance backpacking popular in the 1970's and 1980's. The Washington State Trails Plan (1991) outlined user trends and recreation economic trends to the year 2000 (Appendix D).

In the Middle Fork of the Snoqualmie the use trends have not followed the standard pattern of steady increases. During the 1970's the use was exceptionally high (observation). Use that has been documented since the 1980's seems to show that the use dropped off somewhat from the 1970's and has stabilized. This trend is based on the observation of long-term fire prevention, law enforcement, and recreation personnel. There has not been a formal use study done in this area.

General areas of concern for the management of recreation opportunities in the Middle Fork will revolve around day hiking, mountain biking, availability of day use sites, and overnight camping. At this time use by backcountry hikers and climbers doesn't appear to be very heavy. The Alpine Lakes Entry Permit System has been in place for only one year, making conclusions difficult to draw. As compliance and public knowledge increase these numbers will become more reliable.

Day Hiking/Mountain Biking

Users are demanding an increase in the number of miles of trail available for both of these activities in the Middle Fork and across the Forest. Given proper trail location and design the area may be able to absorb more miles for these opportunities; however, an increase in miles may conflict with wilderness, riparian, wildlife and other resource-related standards and guidelines.

User conflicts sometimes arise between day hikers and mountain bikers. These conflicts will need to be considered when determining which users are permitted on specific trails.

The future implementation of restricted entry into the Alpine Lakes Wilderness Area may increase day use on non-wilderness trails.

Day Use/Overnight Camping

In the Middle Fork this use has seemed to stabilize (simple observation). Almost all the currently established picnicking and camping sites that exist in the Middle Fork are located directly on the banks of the Taylor and Middle Fork Snoqualmie Rivers. Future management of these sites and opportunities will be very difficult. People tend to be drawn to sites adjacent to streams, rivers and lakes. When these attractive sites are closed or become unavailable, a small number of users will create new sites in other attractive locations, causing further damage to the resource. The future challenge will be to educate the public concerning riparian and biodiversity issues and to create opportunities that will meet the needs of the public and the resource.

Hunting

Hunting is expected to remain low and stable.

Water Sports/Fishing

Kayaking in the lower reaches of the Middle Fork Snoqualmie River appears to be increasing. Many more whitewater kayaks are seen on the river each year. This is generally occurring below the forest boundary.

With the trend toward the preservation of riparian habitats the quality of the fishing could be expected to increase. There also seems to be an increased interest in fly-fishing. More anglers have been observed in the past five years.

CHAPTER 5 - FINDINGS AND RECOMMENDATIONS

Summary of Key Findings

Findings and recommendations are outlined in Table 5.1. The general condition of the watershed is good. The valley bottoms were heavily logged in the 1930's and 1940's and as a result there is very little low elevation old growth. The mid and high elevation areas on National Forest lands have not had much timber harvest. Therefore there are large blocks of old growth, or late seral forest. The majority of the low elevation areas have mid seral forest which serves as good dispersal habitat for many species, connecting the blocks of late seral habitat. Silvicultural methods that would hasten the development of late seral conditions in these low elevation forests are recommended.

The major human use of National Forest lands within the analysis area is for recreation. Use has been stable for at least two decades but an increasing population and use restrictions in other areas may result in an increase in recreation demand here. The Forest has an opportunity to build upon consensus efforts currently underway to develop a plan to manage recreation in the Middle Fork Snoqualmie River watershed.

Table 5.1 Findings and Recommendations

Issue	Finding	Cause	Future Trend	Outcome/ Resources Affected	Recommendations
Terrestrial Patterns of Vegetation	1. Forests in the analysis area are well within the range of natural variability. Large late seral stands dominate the mid and upper elevation zones, especially on National Forest (NF) lands. The majority of low elevation areas (western hemlock zone) are in the mid seral stage with little late seral forest. It is near the low end of the range of natural variability for that zone.	Railroad logging in the 1930's and 1940's removed the majority of the timber along the major river valleys. This logging did not extend much beyond the valley floors.	The majority of the late seral stands will remain stable until a large scale natural disturbance occurs, such as a fire of the scale of the 1300 fire. The majority of the western hemlock stands on NF lands will develop into late seral stands over the next few decades. The Pratt Watershed is allocated as a late-successional reserve (LSR). Only silvicultural treatments that hasten development of late seral conditions are allowed.	General increase in diversity and ecosystem resilience on NF lands. Diversity on non-NF lands will likely remain the same.	Follow the Forest Plan.

Issue	Finding	Cause	Future Trend	Outcome/ Resources Affected	Recommendations
Suitability	2. Approximately 1,000 acres near Quartz Mountain (south of Quartz Ck.) is allocated as General Forest. It may be too rocky to reforest within the five year period required by the National Forest Management Act (NFMA).	Steep, rocky ground.	No change.	Reforestation cannot be assured if the area has a regeneration harvest. NFMA requirements may not be met.	Survey to determine the extent of possible non-reforestable area and reallocate it as unsuitable for timber production (J8), if appropriate.
Noxious Weeds	3. Noxious weeds are spreading within the analysis area. Three of these species (field bindweed, oxeye daisy, and Canada thistle) have relatively small infestations.	Vegetation disturbance (logging, road building and road maintenance) coupled with the transport of weed seeds by cars, ORV's, heavy equipment, and stock.	Noxious weed populations are likely to increase.	Native plant diversity may diminish as native species are out-competed by weeds, especially in areas near chronic vegetation disturbance such as road and river corridors.	Begin with an inventory of the noxious weed infestations. Develop an integrated weed management program for the analysis area.
Terrestrial Wildlife Habitat Diversity	4. The quality of most wetlands, lakes, ponds, cliffs, and talus areas are at near optimum levels.	Most of these areas are in primitive locations where potential for damage is low.	Most are likely to remain the same.	Biodiversity will continue to be high for terrestrial plants and animals.	Where necessary, implement mitigation to protect these unique habitats.

Issue	Finding	Cause	Future Trend	Outcome/ Resources Affected	Recommendations
	5. The majority of the riparian reserves are in fair to good condition.	Existing conditions for most of riparian reserves are stable or recovering and improving with restoration and time. Some dispersed recreation sites are not meeting the ACS objectives.	Riparian reserves currently in good condition should remain stable or improve with time. Damaged sites should improve with rehabilitation.	Where riparian reserves have been degraded the high number of plants and animals dependent on them for a major portion of their life cycle may have reduced opportunities for breeding, feeding, and /or dispersal. The majority of riparian reserves will remain in fair to good condition.	Inventory riparian reserves for ACS function. Consider developing a plan for long range riparian reserve management.
	6. There are large blocks of late-successional habitat (LSH) and they are relatively well connected except in valley bottoms and on private land.	Logging in the 1930's and 1940's removed the majority of the timber in the valley bottoms but did not extend to the mid or high elevation areas.	Previously harvested areas on NF lands will develop into LSH over the next several decades as these stands mature. Private lands are not likely to provide large blocks of LSH.	Species dependent on low elevation LSH have reduced populations due to previous logging.	Improve connectivity between existing blocks of LSH by promoting development of LSH in LSR and riparian reserves in valley bottoms.
	7. Snag and down log (large woody debris) levels have not been surveyed but are likely to be high on most NF lands outside of the low elevation areas.	Snags and down logs were probably removed from valley bottoms during logging and fires.	Previously logged stands on NF lands will develop a snag and down log component over time. Natural levels will likely remain in unharvested areas.	Species dependent on snags and down logs have reduced populations in logged areas. The remainder of the analysis area should have sufficient habitat for these species.	Survey to determine the current condition of snags and down logs and, if necessary, develop a management plan for these features.

Issue	Finding	Cause	Future Trend	Outcome/ Resources Affected	Recommendations
Terrestrial and Aquatic Species of Concern	8. Amphibian populations are a possible concern due to research findings in other areas.	Possible causes could be stocking of non-native fish in high elevation lakes and UV radiation.	Unknown.	Amphibian populations may be affected.	Begin long term surveys to determine population trends and causes.
	9. Populations of species of concern generally appear stable. More information is needed on populations.	Large scale logging and road building has ceased on NF lands. Recreational use has been stable over the last two decades.	The availability of suitable habitat for some species should increase or remain stable.	Species not affected by human disturbance should remain stable or increase as suitable habitat increases. Those affected by human disturbance may decrease.	Survey suitable habitat to determine population trends and identify management opportunities.
	10. Mountain goats utilize Garfield Mountain extensively year round.	Suitable habitat (cliffs adjacent to late-successional forest) is abundant.	Suitable habitat should remain stable.		Retain this mountain goat allocation.
	11. An occupied marbled murrelet site was located near Goldmeyer Hot Springs.	Suitable habitat is present.	The area is currently allocated as "dispersed recreation."	Protection of a threatened species.	Study the site to determine if the allocation should be changed.
	12. Management situation recommendations should be made for Grizzly Bear Management Unit #1.	Required by the Grizzly Bear Recovery Plan.	N/A	Grizzly bear recovery.	Management Situation Area 1 should coincide with the Alpine Lakes Wilderness. Management Situation Area 2 should include the remaining NF lands within the analysis area.

Issue	Finding	Cause	Future Trend	Outcome/ Resources Affected	Recommendations
Terrestrial Species/ Human Inter-actions.	13. Road and trail densities on National Forest land are at appropriate levels for wildlife species sensitive to human interaction. Security habitat is at 70% on National Forest land.	There is human use in 30% of the analysis area on National Forest land.	There is public demand for new trails.	Security habitat may be affected.	When analyzing new trail proposals, consider all species that may be impacted.
Surface Soil Erosion	14. Information is needed to determine the significance of contribution of the surface soil erosion to the sediment levels in the Middle Fork stream system.	Lack of survey data.	The need for mitigation measures can not be determined without more data.	Water quality, fish habitat, and aesthetic quality.	Inventory potential sites of surface soil erosion. Document the extent and severity.
Mass Wasting	15. Lack of inventory information prevents the identification and scope of mass wasting occurrences and their effect on water quality and fish habitat.	Lack of survey data.	No change until adequate surveys are completed.	Water quality and fish habitat may be adversely impacted.	Complete a mass wasting inventory to validate frequency and distribution of unstable slopes identified by the model.

Issue	Finding	Cause	Future Trend	Outcome/ Resources Affected	Recommendations
	16. Quartz Creek (within the Taylor River fifth field watershed) has the highest priority for restoration work.	Highest concentration of road/stream intersections in conjunction with young stands and a moderately high acreage of naturally unstable slopes.	Increased erosion, including mass wasting, without restoration.	Water quality and fish habitat.	Develop a restoration work plan and consider that Quartz Creek is a high priority.
	17. The lower Middle Fork fifth field watershed has the highest percent of area with a high potential for mass wasting.	High concentration of inherently unstable glacially deposited lake sediments and glacial till.	River migration and the resulting erosion of unstable banks and toeslopes will result in a continued high frequency of mass wasting events.	Water quality and fish habitat.	Investigate slope stability before beginning slope disturbing activities, particularly in areas rated as high and moderately high risk (see map in Chapter 3).

Issue	Finding	Cause	Future Trend	Outcome/ Resources Affected	Recommendations
Hydrologic Conditions	18. Baseflows in late summer and early fall are very shallow in the mainstem of the Middle Fork Snoqualmia during some years, and are thought to be very shallow and perhaps subsurface near the mouths of some tributaries.	Low elevations do not provide a deep, persistent snowpack to augment summer flows. Deep alluvial valley sediments result in wide shallow reaches, and may contribute to subsurface flows near tributary mouths in low water years. These natural factors are compounded by increased aggradation due to additional sediment inputs over the past several decades.	Results from studies investigating past trends in the mainstem and elsewhere in the Snoqualmie basin differ somewhat, but overall it appears that baseflows have decreased in the last few decades. Current patterns of relatively frequent, low summer baseflows will likely continue over at least the next few decades.	Connectivity of aquatic habitat may be reduced during low water years when most or all of the flow goes subsurface. Fish and other aquatic organisms could be stranded or isolated at some times. Shallow summer flows result in higher water temperatures and lower dissolved oxygen levels. This stresses some fish species and other organisms and reduces the quality and quantity of available aquatic habitat.	This is a long term concern. Develop a plan to mitigate the situation where possible.

Issue	Finding	Cause	Future Trend	Outcome/ Resources Affected	Recommendations
Hydrologic Conditions	19. The largest floods in the analysis area are the result of early winter rain-on-snow warm fronts, with heavy rains and warm winds. Over one-third of the subwatersheds in the analysis area have over half of their lands in the snow dominated or rain-on-snow zones, those areas most prone to rain-on-snow events. Approximately 94 to 100% of the lands within each fifth-field watershed have at least 70% crown closure and are thought to be "hydrologically mature."	Cold, low elevation snow storms from the north Pacific followed by warm, moisture laden storms from the southwest, produce large peak levels of stream runoff. The impacts of past and current land management are undetermined.	Large rain-on-snow events will continue to occur up to several times each year. Many regional climatologists are predicting wetter years over the next two decades, so the frequency of these events will likely remain stable or increase. The frequency of large storm flows has apparently increased in the mainstem in the last two decades compared to storms in the 1960's and 1970's. Storm frequency and magnitudes are expected to continue at these higher levels or increase in the foreseeable future.	Stream channels and road drainage systems are subject to periods of extreme runoff causing scour. Hillslope soils and road fills are subject to periodic high pore water pressure, increasing the risk of failure.	Use a physically-based, dispersed hydrologic model to predict future stream flows under anticipated land management scenarios (validate by estimating past known flows), when possible.

Issue	Finding	Cause	Future Trend	Outcome/ Resources Affected	Recommendations
Hydrologic Cumulative Effects	20. Almost all of the subwatersheds in the analysis area have been steadily maturing and hydrologically recovering since the 1930's and 1940's when up to 40% of some subwatersheds were logged, roaded, or recently burned. The lower Taylor and Quartz Creek subwatersheds have the highest current levels of disturbance (about 13% of their areas have less than 70% crown closure).	Most of the subwatersheds in the analysis area were first harvested in the 1930's and 1940's, and have not been harvested since. Some logging has since occurred in the Taylor River fifth-field watershed in the 1970's. Land conversion to urban uses is occurring at a rapid rate in the lower Middle Fork Snoqualmie fifth-field watershed.	Timber harvest and land conversion to urban uses on private lands will likely continue at current rates or increase, but stream buffer protection should be better than in the past. Based on current land allocations, rates of future timber harvest on NF lands will be well below past levels. All subwatersheds on Forest lands should have over 90% hydrologically mature stands within a decade.	Vegetation disturbance increases peak flows during frequent events (the degree is undetermined). This may increase sediment transport to and within stream channels, negatively impacting some aquatic communities through aggradation and high turbidity. Increase in runoff and debris delivery to road drainage systems may occur, increasing the risk of road failure. Changes in vegetation result in variability of root strength over time on hillslopes, resulting in a higher risk of failure during peak events.	Conduct more detailed studies to determine the amount of vegetative disturbance that would trigger cumulative impacts to channels in the lower watershed. Identify and stabilize, if possible, high erosion sites. Survey failures near mouth of Pratt River, in the mainstem between Burntboot and Wildcat, and downstream of the Taylor River. Determine if possible restoration or mitigation actions are warranted at these failure sites.

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Hydrologic Conditions	21. The risk of dam break floods is probably high in Quartz Creek and throughout much of the upper Middle Fork Snoqualmie fifth field watershed. However, the average risk over the entire analysis area is relatively low.	Mass failures in areas with steep inner gorges, unstable soils and confined channels can lead to dam break floods.	Dam break floods may occur at frequency rates and magnitudes similar to current conditions.	Stream channels and infrastructure in Quartz Creek are at risk of surge flows from dam break floods. Stream segments within and downstream from this subwatershed are subject to catastrophic inputs of sediment that may bury aquatic habitat. Streamside vegetation would be modified. Some stream reaches may be scoured to bedrock.	High risk areas should be examined after large storms to identify any possible risks to downstream resources and consider possible mitigation actions. Forest planning should anticipate that vegetation in valley bottom areas that are vulnerable to dam break floods may be periodically disturbed.

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Water Quality	22. Available data indicates that water temperature and dissolved oxygen (DO) levels may be limiting fish populations in some reaches of the mainstem of the Middle Fork. No data is available for tributary conditions. Current turbidity levels may limit fish in the lower Pratt River and in the mainstem below Burnboot Creek by clogging gills and reducing visibility and degrade fish habitat by the salutation of gravels. Illegal dumping and dispersed camping are possible point sources of bacterial, hydrocarbon, and toxic contaminants.	Reduced riparian canopy cover on some streams on NF lands due to past timber harvests and roads. Reduced riparian canopy cover on some streams on private lands in the lower watershed due to past and current timber harvests, land conversions, and roads. Both chronic and catastrophic delivery of fine sediments to streams due to bank slumping and mass failures. Law enforcement is not sufficient to prevent illegal dumping, nor control inappropriate activities related to dispersed camping.	Water temperature and dissolved oxygen levels will slowly improve on NF lands as stands mature. Water temperature and OO levels on private lands will improve in some areas as buffers mature but deteriorate in other urbanizing areas if adequate buffers are not provided. Turbidity levels should improve in many areas on NF lands, but they will continue to be high in the lower Pratt River and lower mainstem of the Middle Fork because of chronic sources of fine sediment. They will increase on some urbanizing lands. Future contamination will depend on future access and control; current conditions are better than past conditions.	Fish populations are limited by turbidity and temperature in some reaches, and at risk to be impacted further in the future. Contamination from trash and dispersed camping causes a potential health risk to humans and other species.	Monitor water temperature (seasonally) and DO levels (intermittently) in selected reaches lacking canopy cover over at least one summer every five years, if possible. Monitor suspended sediment levels in the lower Pratt River and lower mainstem Middle Fork Snoqualmie intermittently over a range of discharges, preferably over at least two water years. Develop a plan to control possible negative impacts of dispersed camping. Continue to reduce illegal dumping of trash.

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Water Quality	23. Only a few lakes within the analysis area have been sampled for a comprehensive set of water quality variables. The acid neutralizing capacity of many lakes within the region is known to be very low, making aquatic communities potentially vulnerable to acidic inputs.	Acid deposition, particulate, and ozone emissions from Puget Sound lowlands travel downwind to the analysis area.	Stable or deteriorating in the next decades due to air pollution emissions. Contamination from recreation will continue if access remains the same.	Fish, amphibian and zooplankton populations may be at risk. Some terrestrial plant species may be at risk.	Consider reestablishing the acid deposition monitoring site at Snoqualmie Pass by cooperatively funding with Washington State Dept. of Ecology and Region 6 Forest Service Air Program. Monitor water quality in at least three lakes within the watershed during fall turnover and spring snowmelt at least once every two years over the next decade, if possible. Attempt to determine the source of copper in Williams Lake and low pH in Quartz Lake.
Aquatic Species Protection	24. While overall trout populations have increased within the analysis area over the last ten years, the proportion of trout over 9" has decreased.	The Washington State Dept. of Fish and Wildlife (WDFW) studies have shown evidence of non-compliance with State "catch and release" regulations.	If fishing pressure remains the same and "catch and release" regulations are not either respected or enforced then the current trend will continue. Trout populations may increase but trout over 9" will decrease.	Trout that recreational fishermen desire to catch will be limited.	Forest Service fish biologists must work with State biologists and wildlife agents to enforce regulations through education, signing, law enforcement presence, etc.

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Unstable Channels	25. Channel migration and instability are greatest in the mainstem of the Middle Fork from the Forest boundary to Taylor River and from Wildcat Creek to Burntboot Creek.	Flood events combined with low amounts of LWD (pieces over 21" in diameter and over 50' long) and sediment from natural and management related processes in upstream areas are deposited in these portions of the river. The Nov. 1990, Nov. 1995, and Feb. 1996 floods impacted these reaches.	Pfankuch (1975) channel stability ratings in both reaches from 1996 surveys document poor channel stability and channel width measurements show increased channel widening compared to photos taken in the 1940's for the mainstem between Wildcat and Burntboot Creeks.	Roads and other facilities are in danger of being lost. Aquatic habitat is scoured or buried. Sediment from bank erosion continues to be deposited, filling pools and covering spawning gravels.	Monitor channel widening and stability in these areas. Evaluate potential treatments to protect roads and facilities and to improve channel stability. Implement the most effective treatments.
Fish Habitat Condition	26. There is a low frequency of pools per mile of stream in the Middle Fork, Pratt, and Taylor Rivers.	Low frequency of LWD in the streams and few large trees available for recruitment, particularly in the mainstem of the Middle Fork from river mile 71 to 74.5 and in Taylor River.	Pool frequencies will increase over the long term as riparian stands mature. However, highly disturbad portions of the Middle Fork will take much longer to develop pools.	Decreased fish populations in the Middle Fork, Taylor, and Pratt Rivers.	Consider management techniques in riparian stands to hasten the development of trees large enough to provide shading and eventual recruitment as LWD. Evaluate the need for instream structure placement. Limit these to mainstem edges and low gradient tributaries.

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	27. There is a lack of definitive information regarding potential management induced fish migration barriers within the analysis area.	The need for this information has been low priority until recently. Other more heavily managed watersheds have priority over the watersheds within the analysis area. Low staffing and funding have also contributed to data gap.	Fish passage is now a high priority issue in all watersheds within the MBS. Therefore more time and funding will most likely be focused on data gathering.	All of the Forest's watersheds will be surveyed for potential management induced fish migration barriers eventually.	The watersheds within the analysis area should be surveyed for potential management induced fish migration barriers.
	28. Most low elevation riparian areas are in the early or mid seral stage. There is very little late seral forest in these areas. This differs significantly from conditions common before logging. Even stand replacing fires did not burn as hot in riparian areas, leaving large trees in place.	Railroad logging in the 1930's and 1940's and later clearcut logging.	On NF lands conditions will improve as riparian stands mature. Outside the NF boundary conditions are likely to improve somewhat due to improved stream protection regulations but much of the riparian areas will alternate between the early and mid seral stages. Conditions will vary due to different policies on different ownerships.	Lower fish populations due to higher stream temperatures, greater stream instability, and lower levels of LWD.	Consider surveying riparian areas to delineate potential areas requiring restoration to promote late seral forest and/or streambank stability.

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Human and Economic	29. Recreation use in the Middle Fork is stable but the demand for quality recreation opportunities is increasing statewide.	Increasing population base and economic growth in the Puget Sound Basin. Increasing use restrictions on public lands and reduced access to private land. Reduced level of Forest Service presence in the valley, reduced levels of management, reduced recreational opportunities, such as the closing of Taylor River CMPG.	Recreation use and demand may increase, especially for specific activities such as dayhiking, mountain biking, stock use, dispersed camping, sightseeing, driving for pleasure, and other non-wilderness activities.	Public demand for hiking and mountain biking may become greater than the existing trail system can provide.	Consider the construction of new trails and the reconstruction of old trails and road-to-trail opportunities to meet wilderness standards and to provide non-wilderness opportunities. Consider the development of a new campground.

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	30. Most recreation use is in the riparian areas.	Human nature is to recreate and find peace and quiet near water.	People will continue to seek out areas near water for recreation.	Loss of woody debris in the riparian communities where dispersed camping takes place. Loss of vegetation, soil compaction, soil erosion and bank stabilization. Potential increase of human waste near lakes, rivers and streams.	Develop a plan for dispersed site use, and consider hardening, repair, or relocation of sites. Consider installing backcountry-type toilets as needed at dispersed sites, and outhouses at trailheads. Continue programs to increase public education regarding human sanitation, leave-no-trace camping, wildlife, riparian, and wilderness values.
	31. Management of the valley has become very controversial.	Various user groups have a different vision of where and what types of recreational opportunities should occur in the valley.	Increasing demand for all types of recreational opportunities will cause continued conflict and controversy.	Certain recreational activities may not be available where some users would like to have them.	Develop a management plan or recreation strategy for National Forest lands that brings all user groups together to develop consensus and provide for the full range of recreation opportunities.