ASSESSMENT OF THE JACK AND MOSQUITO CREEK WATERSHEDS

DRAFT 1.0

Notes

1. Maps have been inserted where they will appear in the document. In some cases, blank pages had been set for these maps, but others were not expected. The final will have the maps paginated as part of the document.
2. Initial font is Times New Roman, 12 pt., bold.
3. Main Chapter headings are 18 pt., bold.
4. Secondary chapter are 14 pt., bold.
5. Subordinate headings are 12 pt., bold.
6. Key items of interest are highlighted bold.
7. Quotes and side notes are italicized, and in some cases bold.
8. Margins are set at 1" - left; 0.5" - right; and 0.4" - top and bottom.
9. Line spacing is set at 1.
10. Paragraph spacing is set at 0.9.
11. Tab settings are at 1/4".
12. In some situations, font size was reduced to facilitate fitting into format, such as some tables.

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Assessment of the Mosquito/Jack Creek Watersheds

I. Introduction

The intent of this assessment is to provide a general description of ecosystem structure, process, and function occurring within the combined watersheds This information is critical if one is to understand the present conditions, and project trends into the future. Understanding the past, present, and possible future of the vegetation, riparian communities, cultures, wildlife, and other ecosystem components will help identify the biophysical and social limits of the watersheds.

Information is limited for the watersheds. Consequently, the team has attempted to highlight the interrelationships of ecosystem components. The assessment is a blend of current scientific knowledge, information gathered during on-site visits, interviews with local publics familiar with the area, and a review of existing records and documents (see appendix). The assessment includes a degree of uncertainty and speculation within it.

This is not a decision document. It will neither resolve issues, nor provide answers to specific policy questions. This document is prepared to provide the foundation for proposed changes in land management, and to aid the line officer in making sound decisions for project level analyses.

The District Ranger requested that the assessment team focus on the following concerns:

- How has the character of the subwatershed changed over time, and how does this affect sustainability of key habitats and vegetation?
- What role have natural disturbance processes had in the function and conditions of the area (particularly as it relates to vegetative and channel conditions)?
- How has water availability changed over time and how do changes in vegetation stocking levels affect stream flow?
- How have stream channels changed over time and what activities or events are likely to affect any future trends?

In order for the assessment team to portray the current condition, function and processes going on in the watersheds, two time frames were elected: Pre-1900, and current. These timeframes were selected because this was about the period when Euro-americans, rather than nature, initiated activities within the watershed which changed the conditions, and thereby the functions and processes.

II. Future Trends and Opportunities

Matrix of Changes Within the Watershed

	Soils	Water and Riparian Conditions	Change in Fire Regime	Change in Upland Conifer Stands
Opportunity	Restore historic function Restore soil potential. Reduce compaction	Improve streambank stability Restore riparian hardwood plant community Restore historic function on riparian areas.	Reintroduce fire similar to historic regime, both in intensity and season	Return upland conifer sites to a stand type and stocking level which would not result in a stand replacement event when subjected to fire or insect or disease epidemics
Resiliency Capacity	Little natural recovery from compaction	High resiliency when riparian hardwoods were in place, capacity appears low for channel to return to historic condition subsequent to loss of riparian hardwoods and initiation of headward downcutting.	Ability of fire to burn has not changed. Fuel bed and stand structure is changing.	Conifers have demonstrated high capacity to regenerate and grow to stocking levels far outside of historic range Current stands are highly susceptible to stand replacement events
History/ Current situation	Extensive areas of **compaction** in harvest units, minor displacement, erosion or severely burned soils. Roads greatest source of erosion.	Major factors; **70% of Mosquito** was **clearcut** or **seed tree cut** between **1940** and **1950**. **Beaver** are now **absent** **Road density is in excess of 6 miles per square mile.** **Fire regime has changed** from historic. **Lodgepole** has **replaced** the **riparian hardwood** community. The 1964 flood.	Few acres have burned since fire suppression started in early 1900s, also: Logging and fuels treatment between 1941 and 1950 removed both down and live fuel. Lodgepole pine stands were less susceptible to fire. Aggressive fuels treatment following harvest reduced fire hazard. **Fire hazard**, and **risk of stand replacement fire is increasing** because: LP stands are becoming susceptible to fire, harvest related fuels treatments are leaving more fuel on the ground. Stand crown closure is increasing. Without hazard reduction activities, **75% of the watershed** will be in **High** or **Extreme** fuel hazard **within the next decade.**	Current **conifer stocking levels** in many stands is 2-6 **times historic levels** Structure has changed to **multi-storied stands** which are susceptible to **stand replacement events** which are not a natural process for this type.

	Soils	Water and Riparian Conditions	Change in Fire Regime	Change in Upland Conifer Stands
Scenario 1	Continue activities which result in soil compaction without mitigation	No modification of fire, road building and timber harvest activities, major wildfire has not occurred.	No change in fire suppression or prescribed burning practices	No change in fire and timber harvest practices
Scenario 1 (cont.)	Other management considerations may result in implementation of this scenario by default. Effective widespread subsoiling cannot be done in heavily stocked stands due to resulting root/tree damage. Stands need to be at wide spacing or only occasional skidtrails and landings can be subsoiled.	Grazing, authorized and unauthorized, continues at current intensity. Lodgepole continues to dominate riparian areas.	Wildfires will increase in frequency, intensity, severity and size. Eventually most of the area will be burned in one or multiple fires.	Large, stand replacement events will occur, either from fire or other causes. Area will be dominated by a grass/shrub type for many years. Potential for slightly to greatly increased runoff due to less evapotranspiration Potential for increased erosion.
Risk	Violates Regional Standards. Current conditions will remain unchanged.	Riparian hardwoods will continue to decline. Continued lowering of watertable, changes in species composition.		
Scenario 2	Aggressively treat impacted areas of detrimentally compacted soils. Begin a program of subsoiling to reduce compaction. Roads, skidtrails and landings are high priority. Coordinate with activities which result in open stand conditions.	Mechanical restoration of channel(s) occurs in selected locations	Introduce underburning without harvest.	Return to historic structure of upland ponderosa pine types
Opportunity	Reduce compaction	Reduce effects of channel downcutting and draining of water table.	Reduce hazard of large stand replacement fire.	Implement a combination of understory removal, thinning and underburning.
Risk	Potential for increased erosion or displacement	Project fails at first "above normal" event. Sedimentation increases as a result.	Highly variable outcome due to large amount of fuel and standing timber and live fuel ladder conditions. Risk of prescribed fires burning out of prescription. High cost	

	Soils	Water and Riparian Conditions	Change in Fire Regime	Change in Upland Conifer Stands
Scenario 3	Alter management practices to reduce or eliminate impact	Disturbance regimes, reintroduction of fire to riparian zones	Introduce underburning with harvest	
Background		With no or limited timber harvest in riparian zones, wildfire is inevitable. High probability that wildfire will be a high intensity stand replacement event.	Many stands are currently in a fuel/stocking condition that underburning without fiber removal is either hazardous, high cost, or impossible due to risk of causing a large stand replacement event.	
Activity	Redesign of management activities that cause compaction, displacement and erosion. Use predesignated skidtrails, over snow yarding, helicopter yarding, restrict clippers to skidtrails	Reestablish hardwoods by reintroducing fire to the riparian lodgepole stands May or may not include timber harvest Need to design burning so that lodgepole does not reestablish. May include planting of hardwoods.	Harvest should focus on understory removal and thinning of larger trees as necessary to facilitate\underburn of adequate intensity that risk of stand replacement wildfire is removed.	
Risks	Damage to conifer roots. Erosion potential if major, sudden storm event occurs immediately after subsoiling.	Soil erosion if major storm event occurs before vegetation recovery. Lodgepole pine reestablishes. Water table is currently too low to support riparian vegetation away from streambank.		
Links	Less later season soil moisture reduces capability for some species to grow on some sites. Reduction in moisture holding capacity. Barrier to root penetration.. Changes amount and duration of water flow through riparian areas and streams. May contribute to early drying of streams.	Currently lowered water table may preclude success at hardwood revegetation. Upland stocking my affect water availability in riparian areas. Return of willow should help stabilize channels, provide habitat for riparian dependent species. Could develop habitat which would allow for return of beaver.	Large stand replacement events have high potential to increase water flows due to lack of evapotranspiration by conifers. Lose habitat for climax or large tree dependent species, increase habitat for early seral dependent species.	

A. Soils

Opportunity. Where possible and desirable, restore historic soil functions, mitigate impacts of past management, and enhance or restore the potential of the soil to produce desirable products

Resiliency/Capacity

- Compaction is the major concern for soils in the area
- Soils have shown little natural recovery from compaction. Therefore their resiliency is low, and their capacity to maintain historic function after activities which cause compaction is low.

Description: While little or no monitoring has been done on the soils of the watershed and large data gaps exist, it is thought that management activities have heavily impacted (mostly adversely) the local soils. It is almost assured that soils in some areas will exceed forest plan standards and guidelines for detrimental compaction. That is, an increase in bulk density of 20% or greater over background bulk densities. Monitoring (Cassidy, unpublished data, 1993-94) of similar soils in areas adjacent to the watershed revealed:

- Extensive areas of compacted soils. Timber sale units outside the watershed revealed "severely" compacted conditions varied from 10% to greater than 70% of their total areas.
- Minor areas of displaced, eroded and severely burned soils.
- Roads eroded and transported sediments to local streams, and road maintenance practices were seen to accelerate this process.

We assume that the soils within the watershed react to management in a similar manner to those in adjacent areas on similar slopes and aspects.

1. Compaction: Compaction has been caused, to various degrees, by grazing, timber harvest, and more recently by harvest related activities such as brush disposal and mechanical tree planting.

Compaction from grazing is generally shallow in depth when compared to equipment-caused compaction, but may have started in the late 1800's. Compaction from grazing is found more in meadows and other riparian areas where cattle and sheep are held for extended periods.

Compaction from logging activities primarily occurred after 1940. On the Klamath Indian Reservation lands the soil compaction from the initial harvest entry was probably minimal, as an average of only 3-6 trees per acre were removed. Exceptions would include landings, reload sites and major skid trails where activity was concentrated. Following the original harvest, slash was apparently piled by hand (National Archives). On the upper two-thirds of the watershed, the removal may have been up to an average of 20 trees per acre, which could have caused more area-wide compaction.

A number of studies have revealed the effects of soil compaction. Most, if not all of these studies have been on soils with different characteristics than pumice. These effects include:

- Potentially decreased infiltration rates, often leading to accelerated erosion and runoff, increased sedimentation, earlier peak stream flow potential, and greater channel erosion.
- Interference with subsurface water flows through a subsurface damming effect. This often leads to some areas becoming wetter and others drying out as water tables change in response to the compaction.

In addition, soil compaction has been shown to affect tree growth, vigor and stability Studies indicate

- Almost universally, a loss of tree volume growth and a decrease in basal area on compacted soils compared to non-compacted soils This is often due to roots being unable to penetrate the higher density soils and access necessary nutrients and water Growth losses can exceed 50%

- Decreased tree vigor leading to less resistance to disease and insect attack.

- Greater windthrow potential due to truncated root systems

- Loss of soil macropores, restricting the flow of water and air to the tree root mass, inhibiting growth potential.

- Soil compaction may promote frost heaving and result in the death of seedlings.

Other major and minor effects (mostly adverse) are attributed to compaction. With the lack of studies on pumice-derived soils, however, we hesitate to extrapolate data derived from other, often very different soil types to the Watersheds Watershed

Some studies have shown compaction to be very long-lived, depending on its depth and the intensity of the ameliorating factors. It appeared, during monitoring of similar soils, that occasionally the upper 2-3 inches of the soil surface was free of compaction but lower portions were still compacted. This could be due to shallow freeze/thaw cycles occurring during non-winter seasons. Locally, when the freeze/thaw cycles are most intense in the watershed, the area is blanketed and protected by a layer of snow several feet thick. This reduces amelioration of compaction from frost heaving.

2. Displacement, Erosion and Severely Burned Soils: Visual monitoring on over 12,000 acres in areas near the Mosquito Watershed has revealed surprisingly little erosion, severely burned, or displaced soils. The definition of displacement makes it difficult to meet established criteria, however, and there is probably more displacement than recognized, especially on steeper slopes. This may also prove true on the steeper slopes of the Mosquito Creek Watershed. Monitoring scheduled for 1995 will attempt to fill in this data gap.

3. Roads and Road Maintenance: Historically, forest roads have proven to be the greatest source of erosion and sedimentation in most land management schemes. On the Winema National Forest, roads have been constructed within and along 4th class drainages and other low spots in the topography that concentrate water. The compacted surface of the road prohibits water infiltration, so overland flow commences. Due to the topographical position, water has no where to flow except on the road prism. Eventually sufficient flow volume and velocity are reached, and the road surface erodes, often dumping the sediment load into a nearby stream.

It is often assumed that road construction began with the onset of logging activity. Our investigations indicate that this was not the case within the watershed, and other areas on the former Klamath Indian Reservation. Logging activities have definitely increased the density of roads, but most areas of the Reservation were well roaded as early as 1912 (National Archives), many years before the initial logging occurred. Early BIA documents refer to "well roaded" areas, "often traveled" and "heavily used" roads Timber type maps dating from the 1920s show 1-3 miles of road per section in the Mosquito Watershed lands that were in the Klamath Indian Reservation during the period. There are references to "old road" on those maps. While a contemporary measure of "well roaded" or "often traveled" is probably different than that of 1912, we suggest that roads and the associated resource problems have been present or developing in the watershed for at least 70 years.

At the present time, little is known about the road system within the watersheds The forest transportation system base maps generally show only approximately half of the roads within an area This may hold true for both areas If it is similar to those outside the watersheds, then a careful study will be needed to assess the viability and condition of the system and the desirability of putting some of the road system "to bed"

Ditch lines are constructed along roads to drain surface water off, to avoid erosion of the prism. However, the ditch then erodes and dumps its sediment load directly into a stream course. This could be avoided by directing the ditch flow into vegetated, or duff or litter covered ground prior to reaching the stream course

Disclaimer: Definitions for detrimental compaction and displacement may prove to be inadequate for our purposes. As an example, at least two studies point out the potential for lodgepole pine roots penetrating very dense soils, i.e. 1.56 grams per cubic centimeter (g/cc). Local pumice-derived soils often have a natural bulk density of 0 6 or 0.7 g/cc with 70% pore space. The prescribed 20% increase in bulk density would be up to 0.84 g/cc - well under the density of the soils mentioned earlier. Macropore spaces would also be significantly reduced, but perhaps not enough to hamper plant growth. A small amount of compaction may even aid plant-water relationships. In a natural state, the pumice-derived soils have a huge amount of macropore space, and water (at field capacity) moves very slowly due to the lack of soil particles bridges. A small amount of compaction may increase the particle contacts and hasten water movement.

Data Needs: Monitoring of the Mosquito Creek Watershed soils is planned for 1995. There are many data gaps in this area. We have information indicating that bulk density has increased. Pumice is a young soil; most research has been done in older, more developed soils. We need a clearer picture of what is "detrimental" compaction on pumice soils, and how long compaction persists in the soil. We also need more work on classification, as current classifications appear to be too broad to use in predicting a response to activities. We do not have a complete inventory (or combination of inventories) of road locations that are impacting the resource. The forest transportation system map often shows less than half of the existing roads that are an impact This is true for older "historic" transportation system maps as well. The road maintenance program needs review to determine if it is causing water quality problems, and if so, what can be done.

Scenario 1. No Change in Management Practices.

Allow soils conditions to remain as they are, and allow management to continue the practices that created these conditions. If monitoring within the Mosquito Creek Watershed produces similar findings to monitoring outside the watershed, then this scenario would continue to move the soils condition farther away from historic condition and function.

> **Risk:** Scenario 1 risks violating the objectives set forth in planning documents such as the Winema LRMP. In addition, erosive and plant inhibitive factors (described above) will continue to be active in the watershed.

Scenario 2. Aggressively Treat Impacted Areas.

If monitoring proves the existence of "severely" compacted soils, implement a subsoiling program to restore soil bulk density and porosity. Meet forest plan standards that require that "less than 20% of an activity area will be left in detrimental soil conditions". Roads identified as causing water quality problems will be "put-to-bed" by subsoiling, returning to preconstruction grade and seeding for control of erosion

Properly done, subsoiling should not greatly disturb the "A" horizon. The winged subsoiler "lifts" the soil, causing the compacted mass to crack and break below the soil surface. Surface disturbance is from the shaft that connects the subsoiler portion to the tractor, and vertical "lifting" and "fluffing" results in the de-compacted soil now containing more air space, therefore occupying more space. In areas where there is a high amount of compaction dispersed across the area, as with a high density of skid trails, subsoiling is most effective when the stand is in an open condition. Therefore area-wide subsoiling needs to be coordinated with a major harvest activity, fire, precommercial thinning or areas of natural regeneration after seed tree cuts. Landings, roads and occasional skid trails may often be subsoiled within heavier stands in some cases.

Active or potential erosion areas should be treated by seeding, mulching, check dams and other methods. We recommend the use of native seed and weed-free mulch or straw for these operations, and recognize that each situation requires a unique solution to check the erosion.

Risk: Initially increase erosion of soil surface in treated areas; increase displacement of A horizon through increased mechanical activity.

Scenario 3. Alter Management Practices to Reduce or Eliminate Impact.

This scenario would result in changes in management activities that caused compaction, displacement and erosion. Obviously, reducing or eliminating the amount or frequency of management activities within the watershed is an option in this scenario. Eliminating unauthorized livestock grazing would be beneficial. Use pre-designated skid trails, over-snow yarding, horse or helicopter logging. Restricting the use of feller-bunchers, tractor-mounted shears, or other machines which must approach each individual tree will help to avoid future compaction. In general, use only feller-bunchers, with excavator-type arms, which can operate from skid trails.

Links: Reduced later-season soil moisture restricts the capability of some species to grow on some sites, changes the amount and duration of water flow through riparian areas and streams, and may contribute to early drying of streams.

B. Water and Riparian Condition

Opportunity: Improve existing stream bank stability, restore riparian plant communities and the historic function of the riparian area.

Resiliency/Capacity: (No clear agreement on this issue.)

- Believe that resiliency was high when historic riparian hardwood community was in place.
- Capacity appears low for channel to return to historic condition subsequent to loss of riparian hardwoods and initiation of headward downcutting,

Description: There is no agreement within the Watershed Team on the precise range of historic channel conditions of the mainstem channel, or whether the existing channel condition is within the historic range of variability. We recognize that multiple factors have influenced the existing condition of the mainstem channels and tributaries:

Major contributors to the current channel condition:

- With the exception of pure lodgepole and non-forest types within the watershed (30%), the ***Mosquito watershed was clear-cut or seed-tree cut between 1940 and 1950. 60% of that occurred between 1947 and 1950.***

- Livestock, primarily sheep, have used riparian, meadow and upland communities since at least 1900, and continue to graze the watershed on an annual basis

- ***Beaver*** no longer occupy the watersheds, hydraulic retention has changed as a result

- The watershed has a ***road density in excess of 6 miles per square mile.*** In some areas, roads were constructed within the stream channel and floodplain. Roads are affecting the hydraulic function of the watershed

- The ***fire regime within the watershed has changed from the historic past.***

- The ***riparian hardwood community has been replaced by a lodgepole pine dominated community.***

- The ***1964 flood*** event.

Our assumption is that channels function in dynamic equilibrium, and that the existing condition of the channel reflects past and current influxes of water and sediment into the channel. We assume that riparian plant communities have a strong protective or buffering influence on stream banks, and that alteration of riparian plant communities through the reduction coverage, or change in species composition, can reduce the resiliency of channels during high flows. We assume that riparian plant communities have been altered by the above factors, and current channel conditions, whether within or outside of the historic range of conditions, reflect this. We also assume that both mainstem and tributary channels are currently adjusting to watershed conditions. See *Riparian Habitats* for further discussion

Scenario 1. No Change in Management Practices, and stand replacement wildfire has not occurred.

Channel restoration does not occur as a scheduled management activity. Grazing continues at current intensity in authorized and unauthorized situations. Roads are left "as is", or are reduced through current mitigating efforts. Harvest and other management activities are generally restricted in riparian areas Lodgepole will continue to dominate riparian areas, precluding return of riparian hardwood vegetation

The mainstem channel will continue to down and head cut in some locations. Widening will occur as the channel adjusts to the gradient and flow regime. If changes in influx are minor, "stabilization" of the channel may occur. If large storm events occur, channel widening and downcutting could be accelerated until such time as healthy riparian communities are re-established. Successional replacement of hardwood communities by conifer communities will continue. The event that resets the successional clock in this scenario is large. Communities may not return to hardwood associations.

Risk: Hardwood riparian habitats will continue to decline spatially. Reduced opportunity for feeding, nesting and cover for wildlife species. Continued lowering of local water tables in specific areas. Changes in floral species composition as a result.

Scenario 2. Mechanical Restoration of Channel(s) Occurs in Selected Locations.

Opportunity To reverse effects of channel downcutting, and reduce effect of downcutting on draining of water table

Following site specific analysis, restoration or reworking of channels occurs in an attempt to arrest channel widening and lowering of local watertables Planting of riparian species on reworked areas to hold soil and slow rework of established banks/floodplain. Spatial decline of riparian habitats is slowed and in some areas reversed This activity may have limited application in Mosquito due to the physical limitation of space in the riparian areas

Major restoration may involve large amounts of soil and soil movement. We may have to move soil, then plant and monitor. This option may partially or totally restore floodplain. Consider doing scenario 2 first and then going to scenario 3 if unable to restore hardwood plant community due to increased depth to standing water/high soil moisture.

Links: Existing lowered water table may preclude widespread success at hardwood re-vegetation Upland stocking levels may affect water availability in riparian areas. Riparian re-vegetation with willow and associated hardwood species is key to stabilization of channels. Return of riparian vegetation and later season flows (or ponded water) provides habitats for many riparian dependent species. Increased hardwoods could facilitate the return of beaver, leading to an in increase in pooling and ponding, which would aid in sediment retention and modify the effects of downcutting.

Risk: Project failure. Project fails at first above "normal" event. Sediment influx to channel is increased as a result of failure. We all look like fools.

Scenario 3. Disturbance Regimes: *See disturbance discussion following, we don't have much control over inundation or flooding so this scenario is fire.*

Disturbance regimes recreated in riparian zone Three disturbance regimes historically influenced the riparian zones in the watersheds. These are:

- **Fire**. The period of fire disturbance was influenced by the width of the riparian zone (Agee, 92) and the bordering plant community. Our assumption is that the fire return interval in hardwood communities was approximately 50-75 years; in lodgepole communities, 75-150 years.

- **Inundation**. Inundation by water from beaver impoundments may have been on a periodic basis; inundation of an individual reach may have been for a period of several decades every two or three centuries (speculation).

- **Flooding**. Periodic or cyclic flooding influenced channel and floodplain morphology and the extent of riparian communities on the floodplain.

We assume that with non-entry of riparian zones by timber harvest, fire in the riparian zone is inevitable. Wildfire in the riparian zone will likely be a high severity, stand replacement fire. This will result in long term soil degradation and long tern species composition changes (for both plants and animals). We also assume that the re-introduction of beaver is not currently possible due to conditions of the channel and floodplain.

Return fire to the lodgepole stands as an opportunity to both reduce fire hazard and start reintroduction of a hardwood dominated riparian community. Potential soil damage, on soil types more susceptible to damage from high surface temperatures will be one limiting factor if the stands can be burned without removal of some or all of the lodgepole Another limiting factor is ability to control spread of prescribed fire May need to pretreat by falling a portion of the lodgepole, allowing felled trees to "cure", then burning during spring or fall Removal may or may not be necessary or desirable

There is potential for soil disturbance due to lack of ground cover after burning, this danger would be if a major storm event occurred during that time Burning needs to be designed to discourage lodgepole pine regeneration and stimulate hardwoods Hardwood planting may be beneficial However, uncertainty exists as to where the water table will stabilize, so we suggest careful monitoring of plantings and soil moisture to determine this

Alder, cottonwood and some spp. of willow are more dependant on proximity to the water table than aspen. Grazing in riparian zones will need to be controlled to allow re-vegetation. Sheep use should be manageable, but cattle use (trespass or permitted) needs to be removed from re-vegetated areas Obliterate or redesign roads in riparian areas so that they do not channel water into, or limit water movement through riparian areas.

Start periodic burning in meadow areas (with or without lodgepole encroachment). This period should be determined by fuel loading and evidence of lodgepole encroachment. Holding cattle in meadows is potentially responsible for lack of lodgepole pine encroachment, and lodgepole may be more of a concern after removal of cattle use. Data need is current depth of water table to determine suitability of site to grow willow/hardwoods. Start plantings of Willow/hardwood, monitor success. Consider reintroduction of Beaver after adequate stocking of hardwoods is established to serve as a food source without being wiped out

Evapotranspiration: When viewed as a land unit, we assume that the amount of evapotranspiration (ET) that has occurred within the watershed has varied over time. Factors that influence variation in ET include:

- Geophysical, seasonal and climatic moisture availability.
- The type of vegetation on a given site.
- The amount of transpiring vegetation on a given site.

Studies suggest that as much as two-thirds of the total precipitation received in the watershed is transpired by plants. Following removal or reduction of vegetation in a watershed, ET is reduced for a short period (5-20 years). Research indicates that a 35% increase in water availability occurs with 100% removal of vegetation and a 0% increase with 10% vegetation removal with a linear fit between the two points (Troendle, 87). Water that is not transpired is available to move into lower water tables (recharge), or to enter the stream channel as surface or subsurface flow. Troendle (1986) states:

"Soil moisture studies in lodgepole pine stands that range in basal area from 32 sq. ft. 180 sq. ft. per acre, show that soil water depletion (and evapotranspiration loss) is reduced and water available for stream flow is increased in direct proportions to the basal area reduced".

A number of variables influence the relationship between reduced ET and increased stream flow These include:

- The increase in water availability is insignificant in dry years or from summer precipitation, as those waters are retained on site.
- Routing of the water toward the stream is a complex process

- Increases in stream flows are positively correlated with precipitation, so greatest increases are in the wettest years

- A significant portion of the increase in water availability is a result of a reduction of interception loss from vegetation removal, not from ET

Variables specific to Mosquito Creek watershed include

- Soils of the drainage are extremely porous, with high infiltration rates

- The watershed's low topographic gradient slows the transport of water

- The greatest water savings occur on north facing slopes, where as Mosquito Creek is generally south facing.

- Precipitation in the watershed can be characterized as low, although precipitation is variable from year to year.

A general consequence of vegetation reduction is that the soil water depletion rate that occurs during the growing season is reduced due to lower ET rates. More water would remain locally to keep the soil moister for a longer period, supporting a higher density of surface vegetation. Increased stream flow from reduced ET rates would not occur in most years due to the low levels of annual precipitation.

Links: Lower water tables may preclude widespread success at hardwood re-vegetation. Upland stocking levels may affect water availability in riparian areas. Riparian re-vegetation with willow and associated hardwood species will assist stabilization of channels. Return of riparian vegetation, and later season flows (or ponded water) would provide habitats for many riparian dependent species. Increased hardwood stocking would allow for return of beaver, leading to an in increase in pooling and ponding, sediment retention, and modify the effects of down cutting.

C. Change in Fire Regime Resulting from Fire Suppression since Early 1900's.

Resiliency and Capacity: This discussion does not apply to fire in the same way as the other topics. Fire's capacity to burn has not changed, the availability of fuel has. The area has demonstrated high capacity to produce fuel.

Opportunities: Re-introduce fire similar to historic regime to area. All types, and during summer/fall period.

Description: Since fire suppression began in the early 1900's, few acres have burned in the watershed. Less than 5 acres have burned in the past 20 years. There are multiple reasons for this:

- Logging and fuels treatment prior to 1950 removed much potential fuel from the area.

- Lodgepole pine stands were in much younger age classes, so less susceptible to fire.

- Aggressive fuels treatment following harvest reduced fire hazard.

Conditions in the watershed are changing Lodgepole pine stands such as Jackies Thicket have become susceptible to fire Two fires near the watershed have occurred in dense stands of mature lodgepole with little dead or down fuels in recent years Ponderosa and mixed conifer stands are increasing in fire hazard Post harvest fuel treatments are leaving much more fuel on the ground For these reasons, the risk of stand replacement fire in the watersheds is increasing

Without hazard reduction activities, 75% of the watershed will be in **High** or **Extreme** fuel hazard within the next decade By the end of the decade, the probability of a fire starting in High or Extreme hazard fuels will be 78% each year Fires in these fuels are becoming increasingly difficult to control A fire start in Jackies Thicket during August conditions could easily burn to the top of Sugarpine Mountain, for example. This would consume all of the mixed conifer plant association in the watershed.

When discussing current or historic fire it is important to identify which forest type is being addressed There are four dominant types in the watersheds. Mixed conifer, ponderosa pine, dry lodgepole and wet lodgepole/riparian hardwood.

1. Mixed Conifer and Ponderosa Pine.

Historically, the mixed conifer and ponderosa pine types had similar fire conditions. Their historic fire regime was generally a surface fire with occasional torching of individual trees and small clumps Fire frequency averaged 5-15 years. These fires kept the surface vegetation at a seral condition, removed or charred surface fuels, and had only minor effect on the larger sized conifers within a stand.

2. Dry Lodgepole.

The types currently described as "dry lodgepole" mostly occurred as shrub-grass-steppe with scattered small groups of lodgepole. Fires in this type would have occurred every 25-30 years and would have been of low to moderate severity.

3. Wet Lodgepole/Riparian Hardwood.

In the riparian lodgepole type, the fire frequency was 75-150 years. We assume that the fire frequency in the riparian hardwood type was somewhat shorter, 50 to 75 years. This is because the moister types do not dry out as easily and are susceptible to fire for shorter periods of time. Fires in these types would have burned in a more patchy mosaic with larger stand replacement areas, but still not of today's magnitude in most cases. A high intensity burn over a thousand acres was probably a large fire. One of the (few) early references to lodgepole fires exceeding 30 acres described a fire at Sand Creek in August, 1915, which burned 1040 acres of "scrubby lodgepole pine timber" (National Archives).

Scenario 1. No Change in Fire Suppression or Prescribed Burning Practices.

Continue current fire suppression but no change in prescribed burning or fuel treatment, natural or human caused.

Fires will increase in intensity, severity and size. Potential for loss of life as well as impacts to various resources is high. Eventually, most of area will be burned severely in one or multiple fires. Due to orientation of the subwatershed and past harvests, a single large fire burning the entire watershed is a low probability. Soils have potential for long term damage where surface fuels are large or heavy enough to produce high sustained heat. This would especially occur in a reburn situation. Increased potential for soil erosion.

Scenario 2. Introduce Underburning Without Harvest (Ponderosa pine, mixed conifer and dry lodgepole pine types)

In this scenario stands would be underburned without any removal of material from site Some mechanical preparation work might be done prior to burning Multiple burns of increasing severity coul be used Outcome would be highly variable depending on existing stand conditions, and specific burn objectives and prescriptions

There are areas in the watershed where this scenario could occur without conducting fuel reduction first Other areas, however, could lose large clumps of trees. Some stands would sustain high amounts of mortality, while some - especially lodgepole - would have a stand replacement event. Long duration, high surface soil temperatures would occur either where large amounts of fuel exist on the surface now or surface fuel . added from fire-killed trees. This impact can be reduced by mechanical pre-treatment of surface fuel. If proportionally small burns are done, this area will have proportionally greater increase in bark beetle activity.

The resulting landscape would be a mosaic of openings and small stands of larger trees. Lodgepole pine and white fir would be reduced. This would be a slower activity than scenario 3, as a period of fuels buildup would be needed between burns to facilitate the next burn. High fire hazard would continue for many years due to mortality caused by the burning; or the incomplete consumption of fuels associated with "stage" burning or sequential burning in progressively more intense/severe fires.

Implementing this scenario would be very expensive and may not be feasible. The large amount of smoke generated would require careful coordination with weather events that favor atmospheric mixing. If attempts were made to apply this management scheme across the district and forest, it is likely that the lack of availability of burning windows and skilled personnel would limit its success.

Scenario 3. Introduce Underburning with Harvest. (Ponderosa pine, mixed conifer and dry lodgepole pine types) In this scenario stands would be harvested to remove the understory, or thinning the overstory to meet some desired condition that also allows underburning at higher intensities. Underburning might be preceded by mechanical pre-treatment of surface fuels to reduce mortality to residual stands. Multiple underburns would be done both to prevent damage to residual stands and soils, and to maintain stand conditions once the goals are reached. The residual stand objective should be a stand similar in character to the historic stand types described in the vegetation section. This activity could be completed, at least logistically, across large areas in a relatively short period of time. Fire hazard would be reduced for most of the time, the exception being immediately after harvest and prior to mechanical pre-treatment or the first under burning.

Links: Large stand replacement events have high potential to increase water flows due to lack of evapotranspiration by conifers. Loss of habitat for climax or large tree dependent species, increase habitat for early seral dependent species.

D. Change in Upland Conifer Stands from Historic Structure and Stocking.

Resiliency and Capacity

- Conifers have demonstrated high capacity to regenerate and grow to stocking levels far outside historic range
- Current stands are highly susceptible to stand replacement events; fire, insects or disease, that occurred as single tree or small group mortality events in historic stands.

Opportunity is to return upland conifer sites to historic range - an individual tree or generally small group replacement system in the pine and drier mixed conifer types. Develop stands and stocking which would not result in a stand replacement event when subjected to fire or insect or disease epidemics

Return potential for water movement to riparian areas by returning vegetative stocking levels to within historic ranges Reduce impacts from roads and soil compaction on water infiltration, transport and storage Also, reduce potential loss to stand replacement event which leaves a stand of dead trees with few options left Want to keep a live stand with more options to choose from, and live trees to work with.

Reduce upland vegetation to within range of historic levels. Reduce area of compacted ground from roads and equipment operations. Return historic function of water infiltration, storage and movement There is no clear agreement on quantitative relationship between conifer/brush stocking levels and water use and availability to riparian areas. There is a tie between vegetation stocking and water availability Estimates of water use by conifers range from 1/3 to 2/3+ of total precipitation. This relationship needs to be tested and monitored, with projects designed to be adaptive to non-quantified response. Need to take care in project design that potential for significant increase of flows into channel is avoided, at least until channel has stabilized further.

Scenario 1. No Change in Fire and Timber Harvest Practices.

Continuation of fire suppression stocking levels continue to increase . Harvest or prescribed fire activities remove less fiber than area is growing. Harvest treatments not designed to develop an open, historic or semi-historic structure. Continued build up of fuels on the ground, continuation of ladder fuels from ground to crown level. Lack of a prescribed fire program.

Large, high severity wildfires will be difficult to prevent. These fires will be followed by long intervals in shrub dominated plant associations, interrupted by severe reburns at 5-20 year intervals with most or all of original tree/snag component consumed. This will result in large stand replacement events (1000 acres or more would be expected) from fire and/or stress related mortality.

Initial natural reproduction will be mostly limited to grasses, forbs and brush - which will return in abundance. Conifer reproduction will be limited and of sporadic distribution. Areas of heavier conifer reproduction will be determined largely by presence of seed bearing PP or residual seed. The actual number of established PP seedlings may be within historic stocking levels, but they would be small-sized for many years. This situation would not provide wildlife cover, would not be highly visible, or provide a forested landscape. While pines will regenerate, their continued survival is jeopardized by reburn potential after dead trees fall, and sufficient grass/brush is present to carry a fire. Ponderosa pine regeneration will take longer to occupy the site than a sequence-of-reburns scenario. A grass/forb/shrub community could be established for many years over many acres. Large trees that were present in historic stands would be absent.

Other Considerations: If stand replacement events occur over large areas of the watershed, potential exists for slight to greatly increased runoff, until vegetation stocking is sufficient to utilize most available water in the rooting zone. The actual amount is unknown, but dependent on many other factors such as soil/road condition, precipitation amounts, etc... This condition also has potential for increased erosion There is a high probability for loss of most of the large, old structure trees. Generally, large trees are not good at surviving the currently occurring mortality events. There are, and will continue to be, exceptions to this. Vegetation resiliency is generally highl in this watershed (refer to Vegetation section).

Scenario 2. **Return to Historic Structure of Upland Ponderosa Pine Stands**

Implement a combination of understory removal, thinning and underburning. This is a long term project if implemented at the landscape level This activity needs to be integrated closely with riparian condition and need Leave stocking levels so that conifers at least minimally occupy the site so that water flow to riparian areas is not greatly increased - at least until riparian areas are in condition to accept additional water This relationship needs monitoring to determine impact of lowered stocking levels. Stocking level control can be accomplished in one entry, or two or more lighter cuts to attain the final stocking level See Vegetation section for historic stand structure and stocking level ranges.

Initial entries need to open stands and treat fuels, so that stands can be both underburned (with somewhat high intensity), and withstand a wildfire with limited mortality. When open stand conditions are achieved, there is potential for increased diversity of ground vegetation.

Frequent underburning will maintain fuel beds at levels that preclude severe fire effects (even from a wildfire). However, a two or three stage series of burns may be necessary before implementing a burn rotation. Mitigation measures may be taken to eliminate one or two of the burns. Examples of mitigation include lop and scatter, machine crushing, and understory removal harvest.

Links: Current stands are expensive to maintain or protect. Increase in surface and/or ladder fuels leads to an increased fire hazard. Lack of frequent surface fires results in increased root rot pathogens Increased surface fuel leads to increased potential for soil damage from long duration and high severity wildfires.

III. Physical Environment

The present drainages have been developing since the eruption of Mount Mazama (Crater Lake) approximately 7,000 years ago Vegetative and wildlife community presence, together with the form and function, are primarily results of natural events Man's role in developmental processes has been conspicuous only in the past 150 years, and most significant since around 1940 The processes will be described in chapters as the ecosystem components are discussed.

Overview

Situated in the eastern portion of the Chemult Ranger District, the generally north-to-south sloping Mosquito Creek Watershed drains an area of approximately 18,010 acres. The watershed begins approximately two miles north of perennial Huckleberry Spring, and terminates at the Klamath Forest Marsh at an elevation of 4,520 feet. Sugarpine Mountain (6,393 feet) is the prominent feature of the watershed, God Butte is another, at 5,048 feet

The landscape sustains a variety of vegetation and wildlife supportive of human habitation and exploitation. The northern half of the watershed historically was too cold and harsh for permanent human occupation, but ethnographic data shows the aboriginal Klamath Indians inhabited the area along Klamath Marsh, soprobably frequented the area.

Mosquito Creek is the main watercourse within the drainage. It is a Class IV intermittent system. An unnamed fork, which merges with the main channel just above the narrow canyon east of God Butte, has the same attributes. All other channels that feed Mosquito Creek are intermittent or ephemeral only.

Climate is characterized by warm, dry summers and moderately cold, wet winters. Annual precipitation averages 15 to 30 inches per year, occurring mostly as snow in November through February. Summer temperatures reach as high as 105° F, and winter lows have dropped to minus 24° F. Average temperatures range from 24° F in January to 40° in July.

The eruption of Mt. Mazama distributed a thick deposit of pumice over the watershed. Prevailing wind strength and direction dictated the extent of deposition across the landscape, to depths of 40 inches or more Ash and pumice derived soils are coarse-textured, non-structured, and non-cohesive. They have low fertility, low bulk density, and are (mostly) excessively drained. Soil temperature regimes are cold, and growing seasons are short. Killing frosts may occur any month of the year.

The watersheds contain diverse vegetative structures, including wet and dry meadows, hardwood, ponderosa pine, lodgepole pine, and mixed conifer stands. Composition and structure vary from even-aged, to multi-storied stands of single species, to those with several species represented. Most of the forested communities within the watershed have been entered for harvest activities. Grazing has occurred in most, if not all, riparian, meadow, and upland areas. Most harvest activities have taken place within the past 60 years.

Approximately 6.4 miles of roads per section were mapped using aerial photos for this watershed. The figure does not include associated skid roads and trails, but observation suggests the components represent approximately double the GIS transportation system road miles. The roads are represented in many stages of use, from main system to rustic. Though some have been closed and others obliterated, use continues where a route has been found to reach the original prism.

There are still remnants of grades, crossings, and spurs associated with rail and truck-to-rail logging that occurred in the watersheds Regardless whether roads or grades are being used, their presence on the landscape still affects soil resources and water flow A portion of the Sugarpine Administrative Road Closure Area is within the watershed

Habitat conditions affecting wildlife distribution in the watershed are primarily in early successional stages Distribution of late successional stages is poor, so they are not effective in meeting individual needs for late successional wildlife On private ownership within the watershed, most plant communities are in early successional stages - both forested and riparian

Boom/bust population cycles are occurring in early to mid-successional wildlife species. Populations of some species dependent on late successional plant communities are in decline. Big game populations have increased - except for mule deer, whose numbers appear to be declining. Elk populations within the watershed appear to be increasing.

Recreation is limited within the watershed, primarily due to an absence of fish bearing waters. The primary recreational activity is big game hunting. Dispersed camping sites occur in or adjacent to nearly all meadows and riparian areas, as well as in upland areas. Incidental sightseeing, snowmobiling, cross country skiing, hiking, and horse back riding probably occur within the watershed.

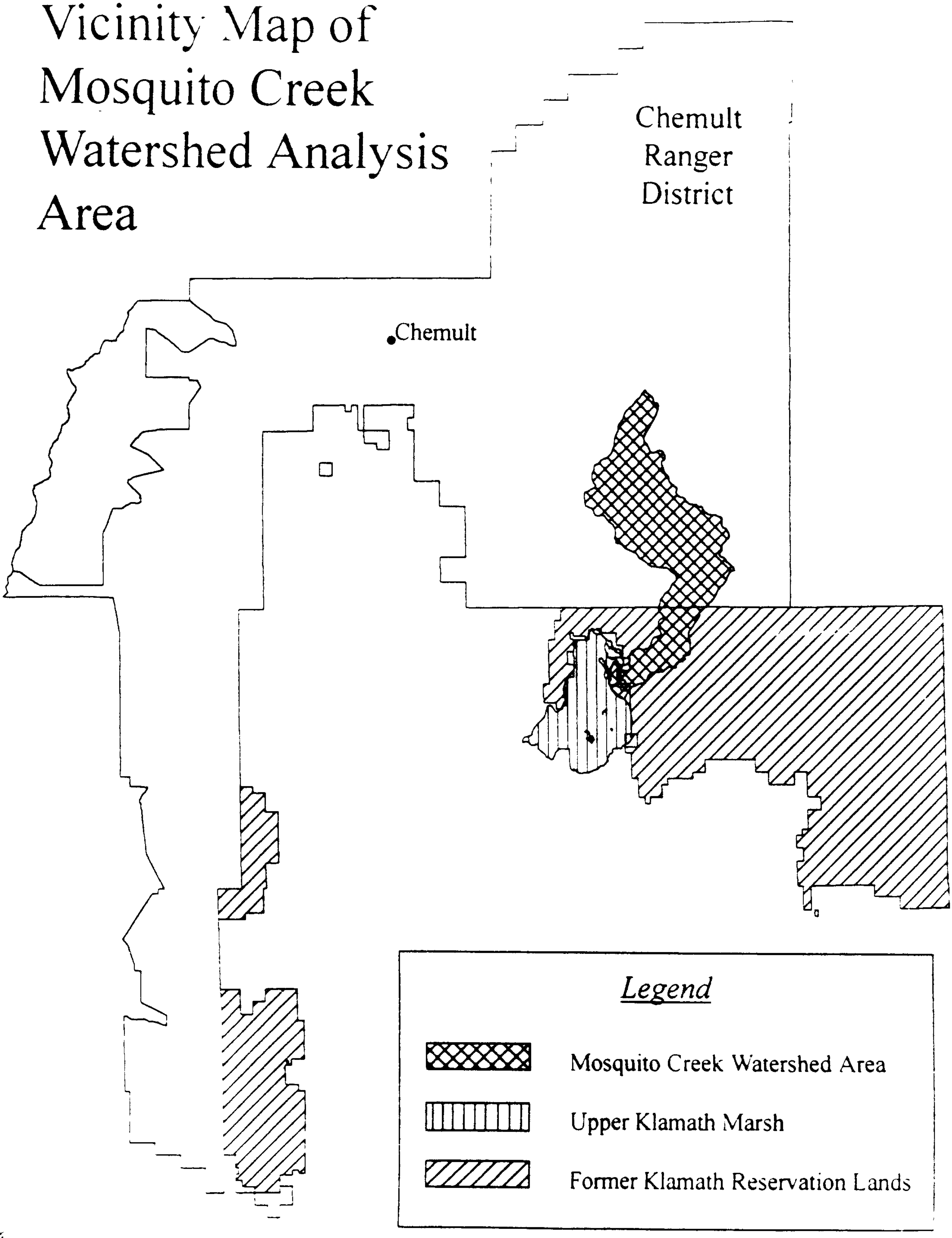
Members of The Klamath Tribes continue to use portions of the watershed for hunting, spiritual, and cultural activities. Most activities take place on former tribal lands, but some tribal members may pursue some of their activities anywhere within the watershed.

Six management areas and ownerships are identified in GIS. The designations, approximate size, and approximate percent of the watershed are:

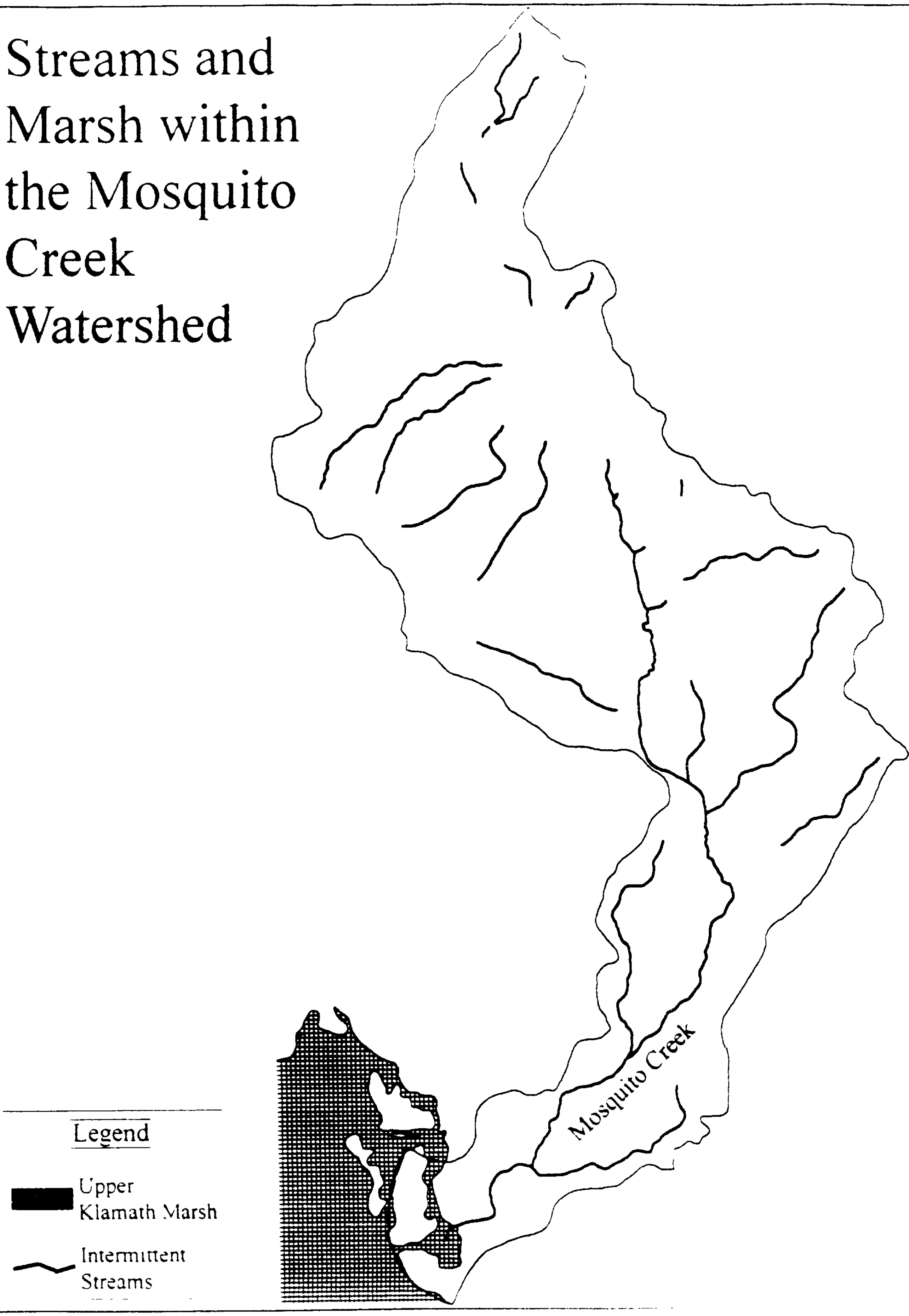
Designated Old Growth - 656 acres (4%).
Riparian Area - 2,179 acres (12%).
Bald Eagle Replacement Habitat - 92 acres (<1%).
Timber Production - 14,597 acres (81%).
Upper Williamson - 31 acres (<1%).
Private ownership - 455 acres (3%).

(There are 1,689 acres of inventoried old growth within the watershed.)

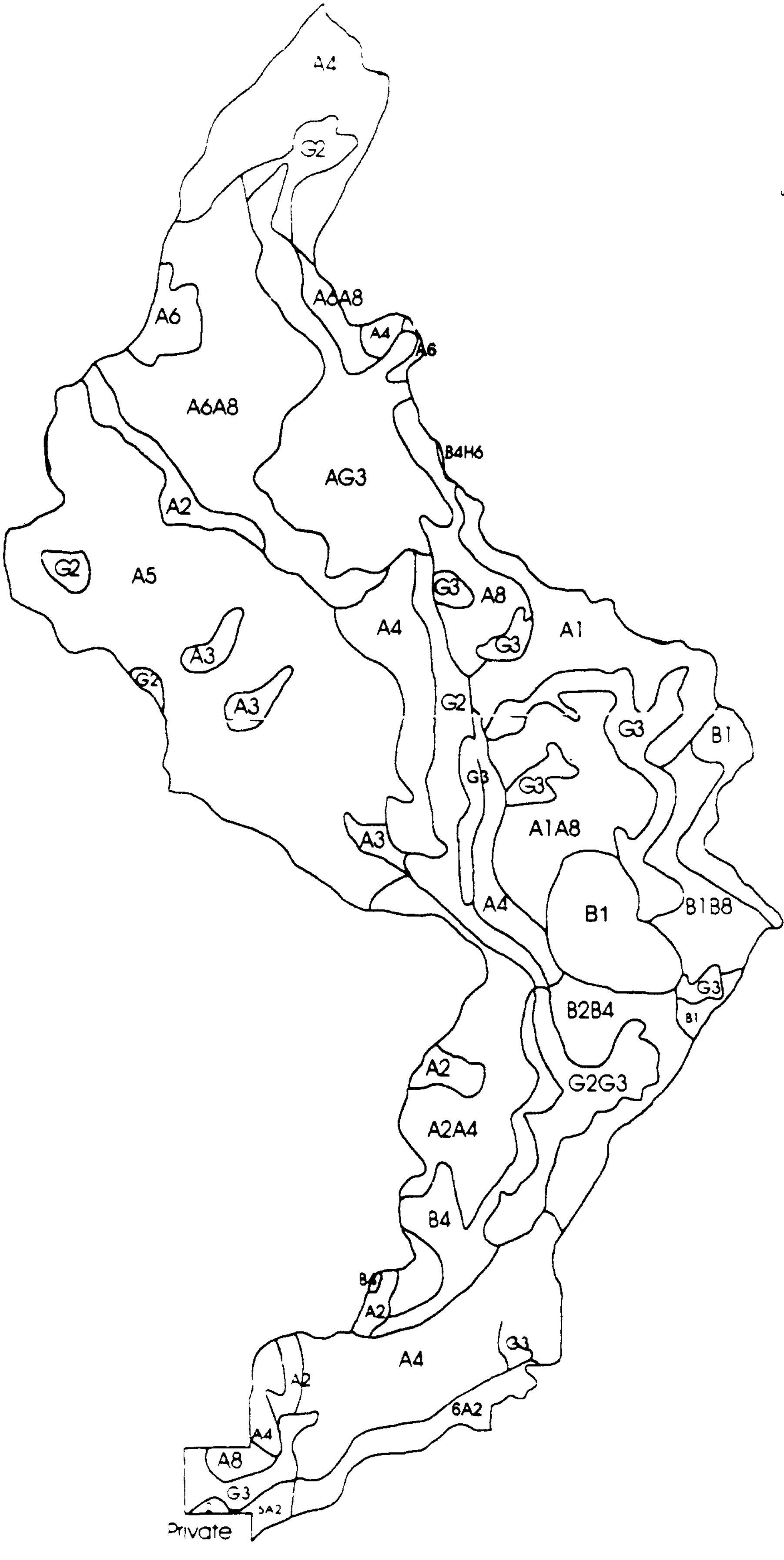
Vicinity Map of Mosquito Creek Watershed Analysis Area



Streams and Marsh within the Mosquito Creek Watershed



Soil Group Landtypes within the Mosquito Creek Watershed



Acres	
2	17
4B4	100
6A2	283
6A8	65
A1	747
A1A8	781
A2	421
A2A4	825
A3	203
A4	2864
A5	3310
A5B6	3
A6	161
A6A8	1657
A8	476
B1	800
B1B8	427
B2B4	529
B4	451
B4H6	4
G2	738
G2G3	464
G3	2227
H6	1

IV. Components of the Mosquito\Jack Creek Watersheds

This section will describe the present conditions for the various components which regulate the form, function, and processes of the ecosystem A comparison with what is believed to be past conditions is included , along with discussion on processes influencing the changes

A. Soils

Principle Functions

- **Surface storage of water** Precipitation is intercepted and stored on the surface in the duff/litter layers, and within the soil profile Water stored here (except snow) seldom remains long unless the soils are saturated. Water is released from this area through evaporation into the atmosphere, transpiration from vegetation, runoff as overland flow(a very minor amount), or infiltration through the soil matrix to deeper horizons

- **Storage of available nutrients** for plant uptake Most feeder roots grow in the upper 6-20 inches of the soil, so those layers are the most important for determining plant growth potential

Properties . . . . . (Effects are less pronounced when the soils are wet.)

- Pumice and ash parent material covers most of the watershed

- Excessively cellular

- Low bulk densities.

- High water holding capacities

- Thermal properties.

    Low heat storage within the soil profile.

    Slow heat transfer within the soil matrix.

    Large temperature responses at the soil surface to added heat.

    Shallow penetration of significant temperature variations.

    Lack of heat radiation from the soil at night.

Soils derived from pumice and ash may become **water repellant** when dry. **Fungal mycelia** may also cause soil **hydrophobia**, resulting in soil erosion through rapid runoff and overland flow. There is no indication of this occurring within the watershed.

Low clay and organic matter content causes very low aggregate stability. **When dry**, these soils are **easily displaced** by machine operations. With 70-80% of the (limited) nutrients found in the upper 8 inches of the soil profile, displacement can reduce site quality drastically

These soils often support sparse ground vegetation as a result of their **insulative qualities** Due to lack of heat penetration and storage, and an inability to re-radiate heat at night, surface air temperatures can be very cold **Frost heaving** often occurs when soils are wet to the surface and air temperatures drop below freezing Summer surface temperatures have been recorded in excess of 160 degrees F in the open Both extremes may be lethal to new seedlings

Our knowledge is limited regarding how **land use**, **terrain features**, and **other** factors **influence soil productivity**. Available information is limited to SRI data, a few brief visits to the area, and several studies performed on [illegible]r soils by the Pacific Northwest Research Station.

Compaction

The Chemult District is currently conducting a two year study (field seasons 1993 and 1994) related to soil compaction, erosion, displacement, and severely burned soils. The data is incomplete, but will be used to infer certain soil factors

- **Mass wasting** and **soil puddling** (except on exposed residual Group H soils) is not a factor affecting soil productivity within the watershed.

- **Soil Compaction** exists within the watershed. Detrimental soil compaction for ash/pumice soils is defined as an increase in bulk density of 20% or more over the undisturbed level (Win. LRMP 1990)

Monitoring done on 24 harvest units (about 3000 acres) in 1993 indicated **compaction** has occurred. This varied from less that 10% to greater than 50% of a given unit being severely compacted. Almost all units exceeded forest Standards and Guidelines for compaction (less than 20% detrimental impacts), when severe and moderate compaction classes were combined. Units that were monitored contained soils similar to those in the watersheds. The 1994 monitoring addressed about 12,000 acres, and was spread out over the entire ranger district. The data was very similar to that of 1993. Monitoring plans for the 1995 field season include several units within the Mosquito Creek Watershed.

To date, the most noticeable effects of compaction are:

- **Lack of vegetative growth** on compacted landings and skid trails.

- **Stunted and less vigorous** growth is exhibited in established vegetation on compacted soils This is different than what occurs on adjacent, non-compacted areas.

- **Sheet and rill erosion**, commonly associated with compacted soils, is evident on some compacted landings and skid trails .

- **J rooting** is exhibited in some excavated seedlings .

Erosion

Erosion is the detachment and movement of soil or rock fragments by running water, ice, or other geologic agent, including gravitational creep (ravel). The forest plan does not have an erosion standard and guideline, only a "Minimum Percent Effective Ground Cover" table. Erosion within project areas does not appear to be significant. Project areas containing steeper slopes (>30%) may exhibit more evidence of erosion.

There are three areas of concern when addressing erosion

- General project areas such as timber sales **Landings** and **skid trails** are major sources for eroding particles

- Constructed system **roads** and their maintenance

- Stream channel erosion - **downcutting** and **bank erosion**

Erosion and **sedimentation** from project areas within the watersheds are **minor** on slopes up to 20%, and slight on the steeper areas, relative to the road and channel erosion These observations are based on

- Survey of areas within the watershed discovered **little erosion**

- Erosion monitoring of similar soils and terrain adjacent to the watershed in 1993 indicated erosion was occurring on **less than 5% of the area** Similar information was gathered during 1994 monitoring.

- GIS data indicates **low overall slope gradients** within the watershed.

The following slope classes, approximate acreage, and percent of the watershed occupied, were developed using the GIS database:

Mosquito Creek Watershed

Percent Slope Class	Approx. Area Acres	Approx. % of watershed
<10	13,086	73
10-20	4,086	23
20-30	636	4
>30	21	<1

Jack Creek Watershed

Percent Slope Class	Approx. Area Acres	Approx. % of Watershed
<10	58,558	86
10-20	8,000	12
20-30	1,082	1.5
>30	150	<0.5

Infiltration and **permeability** capacities are **very high**. Low bulk density pumice soils have a very high proportion of macropores through which surface waters enter into the soil matrix. Due to the soils' high capacity to absorb water, natural geologic erosion rates are very low. Management practices that generate overland flow and accelerated erosion on other soils do not appear to adversely affect the pumice soils to a great extent.

Displacement

Detrimental **displacement** is the removal of more than 50 percent of the topsoil (or humus) A1 or AC horizons from an area of 100 sq ft or more, at least 5 feet in width Not only is this definition unwieldy, it is difficult to discern in the field How does one detect if 50% of the topsoil has been removed?

Multiple entries into an area tend to mask the previous entries The 1993 and 1994 monitoring indicate **very little detrimental displacement** has occurred, and is believed to hold true for thewatersheds

Potentially, soil displacement could greatly reduce site productivity. The majority of soil nutrient reserves are located in the upper 6 to 8 inches of the soil profile, and therefore subject to mechanical manipulation and loss Soil organic matter **displacement potential is high** during harvest operations. This could potentially affect site fertility.

Effects from Fire

Severely burned soils occur when the top layer of mineral soils is significantly changed in color, usually to a reddish color. The next 0.5 inch is blackened from organic matter being charred by heat conducted through the top layer.

Research specific to the Klamath Basin is lacking, but some research on soils has been completed in the pumice zone of central Oregon Soil productivity for conifers may have increased due to increased levels of organic matter in the soil and in the litter layer resulting from fire suppression (Cochran and Hopkins, 1990). Hypothesis suggests that increased levels of coarse woody debris, litter, and duff result in increased availability of water and nutrients to on-site and down slope vegetation. Prior to fire suppression, the fire return interval of 5 to 15 years (Kilgore, 1981; Bork, 1984; Morrow, 1985) prevented extensive accumulation of forest duff, litter, and coarse woody debris.

The **decomposition** of organic matter or necromass is an important function in forest ecosystems, providing much of the nutrient capital. Generally, ponderosa pine growth can be increased by application of nitrogen. Decomposition is accomplished through a diverse and complex association of bacterial microflora (both aerobic and anaerobic), and occurs within the litter and fermentation layers. Mineralization of nitrogen and decomposition of organic litter occurs slowly in cold, dry ecosystems, largely as a result of climatic constraints to microbial activity in place for a large portion of each year A large portion of the nitrogen compounds mineralized during decomposition are used by nitrifying organisms for respiration, reproduction, and growth. Slow decomposition and the absence of wild or prescribed fire allows litter in various stages of decomposition to accumulate on the forest floor.

Fire affects soils **directly**, through **physical, chemical**, and **biological** changes induced by heat pulses downward, and **indirectly** through it's effects on aboveground living vegetation and accumulations of dead organic debris. Fires (both wildfire and prescribed fire) vary greatly in **intensity** (rate of heat release) and **severity** (effects on ecosystem components, both biotic and abiotic). This variability is due to differences in fuels, weather, and topography and can arise temporally (changes by time of day or season that fire burns) or spatially (transitions from flat to slope or vice versa).
High intensity crown fires may severely impact soils when they consume all coarse woody debris, surface litter, and duff layers. The heat pulse into the soil may persist for many hours or days, particularly where coarse woody debris exists.

High fire intensity is not always associated with high fire severity. For example, a rapidly moving crown fire may also be a low severity fire if vegetation re-sprouts or recolonizes quickly and much of the litter and duff layers remain. Conversely, a low intensity, smoldering surface fire may be a high severity fire if it completely consumes most or all surface litter and duff, imparting a long-duration (many hours or days) heat pulse deep into the soil. Duration and intensity of the downward heat pulse (fire severity) is directly related to accumulations (and ultimate fire consumption) of coarse woody debris and duff depth.

Combustion of soil organic matter is the most important effect of fire on the **physical** properties of soils. As soil organic matter decreases (through combustion), bulk density increases (McNabb and Swanson, 1990), moisture holding capacity decreases (Neal, et al, 1965), infiltration rate decreases (Fuller et al., 1955), and a loss of structure results in increased erosion potential (Wells, 1979, Ahlgren and Ahlgren, 1960). Additionally, hydrophobic layers can be created which might result in an increase in mass wasting potential (DeBano, 19xx).

Soil organic matter is combusted only when surface fires burn accumulations of coarse woody debris and/or deep duff layers for a prolonged (several hours or more) period. Increased erosion potential may occur due to elimination of great amounts of protective living vegetation, litter, and duff cover even when soil organic matter is not consumed (Clark, 1994).

Fires that do not kill most of the living vegetative cover, nor burn for prolonged periods and consume coarse woody debris and deep duff layers (exposing large expanses of mineral soil), do not consume soil organic matter and consequently do not induce the effects described above (Boyer and Dell, 1980). Low severity fires that only partially consume coarse woody debris and duff may affect soils through chemical changes that can lead to an increase in flocculation and structural characteristics (Kimmins, 1987) which increase moisture holding capacity and infiltration rates.

Fire **effects on soil biology** range from negligible to complete sterilization and are related to fire severity (Harvey, et al, 1994). Effects may persist from a few days to many years (Woodmansee and Wallach, 1981), and again are related to fire severity. Effects may be **direct** (where organisms are killed outright by the heat pulse); or **indirect**, where the soil environment becomes unfavorable for the organisms.

Generally, those organisms that dwell in the duff, litter, and coarse woody debris experience high levels of heat-induced mortality with even low severity surface fires. However, these populations usually return to pre-fire levels within a few years where unburned islands, or layers of unburned duff exist (Kimmins, 1987). High severity fires that consume much of the coarse woody debris and duff layer may cause complete mortality of bacterial and fungal soil populations. Rapid invasion by wind, rain, adjacent area populations, and lower soil horizon populations oftentimes return microbial biomass to pre-fire or higher levels (Jalaluddin, 1968; Wells, et al, 1979; Harvey, et al, 1976; Bissett and Parkinson, 1980). Populations are commonly reduced only until the first rainfall (then increase) and species composition is altered (Ahlgren and Ahlgren, 1965).

In both watersheds, **mycorrhizae fungi** and **nitrogen-fixing bacteria** are important soil organisms that can be affected by fire. Fire can affect mycorrhizae in two ways - by killing the fungus outright; or by killing the host, which eventually kills the fungus. Fires that produce total mortality of host species can markedly reduce mycorrhizae density.

In low to moderate severity burns, rapid re-vegetation by appropriate host species can prevent or limit decline (Borchers and Perry, 1990). Nitrogen-fixing bacteria tend to increase following burns of low to moderate severity due to increases in pH (Vance, et al, 1983).

Some **host-pathogen relationships** can be altered by fire. For example, occurrence of *Heterobasidion annosus*, a root rot fungus present in the watersheds, has been reduced where fires have occurred (Wells, et al, 1979).

There are several **chemical changes** induced by fire that significantly affect soil properties Fire will likely increase pH (Grier, 1975, Chandler, et al, 1983), leading to a more favorable environment for decomposition and mineralization of organic nutrients, and a more favorable environment for nitrogen fixing bacteria (Covington and Sackett, 1990, White, 1985) Cation Exchange Capacity (a measure of the ability of soil to retain nutrients leached from ash) decreases to the extent that soil organic matter decreases (Harvey, et al, 1994) Soil nutrient abundance and forms change as a result of fire (Kauffman, et al, 1992)

Fire-induced soil changes (physical, biological, and chemical) can generally be managed by controlling the severity of fires Fires that remove most or all litter and duff, plus high proportions of the soil organic layer, generally reduce long term soil productivity. Fires that leave some amount of litter, duff, and most of the soil organic layer, will usually have positive effects on long term soil productivity (Wells, et al, 1979). Burning accumulations of coarse woody debris and/or deep duff layers during dry conditions (mid-summer wildfire season) invariably causes degradation of site potential. Carefully planned prescribed burning during more moist conditions can reduce fire hazard without reducing productivity (McNabb and Cromack, 1990).

The 1993 monitoring found little area (<1%) considered as severely burned. Occasionally, soils under a burn pile appeared to meet the definition. It is uncertain whether the definition is adequate for identifying areas where damage has occurred in large-area slash burns. This is especially true when using the definition to identify areas where burning may affect the soils, nutrient reserves, and residual organic matter. Severely burned soils do not appear to be a major concern within the watershed, according to 1994 monitoring.

Descriptions of Soil and Landtype Groups

The following information was derived primarily from the *Soil Resource Inventory* (SRI) for the Winema National Forest

A Group Soils landtypes and complexes are the major occurrence across the watershed Minor differences in horizon thickness, gravel content, and soil depth exist The pumice and ash layer over the buried soil is greater than 40 inches

Litter layer - 0 5-3 inches thick, covers 50-80% of the soil surface.

A1 Horizon - 2-6 inches thick; Gravelly, loamy sand; weak, fine granular structure. Non-sticky, non-plastic. 15-35% pumice gravel; slightly acid (pH 6 3).

AC Horizon - 6-12 inches thick; very gravelly loamy coarse sand texture; single-grained to massive structure; non-sticky, non-plastic (soft and very friable); 35-50% pumice gravel; slightly acid (pH 6 5).

C Horizon - 30-40 inches thick; very gravelly coarse sand texture; single-grained, loose structure, non-sticky, non-plastic; 50-85% pumice gravel; slightly acid-neutral (pH 6.7-7 0)

II B Horizon - A buried soil horizon at a depth greater than 40 inches; very gravelly, cobble loam texture.

Features and qualities

Drainage class - Excessively drained.

Infiltration class - rapid (undisturbed conditions) .

Permeability - Very rapid (> 20 inches/hour).

Bulk density - 0.5-0.7 grams/ cubic centimeter.

Natural fertility - Low (70-80% of total soil nutrient reserves in the upper 6 inches)

Interpretations

Sediment yield - Low.

Mixing and displacement hazard - High.

Detrimental compaction hazard - Low (monitoring shows these do compact).

Natural stability - Very stable.

B Group soils are very similar to A Group soils The primary difference is the depth of the pumice and ash layer over the buried soil, between 20-40 inches

Litter layer - 0 5-3 inches thick, covers 40-75% of the soil surface

A1 Horizon - 2-6 inches thick, gravelly to very gravelly loamy coarse sand texture, massive structure, non-sticky, non-plastic (soft and very friable), 15-35% pumice gravel content, slightly acid (pH 6 3)

AC Horizon - 4-14 inches thick, gravelly to very gravelly loamy coarse sand texture; massive structure; non-sticky and non-plastic (soft and very friable); 10-75% pumice gravel content; slightly acid (pH 6 5).

C Horizon - 10-30 inches thick; coarse sand to very gravelly coarse sand texture; single-grained to massive structure; non-sticky and non-plastic (soft and very friable), 10-75% pumice gravel; slightly acid to neutral (pH 6 5-6 8)

IIB Horizon - A buried soil; 26 to 60 inches thick to bedrock; very cobbly sandy loam texture, massive structure, non-sticky, non-plastic (soft to slightly hard and friable); 25 to 50% gravel and cobble, Neutral (ph 6 9).

Features and qualities;

Drainage class - Excessively drained.

Infiltration class - Rapid except when water repellant (hydrophobic).

Permeability - Very rapid (> 20 inches per hour)

Natural bulk density - 0 5-0.7 grams/cubic centimeter.

Natural fertility - Low (70-80% of reserve soil nutrients in upper 6 inches).

Interpretations:

Sediment yield - Low.

Potential for high surface soil temperatures - High.

Displacement and mixing hazard - High.

Detrimental compaction hazard - Low.

Natural stability - Very stable.

G Group soils and landtypes occur in valley bottoms and concave drainages Most of the pumice and ash material has been reworked by water Water tables are commonly at or near the surface in the spring and at various depths during summer and autumn

Litter layer - 0 5-3 inches thick, 60-100% of the soil surface is covered

A1 Horizon - 2-6 inches thick, gravelly loamy coarse sand to loam textures, weak, fine granular to crumbly structure, slightly sticky, slightly plastic, very friable, 5-20% pumice gravel, slightly acid (pH 6 4)

AC Horizon - 4-10 inches thick; sandy loam to gravelly loamy coarse sand texture, weak, fine crumb structure; non-sticky and non-plastic; very friable; 10-35% to pumice gravel, moderately to slightly acid (pH 6.0-6.4)

C Horizon - 10-24 inches thick; very gravelly loam sandy or coarse sand texture, massive structure, non-sticky and non-plastic; 25-60% pumice gravel; slightly acid to neutral (pH 6 4-6 8).

II B horizon - Buried soil, 20-30 inches thick; gravelly and cobbly loams.

Features and qualities

Drainage class - Somewhat poor to poorly drained.

Infiltration class - Rapid.

Permeability - Rapid (6-20 inches per hour).

Bulk Density - 0 55-0.70 g/cc

Natural fertility - Low to moderate.

Interpretations

Sediment Yield - Low.

Displacement and mixing hazard - Moderate.

Detrimental compaction hazard - Moderate.

Natural stability - Very stable.

H Group soils are derived from the andesites, basalts, and breccias mixed with volcanic ash and pumice These are the buried soils found under Soil Groups A, B, and G These soils are generally exposed by erosion of the ash and pumice Depth to bedrock is 30-72 inches

Litter layer - 0 5-3 inches thick, covers 50-80% of the soil surface

A1 Horizon - 4-8 inches thick, gravelly and cobble loams, sandy loams and coarse sandy loams textures, weak, fine crumb to weak, fine to medium subangular blocky structure, slightly sticky and slightly plastic, 15-35% gravel, 10-30% cobble and 0-30% stone coarse fragments, slightly acid (pH 6.4)

B Horizons - 10-36 inches thick; very gravelly and cobble loams, sandy loams and clay loams textures; weak to moderate, fine subangular blocky structure, slightly sticky and slightly plastic to sticky and plastic, 20-40% cobble and 0-40% stone coarse fragments, slightly acid (pH 6 4)

C Horizons - 12-30 inches thick; very gravelly and very cobble loamy coarse sand texture; massive structure, non-structure; non-sticky and non-sticky; 15-35% gravel, 20-35% cobble and stone; slightly acid (pH 6.3)

Features and qualities:

Drainage class - Well drained.

Infiltration class - Moderate to rapid

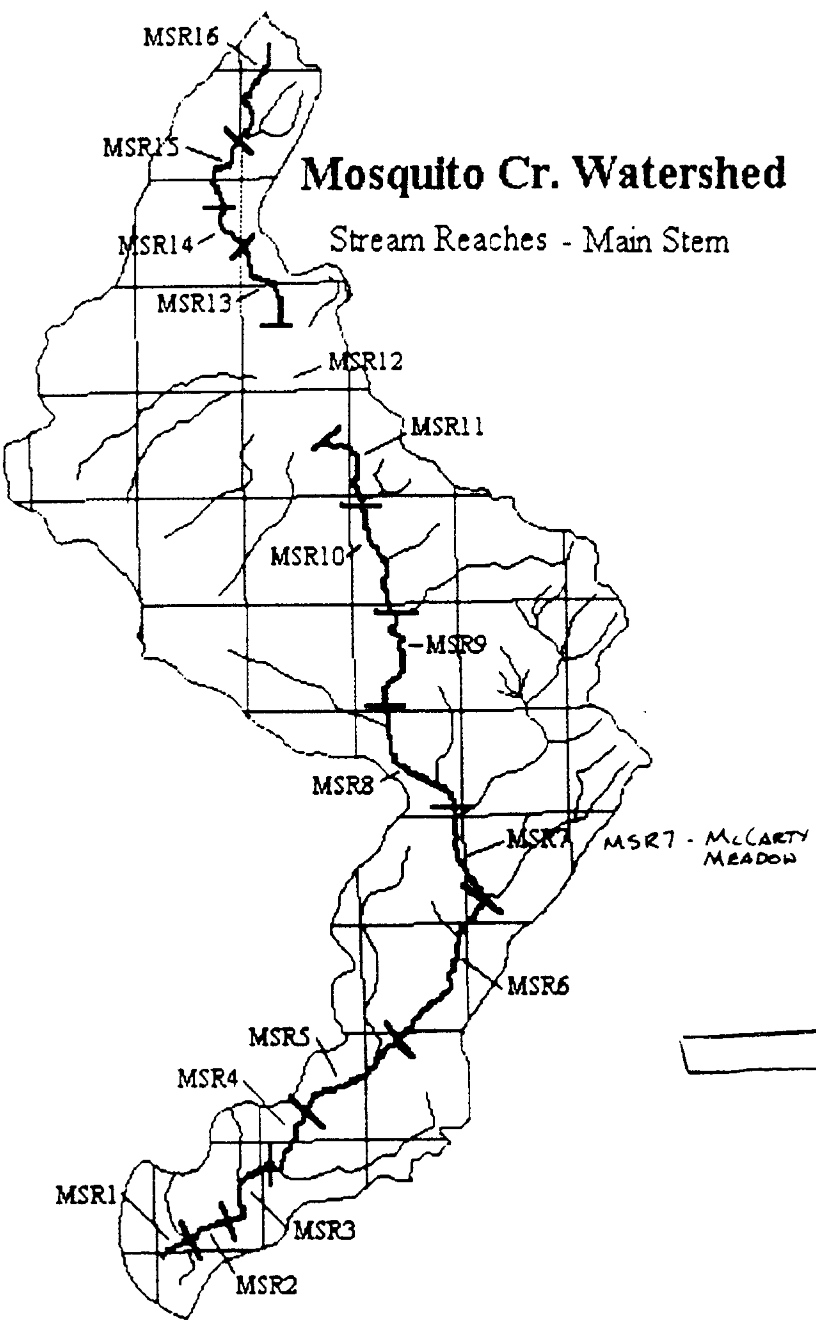
Permeability class - Moderate to rapid (2-20 inches per hour).

Bulk density - 0.75-1.0 g/cc.

Natural fertility - Moderate.

B. Water

The Mosquito Creek Watershed is located in Townships 27, 28, and 29 South in Ranges 9 and 10 East on the Winema National Forest The Watershed is a narrow (<5 miles wide) drainage on the northeast boundary of the Klamath Marsh The Mosquito Creek channel runs north from the confluence with the Marsh approximately 14 miles The watershed encompass 18,014 acres all except 453 acres are within the boundary of the Winema National Forest The elevation at the mouth of the Watershed is 4,518 feet with the highest point located on the western boundary of the Watershed at the summit of Sugarpine Mountain (6,393 feet) The elevation at the headwaters of Mosquito Creek is 5,310 feet Mosquito Creek drops 792 feet over its approximate 14 mile length



Approximately 42 miles of stream reaches have been identified for this analysis. This offers a low stream density of only 1 5 miles of stream per square mile of watershed. These are the well defined intermittent and ephemeral channel. Other channel segments would likely be identified in a comprehensive field review. These additional channels would not change the characterization of the Watershed as having a low stream density

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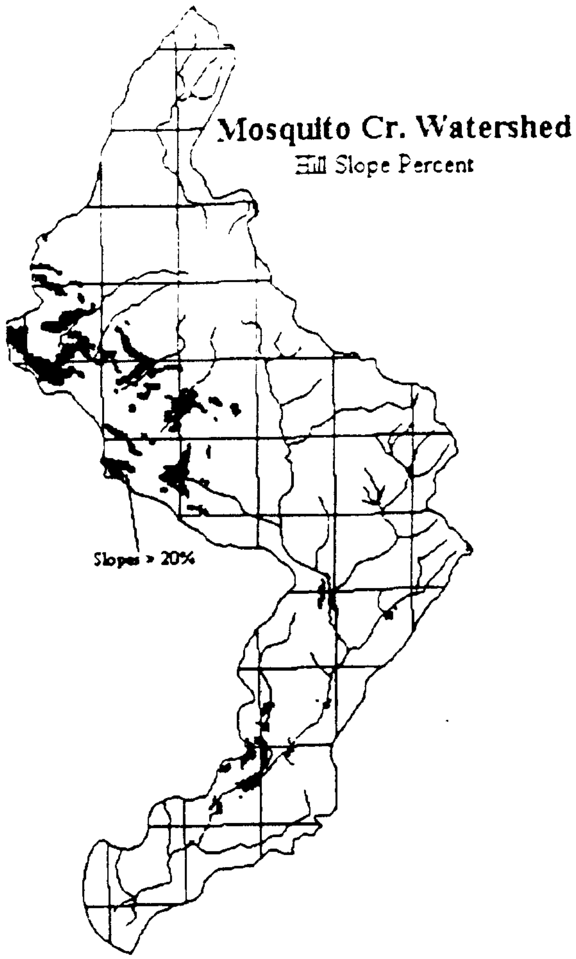
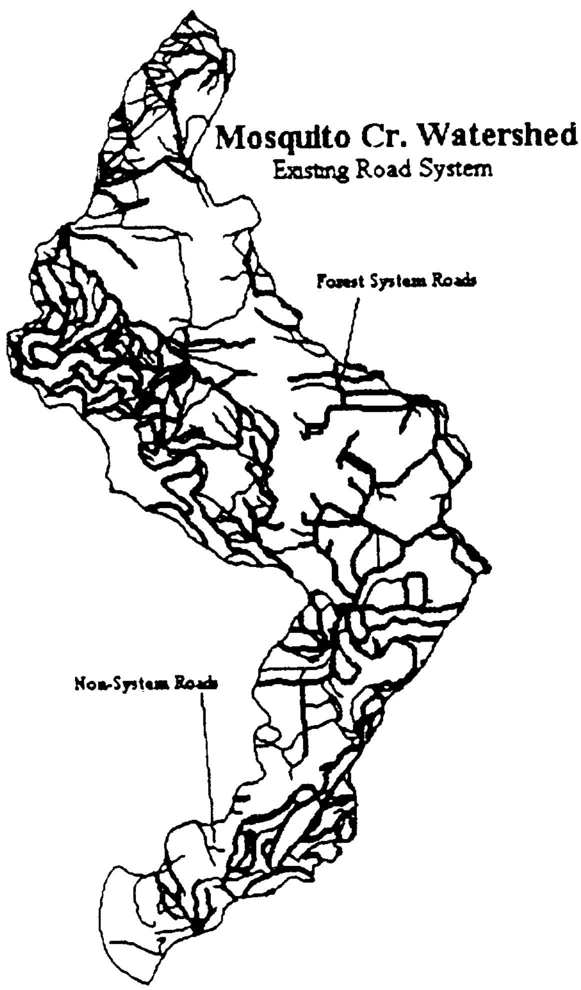


GIS slope data and field observations indicate low overall ground slopes; 73% of the watershed has general slopes less than 10%, 23% of the watershed is between 10% and 20% slope, and less than 5% of the watershed has slopes greater than 20%. Ground slopes greater that 40% are rare. The Watershed has been heavily roaded in the past. Winema GIS road data show 108 miles of Forest system roads within the Watershed.



This is equal to 3.8 miles of road per square mile of watershed. Aerial photographic interpretation has identified an additional 68 miles of non-system roads and historic railroad grades. This increases the density of transportation facilities to over 6 miles per square mile of land area.

Precipitation:

Precipitation falls mostly in the form of snow during the months of November to February (see Figure 1) It is not uncommon for rain to occur on the snow pack during the winter months Occasionally this can be an extreme event such as took place in December of 1964 where nearly 15 inches (14 71 in) of precipitation fell in the month of December at the Chemult weather station. Other one month high precipitation values occurred in December 1942 (12 32 in), December 1955 (9 91 in), January 1970 (10 06 in), November 1973 (11 94 in), and December 1981 (10 76 in.). Infrequent summer thunder storms can also produce localized intense rain fall

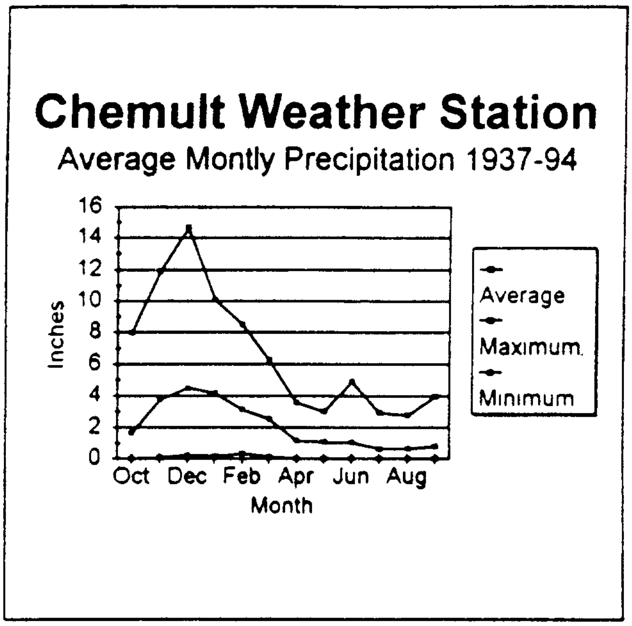


Figure 1 displays the average monthly precipitation at Chemult over the period 1937 to 1994 as well as maximum and minimum values.

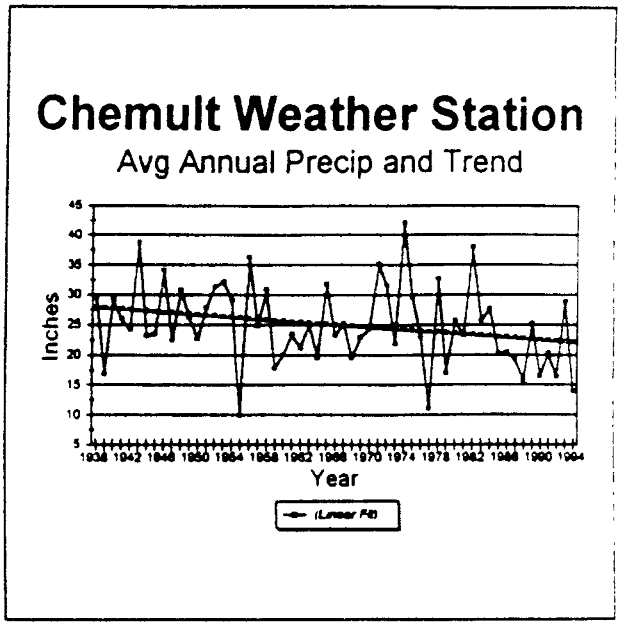


Figure 2 shows the fluctuations in average annual precipitation over the same time period with a calculated linear trend.

*SCS Centralized Database System (CDBS)

The Chemult, Or. Weather Station is located 10 mile to the north and west of Mosquito Creek at an elevation of 4,760 feet. Because of its location and elevation, this station is expected to indicate the general precipitation amounts and timing in Mosquito Creek drainage and is used in this analysis. The Chemult Station shows a high degree of variability in precipitation amounts from year to year with an average of 25.14 inches of water equivalent between the years 1937 and 1994. The high year is 1974 @ 42.02 inches and the low year 1955 @ 9.80 inches.

Geology:

The rock formations underlying the Mosquito Creek watershed are all volcanic in origin The major volcanic activity is thought to have ceased prior to the advent of Pleistocene glaciation The majority of the watershed is underlain by basaltic flows built up during multiple eruptive events The exceptions to this are Sugar Pine Mt which is a major basaltic eruptive center (volcano)and God Butte an eroded Cinder Cone

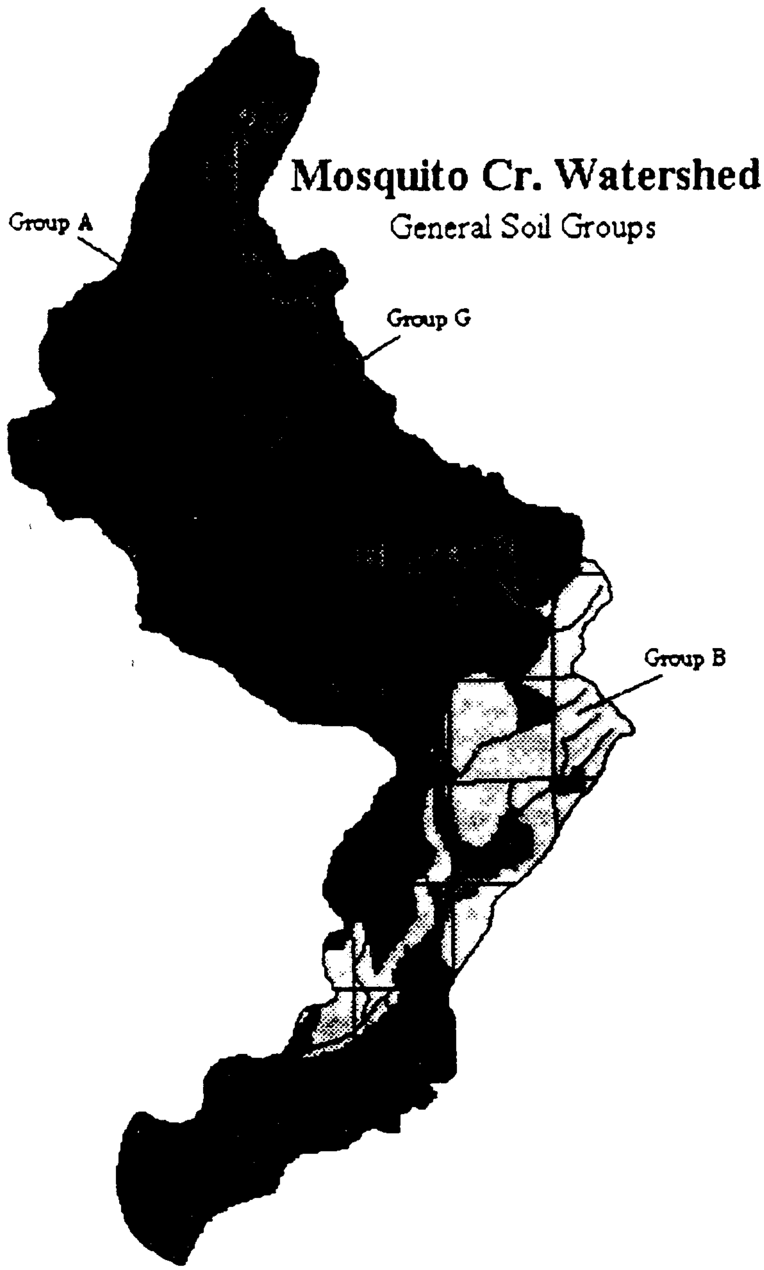
All of the underlying rock formations have been covered by pumice deposited from the eruptions of Mt Mazama approximately 7,000 years ago The depth of the pumice is variable but is generally in the range of 5 to 10+ feet (State of Oregon 1970) The basalt flow material is exposed in short reaches of Mosquito Creek where channel activity has remove the pumice overburden.

The general form of the watershed is controlled by the basaltic parent material and the orientations of the individual flows and eruptive centers Erosion activity deposited the easily eroded pumice material in the valley bottoms between basaltic reefs to form sediment basins These basins support riparian and meadow plant communities of various widths adjacent to the stream channels. These areas likely function as storage basins for ground water. The most significant example of this is Jackies Thicket. A large (600+ acres) basin near the headwaters of Mosquito Creek. I believe this area could have been a lake prior to the eruption of Mt. Mazama which filled the lake basin with pumice to the point that surface water is only present during rapid snow melt in the spring. No obvious stream channel is present in this portion of Mosquito Creek. I believe this basin functions as a ground water storage area, as do other low gradient (<0 5%) sections of Mosquito Creek, releasing water to the steeper channel reaches down stream.

Soils:
The soils in the Watershed have very high infiltration and permeability capacities. The low bulk density pumice soils have a very high proportion of macropores through which surface waters enter into the soil matrix. Relative to other areas, the Chemult Ranger District has very few perennial streams. Due to the soils high capacity to absorb water, natural geologic erosion rates are very low and management practices that generate overland flow and accelerated erosion on other soils do not appear to adversely affect the pumice soils to a great extent (Winema NF SRI 1979 & personal communications, Jim Cassidy).

Soils are of three general types: Soil Group A (66% of Watershed), Soil Group B (12%), and Soil Group G (22%).

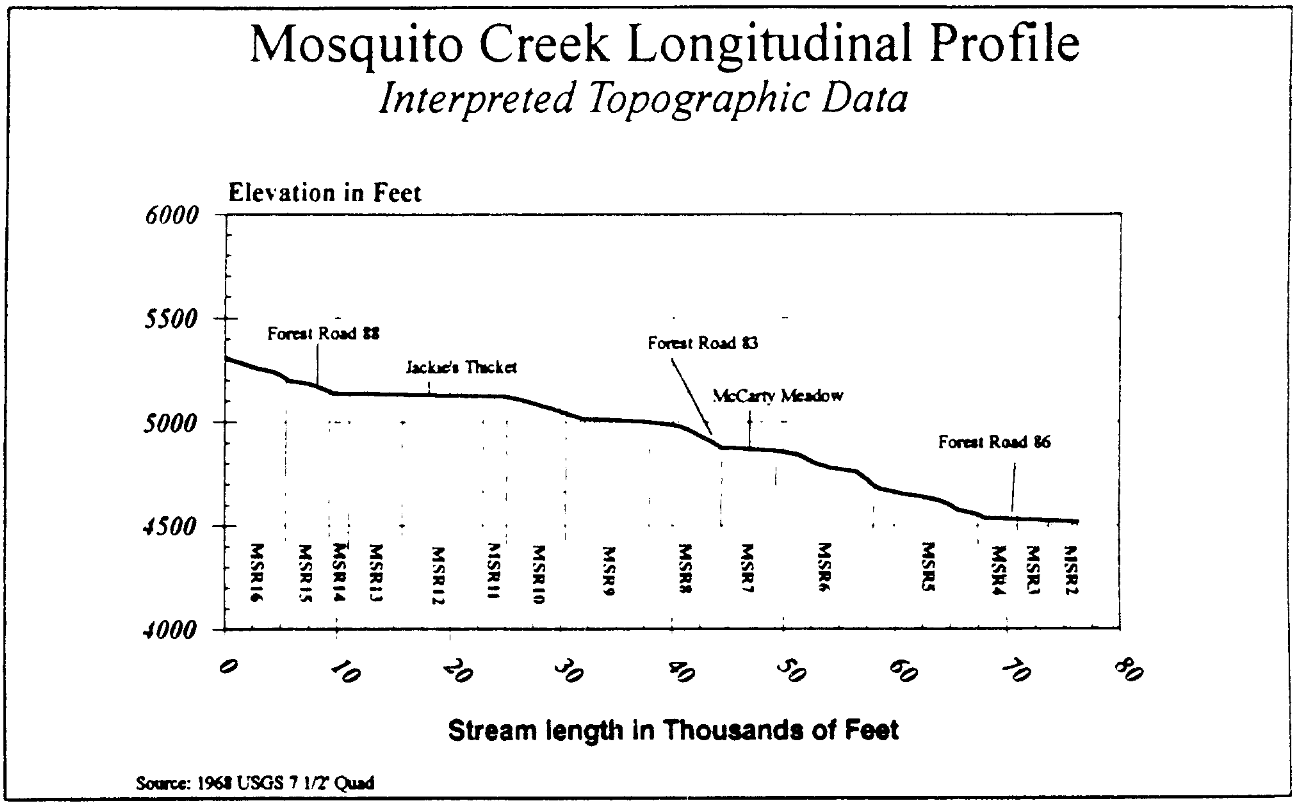
Although, these soils have been interpreted as having low sediment yields and are considered very stable their low bulk densities and lack of clay content make them very susceptible to erosion by any concentration of surface water flows. This includes concentration of storm runoff in road ditches and in streams where bank stabilizing vegetation has been removed.



Soil groups A and B (upland soils) are very similar in their relationship to hydrologic function. They are excessively drained, have rapid infiltration rates, low bulk densities, have low sediment yields, and are classed as naturally very stable (Winema SRI 1979). Soil group G (valley bottom soils) are poorly drained, have rapid infiltration rates, low bulk densities, are rated as low for sediment yield, and are also considered as very stable.

Mosquito Creek Channel:

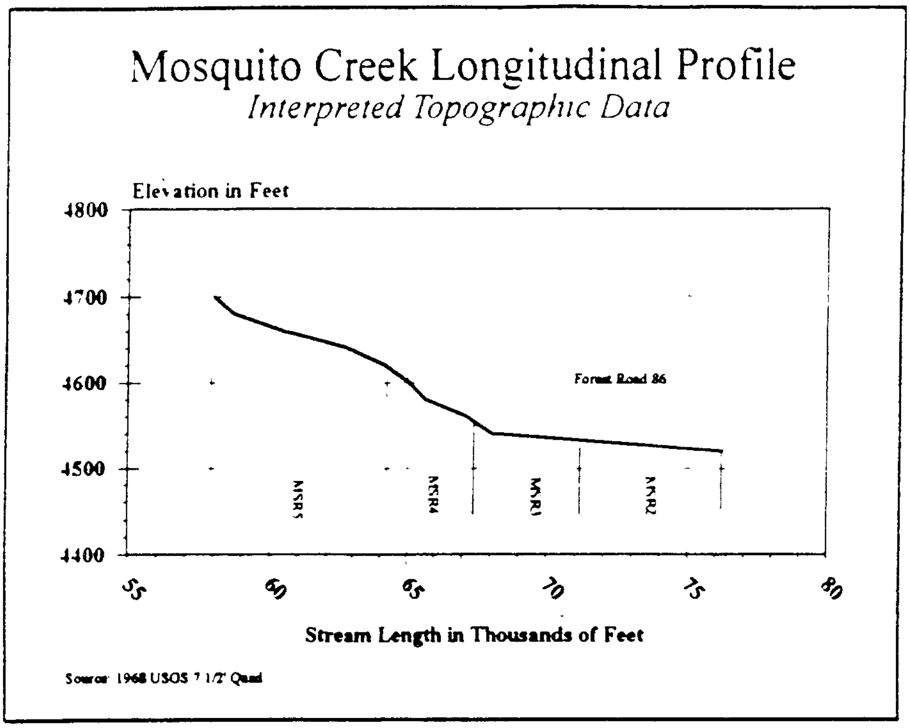
For purposes of the Mosquito Creek Watershed Analysis, the main steam of Mosquito Creek was divided into 16 separate reaches Reach "MSR1" located at the mouth of the system and reach "MSR16" located at the headwaters above Huckleberry Springs Thirty tributary stream reaches were also identified, however, the scope of this analysis is limited to the main stem of Mosquito Creek



Interpreted topographic data from 1968 USGS 7 1/2' quadrangles shows Mosquito Creek to have an overall gradient of approximately 1%. Interpretation of topographic map data will tend to over estimate the actual channel slopes; therefore, all gradients presented in this analysis may be considered as the maximum values. The longitudinal profile of the Mosquito channel shows that steeper channel segments are broken by flatter segments. Often these flatter segments are associated with the grassy meadow plant communities such as Little Round Meadow, McCarty Meadow, and the meadow at the mouth of the watershed. In some of the flatter segments no actual channel has formed such as in Jackies Thicket The steeper section of the lower channel, below McCarty Meadow, have channel segments lined with large (1-2 foot in diameter) basalt boulders.

Long term stream flow data for Mosquito Creek is not available; however, four flows have been measured in the 1995 water year Two flows in reach MSR8 at the Forest Road 83 channel crossing, one on Feb. 23, 1995 of <1cfs (this flow went underground less than 1/4 mile down stream) and one on March 30, 1995 of 5.9cfs. Two flows were also taken at the boarder between MSR2 and MSR3 at the Forest Road 86 channel crossing; one on Feb. 23, 1995 with no flow present and one on March 30, 1995 with a flow of 10.3cfs. Observations of stream bank condition and reports from other team members on an earlier visit indicate the flows recorded on March 30 at the Forest Road 86 crossing were shortly (2-3 days) after a peak flow event.

Reaches MSR1(0 28miles), MSR2 (0 45miles), and MSR3(0 70)



The reach lengths in miles displayed above were summarized from a data base developed for the Mosquito Creek Watershed analysis This data base represents Watershed as contiguous 1/2 acre cells coded with various attributes derived from Winema GIS data All reach lengths in this analysis are likely to under represent the actual reach length. However, all length will be relative and suitable for this assessment.

These reaches are described in the 1993 Watershed Improvement Needs (WIN) inventory as; "Channel is downcutting, mainly in those areas where the creek makes sharp bends. The depth of the channel is between 4' - 5' with a width of 20' - 25'. The affected length is all of Mosquito Creek within section 24 both above and below road number 86; approximately 5,000'." The lower three reaches of Mosquito Creek are low gradient (<0.3%). From field observation it is estimated that these reaches are entrenched channels, with low width/depth ratios (approximately 5) , moderate sinuosity (estimated), and sand or gravel channel materials. This would classify as "G4c or G5c" channel in the Rosgen Stream Type (RST) system. These types of channels are classed as extremely sensitive to disturbance (including increases in stream flow magnitude and timing, and/or sediment increases), have very poor recovery potential (natural recovery after the destabilizing effect has been mitigated), very high sediment supply, very high stream bank erosion potential, and high vegetation controlling influence (channel stability relies heavily on continuous streambank vegetation).

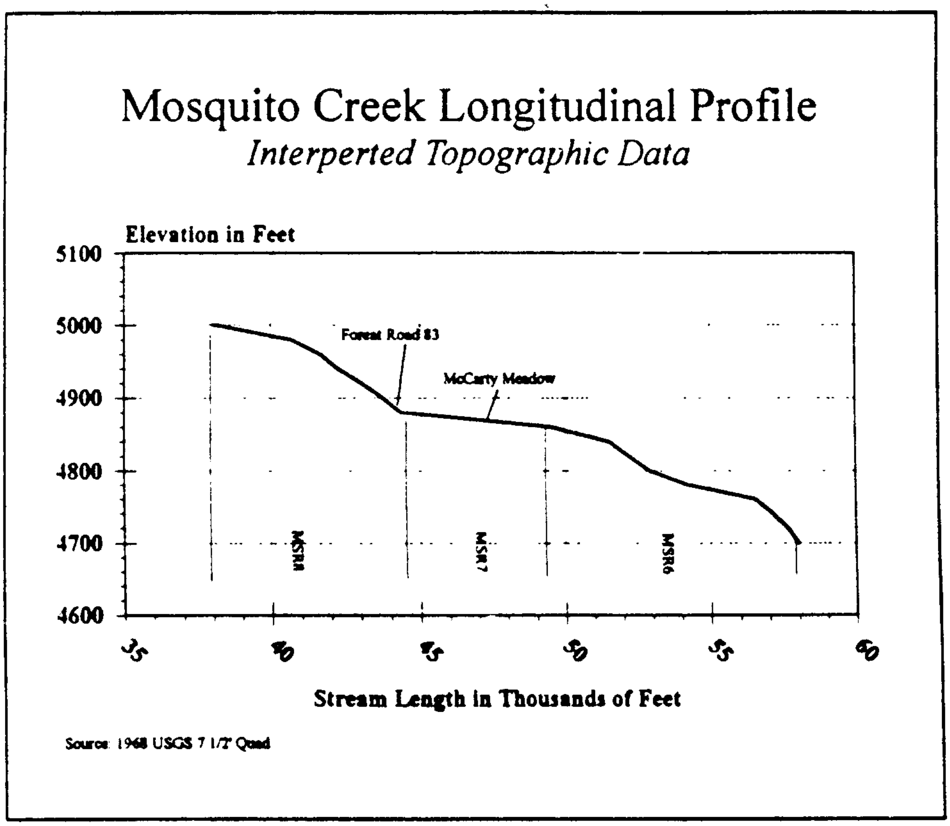
Reach MSR1 is a wide (>50foot) gully in a grass meadow which appears to flow from the beginning of the reach back toward reach MSR2. This channel is separated from reach MSR2 by a man made structure (dam). The current Mosquito Creek flows have been diverted at this point onto an existing road (tributary T1). Flows on March 30, 1995 used the road prism for a channel for approximately 1/2 mile and then breached the road bank and flowed out over the meadow.

Road information used in this analysis is obtained from the Winema GIS data base. These roads are part of the Forest's maintained road system. In addition to these roads, historic roads and railroad grades are photo interpreted from 1988 aerial photos of the watershed. The road statistics displayed in this analysis are summarized from the Watershed data base which represents roads as a series of contiguous 1/2 acre cells. Where a cell contains both a road and a stream, this may mean the road crosses the stream or parallels the stream within 100 feet or less or both.

Reach MSR2 runs through a forested area of small saw sized ponderosa pine and lodgepole pine trees (Winema GIS data base of PMR vegetation). Downed woody debris in this reach of the channel is common (field observations) There are two system road occurrences and five non-system roads identified in the same data base cell as the stream for this reach of Mosquito Creek.
MSR3 also runs through a forested area of small saw sized ponderosa pine and lodgepole pine trees with a 1/4 mile segment classified as pole sized aspen trees. Evidence of previous beaver activity (10 to 20 years old) was observed in the Aspen segment of this reach in 1994 and 1995. Existing beaver dams were not observed, however, downed trees and other sign were apparent.

A stable channel condition (the likely channel condition before downcutting occurred) in Reaches MSR1 - MSR3 would be a slightly entrenched channel, with a moderate width-depth ratio and a high sinuosity (> 1.4). This would classify as a C4 or C5 channel (RST). C4 and C5 channels have a very high sensitivity to disturbance, fair to good recovery potential, high to very high sediment supply, and very high streambank erosion potential. The current channel is tending towards the C4 - C5 channel type by increasing it's overall width, developing point bars (the primary flood plain and energy dissipation feature of "C" channels) and increasing sinuosity. Channel stability will require establishment of deep-rooted vegetation such as willows, sedges, and other bank armoring.

Reaches MSR4 (0.56miles), MSR5 (0.98miles), and MSR6(1.34miles)



This series of reaches runs through pumice sediment and sections of basalt boulders in an incised canyon with basalt outcrops common on the canyon walls.

A portion (roughly half) of MSR5 is described in the 1993 WIN inventory as; "Channel has eroded away from original course. Downcutting is 6'-7' deep and the average width is approximately 30'. The flood plain varies in width from 75'-200', with the average being about 150'. Grass is growing on the floodplain and in the channel. The old flood plain has many old beaver trees, but no Aspen are growing now Approximate-affected length is 2600'.".

A portion (roughly 1/3) of MSR6 is also described in the WIN inventory as, "Stream is downcutting bank to a depth of 3'-4' Channel has vegetation growing in it Width of flood plain is approximately 100' Affected length = 2500 feet " The maximum gradient varies between 1 to 1 5% in the pumice sediments, and up to 4% in the boulder sections The boulder sections are moderately entrenched channels, with moderate width/depth ratios, moderate sinuosity (estimated), and boulder and cobble channel materials This would classify as "B2 or B3" channels (RST) These types of channels are classified as very low to low sensitivity to disturbance, have excellent recovery potential, very low to low sediment supply, very low to low stream bank erosion potential, and negligible to moderate vegetation controlling influence

In the pumice sediments, several channel forms are represented Approximately 1,000 feet of channel is slightly entrenched, with low width-depth ratios and high sinuosity. This segment classifies as an "E4 or E5" (RST). These types of channels are classified as very high sensitivity to disturbance, have good recovery potential, moderate sediment supply, high stream bank erosion potential, and very high vegetation controlling influence. The remainder of these segments are entrenched with low to high width-depth ratios and moderate to high sinuosity. These segments will classify as either "F4-5 or G4-5" (RST) These types of channels are classified as very high to extreme sensitivity to disturbance, have poor to very poor recovery potential, very high sediment supply, very high stream bank erosion potential, and moderate to high vegetation controlling influence

Reach MSR4 runs through a forested area of pole and small saw sized ponderosa pine and lodgepole pine trees (Winema GIS data base of PMR vegetation). There is one system road occurrences in the same data base cell as the stream for this reach of Mosquito Creek.

MSR5 also runs through a forested area of pole and small saw sized ponderosa pine and lodgepole pine trees. Evidence of previous beaver activity was observed in a segment of this reach as noted in the 1993 WIN inventory Beaver dams were not observed; however, all aspen trees had been felled by beaver, and other sign were apparent Field observations identified segments of an abandoned "E5" channel in this reach (this is assumed to be the channel form before downcutting occurred). One non-system road was identified as occurring in the same data base cell as the stream channel in this reach of Mosquito Creek

MSR6 runs through a forest area of pole and small saw sized ponderosa pine and lodgepole pine r trees with a 500 foot segment identified as pole sized aspen trees. No evidence of Beaver use in this area has been reported in the WIN inventory. One non-system road was identified in the same data base cell as this stream reach.

The "B2 and B3" channel segments in reaches MSR4 and MSR6 are currently in stable condition.

A stable channel condition in the "G4-5 and F4-5" segments in Reach MSR5 would be a slightly entrenched channel, with a moderate width-depth ratio and a high sinuosity (> 1.4). This would classify as a C4 or C5 channel (RST). C4 and C5 channels have a very high sensitivity to disturbance, fair to good recovery potential, high to very high sediment supply, and very high streambank erosion potential. The current "F" channel segments are well along in this transition to the C4 - C5 channel type by developing point bars, increasing sinuosity, and establishing sedges on the new channel banks and flood plains. Channel stability for the "G" segment will require establishment of deep-rooted vegetation such as willows, sedges, and other bank armoring as well as broadening of the overall channel to allow for sinuosity and development of a flood plain.

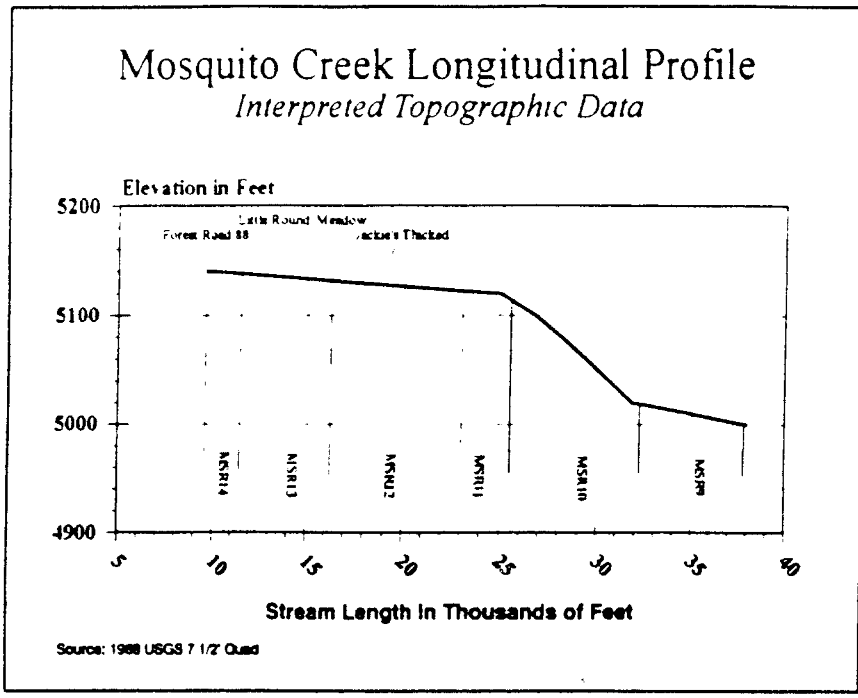
Reach MSR7(0 81miles)

This reach (McCarty Meadow) is described in two separate entries in the 1993 WIN inventory First. "Stream is downcutting in lower end of McCarty meadow Begins with a headcut approximately 1 1 2' deep Affected length of stream is approximately 600 feet ", Second, "Creek is downcutting the banks of the channel Depth of cut is 2'-4' Stream is shallow and wide with very little meandering Approximate width of the riparian zone is 50'-75' above McCarty Meadow The entire upper half of McCarty Meadow is effected Affected length of creek = approximately 2400' " The McCarty Meadow reach of Mosquito Creek has a gradient of <0 4% Field observation (1995) confirm these channel segments are entrenched, with low width/depth ratios, moderate sinuosity (estimated), and sand channel material This would classify as "G5c" channel (RST) This type of channel is classed as extremely sensitive to disturbance (including increases in stream flow magnitude and timing and/or sediment increases), have very poor recovery potential, very high sediment supply, very high stream bank erosion potential, and high vegetation controlling influence.

Reach MSR7 includes McCarty Meadow (a grassy meadow 100 to 400 feet wide and approximately 3,000 feet long) and the forested lands on either end of the meadow. The lower 1/2 of meadow area does not have an obvious channel. A stand of willows mark the most likely location of historic flows. Observation on March 30, 1995, showed that flows leave the entrenched channel at its terminus and flow across the entire meadow surface with a concentration of flow through the willows. The Winema GIS data base of PMR vegetation indicates that approximately 0.4 miles of the reach is grass with the remainder vegetated with ponderosa pine and lodgepole pine trees. One non-system road has been identified as occurring in the same data base cell as the stream channel.

A stable channel condition in Reach MSR7 would be a slightly entrenched channel, with a very low width-depth ratio and a very high sinuosity (> 1.5) This would classify as a E5 channel (RST). E5 channels have a very high sensitivity to disturbance, good recovery potential, moderate sediment supply, high streambank erosion potential, and very high vegetation controlling influence. The current channel in the meadow appears to in the process of widening with little additional downcutting taking place. Channel stability will require establishment of deep-rooted vegetation such as willows, sedges, and other bank armoring. Increase in sinuosity would also tend to increase stability by reducing the overall gradient of the channel and reducing the energy available for bank erosion.

Reaches MSR8 (1 18miles), MSR9 (0 92miles), and MSR10(1 34miles)



The Watershed Analysis team has no personal knowledge of these stream reaches.

The 1993 Win inventory describes two segments of reach MSR9. First, a 200 foot segment near the middle of the reach, "Stream has downcut channel to an approximate depth of 3 feet. Effected length = 200 feet. Effected width = 200 feet."; Second, a 1,300 foot segment near the top of the reach, "Channel through meadow is wide and shallow. Some downcutting has occurred on the banks of the channel Water is present at the top of the meadow, but quickly soaks into the ground. Approximate length of effected area = 1,300 feet. Average width is 200 feet.".

The maximum gradients in reaches MSR8 and MSR10 are generally in the 2% range. The 1993 WIN inventory did not identify any degraded channel segments in these reaches. The lack of identified problems with the channel would tend to eliminated channel types "F" and "G". The steeper gradient (2+%) would indicate channel types of "C", "E", or "B" The "B" type channel is naturally a very stable type and requires little maintenance effort. If the channel types in these reaches are "C" or "E", maintenance of deep-rooted vegetation on the channel banks will be critical to their continued stability

MSR9 has a gradient of >0.3%. The WIN inventory photos indicate that the current channel is entrenched, with a low to moderate width/depth ratio, and moderate sinuosity. This would classify the existing channel as either a "G4-5 or F4-5" (RST). These types of channels are classified as very high to extreme sensitivity to disturbance, have poor to very poor recovery potential, very high sediment supply, very high stream bank erosion potential, and moderate to high vegetation controlling influence.

Reach MSR8 runs through a forested area of pole and small saw sized trees of mixed conifer species specifically ponderosa pine and lodgepole pine (Winema GIS data base of PMR vegetation). There is one system road and two non-system roads occurring in the same data base cell as the stream channel

MSR9 reach is identifies as approximately 1/2 grass meadow and 1/2 forested area of pole and small saw sized lodgepole pine trees. No system or non-system roads were identified in this reach

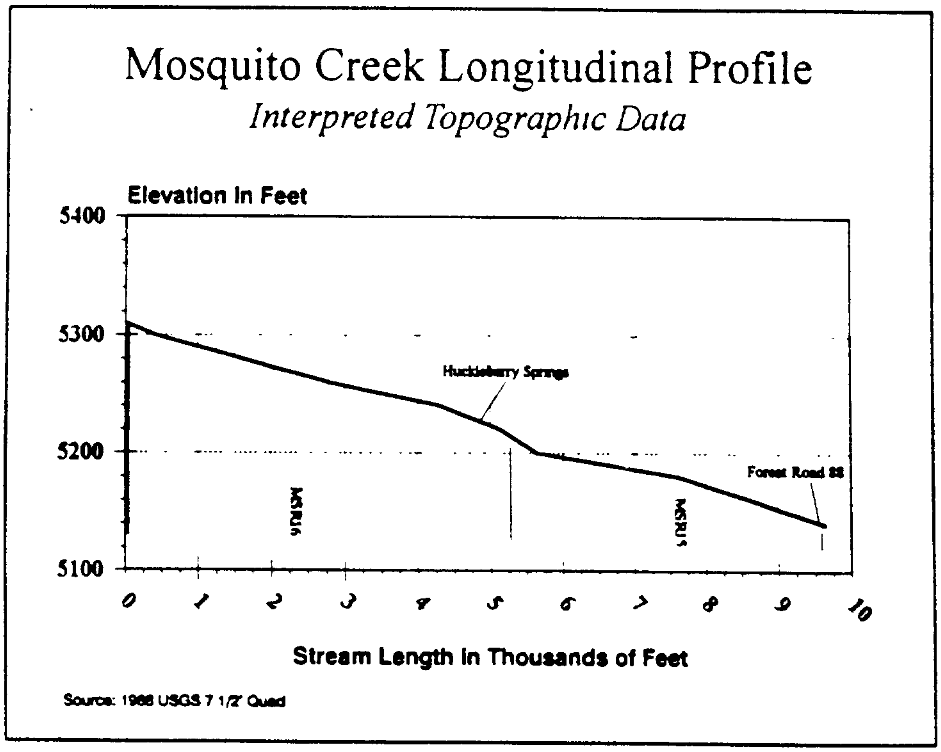
MSR10 runs through a forest area of pole and small saw sized lodgepole pine trees One non-system road was identified in the same data base cell as the stream channel in this reach

A stable channel condition in the Reach MSR9 segments described in the 1993 WIN inventory would be a slightly entrenched channel, with a very low width-depth ratio and a very high sinuosity (> 1 5) This would classify as a E5 channel (RST). E5 channels have a very high sensitivity to disturbance, good recovery potential, moderate sediment supply, high streambank erosion potential, and very high vegetation controlling influence Channel stability will require establishment of deep-rooted vegetation such as willows, sedges, and other bank armoring. Increase in sinuosity would also tend to increase stability by reducing overall gradient and lowering erosion energy.

Reaches MSR11(0.45miles), MSR12 (1 36miles), MSR13 (1 01miles) and MSR14(0 31miles)

These reaches are all in a very low gradient (0.1%) section of the Mosquito Creek Watershed. The 1993 WIN inventory did not identify any channel segments in these reaches as downcut or other wise negatively effected. These reaches are generally without a defined channel. Reaches MSR11 and 13 are generally forested with lodgepole pine, reach MSR12 is Jackies Thicket a flat lodgepole pine thicket with a high water table. Reach MSR14 is Little Round Meadow and is a flat and generally dry grassy meadow with no stream channel feature over most of its length. The MSR14 reach has two system roads identified as associated with the reach. MSR12 (Jackies Thicket) also has several non-system roads present is various parts of the area.

MSR15 (0.78miles) and MSR16(0 92miles)



These two reaches encompass Mosquito Creek from Forest Road 88 at Little Round Meadow to its headwaters. These reaches range in maximum gradient between 1% and 2% with a steep pitch of approximately 500 feet with a 4% gradient just below Huckleberry Springs.

The WIN inventory did not identify any segments of channel as downcut or other wise negatively effected. Field observation of segments of these reaches has found a slightly entrenched channel, with very low width/depth ratio (1 to 5) and high sinuosity. This channel classifies as "E5" (RST). E5 channels have a very high sensitivity to disturbance, good recovery potential, moderate sediment supply, high streambank erosion potential, and very high vegetation controlling influence.

The channel is generally in a narrow valley (<100 feet) The valley bottom is well vegetated with sedge and willow surrounded by and incorporating lodgepole pine and ponderosa pine forest Many segments of the valley have significant amounts of large woody debris incorporated into the valley floor Much of this material has become part of the soil profile increasing the erosion resistance of the valley bottom The Channel banks appear stable even where recent logging activities have encroached into the riparian area Late season (August) flows have been noted in these reaches by Chemult District personnel

Reach MSR15 is identified as a forested reach by the Winema GIS data base of PMR vegetation The forest is composed of pole, small saw, and medium saw sized ponderosa pine and lodgepole pine trees Three system roads are associated with this reach. One of these roads is Forest Road 88 which crosses the Mosquito Creek with a 5+ foot fill. This fill contains a culvert that is placed in the fill at a level of three to four feet above the existing channel bottom This feature along with another road fill and culvert immediately down stream have effectively cut off surface flows to Little Round Meadow.

Reach MSR16 is also identified as a forested reach vegetated with small saw sized trees of ponderosa pine and lodgepole pine. Pole sized stands of Aspen were also observed in portions of this reach, around Huckleberry Springs and at several other locations. Two system roads and an additional five non-system roads were identified from Winema GIS road data as either crossing this reach or located immediately adjacent (<100 feet) to the channel.

Continued stability of these channel segments will require the careful maintenance of willow, aspen, and sedge plant communities that occupy the channel banks. In addition, the maintenance of large lodgepole pine and ponderosa pine trees at the edge of the riparian area to recruit to the valley bottom as woody debris may be a key factor in overall stability.

Conclusions:

The Mosquito Creek drainage is an intermittent stream system feed by snow melt, ground water, and spring flow (Huckleberry Springs is the only spring identified on the USGS Quads). The precipitation history of the general area as recorded by the Chemult weather station (1937 thru 1994) does not, I believe, indicate a climatic change of sufficient magnitude to have supported a perennial system during this period of time I believe the low precipitation amounts and highly porous soils and rock formation are driving the intermittent condition of the system. Long term climate fluctuations are summarized in section "F. Climate" of the Mosquito Creek Watershed Analysis report; "Throughout the Holocene, long term and short term climatic variations resulted in dramatic shifts in water tables, peak stream flows, plant community species composition and abundance, and fire regimes. Change has been continual and unpredictable (Johnson, et al, 1994).". During some of these dramatic climate shifts, Mosquito Creek may have been perennial or even ephemeral, but not within the period of time associated with significant human caused environmental change (late 1800's to present).

Since around the turn of the century (1900), significant changes have taken place within the boundary of the Mosquito Creek Watershed. Man's desire to exclude fire from the ecosystem has introduced changes to the watershed such as increased density of vegetation (primarily conifers), reduction in hardwoods and grass meadows, and increased risk of high severity and intensity fires (see section "G. Role of fire" and "C. Vegetation Conditions in Mosquito Creek Watershed Analysis report). The increase in vegetation densities would have increased evapo-transpiration and potentially reduced peak stream flows and extended the snow melt season on the average (Goodell, 1958; Johnston 1975; Potts, 1984).

Livestock grazing has declined in recent years, but in the early to med 1900's approximately 5,000 sheep were grazed annually in the Watershed along with periodic use by cattle (see section "E. Livestock Use" in the Mosquito Creek Watershed Analysis report). This level of activity reduced the willow and aspen component of riparian plant communities, selected against tufted hairgrass/sedge, compacted meadow soils, and disturbed stream banks These changes would have tended to destabilize the Mosquito Creek channel system and make it more susceptible to intermittent intense winter and summer storms and high spring runoff events

Between 1941 and 1950 timber harvest of all stands containing significant amounts of ponderosa pine (>50% of the Watershed) took place (see section "H Disturbance Factors Affecting Change" in the Mosquito Creek Watershed Analysis report). This harvest removed at least 60% of the commercial ponderosa pine trees leaving only a scattering of trees and very little ground cover even in the lands adjacent to the stream channels. Associated with this activity was the construction of a substantial road system (>4miles per square mile of land area) This logging activity is also likely to have created substantial soil compaction. This period of logging would have created the opportunity for increased peak flows, and along with grazing effects on the meadows and channel banks, the destabilizing of the channel system. Research in the area of stream flow response to decreases in vegetation (Goodell, 1958, Johnston 1975; Leaf 1975, Potts, 1984) are not definitive. They tend to predict and increase in overall flows of 15% to 25% with a mixed response on the affects to peak flows. All cases show an earlier runoff in snow melt environments with a broader overall peak to the hydrograph. The late season tail of the hydrograph (June thru September) is little effected by removal of vegetation.

Road construction has resulted in approximately 15 miles Forest System roads located within 300 feet of identified stream reaches. In addition, 12 miles of the historic road system (non-system) is located within 300 feet of the existing channel system. Because of the high infiltration rates of the soils and rock formations and gentle ground slopes of Mosquito Creek, the road system is not likely to intercept ground water and deliver it to the existing stream system over a distance greater that 300 feet. The existing identified stream system extent is equal to approximately 42 miles. If the roads within 300 feet of existing channel were functioning as extensions to the existing system, this would equal an increase of 65% to the natural system. Observations during 1994 and 1995 do not indicated this is taking place, but some effective extension of the natural system by forest roads is likely. The reduction of overall road miles, especially those within 300 to 500 feet of the channel would advisable where ever possible.

The six water years (Oct. thru Sept.) after this timber harvest (1951 to 1956) annual precipitation was above average except for 1955 which was the lowest recorded at the Chemult weather station. Each of these high years also had monthly precipitation total in the fall and winter months well above average (1952 and 1953 were 30% above average; 1956 was 45% above average). These above average precipitation years in conjunction with the timber harvest in the 1940's, associated road construction, and long term grazing affects would have created a high potential for peak flows and streambank conditions in Mosquito Creek that support channel downcutting.

Since the initial harvest, logging has taken place in the Watershed on a continual basis (see section "H. Disturbance Factors Affecting Change" in the Mosquito Creek Watershed Analysis report). These harvest activities, although not as extensive as those in the 40's, would serve to maintained and in some cases compounded the effects of logging in the Watershed.

The existing Mosquito Creek channel above Forest Road 88 (reaches MSR15 and 16) is currently in stable condition with healthy streambank vegetation and access to a wide and well vegetated flood plain The very flat (0.1%) gradient reaches MSR11 thru MSR14 are generally without a channel and without obvious interruption to hydrologic function (precipitation, infiltration, and groundwater storage). The disrupted surface flows to Little Round Meadow by the Forest Road 88 stream crossing is the exception and should be addressed.

Below Jackies Thicket, reaches MSR10 thru MSR1, several segments of the channel have degraded from what were likely C and E type channels to E and F channel types The degraded segments have downcut from 2 to 6 feet (1993 WIN inventory and field observations) and for the most part still display raw unprotected streambanks with very high erosion potentials The downcutting has tended to reduce sinuosity, increase flow velocities, lower local water tables, and make a terrace out of the former flood plain The lowered water table affect will be localized to the riparian areas and meadows adjacent to the stream Although these areas will continue to be saturated during the snow melt season in normal precipitation years, the downcut channels will drop the water table adjacent to the channel much faster than normal This change will likely not be significant on dryer than normal years, but may lower the water table early enough in normal precipitation years to affect the life cycle of riparian vegetation.

The mouth of the Mosquito Creek drainage at the transition between reaches MSR1 and MSR2 has been completely modified to the point that the natural channel is no longer obvious and the current flows have been diverted on to an existing road changing the relationship between the stream and the Klamath Mash

Recommendations:

The stream channel types identified for the Mosquito Creek drainage are "B, C, E, G and F" (RST) Of these, G and F channel types are the degraded segments within the defined channel reaches These channel segments are extremely sensitive to disturbance (including increases in streamflow magnitude and timing, and/or sediment increases), have very poor natural recovery potential once the destabilizing factor is mitigated, produce very high sediment supplies, have very high streambank erosion potential, and have a high response to vegetative controls (Rosgen 1994). These channel forms will naturally tend toward C and E type channels by widening the channel, establishing sinuosity, building a flood plain, and allowing the growth of stabilizing vegetation.

Restoration of these G and F channels should center around avoiding increases in streamflow magnitude or timing, and/or sediment increases and encouraging the transition to a C or E type channel by increasing sinuosity and the development of an effective flood plain. Establishment of stabilizing vegetation (willow, aspen, and sedge) on the raw streambanks will reduce sediment yield and will over time incorporated into the channel recovery.

The"B" type channel segments are inherently stable with very low sensitivity to disturbance, excellent recovery potential, very low sediment supply, very low streambank erosion potential, and negligible controlling influence from vegetation. Maintenance of these channels may include the manipulation of the stream bank vegetation to enhance other values. Restriction of the channel by road crossings or other channel bank changes should be avoided.

The C and E type channel segments of Mosquito Creek, although considered natural for the landform of the Watershed, have a very high sensitivity to disturbance, fair to good recovery potential, moderate to very high sediment supply, very high streambank erosion potential , and vegetation has a very high controlling influence.

Maintenance of these C and E channel forms should include avoiding increases in streamflow magnitude or timing, and/or sediment increases and the protection and encouragement of stabilizing vegetation such as willow, aspen, and/or sedge on the channel banks.

The channel configuration at the mouth of Mosquito should be investigated and redesigned to best serve the needs of meadow and marsh lands of the lower watershed and the Klamath Marsh National Wildlife Refuge

The channel crossing of Forest Road 88 at Little Round Meadow should be redesigned to allow normal surface flows to the meadow This redesign will have to be sensitive to the need for stabilizing vegetation along the abandoned channel below the crossing

Jack Creek Watershed Specifics

Specific water quality data for Jack Creek is not available, however a 1992 survey (Appendix 4) of the northern 1/2 of Jack Creek noted the presence of frogs, leeches, and small fish (Speckled dace) indicating a level of water quality sufficient to support these species.

Recorded flow information for Jack Creek is limited to a short period of time between August 1993 and July 1994 in which twelve flow measurements were made. Seven of the twelve readings showed zero flow. The five readings that showed flow were taken in March, April, and May of 1994 and showed flows in the range of 1 gallon per minute. The recording station is located approximately four miles up stream from the mouth of Jack Creek near Paddys Meadow.

The lower portion of Jack Creek as it merges with the Williamson River does not appear to have any surface flows outside of the spring snow melt. These flows are not sufficient to form a developed channel.

The 1992 Stream Survey of the upper 1/2 of Jack Creek indicated Jack Creek is made up of flowing sections of stream broken by stretches of dry channel. At the time of the survey, the area had been subjected to nearly eight years of drought conditions. One three mile section of Jack Creek in the northern part of the watershed was described as having a stream flow of less than 0.5 cubic feet per second in the month of August.

The only recorded information on stream temperature for Jack Creek is recorded as part of the 1992 stream survey. In the month of August, water temperatures were in the range of 55 to 65 degrees fahrenheit.

No information exists on turbidity levels in Jack Creek or its tributaries.

No quantitative information exists on sediment sources, yields, or its transport. The 1992 stream survey information identified several locations of active stream bank erosion as did an early survey from the late 1970's. No analysis or discussion is available on the effects of sediment transport from these sources.

A stream survey conducted by Winema National Forest employees in the late 1970's (project file) covered all of Jack Creek and many of its tributaries. The objective of the survey was to use channel and stream bank factors to rate the stream as being in excellent to poor overall condition with respect to the stability of the existing channel.

The survey indicated the Jack Creek channel was in either good or fair conditions over its full length. Sight specific factors that indicated poor conditions in small sections of channel were primarily erodible stream banks and stretches of continuous bank cutting activity over 24 inches in height. These features were not frequent or extensive enough to warrent a rating in the poor catagory for any stream reach. This late 1970's vintage stream survey indicated the channel condition of the Jack Creek tributaries were also in good to fair conditions.

In five of the seven stream reaches described in the 1970's survey, livestock uses was associated with channel bank erosion and reduction of vetetation on the stream bank.

The 1992 survey of the upper portion of Jack Creek inventoried instream woody debris where it contributed to the aquatic habitat No other surveys of woody debris exist for the Jack Creek area General observation of the Jack Creek system indicates woody debris in the portions of the channel that pass through meadow lands is generally absent Those portions of the channel that pass through forested plant communities generally have woody debris present in the stream channel These communities also have ready access to new woody material over time The exception to this case is where timber harvest has removed the large trees from the area near streams

The Dillon and Doeskin Creeks flow through forested plant communities over their entire lengths and therefore have access to woody debris. Jack Creek flows through meadow plant communities over 23% of its total length and generally does not have access to woody debris of any size in these areas. The remaining 77% flows through forested plant communities with potential to supply abundant woody debris to the channel. Of the unnamed tributaries within the Jack Creek area, 8% flow through meadow communities and the remainder through forested plant communities.

Dillon and Doeskin Creeks have had 4% and 10% of their respective lengths involved in a near channel timber harvest activity since 1987 Jack Creek has had 13% of its length associated with a near channel timber harvest activity since 1987. The tributary channels within the Jack Creek area have received timber harvest activities along 36% of their collective length. These activities will tend to increase woody debris in the short term, but will reduce the opportunities for large debris in the future.

About 7% or 4,600 acres of the Jack Creek watershed is classified as riparian areas, which means supporting riparian plant communities 1600 of the 4600 acres are classified as "wet" or having a water table near the surface for much of the year. This includes the location that is classified as the bog.

C. Vegetation Conditions

Current Condition

The watershed contain a diverse mosaic of vegetative conditions ranging from wet and dry meadows to mixed conifer stands. Current stand exams cover only 12% of the land base within the watershed. Descriptions of the current conditions of the upland vegetation will therefore be very broad and general, with no site specific information regarding stand structure, age, or seral stages identified. ***This is a data need.***

The natural composition of forest stands has been altered over the past 60+ years by management practices such as fire prevention and exclusion, and extensive harvest activities. Ponderosa pine areas have been entered many times during this period for harvest activities ranging from removal of all large trees to partial cuts, to salvage, and (most recently) selective logging practices. Prescriptions for the lodgepole pine areas have been a combination of clearcuts and seed tree cuts.

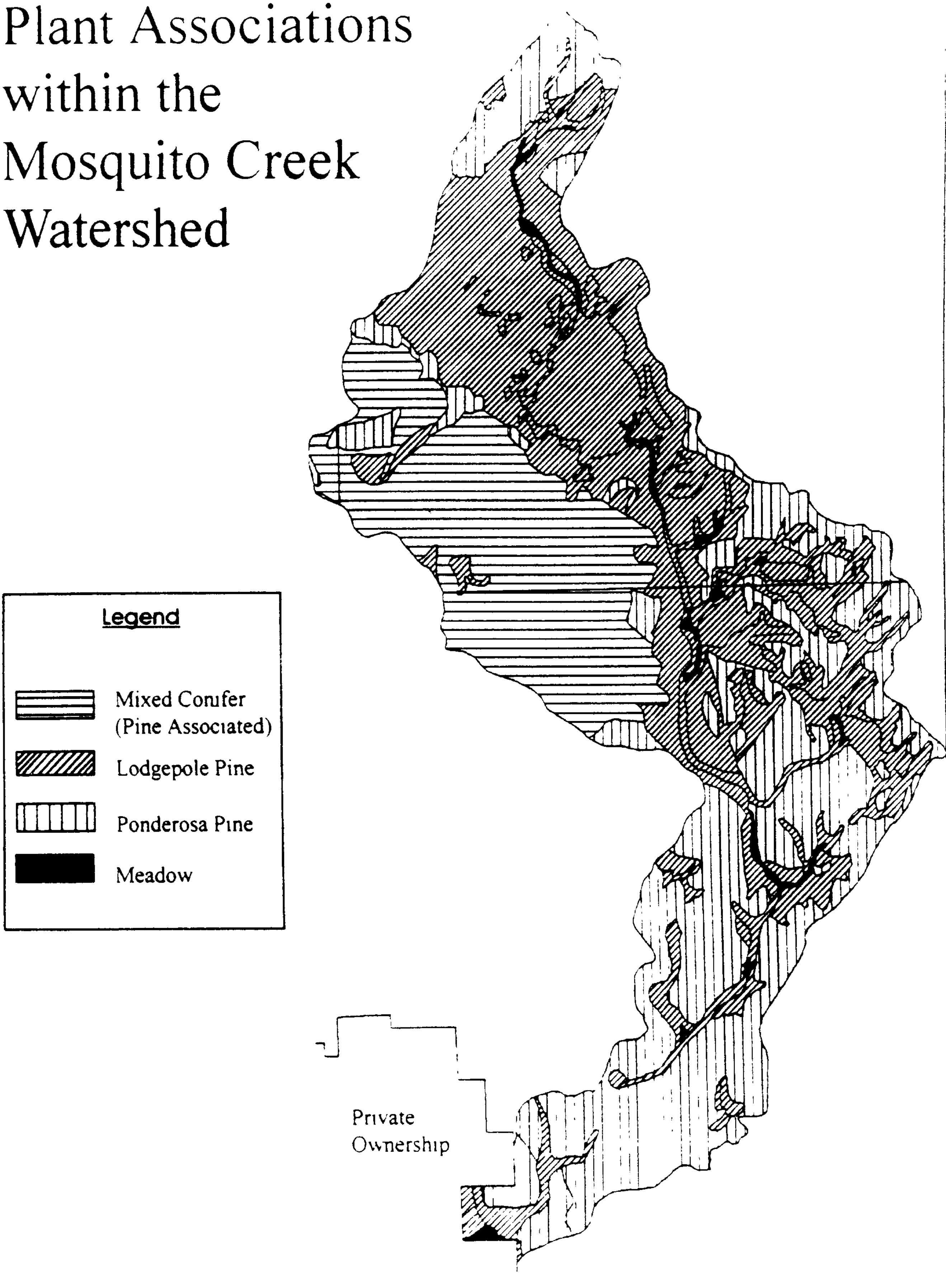
The following summarizes plant association groups found within the watershed

Plant Association Group	Acreage
CL-G3-11	145
CL-M2-11	2386
CL-S2-11	4779
CL-S3-11	52
CP-S2-11	251
CP-S2-12	6057
CW-S1-12	3672
CW-S1-14	1
Unique Associations:	
Wet Meadows	200
Dry Meadows	11
Total Ac	17,554
Private Ac	456
Total watershed Acres	**18,010**

For more information refer to Plant Associations of the Central Oregon Pumice Zone. (Volland, 1985), *Note: This guide describes plant associations as abstract classifications comprised of plant communities that would become established under current environmental conditions if all successional sequences progressed without human intervention, except for continuation of fire suppression.*

Two ponderosa pine associations (**CP-S2-11** and **CP-S2-12**) are found within the watershed area, **ponderosa pine/bitterbrush/needlegrass** and **ponderosa pine/bitterbrush/fescue.** Ponderosa pine is the dominant tree specie with lodgepole pine occurring in minor amounts. Bitterbrush is present in both associations in approximately the same amount. The main difference is that fescue and squirrel tail are present on drier sites and needlegrass is present on moister sites. These associations are found in the southern portion of the watershed at low to mid slope elevations.

Plant Associations within the Mosquito Creek Watershed



Current stand information shows **ponderosa pine** (CP-S2-12) areas within the watershed have volumes ranging from approximately 10,000 to 36,000 board feet per acre Basal areas range from 65 to 236 per acre Moderate to heavy mistletoe damage is documented, which could affect the amount of volume an area produces Other documented damage is minimal

Ground vegetation is predominately antelope bitterbrush, western needle grass, and ross sedge Other ground vegetation may include squaw currant, bottlebrush squirrel tail, rabbitbrush goldenweed, Idaho fescue, manzanita, and wetland grasses

Ponderosa pine trees dominate the area with lodgepole pine increasing as it encroaches due to lack of periodic fire disturbances. On the fringes of the lodgepole areas, the lodgepole is increasing in association with the pine, though the area is still considered a ponderosa pine site. The same would hold true for the fringes between the mixed conifer and ponderosa pine areas.

Insert map #2   Mike

Lodgepole pine/bitterbrush/needlegrass (CL-S2-11) generally occurs as a transition area between the drainage and ponderosa pine types These areas are found at mid to lower elevations within the watershed Moderately productive, this type is dominated by lodgepole pine, along with scattered ponderosa pine at higher elevations Bitterbrush is the dominant shrub but is only present in minor amounts Needle grass and squaw current are present in minor amounts along with other forbs

Information from six stand exams in **lodgepole pine** (CL-S2-11) show volumes ranging from 8,900 board feet per acre to 14,000 board feet per acre Basal areas range from 64 to 116 per acre Dead lodgepole is present as a result of past and present beetle infestations. Low to moderate lodgepole pine mistletoe occurs within these stands Other damage is minor These stands are not 'pure' lodgepole pine, however, as ponderosa pine is present in minor amounts. There may be other lodgepole stands within the watershed considered 'pure' Ground vegetation within these stands consists mainly of antelope bitterbrush, western needle grass, and ross sedge Other vegetation present in minor amounts include lupine, squaw currant, manzanita, rabbitbrush goldenweed, and wetland grasses

Lodgepole pine/needlegrass (CL-G3-11) basins occur in minor amounts within the watershed, mainly on the west and northwest sides of Jackies Thicket. These areas are composed of lodgepole pine with approximately 10% bitterbrush cover, and less than 10% needlegrass cover. Tree productivity is low and natural regeneration is difficult to establish.

Lodgepole pine/bearberry (CL-M2-11) comprises the majority of the vegetative type within the drainage bottom. This is a thick lodgepole pine forest with bearberry as the dominant shrub. This type is usually a thin, long strip located on either side of wet and dry meadows

Lodgepole pine/manzanita (CL-S3-11) is found in two small areas on the slopes of Sugarpine Mountain. This type is characterized by lodgepole pine with (possibly) white fir present, depending on slope position. Pinemat and green leaf manzanita are the dominant shrubs - which increase as a result of disturbance activities.

Insert Map #3 Mike

There are no stand exams in **mixed conifer** stands within the watershed The best source at this time may be to refer to the plant association or inventory data. The plan association groups describe 'potential' vegetation *This may or may not accurately reflect the current condition of the mixed conifer vegetation within the watershed.*

Sugarpine Mountain is the highest elevation within the watershed, on whose slopes is found the **mixed Conifer/snowbrush/manzanita** (CW-S1-12 and CW-S1-14) vegetative type There is much variability in the canopy cover of this type On Sugarpine Mountain, the north and northeastern slopes are within the watershed area White fir is a prevalent species on these slope aspects, along with ponderosa pine and (occasionally) sugar pine Snowbrush, greenleaf manzanita, and bitterbrush are the dominant shrub species, with bitterbrush found at the lower slope elevations. Other grasses and forbs are also present This site has moderate productivity

Insert Map #4 Mike

Wet and dry meadows occur along the drainage systems of the watershed Wet meadows are characterized by dominance of one or more mesic sedges and rushes Soil surfaces are usually moist, but may be wet Dry meadows are characterized by a dominance of cusick bluegrass distributed with wheatgrass, junegrass, and other subordinates Perennial forbs are also present

Riparian areas in the Mosquito Creek Watershed represent a small portion of the total landscape (12%), but play a significant role in the life history of aquatic and (many) terrestrial animals. Typically, floral and faunal species richness is higher in healthy riparian areas than in adjacent upland habitats (Knopf, 85, DeByle, 85) The current physical condition of the channel and flood plain strongly suggest that the extent of riparian habitats in the watershed has decreased over the past century

Riparian area mapping for the Winema Land and Resource Management Plan (LRMP) indicates roughly twenty-eight percent of the Mosquito Watershed riparian zone is in a hardwood plant grouping This is the best riparian mapping done on this drainage to date, though it should be noted that this mapping was intended for broad scale planning only (Frazier, pers comm, 1994). Mapping was done using plant dominance groupings, and polygons are identified by codes. *These are rather loose groupings; the reader should refer to documents associated with the LRMP planning effort for clarification of codes and objectives.* Limited ground verification was attempted in 1992, though incomplete, and probably inadequate for the planning of any riparian habitat manipulation.

For the Mosquito Watershed analysis effort, we recognize two major **riparian hardwood** groupings; **hardwood dominated** community types, and **shrub dominated** associations (Kovalchik, 87). We assume that riparian **deciduous forest** community types are seral to riparian conifer communities (Ibid) and have been maintained in disclimax or have been rejuvenated in a cyclic manner through periodic disturbance (elements of disturbance are discussed elsewhere in this analysis).

Riparian hardwood communities comprise a fraction of the landscape in the interior west; less than five percent of the Mosquito Watershed is in a riparian hardwood plant community. The aspen dominated riparian hardwood plant community is thought to be rare on the Chemult Ranger District (Olmedo, pers com. 1994). Black cottonwood is extremely rare in the upper Williamson River drainage (Jean, pers. com. 1994), and is considered "at risk" in the Eastslope Cascades Province by a number of authorities (Jean, 95). Evidence indicates the extent of the aspen plant community is in decline in the Mosquito Watershed.

Shrub dominated riparian associations are closely tied to soil structure and the proximity and duration of the watertable to the ground surface. Typically, shrub dominated associations are found where the watertable is high during most of the year (within ninety centimeters of the ground surface), but may drop to lower rooting depths in late summer or during droughts (see Kovalchik, 87).

Lowering of local water tables through channel down cutting can result in a decline in alder and willow communities (Kovalchik and Chitwood, 90; Youngblood et al, 85), as can extensive herbivory (Kovalchik and Elmore, 91; Bohn and Buckhouse, 86; Hayes, 78).

Successional replacement by conifers of shrub dominated communities also occurs, though this has not been adequately addressed in the literature. In the Mosquito drainage, shrub dominated associations appear to be closely linked with meadows.

Only seven percent of the area mapped as **hardwood** community (the HW grouping) is identified as not having a conifer component or mix. The remaining ninety-three percent of the hardwood communities detected during infrared photo analysis contained a high conifer component. The high degree of area in HCM and HCW (Hardwood/Conifer mixed) groupings suggests that ninety-three percent of that area mapped as hardwood community is moving toward the latter stages of successional replacement by lodgepole as a result of the interruption of disturbance regimes, specifically wildfire and long-term inundation by water

Small stands and individual aspen trees are found in a narrow stringer on either side of Mosquito Creek and it's tributaries in (roughly) the lower half of the drainage Why the upper portion of the drainage does not currently contain a well distributed hardwood component is unknown, though it has been suggested that successional replacement has occurred here as well. The extent of successional replacement of hardwoods by overstory conifers is illustrated by the following example·

The first three hundred meters of channel and floodplain upstream from the 86 bridge contain numerous down, decomposing aspen trunks, many showing evidence of beaver. On a short (120 feet) longitudinal transect in this reach, forty-five percent of the coarse woody material in channel was aspen. There were no aspen trees remaining in the overstory along this transect. Aspen reproduction is extremely limited throughout the entire reach. Conversely, lodgepole pine reproduction is extensive on this site and is represented in all layers. Directly upstream is "Permanent Neotropical Monitoring Station #1" - a similar aspen community in an earlier successional state. The overstory is aspen, and the understory contains increasing lodgepole reproduction. The linear nature of the aspen community has now become patchy, and those patches are becoming further reduced in area.

Other hardwood sites visited during the limited field period include several small aspen clumps near McCarty Meadow and along the channel upstream from there. Consumptive forage use by livestock and wildlife undoubtedly contribute to the lack of aspen reproduction on these sites; successional replacement, however, appears to be the driving force in the reduction of these communities. **Riparian hardwood** communities are becoming extremely limited within the watershed when compared to historic context, and should be considered at risk under current fire management and timber harvest regimes

Fifteen percent of the area in riparian associations in the Mosquito Watershed are **meadow** communities. These meadows are currently classified by the **meadow moist/meadow dry** scheme developed for the Winema LRMP planning effort. This classification system does not attempt to address the ecological potential, trend or vegetative composition of the meadow community.

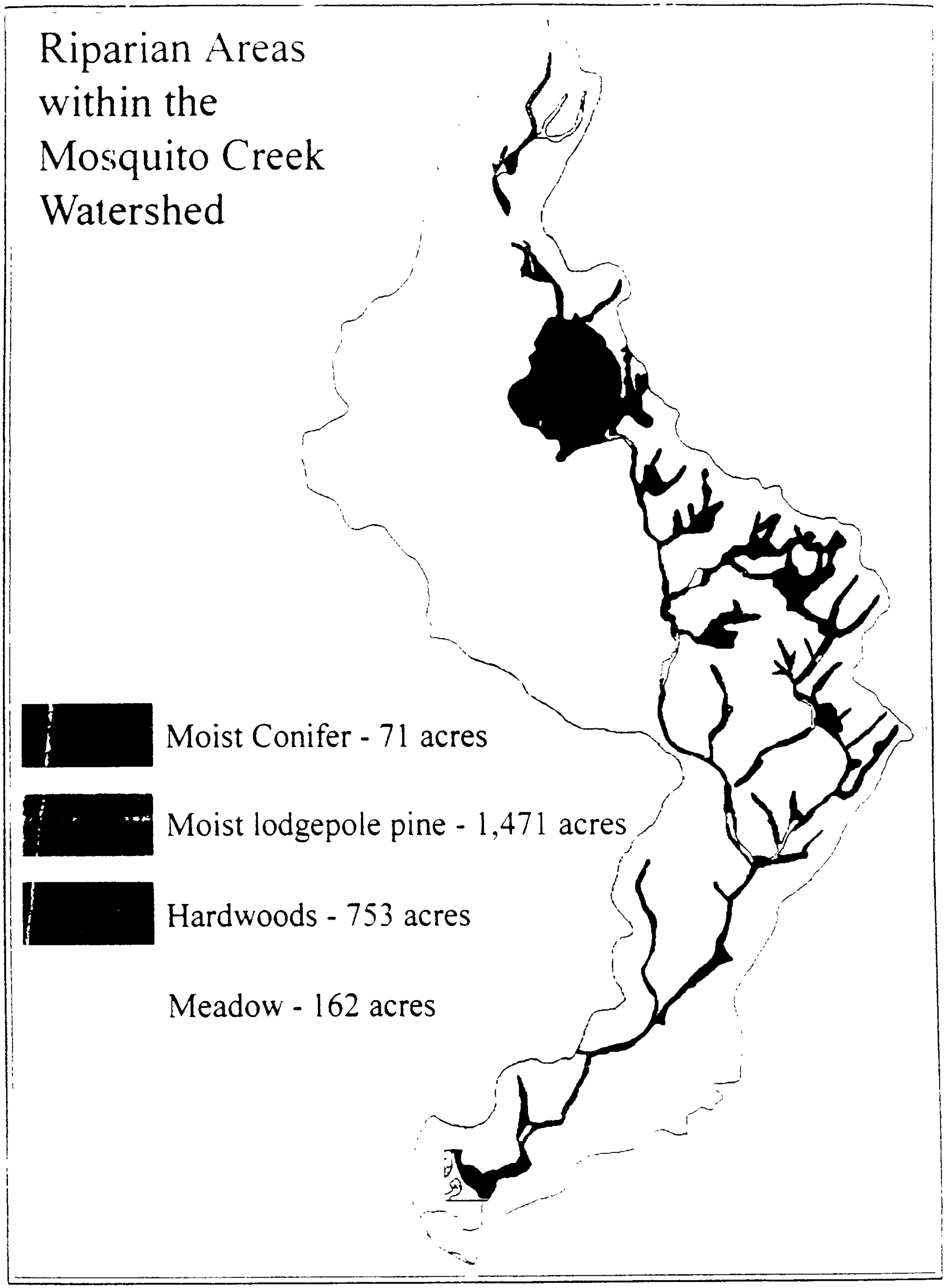
For example, the Mosquito EA planning effort classified McCarty Meadow as "Meadow Moist". Review of aerial photos indicates that where a developed channel is obvious, significant drying of the meadow has occurred. Field review of McCarty meadow indicates that meadow drying is associated with slumping and gullying in a discontinuous, deeply incised channel.

Where slumping and gullying has not yet occurred, willow is a major component of the habitat over a graminoid layer of sedge, representing a higher moisture level in the meadow. The combination of water flow changes due to road construction above and through the meadow, diking and livestock grazing have resulted in a progressive conversion of this meadow from a willow/sedge plant association to a Kentucky bluegrass community type (Kovalchik, 1987).

Most of the meadow vegetation is in the late seral stages of development. Based on current range analysis, the primary dominant grasses that are present throughout most of the analysis area are: Kentucky bluegrass, Cusic's bluegrass, and tufted hairgrass. Dominant sedges include Inflated sedge, Beak's sedge, and Nebraska sedge. Dominant forbs are longstalk clover, and cinquefoil (buttercups)

The extent that replacement of shrub dominated communities has occurred in other meadows is not known. However, down cutting and head cutting have been identified in four other meadows through the WIN and watershed analysis process. It is reasonable to assume that where down cutting of the channel through the meadow has occurred, lowering of the local watertable has occurred as well Where lowering of the watertable is occurring in meadows, conversion from willows to dryer communities is expected

Unfortunately, the timing and scope of the watershed analysis program precludes extensive investigation of site-specific conditions The extent of the aspen community type in the watershed has not been determined The deciduous hardwood communities are being replaced by successional conifer dominated communities Shrub dominated habitats are becoming less mesic meadow environments and more conifer dominated



Riparian Areas within the Mosquito Creek Watershed
Moist Conifer - 71 acres
Moist lodgepole pine - 1,471 acres
Hardwoods - 753 acres
Meadow - 162 acres

Trends

The trend in riparian zones exhibiting deeply incised channels is toward a reduction in area of riparian communities Riparian communities in sections where streamflow can no longer make contact with the floodplain due to incision or diking will eventually be restricted to within the incised channel These riparian communities are, and will continued to be greatly reduced from historic conditions for a long period without extensive and costly restoration Channels and flood plains will recover to some intermediate state resembling the former condition following the movement of extensive amounts of sediment, widening of the gully and a liberal allowance of time

The trend of riparian hardwood communities in the Mosquito drainage is toward successional replacement by a conifer dominated community Riparian hardwood communities are becoming extremely limited within the Mosquito watershed when placed in a historical context, and should be considered "at risk" under current fire and timber management. Further site specific analysis should be conducted on the viability and desired extent of riparian hardwood communities. Restoration of the these communities through prescribed burning or other appropriate means should be conducted as a priority

The trend of McCarty Meadow toward further drying, resulting from deepening, widening and lengthening of the channel through the meadow. The end product will be a further reduction of the mesic meadow communities and the willow component of the system.

The trend of the meadow at the mouth of Mosquito Creek is uncertain depending upon management of cattle grazing in the area.

The trend of Little Round Meadow is toward further drying as headcuts in the north end of the meadow progress. If it has not occurred already, native meadow vegetation will be replaced by Kentucky bluegrass. Should modification of the road fills at the head of the meadow occur, meadow habitats may become more mesic, specifically at the north end of the meadow Meadow edges could become moister as lodgepole stands around the meadow edge burn.

The trend of the meadow in T28 R10 S29 is also toward drying, as headcuts continue to alter the hydrologic regime.

The trend of Huckleberry Springs may be toward higher quality habitat, as the time since extensive sheep use increases. Observations indicate that willow may be drying out on this site; this may be a function of overhead stand density. Further analysis is needed on this wetland prior to vegetation manipulation, but it should be noted that this is an extremely important site.

Threatened, Endangered, and Sensitive Plants

Two surveys have been conducted in the watershed for **threatened, endangered, and sensitive plants**, both within the Mosquito IRA project area. Using air photos, field surveys, reference material and district files, potential habitat was identified for the following species:

Species	Status
Botrychium pumicola	C1 Federal
Agoseris elata	Sensitive (WA)
Silene nuda (var. insectivora)	Sensitive (FS)
Lobelia dortmanna	Threatened (OR)
Rorippa columbiae	C2 Federal
Mimulus pygmaeus	C2 Federal

During 1992 a field survey by Forest Service personnel was conducted A second field survey was conducted in 1993 by Ron Vincent, Botanical Identification Services No sensitive, threatened, or endangered species were found in the Mosquito Creek Watershed

Jack Creek Watershed Occurance

Little grapefern (*Botrychium simplex*) is listed as sensitive in Washington State, but not in Oregon It has been located within the Jack Creek Watershed It is less than 3 cm in size, grows in meadows and riparian areas, and may be dependent on some level of disturbance such as mild flooding. It is sighted with tufted hairgrass, kentucky bluegrass and yarrow, all of which are common in the watershed. One of the meadows within Jack Creek watershed, where a large population of little grapefern exists, was fenced in 1991 to reduce dispersed camping and motor vehicle traffic. Opportunity exists to monitor the population since it is excluded from livestock grazing and other human influences.

Pumice grapefern (*Botrychium pumicola*) is located in a lodgepole basin at the edge of the watershed It is an unusual species of fern due to the dry and severe habitat in which it resides The maximum height of this species is 5 cm and it blends into its surroundings. Distribution is scattered and patchy, the plant apparently grows best with little shade, cold temperatures, and pumice soil. It reproduces through spores. The pumice grapefern can undergo sudden population increases under the right environmental conditions.

Bristle flowered collomia (*Collomia macrocalyx*) is listed as sensitive for Oregon. It is located in the southern portion of the Jack Creek watershed. This species grows up to 10 cm tall and likes the dry, open, rocky ridges. It was originally thought to be a small population, but surveys done in other areas shows the plant to be more prevalent than was first suspected.

A survey of wet meadow and riparian areas in recent years identified a unique site at the headwaters of Jack Creek within the Jack Creek watershed. The site contains a bog (wet, spongy ground with peat moss) dominated by bog huckleberry and few-flowered spikerush with some occurrence of moss. Many diverse species of riparian vegetation occur in this area (Appendix 3). The bog is surrounded by tufted hairgrass-sedge wet meadow with lodgepole pine forests at the edges.

Different types of insects and disease affect the vegetation in Jack Creek watershed. An outbreak of tent caterpillers occured in the 1930's, nearly wiping out the bitterbrush. In the lodgepole pine, an epidemic of the mountain pine beetle began in the 1960's and was widespread by the 1980's. Outbreaks also occured in the past. This type of epidemic produces widespread changes in the tree stand structure. After a stand replacement fire, lodgepole pine stands generally regenerate into thick stands the same age. Once these stands are over 100 years old, the conditions are right to trigger mountain pine beetle epidemics. As a result of these attacks, the stand structure is altered dramatically. 200-300 trees per acre may be killed during an outbreak of the mountain pine beetle.

Historic Conditions

Confidence in prediction of historic vegetative condition

First it is important to note that both historical and current conditions are not static but change over time These conditions occur as ranges created by natural or human caused disturbance events and the vegetative response to those events. Some vegetative types have wider natural ranges of conditions than others At least two types, riparian hardwoods and drier lodgepole grasslands do not currently exist in their historic form and we can only use our best guess as to what they were. Therefor the confidence of our predictions of both historic and future conditions is different between types.

We have a high degree of confidence of our predictions for the Ponderosa pine type, least confidence on the lodgepole pine type, moderately good confidence on other types The low degree of confidence on the lodgepole pine type I believe is due both to a wide historic variation within type and very rare historic descriptions of it as a type as we know it We must make our best professional guess as to what was there in its place What we are sure of in the lodgepole pine type is that historical stand types are do not resemble the condition lodgepole is found in today

Conversely I feel a high degree of confidence on the Ponderosa pine type because of the high correlation between historic descriptions and the many quantitative measurements made in this type due to its economic value. These measurements were made between 1899 and 1922, and should still reflect the pre-European condition. Grazing, logging and fire suppression started during this period but could have had an effect only on the young seedlings component. Since we have a good quantitative record of the large tree component, most of the seedlings never grew to maturity.

Excerpts from historical accounts

Leiberg (1899, p. 238) states *"The aspect of the type is that of an open forest with a minimum of undergrowth and seedling or sapling growth. The forest on the eastern side of the Cascades is more conspicuous in this respect than the forest on the western, owing to less variety in the frutescent flora of the former and, in general, to a smaller precipitation. But the open character of the yellow-pine type of forest anywhere in the region examined is due to frequently repeated forest fires more than to any other cause."*

"The age of the timber utilized in sawmill consumption varies from 100 to 350 years. Most of the yellow pine falls below 175 years; the higher limit is reached chiefly in the sugar pine." (p.274)

The following are excerpts from *Western Yellow Pine in Oregon*, Thornton T. Munger, USDA Bulletin No. 418, February 6, 1917:

"Yellow pine grows commonly in many-aged stands, i.e., trees of all ages from seedlings to 500-year-old-veterans, with every age gradation between, are found in intimate mixture. In some stands there is a preponderance of very old trees; in fact, in many of the virgin stands of central and eastern Oregon there are more of the very old trees and less of the younger than the ideal forest should contain."

"Usually two or three or more trees of a certain age are found in a small group by themselves, the reason being that a group of many young trees usually starts in the gap which a large one makes when it dies. In the virgin stands throughout the State there seems to be a very large proportion of trees whose age is about 225 or 275 years, suggesting that after this age their mortality is greater." (pp.18,19)

"Yellow-pine forests are so irregular in density that figures for the average stand per acre or per quarter section are apt to be misleading." (P21)

"Yellow pine is a long-lived tree. The oldest encountered in the analysis of 4,997 stumps in eastern and central Oregon was in its six hundred and eight-seventh year when cut for lumber." (p.24)

"In the yellow-pine forests of Oregon (except those on both slopes of the Cascades south of Crater Lake and those on the Siskiyou Mountains in southern Oregon and on some of the pumice-stone land towards the head of the Deschutes River) the trees are so open-grown and the woods are so free of underbrush that a good herbaceous vegetation suitable for forage springs up each year. The character of the vegetation depends upon the region, but it usually consists in part of a variety of grasses and in part of 'weeds' (annual flowering plants)." (P31).

Discussion on historic types

It is generally difficult to discuss historic types using terms developed for and associated with contemporary stand types There have been vast changes in stands - generally classes within the same type For example, historic ponderosa pine stands had a Basal Area Range of perhaps 20-60 (Appendix H), current stands in the Mosquito area have Basal Area up to 236

The following is an attempt to describe what may have been the vegetative composition across the landscape, structurally as well as spatially, within the Mosquito Creek Watershed. The purpose is to provide some measure of how present conditions compare with those of the past, and how processes within the watershed have been affected. These changes can best be recognized by addressing the major types within the area - the ponderosa pine, lodgepole pine, mixed conifer, wet and dry meadows, and riparian communities

Ponderosa pine (Present occupancy - 6208 acres). This type is characterized as an open, large tree pine stand, generally 10-20 large trees per acre with few scattered smaller trees. Some lodgepole pine may be mixed in. Stands were maintained in this condition by either natural or human-caused fire. Understory vegetation was present and diverse. Munger refers to good herbaceous vegetation, suitable for grazing, springing up each year. Vegetation would be short and generally less than 15 years of age. Brush species would be present, but short and not woody. Grasses, annuals and perennials, would be dominant. Woody material (down trees and limbs) would be the accumulation since the last fire, generally less than 15 years Leiberg refers to a thin layer of humus or bare soil, never more than a "fraction of an inch" in thickness

Historically this type was dominated by a fairly continuous large tree structure with occasional small (less than 1/5 acre) clumps of reproduction, and very occasional smaller trees (less than ten trees per acre). Since this structure takes a long time to develop and was almost universally present over so many acres, it is reasonable to assume this was the dominant structure for the type for at least the past 500-1000 years.

This assumption does not preclude exceptions, where small stand replacement events may have created a stand of younger trees, but references to this are very rare. Munger implies that in regions outside of the Blue Mountains, pine stands ordinarily average less than 20 trees per acre (see Appendix G). Actual plot data from 1936 and 1948 (BIA archive files) of trees larger than 12" shows a range of 9.5 to 17 trees per acre for the South Calimus and Wildhorse Ridge areas - sites similar to those in Mosquito, but south of Klamath Marsh.

Numbers of trees per acre in smaller size classes were recorded less frequently, though anecdotal notes often comment on a lack of understory vegetation. The Long Prairie cut-over cruise recorded 2.8 small poles (4-7") and 3.4 large poles (8-12") per acre, but noted in comments that these were in clumps. Due to the few numbers of trees per acre removed and the numerous comments and contract requirements requiring protection of small trees, this is believed to be a reasonable picture of the understory stand. Trees under 12" DBH would become increasingly susceptible to the type of fires which occurred, and it is reasonable that smaller diameter trees would be scarce.

Lodgepole pine

For the purpose of historical characterization, **lodgepole pine** is divided into **wet** and **dry** types. These moisture regimes also need to be considered as a site condition wherein lodgepole may not have been present. **Wet lodgepole** conditions would include all the CL-M2-11 type and the lower portions of the CL-S2-11 type. **Dry lodgepole** conditions would include the CL-G3-11 type and the upper, drier portions of the CL-S2-11 type.

Leiberg makes several references to lodgepole pine reproduction areas. and speculates they would become ponderosa pine stands with the absence of fire After observing the effects of nearly a century of fire suppression, we see that lodgepole replaces lodgepole in these types and they show no indication of progressing to ponderosa stands

Wet lodgepole (present occupancy - 5775 acres) types occurred within the flood plains of riparian areas Historically, lodgepole may have ranged from totally absent to present in riparian stringers, but not dominant over large areas These acres were probably dominated by a riparian hardwood community (absent today), and occupied by a hardwood/grass/forb type Willows would have been thick along the old stream banks and meanders. Clumps of willows would have been scattered throughout the type Aspen, alder, black cottonwood, along with sedges, grasses (and perhaps tule and bulrushes) would have been present in unknown quantities. The presence of large amounts of tall willows in similar areas are prominently shown in historical photographs (BIA archive material), though the other vegetation is not discernable.

Many of these areas - particularly the wider ones - would have been in meadow types. Since remnant aspen patches are still present, it can be presumed to have been common. Tule is mentioned in historical accounts (Abbot). Presence or absence of other vegetation is pure speculation based on plants which are suited to that site, and Kovalchik's riparian types. Few good examples of a riparian hardwood type exists today, only small partial types. I believe this type was fairly static, with fewer fluctuations in composition due to fire frequency than other types, although fire would be present and responsible for maintaining this type.

Small (<1,000 acres) stands of lodgepole would have sporadically become established. These stands would have been fairly resistant to fire, except around edges, where creep from surrounding types might get into the lodgepole. These stands would probably have developed into a mature structure, and then have been susceptible to stand replacement events such as insect and disease, blowdown, and fire.

No stands of historic condition dry lodgepole pine type (present occupancy - 2534 acres) exist today The belief is that there was a wide range of natural variability that progressed from a grass/dry sedge type through a period of slow lodgepole encroachment, to occasional establishment of young lodgepole - generally in small stands. An early report from the BIA makes reference to lodgepole "brush" areas. In the same era, lodgepole were tallied as small poles if they had reached 4" DBH; which leads to the speculation that the average trees in the "brush" areas were under 4" DBH.

When lodgepole did get established as a conifer dominated stand, the area would be resistant to fire for perhaps up to 40 years. This is because young lodgepole does not burn well and takes a long time to produce a fuel bed which readily carries a fire. Lodgepole is, however, very susceptible to mortality from a fire. Once enough litter was present to carry a fire, the stand would be easily killed, probably in a mosaic pattern, and be physically removed over the course of several fires. Due to the almost total absence of historical mention of lodgepole stands, it is doubtful lodgepole stands established very often, Most of this type would more often have been a grass or dry meadow type, with some small clumps of lodgepole and (possibly) greater amounts of bitterbrush and sagebrush.

Mixed Conifer

Historically, the **mixed conifer** type (present occupancy - 3671 acres) would have characteristics of the ponderosa pine type. At upper elevations, the characteristics would be a higher elevation, stand replacement event type stand. The degree of confidence in these stand descriptions is similar to the ponderosa pine type except for the location of the line where stand replacement events begin to dominate

The Mosquito Creek area would have been mostly similar to the ponderosa pine type The "line" between open pine type and stand replacement regime may well have been at higher elevations or wetter sites than occur in Mosquito

The type would be dominated by ponderosa pine with an open stand structure similar to the ponderosa pine type Stocking could be up to 50% greater, due to higher moisture regime. Some sugar pine would be present in the stand More understory trees, mostly sugar pine, would also be present. Fire intervals might be slightly longer, allowing more surface vegetation to develop and small stand replacement fires to occur This would create occasional small patches of younger trees, probably not over several acres in size. More white fir would be present at higher elevations , resulting in more, and larger, stand replacement fires. Stands would also, for short periods, develop much higher stocking levels, with more understory and more down woody material than the lower elevation stands. Because these upper slopes produce more fuel, and because they are on slopes, fire likely visited them about as frequently as their drier neighbors below them.

Overall, most forested stands within the watershed have increased stocking levels - sometimes as much as six-fold increase, particularly in younger age classes and reproduction. Other noticeable changes in vegetative structure are multiple canopy layers, increased ground vegetation, and increased fuel loadings Species' overlap into others' historic range has also occurred since management activities began.

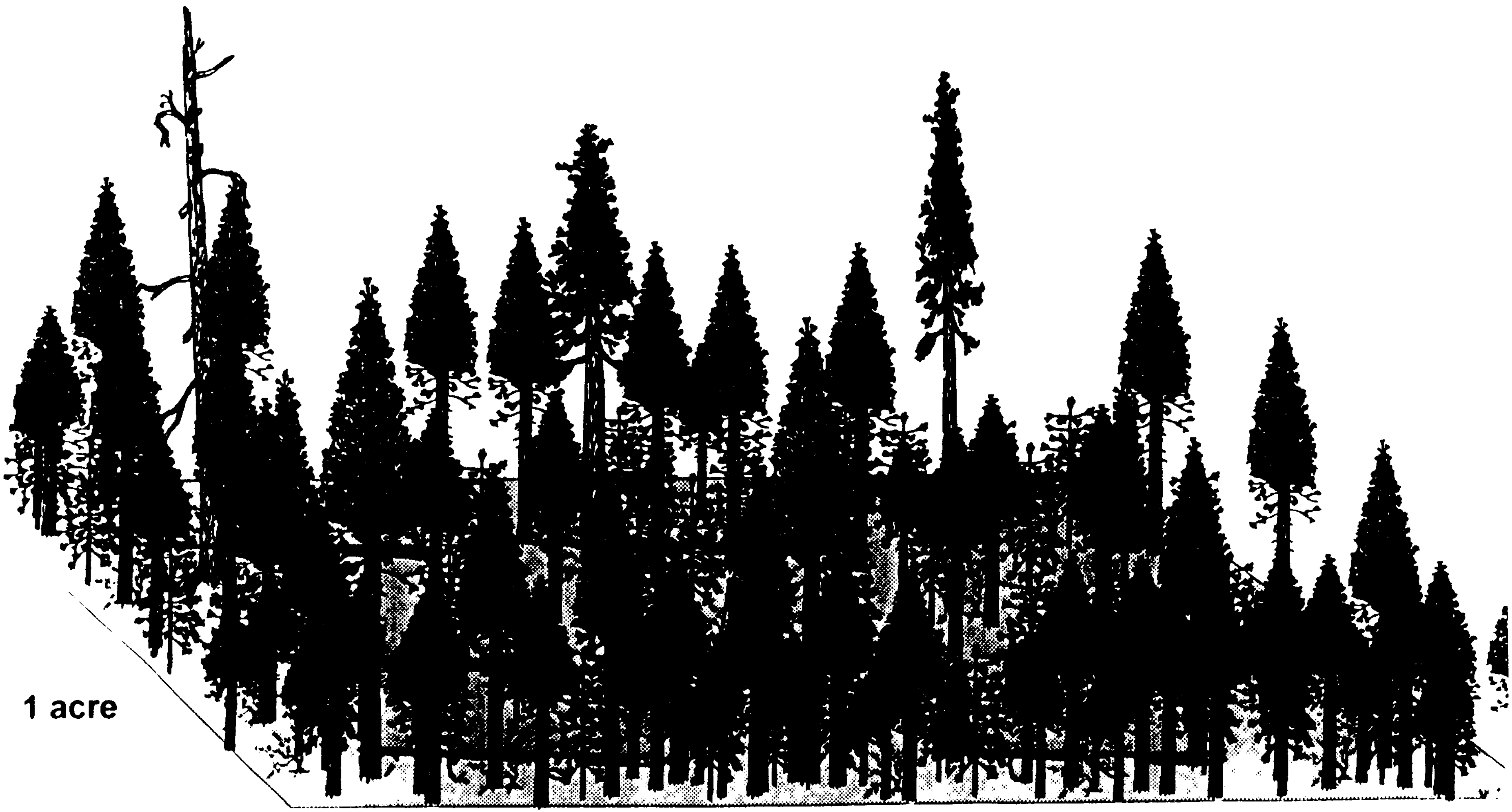
Except for white pine blister rust (an introduced agent) significant insect and disease agents present today are native and therefore have been present for a long time. Epidemic levels of bark beetles (both Western and Mountain pine) were cyclic and caused mortality in up to 50% of the stands (National Archives).

Insect and disease outbreaks were observed and recorded as early as 1911. The ponderosa pine on BIA lands east of the watershed experienced a major outbreak of bark beetles (probably the mountain pine beetle). The overstocked lodgepole pine stands experienced an epidemic outbreak of the mountain beetle as late as the 1980's.

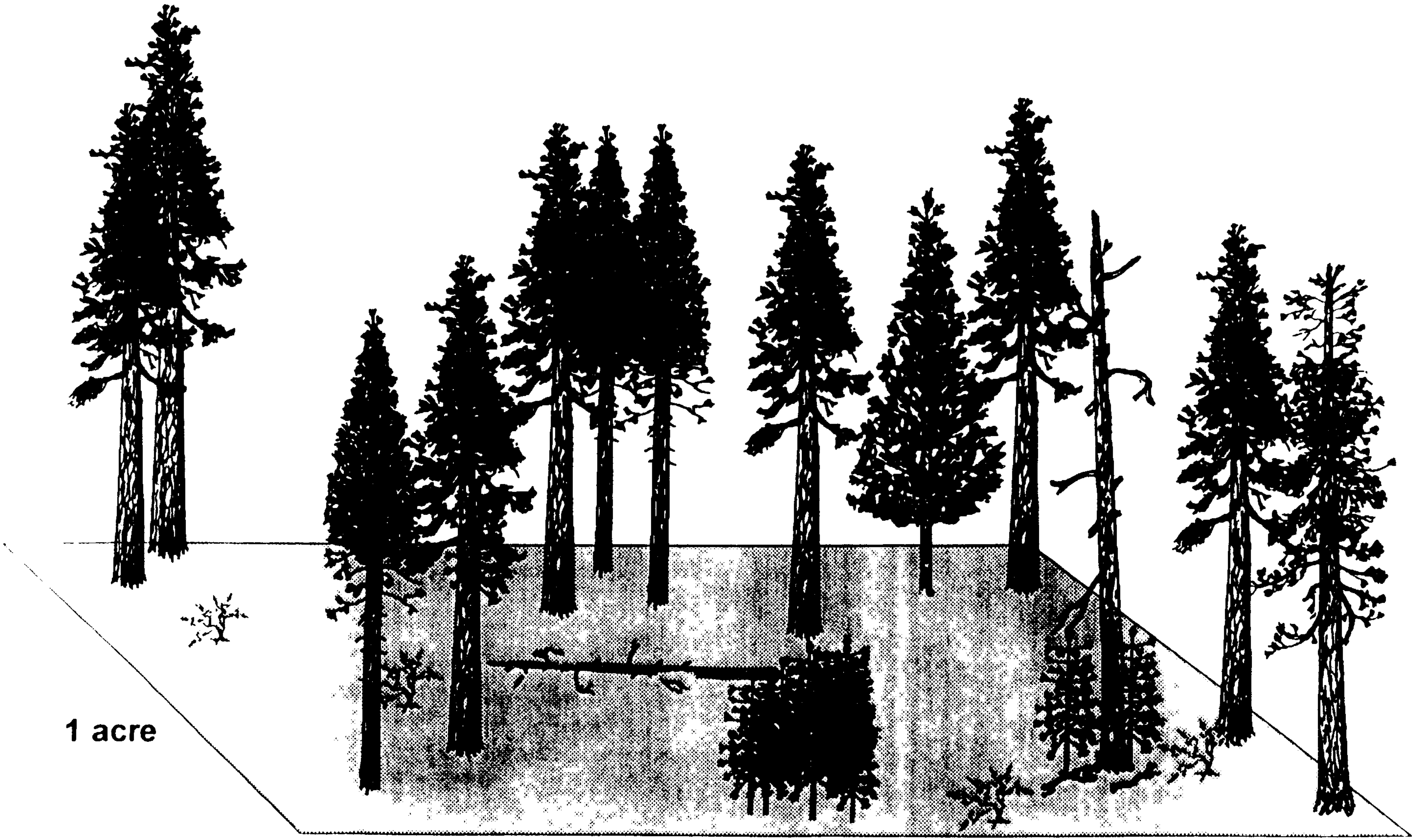
Dwarf mistletoe was probably present within the watershed in pre-management times. Theories suggest that this parasite has evolved through time with ponderosa pine trees. Mistletoe infections in understories which survived previous fires may have helped increase fire spread in stands with a more developed understory component.

No information exists as to the extent of root diseases and stem decays within the watershed prior to management activities. Root diseases probably exist more so in the mixed conifer types on Sugarpine Mountain. The pathogens for root disease are native to this area, so it is expected they have always been present, either at endemic or epidemic levels throughout the history of the watershed.

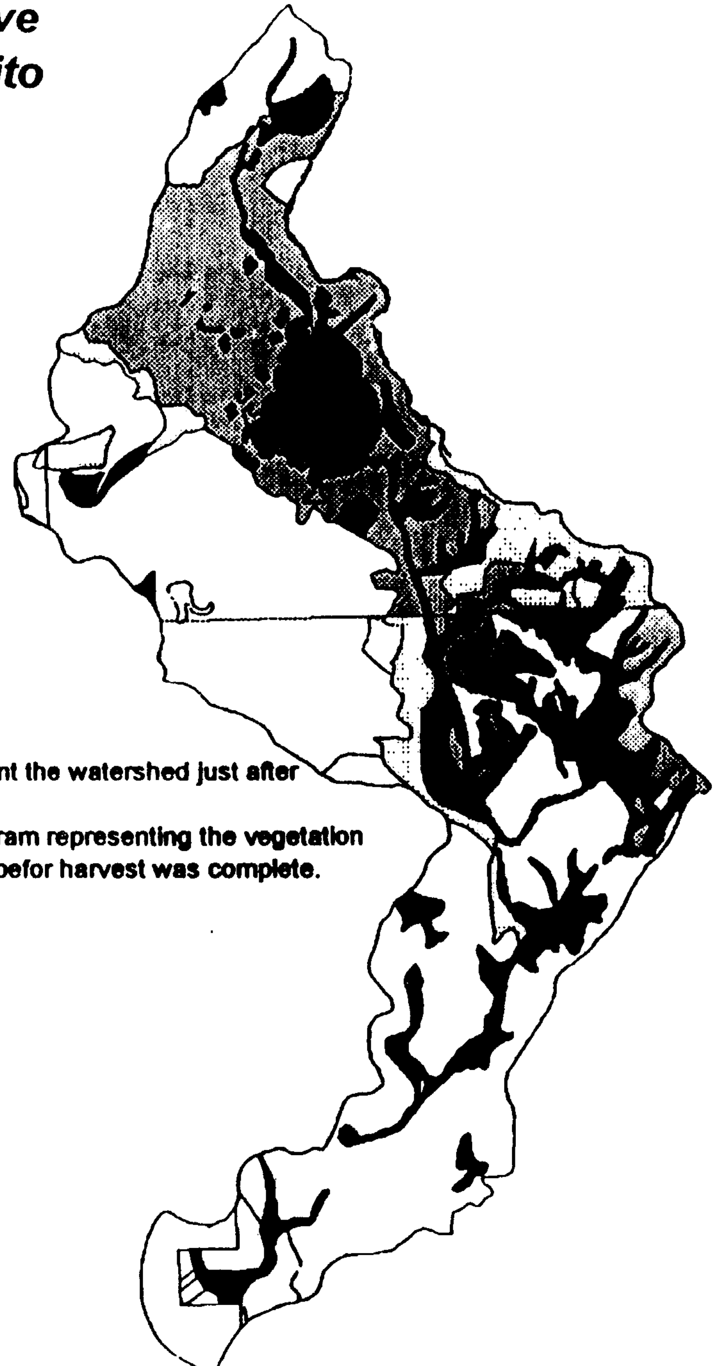
Present conditions
with several partial cut entries
diagram is conceptual, actual number
of stems produces a black print



Historic conditions



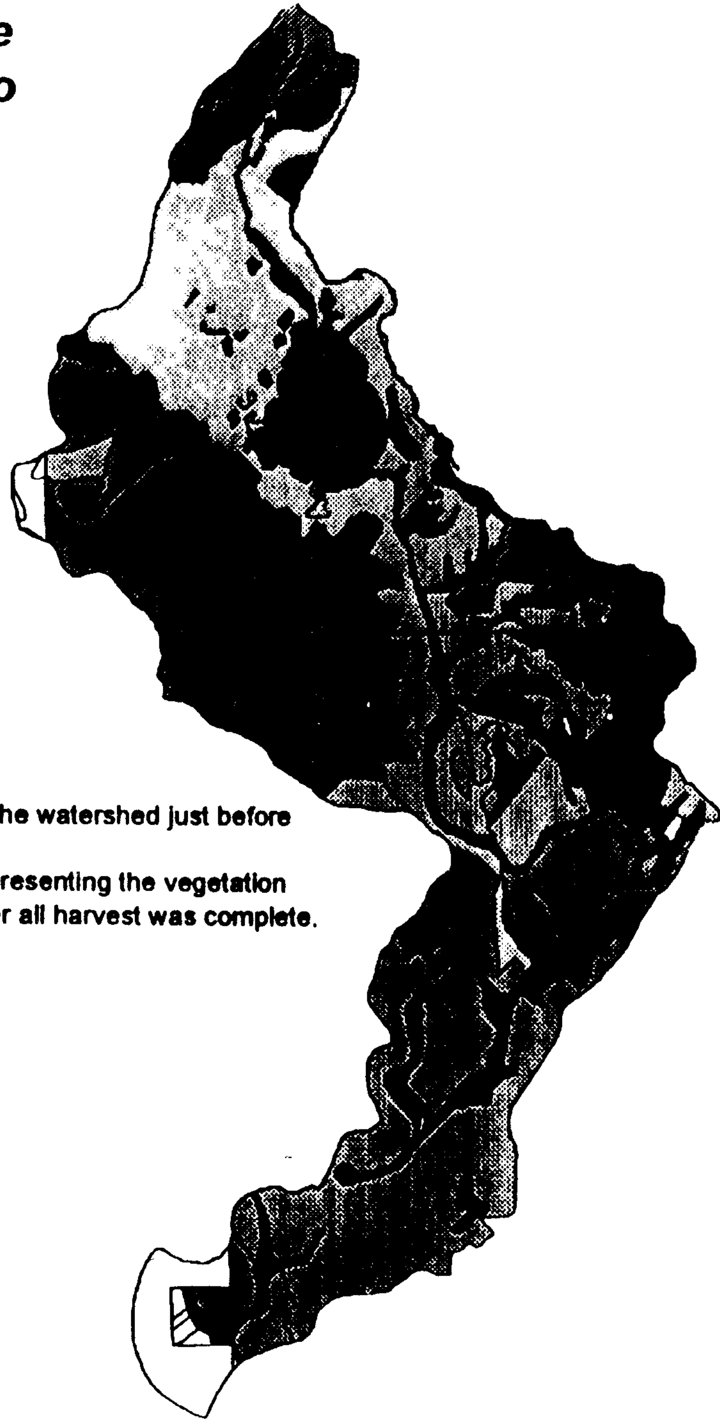
Conceptual Vegetative Condition Of Mosquito Watershed in 1950



This diagram is intended to represent the watershed just after the first logging ended in 1950
Contrast this with the previous diagram representing the vegetation condition of the watershed in 1940 befor harvest was complete.

shading reflects relative vegetation stocking/ density
darker is greater density or more soil moisture

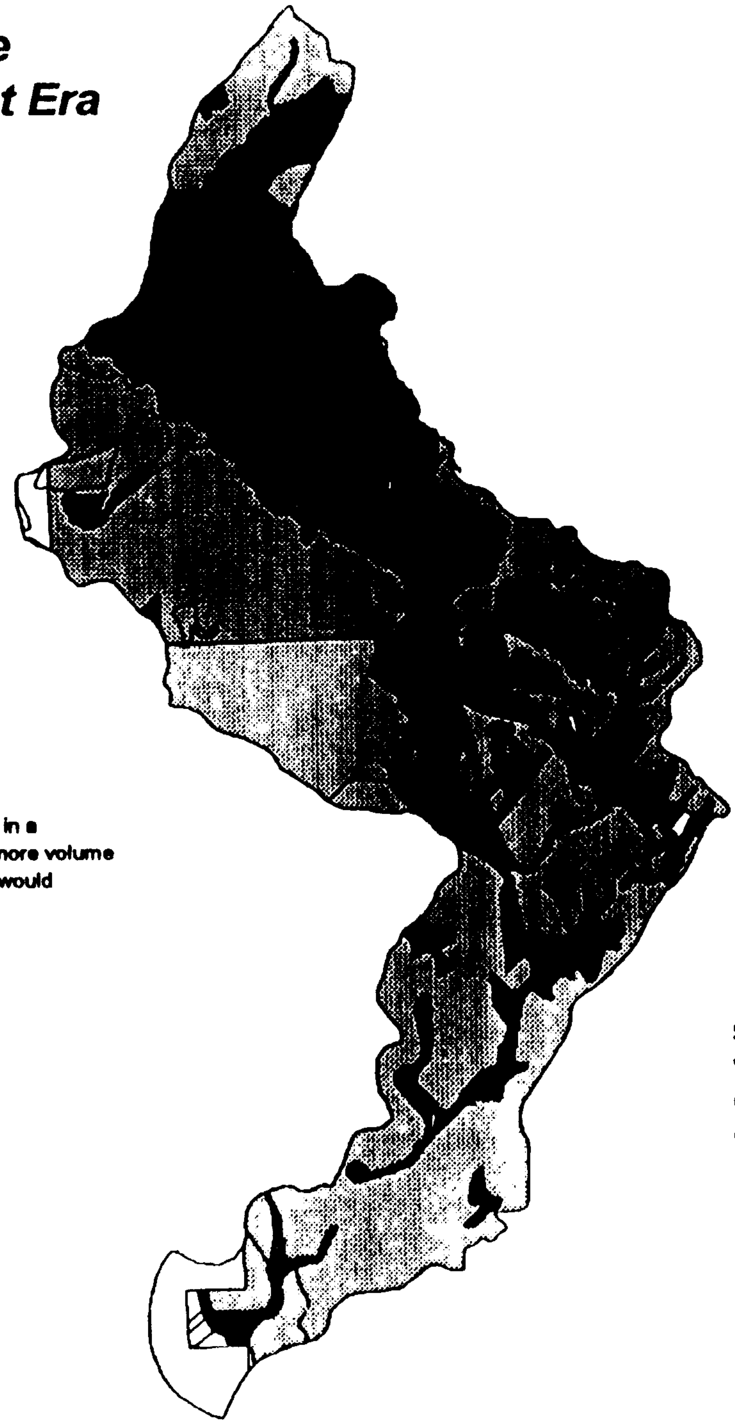
Conceptual Vegetative Condition Of Mosquito Watershed in 1940



This diagram is intended to represent the watershed just before the first logging started in 1941.
Contrast this with the next diagram representing the vegetation condition of the watershed in 1950 after all harvest was complete.

shading reflects relative vegetation stocking/ density
darker is greater density or more soil moisture

Conceptual Vegetative Condition Historic Wet Era Mosquito Watershed



This era is intended to show historic vegetation in a wet era, Wetlands and drainages would have more volume and longer periods of flow, vegetation stocking would be heavier than in dry periods.

shading reflects relative vegetation stocking/ density
darker is greater density or more soil moisture

Conceptual Vegetative Condition Historic Dry Era Mosquito Watershed

This era is intended to show historic vegetation in a dry era. Wetlands and drainages would have less and shorter periods of flow, vegetation stocking would be less than wetter periods, fire frequency may shorten or intensity may increase.

shading reflects relative vegetation stocking/ density
darker is greater density or more soil moisture

D. Wildlife

Riparian and Aquatic Habitats

Analysis of riparian structure and habitats in the Mosquito Watershed has, to date, been cursory and limited While developing the Winema Land and Resource Management Plan (LRMP), a series of maps was developed from infrared imagery that divided the riparian corridor into plant groupings (see Appendix I) This GIS layer is still in use as the basis of Management Area 8 During the analysis phase for the Mosquito EA in 1992, part of the lower Mosquito channel was surveyed for general trend and condition. Limited ground truthing of the map work done for the LRMP was completed during this effort.

In 1993, the Watershed Improvement Needs (WIN) Inventory was conducted in the Mosquito drainage. it appears the entire watershed was addressed in this program. A small portion of the drainage is monitored for neotropical bird use through the Region 6 Neotropical Migratory Songbird Monitoring Project. These sources, plus recent (1988) and historic (1952, 64, 69) aerial photography and approximately six days in the field have been incorporated into this analysis. This area was not surveyed during the ODF&W Aquatic Inventories Project (1991), nor by Klamath Basin Adjudication for water or streamflow data.

Riparian areas in the Mosquito Watershed represent a small portion of the total landscape (12%) but play a very significant role in the life history of aquatic, and (many) terrestrial animals. Typically, floral and faunal species richness is higher in healthy riparian areas than in adjacent upland habitats (Knopf, 85, DeByle, 85). In the Great Basin of southeastern Oregon, for example, 75% of the terrestrial wildlife species are either directly dependant on riparian zones or utilize riparian zones more than drier upland habitats (Thomas et al, 78). Structure and compositional diversity in undisturbed or "natural" riparian areas can be extremely high when contrasted to upland sites (Gregory et al, 91; Kovalchik, 87, Krausman et al, 85), a result of increased water availability (Groenevelde and Griepentrog, 85; Thomas et al, 79) and a deeper soil profile. The physical structure of diverse riparian plant communities provides a high number of dispersal, foraging, nesting and cover opportunities not found on drier upland sites. The linear nature of riparian areas provides connectivity between upland habitat patches and migratory corridors on an elevational cline. In general, the availability and quality of riparian habitats directly influence the dispersion and density of aquatic, riparian obligate and terrestrial wildlife species.

Historic Condition

The riparian resource in the watersheds was not static prior to land management activities. The channel, floodplain and associated habitats fluctuated in dynamic equilibrium, and were influenced by climatic and natural disturbance regimes long before anthropogenic disturbances began. The current, physical condition of the channels and floodplains strongly suggest that the extent of riparian habitats in the watersheds has decreased over the last century. Though a gradual decline in water levels in the Klamath Forest Marsh has occurred since the retreat of glacial ice, this process was accelerated by the alleged lowering of a basalt dike in Solomon Flat in 1908. Lowering of the water table of the Klamath Forest Marsh (or some other mechanism) in 1908 initiated a series of headcuts in the Mosquito Creek channel. Subsequent events such as extensive timber removal, fire suppression, dam construction, road construction, and livestock grazing promoted further degradation of the channel; directly and indirectly altering riparian vegetation.

Changes to riparian habitats resulting from these events are dramatic. Mosquito Creek is currently a Class IV intermittent system, though flow at Huckleberry Springs appears to be perennial in nature (see Gordon et al, 1992, for use of these terms). There is evidence, though anecdotal, that portions other than

Huckleberry Springs were perennial within the last century Lowering of local water tables, loss of beaver, channel degradation, and riparian and up-slope vegetation alterations have reduced the hydraulic retention of the system At a minimum, intermittent flows are reduced in duration from periods in the recent past

There is a high probability that the lower reaches of Mosquito Creek were in contact with the inundated portions of Klamath Forest Marsh in the latter part of the nineteenth century, and at other times in the past Marsh contact would have resulted in a higher permanent water table in the lower drainage Combined with perched surface water from beaver dams, reduced evapotransporation in upland plant communities, and well developed, functioning flood plains, year round instream water flow was the potential result. Given this scenario, Mosquito Creek then provided habitat for reproducing populations of fish and other aquatic organisms Native species that are currently found in the Upper Williamson River, of which Mosquito Creek would have been a surface tributary include Speckled dace, blue chub, tui chub, Klamath large-scale sucker, lampreys and redband trout. In addition, wildlife species that we recognize as riparian obligate would have had a broader distribution within the drainage.

Anecdotal evidence suggests that salmonids were present in Mosquito Creek up through or during the mid 1950's. Flow at various levels throughout the length of the Mosquito channel persisted well into late summer during the late 1950's (Pigg, 1962), and possibly later during wetter periods. If salmonids did occur in Mosquito Creek during the 1950's, stream conditions at that time were either perennial or long season intermittent, with year round refugia at various points in the system. Refugia for salmonids and other aquatic species was provided by beaver impoundments, which are known to have occurred in the lower reaches during this period.

In essence, three interrelated physical and biological processes are addressed in the analysis of riparian habitats. These are:

- Alterations in the interaction of the channel and floodplain; and the effects on riparian vegetation and habitats.
- Riparian hardwood communities and the effect of disturbance processes on these habitats.
- The physical and biological influence of beaver on the watersheds.

The lower reaches of Mosquito Creek are still degrading, and remnant riparian habitats in the drainage are continuing to decline. This is evident from surveys and observations of the Mosquito tributaries and mainstem channel from the private land boundary upstream to McCarty Meadow. The 1993 WIN Inventory identified seven specific sites in this series of reaches that had active headcuts or areas of channel down cutting. The WIN inventory estimated forty-two percent of the Mosquito mainstem channel below McCarty Meadow and sixty-seven percent of Tributary #5 (east of God Butte) is affected by head cutting or down cutting of the channel, or other erosional activity. In some areas, down cutting has resulted in thalweg depths of five and six feet (to a maximum of over eight feet) below the floodplain. In addition, an active head cut is lengthening Tributary #1 (T-1) in section 24. Though moving onto private land, Tributary #1 originated as a headcut on Federal Property (presumably in a wheel rut) sometime following the 1923 timber cruise (see interviews with Bowen, D. and Basey, C. in appendix II) Forest Service land around Tributary #1 and the mainstem channel below the 86 Road are receiving excessive, unregulated livestock use from the neighboring Lane Ranch; riparian vegetation in the bottom of these channels is "grazed to the dirt" by what appears to be season long grazing pressure.

How is down cutting of channels affecting wildlife habitat? The following example illustrates the complexity of the association between physical channel structure and habitat. There are two distinct grade control sections, or points, in the lower reaches of the Mosquito drainage. Moving upstream from the 86 Road bridge, the first is a cut and fill road crossing, perpendicular to the channel and forming a dike across the floodplain. Though temporarily restricting the upstream migration of the most recent of a series of in-channel headcuts, this road fill also forces flood water from the floodplain into the channel. Below the road fill, contact between the mainstem channel and the floodplain has not occurred for some time.

In-channel measurements indicate that high flow conditions within the last two seasons (1993 and 1994) did not exceed the streambank in this reach, though 1993 was a high flow year. The thalweg depth in this reach exceeds six feet in some locations, the average stream bottom width is 19 feet. Streambanks in this reach are steep, exposed and actively slumping, contributing sediment to the system. Willow (*Salix sp*) and other riparian species are not successfully reproducing along the channel or on the floodplain; lodgepole is the dominant understory and overstory species.

Upstream from the road fill, seasonal flows have been in contact with the floodplain within the last two years. Though variable, the measured floodplain here exceeds 165 feet. Riparian communities are distinctly different from those downstream, exhibiting a higher degree of floral diversity, specifically at the channel edge. Douglas spirea (*Spirea douglasii),* sedge (*Carex sp.*) and forbs compose the understory and ground vegetation, aspen (*Populus tremuloides*) the overstory.

Deepening of the channel is one of the mechanisms restricting the expression and reproduction of riparian obligate vegetation on what was historically the floodplain, as evidenced by the distinct differences in understory communities. The interaction of the floodplain and channel determines the extent of riparian communities laterally from the stream channel (Gregory et al, 91). Where flood plains are active, vegetative diversity is high the full width of the floodplain. Where contact between channel and floodplain is limited or has been eliminated, processes that maintain the high productivity of the floodplain, such as nutrient spiraling, sediment deposition, cycling of organic matter and seed dissemination do not occur (Junk and Sparks, 89) and the extent of riparian obligate vegetation is reduced. The expression of phreatophites such as black cottonwood (*Populus trichocarpa)* and some species of willow is a function of the depth of the watertable from the ground surface (Brooks et al. 91) and the ability of roots to reach the watertable (see Soils discussion on compaction).

The lack of reproducing riparian willow within the drainages indicates an altered capability of the riparian zone to retain water. Channel deepening has lowered localized watertables, specifically those associated with valley bottom riparian zones to the point where this preatophitic species can no longer survive and successfully reproduce.

Where flow is restricted to the incised channel for an extended period, the riparian zone will abandon the floodplain and become restricted to the width of the channel. This is occurring in the reach directly south of God Butte, where road construction adjacent to a beaver impoundment has resulted in a severely degraded gully over seven feet below the floodplain. Early seral vegetation is colonizing recently developed point bars and the channel edge at the bottom of this gully, and a new floodplain within the gully is forming. This is also occurring in the aforementioned reach below the road fill. The corresponding reduction of the area of the riparian zone from the floodplain width of 165 feet above the road fill to a channel bottom width of 19 feet below the road fill represents a significant (88%) reduction in the amount of riparian habitat available to aquatic and terrestrial species within these specific reaches. The extent that riparian zone restriction has occurred in other reaches is unknown, but where extensive channel deepening has occurred, the reduction in floodplain riparian habitats will also be extensive.

Biologically, the reduction of riparian zones on either side of Mosquito Creek represents a loss of nesting and foraging opportunities, which corresponds to a reduction in the numbers of individuals that can effectively utilize the riparian resource

Riparian communities in sections where streamflow can no longer make contact with the floodplain due to incision or diking, as described above, will be restricted to within the incised channel These riparian communities are, and will continue to be greatly reduced from historic conditions for a long period without extensive and costly restoration Channels and flood plains will recover to some intermediate state resembling the former condition following the movement of extensive amounts of sediment, widening of the channel and a liberal allowance of time

Riparian Hardwood Communities

Riparian hardwood communities are linear corridors of high diversity in a landscape dominated by conifers, and receive extensive use by numerous species of wildlife. Riparian hardwood communities provide forage and cover for mule deer and elk, and are especially important as fawning and calving areas for these species. Hardwood communities provide foraging and nesting opportunities for resident birds and mesic micro sites for amphibians and invertebrates (DeByle, 85). Riparian aspen sites in the watersheds have been identified as important nesting habitat for neotropical migrant species such as the red-breasted, Williamson's and red-naped sapsuckers, and several species of flycatchers (Bettinger, 94) Riparian hardwood communities with high components of willow, aspen and cottonwood are the forage base for beaver in aquatic systems (Olson and Hubert, 94).

Riparian hardwood communities comprise a fraction of the landscape in the interior west; less than five percent of the Mosquito Watershed is in a riparian hardwood plant community. The aspen dominated riparian hardwood plant community is thought to be rare on the Chemult Ranger District (Olmedo, pers com. 1994). Black cottonwood is extremely rare in the upper Williamson River drainage (Jean, pers com. 1994), and is considered "at risk" in the Eastslope Cascades Province by a number of authorities (Jean, 95). Evidence indicates the extent of the aspen plant community is in decline in the watersheds

Riparian area mapping for the Winema Land and Resource Management Plan (LRMP) indicates roughly twenty-eight percent of the Mosquito Watershed riparian zone is in a hardwood plant grouping. This is the best riparian mapping done on this drainage to date, thc . gh it should be noted that this mapping was intended for broad scale planning only (Frazier, pers. com.)4), not site specific management actions or to indicate trend. Mapping was done using plant dominance groupings, and polygons are identified by codes. These are rather loose groupings; the reader should refer to documents associated with the LRMP planning effort for clarification of codes and objectives (see Apppendix 1 for further discussion). Limited ground verification was attempted in 1992; this effort is incomplete and probably inadequate for the manipulation of riparian habitats.

For the analysis effort, we recognize two major riparian hardwood groupings: deciduous forest-dominated community types and shrub-dominated associations (see Kovalchik, 87). We assume that riparian deciduous forest community types are seral to riparian conifer communities (Ibid.) and are maintained in disclimax or are rejuvenated in a cyclitic manner through periodic disturbance.

Disturbance regimes that shaped and maintained deciduous riparian communities in the watersheds are periodic wildfire, inundation resulting from beaver impoundments and, to a lesser extent flooding. These elements of disturbance are discussed elsewhere in this analysis.

Shrub dominated riparian associations are closely tied to soil structure and the proximity and duration of the watertable to the ground surface Typically, shrub dominated associations are found where the watertable is high (within ninety centimeters of the ground surface) during most of the year, but may drop to lower rooting depths in late summer or during droughts (see Kovalchik, 87) Lowering of local watertables through channel down cutting can result in a decline in alder and willow communities (Kovalchik and Chitwood, 90, Youngblood et al, 85), as can extensive herbivory (Kovalchik and Elmore, 91, Bohn and Buckhouse, 86, Hayes, 78) Successional replacement by conifers of shrub dominated communities also occurs, though this has not been adequately addressed in the literature. Shrub dominated associations appear to be closely linked with meadows

Small stands and individual aspen trees are found in a narrow stringer on either side of Mosquito Creek and it's tributaries in roughly the lower one-half of the drainage. Why the upper portion of the drainage does not currently contain a well distributed hardwood component is unknown, though it has been suggested that successional replacement has occurred here as well. Only seven percent of the area mapped as hardwood community (the HW grouping) is identified as not having a conifer component or mix. The remaining ninety-three percent of the hardwood communities detected during infrared photo analysis contained a high conifer component. The high degree of area in HCM and HCW (Hardwood/Conifer mixed) groupings suggests that ninety-three percent of that area mapped as hardwood community is moving toward the latter stages of successional replacement by lodgepole as a result of the interruption of disturbance regimes, specifically wildfire and long-term inundation by water The extent of successional replacement of hardwoods by overstory conifers is illustrated by the following example.

The first three hundred meters of channel and floodplain upstream from the 86 bridge contain numerous down, decomposing aspen trunks, many showing evidence of beaver. On a short (120 feet) longitudinal transect in this reach, forty-five percent of the coarse woody material in channel was aspen. There were no aspen trees remaining in the overstory along this transect. Aspen reproduction is extremely limited throughout the entire reach. Conversely, lodgepole pine reproduction is extensive on this site and is represented in all layers. Directly upstream is "Permanent Neotropical Monitoring Station #1", which is a similar aspen community in an earlier successional state; that is, the overstory is aspen, the understory contains increasing lodgepole reproduction. The linear nature of the aspen community has now become patchy, and patches are becoming further reduced in area.

Other hardwood sites visited during the limited field period include several small aspen clumps near McCarty Meadow and along the channel upstream from there. Consumptive forage use by livestock and wildlife undoubtedly contribute to the lack of aspen reproduction on these sites; successional replacement, however, appears to be the driving force in the reduction of these communities.

Fifteen percent of the area in riparian associations in the Mosquito Watershed are meadow communities These meadows are currently classified by the "meadow moist/meadow dry" classification scheme developed for the Winema LRMP planning effort. This classification system does not attempt to address the ecological potential, trend or vegetative composition of the meadow community. For example, the Mosquito EA planning effort classified McCarty Meadow as "Meadow Moist". Review of aerial photos indicates that where a developed channel is obvious, significant drying of the meadow has occurred. Field review of McCarty meadow indicates that meadow drying is associated with slumping and gullying in a discontinuous, deeply incised channel. Where slumping and gullying has not yet occurred, willow is a major component of the habitat over a graminoid layer of sedge, representing a higher moisture level in the meadow. The combination of road construction above and through the meadow, diking and livestock grazing have resulted in a progressive conversion of this meadow from a willow/sedge plant association to a Kentucky bluegrass community type (see Kovalchik, 87).

The extent that replacement of shrub dominated communities has occurred in other meadows is not known However, down cutting and head cutting have been identified in four other meadows through the WIN and watershed analysis process It is reasonable to assume that where down cutting of the channel through the meadow has occurred, lowering of the local watertable has occurred as well Additionally, all four of these meadows receive livestock use, which has been shown to be detrimental to riparian vegetation (Kauffman, 83b, 84, Platts 90b, 85a, 85b), channel morphology (Platts, 85a, Kauffman, 83a, Hayes, 78, Marcuson, 70) and rate of water infiltration (Rauzi and Hanson, 66) when not properly regulated Where lowering of the watertable is occurring in these meadows, conversion from willows to dryer communities is expected.

It is my contention that riparian hardwood communities are becoming extremely limited within the watersheds when placed in a historical context, and should be considered at risk under current fire and timber management. Further site specific analysis should be conducted on the viability and extent of riparian hardwood communities for the drainages using Kovalchik's "Riparian Zone Associations" prior to site specific vegetation manipulation. In addition, we will need to address the extent of riparian hardwood communities on a larger scale than individual subwatersheds. Restoration of these communities through prescribed burning, control of trespass livestock improvement of channel conditions or other appropriate means should be conducted as a management priority.

There are no longer beaver in the watersheds. There is ample evidence that beaver did inhabit the watershed until roughly 40 years ago. Over the course of the last century, conditions have become such that habitat within the watershed is no longer suitable for this species. Habitat suitability for the beaver is a reflection of the available food resource, primarily small diameter (Dieter and McCabe, 89) willow and aspen. As described above, aspen communities are cyclic in nature, and must be periodically rejuvenated by disturbance.

One element of disturbance was inundation of the floodplain, brought on by activities of the beaver colony Inundation of a specific reach of stream made conditions unfavorable for conifers but highly favorable for alder (*Alnus sp*) and willow, major forage species of beaver. When food supplies in and adjacent to the impounded section of creek were exhausted, dams and lodges were abandoned, and the colony migrated up or down stream. Collapse of the dam and subsequent drying of the floodplain fostered recolonization by aspen and cottonwood, which eventually led to recolonization by the beaver (see Olson and Hubert, 94).

Beaver play an important role in low gradient streams, both functionally and biologically. Structures emplaced by beaver are often built in series and typically create lower gradient pond habitats in flowing systems, often inundating the floodplain for extended periods, possibly decades. Each beaver dam in the series has some storage capacity, so impoundments collectively can reduce peak discharge during high flow events (Parker et al, 85). Reducing the channel gradient slows water, dissipates water energy and allows sediment to settle to the pond bottom or on to the floodplain. The improvement in water quality can be significant. B.H. Smith (1980), for example, reported that stream sedimentation below beaver dams was reduced as much as 90%, though this figure certainly varies between sites. Beaver dams, a "continuously renewed, erosionally resistant substrate" (Parker et al, 85), effectively resist erosional perturbations up to a threshold (Ibid.) as long as they are maintained by the beaver. Conditions that exceed this threshold are typically those that result in large, rapid increases in stream discharge, such as rain on snow or extreme flood events.

The biological importance of beaver dams is that they greatly increased the hydraulic retention of the system, allowing for a slow discharge of water throughout the driest parts of the year. This occurred in several manners. Impoundment greatly increases the area of contact between the ground surface and standing water. Increasing the area and duration of contact allows a higher rate of infiltration to lower substrates than occurs from precipitation The actual impoundment creates a pond, the volume of which was determined by substrate, gradient and other factors, typically lasting year round and providing a sometimes slow but steady trickle into the channel

Water availability greatly affects the suitability of the habitat for virtually all wildlife species Standing or flowing water during August and September may determine which species will actually be present in the watershed and those that will not. Take, for instance, the western toad, *Bufo boreas*. Tadpole metamorphosis does not occur until late summer or early fall in this species, so western toads are dependant on standing water through the driest portion of the calender year. The loss of beaver from the system results in a habitat loss for a critical portion of the life cycle western toad, greatly restricting the reproductive opportunities for this species. Fish, bats, waterfowl, and some species of reptiles utilize beaver ponds as elements of habitat; beaver ponds are slack water refugia for aquatic species during high and low flow periods (Meehan, 91).

Is the re-introduction of beaver plausible at this point? Further analysis is certainly in order, but it should be recognized that current habitat conditions probably are not suitable. Until such time as aspen, willow and alder are at early seral stages and abundant within the drainage, re-introduction would probably fail Current channel condition (incised, actively down cutting) and the subsequent low retentiveness of the system would suggest failure as well.

Aquatic and Riparian Obligate Species

Fish

As noted earlier, fish species are not currently present in the watershed. Anecdotal evidence suggests the presence of brook trout (*Salvelinus fontinalis*) in the watershed in the mid 1950's. Fish have not been present in the Mosquito watershed since at least 1970 (Fortune, pers. com. 1994). Habitat conditions are not suitable for fish at this time.

The speckled dace is present in the Jack Creek Watershed. It can survive in any small pool that lasts through the summer. Other fish such as suckers and trout do not have access to Jack Creek, except under high runoff situations when the Williamson River and Jack Creek are linked, which last occured in the late 1960's.

Amphibians

Amphibians as a group are very sensitive to environmental change. Alteration, degradation or physical loss of wetland habitat, regardless of the cause, can adversely affect individual or multiple aspects of the life history of most amphibian species, as all amphibians are reproductively connected to flowing or standing water. Not only does the physical presence of standing or flowing water determine the reproductive opportunity for amphibians, but the ephemeral duration of streams or pools can determine the breeding success.

Amphibian, reptile and mollusk surveys of the Mosquito Watershed have not been completed or even attempted. A limited survey of reptiles and amphibians was conducted on the neighboring Jack Creek watershed with limited results. Habitats for amphibians, however, can be assessed in a rudimentary fashion by examining the existing condition of the stream structures that currently or historically contained water, assuming that one can adequately identify key elements of critical habitat.

Of the four anuran families represented in the Klamath Basin, the following four native species should be found in the Mosquito Creek drainage

Rana pretiosa	(Fam Ranidae)	Spotted Frog
Pseudacris regilla	(Fam Hylidae)	Pacific Tree Frog
Scaphiopus intermontanus	(Fam Pelobatidae)	Great Basin Spadefoot
Bufo boreaus	(Fam Bufonidae)	Western Toad

The Spotted Frog, *Rana pretiosa*, is a Federal category 2 species and a species for which listing as threatened or endangered in Oregon is pending. This species has experienced dramatic reductions in range in the past fifty years, and may have been extirpated from the west side of the Cascade Mountains in the pacific north west (Leonard et al., 1993) Reasons for this decline are as yet not fully understood, but there is a definite relationship between wetland habitat degradation and population decline (Hayes, 1986, Leonard et al, 1993) and the introduction of non-native predators and population decline (Leonard et al, 1993). For the spotted frog, suitable ovoposition, nursery sites and refuges for hibernating adults are probably critical aspects of habitat (Ibid.). These aspects of the spotted frogs' life cycle involve standing water; the Spotted frog has a close affiliation with aquatic habitats for many, if not all, aspects of it's life cycle (Leonard et.al. 1993). Alterations of water quality or water availability, as has occurred in the watershed as a result of management activities can reduce habitat suitability for this species.

Recent surveys for the spotted frog have identified populations within the Klamath Basin in the Wood River and Spencer Creek drainages (Hardy, pers. com. 1994) but not within the Jack Creek system (Olmedo, pers. com, 1994). Subsequent investigation has located a large population of spotted frogs, possibly the largest remaining in the Klamath Basin, in Klamath Forest Marsh, directly south and previously connected by surface flow to the Mosquito Creek Drainage.

On the Klamath Forest Marsh, adult spotted frogs have been found rush/sedge and grass/forb habitat types with distinguishably different moisture regimes. Initial observations in June, 1994, were of two adult frogs in a grazed Deschampsia/Poa meadow that bordered an active drainage ditch. Tadpoles were found in this ditch in late June, though by that time flow within the ditch was intermittent. Sub populations were later found in several areas including Carex/Scirpus communities in the Big Springs area.

Breeding habitat for the Klamath Forest Marsh populations has been characterized as being in "very intermittently flowing" drainage ditches, many of which cease to flow by early summer and become isolated pools following marsh drainage or pumping. Within the basin that forms Klamath Forest Marsh, these pools represent the intersection of the ground surface - albeit excavated for irrigation - and the water table. These breeding pools receive a regular influx of ground water, as evidenced by significant water temperature gradients from the surface to the bottom during the breeding period (Drew, pers. com. 1994). These conditions are very similar to those found in the Mosquito Watershed. One would thus expect to find this candidate for federal listing in this drainage.

The Pacific Tree Frog or chorus frog, *Pseudacris regilla*, is common in riparian habitats throughout the Pacific Northwest. Populations of the Tree Frog were found in the Jack Creek drainage in a survey in 1994. This species is expected to occur in the Mosquito Watershed.

The Great Basin Spadefoot, *Scaphiopus intermontanus*, is well suited for xeric upslope areas in the eastern Klamath Basin where they inhabit sagebrush and open Ponderosa pine habitats (Leonard et al., 93) Breeding and embrionic development are extremely rapid in this species, so streams and pools with short intermittency or seasonality are suitable breeding locations, though perennial systems with slow or slack water environments are certainly suitable as well This species is expected to occur in the Mosquito Watershed

The Western Toad, *Bufo boreas*, is found throughout the Klamath Basin, but is most common near marshes or lakes The western toad is a sensitive species in Oregon, though reasons for the decline of this and other amphibians are unclear Tadpole metamorphosis does not occur until late summer or early fall, so western toads are dependant on standing water through the driest portion of the calender year. The duration of intermittent flow directly effects the breeding viability of this species. The loss of beaver from the system may have had dire effects on the western toad. This species undoubtedly bred in the Mosquito watershed. Two individuals of the species were found in the extreme lower reach of Mosquito Creek in March, 1995

The bullfrog, *Rana catesbeiana*, was intentionally introduced into the Pacific Northwest to replace diminished populations of native frogs that were used as a food resource. The bullfrog is a known predator of many native species of amphibians, fish and reptiles, and has been linked to declines in the spotted frog, leopard frog, and western pond turtle. In eastern Oregon, the bullfrog is localized and not yet widespread, though the trend appears to be toward a broad distribution.

The bullfrog is known to exist in the tributaries of Klamath and Agency Lakes, including the Sprague and lower Williamson Rivers, and has recently been found north of the peninsula in Klamath Forest Marsh. This indicates that the bullfrog has entered the Upper Williamson drainage, and will probably expand to the headwaters inside of a few years if this has not already occurred. Expansion of the bullfrog into the upper Williamson drainage, to include Mosquito and Jack Creeks, could prove non-beneficial to many aquatic organisms (Hayes, 86)

Conditions are favorable for expansion of the bullfrog into habitats once dominated by native amphibians Not only is the bullfrog substantially larger than most native species, but the bullfrog may be better adapted to the conditions of riparian habitats that result from land management activities. Bullfrogs appear to be able to tolerate higher breeding temperatures in the pre-metamorphic stage than other ranids, so increased water temperatures, a symptom of many grazed riparian systems, may favor bullfrogs. (Hayes, 86). Conversely, the bullfrog is not well suited to systems that are not perennial, so the conversion of perennial systems to intermittent systems may favor native species such as the spotted frog.

Two native species of salamander are known to occur in the Klamath Basin; only one is expected in the Mosquito Watershed. The long toed salamander, *Ambystoma macrodactylum* is fairly common in the pacific northwest, and breeds early when conditions are favorable. Larval development is rapid; environmental conditions can influence metamorphosis and delay maturity until the second and third year Intermittent streams without year-round refugia may or may not be suitable habitat for the long toed salamander.

Invertebrates

Very little information is available on aquatic invertebrate communities in the watersheds. Significant differences exist between invertebrate communities in perennial systems and intermittent systems There have been no observations of the threatened species of caddisflies within the analysis area, though there may be some areas that provide habitat for two species of concern, Schuh's Homoplectran Caddisfly and Fisher's Caddisfly These species are typically associated with perennial water sources

Habitat Summaries

Plant Community Summaries (Appendix D) lists various components of the different plant communities and the wildlife species which use of these communities The communities are tied in with the Forest Species List Categories within each plant community show different time periods; i.e., Pre-1900, 1900 to Present Future Trends are predicted based on no management, continuing current management, or management toward returning to 1900 conditions A note and Reference guide is there for the user, to refer to pages of this analysis with supporting documentation. Below each time period, general conditions of the plant community are noted, such as Dominant plants, water conditions, and disturbance regimes (ex. fire, man activities) Below each time frame is a general grouping of wildlife species (ex. woodpeckers, bats, big game, etc.). Along with the wildlife grouping, there is a note of presence of that particular group. For example, woodpeckers under 1900 time frame we would expect that as a group they would probably be more cyclic, likewise under 1900 to present, we would expect there to be less numbers/species of these birds present.

Under the future trends, three different management strategies are presented, i e , no management, an attempt was made to show the expected results of the plant community and the resulting response we would expect from the wildlife groups Below the species listed is a general condition of habitats, i e, "habitats sustainable", and what one would expect the conditions to be barring major events, such as major earthquakes, storm events, etc

Mixed Conifer Community Summary

This community is very limited in the analysis area, and is limited to the higher elevations of Sugar Pine Mountain Prior to 1900, based on literature searches, it is felt that this community was probably dominated by ponderosa pine, with small representation of white fir, incense cedar, sugar pine, and lodgepole. This community was similar to the juniper/mountain mahogany communities of the great basin, in its response to fire. There would be a periodic moving down slope of the fir, until periodic fire would come through pushing the fir back upslope to the cooler moist areas. The wildlife species present would cycle in response to the conditions present, probably most species that use this community were represented although at times their numbers were fairly low depending on when fire ran through parts of the community. After 1900, with the intense logging, road construction, and fire suppression, the habitats changed to allow more white fir and brush to become more prevalent and dominant in this community. This in turn favored different wildlife species, ex. where white headed woodpeckers, may have been more obvious prior to 1900, after 1900, pileated woodpeckers should be more prevalent, although it is felt that the pileated woodpecker's present today are an isolated population, and from time to time may not be present in this area.

Future Trends

Three scenarios that are depicted are no management, managing the area as it is today, and managing the community towards 1900 conditions. There are several other scenarios that could occur, and only time will tell where this community will end up at any given point of reference.

If little timber harvest or prescribed burning becomes the future trend, it is expected that the dominant plants will remain the same although there is a potential of a stand replacement fire. If this fire does occur, due to the higher plant density, the fire will burn hotter and faster, this in turn may keep the community in lower successional stages for a longer period of time, favoring those species dependent on these stages of community development(ex. mule deer, elk, pocket gophers). A good example of this is the Cave Mountain Burn on the Chiloquin Ranger District. If the above mentioned area had not been replanted there would be more brush fields present today. Under the no management scenario, brush fields would be dominant for longer periods of time, restricting conifer establishment in this community. The water cycle will be variable under the no management strategy, since most roads would still be present with their effects on ephemeral drainages, it is expected that during the high plant density, that water flow would be reduced, and if fire moved through the community, the amount of available water would be increased. Some discharge points (seeps, springs) may be rejuvenated. Late seral dependent species, would not be present in the community for extended time periods if this type of fire occurred

Continuing current management into the future, parts of this community will stay in earlier stages of development. There will be periodic reentry into the community to manage the timber stand. There will probably be increased roads with added effects to ephemeral and intermittent drainages, which will effect timing of available water flows. Potential for stand replacement fires will be lower, but still present. This management strategy will favor wildlife species more dependent on the early to mid stages of community development, and tolerant of continual disturbance.

Also, those species that tend to immediately respond to these earlier stages will expand their populations very rapidly Habitats for late seral dependent wildlife will tend to be smaller, and those species will continue to experience declines in their distribution and population numbers

The third strategy is to manage the community towards its 1900 condition, which would be to favor larger trees, lower plant density, especially the density of white fir in the community At the same time controlled fire would be reintroduced into the community, along with restoring roads to a more natural condition These actions would start to restore the water cycles, allow discharge points if present to start their water flows, and make existing water supplies available to a larger area

At the same time those wildlife species that are more dependent on later successional stages would have the opportunity to use this community. This will take a long time period to achieve, management activities would initially be more evident the first 20 years, but as the management objectives start to become evident the maintenance of this community should become less frequent, and management activities should not be as obvious.

Ponderosa Pine and Upland Lodgepole

Prior to 1900, both of these communities were more open, there was less bitterbrush present, and more grass and forbs, the overall plant density was lower. Periodic fire kept the stands in this condition. The main difference between these communities was that the ponderosa tended to occupy more ground and generally be older, while the lodgepole tended to be younger. Wildlife species that used these communities tended to be dependent on the later stages of successional development. Generally there were less big game animals, and more raptors, bats, and owls. The habitats provided were sustainable over longer time frames.

Presently these communities have a higher plant density, more bitterbrush, less water moving through the communities, more roads, and more management activities are needed to keep the communities in the earlier stage of development. Wildlife use in these communities are those species that are dependent more on the early to late development state with very little fire moving through the community. Any fire that does occur will in most cases, take these communities to the bare ground stage, and require a longer time frame to get back up the successional ladder.

Future trends are pretty much the same as the mixed conifer community. using the three different management strategies. Wildlife species response to the different strategies is expected to follow similar paths depending on the strategy selected.

Wildlife species that depend on these communities today, were present prior to 1900, however the make up of species has changed where we now have more big game use, prior to 1900 there probably was very few of these animals. Conversely, prior to 1900, there were probably more owls, now there is a high probability that there are fewer owls (e.g. northern pygmy owl, saw-whet owl). Wildlife species and numbers of wildlife will respond according to which future trend of management is selected for this community (Thomas, 79).

If management is selected towards 1900, one would expect that big game populations would probably become lower, northern goshawks would probably increase.

If management decides to not manage these communities we would expect in the short term that the current trends of existing wildlife species that use this community would continue until some major event or the community degenerates with stagnation, which will tend to start favoring other wildlife species If current management is selected, we would expect less late seral dependent species, and more early to mid-seral dependent species to be present.

Upland Brush/Rock Communities

Prior to 1900, these communities were probably more visible, even though they make up a minute part of the landscape These communities probably had a higher component of grass and forbs, with no or little conifer influence After 1900, extended fire suppression allowed the brush and conifers to dominant, this made these habitats favor some raptors, while discouraging others from using them These, especially the rock, communities under present management are generally avoided due to their uniqueness. However, some harvesting of timber and road construction has taken place affecting their role in the cycling of water, and providing habitat for wildlife. If the current fuel treatment and lack of prescribed burning continues, these communities could prove to be ignition sources for major fires, which will result in changes in the wildlife species currently using them. One would expect, in the short term, more mice, big game, and carnivores (coyotes, bobcats, mountain lions) to be drawn to these areas as their prey base expanded in numbers. As successional development of the plant community changed so would the prey base and the predators. If these areas are managed towards 1900 under a controlled fire system, one would expect prey bases to become less eruptive in population growth, and a general leveling off of species dependent on early plant community development.

The primary effects on and changes to wildlife habitats are the result of long term fire suppression combined, direct habitat alteration and increased disturbance with a high density of road systems, and broad scale timber harvesting that has dominated most of the watershed. Lodgepole pine harvesting has definitely affected the primary goshawk foraging and nesting habitat associated with the main channel of Mosquito Creek. The road systems in place have changed the water runoff timing and quantity, along with drying some of the wetter riparian systems, although there is no data collected within the analysis area that supports this supposition. Road systems have potentially added more human disturbance to all wildlife species and their use of habitats which, given the different tolerance levels of the above mentioned species, has probably decreased the overall effectiveness of the habitats used by them. Long term fire suppression has added more stress to the older conifer stands by allowing understory vegetation to increase over time.

Fire suppression has probably increased the water evaporation and transpiration into the atmosphere by the overall increased amount of vegetative growth both in and outside of the analysis area. This moisture then is obviously not available for surface water flow and underground water storage within the watershed. This has probably dried up some spring areas, and changed the length of time that water flows in the intermittent and ephemeral channels. All of these actions have led to a change in habitat conditions for wildlife, and a highly probable change in the number and composition of wildlife species that use the analysis area.

Combined with the effects of the above activities is the historic use of this area by livestock. This has changed the plant species composition of some riparian areas; favoring some wildlife species while putting others at a severe disadvantage.

Terrestrial habitats

The fauna native to the Klamath Basin evolved within a variable range of climatic, vegetative and disturbance-based conditions. Though differing peaks and valleys within this range of habitat conditions periodically favored some wildlife species over others, the wildlife communities represented today were well established prior to management activities. Though the native wildlife species currently found in the region were present at any given time in the past, the spacial distribution and density of individuals fluctuated in response to cyclic or stochastic changes in the availability and suitability of habitat

Resource extraction can, simplistically, be considered a non-cyclic fluctuation in available habitat patches specific to individual species or guilds Climatic and conditional habitat fluctuations, when combined with additional induced alterations to the habitat, can force the extirpation of some species through a reduction in habitat suitability This is the case of the beaver and possibly other species in the Mosquito Watershed

There is a direct relationship between wildlife population density (the number of animals of a given species in a given area) and the suitability of the habitat that species occupies (Krebs, 94), though this relationship is not well understood for most species. Habitat is composed of three distinct elements - water, food and cover - necessary for survival of the individual (Thomas, 79). Occupancy of a habitat more suitable to the animal often results in the production and recruitment of higher numbers of offspring than occupancy of less suitable habitat. Wildlife populations may flourish when habitat suitability is high for the given species. Conversely, habitats with poor suitability or quality can adversely affect survival, reproduction and recruitment of the occupant species. Habitat conditions can reach the point that the species can no longer occupy the site or environment, and extirpation or local extinction occurs

Widespread habitat conditions that favor one species or a group of species may disfavor others. For example, throughout much of south central Oregon (and, in fact, much of the western United States), management activities such as livestock grazing, fire suppression and timber extraction in the late nineteenth and early part of the twentieth century set the stage for a dramatic increase in mule deer numbers from the 1940's through (about) 1965 (see Patton, 92).

Other groups, such as native fish stocks, amphibians and late seral dependant species found habitat conditions less favorable because of these activities and declined as a result. Mule deer numbers are much lower now than thirty years ago, again largely as a result of habitat change. Other factors certainly play a significant role in the density of mule deer in the Klamath Basin, however.

Current habitat conditions likewise favor some species over others. A recent report by Foster (1994) indicates that the Mosquito watershed is currently used quite heavily by locally migratory elk, whereas historic documents indicate extremely limited elk distribution fifty years ago in the same area (Moore, National Archives Document #1).

Terrestrial Wildlife Species

Birds

Proposed, endangered, threatened and sensitive bird species that may occur or have been documented in the Mosquito Watershed are: American Bald Eagle (LT), Peregrine Falcon (LE) and the Northern Goshawk (C2).

Bald Eagle, *Hailaeetus leucocephalus*

Although there are no recorded sightings, there is a moderate probability that the bald eagle may use the southern portion of the watersheds. Habitat elements that would effect use of this area by bald eagles is are the proximity of open water and the availability of prey. Open water in the Williamson River or Klamath Forest Marsh is probably three miles away at it's closest point. Eagles prefer large conifers that are within a couple miles of marshes, rivers, lakes, and streams for nesting and perching habitat. There are other areas with large conifers, but they are not located with direct flight paths to a large marsh like the upper Klamath Marsh, or to a perennial river such as the Williamson River

Peregrine Falcon, *Falco perignius*

The peregrine falcon nests in Crater Lake National Park and has been observed to forage near the upper Klamath Forest Marsh and the Williamson River It is possible that the peregrine use the watersheds for foraging, to date there have been no recorded sightings of this species There are no large cliffs within the analysis area that would provide adequate nesting habitat for this species

Northern Goshawk, *Acipiter gentilis*

The Northern Goshawk, a federal C2 species, is being treated as though it were federally listed, due to the effects of timber harvesting that has occurred within its range, and the decline of primary nesting habitat Preferred nesting for the Northern Goshawk appears to be in relatively closed canopied riparian conifer stands, though nesting has been documented in stands with fifteen percent canopy closure on the Chiloquin Ranger District The primary forage for Goshawks are woodpeckers and other bird species They prefer birds to rodents, but will use rodents for a food source They hunt in the more open mid-to-late pine stands Goshawk surveys have been conducted in parts of the watershed.

Numerous other bird species are residents in or utilize the watersheds. A (semi) complete listing of these will be found in Appendix C. There are several species within or adjacent to the watershed that warrant special attention and will be discussed here.

Greater Sandhill Crane, *Gruis canadensis*

This bird is a summer, breeding migrant to the interior valleys of Oregon. A sensitive (vulnerable) species in Oregon, the Sandhill crane is currently considered common in the East Slope of the Cascades (ESC) province (Puchy and Marshall, 93) Frequently encountered "about the Klamath Lakes" and in Cascade alpine meadows in the mid nineteenth century (Newberry (1857), quoted in Dawson, 23), this bird declined drastically by 1920 (Dawson, 23,) Reasons for the decline include the draining of wetlands, market hunting (Ibid) and spacial conflict with livestock (Rees, 93).

Summer breeding habitat for the Sandhill crane consists of large, moist and wet meadows and marshy areas. Forested stands adjacent to marshes are also used, though the extent is unknown. This species is considered vulnerable as a result of reduced wetland conditions and high levels of predation from ravens and coyotes (Marshall, 92). Recorded observations have occurred in the Jack Creek system within subwatersheds 02, 03, and 05. They may occur in other subwatersheds (such as 19) where habitat conditions listed above occur.

The Sandhill crane has been the subject of study on the Klamath Forest Marsh NWR for the last few years. This breeding group is thought to be an important "nucleus population" for south central Oregon (Null, 94). Unfortunately, breeding within the 155 bird Klamath Forest Marsh population resulted in the recruitment of 1 bird in 1994.

In addition to the T,E,S and indicator species, there are species of concern present within the analysis area, such as the **Great Gray Owl**, and **Flammulated Owl**. Considerations are given to other raptors during their respective nesting seasons (ex. Red-tailed Hawk). The Forest and Chemult District have taken precautions with their management activities to protect known nest sites of these birds and any other species of concern. The Forest and the District maintain an unofficial list of species of concern and use some of the species included on the Oregon Department of Fish and Wildlife lists.

As mentioned earlier, a small portion of the Mosquito Watershed is surveyed annually as part of the ongoing R6 **Neotropical Migratory Birds** survey program. Riparian aspen sites in the Mosquito

Watershed have been identified as important nesting habitat for neotropical migrant species such as the red-breasted, Williamson's and red-naped sapsuckers and several species of flycatchers (Bettinger, 94) Habitat for these species has changed over the last century, largely as a result of alteration of riparian communities through " natural" and anthropogenic forces Impacts to neotropical migratory birds has occurred in the watershed as a result of the modification of the landscape and vegetation structure Recent trend information indicates a decrease in neotropical migratory bird numbers, probably as a result of habitat loss of the same fashion as has occurred in the Mosquito Watershed. It is estimated that approximately 22 species of neotropical migratory birds are on the decline in the Pacific Northwest

Mammals

Proposed, endangered, threatened, sensitive or indicator mammal species that may occur or have been documented in the Mosquito Watershed are: Pacific fisher (C2), American marten (indicator), mule deer (indicator)

Pacific Fisher, *Martes pennanti pacifica*

The pacific fisher was recently sighted in the mosquito watershed . Populations of the pacific fisher appear to be recovering in the pacific northwest, specifically in Idaho and Montana. Data is lacking for Oregon, but the fisher appears to have been extirpated from the coast range. The pacific fisher is widely regarded as old-growth forest associate (Buck, 94). Habitat fragmentation is thought to be one of the leading causes of this species decline. Open stand conditions foster increased interactions between competing individuals, resulting in territorial conflicts. Slader et al. (1994) hypothesized that open stand conditions, such as are thought to have occurred in the pre-suppression ponderosa pine environment, are non-suitable as fisher habitat. Habitat in the Mosquito watershed are upslope, mixed conifer stands and riparian lodgepole and hardwood communities.

American Marten, *Martes americana*

Another species that is an indicator, but not for this watershed, is the American Marten, which is present in the watershed. Under the management guidelines used in putting the land management plan together, only minimum marten habitat requirements were established, and areas east of U.S. Highway 97 were not included as American Marten habitat, even though martens have been historically present east of the above mentioned highway. Even though the marten is not an indicator in this analysis area, the Chemult District has been conducting an active management strategy to maintain some habitat components necessary for marten survival. We won't pretend to know more about martens than the wildlife staff on the Chemult Ranger District, where the Mosquito Watershed is.

Mule Deer

Mule deer are spring, summer, and fall residents of the Mosquito Watershed. There is no recognized winter range within the Mosquito Watershed. Habitat for this species has changed since 1850; the degree or severity of this change, or the effect on the local, seasonal distribution of animals is not fully understood. We assume that fire suppression, by reducing the effects of periodic disturbance, has led to a decrease in floral diversity in upland communities and has resulted in a large scale habitat modification through alteration of understory forage species. Meadows and riparian hardwood stringers have likewise been altered, resulting in drier conditions and a shift or change in vegetative structure. Willows, aspen and forbs, all important forage species, are reduced from pre management levels (see Riparian Habitats) Late season water is less available now than in the historic past.

Mule deer require a diverse array of plant species for forage (Wallmo, 81) Mule deer intake of a specific forage plant or group of plants is tied to the availability and seasonal palatability of the forage species Numerous authors have demonstrated the importance of succulent forbs to mule deer during spring and early summer, a period of high energy demand for does and fawns (Julander et al, 61, Salwasser, 76, Thomas et al, 79, Leckenby et al, 82) Stuth and Winward (1977) demonstrated the importance of herbaceous meadow plants on the early summer diet of mule deer on the Chemult Ranger District Salwasser (1977) linked the reduced availability of succulent spring and early summer forage to the dramatic decline of the neighboring Interstate mule deer herd, and pointed out that the decline in succulent plant availability was a direct result of the cessation of one or more disturbance factors Given these considerations, it seems reasonable to assume that the interruption of fire regimes and the degradation of riparian communities, to include moist and wet meadows has had an adverse effect on the available spring and summer forage for mule deer

The shift in use from forbs to woody shrubs occurs in this area about mid July (Stuth and Winward, 77) Bitterbrush is a key late summer and fall forage species for mule deer in he watershed, and by far the most common non coniferous plant in upslope ponderosa pine and lodgepole habitats. Bitterbrush under a fire return interval of 15 years was not represented in the stand as it is today, but instead was much sparser and typically was represented by low growth to about 30 inches. The robust shrub form requires a high degree of energy for maintenance. Under a short fire return interval, annual leader growth is concentrated, succulent and easily accessible to browsing mule deer. Herbaceous forbs and grasses were more abundant under the ponderosa pine overstory (Franklin and Dyrness, 73), allowing a broader seasonal use of upland ponderosa sites by mule deer

We assume that mule deer require security cover to make maximum use of available habitat. Security cover must occur in a spacial arrangement such that it is physically available to the animal when needed, the juxtaposition of cover and forage areas is an important biological consideration. Dry, upland habitats such as the lodgepole/bitterbrush/needlegrass (CLS2-11) association and the ponderosa pine/bitterbrush/needlegrass (CPS2-12) association support greater stem densities now than prior to fire suppression, providing a higher degree of security and thermal cover. These two plant associations have received extensive timber extraction and understory disturbance over the past fifty years, however, so the current availability of security and thermal cover is not known.

We havc no wish to argue the value or necessity of hiding cover. It is evident that the available screening in the ponderosa pine plant community was quite different prior to the broad scale suppression of periodic wildfire than what we are attempting to manage for today. Numerous authors have described pre-suppression ponderosa pine stands as open, "park-like", with limited understory regeneration (Leiberg, 99; Munger, 17; Franklin and Dyrness, 73). Cooper (1960) describes the ponderosa pine plant community as an uneven aged forest composed of a mosaic of small (one-quarter acre or less), even aged stands. Understory conifers were far less prevalent and in much smaller patches than are represented under the present fire suppression regime. Large stands (greater than five acres) of even-aged conifers six to fifteen feet tall were rare, and occurred only following stand replacement events, which were also quite rare (Agee, 92). By our current definition (see Thomas, 79 and the ITAC mule deer model), hiding cover was virtually non-existent in the ponderosa pine plant community and greatly reduced in the dry lodgepole associations.

Where was the hiding cover if, indeed, any existed in the pre-suppression ponderosa pine forest? In the classic and much cited *Wildlife Habitats in Managed Rangelands-The Great Basin of Southeastern Oregon*, Leckenby et al (1982) describe optimum hiding cover as vegetation at least 24 inches tall and "...capable of hiding 90% of a *bedded* deer from view at 45 meters...". Though discontinuous and patchy, the pre-suppression pine forest provided cover in this form.

Ecotonal, moist lodgepole stringers or bottoms (such as Jackies Thicket) fluctuated in stem density, often being thicket-like as a result stand replacement outbreaks of insects, disease or periodic wildfire of various size and periodicity These sites were and are important cover areas for mule deer Riparian corridors containing hardwoods and willows were extremely important for cover, forage and dispersal

Mule deer using the Mosquito Watershed are roughly grouped as part of the Oregon State Fort Rock and Silver Lake Herd Units Oregon Department of Fish and Wildlife management objectives have set population numbers to be managed for 11,200 animals in the Fort Rock Herd Unit which is almost 100% of the analysis area. The number of mule deer that should be managed for within the analysis area is between 200-250 animals, or about two percent of the total herd management objective based on square miles of the analysis area per total square miles within the Fort Rock Herd Unit.

The lower third of the analysis area is under the consent decree between the US Forest Service, The Klamath Tribes, and Oregon Department of Fish and Wildlife. This decree basically outlines the responsibilities of the respective governments for the management of mule deer that use former Klamath Tribal Reservation Lands. This document is included as part of the Winema Forest Plan, 1990. Mule deer herds increased in population numbers during the 1950's and the 1960's, and now are following the long term declining trend across the Western United States from the 1970's to the present time. This decline is the result of many different changes to habitat conditions, and cumulative actions across the entire landscape.

The District and the Forest have implemented management strategies for mule deer to minimize human disturbing activities during the fawning season, which includes restrictions on management activities in key fawning areas; i.e., which are meadows and riparian areas. Livestock utilization levels are monitored to insure that they are not reaching levels that would create animal conflicts, and livestock are being rotated so that they are not impacting all the key fawning areas between May 1 and July 15. In addition, some areas are being totally excluded from livestock use.

Numerous other mammal species are residents in or utilize the Mosquito Watershed. A (semi) complete listing of these is located in Appendix C. There are several species within or adjacent to the watershed that warrant special attention and will be discussed here.

Elk

Elk populations throughout the western United States are recovering from a period of severe decline that occurred as a result of over exploitation and the loss of suitable habitat (Thomas et al, 82). During the 1940's (and the preceding two decades), elk were extremely rare on and in the vicinity of the Klamath Indian reservation (Moore, 43). Hunting pressure on the reservation was low during this period (Ibid.). The elk population and elk use of the area has increased dramatically since this time (Foster, 94), as has elk harvest (Nolls, 94). Review of available literature on elk strongly suggests that the density of elk is closely tied to the availability of hiding and escape cover, which is directly associated with the density of conifer and hardwood stems. Elk numbers are rising, availability of cover can increase their rate of recovery.

The Mosquito Watershed has been identified as an important calving area for the Yamsay elk herd The Oregon Department of Fish and Wildlife has recently established management objectives for elk in south central Oregon. The Winema National Forest has not made active attempts to manage for elk east of US Highway 97, other than partially funding a joint elk population study with the Oregon Department of Fish and Wildlife and the Oregon Hunter's Association.

Elk are probably playing a bigger role in inter-specific competition with mule deer use of the analysis area than is currently being realized There have been no attempts to document this, and no studies have been designed to determine the extent that competition is occurring between deer and elk

Antelope

Antelope are primarily migrants through the analysis area, although with the current amount of reforestation units there may be more antelope present since there are more acres of transitional upland forage present now than in the past Antelope generally migrate through portions of the analysis area to traditional summer ranges west of US Hwy 97.

Carnivores

Limited information is available on the presence of carnivores within the **Jack Creek Watershed**. Sighting records for bobcat and black bear in the watershed exist. Black bear sightings have occurred in or near Stimson Meadow and subwatershed 10 near O'Connor Meadow. Bobcat sightings have been recorded for subwatershed 03 on 3 separate occasions. Den sites and other components of habitat do exist within the watershed for black bear and bobcats, as well as other carnivores. However, no quantitative or qualitative information is available in district files.

Bats

Bat surveys have been conducted in 1994 on the Chemult RD by bat researchers under a Challenge-Cost Share Agreement. Portions of the watershed were included in the bat surveys. Appendix C contains species found and subwatershed where bats were found.

Open water sources, which are important for bats, are used after bats emerge in the evenings from roost sites. Open water sources both natural and artificial are rare within the watershed. During dry periods (less than average rainfall), and high demands for water by sheep herders, fire suppression personnel, road dust abatement personnel, and others, available open water can be drastically reduced and minimally available for bats and other wildlife.

The upland forests in the watershed may provide foraging habitat in the form of clearings and roads, although when gleaning insects (some species), some bats may feed within the canopy. However, recently harvested areas do not seem to provide suitable foraging habitat. Extensive areas, particularly in the northern portions of the watershed have been harvested.

Bridges, rock cliffs, crevices and cavities in live and dead trees provide suitable day roosts for bats. Large rock outcrops and cliffs are very limited in the watershed but do occur (i.e. Teatable). Snags and live trees with cavities and loose bark/crevices exist but may be limited to designated wildlife/snag clumps and Old-growth MRs. Some bridges and artificial structures do occur within the watershed but their documented use by bats are unknown (in 1994 some bridges and buildings within the watershed were visited but no indications of bat use were found).

Wildlife Importance to the Klamath Tribes

Several different species of wildlife are important to the Klamath people, not only as food sources, but in practicing their traditional cultural activities. Different species of wildlife provide different symbols and play different roles in their stories, and spiritual practices. Wildlife that are important to the Klamath people include, but are not limited to: coyotes, porcupines, woodpeckers, goshawks, great gray owls, and eagles. The importance of one animal species over another is based on individual preference.

Wildlife Importance to Recreational Users

Probably the most important wildlife in the Jack Creek Watershed to recreational users are two big game species which are mule deer and elk. Mule deer hunting activities historically since the 1950's have been a key recreational experience for the public. Since the buildup of elk numbers, there are more people who are enjoying the opportunity to hunt this big game species

Wildlife Importance to Other Publics

The livestock industry has expressed concern over the level of coyotes in the vicinity of the watershed This is due to those people who raise livestock, primarily sheep, but some cattle operators claim to have coyote problems when their cows are calving. We have no information that suggests that predator populations in the watersheds have changed from historic levels

E. Livestock Use

Livestock use of the watershed is currently regulated under terms of a grazing permit, and the Winema National Forest Land and Resources Management Plan (1990). The plan sets specific guidelines for forage utilization until such time as a new allotment management plan is developed. The Chemult District has reached agreement with the permittee to minimize use of the analysis area, because of high big game (deer) use. Forage utilization Standards and Guidelines are incorporated into the annual operating plan - developed yearly to cover the actual movement of sheep across the allotment

Until 1961, the watershed was divided into two primary administrative units, public domain and the Klamath Indian Reservation. This resulted in two separate grazing allotments: The Forest Service (FS) administered Jack Creek Sheep Allotment; and the North Marsh Allotment, administered by the Bureau of Indian Affairs (BIA). BIA allotments were put out on a lease basis, while FS allotments were issued on a ten year permit system. Both systems had problems dealing with on-ground management, from extended use of meadows or other areas preferred by operators, to numbers and extent of animal use. Both agencies experienced varying degrees of success or failure in dealing with unauthorized livestock use.

Sheep numbers grazing the watershed have declined, consistent with the general trend for public lands grazing. During the early 1900's approximately 5000 sheep were grazed in the watershed. After 1950, the number of animals decreased to 2000 ewe/lamb pairs; 1000 on the Jack Creek, and 1000 in the North Marsh Allotment. Currently all within the Jack Creek Allotment, the watershed makes up only about 14 percent of the approximately 119,000 acre allotment. Permitted numbers are 2500 head of dry ewes, which are managed on a (1000 head) band basis.

The Mosquito Creek area was primarily grazed by sheep historically , though some parts have been used by cattle. Cattle were trailed back and forth between Silver Lake and adjacent private lands located southwest of the analysis area. While trailing, the cattle would spend 3 to 5 days in McCarty Meadows in early summer, and again in late fall on the return trip.

Most of the forage conditions on both the Jack Creek and Antelope Allotments are in fair to good condition. There are small areas scattered throughout both allotments that are in poor forage condition

It is estimated that most of the **meadows** (about 15%) on public lands in the **Jack Creek Watershed** area are in a middle stage of development. Probably 70% are in late stages of development and about 15% or less are in early stages of development. These are only estimates and will be validated as a range analysis is completed for the Antelope and Jack Creek Allotments.

Preliminary information from the Antelope Allotment Range Analysis shows meadow and riparian areas within the Jack Creek Watershed are 64% in late growth condition, 17% are in mid-growth stage of development, and 19% are in the early growth stage of development These acres will be entered into the Geographic Information System, and can be more accurately tallied.

Unauthorized cattle use has historically been a problem , and continues to be so today Absence of fencing between private and public land, and permitted cattle from the Antelope Allotment drifting into the analysis area are two reasons the unauthorized use has occurred

Livestock grazing, plus associated management activities, has probably affected the following changes within the watershed

- The development of stock ponds and deepening of stream channels may have influenced the drying out of meadows.
- Changes to vegetation and species composition within meadows. Reducing the willow and aspen component, and changing tufted hairgrass/sedge communities to bluegrass are two examples. These changes are generally attributed to cattle grazing.
- The reduction or elimination of some wildlife species.
- The introduction of non-native plants, either by livestock carrying seed in hair or wool, or by seeds being present in their manure. Some species were introduced through management's active seeding of non-native, but desirable, forage species..
- Compaction and soil displacement from using excessively wet areas, and continually using the same areas and trails for movement to water, salting, or bedding areas.

F. Climate

Climate of the Klamath Basin, which contains the Mosquito Creek watershed, is characterized by warm, dry summers and moderately cold, wet winters. Annual precipitation averages 15 to 30 inches per year with much of it occurring in December and January as snow (Carlson, 1979). Summer temperatures have peaked as high as 105° F, and winter lows have dropped to minus 24° F. Average temperature is approximately 24° F, with daily variance averaging 20° in January and 40° in July. Killing frosts (associated with temperatures below 32° F) commonly occur every month of the year (Ibid.).

Investigations into Holocene (current geologic epoch starting approximately 10,000 BP) climate have not addressed the watershed specifically, nor the Klamath Basin in general. Research in eastern Oregon may be used for relative comparisons between current, recorded historic, and prehistoric climatic regimes.

A condensed review of major climatic shifts during the Holocene reveals

- The altithermal or hypsithermal (warmer and drier) period occurred in southeastern Oregon from 8000 to 4500 BP (Wigand, 1987) Lakes and marshes dried up during this time, and native American activity throughout the Great Basin decreased (Aikens, C M , 1986)

- Between 5400 BP and 4500 BP conditions were warm, with moisture amounts similar to today's Evidence indicates this period was punctuated by brief but dramatic increases in moisture Flooding likely occurred on a scale not experienced in the recent past (Davis, 1982).

- A neoglacial period characterized the climate in southeastern Oregon from 4000 to 1900 BP During this time, conditions were wetter and summer temperatures were cooler than today (Pielou, 1991)

- From 1900 BP to 1000 BP aridity increased in southeastern Oregon (Wigand, 1987).

- From 700 to 500 BP southeastern Oregon experienced severe drought and frequent fire (Wigand, 1987)

- The Little Ice Age occurred in North America from about 1500 to the late 19th century During this period, precipitation was higher than before or after, and temperature was lower than before or after (Levin, 1988)

- Since the end of the 19th century, average temperature has increased and average precipitation has decreased in the intermountain west (Ghil and Vautgard, 1991).

These climatic variations have not changed the type of flora in the Mosquito Creek watershed. Altitudinal shifts and relative abundance of species likely fluctuated with climatic changes (Miller, et al, 1994)

Because of the variation in climate, there were significant changes in the hydrology of the Mosquito Creek watershed. During the neoglacial period and again during the Little Ice Age, the mouth of Mosquito Creek was likely up drainage quite a distance from current location due to higher water levels in the Upper Klamath Marsh (Orr, 1992). During these periods, Jackies Thicket most likely was a small lake (Morrison, 1964). During the altithermal period there was probably much less water flow in general (Antevs, 1938).

Throughout the Holocene, long term and short term climatic variations resulted in dramatic shifts in water tables, peak streamflow, plant community species composition and abundance, and fire regimes Change has been continual and unpredictable (Johnson, et al, 1994).

G. Role of fire

Current

Fire regimes of plant associations in specific geographic areas have been defined in terms of fire severity and fire frequency (Kilgore, 1981, Wright and Bailey, 1982). Fire severity is a measure of the effects of the heat pulse (intensity and duration) directed downward into the soil and the effect of the upward heat pulse on living organisms aboveground (Miller and Findley, 1994, Wells, et al , 1979, Hungerford, et al , 1991) Fire frequency is a measure of the periodicity of fire at a specific site or for a specific area (Johnson, 1992).

Fire's role in the Mosquito Creek Watershed can be characterized by specific fire regimes and their effects on ecosystem components and processes such as site productivity, nutrient cycling, hydrology, soils, flora, fauna, and biodiversity Fire exclusion can also be characterized via effects on those properties Many of the effects (of fire and fire exclusion) are associated with specific fuel mosaics and their successional stages which are present in the different plant associations The major plant associations within the watershed exhibit different effects from naturally-occurring fire and from fire exclusion Consequently, each plant association will be addressed separately

The potential for fire is referred to as fire danger The components of fire danger are hazard and risk Hazard is that part of fire potential associated with fuels (both living and dead) and their moisture content (Chandler, et al., 1983). Risk is that part of fire potential associated with lightning occurrence and human activity (Deeming, et al., 1978). Rate of spread and fireline intensity (or simply fire intensity) are terms used in describing fire behavior as it relates to suppression resource effectiveness.

Rate of spread is usually expressed in chains per hour (1 chain per hour equals 1.1 feet per minute) and refers to the rate of advance of the head of the fire (Rothermel, 1983). Fire intensity refers to rate of heat release per unit length of flaming front and is directly related to the length of flames produced at the head of a fire (Albini, 1976).

Qualitative Descriptions of Current Fire Hazard/Fuel Profiles by Major Plant Associations

Mixed Conifer

Plant Associations on the slopes of Sugar Pine Mountain can be divided into two fuel types. The first type is characterized by ponderosa pine/sugar pine overstory with scattered, mature white fir. The understory is dense conifer reproduction (white fir, ponderosa pine, and sugar pine) and shrubs (primarily manzanita and ceanothus). Litter and duff occur on the forest floor in varying amounts from 10 to 20 tons per acre The primary fire hazard is the "ladder" effect of the understory vegetation. This substantially increases the potential for crowning and associated high severity/stand replacement fires. Wildfire that escapes initial attack in this fuel type will likely remove much (if not all) of the litter layer and fermentation (duff) layer Currently, there are approximately 2200 acres of the watershed in this fuel type. Fire hazard in this type is likely to increase over time as forest litter continues to accumulate and understory density increases.

A second mixed conifer fuel type is characterized by a ponderosa pine/sugar pine overstory with dense shrub understory, spaced conifer reproduction, and thinning slash scattered throughout. The primary fire hazard is from the thinning slash which will contribute to high intensity and rapid surface fire spread. Additionally, the shrub component and the thinning slash serve as ladder fuels, contributing to crown fire potential. Wildfire that escapes initial attack in this fuel type will likely remove much (if not all) of the litter layer and fermentation layer. Where thinning slash or coarse woody debris is present, portions of the soil organic layer will likely be consumed. Currently, there are approximately 1470 acres of this fuel type in the watershed. Most of this fuel type is on the lower half of the slope. This type may exhibit some natural reduction in hazard as the thinning slash decomposes, however, this will occur over many years and will likely be offset by increased litterfall and shrub growth.

Dry Lodgepole

These associations have three fuel types The first type presents very low fire hazard These include areas that were harvested, followed by intensive slash treatment and site preparation (primarily before the mid-1980's) These areas generally have less than 10 tons per acre of fuel with considerable bare soil to disrupt the horizontal continuity of the fuels Very low fire intensities and very slow fire spread rates are associated with this type There are approximately 1750 acres of this in the watershed. This type will continue to exhibit very low hazard conditions for several decades

The second dry lodgepole fuel type occurs in areas that were harvested under ERC's (End Result Contracts) and other harvest treatments which have occurred mostly since the mid 1980's. Fuel loadings range from 12 to 30 tons per acre, with more residual snags and seed trees. Fuels are more horizontally continuous (less bare soil to disrupt the spread of fire) Currently there are approximately 2490 acres of this fuel type in the watershed This type will exhibit hazard reduction over time as the residual slash and debris decompose.

The third dry lodgepole type is a very high (up to extreme) hazard fuel characterized by heavy loadings of dead and down forest debris. Overmature stands that have reproduction in the understory and substantial amounts of treefall from mortality result in potential for high intensity/severity surface fire and high crown fire potential. There are approximately 750 acres of this type in the watershed. Much of this is arranged in corridors of hiding cover adjacent to roads and forest openings These stands are at high risk for high severity fire. The high hazard associated with these stands is not likely to abate naturally, rather it will continue to increase.

Wet Lodgepole

Areas occur along streams and in Jackies Thicket. Jackies Thicket is a very dense, suppressed stand of lodgepole that is becoming decadent. It is starting to accumulate fuel at the surface from branchfall, needle litter, windthrow and increasing mortality of the suppressed trees. This plant association typically displays very low surface fuel loadings (and associated low fire hazard) for the first 70-100 years from establishment (Brown, 1975). With increasing age after that time, fuels accumulate rapidly and ultimately the stand is consumed by high intensity/severity fire.

Streamside lodgepole exhibits much the same life history. Dense stands of lodgepole dominate the site for many years, depositing little fuel to the surface and consequently remaining very low in fire hazard. However, after 70-100 years, mortality (often caused by bark beetles) begins causing increased fuel loadings at the surface which increases fire hazard until fire replaces the stand (Weaver, 1974).

There are approximately 2386 acres of this type in the watershed. Much of it is a contiguous block in Jackies Thicket, with the remainder in "stringers" along riparian corridors. Without intensive fuels treatment, high severity fire covering hundreds of acres or more is likely to occur in this portion of the watershed within the next twenty years.

Ponderosa Pine

This type is characterized by scattered bitterbrush and grass in the understory along with conifer reproduction Overstory trees are also spaced with very little canopy closure Surface litter loading is low; generally less than 10 tons per acre There are, however, small scattered stands of densely stocked second growth ponderosa pine which are susceptible to crown fire during windy conditions Overall fire hazard is low except where pockets of reproduction occur below overstory trees There are approximately 6300 acres of this type in the watershed. Hazard will increase as the shrub component ages, and after ponderosa pine reproduction matures enough to start depositing litter.

Ponderosa pine reproduction will not deposit enough litter to carry a surface fire until at least eight years of age (Cooper, 1960). In most cases, young ponderosa pine stands do not experience excessive mortality from surface fire until after 20-30 years of age and associated fuel accumulation (Cooper, 1960). Measurements in dense stands of ponderosa pine have recorded annual needlefall deposition totals of from 1-1.5 tons per acre. Thinned stands deposit lesser amounts. Removal of 50% of the basal area results in about a 50% reduction in needlefall, but the reduction persists for only about three years (Biswell, 1973).

Topography is not usually considered a component of hazard. However, steepness of slope is a significant factor affecting fire spread rate and intensity (Rothermel, 1983). Fire behavior associated with fuel hazards on flat ground may increase significantly if the hazard is located on a slope. Much of the Mosquito Creek watershed is flat; however, the mixed conifer association on the slopes of Sugar Pine and ponderosa pine association on God's Butte are on topographic relief that significantly increases potential fire spread rates and intensities.

Fire Risk

There have been 21 fires over the past 20 years on the federal portion of watershed, for an annual occurrence rate of 1.05. This equates to one fire per 16,667 acres per year or about 6 fires per year per 100,000 acres. The Winema National Forest as a whole has experienced about 80 fires per year (1982-1992 inclusive) for an occurrence rate of one fire per 12,958 acres or 7.7 fires per 100,000 acres per year

The total area burned within the watershed over the past 20 years has been less than 5 acres; or less than .25 acres per year. This represents an annual burn of about .001% of the watershed.
The Winema National Forest as a whole has burned 3,019 acres per year (1982-1992 inclusive). This represents an annual burn of .03% of the forest (roughly thirty times the rate of the Mosquito Creek watershed). Intensive fuels treatment after most harvest activities has maintained low levels of fuels until the past ten years. Since the mid 1980's, increased levels of residue after slash disposal have been prescribed and implemented. Additionally, recent harvest activities have left residual understory shrubs and trees, where before, much of this component was destroyed during the timber sale and post-harvest activities. As a result, both horizontal and vertical fuel accumulation has occurred over the past decade In many places, these accumulations are reaching threshold levels which will facilitate the transition from surface fire to crown fire.

The only large fires (greater than 10 acres) that have occurred in recent history near the watershed were the Rakes Meadow Fire that burned 182 acres on September 9, 1966 just south of the watershed (T29S, R10E, section 33) and the Bartley Fire that burned 320 acres on July 12, 1972 about 6 miles east of Jackies Thicket (T28S, R10E, section 12). A note of interest is that these two fires were in a dense stand of mature lodgepole pine with little dead and down material. The proximity of those fires to the watershed is indicative of similar fire behavior potential within the watershed.

The Winema National Forest has not completed the second phase (fuels assessment) of National Fire Management Analysis System (NFMAS) planning Consequently, quantitative assessments (using approved procedures) of fire danger, so probabilistic calculations of acres burned per year cannot be made at this time Neither can we estimate the cost of protection and suppression plus net value change of forest resources under current and future fuel hazard conditions We can summarize the relative amounts of various fuel types in the watershed for a qualitative assessment of potential fire business, however

Plant Association Description	Hazard	Acres in Watershed	Percent of Watershed
Dry lodgepole (machine piled and burned)	Low	1,750	
Total Low Hazard		1,750	10%
Dry lodgepole (with increased post- harvest residues)	Moderate	2,490	
Ponderosa pine	Moderate	6,300	
Total Moderate Hazard		8,790	51%
Wet lodgepole (currently moderate/ increase to high w/i next decade)	Mod-high	2,386	14%
Mixed conifer	High	3,670	
Dry lodgepole (screening)	Extreme	750	
Total High to Extreme Hazard		4,320	25%

These fuels complexes are not static. All will increase in hazard over time. In fact, without hazard reduction activities, the ponderosa pine, wet lodgepole, mixed conifer, and dry lodgepole screening will all be High or Extreme within the next decade. This represents approximately 75% of the watershed in High or Extreme hazard fuels within the next ten years. Fire occurrence analysis has not revealed any patterns for ignition, rather it has shown that ignitions are completely random. Consequently, there is currently a 26% chance that a fire will start in High to Extreme fuels each year.
However, by the end of the decade, the probability that a fire will start in High or Extreme hazard fuel will rise to about 78% each year (1.05 fires per watershed per year X .75 of the watershed in High to Extreme fuels = .78 per year).

While the recent past fire record does not indicate significant fire danger, dramatic changes in fire activity (as a result of fuel accumulation) can occur within a decade. The preceding table quantitatively displays the expected changes. The experience of the district to the south of Mosquito Creek Watershed is also revealing. During the 1970's, Chiloquin Ranger District burned about 2,097 acres, during the 1980's over 6,427 acres, and so far in the 1990's over 27,889 acres. Because of past intensive harvest and fuel treatments, Chemult Ranger District has lagged behind in fuel accumulation. However, with decreased timber sale activity and changes in fuel treatments (allowing greater amounts of live and dead fuel) fire hazard is rapidly building.

Fire Exclusion Effects

Fire exclusion allows fire hazard to increase (in the form of accumulation of forest litter) until the stage is set for high severity wildfire (Weaver, 1955). There are several factors in addition to fuel accumulation that contribute to increased levels of hazard when fire is excluded. Ponderosa pine has a tendency to form dense thickets of pine or shade-tolerant species in the absence of regularly occurring fire (Biswell, 1973, Lunan and Habeck, 1973; Weaver, 1951). These dense thickets develop fuel profiles that are both horizontally and vertically continuous which makes them very receptive to crowning and carrying fire to mature overstory (Weaver, 1964). Fire exclusion allows the perpetuation of low crown trees. That is, the lower branches on young trees remain alive, even in dense stands, in the absence of periodic fire. This condition contributes greatly to subsequent crown fire potential as the stand ages and fuel accumulates at the surface (Cooper, 1960) The shift in understory species composition from forbs and grasses to shrubs and conifer reproduction tends to increase the intensity and severity of subsequent fires (Deeming, 1990)

In addition to increased fire hazard and increased potential for high severity wildfire on a landscape scale, fire exclusion has many effects on other ecosystem properties Accumulation of host-specific insects and disease occur with fire exclusion (Heinselman, 1971) Shifts in species composition, greater stem densities, and weakened resistance through competition has created ideal conditions for insect (Mitchell, 1990, Schmid and Parker, 1990) and disease outbreaks (Wright and Heinselman, 1973, Thies, 1990) Habitat diversity decreases with fire exclusion (Kauffman, 1990) as well as biodiversity in general (Severson and Rinne, 1990, Hungerford, et al., 1991). Forest health decline due to increased density of vegetation (both tree and shrub) provides inter- and intra- specific competition for water, nutrient, and solar energy resources (Mutch, 1994). Ultimately, there may be a reduction in mineral nutrients that are available for plant uptake due to binding in organic form (Covington and Sackett, 1990).

Species composition changes occur with fire exclusion; shade tolerant species become more abundant both in the understory and eventually in the overstory (Dickman, 1978). Mixed conifer plant associations were maintained by fire in a state closely resembling ponderosa pine climax plant associations; ponderosa pine dominated the sites with sugar pine and only a few scattered white fir. The shrub component was less prominent, likely occupying less than 20% cover in the understory. In some cases shrubs were almost totally absent. Forb and grass surface vegetation was much more prevalent than under current conditions Both intra-specific genetic diversity and overall species diversity decreases with fire exclusion (Wright and Heinselman, 1973, Weaver, 1974).

While short-term gains in tree growth have been correlated with fire exclusion (Hopkins and Cochran), these may not be biologically sustainable, and are definitely not sustainable from the standpoint of protection from fire (without periodic hazard reduction actions). Additionally, the loss of understory production (forbs and grasses) has not been factored in to overall site productivity changes associated with fire exclusion (Hungerford, 91).

In general, fire exclusion tends to increase time between disturbances and increase severity of disturbance, which decreases ecosystem stability (Habeck and Mutch, 73, Deeming, 90).

Past: (There are at least three major plant community associations that have and had specific fire regimes.)

Ponderosa Pine

These plant associations were described by many early visitors to the Klamath Basin. Albert Gatschet, an ethnographer with John Wesley Powell's Geological Survey provided this description: "They [ponderosa pine] stand at intervals of twenty to fifty feet from each other, and are free from manzanita bushes and other undergrowth except at the border of the forest, leaving plenty of space for the passage of wagons almost everywhere." (Gatschet, p. xxiii, 1890). Twenty to fifty foot spacing equates to 70 to 17 trees per acre.

Forest Examiner Thornton Munger (1917) characterized them as, "In most of the pure yellow-pine [ponderosa pine] forests of the State [Oregon] trees are spaced rather widely, the ground is fairly free from underbrush and debris, and travel through them on foot or horseback is interrupted only by occasional patches of saplings and fallen trees Ordinarily, [there are] less than 20 trees per acre over 12 inches in diameter."

John Leiburg, in his evaluation of timber versus suitable agriculture lands characterized the ponderosa pine associations as, " the open character of the yellow-pine type of forest anywhere in the region examined is due to frequently repeated forest fires more than to any other cause "(Leiburg, 1899, p 248), and " large areas are annually overrun by fires " (Ibid , p 249) His comments pertinent to Mosquito Creek ponderosa pine associations reveal that " all of the timber [ponderosa pine] in the township [T30, R9 - immediately south of Mosquito Creek] is fire marked. Result of fires is the suppression of young growth, fire scarring of the older there is little brush growth throughout " (Ibid , p 321)

Undoubtedly, these stands experienced fire on a regular basis, varying from about 5 to 15 years (Bork, 84, Morrow, 85) Fire severities were generally very low, with only very young trees and shrubs killed (Agee, 93). Mature trees were often fire-scarred but not killed (Weaver, 43). Understory conditions remained open and "park-like" into the early years of the twentieth century. Interviews with early forest officers on the Klamath Indian Reservation consistently described forest conditions as being "open and park-like" and that brush occurred only in "clumps" that did not grow very high. The understory was so free of underbrush and reproduction that they were able to construct fireline by dragging a manzanita bush behind a horse (Weaver, 61).

Wet Lodgepole

Fire regimes were characterized by infrequent (every 70 to 150 years), high severity (total mortality of aboveground vegetation) wildfires (Brown, 75). These plant associations in Mosquito Creek were likely somewhat smaller in size due to influence of more frequent fire in adjacent plant associations (Agee et al , 90).

Dry Lodgepole

These plant associations were also smaller in extent, and different in character. Much of the dry lodgepole in Mosquito Creek was likely in a shrub-grass steppe with small groups of lodgepole scattered throughout the area. Leiburg described the lodgepole community to the west of Mosquito Creek as, "... lodgepole pine growth has been reburned here and there within recent times. The result of such reburning is, almost invariably, creation of sparsely grassed, absolutely nonforested areas." (Leiburg, 1899, p. 302 referring to T28S, R8E - Beaver Marsh to Diamond Lake Junction).

In another passage he points out that, "...deficient reforestation of burned tracts in the lodgepole pine stands, and the evident tendency of such places to become covered with a growth of desert shrubs or grasses in place of the former forest." (Ibid.). Arno (1980) describes the fire regime of areas similar to this as 25 to 30 year return of low to moderate severity fire.

Mixed Conifer

Plant associations were likely much more dominated by ponderosa pine with much less white fir, and wider spacing of trees. The understory included more forb and grass surface vegetation and only scattered shrubs (Wright, 1978). It was so similar to the ponderosa pine association that Leiburg and Munger did not identify it as a separate forest type. The fire regime in this plant association was very similar to ponderosa pine associations; frequent (5-15 year return interval), low intensity/severity fire (Agee, 1993).

Fire History for Jack Creek Watershed

The following information was compiled from fire records on the Chemult R D from 1962 thru 1993 and only covers national forest lands that are managed by the district

During the last 32 years, between 1962 and 1993 there were 89 wildland fires that burned approximately 998 acres in the Jack Creek watershed on national forest lands The average fire frequency is 2.78 fires per year Approximately 30% of the fires were human caused which is very close to the district average for human caused fires The human caused fires account for over 60% of the total acres burned. The primary reason for this is due to the moisture that is generally associated with lightning.

Fire records obtained from the Oregon Department of Forestry indicate that during the last 26 years there were 6 fires on privately owned lands that burned approximately 260 acres. The average fire frequency is .25 fires per year. Two of the fires (33%) were human caused.

Some of the larger fires that have occurred in recent history are listed below.

YEAR	NAME	CAUSE	SIZE	YEAR	NAME	CAUSE	SIZE
1972	BARTLEY	HUMAN	550	1988	CREEPER	HUMAN	21
1980	CRIB	HUMAN	06	1992	MYSTERY	LIGHTNG	05
1980	McCARTY	HUMAN	14	1993	SILVER	HUMAN	02

Average Fire Occurrence Rate for the Jack Creek Watershed: 4.25 fires/100mac/year

Based on the information obtained from the fire records, the average annual percent of the watershed burned by wildland fires in the Jack Creek Watershed is less then 1/5 of (1%) one percent.

H. Disturbance Factors Affecting Change

There have been dramatic changes in the vegetation in Mosquito since approximately 1900 or slightly before.

- The activity with the major immediate impact was logging **Mosquito had a dramatic change of stocking of ponderosa pine dominated areas between 1941 and 1950.**
- At that time **ponderosa pine dominated areas included all the watershed except for the riparian and dry meadow areas.**
- Approximately 70% of the watershed was harvested between 1941 nad 1950. **Approximately 50% of the watershed was harvested within a 3 year period.**
- Current conifer stocking levels are often **2-6 times those measured in historic stand types**
- Some historic plant community types, especially **riparian hardwood and dry lodgepole grasslands, are nearly or completely absent.**
- As a result of successful fire suppression programs, current **conifer stands are a high risk** to loss from fire, and **riparian hardwoods and shrub-stepp grassland types are nearly absent..**

North Marsh Sale covered the Reservation portion of the watershed. Sold in 1924, logging did not begin until 1936 (and that was not in the Mosquito area). Logging was stopped shortly after that due to a mill fire. The sale was then sold to another company, and the Mosquito area was logged between 1941-1946

This area was logged as a partial cut, with the objective to remove 60% of the standing volume This sale generally left 5-7 trees greater than 12" DBH per acre Trees were not cut less than 16" DBH, however leave trees were in all size classes, including in the 30-40" DBH class Lodgepole pine was harvested for rail tie production, posts and poles, and firewood The land was acquired by the US Forest Service in 1961

Data (BIA records) from post mark plots on the South Calimus sale area, which contains similar types and was marked under similar marking rules, gives us a picture of stand conditions. On one area where we also have the diameters to enable Basal Area (BA) calculations; the stand, 12" DBH and greater, before harvest had 38 BA and 9.5 trees per acre. After harvest that stand had 6 14 trees per acre and a BA of 18. Current stands contain from 65 to 236 BA in the ponderosa pine areas (current vegetation report).

Shevlin-Hixon logged the upper 2/3 of Mosquito between 1947 and 1950. We don't have the details on that harvest, but most private land was logged heavier (various oral histories on file, Winema NF) than Reservation land. We expect that most trees over 18" (stump diameter) were cut, and the area resembled a clearcut. The Reservation lands would resemble a heavy seed tree cut. As a result of these activities the ponderosa pine acres were very open and this occurred in a very short period of time. The lodgepole areas would be generally unchanged except that, due to fire suppression, the lodgepole continued to grow into thick stands. Riparian areas and especially Jackies Thicket were not logged at this time.

Fire suppression started around 1908. Fire suppression actually had a dramatic, but slower impact on the area than logging. Stand stocking levels and structure changed as a result of fire suppression. Referring to the BA figures for the example in the previous logging discussion, stand stocking has increased from 2 to 6 times the pre-fire suppression levels, even after many subsequent harvest entries. Structure of the ponderosa pine type stands changed to a thick, multi-storied stand, often with tall, woody bitterbrush Similar changes occurred in the mixed conifer type only with additional species present. The lodgepole type developed into the conifer dominated stand we see today.

Early logging within the watershed was accomplished using tractors to move the logs from the stump to be loaded on a truck. The truck then hauled the logs to a railroad reload site. Two long railroad spurs from the mainline to Bend reached to the edge of the Mosquito area. Even though these areas would be considered to be a seed tree type cut by today's standards, the nature of the stands (open, well-spaced large trees) actually produced relatively light fuel loading from logging slash. Harvested areas were generally broadcast burned to reduce fire hazard. Planting and thinning did not take place after logging, and only the uncut trees remained to occupy the site, grow, and become the dominant component of today's stands.

A basic road system was present in the area prior to any logging activity. The tractor to truck to rail logging system would have increased the road density in the area.

Logging

Logging and associated transportation systems are probably the most visible, as well as wide spread, disturbances to have taken place within the watershed. Most, if not all, forested communities within the watershed have been entered for timber extraction since the advent of logging in the region. On the Chemult Ranger District, harvest activity areas generally overlap each other, sometimes as many as 3-4 times (including pre-Forest Service). This is the case within the Mosquito Creek watershed, resulting in some areas being impacted repeatedly.

Under Forest Service management, the first harvest activities that occurred were broad area salvages in the 1960's These projects essentially covered the entire watershed, excluding Jackies Thicket Trees not expected to survive in the next ten years, based on Keen Class identification were harvested A small portion of Jackies Thicket was pre-commercially thinned (probably) in the 1970's Jackies Thicket is usually deferred from management activities, so little data exists for the area

There was probably an increase in associated road building during this period. Due to the salvage nature of the entries, resulting stands were greatly reduced in snag and future snag numbers. Otherwise, these entries didn't significantly alter the characteristics of the stands. Skidding was usually done with large tractor-type equipment making multiple passes within stands to access individual felled trees. Slash was machine piled, and the concentrations were burned. Both these operations initiated localized compaction and displacement of soils. Surface layer scorching occurred under the burned piles. Neither planting nor thinning of young stands took place in conjunction with these entries.

In the 1970's, harvesting took place on five sales within the watershed. These sales consisted of individual units, rather than the broad area salvages of the 1960's. Approximately 3062 acres of land were harvested - probably with a shelterwood seed, or seed tree prescription. Additional roads were constructed in the watershed in conjunction with these sales.

Ponderosa and Pine Associated stands that were entered were mostly commercially thinned, favoring ponderosa pine over lodgepole, white fir, and (where it occurred) incense cedar and sugar pine. Understories began to become severely overstocked. Slash was piled with heavy equipment, and subsequently burned, leading to more broad scale compaction, displacement, and some scorching of soils.

Lodgepole pine stands were the primary focus during this period, as it became economically feasible to market the material, particularly as chips, from the dead stands resulting from a mountain pine beetle infestation. High impacts were experienced in areas of lodgepole pine that were entered. Multiple passes by heavy equipment, either for harvesting (shears), skidding, or slash piling initiated compaction and displacement over much of the harvested acres. On-site chipping came into being during this time, so landing sizes increased dramatically (2-10 acres) to facilitate the operation. Though large, only a moderate number of landings were constructed per 70-100 acre unit.

Logging in lodgepole stands during this period involved varying degrees of utilization, depending on market conditions. Large volumes of heavy slash were created. Some areas were machine piled and burned, others accumulated huge masses of slash at the landings, which were eventually burned. Slash was scattered and/or crushed in other units. Various degrees of compaction and displacement occurred as a result of slash treatment, from nearly 100 percent of some units, to negligible in others (where compacted slash was retained in the unit). Units were hand planted with augers, primarily to lodgepole pine, perpetuating its dominance on sites which historically were different species dominated.

The early 1980's saw an increase in logging activity within the watershed. Seven sales were operating, some having as many as a dozen large units scattered over a wide area. These sales were mainly in the ponderosa pine and mixed conifer type. Prescriptions consisted of clearcuts, seed cuts, shelterwood/seed cuts, and overstory removals. Approximately 1734 acres of land were logged with these sales.

Rubber-tired skidders with integral arches became more common, although heavy cats were used in many logging operations, particularly on steeper ground (possibly the first entry in some of these areas). Slash was primarily piled and burned. Additional roads were constructed in conjunction with the sales.

Prescriptions began to transition stands to more fir in their composition High stocking levels in the understory began to move many stands into severely overstocked conditions Stands operated in during this period lost a significant amount of their snag and future potential snag component Pre-commercial thinning was done in many of the residual stands, with most of the generated slash lopped and scattered, or sectioned and left on site Soil compaction and displacement increased as a result of these operations

In the late 1980's and early 1990's, approximately 2028 acres were harvested within 2 timber sales. These sales were clearcuts and overstory removals. The Blue Grouse Timber Sale logged a major portion of Sugarpine Mountain, and the Fork Timber Sale logged units in the southern portion of the watershed. Additional roads were constructed in conjunction with these sales.

Harvest prescriptions (clearcuts and overstory removals) continued to move stands to more fir in their composition High stocking levels in the understory began to move many stands into severely overstocked conditions. Stands operated in during this period lost a significant amount of their snag and future potential snag component. Pre-commercial thinning was done in many of the residual stands, with most of the generated slash lopped and scattered, or sectioned and left on site.

Rubber-tired skidders and cats were variously used in logging operations, with cats being the primary skidding method on steeper ground. Slash was primarily piled and burned. Soil compaction and displacement increased within the watershed as a result of these operations.

For the district to have some way of cleaning up the dead lodgepole pine from the mountain pine beetle epidemic, End Result Contracts (ERC's) were developed in 1985. There was no commercial value for dead lodgepole at the time, so the wood was basically "given away". After about 3 years, the value of this product increased, contracts were changed, and bidding for the material took place.

ERC's evolved from clearcut (early) to seed tree harvest prescriptions with reliance on natural regeneration (latter). Bid items for site preparation for natural regeneration, and some timber stand improvement (TSI) work were included in the contracts. Planting was included at one time but dropped as natural regeneration became more acceptable. Over the years a good portion of the seed trees have blown down, greatly reducing the seed tree stocking level. Occasional planting was done in the ERC's where seed trees were lacking, or the expectation for natural regeneration success was low. ERC's harvested large areas on the district and were concentrated mainly in the lodgepole pine type. Within the watershed, portions of three ERC's and two other sales were harvested between approximately 1988 and 1991 covering roughly 2705 acres of land.

The following shows acres harvested by decade: (Excluding the 1960 salvages and early harvests prior to Forest Service management.)

Years	Acres harvested
1970	3061
1980	1734
1988-1991	4733

Fire Exclusion

Prior to man's fire exclusion influence, a natural fire frequency of 5-15 years existed for **Ponderosa Pine** forest types in central Oregon. Fires burning in these stands were probably of low intensity due to light fuels accumulations maintained by the frequent fires. These fires would have snaked around along the ground where ever the litter layer existed, forming a mosaic pattern.

As a result, the ponderosa pine forest was probably a mix of open park-like conditions with even-aged groups scattered about Leiberg's 1899 survey of the area states that open park-like stands of large ponderosa pine were found throughout the ponderosa pine area, which includes what we now classify as the mixed conifer area

Munger (1917) talks of the pure range of ponderosa pine being trees that are widely spaced with patches of saplings mixed in In virgin stands he goes on to say the older pines were the dominants with small groups of 2-4 trees interspersed. The seedling age class was under-represented due to mortality from the frequent surface fires Agee discusses young groups and adjacent clumps being maintained under a frequent fire regime. As these groups and clumps continue to grow and underburn at frequent intervals the regime maintained the even-aged clumpy pattern over time.

As the pine moved upslope and into the moister northern exposures, it became intermixed with other species such as sugar pine and white fir. These areas were denser than the pure ponderosa pine areas and more brushy with surface vegetation, but were still a generally open pine dominated stand type.

Ground vegetation within the ponderosa pine associations probably existed to some extent, although not at the current levels we see today and may have been rejuvenated with periodic fires. Leiberg, in his surveys, notes that bitterbrush was greatly reduced and the forest floor was sparsely covered with grasses and forbs. Agee states that in pre-settlement ponderosa pine associations there was a sizable perennial herbaceous component. He also states that the early pine forests had substantial surface vegetation.

Leiberg observed that **lodgepole pine** areas were mainly concentrated along the drainages, probably due to being better adapted to higher humidity (moisture) in the soil. The lodgepole areas along the meadows were probably not affected by fire as much as the pine areas due to the increased moisture levels in the surface fuels. Mature dense areas of lodgepole pine outside of meadow areas that we are familiar with today probably did not exist in the early 1900's. The bark of lodgepole is very thin and even a fire of low intensity would cause damage and mortality. Frequent fires probably served to keep the density and size/age distribution of the lodgepole to a minimal level in the upland areas.

Within the **mixed conifer** types on Sugarpine Mountain frequent fires probably were of a higher intensity but on a similar frequency. Occasional torching or crowning of trees may have occurred. The low limbs and waxy, resinous needles of the fir would aid in the torching and crowning. As a result the fir species would have been maintained as a minor component due to fire mortality, allowing the ponderosa pine to become established and maintained in the area.

Since the **advent of fire exclusion**, the forest stands have changed from generally open and park-like to having greatly increased stocking levels with multiple canopy layers. Stocking has increased from 2-6 times historic levels. Overly dense stands are subject to periodic outbreaks of **insect** and **disease** attacks As early as 1911, the ponderosa pine BIA lands to the east of the watershed experienced a major outbreak of bark beetles (probably the mountain pine beetle). Overstocked lodgepole pine stands have had attacks as late as the 1980's (epidemic outbreak of the mountain beetle) and probably have been periodically attacked since the early 1900's when stocking levels gradually began increasing.

Dwarf mistletoe is present within the Mosquito watershed and theories suggest that this disease has evolved over time with the ponderosa pine. This disease can cause major downfalls in the amount of volume a stand produces. Mistletoe, once present in the stand, will never be eradicated, and will infect the understory. It can be kept in check though through management practices.

No information exists as to the extent of **root diseases** and **stem decays** within the watershed. Root diseases probably exist more so in the mixed conifer areas on Sugarpine mountain These areas should be identified and monitored

Livestock Grazing

Historic grazing within the Mosquito Creek area was primarily by **sheep**, although portions were grazed by **cattle** The Lane Ranch used to trail their cattle back and forth between Silver Lake ranch and private lands located at the southwest boundary of the analysis area. During the trailing, they would spend 3 to 5 days in McCarty Meadows in early summer, and again late in the fall when they returned to Silver Lake There have been problems with unauthorized use by cattle historically, and continues to the present time Part of this is due to property ownerships not being fenced on legal property lines; and also when permitted cattle on the Antelope Allotment drift into this analysis area.

Until 1961, the watershed area was divided into two primary administrative units. The (roughly) northern 2/3 of the watershed was public domain, and the other third was in the former Klamath Indian Reservation. This resulted in the area being divided into two separate grazing allotments: The Jack Creek Sheep Allotment administered by the Forest Service; and the North Marsh Allotment administered by the Bureau of Indian Affairs (BIA). The main difference in administration was that BIA allotments were put out on a lease basis, and FS allotments were on a ten year permit system. This led to differences in the management of the livestock being grazed within the watershed. These ranged from extended, extensive use of meadows and sensitive areas, to less control of herd or animal movement, to varying degrees of success or failure in dealing with unauthorized use.

The number of sheep using the area has declined in recent years, following the general trend in livestock grazing on public lands. Numbers of sheep during the early 1900's probably approached 5000 animals. After 1950, the number of animals decreased to 2000 ewe/lamb pairs; 1000 sheep on the Jack Creek allotment, and 1000 in the North Marsh Allotment. The analysis area is totally within the Jack Creek Allotment, which permits grazing by a maximum of 2500 head of dry ewes. The sheep are managed on a band basis which is usually composed of 1000 head. The Jack Creek Allotment covers approximately 119,000 acres, of which the watershed comprises about 14%.

The primary impacts from grazing and associated management activities related to livestock grazing within the watershed are:

- The development of stock ponds and deepening of stream channels, which may have influenced the drying out of meadows.
- Along with the road systems, changes to the vegetation and species composition of the meadows: Reducing the willow and aspen component; and changing tufted hairgrass/sedge communities to bluegrass (generally attributed to cattle use).
- The reduction or elimination of some wildlife species, such as wolves, grizzly bears, beavers, and trout (if they occurred in the watershed).
- The introduction of non-native plants into natural systems that reduce or eliminate native vegetation The mechanisms for this may have been either by livestock carrying seed in hair, wool, or manure; or by management actively seeding non-native forage species..
- Compaction and soil displacement from using areas that are too wet; or continual movement over the same ground to water, salting, or bedding areas.

Livestock management practices, combined with other activities have contributed to changing the condition and function of the watershed from pre-1900 to its present state There are indications that some meadows and bedding grounds for sheep have been compacted. Soil displacement has occurred but the extent is not possible to determine How historic livestock grazing contributed to this is not possible to estimate, since cumulative effects like major storm events (as occurred in 1964), timber management, road construction, and other past activities outside of the watershed must be considered

The factors listed above probably all have played some role in the current condition and function of the watershed Stock ponds have been constructed in meadows, and Mosquito Creek was deepened in 1963 for livestock water. Riparian road crossings (culverts) that pond water have been used repeatedly as a drinking source by livestock. Though not well documented, Kentucky bluegrass has been introduced into many of the meadow systems, and will remain regardless of future management. The reduction of willows and aspen in the riparian community can be partly attributed to historic livestock management practices - both in and out the watershed. Examples of wildlife eliminated (if they had occurred in the analysis area) are wolves, grizzly bears, beavers, and trout.

Most predators were probably eliminated prior to 1920. Beaver and trout populations were probably reduced when the Kirk Reef was lowered to increase pasture acreage in the Upper Klamath Marsh in about 1908. Livestock and beaver competition, together with road construction in riparian areas, reduced the willow and aspen component. These losses aided in lowering water tables and changing the hydrologic function of Mosquito Creek. Beaver trapping in the mid-1970's in adjacent Jack Creek was aimed at reducing populations. Speculation is that if beavers were in Mosquito Creek, they could have been trapped out at the same time. Records do not indicate when rainbow trout were eliminated from Mosquito Creek, but it probably occurred within a ten to fifteen year period after the lowering of the Kirk Reef.

Parts of the analysis area still contain most plants and wildlife present prior to development. Some areas that have been changed may not be capable of returning to 1900 conditions. Successional paths will be different due to lower water tables. Introduced species like Kentucky bluegrass will out-compete some native species (such as Cusick's bluegrass and tufted hairgrass) and expand their dominance of sites .

Range Trends

If livestock grazing continues in the Jack Creek Allotment, it will probably remain a sheep allotment. Conversion to cattle should be discouraged. Sheep are not as dependent on riparian vegetation as cattle.

- Sheep can better utilize the upland forage resource (bitterbrush).
- They are moved on a continual basis with a herder.
- Less funds have to be expended for sheep range improvements.
- They are an effective tool to maintain bitterbrush as a usuable forage base for big game.

Recommendations in *" Beaver" (Rich Olson, and Wayne A. Hubert*, pp. 23-24), are excellent for livestock management. This publication is available at the Winema Supervisors Office. Even if beaver are not returned to Mosquito Creek, the suggestions brought forth may be helpful should the District elect to start restoration of the riparian systems in this analysis area.

If livestock grazing ceases to be a tool for management of the forage resources in the watershed, the options to achieve whatever management objectives are:

- No management
- Prescribed fire.
- Manual labor, and/or mechanical operations.

Each of these tools has potential to achieve some managment goals, but also, the potential to create problems such as soil compaction, or treating too large an area and setting plant communities back farther than was intended. Proper planning and funding, having specialists knowledgable in the resource, and public support will determine the success or failure of proposed projects using these tools.

Most forage plants in the analysis area are in fair or good condition. Some upland forage (bitterbrush) plants are starting to lose vigor; this will probably continue. Riparian communities, as a whole, are in fair to good condition, and it is expected this trend will continue. The exception is where headcuts, or downcutting, has occurred, or continues to occur. Those areas that have Kentucky bluegrass as a component will continue to have this species present in the future. If grazed or burned, it will regain some of the density lost. It is expected that most of the forage plants that are currently present in the watershed will continue to maintain their presence in the future. The biggest threat to the area is the continual spread of knapweed, which is migrating south from Deschutes County. The primary transport mechanism for this species is motor vehicles. Reestablishment of willows and aspens in the area may be hampered by elk, since they have been expanding their numbers and use of the entire area; young willow and aspen are preferred forage base. The only control on elk numbers, other than habitat capacity, is hunting. Due to the downward trend in hunting activity, it is not expected this will control elk enough to prevent resource damage, or allow reestablishment of the hardwood component.

Fire as a Disturbance Factor

Both natural wildfire and consequences of fire suppression are the major change agents in the watershed

- Fire was historically the dominant disturbance factor in the watershed.
- Lack of fire has casued, since 1910, the greatest landscape level change from historic condition in vegetation. Fire suppression has allowed conifer stocking levels to increase 2-6 times historic levels, and to develop a stand type highly susceptible to fire. Potential for large stand replacement wildfire is potentially the major disturbance factor to occur in the future..
- Recent logging activities have caused more short term change at the stand lvel on portions of the watershed than recent fire.
- Contemporary fires are often stand replacement fires vs, historical fires were generally surface fires with torching of individual trees or small clumps of trees.
- Historic fire, depending on plant community type, maintained an open ponderosa pine stand, a lodgepole grassland, or riparian hardwood community.
- Contemporary fire generally returns the site to a very early seral stage not present, at least in large averages, in historic condition.

- Due to buildup of fuels and contemporary stand structure, fires are becoming increasingly difficult or impossible to suppress

Refer to the fire section of this document for further discussion.

Roads

For the purpose of watershed analysis the focus on "roads" is primarily the impact of "roads" to hydrologic function. It does not matter greatly if a road is open or closed, but only if the soil and vegetation have returned to the pre-road condition There are other issues surrounding roads, for example road use can affect wildlife security. And many of those issues can be addressed by limiting use or road closure.

Therefore it is important to define what we are talking about when we talk about "roads", and related statements such as road density. For the purpose of this discussion roads are any travel ways, including railroad grades and in some cases major skid trails, which have an impact on the water holding or transporting capacity of the soil.

History

The road system in the Mosquito area predated logging activities by 20-40 years or more. The timber cruise from 1921-22 era shows a road system in the Mosuito area with one to three miles of road per square mile (BIA Achieves). The timber cruise maps show both roads and "old roads" we can only speculate how old "old" is. Reservation reports from 1912 on refer to the reservation as "well roaded" Earlier reports have not been reviewed. "Well roaded" in 1912 may have a totally different meaning than today.

These roads were generally not constructed. One notable exception was the road across the marsh, now called the Silver Lake Highway. The section of road across the marsh was constructed over a period of several years.

Probably these road began as paths, since at the turn of the century a wagon could travel almost everywhere. Then the "paths" evolved as a road system especially when vegetation establishment subsequent to fire suppression became a barrier to travel.

Current Situation

The roads that are in place today, are the result of the discussion above, plus the added system and non-system roads (major skid trails, temporary roads) for primarily timber harvesting. Other non-system recreational and woodcutter roads that have developed as offshoots of these roads primarily to access and traverse meadows for camping and harvesting firewood adjacent to meadows.

In addition to these roads, it appears that major skid trails and temporary roads are still being created during present timber operations, plus these roads and skid trails are not being returned to pre-harvest landscape conditions. The estimated miles of road present in the analysis area are 6.4 miles/per square mile.

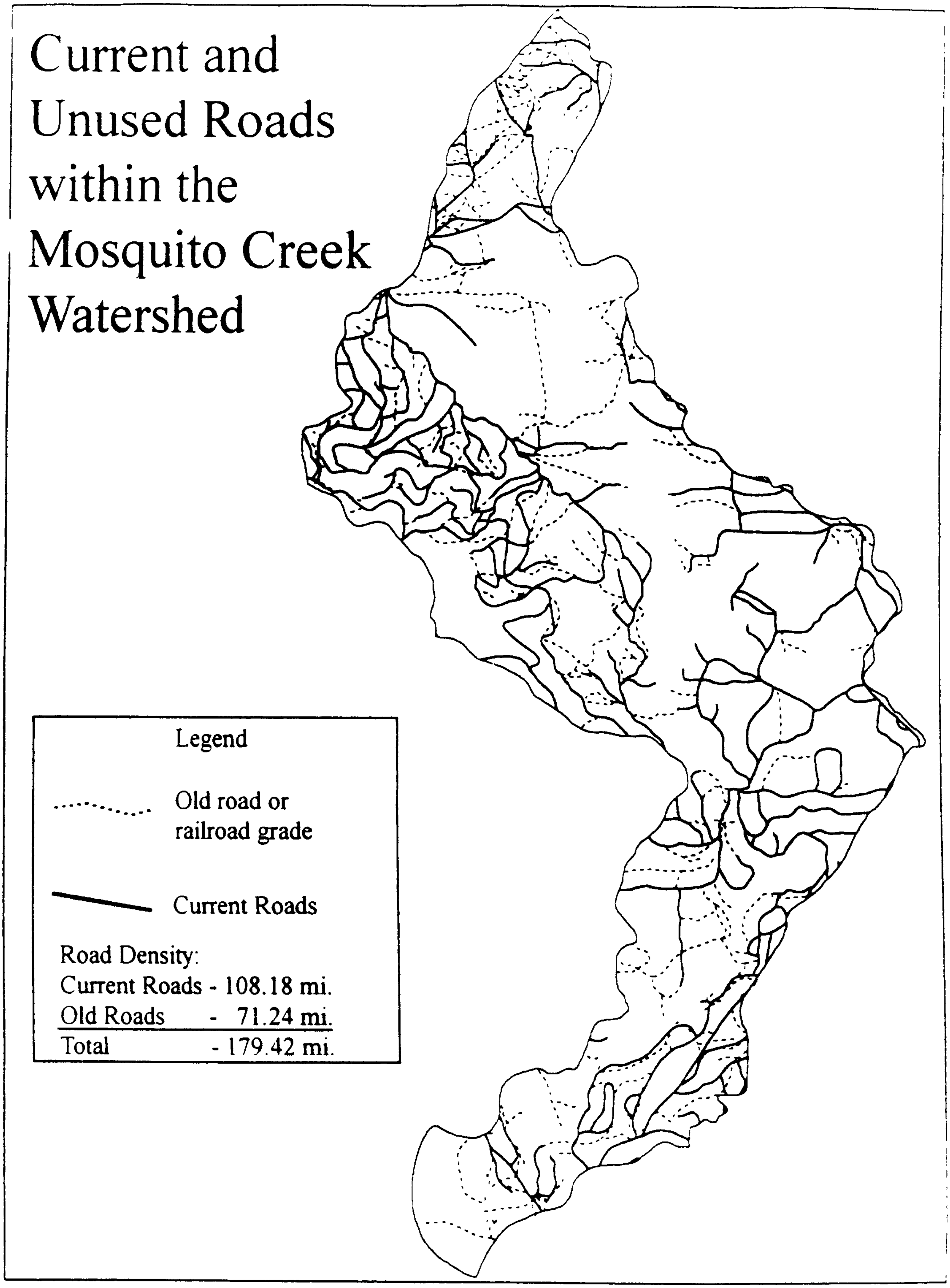
Disturbance

Primary perceived and known effects that roads have in this watershed are

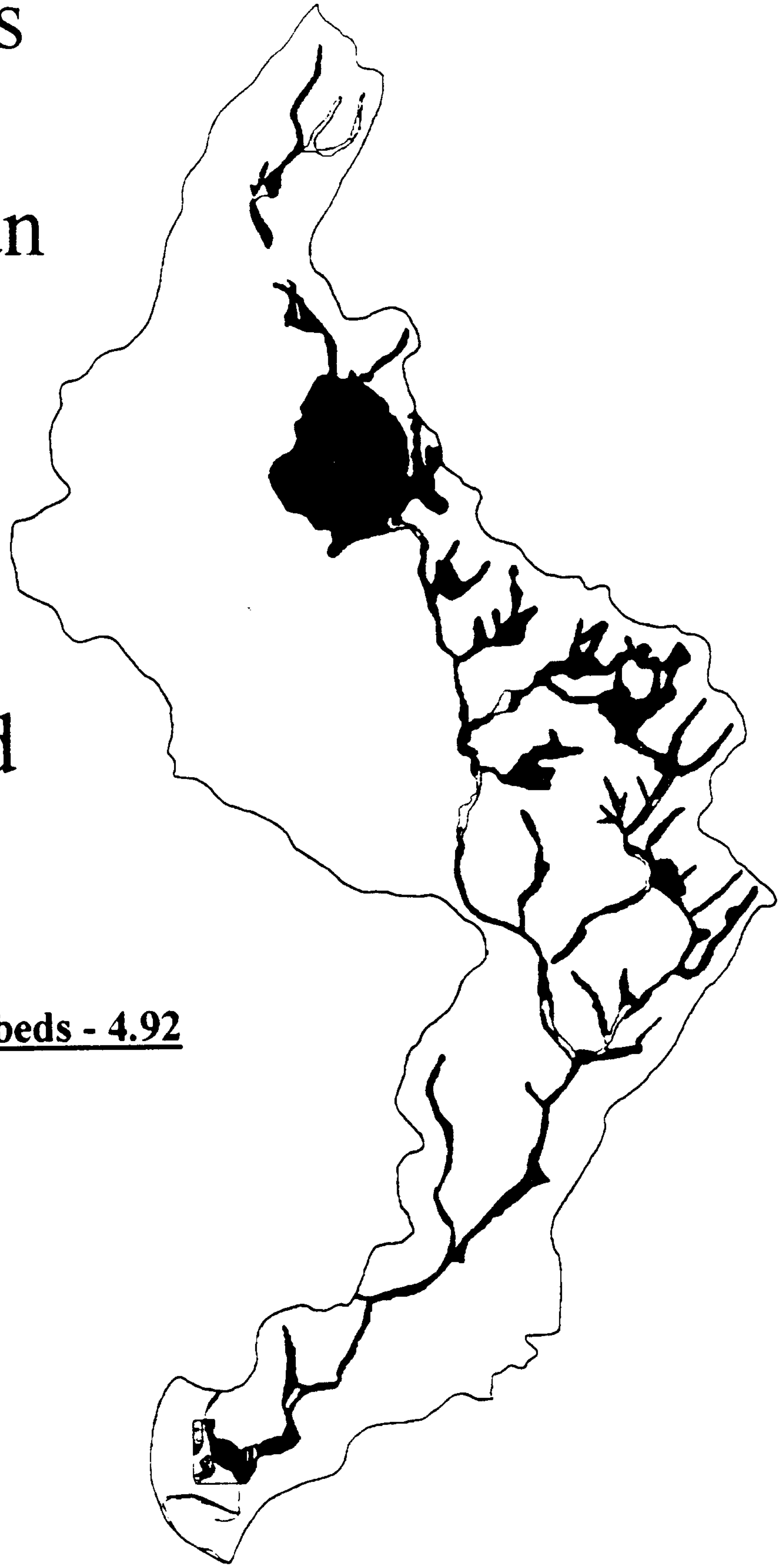
- Act as agents of increased or modified water run-off, soil displacement, and movement (Ex Road drains, and culverts moving more soils into riparian areas).
- Act as compression dams(drying and retaining water) in riparian crossings
- Act as erosion, gully, and compaction creation agents, especially in riparian and drainage areas(ex. Off-road recreational vehicle use in meadows; i.e., is very common in this watershed, and in other meadows on both Chemult and Chiloquin Districts.).
- Along with other management activities, act as agents of plant community successional change. (Ex reduction of willow components due to drying out of a wet area.) There are numerous examples of the effects of roads and other associated activities on changing riparian communities to more upland type shrubs, and conifers across the western United States. This drying out of riparian zones is occurring in this watershed and in other areas on this forest. The primary effect seen in this analysis area is conifer replacement (lodgepole pine) of willow and aspen(ex. Mosquito Creek near the 86 road).
- Along with other management and non-management activities(recreational users) act to decrease habitat effectiveness for most wildlife species.

Trends

If the present miles of road are not reduced, one can expect the above agents to continue their effects on hydrologic function, changing riparian plant communities to more xeric conifers and shrubs, and reducing the effectiveness of wildlife habitats for preferred management species (ex. Northern Goshawk, Fisher, big game). This will happen because more non-system roads will probably be created by users of this area.


Current and Unused Roads within the Mosquito Creek Watershed
Legend
Old road or railroad grade
Current Roads
Road Density:
Current Roads - 108.18 mi.
Old Roads - 71.24 mi.
Total - 179.42 mi.

Old Roads within the riparian areas in the Mosquito Creek Watershed



Miles of old road beds - 4.92

V. Monitoring Activities Within the Watershed

Soils Monitoring

A Select unit(usually a timber harvest unit)

B Select a starting point on the unit.

C. Select an azimuth for transect to follow and if possible select a target on the opposite side of the unit so to align transect azimuth.

Note: Steps 1-3 can be done in the office with a map and protractor, this will help in avoiding the monitors bias and will insert some randomness to the survey.

D. Begin paced transect.

1. Insert tile probe into the soil at the toe of the left foot each time it strikes the ground or every other step.

2. Decide the degree of compaction by the amount of resistance the soil offers to the insertion of the probe: 0 = no compaction, 1= slight, 2 = moderate, 3 = severe compaction. Record the appropriate number on the tally sheet.

Note: Practice getting "a feel" for probing on areas known to be compacted-roads, landings skidtrails and areas that have no compaction - around stumps and unharvested trees, where machines have not operated.

3. While at this site, visually inspect the immediate area for puddling, displacement, erosion and burn intensity (definitions/explanations to follow) If these are evident decide to what degree(0-3, none to severe), record info on form.

Note: If extensive areas are severely impacted, please make a note on the recording sheet and on the appropriate map. Then notify the district Soil Scientist as to the nature of the disturbance and its location.

E. Continue pacing and estimating soil disturbance values on a line transect across the unit. Be sure to adhere to the original azimuth as closely as possible.

Recommendations:

A. We need to continue compaction monitoring, especially within the Mosquito creek watershed.

B. We need to define "detrimental compaction" by measuring on-the-ground factors e.g. tree growth.

C. We need to correlate type of logging system, type of slash abatement, etc., with the severity of compaction.

D. District planners and sale administrators need to be aware of compaction potential and to prescribe appropriate systems to curtail compaction

E. Eventually, if "detrimental compaction" is proven to exceed forest plan standards and guidelines, then, wholesale subsoiling to relieve compaction may be necessary.

F Extend soil monitoring program for measuring soil compaction, erosion, etc, into Mosquito creek watershed The initial monitoring will be primarily a visual review of the project areas for evident erosion and sedimentation If the visual review finds evidence of extensive erosion, then, an effort will be made to quantify the eroding area, cause of erosion, effect of erosion and quantity of material eroded Recommendations to stabilize and rehabilitate the eroding areas will be made Sediment budgets would be calculated

G If the monitoring reveals extensive erosion on project area, this should red flag the need to change management practices Project planners and sale administrators need to be aware of the need to change operations to avoid future erosion.

H. Continue to monitor displacement as part of our on-going program. However, monitoring measurements made during actual machine operations may produce more accurate and useable data

I. Look at changing the definition of displacement to something more easily measurable. Or, we may need to do before and after operation measurements to ascertain baseline data to compare with post-operations data.

J Continue the visual monitoring for severely burned soils that is part of the on-going compaction survey. Concentrate the monitoring in the Jack Creek watershed.

K. Review definition of severely burned soils for its adequacy of soil protection. Review definitions/occurrence of hydrophobic (water repellant) soils caused by burning.

L. Set up program/plan to more closely monitor the effects of prescribed burning on local soils Plan should emphasize pre and post burn nutrient status at various soil depths, effects on litter and duff layers, effect on organic matter and hydrophobicity.

Appendix

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Forest Records and Sources:

Chemult Historical Grazing Records.

Appendix B. Watershed Assessment Team

The following persons were assigned the task of gathering the available information, researching local knowledge of the watershed through local publics, and evaluating conditions on-site. Together, as a team they have worked to assimilate all the information, to produce this assessment report.

Susan Puddy, Chiloquin R.D	Team Leader, Silviculture
Kim Johnson, Chemult R D.	Silviculture/Vegetation
Jim Cassidy, Chemult R.D.	Soils and Geology
Elizabeth Williams, Chemult R.D.	GIS/Database Management
Jay Frederick, Chiloquin R.D.	Wildlife/Fisheries
Rich Howard, Chiloquin R.D.	Range/Wildlife/Cultural Uses
Tim Sexton, Chiloquin R.D.	Fire/Climate
Mike Mcneil, S.O. Ecosystem Mgt.	Hydrology/Geology
Rex Appleby, S.O. Ecosystem Mgt.	Writer/Editor

Thanks also to the following individuals for their assistance, input and technical expertise. Their contributions, though sometime seemingly miniscule, helped to make the completion of this assessment possible.

Jorie Clark, Chemult R.D.	Eddie Olmedo, Chemult R.D.
Elizabeth Budy, Forest Archaeologist	Carol Rogers, S.O. Engineering

Appendix C. Wildlife and Plant Community Associations

Plant Associations and Seral Stages Used With Wildlife Species List

Plant Association	Symbol Used
Pine Associated (includes Mixed Conifer)	1
Ponderosa Pine Associations	2
Lodgepole Pine Associations	3
Riparian all (for those specie that use all riparian plant associations.)	4all
Riparian Hardwood (includes willow, and aspen)	4a*
Conifer Riparian (Wet Lodgepole Associations)	4b*
Riparian Water	4c*
Meadows, Marshes (includes wet, moist, dry meadows)	4d*
Rock habitats	5
Shrub habitats	6

(These associations are dominated by either bitterbrush overstory, or manzanita/ceanothus overstory, or other upland shrub species, or combinations of upland shrub species. They do not include areas with a conifer overstory.)

Plant association seral stage designation code

Late seral stage designated by an "A".*

Mid seral stage designated by a "B".*

Early seral stage designated by a "C".*

* *The different riparian associations are indicated by lower case letter (Ex. 4a indicates a riparian hardwood association). A capital letter indicates a seral stage of an association(Ex. 4aA indicates a hardwood riparian community in a late seral stage of development).*

Life Form Descriptions

(Copied from Managed Habitats in the Great Basin. Thomas, et. al.)

L.F.No.	Reproduces	Feeds
1	In water	In Water
2	In water	on ground, in shrubs and/or trees
3	On ground around water or on floating or emergent vegetation	in water, on ground, in shrubs & trees
4	In cliffs,caves,rims,and/or talus	on ground or in air
5	on ground w/o specific water cliff, rim, or talus assoc.	on ground on ground
6	On ground	in shrubs, trees, or air
7	In shrubs	on ground, in water or air
8	In shrubs	in shrubs, trees, or air
9	Primarily in deciduous trees	in shrubs, trees, or air
10	Primarily in conifers	in shrubs, trees, or air
11	In trees	on ground, in shrubs trees, or air
12	On very thick branches	on ground or in water
13	Excavates own hole in tree	on ground, in shrubs, trees, or air
14	In a hole made by another species or naturally occurring	on ground, in water, or air
15	Underground burrow	on or underground
16	Underground burrow	in water, on ground, or in air

Winema National Forest Bird Species List - February, 1994

Sources

Nomenclature and status from *Oregon Wildlife Diversity Plan* 1993-1998 (Draft), June, 1993 Oregon Department of Fish and Wildlife

Neotropical migratory bird classification, range and habitat from Sharp, Brian E *Neotropical Migrants on National Forests of the Pacific Northwest*, June 1992 USFS, R6

Habitat from Thomas, et al. 1979 *Wildlife Habitats in Managed Forests: the Blue Mountains of Oregon and Washington.* USDA-FS Ag. Hndbk No 553

The following codes are used to identify the status and occurrence of the various species within the Winema National Forest:

Status:
Fe = Federal endangered, Ft = Federal threatened, Fc = Federal C2, Fp = Federal petitioned, S = R6 sensitive, Oc = Oregon critical, Ov = Oregon vulnerable, Op = peripheral or naturally rare, Ou = Oregon undetermined status, G = gamefish or game animal, F = furbearer

Occurrence:
D1 = Chemult District, D2 = Chiloquin District, D3 = Klamath District, F = Forest-wide, UKL = Upper Klamath Lake, LOW = Lake of the Woods

See preceding Plant Associations and Life Form Descriptions for the definition of codes in those two columns.

Common Name	Scientific Name	Status	Occur	Association	L.F.	
Species that use all habitats for nesting and feeding, or do not appear to be specific in habitat requirements						
Black-billed Magpie	Pica pica		F	Ubiquitous	7	
Common Raven	Corvus corax		F	Ubiquitous	4	
European Starling	Sturnus vulgaris	N	F	Ubiquitous	14	
Birds that nest in conifers and primarily use riparian zones for feeding						
Wood Duck	Aix sponsa	M	F	Riparian	14	
Golden Eagle	Aquila chrysaetos		F	large trees or cliff	12	
Bald Eagle	Haliaeetus leucocephalus	Ft	F	Open +/- OG, +\- near large waterbodies	12	
Red-tailed Hawk	Buteo jamaicensis	N	F	Open forest/lg. trees	12	
Osprey	Pandion haliaetus	N	F	OG+/- near large water bodies	12	
American Kestrel	Falco sparverius	N	F	LS/OG	14	
Barn Owl	Tyto albo		F	Structures, cavities	14	
Great Horned Owl	Bubo virginianus		F	Open LM	12	
Great Gray Owl	Strix nebulosa	Ov	F	LM near meadows	12	Purple
Martin	Progne subis	Oc, N	F	Burns with tall snags, along lakes, rivers	14	
Tree Swallow	Tachycineta bicolor	N	F	Riparian, wetlands	14	

Common Name	Scientific Name	Status	Occur	Association	L.F.
Violet-green Swallow	Tachycineta thalassina	N	F	Open for , grasslnds, ag lands, wetlands	14
Barn Swallow	Hirundo rustica	N	F	Open for , dwellngs. Forage in riparian.	4
House Wren	Troglodytes aedon	N	F	Open for., grassland, edges	14
American Goldfinch	Carduelis tristis	N	F	For. openings, riparian	8
Purple Finch	Carpodacus cassinii		F	Riparian, conifer, edge	11
House Finch	Carpodacus mexicanus		F	Forest, riparian	9
Western Wood Peewee	Contopus sordidulus	N	F	Mixed forests; ; near H2O canyons	11
Bird species listed here occur in forested plant associations					
Turkey Vulture	Cathartes aura	N	F	OG +/- open country/cliffs	4
Sharp-shinned Hawk	Accipiter striatus	N	F	Forest; young and mature stands	11
Cooper's Hawk	Accipiter cooperii	N	F	LS/OG; 2nd growth in drainages	11
Northern Goshawk	Accipiter gentilis	Oc	F	Open forest +/-OG	11
Blue Grouse	Dendragapus obscurus		F	Mixed conifer forest	5
Flammulated Owl	Otus flammeolus	Oc, N	F	OG+/- Ppine	14
Western Screech Owl	Otus kennicottii		F	Open forest	14
Northern Pygmy Owl	Glaucidium gnoma	Oc	F	Open forest	14
Northern Saw-whet Owl	Aegolius acadicus		F	Open forest	14
Rufous Hummingbird	Selasphorus rufus	N	F	For. openings/edges; M/OG; streamside	11
Lewis' Woodpecker	Melanerpes lewis	Oc	F?	PPine, junip. for. edge	13
Williamson's Sapsucker	Sphyrapicus thyroideus	Ou, N	F	M/OG, large snags, mixed conifer; riparian	13
Hairy Woodpecker	Picoides villosus		F	Mixed conifer, Lp	13
White-headed Woodpecker	Picoides albolarvatus	Oc	F	M/OG, PPine	13
Black-backed Woodpecker	Picoides arcticus	Oc	F	Mixed con , lp > 10"	13
Northern Flicker	Colaptes auratus		F	Forest >10"	13
Pileated Woodpecker	Dryocopus pileatus	Oc	F	Mixed conifer, Ppine > 20"	13
Olive-sided Flycatcher	Contopus borealis	N	F	Forest w/openings, pref. LM/OG	10
Hammond's Flycatcher	Empidonax hammondii	N	F	Forest w/openings, OG+/- more common	11
Gray Jay	Perisoreus canadensis		F	Forest	11
Steller's Jay	Cyanocitta stelleri		F	Forest	11
Clark's Nutcracker	Nucifraga columbiana		F	High elevation forest	10
Wrentit	Chamaea fasciata		D3?	Dense thickets of ceanothus	8
Black-capped Chickadee	Parus atricapillus		F	Forest	14

Common Name	Scientific Name	Status	Occur	Association	L.F.
Mountain Chickadee	Parus gambeli		F	High elevation forest	14
Plain Titmouse	Parus inornatus		F	Forest	14
Red-breasted Nuthatch	Sitta canadensis		F	Forest cavity user	13
White-breasted Nuthatch	Sitta carolinersis		F	Forest cavity user	13
Pygmy Nuthatch	Sitta pygmaea	Ov	F	Forest cavity user	13
Brown Creeper	Certhiaamericana		F	Forest	14
Bewick's Wren	Thryomanes bewickii		F?	Brushland, stream edge, open woods	7
House Wren	Troglodytes aedon	N	F	Open for., grassland, edges	14
Winter Wren	Troglodytes troglodytes		F	Forest	3
Golden-crowned Kinglet	Regulus satrapa		F	Open forest	10
Ruby-crowned Kinglet	Regulus calendula	N	F	Mature forest/some 2nd growth	10
Western Bluebird	Sialia mexicana	Ov	F	Forest openings with snags	14
Mountain Bluebird	Sialia currucoides	N	F	Edges of pine or juniper and aspen	14
Townsend's Solitaire	Myadestes townsendi		F	Edges, grassland/ shrubland	6
Hermit Thrush	Catharus guttatus	N	F	Mature forest	5
American Robin	Turdus migratorius	N	F	Open forest to juniper grasslands	7
Solitary Vireo				M/OG Forest/2nd growth riparian	11
Warbling Vireo				Open deciduous woods, riparian	11
Red-eyed Vireo				Open decid woods w/ saplings	11
Orange-crowned Warbler				Most forest types; young stands; ripar	6
Nashville Warbler				Open dry woods; decid ripar;forest brush	6
Yellow-rumped Warbler	Dendroica coronata	N	F	Mature conifer	10
Black-throated Gray Warbler	Dendroica nigrescens	N	F	Open Ppine; mix con/ decid/some young	10
Townsend's Warbler	Dendroica townsendii	N	F	LM/OG conifer forest	10
White-crowned Sparrow	Zonotrichia leucophrys	N	F	Open forest, clearings, edges	7
Dark-eyed Junco	Junco hyemalis		F	Forest	5
Western Tanager	Piranga ludoviciana	N	F	Mature conifer	10
House Sparrow	Passer domesticus		F	Edge	14
Pine Siskin	Carduelis pinus		F	Forest	11
Red Crossbill	Loxia curvirostra		F	Forest	10
Cassin's Finch	Carpodacus cassinii	N	F	Mature conifer	11

Common Name	Scientific Name	Status	Occur	Association	L.F.
Evening Grosbeak	Coccothraustes vespertinus		F	Forest	11
Common Nighthawk	Chordeiles minor	N	F	Open forest; clearings burns in forest	6
Gray Flycatcher	Empidonax wrightii	N	F	Open forest; Ppine	7
Western Wood Peewee	Contopus sordidulus	N	F	Open mature conifer	11
Birds which either use rock habitat, or shrub habitat for nesting					
Peregrine Falcon	Falco peregrinus	Fe, N	F (?)	Nests cliffs, open land feeds on birds	4
Prairie Falcon	Falco mexicanus		F	Nests cliffs, feeds in riparian areas.	4
Mourning Dove	Zenaida macroura		F	Open forest, shrub and grassland	11
Common Nighthawk	Chordeiles minor	N	F	Grassland/shrub-steppe	6
Common Poorwil	Phalaenoptilus nuttallii	N	F	Sagebrush, juniper, grassland	6
Gray Flycatcher	Empidonax wrightii	N	F	Sage-bitterbrush, junip-grassland	7
Ash-throated Flycatcher	Myiarchus cinerascens	N	D2,3	Shrublands	14
Cliff Swallow	Hirundo pyrrchonota	N	F	Cliffs, riparian areas	4
Townsend's Solitaire	Myadestes townsendi		F	Edges, grassland/ shrubland	6
Brewer's Sparrow	Spizella breweri	N	F	Shrub-steppe	7
Vesper Sparrow	Pooecetes gramineus	N	F	Open dry uplands	5
Lesser Goldfinch	Carduelis psaltria		F	Grass, shrub, juniper	7
Turkey Vulture	Carthartes aura	N	F	Cliffs,large rock outcrops	4
Wrentit	Chamaea fasciata		?	Dense ceanothus thickets	8
Barn Owl	Tyto albo		F	Cliffs	14
Great Horned Owl	Bubo virginianus		F	Cliffs	12
birds that reproduce and feed in riparian habitats (lakes, marshes, streams, and meadows)					
Great Blue Heron	Ardea herodias		F	Lakes, marsh	12
Snowy Egret	Egretta thula	Ov	F	Lakes, marsh	7
Greater Sandhill Crane	Grus canadensis	Ov	F	Wetland	3
Canada Goose	Branta canadensis		F	Lakes, marsh	3
Wood Duck	Aix sponsa	M	F	Riparian	14
Green-winged Teal	Anas crecca		F ?	Lakes, marsh	3
Mallard	Anas platyrhynchos		F	Lakes, marsh	3
Cinnamon Teal	Anas cyanoptera		F	Lakes, marsh	3
Gadwall	Anas strepera		F?	Lakes, marsh	3
American Wigeon	Anas americana		F?	Lakes, marsh	3
Bufflehead	Bucephala albeola	Op	F	Lakes, marsh	14
Killdeer	Charadrius vociferus		F	Grassland	3

Common Name	Scientific Name	Status	Occur	Association	L.F.
Spotted Sandpiper	Actitis macularia		F	River edge/riparian	3
Common Snipe	Galinago gallinago	F		Riparian/wetland	3
Northern Harrier	Circus cyaneus	N	F	Grassland	5
Calliope Hummingbird	Stellula calliope	N	F	High elev riparian and meadow	7
Belted Kingfisher	Ceryle alcyon	N	F	Riparian, streams	16
Tree Swallow	Tachycineta bicolor	N	F	Riparian, wetlands	14
Violet-green Swallow	Tachycineta thalassina	N	F	Open forest, grasslands, ag lands, wetlands	14
N. Rough-winged Swallow	Stelgidopteryx serripennis	N	F	Riparian, esp. streams	16
Bank Swallow	Riparia riparia	Ou, N	F	Rivers, streams, lakes, high soil banks	16
American Dipper	Cinclus mexicanus	F	Stream riparian		3
Yellow Warbler	Dendroica petechia	N	F	Riparian	8
Wilson's Warbler	Wilsonia pusilla	N	F	Riparian	5
Black-headed Grosbeak	Pheucticus lelanocephalus	N	F	Riparian	11
Savannah Sparrow	Passerculus sandwichensis	N	F	Grassland, marsh	5
Song Sparrow	Melospiza melodia	F		Riparian shrub	7
Golden-crowned Sparrow	Zonotrichia atricapilla		F	Riparian	5
Red-winged Blackbird	Agelaius phoeniceus		F	Marsh	7
Yellow-headed Blackbird	Xanthocephalus xanthocephalus	N	F	Marsh	7
Brewer's Blackbird	Euphagus cyanocephalus	N	F	Pasture, riparian	7
Rosy Finch	Leucosticte arctoa	F		Grassland	4
Rufous-sided Towhee	Pipilo erythrophthalmus		F	Riparian shrub/ streamside shrub	7
Great Gray Owl	Strix nebulosa		F	meadows;marsh	12

Winema National Forest Wildlife Species List - February, 1994

Nomenclature from Oregon *Wildlife Diversity Plan* 1993-1998 (Draft), June, 1993. Oregon Department of Fish and Wildlife.

The following codes are used to identify the status and occurrence of the various species within the Winema National Forest.

Status: Fe = Federal endangered, Ft = Federal threatened, Fc = Federal C2, Fp = Federal petitioned, S = R6 sensitive, Oc = Oregon critical, Ov = Oregon vulnerable, Op = peripheral or naturally rare, Ou = Oregon undetermined status, G = gamefish or game animal, F = furbearer

Occurrence: D1 = Chemult District, D2 = Chiloquin District, D3 = Klamath District, F = Forest-wide, UKL = Upper Klamath Lake, LOW = Lake of the Woods.

Association: The Plant Association key is in the Appendix section.

Life Form: Life Form categories are listed in the Appendix section.

FISH

The only fish which may be present in the watershed is the Speckled Dace, but this has not been confirmed.
No fish fall in the categories for all habitats
No fish in forested habitats
No fish in rock and shrub habitats
No fish in riparian habitats

All Habitat Types

Common Name	Scientific Name	Status	Occur	Assoc	L.F.
	AMPHIBIANS AND REPTILES				
Western Skink	Eumeces skiltonianus		F	All	5
Northern Alligator Lizard	Elgaria coeruleas		D1, D3	All	5
Rubber Boa	Charina bottae		F	All	5
Gopher Snake	Pituophis melanoleucus		F	All	3
	MAMMALS				
California Myotis	Myotis californicus		F	All	14
Botta's Pocket Gopher	Thomomys bottae		D1,3	All	15
Western Pocket Gopher	Thomomys mazama		D1,3	All	15
Northern Pocket Gopher	Thomomys talpoides		D1,2	All,exc. 5	15
Deer Mouse	Peromyscus maniculatus		F	All	15
Norway Rat	Rattus norvegicus		D3	All, w/ peop	15
Coyote	Canis latrans		F	All	15
Mountain Lion	Felis concolor	G	F	All	4
Elk	Cervus elaphus	G	F	All	5
Mule Deer	Odocoileus hemionus	G	F	All,BC	5
Pronghorn	Antilocapra americana	G	D1,2	All,BC	5

FORESTED HABITATS

Common Name	Scientific Name	Status	Occur	Assoc	L.F.
	AMPHIBIANS AND REPTILES				
Great Basin Spadefoot	Scaphiophus intermontanus		F	2A	2
Sagebrush Lizard	Sceloporus graciosus		F	2AB	5
Western Fence Lizard	Sceloporus occidentalis		F	1,2,3AB	4
Short-horned Lizard	Phrynosoma douglassi		F	2,3AB	5
Northern Alligator Lizard	Elgaria coeruleas		D1,3	1,2,3AB	5
Rubber Boa	Charina bottae		F	1,2,3AB	5
	MAMMALS				
Spotted Bat	Euderma maculatum		F, accid	1,2,3A	4
Western Small-footed Myotis	Myotis ciliolabrum		F	1,2,3A	4
Yellow-pine Chipmunk	Tamias amoenus		F	2ABC	15
Least Chipmunk	Tamias minimus		D2(?)	1,3ABC	15
Golden-Mantled Ground Squirrel	Spermophilus lateralis		F	1,2,3ABC	14
Douglas Squirrel	Tamiasciurus douglasii		F	1,2,3AB	14
Northern Flying Squirrel	Glaucomys sabrinus		F	1,2,3AB	14
Western Pocket Gopher	Thomomys mazama		D1,3	1,2,3ABC	15
Great Basin Pocket Mouse	Perognathus parvus		F	2AB	15
Pinon Mouse	Peromyscus truei		F	2A	4
Bushy-tailed Woodrat	Neotoma cinera		F	2A	4
Heather Vole	Phenacomys intermedius		F	1,2A	15
Water Vole	Microtus richardsoni		F	2AB	16
Common Porcupine	Erethizon dorsatum		F	2ABC	6
Black Bear	Ursus americanus	G	F	1A	15
American Marten	Martes americana	Oc	F	2A	14
Fisher	Martes pennanti	Oc,Fc	F	2AB	14
California Wolverine	Gulo gulo	S, Ot, Fc	F	1,2A	5
American Badger	Taxidea taxus	F	F	2,3ABC	15
Bobcat	Lynx rufus	F	F	2A	4

ROCK AND SHRUB HABITATS

Common Name	Scientific Name	Status	Occur	Assoc	L.F.
	AMPHIBIANS AND REPTILES				
Great Basin Spadefoot	Scaphiophus intermontanus		F	6AB	2
Western Toad	Bufo boreas		F	6ABC	2
Sagebrush Lizard	Sceloporus graciosus		F	6AB	5
Western Fence Lizard	Sceloporus occidentalis		F	5,6AB	4
Short-horned Lizard	Phrynosoma douglassi		F	6AB	5
Racer	Coluber constrictor		F	5	5
Striped Whipsnake	Masticophis taeniatus		F	5	5
	MAMMALS				
Pallid Bat	Antrozous pallidus	Ov	F	6AB	4
Spotted Bat	Euderma maculatum		F, accid	5,6AB	4

Common Name	Scientific Name	Status	Occur	Assoc	L.F.
	MAMMALS (cont)				
Big Brown Bat	Eptesicus fuscus		F	6AB	14
Townsend's Big-eared Bat	Plecotus townsendii	S, Oc, Fc	D2(?),3	4,5	4
Long-legged Myotis	Myotis volans		F	6AB	4
Western Small-footed Myotis	Myotis ciliolabrum		F	6AB	14
Western Pipistrelle	Pipistrellus hesperus		F(?)	6AB	4
Mountain Cottontail	ylvilagus nuttallii		F	5,6AB	15
Black-tailed Jackrabbit	Lepus californicus		F	5	5
Yellow-pine Chipmunk	Tamias amoenus		F	5	15
Least Chipmunk	Tamias minimus		D2(?)	5	15
Yellow-bellied Marmot	Marmota flaviventris		F	5,6ABC	4
Great Basin Pocket Mouse	Perognathus parvus		F	5	15
California Kangaroo Rat	Dipodomys californicus		D3	5	15
Canyon Mouse	Peromyscus crinitus		D2(?)	6ABC	15
Pinon Mouse	Peromyscus truei		F	5	4
Northern Grasshopper Mouse	Onchomys leugogaster		D2	5,6ABC	15
Bushy-tailed Woodrat	Neotoma cinera		F	5	4
Heather Vole	Phenacomys intermedius		F	5	15
Water Vole	Microtus richardsoni		F	6ABC	16
Bobcat	Lynx rufus	F	F	5,6ABC	4
Pronghorn	Antilocapra americana	G	D1,2	6ABC	5

RIPARIAN HABITATS

Common Name	Scientific Name	Status	Occur	Assoc	L.F.
	AMPHIBIANS AND REPTILES				
Long-toed Salamander	Ambystoma macrodactylum		F	4allABC	2
Western Toad	Bufo boreas		F	4cABC	2
Pacific Treefrog	Pseudacris regilla		F	4a,b,AB	2
Spotted Frog	Rana pretiosa	Oc, Fc	F	4c,d,AB	1
Western Skink	Eumeces skiltonianus		F	4cAB	5
Northern Alligator Lizard	Elgaria coeruleas		D1,3	4dAB	5
Rubber Boa	Charina bottae		F	4dAB	5
Racer	Coluber constrictor		F	4dAB	5
Striped Whipsnake	Masticophis taeniatus		F	4dcA	5
W. Terrestrial Garter Snake	Thamnophis elegans		F	4allABC	3
Common Garter Snake	Thamnophis sirtalis		F	4allABC	3
	MAMMALS				
Pacific Shrew	Sorex pacificus		D1,2	4all,ABC	2
Water Shrew	Sorex palustris		F	4all,ABC	3
Trowbridge's Shrew	Sorex trowbridgii		D1,2	4all,ABC	3
Vagrant Shrew	Sorex vagrans		F	4all,ABC	15
Shrew-mole	Neurotrichus gibbsii		F	4all,ABC	3

Common Name	Scientific Name	Status	Occur	Assoc	L.F.
	MAMMALS (cont)				
Coast Mole	Scapanus orarius		F	4all,ABC	3
Hoary Bat	Lasiurus cinereus		F	4all,ABC	11
Big Brown Bat	Eptesicus fuscus		F	4all	14
Silver-haired Bat	Lasionycteris noctivagans		F	4a,b	14
Little Brown Myotis	Myotis lucifugus		F	4all	14
Fringed Myotis	Myotis thysanodes	Ov	F	4ab	4
Yuma Myotis	Myotis yumanensis		F	4ab	14
Long-eared Myotis	Myotis evotis		F	4ab	14
Western Pipistrelle	Pipistrellus hesperus		F(?)	4c	4
Snowshoe Hare	Lepus americanus		F	4abBC	5
Black-tailed Jackrabbit	Lepus californicus		F	4dABC	5
Yellow-bellied Marmot	Marmota flaviventris		F	4dABC	4
Belding's Ground Squirrel	Spermophilus beldingi		F	4dABC	15
Botta's Pocket Gopher	Thomomys bottae		D1,3	4dABC	15
Western Pocket Gopher	Thomomys mazama		D1,3	4dABC	15
Western Harvest Mouse	Reithrodontomys megalotis		F	4dABC	15
Dusky-footed Woodrat	Neotoma fuscipes		F	4abAB	10
House Mouse	Mus musculus		D3	4dABC	15
Long-tailed Vole	Microtus longicaudus		F	4dAB	15
Montane Vole	Microtus montanus		F	4dAB	15
Water Vole	Microtus richardsoni		F	4dAB	16
Western Jumping Mouse	Zapus princeps		F	4cdAB	3
Pacific Jumping Mouse	Zapus trinotatus		D1(?)	4allABC	3
Black Bear	Ursus americanus	G	F	4allABC	15
Raccoon	Procyon lotor	F	F	4allABC	14
Ermine	Mustela erminea	F	F	4allABC	15
Long-tailed Weasel	Mustela frenata	F	F	4allABC	15
American Badger	Taxidea taxus	F	F	4dABC	15
Striped Skunk	Mephitis mephitis	F	F	4d,ABC	15

Appendix D. Plant Community Summaries

Riparian Area Designation

The objectives of the Winema Riparian Habitat Survey (1992) were to identify and delineate ten classes of riparian habitat on the forest using high altitude color infrared photos. The final products were mylar overlays, at 1:24,000 scale suitable for GIS use, showing delineation and vegetation classes, and a 1" to 1 mile map for use in planning.

Materials used in the mapping: 1988 HAP color I.R. photos for Chiloquin and Chemult R.D., and 1987 HAP color I.R. photos for the Klamath R.D. 1982 Orthophoto maps were used as the basemaps. Following GIS guidelines and standards, mylar was placed over the orthophoto maps, and riparian areas delineated. Additionally, the I.R. photos were used to identify riparian areas not evident on the orthophotos to facilitate identification of vegetation classifications.

The following are the designations and the plant associations which make up the mapping designations. *These classifications broadly encompass the vegetative associations described by Kovalchik (1987)*

Wet Meadows: MW-29-11, MW-19-23, MW-19-24, ME-49-12
Moist Meadows: MD-19-11, MW-31-11, MM-19-12, MW-29-24, MM-29-13, MM-29-15
Wet Hardwoods: SW-29-11, SW-22-11, SW-22-13, SW-11-13
Moist Hardwoods: HQS-2-21, HQM-1-21, HQM-4-11
Wet Lodgepole: CLM-3-14, CLM - 3-11, CLM-3-12, CLM-1-13, CLM-9-11
Moist Lodgepole: CLM-1-12, CLM-2-11, CLM-3-13
Wet Conifer: CEM-1-11
Moist Conifer: CWF-4-31, CEM-2-22
Moist Hardwood: FW-41-11
Moist Meadow: FW-42-11

Descriptions of Communities

Wet Meadows (MW) - Generally those plant associations described as MW, ME, and SW. Boggy, with a consistently high water table, with surface or near-surface water common. Major species characterizing this class include *Vaccinium occidentale, Eleocharis pauciflora, Carex sitchensis, Carex lasiocarpa, Carex vesicaria, and Carex rostrata.*

Moist Meadows (MM) - Generally those plant associations described as MM and MD. Meadows with fluctuating water tables between the surface (during snowmelt and spring runoff), dropping to 5-50 inches during August. Major species characterizing this class include *Poa cusickii, Poa pratensis, Deschampsia cespitosa, Carex nebraskensis, Carex eurocarpa, and Carex simulata.*

Wet Hardwoods (HW) - Generally those plant associations described as HQS and SW Wet, with a consistently high water table, with surface or near-surface water common. Major species characterizing this class include *Alnus incana, Spiraea douglasii, Populus tremuloides, Symphoricarpos albus, and Elymus glaucus.*

Moist Hardwoods (HM) - Generally those plant associations described as HQM. Fluctuating water table between 1 and 3 feet below the surface. Major species characterizing this class include *Populus tremuloides, Elymus glaucus, and Spiraea douglasii.*

Wet Lodgepole (CWL) - Generally those plant associations described as CLM-1-13, 3-11, 3-14, and 9-11 Seasonal flooding with water table above the surface into July, then receding to a maximum depth of 2 fet below the surface Exceptions are CLM-3-11, with a maximum water table depth of 6 inches, and CLM-9-11, which is continually boggy Major species characterizing this class include *Pinus contorta, Picea engelmannii, Arctostaphylos uva-ursi, Vaccinium occidentale, Spiraea douglasii, Carex eurocarpa, and Eleocharis pauciflora.*

Moist Lodgepole (CML) - Generally those plant associations described as CLM 1-12 and 2-11. Subsurface water table ranging from 1-2 feet below the surface to a maximum depth of 4-5 feet. Major species characterizing this class include *Pinus contorta, Picea engelmannii, Arctostaphylos uva-ursi, and Poa pratensis.*

Wet Conifer (CW) - Generally those plant associations described as CLM-1-13, 1-14, 3-11, 3-12, 3-14, and 9-11; and CEM 1-11, 2-21, 3-11, and 3-12. Fluctuating water table from on the surface to 6 inches beneath, to 2 feet below the surface. Major species characterizing this class include those in the CWL class (included due to a mix of species and associations being present, but indiscernable), and *Picea engelmannii, Equisetum arvense, Vaccinium occidentale, and Carex eurocarpa.*

Moist Conifer (CM) - Generally those plant associations described as CLM-1-12, 2-11; CWF; CPS; and CEM 2-22. Fluctuating subsurface water table from 2-3 feet, to 4 feet below the surface. Major species characterizing this class include those in the CML class (included due to a mix of species and associations being present, but indiscernable), and *Picea engelmannii, Pinus ponderosa, Abies concolor, Clintonia uniflora, and Symphoricarpos albus.*

Wet Hardwood/Conifer Mix (HCW) - Conditions, species and associations present in the HW, CWL, and CM classes. This class was created due to a mix of species and associations being present, but indiscernable from one another.

Moist Hardwood.Conifer Mix (HCM) - Conditions, species and associations present in the HM, CML, and CM classes. This class was created due to a mix of species and associations being present, but indiscernable from one another.

Wet Meadow/River (WM/R) - Distinguished by the presence of a major stream or river, this class contains the MW class. Created so that later GIS work could distinguish fish habitat, etc...

Lakes (L) - Characterized by lakes. Created for keeping track of this particular fish habitat type.

These classifications of vegetation are based upon the reflectance of plants in the green, red, and infrared spectrum. Reddish-colored trees along creeks and rivers were considered to be Pinus contorta, except at high elevation - where a mix of conifers occurs - and in cases where the crown diameter indicated Pinus ponderosa.

In both cases, wet and moist regimes were classified based upon the density of the stand and its proximity to a water source or wet meadow Generally, these are pure stands, but may contain a small component of other species.

Wet and moist meadows were identified based upon a lack of trees and the presence of dominate herbs, forbs, and grasses The determination between wet and moist was based on the greenness of the vegetation and the presence or absence of surface water, or indicators of surface water. Wet meadows were generally greener, indicated by red on the photos. The presence of grey, black, or purple indicated the presence of water. Moist meadows were generally light red, with some grey possible.

Hardwood/Conifer and Conifer classes were used when mixes of species occured but could not be discerned. Differences between wet and moist are the same as were used in classifying Hardwood and *Pinus contorta classes.*

Wet Meadows/River was used to delineate rivers and their associated wet meadows. It was felt that larger streams or rivers should have their own classification, as well as Lakes, particularly for GIS and tracking purposes.

Error Analysis:

1. Photo interpretation can be considered as much an art as it is a science. Consequently, errors in classification can occur. The most common error likely to occur is the mis-classification of meadow areas into a wetter category - some areas classified as wet may actually be moist; moist meadows may be classified as dry.

2. Delineation of vegetative boundaries is another potential error likely to occur. Some areas may be mapped larger than they actually are, due to narrowness of some riparian areas, steep slopes, and GIS requirements.

3. There are undoubtedly some areas completely mis-identified as a result of the survey. Quantification of this type of error is impossible.

4. Delineated riparian habitats may fail to correspond completely with the streams appearing on topographic maps. This occurs mainly because some sections of streams are hard to identify due to harvesting, vegetative composition, and lack of a defined channel Errors in the topographic maps may also be a cause.

The point to be emphasized is that there may be errors in the classifications. Having this data in the GIS system facilitates easy correction as field verification identifies such errors. Field-going personnel should be encouraged to report discrepancies as they find them, so that the database can be corrected. Full participation in this process of verifying and correcting is the only way a reliable database can be created, and the GIS program can reach its full potential.

Plant Communities of the Watershed as Related to Wildlife Use Over Time

Mixed Conifer Community

			Predicted Trends: Management Scenarios			
	Pre-1900	1900-Present	No Mgmt	Cur Mgmt	Mgmt to 1900	Notes & Refs
Dominant Plants						
PP/SP	More	Less	Same	Same	More	
Fir/LP	Less	More	More	More	Less	
Shrubs	Less	More	More	Same	Less	
Grass/Forbs	More	Less	Less	Less	More	
H2O	More	Less	Same	Same	More	
Disturbance						
Climate	Cyclic	Cyclic	Cyclic	Cyclic	Cyclic	
Insects/disease	Cyclic	Eruptive	Eruptive	Variable	Cyclic	
Fire	Periodic	Less	More std. replacemt	More std. Replacemt	Reintro.	
Roads	Less	More	Same	Same/more	Remove	
Man Acts	Less	More	None	Same	Less	
Wildlife Presence						
Raptors	More	Less	Same/more	Same/less	Same/less	
Bats	Same/more	Less	Same/more	Same/less	Same/more	
Big Game	Less	Eruptive	Eruptive	Eruptive	Less	
Owls	More	Less	Same/more	Same/less	Same/more	
Pred/Furbs	More	Less	Same	Same/less	Same/more	
Other birds	Cyclic	Less	High var.	Same/less	Same/more	
Rodents/Lags	Cyclic	Eruptive	High var.	Eruptive	Start to cycle	
Woodpeckers	Cyclic	Less	High var.	Same/less	Start to cycleS	
Sust. Habitats	Yes	Not w/o active mgt.	Not for late ser sp	Not for late ser sp	Start to stabilize	

Ponderosa Pine Community

	Pre-1900	1900-Present	Predicted Trends: Management Scenarios No Mgmt	Cur Mgmt	Mgmt to 1900	Notes & Refs
Dominant Plants						
PP	More OG	More YG Less OG	More YG Less OG	More YG Less OG	Less trees More OG	
Bitterbrush	Less	More	More	More	Less	
Grass/Forbs	More	Less	Less	Same	More	
H2O	More	Less	Variable	Same	Restore	
Disturbance						
Climate	Cyclic	Cyclic	Cyclic	Cyclic	Cyclic	
Insects/disease	Cyclic	Eruptive	Eruptive	Variable	Cyclic	
Fire	Periodic	Less	More std. Replacemt	More std. Replacemt	Reintro.	
Roads	Less	More	Same	Same/more	Remove	
Man Acts	Less	More	None	Same	Less plant dens	
Wildlife Presence						
Raptors	More	Less	Same/more	Same/less	Same/More	
Bats	More	Less	Same/more	Same/less	Same/more	
Big Game	Less	Eruptive	Eruptive	Eruptive	Less	
Owls	More	Less	Same/more	Same/less	Same/more	
Pred/Furbs	More	Less	Same/more	Same/less	Same/more	
Other birds	Cyclic	Unstab cyc	Var cycles	Unstab cyc	Same/more	
Rodents/Lags	Cyclic	Eruptive	Var cycles	Eruptive	Stabilize cyc	
Woodpeckers	Cyclic	Unstab cyc	Var cycles	Var cycles	Stabilize cyc	
Sust. Habitats	Yes	Not w/o active mgt.	Not for late ser sp	Not for late ser sp	Start to stabilize	

Upland Lodgepole Pine Communities

	Pre-1900	1900-Present	Predicted Trends: Management Scenarios No Mngmt	Cur Mgmt	Mgmt to 1900	Notes & Refs
Dominant plants						
LP	Young, <80 yrs	More all ages	More	More YG high density	Less trees	
Bitterbrush	Less	More	Less	More	Less	
Grass/Forbs	More	Less	long seral intervals	Less	More	
H2O	More	Less	Variable	Same	Restore	
Disturbance						
Climate	Cyclic	Cyclic	Cyclic	Cyclic	Cyclic	
Insects/disease	Cyclic	More	Eruptive	Variable	Cyclic	
Fire	Periodic	Less	More std. Replacemt	More std. Replacemt	Reintro.	
Roads	Less	More	Same	Same/less	Remove	
Man Acts	Less	More	None	Same	Less plant dens	
Wildlife Presence						
Raptors	More	Less	Same/more	Same/less	Same/more	
Bats	More	Less	Same/more	Same/less	Same/more	
Big Game	Less	Eruptive	Eruptive	Eruptive	Less	
Owls	More	Less	Same/more	Same/less	Same/more	
Pred/Furbs	More	Less	Same/more	Same/less	Same/more	
Other birds	Cyclic	Unstab cyc	High var	Same/less	Same/more	
Rodents/Lags	Cyclic	Eruptive	High var	Eruptive	Start to cyc	
Woodpeckers	Cyclic	High var	High var	Same/less	Start to cyc	
Sust. Habitats	Yes	Not w/o active mgt.	Not for late ser sp	Not for late ser sp	Start to stabilize	

Upland Brush/Rock Communities

			Predicted Trends: Management Scenarios			
	Pre-1900	1900-Present	No Mgmt	Cur Mgmt	Mgmt to 1900	Notes & Refs
Dominant Plants						
Shrubs (BB, Manz, Cean)	More	More	Same	Same	Same	
Trees	None	St. to est.	St. to lose	St. to lose	Remove	
Grass/Forbs	More	Less	Less	Less	More	
H2O	More	Less	Variable	Less	Restore	
Disturbance						
Climate	Cyclic	Cyclic	Cyclic	Cyclic	Cyclic	
Insects/disease	yclic	Same	More	Variable	Cyclic	
Fire	Periodic	Less	More	More potnl	Reintro.	
Roads	Less	More	Same	Same/less	Remove	
Man Acts	Less	More	None	Same	Less plant dens	
Wildlife Presence						
Raptors	More	Less	Same/more	Same/less	Same/more	
Bats	Same/more	Same/ess	Same/more	Same/less	Same/more	
Big Game	Less	Eruptive	Eruptive	Eruptive	Less	
Owls	More	Less	Same/more	Same/less	Same/more	
Pred/Furbs	More	Less	Same/more	Same/more	Same/more	
Other birds	Cyclic	Less erupt	High var	Same/less	Same/more	
Rodents/Lags	Cyclic	Some	Eruptive	Eruptive	Start to cyc	
Woodpeckers	None	Some	Same/less	Same/less	Start to cyc	
Sust. Habitats	Yes	Not w/o active mgt.	Not for late ser sp	Not for late ser sp	Start to stabilize	

Wet Conifer Community

	Pre-1900	1900-Present	No Mgmt	Cur Mgmt	Mgmt to 1900	Notes & Refs
			Predicted Trends: Management Scenarios			
Dominant Plants						
LP	Less YG low dens	More all ages	More	More YG high density	Less trees	
Shrubs	Less	More	Same	Same	Less	
Grass/Forbs	More	Less	Less	Less	More	
H2O	More	Less	Variable	Same	More	
Disturbance						
Climate	Cyclic	Cyclic	Cyclic	Cyclic	Cyclic	
Insects/disease	Cyclic	More	Eruptive	More	Cyclic	
Fire	Periodic	Less	More std. Replacemt	More pot	Reintro.	
Roads	Less	More	Same	Same/less	Remove	
Man Acts	Less	More	None	Same	Less plant dens	
Wildlife Presence						
Raptors	More	Less	Same/more	Same/less	Same/more	
Bats	More	Less	Same/more	Same/less	Same/more	
Big Game	Less	Eruptive	Eruptive	Eruptive	Less	
Owls	More	Less	Same/more	Same/less	Same/more	
Pred/Furbs	More	Less	Same/more	Same/less	Same/more	
Other birds	Cyclic	Eruptive	High var	Same/less	Same/more	
Rodents/Lags	Cyclic	Eruptive	High var	Eruptive	Start to cyc	
Woodpeckers	Cyclic	Less	High var	Same/less	Start to cyc	
Sust. Habitats	Yes	Not w/o active mgt.	Not for late ser sp	Not for late ser sp	Start to stabilize	

Aspen, Willow Community

	Predicted Trends: Management Scenarios					
	Pre-1900	**1900-Present**	**No Mgmt**	**Cur Mgmt**	**Mgmt to 1900**	**Notes & Refs**
Dominant Plants						
Aspen & or Willow	More	Less	Less	Less	Increase	
Grass/Forbs	Less	More	Same	Same	Decrease	
Shrubs	More	More	More	More	Less	
Conifers	Less	More	More	More	Less	
H_2O	More	Variable	Variable	Less	Start cycle	
Disturbance						
Climate	Cyclic	Cyclic	Cyclic	Cyclic	Cyclic	
Insects/disease	Periodic	Less	More	More	Cyclic	
Fire	Periodic	More	More potl	More potnl	Reintro.	
Roads	Less	More	Same	Same/less	Remove	
Man Acts	Less	More	None	Same	Less plant dens	
Wildlife Presence						
Raptors	More	Less	Same/more	Same/less	Same/more	
Bats	More	Less	Same/more	Same/less	Same/more	
Big Game	Less	Eruptive	Eruptive	Eruptive	Less	
Owls	More	Less	Same/more	Same/less	Same/more	
Pred/Furbs	More	Less	Same/more	Same/more	Same/more	
Other birds	Cyclic	Eruptive	High var	Same/less	Same/more	
Rodents/Lags	Cyclic	Less	High var	Eruptive	Start to cyc	
Woodpeckers	None	Some	High var	Same/less	Start to cyc	
Sust. Habitats	Yes	Not w/o active mgt.	Not for late ser sp	Not for late ser sp	Start to stabilize	

Meadow/Marsh Community

			Predicted Trends: Management Scenarios			
	Pre-1900	1900-Present	No Mgmt	Cur Mgmt	Mgmt to 1900	Notes & Ref[c]
Dominant Plants						
Native Grass/Sedges	More	Less	Same/more	Same/less	Same/more	
Shrubs	Less	More	Same/more	Same/more	Same/more	
H2O	More	Less	Variable	Less	Start cycle Restore channels	
Disturbance						
Climate	Cyclic	Cyclic	Cyclic	Cyclic	Cyclic	
Insects/disease	Periodic	Eruptive	Same	Same	Cyclic	
Fire	Periodic	Less	More	Less	Reintro.	
Roads	Less	More	Same	Same/less	Remove	
Man Acts	Less	Int. non-nat species	More intro plants	More intro plants	Less non-nat plants	
Wildlife Presence						
Raptors	More	Less	Same/more	Same/less	Same/more	
Bats	More	Less	Same/more	Same/less	Same/more	
Big Game	Same/more	Eruptive	Eruptive	Eruptive	Less eruptive	
Owls	More	Less	Same/more	Same/less	Same/more	
Pred/Furbs	More	Less	Same/more	Same/less	Same/more	
Other birds	Cyclic	Less	High var	Same/less	Same/more	
Rodents/Lags	Cyclic	Eruptive	High var	Eruptive	Start to cyc	
Woodpeckers	None	None	High var	Same/less	Start to cyc	
Sust. Habitats	Yes	Not w/o active mgt	Not for late ser sp	Not for late ser sp	Start to stabilize	

Appendix E. Soils

Erosion hazards by landtype groups

LT	Erosion Hazard Type				
	Sheet	Gully	Wind	Frost heave	Cold air drainage
A1	Low	Low	Low-Mod	Mod-High	Moderate
A2	Low	Low	Low-Mod	Mod-High	Moderate
A4	Low-Mod	Low	Low-Mod	Mod-High	Low
A5	Low-Mod	Low	Low-Mod	Mod-High	Low
A6	Low	Low	Low-Mod	Mod-High	Low
A8	Low	Low	Moderate	High	High
A10	Low	Low	Moderate	High	High
B1	Low	Low	Low-Mod	Mod-High	Moderate
B2	Low	Low-Mod	Low	Mod-High	Moderate
B3	Low	Low-Mod	Low	Mod-High	Low
B4	Low-Mod	Low	Low-Mod	Mod-High	Low
B7	Low-Mod	Low	Low-Mod	Moderate	Low
B8	Low	Low	Low	High	High
G2	Low	Mod	Low	High	High
G3	Low	Mod	Low	High	High
H6	High	Low	Low	Low	High
2	Low	Mod-High	Low	Moderate	High

Miscellaneous Landtypes

Landtype	Landform Descriptions.
1	Flat to gently sloping valley bottoms-wet meadows.
2	Flat to gently sloping valley bottoms-dry to moist meadows
20	Pumice and ash mantled sideslopes and cindercones.
A1	Upland flats.
A2	Concave toeslopes and valley bottoms.
A4	Convex ridges and sideslopes.
A5	Convex ridges and sideslopes.
A6	Convex ridges and sideslopes.
A8	Broad flats and basins.
A10	Broad flats and basins.
B1	Upland flats.
B2	Concave toeslopes and drainageways.
B3	Concave toeslopes and drainageways.
B4	Convex ridges and sideslopes.
B5	Convex ridges and sideslopes.
B6	Very steep sideslopes.
B7	Convex ridges and sideslopes.
B8	Broad flats and basins.
G1	Valley bottoms.
G2	Valley bottoms.
G3	Valley bottoms.
H2	Convex sideslopes.
H5	Ridges and convex sideslopes.
H6	Steep convex sideslope.

Landtype complexes
All the complexes listed below are composed of landtypes listed above, therefore no new landtype descriptions or interpretations will be necessary.

A2A4	B2B4	G2G3	6A2
A5B6	B4H4		6A8
A6A8	B1B8		4B4

Descriptions and Interpretations for Landtypes and Landtype complexes of soil Groups.

LT	Description	% slope	Elev. Range '	Eff. Root Depth	LT included	inc. plt. comm.
A1	Upland flats	0-10	4000-5500	10-20	A-2,4,8,9	CP-S2-12
A2	Concave toe slope & valley bottoms	0-15	4000-5500	12-24	A-1,4,8,9; G-2,3	CP-S2-12
A4	Convex ridges & sideslopes	0-35	4000-5500	8-18	A-1,2,5,6, 7; B4	CP-S2-12
A5	Convex ridges & sideslopes	0-35	5000-5800	8-18	A-3,5,6,7; B5	CW-S1-12
A6	Convex ridges & sideslopes	0-35	4000-5500	8-18	A-1,4,8; G-2,3	CL-S2-11
A8	Broad flats & basins	0-10	4000-5500	10-18	A-2,6,10; G-2,3	CL-S2-11
A8	Broad flats & basins	0-10	4000-5500	10-18	A-9,D-3	CL-S2-11
B1	Upland flats	0-10	4000-5500	10-40	B-2,4,9, G1	CP-S2-12, 13
B2	Concave toe slope & drainage ways	0-15	4000-5500	10-60	B-1,3,4; G-1,2	CL-S2-12 CW-S1-12
B4	Convex ridges & sideslopes	0-35	4000-5500	10-40	B-1,2,5,7,8; G-1,2; H-3,6	CW-S2-12, 13
G2	Valley bottoms	0-5	4200-5500	36	G-1,3;A9;2	CL-S2-13, 14
G3	Valley bottoms	0-5	4200-5500	36	G-1	CL-M1-4; CL-M2-11, CL-M3-11
H6	Steep convex sideslopes	35-70	4500-5000	20-36	H-3,4,5, 7,13	CP-S2-12 CP-S2-11
2	Flat to gently sloping valley bottoms.	0-10	4000-6500	20-30	N/A	MM-19 MM-90
6	Pumice and ash. Mantled sand dunes.					
B5	Convex ridges and sideslopes.					
	Dry & moist meadows	<1%				

Landtype complexes, which combine 2 or more landtypes into a single mapping unit. Most of the landtypes are described in the text of this report, however the landtypes not included are described below:

6A2	A1A8	A5B6	A6A8	B4H6
6A8	A2A4	A6A8	B2B4	B7B8

Appendix F. Notes from Leiberg
As Apply to the Mosquito/Klamath Marsh area.

P. 229
The volcanic character of the ridges which intersect the Klamath drainage basin is this region has already been alluded to. Some of these ridges have been built up around volcanic vents, others are irregular masses whose origin perhaps is to be sought in earth fissures. The entire basin seems originally to have been a plateau area. The lava outflows inclosed many flats, which in time became lakes. Most of these lakes have been drained by their waters cutting channels through the lava dams. Others are in various stages from marches to shallow lakes.

P.230
The plain or depression which stretches along the base of the Cascades in this region is comparatively narrow, varying from 10 to 15 miles in width. It consists of two distinct terraces, a northern and a southern, the former elevated about 400 feet above the latter. The terraces connect through the valleys of Williamson and Sprague rivers with the terrace or plain which borders the central areas of the Sprague River. ....

The upper terrace is separated from the lower by a broad, thick lava flow, which stretches from northwest to southeast, and possibly may have come from Mount Scott or adjacent craters. The lava flow created a large lake, of which all that remains is Klamath Marsh, most of its area having been drained by the Williamson River cutting a canyon through the lava flow at a point 8 miles east of Fort Klamath. The upper terrace stretches northward to the Klamath-Deschutes divide. Eastward it extends to the foot of the Yamsay Range, which it follows southward along the western base to the head of Williamson River.

The pumice covering both on the upper and on the lower of these terraces was deposited when they were deeply covered with water. The present smoothness of their surface, only roughened by ancient beach lines along high levels and by the courses of modern streams, proves (sic) this. Some of the pumice appears to have been thrown out as fine particles. Much of it came as large, coarse fragments or bowlders (sic) a foot or more in diameter.

The Sycan terrace is situated east of the Yamsay Range and has an elevation of 5,000 feet. It likewise was a lake in past geologic times. It was formed by a lava flow which came from a crater, now extinct. Situated in the Fuego Range, Sycan River has cut through the obstruction, the lake has been drained, and a swampy tract known as Sycan Marsh now remains.

P.231
The higher points in the region show marks of light glaciation, but the terraces and flats show no clear evidences of the scoring or wearing effects of ice. Here, as in the Cascades, the smoothness of the pumice deposits proves either that glaciation preceded their deposition or that the region has not at any time been subject to the action of ice.

P.234
... With the exception of the tracts.... none of the areas at the immediate base of the Cascade can now be considered as truly semiarid, But the region comprised within the limits of the Klamath Marsh terrace shows decided tendencies in that direction. The leaning toward semiarid conditions is there shown by deficient reforestation of burned tracts in the lodgepole pine stands, and the evident tendency of such places to become covered with a growth of desert shrubs or grasses in place of the former forest.

P 238

It will be noticed that the yellow pine easily ranks above all of the other species either singly or combined The reason for this lies chiefly in the smaller annual precipitation on the subhumid areas of the western slope The large proportion of lodgepole pine is chiefly due to forest fires At least 90 per cent of the species owes its growth to this cause. The remainder occurs as the first forest covering on areas gradually being laid bare along margins of marshes and lakes by the lowering of their waters

P.246

Yellow Pine Type

... east of the range it sometimes runs pure to the extent of 99 per cent. Generally it is more or less mixed with varying percentages of white and red fir, incense cedar and sugar and lodgepole pine. When the forest contains yellow pine to the extent of 50 per cent, it is here considered as belonging to the yellow-pine type.... The largest admixture of other species in the examples quoted above consists of lodgepole pine. This growth here represents thin stands around marshy places or fringes along creeks and seepy spots where the soil humidity is too high for a yellow-pine growth.

P.248

The aspect of the type is that of an open forest with a minimum of undergrowth and seedling or sapling growth. The forest on the eastern side of the Cascades is more conspicuous in this respect than the forest on the western, owing to less variety in the frutescent flora of the former and, in general, to a smaller precipitation. But the open character of the yellow-pine type of forest anywhere in the region examined is due to frequently repeated forest fires more than to any other cause.

P.249

The forest floor in the type is covered with a thin layer of humus, consisting entirely of decaying pine needles, or it is entirely bare. The latter condition is very prevalent east of the Cascades, where large areas are annually overrun by fire. But even on the western side the range, where the humus covering most conspicuous, it is never more than a fraction of an inch in thickness, just enough to supply the requisite material for the spread of forest fires.

Freedom from fires insures a good and abundant reproduction the forest type, whether east or west of the range. East of the Cascades, its area is steadily increasing at the expense of tracts covered by the lodgepole pine. The process is slow, owing to fires Were they kept down most of the lodgepole-pine area on high ground would give way to pure or nearly pure growths of yellow pine.

Yellow-pine subtypes

The subtype referred to formed by pure or nearly pure growths of lodgepole pine. It might well be named the lodgepole-pine subtype. It occurs under two aspects, First in the contorta form of the species; secondly, in the murryana form. The aspect of the contorta form is that a dense masses of small, scraggy, limby trees forming a thick fringe along edges of marshes, creeks, or springy localities, or covering low, level areas, occurring in every case where the ratio of soil (p.250) humidity is too high to permit the growth of any other coniferous species indigenous to the region. The aspect of the murrayana form in its ultimate development, is that of close or moderately open stands of tall, straight, slender trees covering well-drained uplands. This form of the subtype is in every case a reforestation after fires, in this region after stands of yellow pine. Between the two forms there are many gradations

The characteristic feature of the subtype is its habit of forming pure growths. In this respect it stands preeminent among the coniferous species which make up the sylva west of the.. The most conspicuous examples occur in Ts. 30 and 31 S., Rs 7 and 8 E., where lodgepole-pine stands cover 40,000 acres c of a total of 48,000 forested, with a growth that averages 99 per cent pure.

P 274
The age of the timber utilized in sawmill consumption varies from 100 to 350 years. Most of the yellow pine falls below 175 years, the higher limit is reached chiefly in the sugar pine.

P 278
The largest burns directly chargeable to the Indian occupancy are in Ts. 30 and 31S., Rs. 8 and 9 E. In addition to being the largest they are likewise the most ancient. The burns cover upward to 60,000 acres, all but 1,000 or 1,100 acres being in a solid block. This tract appears to have been systematically burned by the Indians during the past three centuries. Remains of three forests are distinctly traceable in the charred fragments of timber which here and there little the ground. Two of these were composed of lodgepole pine, The most ancient one appears to have consisted of yellow pine, which would be the ultimate forest growth on this area following a long period of freedom from fire.

P.288
A noticeable feature in connection with the after-effects of forest fires in the yellow-pine type of forest is the suppression of undergrowth and of seedling trees. The yellow pine is by all odds the best fire-resisting tree in the sylva of the North Pacific slope. Repeated conflagrations may run through stands of the yellow-pine type with-out serious damage to the older trees of this species, provided that litter and humus be not to great. But the fires, even should they be of no great force or intensity, work irreparable injury to the seedling trees. On the eastern side of the Cascades, especially, fires have run through the yellow-pine timber many times. The absence or relative scarcity of young growth and underbrush is here very noticeable and striking. Much of the region examined east of the Cascades is included within the boundaries of the Klamath Indian Reservation, and the red man has therefore been under no particular restraint in the matter of burning his timber. In late years it seems to have dawned on his intelligence that good yellow pine may have some value after all, and in consequence fires are set much less frequently than formerly, with the result that where the forest has enjoyed freedom from fire for a number of years seedling and sapling trees of the yellow pine are springing up in the greatest abundance.

P.290
Humus, as applied to a layer of decaying vegetable debris on the forest floor, is not, as a rule, of any great depth in the forests of these regions In stands of the yellow-pine type it is a mere thin sprinkling of pine needles. ... To the light humus layer and the small quantity of litter, more than to any other cause, is due the preservation of the forest from total destruct on those areas.... It is not due to lack of fires that any timber remains. ..the yellow pine, both as an individual and as a species stands at the head of the list.. A fire in stands of this species runs rapidly, burns low, and with not great intensity owing to the extremely light humus cover. So long as the thick bark, which is a characteristic feature of the species, remains intact, the tree is tolerably safe, but sooner or later, either through the effects of repeated fires or through some accidental injury opening the bark and cursing an exudation of resin, fire finds its way into the trunk and produces a fire sear or scar. Each subsequent fire enlarges the burned spot until the tree finally succumbs. ...The custom of the Indians of peeling the yellow pine at certain seasons of the year to obtain the cambium layer which they use for food, is in some localities a fruitful contributory cause toward destruction of the yellow pine by fire. They do not carry the peeling process far enough to girdle the tree, but they remove a large enough piece of bark to make a gaping would which never heals over and which furnished an excellent entrance for fire Throughout the forest on the Klamath Reservation trees barked in this manner are very common. Along the eastern margin of Klamath Marsh they are found by the thousands

(The report then describes surveyed areas by townships. Townships 29-9 and 10 - Mosquito area were not surveyed. Due to the general similarity of the areas, excepts from surrounding townships thought to be applicable to Mosquito are included here.)

P 321
30-9
This township is situated west of the Cascades and consists chiefly of tule and sedge-covered areas belonging to Kalamth Marsh. The extreme eastern areas are formed by a projecting spur of lava and bear the forest. Soil is uniformly a pumice deposit.

All of the timber in the township is fire marked. Result of fires is the suppression of young growth, fire scarring of the older, with twisting and bending of the smaller trunck. There is little brush growth throughout. There is not humus, the foerst floor being bare, sharp, pumice sand.
Mill timber is easy of access, but poor in quality, and mostly of small dimensions.

P.322
30-10
This township is situated east of the Cascades. Its northern portion consists of grassy, non-forested bottom lands bordering the Williamson River, while the southern areas are formed of low lava hills, as a rule, deeply covered by a fine pumice deposit.

The forest in the township is fire marked throughout. In late years there has been fewer fires than formerly and the young growth, formerly mostly suppressed, is asserting itself everywhere. The young growth is yellow pine with a few scattered individuals of white fir. The lodgepole pine is found along the swales of the Williamson River bottoms.

Mill timber is very good in quality, being largely composed of standards and veterans with fair, clear trunks. It is easy of access from the Williamson River bottoms and forms, as a whole, a valuable stand of timber.

Appendix G. Excerpts From Munger

The following excerpts are from "***Western Yellow Pine in Oregon***", Thornton T. Munger, USDA Bulletin No. 418, February 6, 1917

p.17
In most of the pure yellow-pine forests of the State the trees are spaced rather widely, the ground fairly free from underbrush and debris. And travel through them on foot or horseback is interrupted only by occasional patches of saplings and fallen trees. The forests are usually not solid and continuous for great distances, except along the eastern base of the Cascades, but are broken by treeless "scab-rock ridges", or natural meadows.

P.18
Yellow pine grows commonly in many-aged stands, i.e., trees of all ages from seedlings to 500-year-old-veterans, with every age gradation between, are found in intimate mixture. In some stands there is a preponderance of very old trees; in fact, in many of the virgin stands of central and eastern Oregon there are more of the very old trees and less of the younger than the ideal forest should contain. Usually two or three or more trees of a certain age are found in a
p19
small group by themselves, the reason being that a group of many young trees usually starts in the gap which a large one makes when it dies. In the virgin stands throughout the State there seems to be a very large proportion of trees whose age is about 225 or 275 years, suggesting that after this age their mortality is greater.

P20
In pure, fully stocked stands in the Blue Mountains region there are commonly from 20 to 30 yellow pines per acre over 12 inches in diameter, of which but few are over 30 inches. Over large areas the average number per acre is ordinarily less than 20.

P21.
Yellow-pine forests are so irregular in density that figures for the average stand per acre or per quarter section are apt to be misleading.

P.23
Because of the wide range of conditions under which it grows the rate of growth of yellow pine is exceedingly variable, perhaps rather more so than that of most species....
Broadly speaking, during its first 10 or 15 years yellow pine grows very slowly; then follows a period of 75 or 100 years in which both diameter and height growth are rapid, exceptionally thrifty trees making an increase of one-half inch in diameter and 2 feet in height in one year. By its one hundred and fiftieth year the height increment has fallen off very much, the trees has nearly reached its mature height, and thereafter grows but a foot or two each decade. Diameter growth also decreases after the first century of life, the rings become narrower and narrower with age, and on very old trees, or those that have been suppressed, they are so fine as to be hardly distinguishable except with a magnifying glass. It is usual, therefore, for the annual rings to be broad and well defined in young trees
p24
and at the center of old ones, but narrow in the exterior rims of old trees, sometimes 90 to an inch of radius.
Yellow pine is a long-lived tree. The oldest encountered in the analysis of 4,997 stumps in eastern and central Oregon was in its six hundred and eight-seventh year when cut for lumber.

P31

In the yellow-pine forests of Oregon (except those on both slopes of the Cascades south of Crater Lake and those on the Siskiyou Mountains in southern Oregon and on some of the pumice-stone land toward the head of the Deschutes River) the trees are so open-grown and the woods are so free of underbrush that a good herbaceous vegetation suitable for forage springs up each year. The character of the vegetation depends upon the region, but it usually consists in part of a variety of grasses and in part of "weeds" (annual flowering plants).

Appendix H. Historic Logging Information

The BIA managed portion of Mosquito was sold as part of the North Marsh Sale in 1924. The BIA managed approximately the lower 1/3 of the subwatershed. The North Marsh Sale sold 305,000,000 (actually cut the 185,485,010 that Thonsfelt reports) board feet and covered portions of three townships; 29-8, 29-9, and 29-10. The sale was purchased by Fremont Lumber Company, who was closely related the Shevlin-Hixon Lumber Company.

Logging was completed on most sales on the Reservation within 5-10 years of purchase. This was not the case of North Marsh sale. Initially there was no railroad access to the sale area, the Southern Pacific RR had not reached that far north and the Klamath Marsh was an effective barrier to extension of logging grades from the south. It was speculated that the company would build a sawmill to mill the timber. However Shevlin-Hixon began acquiring land north of the reservation and apparently that timber was more economically attractive. Also by then the Northern Pacific had built railroad south from Bend to Chemult so the logs could be sent to their mill in Bend.

Shevlin-Hixon sold the North Marsh Sale to the Forest Lumber Company in 1927. The Forest Lumber Company did not start logging North Marsh until after it completed logging the Calimus Marsh Sale in 1936. Just as they started logging the North Marsh sale their sawmill burned and they did not continue in business. Chiloquin Lumber Company then acquired the sale. The portions of North Marsh that are in Mosquito area were logged in 1941, 1942, 1944 and 1946. The sale was a tractor to truck to rail system, the logs going to the Southern Pacific lines via a single railroad grade going through Chiloquin Camp to Mazama siding.

The Shevlin-Hixon logging on the rest of the Mosquito area occurred between 1947-1950. Logging methods were also tractor to truck to railroad. This was also the last "railroad" logging, or at least last railroad built to access a specific area, in the area. Also Shevlin-Hixon's last logging operation, they then sold their holdings to Brooks-Scanlan.

On both the BIA and Shevlin-Hixon lands logging and brush disposal methods would have been similar. The difference would be that probably the Shevlin-Hixon land was cut heavier, both in removing most, or all, of the larger trees and potentially causing more damage to the understory. Tractors with large arches would have skidded over much of the area potentially causing soil compaction. Slash piling appears to have been by hand. More detailed slash piling info later. Roads would have been built since motor trucks were used to take the logs to a reload site.

General Notes on Logging/Slash Treatment practices of the time and area.

On the BIA contracts in this era trees were cut with an 18" stump and larger. This is approximately equal to 16" DBH and larger. The standard harvest was removal of 60% of the volume. Timber was designated for cutting immediately before harvest rather than marked when the sale was sold. Therefor cutting intensity would be based on the stand at time of harvest, not sale. All snags were required to be fell until contract modifications were started in 1950 to leave snags if they would be cut soon for firewood. The following is an excerpt from "Preliminary Memorandum of General Instructions for the cutting contract personnel of the Klamath Indian Reservation" May, 1934.

"Marking;
A seeding and Improvement method of cutting will be followed under the direct and personal supervision of the forest examiners. The general policy will be to make as light a cutting as is

practicable. The aim must to twofold, priority to be fixed by the requirements of each case 1 The residual stand must be left in as vigorous, thrifty, healthy and therefore resistant condition as that is technically possible. 2. Adequate reproduction must be sought and protected to the utmost limit of natural and social economic practicability. The senile and badly infected condition of an overwhelming part of the forest can not be denied and must be faced courageously. Bloody operations, as it were, cannot be avoided; yet to sustain the cut an adequate residual stand must be left over the forest as a whole and a healthy progeny invited to come as rapidly as possible after cutting. Strictest balancing of all factors must be kept in mind at all times. Never can marking be performed perfunctorily and a la Munson last. Marking is the culmination of the forester's ability. That is weightily true even when applied to a wild forest and wild stands to come under intensive forest management.

All timber will be marked prior to cutting and trees to be cut will be blazed and stamped US both low on the stump and face high on the bole. "

Excerpts from post sale review of South Calimus Unit, which was completed immediately prior to North Marsh Unit and is in similar areas on the south side of Klamath Marsh.

"Marking

An examination was made of some of the cutover arcas on the South Calimus Unit. It appears that the marking rules are being carefully followed. However, in some places, this leaves a very light residual stand, especially where the bulk of the timber is over-mature, spike topped and in class 3C or 4C. Consideration could be given to leaving an occasional tree which is in one of the above classes, but which could be classified as a low risk. Many 4C trees are comparatively healthy and might reasonably be expected to survive until the next cutting cycle. As an added insurance of seed supply in case of a fire, it is felt that this proceeding would be fully justified. Strip checks were made of some of the cutover and marked but uncut areas with the following results:

Unit	No. Of Trees		Volume		
	Cut	Uncut	Cut	Uncut	Area
Wild Horse	47	86	81660	58160	14 acres

Cut per acre - 5833 feet = 58 per cent. Lease(sic) per acre 4,154 feet = 42 per cent

Diameter of Uncut Trees			Diameter of Cut Trees			Total stand		
DBH	No.	BA	DBH	No.	BA	DBH	No.	BA
12"	12	9.42	14"	1	1.0	12"	12	9.42
14"	8	8.55	18"	2	3.53	14"	9	9.62
16"	8	11.17	20"	1	2.18	16"	8	11.17
18"	11	19.44	22"	3	7.92	18"	13	22.97
20"	8	17.45	24"	6	18.85	20"	8	17 45
22"	5	13.20	26"	5	18.44	22"	8	21.12
24"	4	12.57	28"	3	12.83	24"	10	31.41
26"	5	18.44	30"	5	24.54	26"	10	36.87
28"	8	34.21	32"	3	16.76	28"	11	47 04
30"	3	14.73	34"	1	6.30	30"	8	39.27
32"	7	39.1	36"	3	21.21	32"	10	55.85
34"	3	18.92	38"	3	23 63	34"	4	25 22
36"	2	14.14	40"	2	17.45	36"	5	35.35

Diameter of Uncut Trees			Diameter of Cut Trees			Total stand		
DBH	No.	BA	DBH	No.	BA	DBH	No.	BA
38"	1	7.88	42"	4	38.48	38"	4	31.51
42"	1	9 62	44"	4	42 24	40"	2	17.45
			46"	2	23 08	42"	5	48.10
						44"	4	42.24
						46"	2	23.08
Total	86	248.84		48	278.44		133	525.14
per acre	6.14	17.77		3.43	19.88		9.5	37.51

Average volume of cut tree 2,040
Average volume of leave tree 640"

Results of Strip Checks on WildHorse and South Calimus Unit.

Wild Horse, 7 acres

	trees	TA	volume	volume/ac
Cut	36	5.14	67,850	9,700
Leave	86	6.71	31,750	4,540
Total	83	11.85		14,240

Wild Horse, 12 acres

	trees	TA	volume	volume/ac
Cut	51	4.25	130,320	10,860
Leave	86	7.17	80,460	6,750
Total	137	11.42		17,610

South Calimus Unit, 10 acres

	Trees	TA	volume	volume/ac
Cut	41	4.1	76,960	7,700
Leave	129	12.9	52,730	5,270
Total	170	17		12,970

Some examples are shown where as little as 32% of the volume of the stand was left. The highest per cent stand left was 41% of the volume.

Summary from "Instructions for Cruising East of the Cascade Mountains, District 6" 5/10/11.

This copy was found in the BIA archive materials and most likely was the guide followed, perhaps with some modifications. No other guide was found in the BIA records for this era. This was a Forest Service guide.

Cruising was done with the strip survey method. The guide shows 1 chain width but appears that BIA practice was 2 chain width. Interval was 20 chains. These were summarized by acre 1 ch by 10 chains long. There would be 2 sample acres for each 40 which are averaged for the 40. Stream widths are recorded in links. DBH recorded in 2" groups and estimated using a Biltmore stick. All trees above 12" DBH and merchantable are tallied in 2" classes. Trees between 4-8" are tallied as small poles Trees between 9-12" are tallied as large poles.

My comments on cruise accuracy.

This sampling system should give a fairly good estimate for large areas, but be generally less accurate fo each 40 Will reflect the predominant "type" of the 40. The following are several comparisons of cruise vs. scale volumes

North Marsh (not formal review, estimated from info) cruise 305, cut 185, however due to the long term of this sale there could be many factors involved in this.

Formal Reviews:
1928 reviews:
Cruise vs. Scale comparisons done in 1916-1919 show scale overrun cruise by 28.6% average.
Calimus Marsh Sale underrun 16.73%, but some 40s are of by over 100%.
Chiloquin Unit overrun 32.55%.
Solomon Butte overrun 28.04%
Kirk Sawmill unit underrun 1.2%
Long Prairie overrun 1.7%
Cherry Creek overrun 43.31%

1930 review:, Calimus Marsh underrun 15.15%

However there are notes on many of these reviews "not including pickup" which implies damage waste scale was not included. There is other documentation referring to 60 MMBF of "brush" being burned in the fall. This probably was waste scale from breakage.

Another review of Calimus Marsh marking showed:

Reserve volume per acre: <18" 714 bd. Ft. 18%
\> 20" 3270 bd. Ft. 82%
and that in the LP type 72% was cut.

Slash Treatment

The first experiments with machine slash piling started in 1946 By 1950 machine slash piling was becoming common.

North Marsh slash piling specs, 2/17/38

Pile brush 100' wide on each side of all roads designated to remain part of the transportation system.

On roads not designated as part of the transportation system , but designated for treatment, brush will be piled 50-100' on each side. The objective being to leave no area greater than 80 acres not surrounded by a lane or no hazard area.

50% of the sale perimeter will be piled 1-200' wide.

Data on BIA Portion of Mosquito

1921 Cruise Volumes

Twnship	Range	Sect.	Forty	Timber Volume Ponderosa	LP Poles	Acres
29S	10E	7	SWSW	760	18.6	40
			SESW	770	6.5	40
			NESE	420	16.2	40
			NWSE	639	13.4	40
			SWSE	565	32.6	40
			SESE	782	0	40
	Total			10,715	188.3	
		9	NENW	503	14.6	40
			NWNW	603	34.9	40
			SWNW	551	1.9	40
			SENW	569	0	40
			NESW	507	0	40
			NWSW	621	3.3	40
29S	10E	17	NENE	633	1.8	40
			NWNE	728		40
			SWNE	375	1.1	40
			SENE	639	0	40
			NENW	653	18.0	40
			NWNW	513	26.6	40
			SWNW	514	12.8	40
			SENW	685	0	40
			NESW	681	0.7	40
			NWSW	664	2.2	40
			SWSW	627	1.4	40
			SESW	620	2.0	40
			NESE	577	4.6	40
			NWSE	644	9.5	40
			SWSE	373	33.1	40
			SESE	459	1.2	40
	Total			9,385	115.0	
29S	10E	18	NENE	295	0	40
			NWNE	525	10.3	40
			SWNE	558	0	40
			SENE	354	9.5	40
			NENW	480	6.3	40
			LOT 1	651	1.0	38.88
			LOT 2	644	12.9	38.63
			SENW	433	0	40
			NESW	403	18.5	40
			LOT 3	567	0	38.38
			LOT 4	472	0	38.13

Data on BIA Portion of Mosquito

1921 Cruise Volumes

				Timber Volume		
Twnship	**Range**	**Sect.**	**Forty**	**Ponderosa**	**LP Poles**	**Acres**
29S	10E	18	NESW	488	1.2	40
			NESE	505	4.4	40
			NWSE	467	20.7	40
			SWSE	435	0	40
			SESE	556	7.6	40
	Total			7,833	92.4	
29S	10E	19	NENE	829	3.3	40
			NWNE	720	3 2	40
			SWNE	747	4.2	40
			SENE	759	6.6	40
			NENW	654	1.3	40
			LOT 1	884	14.5	37.96
			LOT 2	695	8.9	37.89
			SENW	809	6.7	40
			NESW	716	7.3	40
			LOT 3	617	2.8	37.81
			LOT 4	626	3.3	37.74
			SESW	523	6.8	40
			NESE	501	0.5	40
			NWSE	452	1.1	40
			SWSE	599	4.7	40
			SESE	513	3.3	40
	Total			10,644	78.5	

The following is an excerpt from the Adams Railroad survey, page 68-72 starting after emerging from Williamson River canyon heading north on August 20, 18

"The forest was on fire, and an occasional heavy crash reverberating for miles, warned us to beware of falling trees. The canon was about four miles in length. A short distance beyond its northers entrance, we emerged from the forest and entered a lovely meadow, covered with clover and fine green grass. The ground was miry near the river, which was deep and sluggish, and we encamped at the edge of the timber. The meadow appeared to be an arm of Klamath Marsh, and was evidently flooded at seasons of high water.

August 21 - This morning at daybreak, the fog was so dense that we could not see fifty yards in advance, but the sun soon caused it to melt away. The trail led us over a thickly timbered ridge which projected into the meadow. The soil was light pumice-stone dust, and fallen trees rendered traveling somewhat difficult. At the north eastern base of the ridge we reached the shore of Klamath Marsh. This was a strip of half submerged land, about twelve miles long and seven miles broad. It as covered by clumps of tule and other aquatic plants separated by small sheets of water. Thousands of ducks, plover and other water birds, made it their home. After traveling about sixteen miles we reached a part where it was not more than a mile wide... August 22... Near the spot where we were encamped, the marsh was not more than a mile in width; but it extends an indefinite distance towards the east, and the Indians informed us that the journey round it was very long, and without water. They volunteered to show us a natural causeway to the other side; but it proved too miry for pack mules. Our new friends all declared that the best trail to the Des Chutes valley led round the western side of the marsh... and Lieut. Williamson finally decided to turn back and try that route...August 23... The trail led through open pine timber for about a mile, and then entered a fine, grassy meadow which extended towards the north to Klamath Marsh. About 3 miles from camp we reached Klamath River (note, this segment now called the Williamson), here a sluggish stream divided into two branches by a narrow island. The water rose to the backs of the smaller mules...we continued our course through the grassy meadow until we reached a clear, ice-cold stream flowing through open timber...The brook rose in springs about a mile from where we struck it."

Also from Abbot railroad survey, describing the Williamson, page 28:

"But Colonel Fremont...1843-44, crossed the principle tributary of this marsh. He describes it as a stream thirty feet wide, and from two to four feet deep. It undoubtedly rises, among the mountains east of Upper Klamath Lake, and after flowing towards the north for a considerable distance, bends towards the south, and spreads into Klamath Marsh. When it emerges again, it is a large deep stream, with a sluggish current."

Data on BIA Portion of Mosquito

1921 Cruise Volumes

Twnship	Range	Sect.	Forty	Timber Volume Ponderosa	Timber Volume LP Poles	Acres
29 S	9 E	23	NENE	0	0	10
			NWNE	0	0	0
			SWNE	0	0	5
			SENE	0	38.0	40
			NENW (Marsh)			
			SENW 30 Ac. Marsh		0	10
		24	NENE	386	0	40
			NWNE	336	0	40
			SWNE	299	0	40
			SENE	346	0	40
			NENW	353	0	40
			NWNW	0	0	10
			SWNW	4	2.2	40
			SENW	158	0	40
			NESW	312	0	40
			NWSW	9	24.0	40
			SWSW	0	38.5	40
			SESW	28	39.0	40
			NESE	563	11.0	40
			NWSE	797	12.8	40
			SWSE	320	22.0	40
			SESE	579	0.7	40
	Total			4,490	150.2	
		25	NENW	40	40.2	40
			NWNW	0	21.1	40
			SWNW	0	115.2	40
			SENW	0	112.0	40
		26	NENE	0	150.2	40
			SENE	0	54.0	40
29S	10E	7	NENE	668	6.2	40
			SENE	380	6.4	40
			NESE	789		40
			SESE	597	10.5	40
			NENE	481	46.2	40
			NWNE	842	4.2	40
			SWNE	749	1.6	40
			SENE	608	24.2	40
			NENW	613	1.6	40
			NWNW	832	2.6	40
			SWNW	660	8.9	40
			SENW	569	0	40
			NESW	613	0	40
			NWSW	812	1.8	

Appendix I. Suggested Projects or Areas of Concern

Soils

Where possible and desirable, restore historic soil functions, mitigate impacts of past management, and enhance or restore the potential of the soil to produce desirable products.

At the present time, little is known about the road system within Mosquito Creek Watershed. The forest transportation system base maps generallv show only approximately half of the roads within an area.

Ditch lines are constructed along roads to drain off surface water to avoid erosion of the prism. However, the ditch then erodes and dumps its sediment load directly into a stream course. This could be avoided by directing the ditch flow into vegetated, or duff or litter covered ground prior to reaching the stream course.

Monitoring of the Mosquito Creek Watershed soils is planned for 1995. There are many data gaps in this area. We have information indicating that bulk density has increased. Pumice is a young soil; most research has been done in older, more developed soils. We need a clearer picture of what is "detrimental" compaction on pumice soils, and how long compaction persists in the soil. We also need more work on classification, as current classifications appear to be too broad to use in predicting a response to activities. We do not have a complete inventory (or combination of inventories) of road locations that are impacting the resource. The forest transportation system map often shows less than half of the existing roads that are an impact. This is true for older "historic" transportation system maps as well. The road maintenance program needs review to determine if it is causing water quality problems, and if so, what can be done.

If monitoring proves the existence of "severely" compacted soils, implement a subsoiling program to restore soil bulk density and porosity. Meet forest plan standards that require that "less than 20% of an activity area will be left in detrimental soil conditions". Roads identified as causing water quality problems will be "put-to-bed" by subsoiling, returning to preconstruction grade and seeding for control of erosion.

Active or potential erosion areas should be treated by seeding, mulching, check dams and other methods. We recommend the use of native seed and weed-free mulch or straw for these operations, and recognize that each situation requires a unique solution to check the erosion.

Water and Riparian Condition

Improve existing stream bank stability, restore riparian plant communities and the historic function of the riparian area by reversing effects of channel downcutting, and the effects of downcutting on draining of water table.

Following site specific analysis, restoration or reworking of channels occurs in an attempt to arrest channel widening and lowering of local watertables. Planting of riparian species on reworked areas to hold soil and slow rework of established banks/floodplain. Spatial decline of riparian habitats is slowed and in some areas reversed. This activity may have limited application in Mosquito due to the physical limitation of space in the riparian areas.

Major restoration may involve large amounts of soil and soil movement. We may have to move soil, then plant and monitor. This option may partially or totally restore floodplain. Consider doing scenario 2 first and then going to scenario 3 if unable to restore hardwood plant community due to increased depth to standing water/high soil moisture.

Start periodic burning in meadow areas (with or without lodgepole encroachment). This period should be determined by fuel loading and evidence of lodgepole encroachment Holding cattle in meadows is potentially responsible for lack of lodgepole pine encroachment, and lodgepole may be more of a concern after removal of cattle use Data need is current depth of water table to determine suitability of site to grow willow/hardwoods Start plantings of Willow/hardwood, monitor success Consider reintroduction of Beaver after adequate stocking of hardwoods is established to serve as a food source without being wiped out.

Re-introduce fire similar to historic regime to area - all types, and during summer/fall period. Return upland conifer sites to historic range - an individual tree or generally small group replacement system in the pine and drier mixed conifer types. Develop stands and stocking which would not result in a stand replacement event when subjected to fire or insect or disease epidemics.

Implement a combination of understory removal, thinning and underburning. This is a long term project if implemented at the landscape level. This activity needs to be integrated closely with riparian condition and need. Leave stocking levels so that conifers at least minimally occupy the site so that water flow to riparian areas is not greatly increased - at least until riparian areas are in condition to accept additional water. This relationship needs monitoring to determine impact of lowered stocking levels. Stocking level control can be accomplished in one entry, or two or more lighter cuts to attain the final stocking level. See Vegetation section for historic stand structure and stocking level ranges.

Initial entries need to open stands and treat fuels, so that stands can be both underburned (with somewhat high intensity), and withstand a wildfire with limited mortality. When open stand conditions are achieved, there is potential for increased diversity of ground vegetation.

The reduction of overall road miles, especially those within 300 to 500 feet of the channel would be advisable where ever possible.

Below Jackies Thicket, reaches MSR10 thru MSR1, several segments of the channel have degraded from what were likely C and E type channels to E and F channel types. The degraded segments ha\ downcut from 2 to 6 feet (1993 WIN inventory and field observations) and for the most part still display raw unprotected streambanks with very high erosion potentials. The downcutting has tended to reduce sinuosity, increase flow velocities, lower local water tables, and make a terrace out of the former flood plain. The lowered water table affect will be localized to the riparian areas and meadows adjacent to the stream. Although these areas will continue to be saturated during the snow melt season in normal precipitation years, the downcut channels will drop the water table adjacent to the channel much faster than normal. This change will likely not be significant on dryer than normal years, but may lower the water table early enough in normal precipitation years to affect the life cycle of riparian vegetation.

The mouth of the Mosquito Creek drainage at the transition between reaches MSR1 and MSR2 has been completely modified to the point that the natural channel is no longer obvious and the current flows have been diverted on to an existing road changing the relationship between the stream and the Klamath Mash.

The stream channel types identified for the Mosquito Creek drainage are "B, C, E, G and F" (RST). Of these, G and F channel types are the degraded segments within the defined channel reaches. Thes. channel segments are extremely sensitive to disturbance (including increases in streamflow magnitude and timing, and/or sediment increases), have very poor natural recovery potential once the de-stabilizing factor is mitigated, produce very high sediment supplies, have very high streambank erosion potential, and have a high response to vegetative controls (Rosgen 1994). These channel forms will naturally tend toward C and E type channels by widening the channel, establishing sinuosity, building a flood plain, and allowing the growth of stabilizing vegetation.

Restoration of these G and F channels should center around avoiding increases in streamflow magnitude or timing, and/or sediment increases and encouraging the transition to a C or E type channel by increasing sinuosity and the development of an effective flood plain. Establishment of stabilizing vegetation (willow, aspen, and sedge) on the raw streambanks will reduce sediment yield and will over time incorporated into the channel recovery.

The"B" type channel segments are inherently stable with very low sensitivity to disturbance, excellent recovery potential, very low sediment supply, very low streambank erosion potential, and negligible controlling influence from vegetation. Maintenance of these channels may include the manipulation of the stream bank vegetation to enhance other values. Restriction of the channel by road crossings or other channel bank changes should be avoided.

The C and E type channel segments of Mosquito Creek, although considered natural for the landform of the Watershed, have a very high sensitivity to disturbance, fair to good recovery potential, moderate to very high sediment supply, very high streambank erosion potential , and vegetation has a very high controlling influence.

Maintenance of these C and E channel forms should include avoiding increases in streamflow magnitude or timing, and/or sediment increases and the protection and encouragement of stabilizing vegetation such as willow, aspen, and/or sedge on the channel banks.

The channel configuration at the mouth of Mosquito should be investigated and redesigned to best serve the needs of meadow and marsh lands of the lower watershed and the Klamath Marsh National Wildlife Refuge.

The channel crossing of Forest Road 88 at Little Round Meadow should be redesigned to allow normal surface flows to the meadow. This redesign will have to be sensitive to the need for stabilizing vegetation along the abandoned channel below the crossing.

The trend of McCarty Meadow toward further drying, resulting from deepening, widening and lengthening of the channel through the meadow. The end product will be a further reduction of the mesic meadow communities and the willow component of the system.

The trend of Huckleberry Springs may be toward higher quality habitat, as the time since extensive sheep use increases. Observations indicate that willow may be drying out on this site; this may be a function of overhead stand density. Further analysis is needed on this wetland prior to vegetation manipulation, but it should be noted that this is an extremely important site.

Is the re-introduction of beaver into the Mosquito Watershed plausible at this point? Further analysis is certainly in order, but it should be recognized that current habitat conditions probably are not suitable. Until such time as aspen, willow and alder are at early seral stages and abundant within the drainage, re-introduction would probably fail. Current channel condition (incised, actively down cutting) and the subsequent low retentiveness of the system would suggest failure as well.

Roads

Reduce the miles of road and their effects on the hydrologic function. This is probably the easiest and most beneficial project that the district can undertake, except for that portion of the watershed that is located on former reservation lands. The portion that is located on former reservation lands will require careful negotiations with the Klamath Tribes in order to accomplish the desired project objectives.

For these road reduction projects to be effective, the projects should return the system and/or non-system roads towards the natural landscape, so that there is no evidence that a road was present. This may include in addition to subsoiling, tree planting and/or transplanting, placement of root wads, logs, rocks, etc.

Road effect reduction projects, where existing roads are still needed that cross drainages, or wet riparian areas, may be accomplished in several different ways. Construction of french drains along the total riparian road length, french drain at culverts to slow water movement through pipe; install more culverts with proper angles; replace existing culverts with proper sized pipe at the proper depth and not above the ground surface Proper interpretation of the pre-project conditions will determine the type of project needed.

Livestock Grazing

Unauthorized cattle use has historically been a problem , and continues to be so today. Absence of fencing between private and public land, and permitted cattle from the Antelope Allotment drifting into the lower region of the Mosquito Creek Watershed, are two reasons the unauthorized use has occurred.

Jack Creek Watershed Projects

Davis Flat: If Channel reconstruction is to be done, necessary vegetation for the rehab needs to be on hand for the new channel. The Forest and other experienced hydrologists need to be available for the redesign and actual construction. Of course all surveys for sensitive resources, planning records, and environmental documents will need to be completed prior to project implementation. This is probably a $500,000-750,000 project, minimum.

If channel reconstruction is not going to be done, the existing rock structures need to be maintained on a continual and long term basis. Jute matting, or erosion control matting should be placed on raw exposed banks. Native plant planting, transplanting such as sedges, rushes, and native willows can be tried where soil conditions will allow. Places to establish other control points on the channel should be evaluated by the Forest hydrologist.

The meadow itself in some areas should be looked at for some subsoiling, where compaction is moderate to severe. Livestock use if continued should be restricted from areas where project work is contemplated. Cattle should be herded or fenced out from project areas for a minimum of three to five years, regardless of the type of project to be selected.

Rakes Meadow: This area was slashed and burned in the mid-60's, and due to the treatment the portion of Jack Creek that runs through this area is braided, and there are several dug out areas in this meadow. This is a very narrow drainage, and there is not very much room to work in. Suggested activities for this area would be to fill in dug out areas and reestablish a more natural meandering channel in these small areas, with control points at both ends to preclude further downcutting. Along with the channel reconstruction at these selected areas, the other channels should probably be plugged so that water can be directed through the reconstructed portions. ***This needs to be evaluated by a journey level hydrologist before being attempted***. Also, small lodgepole trees could be tree spaded into the meadow, to start cooling down this area. Trees should be 4 to 5 ft tall. Willow planting in along the creek bottom could be tried on a trial basis, and monitored to see if they could become established. These plants will need to be caged, so that they are proteceted from domestic and wild ungulates. Permitted sheep should be routed so that no effects from them are present for at least 5 years.

Jack Creek: Forest Boundary, and adjacent private land, this area should be monitored. There are problems on the private land, and a moderate to high potential for those problems to work back onto public lands. There is a low level maintenance road that crosses the main Jack Creek drainage, it should be subsoiled, and put to bed. Again there is a good opportunity to tree spade the entrance and back 200 feet to disguise the road.

Jamieson Ranch: The team looked at this area, and this would be a good project to work with the

Iverson's, SCS, ERO This area is starting to blow, and it is the opinion of the team that the headcutting that is present there will continue to work back onto the Forest Service Lands There are headcuts present on the Forest Service land, also There are numerous willow skeletons present. A suggested project is to use fire on these willows, starting with a representative sample of 10 to 15 plants, use fire to burn them, then establish protective cages around the burned plants, to protect them from big game (elk) and incidental livestock use. Also, willows can be collected from some of the remaining vigorous plants and grown in the nursery for future rehabilitation efforts.

From App. I

- Wilshire log cabin was built by the Wilshire brothers from Silver Lake. They built the cabin next to a year-round spring on Crooked Meadow.