MONTANA DEPARTMENT OF NATURAL RESOURCES
AND CONSERVATION

STATE FOREST LAND MANAGEMENT PLAN

IMPLEMENTATION MONITORING REPORT

FISCAL YEARS 2001-2005

October 2005

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EXECUTIVE SUMMARY

Since the adoption of the State Forest Land Management Plan (SFLMP) in June 1996, the Forest Management Bureau has coordinated the implementation of its philosophy and guidance. The following were accomplished from July 2001 through June 2005.

PLAN IMPLEMENTATION

- Developed, proposed, and adopted Administrative Rules for Forest Management (ARM 36.11.401 through 36.11.450), providing consistent policy and direction for all resource areas in the SFLMP.
- Completed SFLMP or Rules Implementation Checklist for 106 timber sales.
- Documented contract administration through 2,224 timber sale inspections.
- Revised and updated DNRC approach to old growth management.

MONITORING

Biodiversity

- Completed Biodiversity Field Reviews on the Northwest and Southwest Land offices. They confirmed that the department implemented most of the direction from the SFLMP and Administrative Rules.
- Updated the estimate of current old growth, based on more complete Stand Level Inventory information and a new definition based on Green et al.
- Revised and refined protocols for quantifying desired future conditions and current status.

Silviculture

- Completed a combination of stakelines and regeneration surveys on 6819 acres in 2001-2004. Seedling survival on planted sites was 80-85%.
- Forest Improvement accomplishments from 2001-2005 included tree planting, browse prevention, pre-commercial thinning, herbicide application, brush piling and burning, tree improvement, cone collection, and road maintenance (Table S-1).
- Timber sale annual revenue/cost ratios averaged 1.94 between 2001 and 2005 (Table S-2).
- Logging contracts used tractor-based systems on 79% of the harvest acres from 2001-2005 (as compared to 91% from 1998-2000) (Table S-3).
- Planned sales showed an increase from 14% to 31% in even-aged regeneration harvests (clearcut, seed tree and shelterwood), compared to the previous monitoring period. The proportions of selection and intermediate harvests have decreased since the last monitoring report, but continue to be used more often than was forecast in the SFLMP (Table S-4).

Watershed and Road Management

- Completed ten watershed inventories, covering 58,423 acres in fiscal years 2001-2002. These included approximately 456 miles of existing road, 158 miles of stream channel and 325 stream crossing structures (Table W-2).
- During timber sale contract inspections in 2001-2004, 61 items in need of improvement and 3 contract violations were related to road Best Management Practices (BMPs), Streamside Management Zones and other watershed protection measures.
- Internal BMP audits on 83 timber sales found that BMPs were applied and effective 97-98% of the time (Table W-2). These results were comparable to statewide audits.
- Water Quality was monitored on the Stillwater, Swan River and Sula State Forests.
- New road construction statewide in 2001-2005 averaged 0.65 miles/MMBF, and was below that forecast in the SFLMP (Table R-1).
- Compiled soil monitoring results from studies of 74 timber sale projects, and made recommendations for future project design.

Fisheries

- Monitoring on the Swan River, Stillwater, and Coal Creek State Forests found spawning conditions for bull trout and westslope cutthroat trout to be within acceptable limits on 7 of 10 streams (Tables F-1 and F-2).
- Collected inventory data for 10 streams for fish habitat inventories.
- Initiated DNRC Fish Passage Assessment Project, including 264 technical surveys of road-stream crossings.
- Established stream temperature monitoring projects for 18 streams on state trust lands.

Threatened, Endangered, and Sensitive Species and Big Game

- DNRC biologists monitored five bald eagle nest territories in 2001-2005 (Table T-1).
- DNRC biologists participated in Swan Valley Grizzly Bear Conservation Agreement monitoring and submitted five monitoring reports to the US Fish and Wildlife Service.
- Wildlife mitigation measures were reviewed on five timber harvest projects during 2001-2005. 87% of the measures were rated to have reasonable likelihood of effectiveness.
- Monitoring found that post-harvest levels of snag recruitment trees and coarse woody debris met or exceeded recommended ranges. Retention of snags had mixed results, with some variation due to the availability of suitable trees.
- Fifty-five observations on state lands of T&E, sensitive and other species of interest were reported.
- Monitoring of project specific mitigations was done for five timber sales (Table T-9).
- 17 lakes were surveyed for occurrence and reproductive success of common loons.
- DNRC participated in cooperative monitoring of Canada lynx, grizzly bear, grouse, and wolves.

Grazing on Classified Forest Lands

- 228 supplemental grazing evaluations were performed on classified forest grazing licenses from 1998-2004.
- Changes in grazing management were recommended in 39 inspections, to address 77 criteria that exceeded SFLMP criteria.

Weed Management

- Completed 6 year Cooperative Integrated Management Agreements with all County Weed Districts.
- Out of 108 timber sales, existing noxious weeds occurred on 85 timber sale project areas and adjacent lands, mainly along existing roads.
- Integrated weed management practices were applied to all projects, which included requiring the use of weed-free / washed equipment, grass seeding of roads, herbicide applications, and biological insect controls.
- 128 grazing licenses were reviewed for noxious weeds during license reviews, and recommendations were made for addressing invasions.

PLAN MAINTENANCE

- Management direction was revised with the adoption of administrative rules for forest management in 2003; the rules are consistent with the SFLMP premise and philosophy.
- Compiling monitoring data into accessible information, such as GIS layers, will be a priority for adaptive management.
- The DNRC is currently in the process of developing a Habitat Conservation Plan under Section 10 of the Endangered Species Act in cooperation with the U.S. Fish and Wildlife Service. In conjunction with the environmental review of this project, DNRC will assess the need for changes to the SFLMP and rules if an HCP is adopted.

INTRODUCTION

The State Forest Land Management Plan (SFLMP), approved by the State Board of Land Commissioners in June 1996, guides management on approximately 735,000 acres of forested trust land. This guidance was provided in the form of a general management philosophy and specific resource management standards. The strategic guidance provided by the SFLMP is summarized in this excerpt:

Our premise is that the best way to produce long-term income for the trust is to manage intensively for healthy and biologically diverse forests. Our understanding is that a diverse forest is a stable forest that will produce the most reliable and highest long-term revenue stream. Healthy and biologically diverse forests would provide for sustained income from both timber and a variety of other uses. They would also help maintain stable trust income in the face of uncertainty regarding future resource values. In the foreseeable future, timber management will continue to be our primary source of revenue and primary tool for achieving biodiversity objectives.

Since June 1996, the land offices and the Forest Management Bureau have worked to implement this guiding philosophy on trust lands, primarily through project development, MEPA review, and monitoring. In addition, programmatic guidance for specific resource categories was developed over time and was adopted through formal rulemaking in March 2003. The Administrative Rules for Forest Management (ARM 36.11.401 through 36.11.450) will be referred to in this report as "Forest Management Rules" or "the Rules".

This document gives an overview of DNRC's efforts and accomplishments toward implementation of the SFLMP during fiscal years 2001-2005.

Purpose of the Monitoring Report

The SFLMP Record of Decision (ROD) was finalized on May 30, 1996. A report due to the Director of DNRC is required under the section entitled "Managing the Plan" (ROD page 10). This report was to discuss the current status of SFLMP implementation and effectiveness, including a recommendation on the need for any significant changes. This report was to be generated in the year 2000 and every 5 years afterwards. In October 2000, DNRC published an Implementation and Monitoring Report that summarized SFLMP accomplishments during fiscal years 1997-2000.

The Monitoring Report committed to in the SFLMP is also required by the Administrative Rules for Forest Management that were adopted in March 2003 (MT DNRC, 2003a). The Rules include monitoring components from the SFLMP, both for individual resources and the overall status of implementation and effectiveness. Specifically, the department is required to compile the results of monitoring into a report for the Director of DNRC, the Trust Land Management Division Administrator, and the State Board of Land Commissioners by October 2005 and every five years thereafter.

This document fulfills commitments of the SFLMP and Rules to both the Land Board and the Director of the DNRC.

Implementation of the SFLMP

Following the approval of the SFLMP, the Department conducted phased-in implementation of the Plan. Timber sales already in development incorporated SFLMP standards where it was reasonable. The SFLMP standards were fully incorporated into sales where scoping was initiated after approval of the SFLMP.

The philosophy of the SFLMP is based on "adaptive management." Its intent is to be a guiding document, with enough flexibility for managers to adapt their management practices to changing circumstances. (Examples are the de-listing of the peregrine falcon and the listing of the lynx under the

federal Endangered Species Act.) Consequently, the Plan did not list in detail (beyond the Resource Management Standards) management or monitoring procedures. The intent was to issue these as recommended (not mandatory) guidance. Following the adoption of the SFLMP, resource specialists in the Forest Management Bureau worked with foresters and specialists in the field and completed guidance for implementation of the SFLMP. This guidance was subsequently incorporated into administrative rules.

Adoption of Administrative Rules

In March 2003, the State Land Board adopted Administrative Rules for Forest Management (ARM 36.11.401 through 36.11.450,) through formal rulemaking under the Montana Administrative Procedures Act (MAPA). The programmatic rules are consistent with the fundamental intent and philosophy of the SFLMP, and provide field personnel with policy and direction for managing forested school trust lands. The Rules subchapters correspond to resource areas identified by the SFLMP and incorporate language from the Resource Management Standards. Some additions and revisions to the original SFLMP guidance were made to address trust mandate considerations, species status changes, increases in local knowledge, improvements in clarity, and fit with administrative rule format.

This report will refer to the SFLMP's overall guidance for each resource area, as well as specific items described in the rules.

Implementation Checklists

In January of 1997, an SFLMP Implementation Checklist was finalized for use in planning timber sales. The Checklist was comprised of specific Plan Resource Management Standards (RMS) pertinent to timber sale preparation and issues often raised concerning timber harvest. It listed 44 separate items. The Implementation Checklist was developed for two purposes: 1) as an internal check to ensure that the SFLMP philosophy and RMS are being incorporated in the project; and 2) for external accountability, when presenting our projects to the Land Board.

In June 2003, the Forest Management Bureau revised this Implementation Checklist to correspond with the adoption of forest management rules. The Rule Implementation Checklist identifies 48 items to address during timber sale planning. These include separate items from 9 of the 10 resource areas: Biodiversity, Silviculture, Road Management, Watershed, Fisheries, Threatened & Endangered Species, Sensitive Species, Big Game, and Weed Management. (Rules for Grazing on Classified Forest Lands were excluded as not applicable.)

An SFLMP or Rules Implementation Checklist has been filled out for 106 of the 108 timber sales that have were sold from fiscal year 2001 through fiscal year 2005. One limited access timber sale and one other small (75 acre) sale did not include Implementation Checklists. From other project documents, however, it is clear that resource management standards were addressed on each sale through project design. All sales complied with the SFLMP and incorporated applicable resource management guidance.

Timber Sale Inspections

DNRC field personnel oversee the implementation of timber sale contracts. Management foresters spend a substantial amount of time on the ground, visiting active sales to ensure contract compliance. Foresters communicate with purchasers and contractors, and direct them in meeting stipulations and requirements of the contract. This often includes adjusting operations or prescribing actions in order to avoid contract deviations or impacts.

During fiscal years 2001-2005, management foresters documented 2,224 timber sale inspections. Timber sale contract terms often have indirect ties to the SFLMP and rules, and they reflect multiple observations of all operating timber sales. Highlights of information from these inspections are discussed under corresponding resource sections of this report.

Monitoring Report Format

The monitoring report is divided into eight sections, corresponding to the ten Resource Management Standard areas and ARM Sub-Chapters (Threatened & Endangered Species, Sensitive Species, and Big Game are combined in one section). Under each heading is a brief summary of the management framework and monitoring standards, followed by the monitoring results. Each monitoring activity is presented with the following general outline:

Introduction - a general description of the monitoring procedure and its purpose

Methods - a summary of the procedures necessary to understand the results

Results - presentation and interpretation of the results

Conclusions or Recommendations - management actions that were or will be made in response to the results

Because there are overlaps in the Standards between several of the resources (e.g. between Watershed, Grazing on Classified Forest Lands, Road Management and Fisheries; and between the Biodiversity and wildlife standards), there is corresponding overlap between the reports. Consequently, there are cross-references between the individual resource reports, and some repetition of information to make each report self-contained.

BIODIVERSITY MONITORING

The SFLMP and Rules (ARM 36.11.404) use the "coarse filter" approach to promote biodiversity, by favoring an appropriate mix of stand structures and compositions on state lands based on natural landscape patterns and processes. This would be accomplished through the following practices:

- ***Manage for a variety of forest conditions;***
- ***Employ a "fine filter" approach for threatened, endangered, and sensitive species, which focuses on species' specific habitat requirements;***
- ***Manage for a desired future condition characterized by the proportion and distribution of forest types and structures historically present on the landscape;***
- ***Pursue cooperative planning where reasonable;***
- ***On scattered tracts, restore a semblance of historic conditions within the State ownership;***
- ***Manage old growth in keeping with the trust mandate with no numeric retention commitment;***
- ***Use current references as guidance for promoting biodiversity.***

These standards would be monitored through Field Reviews of projects and Landscape Evaluations, and through forest inventory data collection and analysis. Additional monitoring would be done under THREATENED, ENDANGERED AND SENSITIVE SPECIES AND BIG GAME MONITORING. Results of the monitoring would be used to plan future actions. No cooperative agreements have been initiated as yet.

Biodiversity Implementation

The SFLMP and Rules rely on management for biodiversity to accomplish the department's fundamental management premise. Adopting the SFLMP resulted in the DNRC adjusting our management focus from the stand level to consideration of how individual stands contribute to landscape function through the use of the coarse filter/fine filter approach. Our efforts at implementing the coarse filter are focused on assessment and management of appropriate stand conditions at the landscape level, and emulation of natural disturbance processes in our selection of proper treatments. We have developed management tools for describing desired future forest conditions and for comparing them to current or existing conditions. Through an ongoing, adaptive management process we are monitoring the utility of these tools and refining them to better fit the lands we manage (MT DNRC 1998c; MT DNRC 2000a).

Biodiversity Field Review Monitoring Process

Methods: An internal audit team composed of the Forest Improvement Section Supervisor, a wildlife biologist, a lead management forester, and a management forester was formed. The group was occasionally augmented with other observers from within the DNRC.

Sales from each of the Northwest and Southwest Land Offices, planned and conducted with SFLMP concepts, were selected for review. The audit team reviewed the Montana Environmental Policy Act (MEPA) documents for the sales selected, reviewed the pertinent resource management standards, and reviewed the field form. The team then discussed the projects regarding completeness of the MEPA documents and identified any areas where clarification would be needed during the field review.

Following the office review of documents, the team conducted field site visits guided by the Project Leader. The site visits were

to examine first hand the implementation of the MEPA document commitments and to verify the conditions described. For each site the Biodiversity Field Review Form was completed. Additionally, informal review of numerous projects has occurred each year.

Results: The biodiversity reviews indicated that the department was successfully implementing most of the direction from the SFLMP and Rules, but continued to face challenges in implementing some aspects. In particular, it was noted that even aged management was difficult to implement at some sites, although it would have been the preferred silvicultural system. Several factors contribute to the difficulties encountered when attempting to emulate stand replacement disturbances with even aged management. One of the primary factors limiting the department's application of even aged treatments is response to public concerns. Other factors, including hydrologic constraints imposed due to effects of past harvesting may limit the application of even aged treatments in a specific watershed. Additionally, riparian buffers for watershed protection, visual screening along roads and distance to cover for wildlife purposes also reduce the amount of even aged harvesting. As such, treatments across many administrative units relied more on partial harvests than intended in the SFLMP, specifically intermediate treatments such as commercial thins. The lighter than projected treatments result in slower progress toward identified desired future conditions than anticipated, however they also reflect the department's consideration of other uses and the responsiveness to public input through the MEPA process. The non-salvage proportions of stand-replacement harvests has increased since the last monitoring report from 14% to 31% overall, suggesting greater success in implementing the intent of the SFLMP and Rules. Overall, the reviews indicate that the department is meeting most of its biodiversity objectives, while also considering resources other than timber.

Old Growth

2000 to 2005 – A Period of Transitioning

The Department's approach to managing old growth has undergone several adjustments in the last five years. The SFLMP made a clear commitment to old growth maintenance and retention in amounts not less than one half of amounts expected to develop naturally. Controversy arose almost immediately following signing of the SFLMP ROD in 1996 because the SFLMP failed to communicate an adequate old growth definition that could be used to demonstrate compliance with the commitment. Consequently, the years from 2000 to 2003 were very contentious regarding the department's old growth retention efforts – at one point old growth was being debated and dealt with simultaneously by the legislature, the Land Board, and state courts. A new law was passed that required compensation to the trust for any old growth deferral (77-5-116 MCA). An outcome of those various efforts was the Administrative Rules for Forest Management, adopted in 2003, that removed the department's numerical retention requirements and replaced them with the concept of "managed" old growth. However, divergent opinions remain and the controversy is not resolved to the satisfaction of all interested parties.

The Rules adopted quantitative definitions of old growth based on an unpublished US Forest Service report (Green et al., 1992). Specific to habitat type groups and refined by existing cover types, the definitions are based on the number and age of the large tree component of forest stands. Definitions for forest stands east of the continental divide include a minimum density requirement as well.

This emphasis on old growth as being defined by the presence of large trees rather than one focused on multiple stand attributes associated with old age came about following extensive efforts by the department to engage and accommodate the views of some interested publics. However, much like the working and conceptual definitions used from 1996 to 2003, the new definitions present unresolved issues such as what managed old growth means, how much old growth will be on the landscape in the future, the importance of "nearly" and "post" old growth conditions, and the role of other attributes commonly associated with old forest stands.

Old Growth Amounts

The data reported here show old growth amounts present on lands managed by the NWLO and SWLO. Also shown is the age class distribution across the same landscape. The amount of old growth east of the continental divide is not portrayed here, since our activities are evaluated at the sale level, due to the distances between state parcels, the level of data available, and the amount of state trust lands that are inaccessible.

In addition to the results presented in this Monitoring Report, old growth amounts and effects are evaluated on every timber sale where old growth is considered for treatment, including assessment of old growth amounts at the Unit level in the appropriate MEPA documents.

For this report we are using our current old growth definitions that are based on Green et al., (1992). It should be noted that this definition differs from that used in the 1997 to 2000 Monitoring Report. The earlier Report relied on a working definition of old growth that was similar to the one used by DNRC to determine old growth effects and amounts in the State Forest Land Management Plan (DNRC 1996a). In the SFLMP, the working definition of old growth was based solely on stand age exceeding 140 years. The previous Monitoring Report used the following definition, "*Old-growth is defined as stands that are 150 years and older (140 for lodgepole pine), contain a minimum of 4 MBF net per acre, and exhibit a range of structural attributes associated with old age.*"

The current definitions, adopted from the Green et al., report, are based on habitat type, current cover type, and number, size and age of the large live trees present. Using the department's current old growth definition there are approximately 45,266 acres of old growth on school trust lands, west of the continental divide (Table B-1). In the SFLMP, using the definition described in the paragraph above, old growth acres on western Montana state lands were estimated to total 74,362 acres (DNRC 1996a). One must remember that the two estimates are derived using different definitions of old growth that are not comparable. In addition, the estimates from the SFLMP "...should be used with caution" (DNRC 1996a). The current estimate is a more accurate assessment of acres meeting the department's old growth definitions and the difference between the two estimates does *not* reflect the harvest of old growth by the DNRC. Rather the difference reflects changed old growth definitions. The change in definitions of old growth hinders our ability to accurately portray changes in the amounts of old growth over time.

Age class data is presented in Table B-2. The data is presented to roughly indicate the predominant ages of the forest stands managed by the DNRC. As can be seen from the data a large proportion of old age stands do not meet the large tree requirements to be labeled as old growth. This further indicates the difficulties associated with comparisons based on divergent definitions of old growth. A definition closely tied to stand age will often label a stand as old growth when the stand would not meet a more stringent set of criteria.

Table B-1. Summary of Northwest and Southwest Land Office current estimated old growth meeting the Green et al. definitions.

CURRENT TYPE	SWLO	NWLO	Total
	Acres		
DF	4,104	800	4,904
LP	1,236	402	1,638
MC	143	11,718	11,861
PP	4,824	2,521	7,345
ALPFIR	422	5,867	6,289
WL/DF	1,637	8,637	10,274
WWP	0	2,956	2,956
Total	12,366	32,900	45,266

Table B-2. Summary of age class distributions at the NWLO and SWLO in 2005 using the Stand Level Inventory.

AGE CLASS	SWLO	NWLO	Total
	Acres		
NO AGE DATA	7,986	5,595	13,581
000-039	17,818	35,298	53,116
040-099	42,526	69,945	112,471
100-150	52,125	68,462	120,587
150+	37,701	113,925	151,626
Total	158,157	293,223	451,380

Desired Future Conditions

The department has defined a desired future condition (DFC) for school trust lands based on the cover types expected to exist with natural conditions as per the SFLMP and ARM. The DFC helps the department determine which stands to target for treatment and the types of treatments necessary to help move the landscape in the direction of the DFC. Practically speaking, movement toward or away from a pre-determined DFC takes substantial time. That is in large part due to the time it takes for regeneration to take place and become established. For example, in many cooler and moister Douglas-fir stands, DNRC often prescribes partial harvests that retain western larch, while removing the more shade-tolerant Douglas-fir trees. However, conversion to the desired type may require the presence of a new generation of young trees that can take several years to become established. During the interim, the stand may remain labeled as a Douglas-fir stand.

Table B-3 shows the DFC for forested lands west of the continental divide. Table B-4 is provided to indicate progress toward achieving the department's DFC. Progress toward the DFC may not be readily apparent in Table B-4 primarily due to the time required for regenerated stands to become established and display a different cover type. Other factors contributing to the rate of progress toward DFC's include the relative amounts of even aged and partial cutting treatments being applied. In addition, some partial harvests do not achieve a change in cover type that would move the stand toward DFC. Large fires have also contributed by converting forested stands to nonstocked stands, particularly in the ponderosa pine types. The large reduction in the amount of western white pine types likely reflects the continued decline in the species due to the introduced disease white pine blister rust.

Table B-3. Desired Future Condition for DNRC managed lands based on current cover type.

CURRENT	SWLO	NWLO
	Acres	
ALPFIR	2,017	22,268
DF	25,424	4,468
HW	1,171	1,104
LP	11,452	16,388
MC	885	14,927
NONCOMM	924	2,924
NONSTKD	-	-
PP	89,755	75,009
WL/DF	26,120	118,756
WWP	400	37,378
Total	158,148	293,222

Table B-4. Summary of Acres and Proportions of DFC by cover type in 2000 and 2005.

COVER TYPE	SWLO				NWLO			
	2000		2005		2000		2005	
	Acres	Proportion of DFC	Acres	Proportion of DFC	Acres	Proportion of DFC	Acres	Proportion of DFC
ALPFIR	5,815	288%	5,396	268%	38,600	173%	38,122	171%
DF	33,768	133%	34,327	135%	6,937	155%	15,105	338%
HW	1,183	101%	1,171	100%	696	63%	1,191	108%
LP	13,898	121%	14,145	124%	23,469	143%	22,201	135%
MC	6,338	716%	6,611	747%	67,823	454%	73,460	492%
NONCOM	325	35%	306	33%	162	6%	119	4%
NONSTKD	1,144	-	10,438	-	2,060	-	5,211	-
PP	71,311	79%	61,716	69%	53,970	72%	54,404	73%
WL/DF	23,205	89%	23,832	91%	74,951	63%	74,863	63%
WWP	287	72%	216	54%	15,981	43%	8,549	23%
Total	157,271	99%	158,157	100%	284,647	97%	293,223	100%

Inspection Reports

Throughout timber sale implementation, foresters inspect sites to identify whether contract terms are being met. From fiscal years 2001-2005, a number of situations occurred where green retention trees were cut. This often occurred in salvage operations, but the magnitude was such that there wasn't deviation from the rules.

Photo Point Monitoring

Two photo point monitoring projects were undertaken during fiscal years 2001 through 2005 to record and document forest recovery after wildfire. Following several large fires that occurred on school trust lands, photo points were established and photos have been taken at regular intervals in order to record the changes to the forest over time.

In the first project, photo points were established at 34 representative locations throughout the Sula State Forest, to track the forest's recovery process. Most photo points were visited annually for a few years while logging activity and regeneration is occurring. We intend to visit the photo points about every ten years for several decades into the future to establish a historical record of the forest's recovery, growth and management activity. To date, we have taken about 350 photos, from which prints, slides and digital copies have been made. Photos were taken looking in three to six different directions from the photo point.

In the second project, DNRC established 18 permanent photo points in the portion of the Coal Creek State Forest burned by the Moose Fire. These were located in the same manner as the Sula photo points and have 3 years of photos recorded. These points will also be revisited in the future to document the recovery of the forest.

Tree Mortality Monitoring in the Sula State Forest

The large fires of 2000 raised several issues regarding salvage and forest management including post-fire mortality rates and snag longevity. In response, the department installed a series of permanent sites to track post-fire survival and mortality in relation to degree of burning and to assess fall rates of existing and newly created snags. The following information is summarized from the 2002 Monitoring Report for The Sula State Forest Fire Mitigation, Salvage & Recovery Project (DNRC, 2002) with additional results from subsequent monitoring.

Methods: DNRC established eleven tree mortality monitoring sites in the Sula State Forest in September 2000 and February 2001. Nine sites surround the French Basin part of the forest, and two more sites are located in the Sula South portion. All sites are located in areas that experienced mixed severity fire behavior during the fires that burned through the Sula State Forest in August 2000.

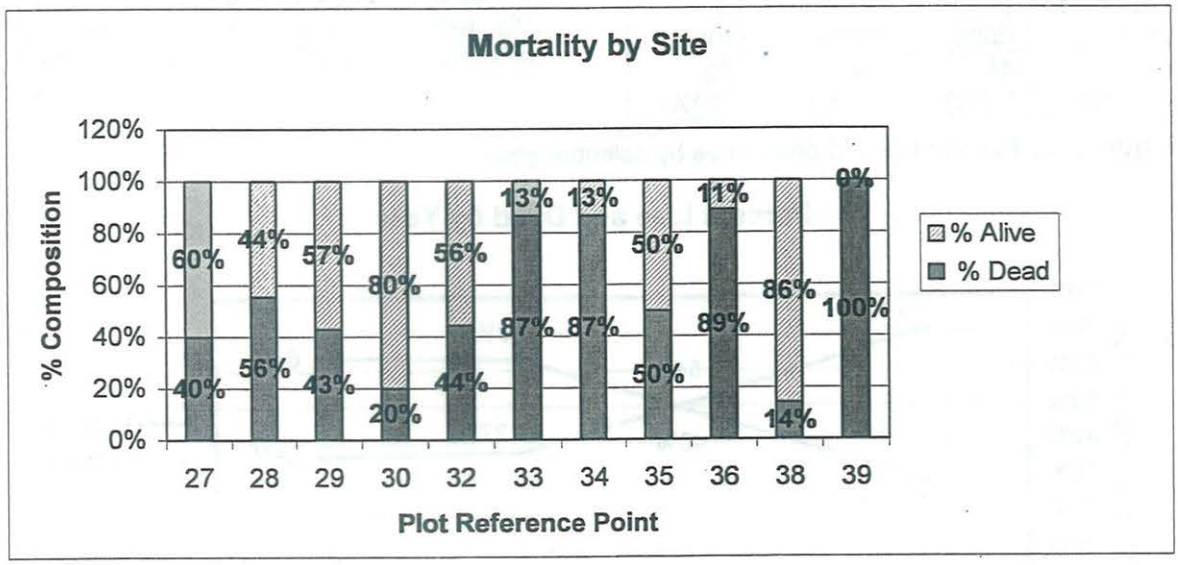
A total of 132 Douglas-fir and ponderosa pine trees were painted and tagged. The selected trees have a wide range of crown scorch, bole scorch and diameters at breast height. The year the tree died was recorded and entered into a database along with information on insect or disease presence. The following information was collected for each tree within a few months of the fire: site number, tree number, species, diameter at breast height, tree height, distance from an established Reference Point (RP), azimuth from RP, crown kill, crown scorch, crown ratio, uphill bole scorch, downhill bole scorch and comments.

Each mortality site was visited annually to determine which trees had died that year. Mortality monitoring site visits were conducted in 2001, 2002, 2004, and 2005. Annual site visits will continue to monitor mortality activity and to monitor the dead tree fall and breakage rates.

Purpose for Mortality Monitoring: There were two main objectives for monitoring mortality following the fires on the Sula State Forest. First, DNRC wanted to find out how many of the fire damaged trees were going to die. Second, DNRC hoped to learn ways to predict which trees were going to die due to fire damage. DNRC forest managers needed a reliable and easy method for determining which trees are likely to die based on easily observed fire damage parameters.

Results, Mortality Amount By Site in 2005: The following chart displays the percent of live and dead trees by monitoring site in 2005. The amount of mortality occurring on the individual sites ranged from 14 percent to 100 percent.

Figure B-1. Percent live and dead trees by mortality monitoring site in 2005.



Each monitoring site was assigned a burn intensity of high, medium or low relative to the range of burn intensity occurring on the monitoring sites. This was a subjective rating based on the apparent burn severity occurring in the immediate vicinity of the mortality monitoring site and its proximity to stand replacement fire activity. Sites numbered 30 and 38 were rated as low. Sites numbered 27, 28, 29, 32 and 35 were rated medium. Sites numbered 33, 34, 36 and 39 were rated high (Table B-5). The total amount of mortality that eventually occurred at each site was strongly correlated to the relative intensity of the fire in the immediate area. This subjective assessment of relative fire intensity cannot reliably be translated to other fires for the purpose of predicting mortality. However the data shows observed fire damage on individual trees can be used to predict which trees are likely to die. Burn damage suffered by the tree indicates the level of fire intensity experienced by the tree and therefore allows its likelihood of survival to be predicted.

Table B-5. Number of dead and live trees by mortality site in 2005.

Site	# Dead	# Alive	Sum	Relative Intensity
27	4	6	10	Medium
28	5	4	9	Medium
29	3	4	7	Medium
30	1	4	5	Low
32	4	5	9	Medium
33	13	2	15	High
34	13	2	15	High
35	7	7	14	Medium
36	16	2	18	High
38	2	12	14	Low
39	16	0	16	High
Totals	84	48	132	--

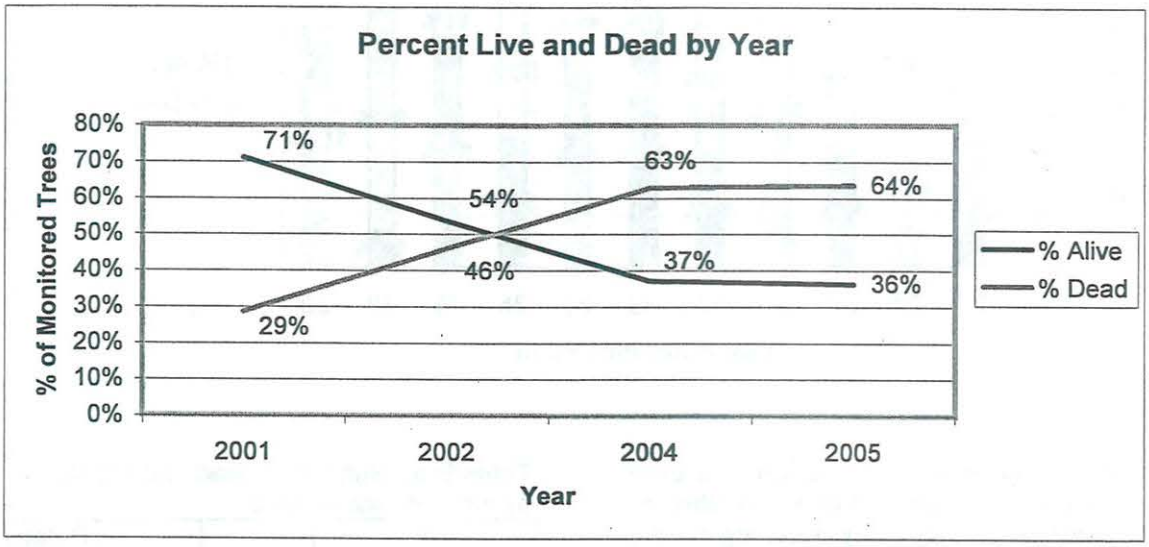
Results, Mortality Amount By Species in 2005: Douglas-fir had a greater amount of mortality than did ponderosa pine. Seventy-seven percent of the Douglas-fir trees were dead as of June 2005. Forty-eight percent of the ponderosa pine trees have died. Overall sixty-four percent of the trees have died (Table B-6).

Table B-6. Number and percent of live and dead trees by species.

SPECIES	LIVE	DEAD	TOTAL
Douglas-fir	16 (23%)	54 (77%)	70 (100%)
Ponderosa pine	32 (52%)	30 (48%)	62 (100%)
All Species	48 (36%)	84 (64%)	132 (100%)

Results, Mortality Amounts by Year: In 2001, one year after the fire, 29% of the trees were dead. In 2005, 64% of the trees were dead. The amount of mortality increased steadily until 2004. Additional mortality has nearly ceased since 2004 (Figure B-2). There were only two additional dead trees observed between 2004 and 2005

Figure B-2. Percent live and dead trees by calendar year.



Results, Bole Scorch and Mortality: The percent of each tree's stem or bole length that was burned black (scorched) by the fire was recorded for the uphill side of the tree bole and for the downhill side of the tree bole. For analysis purposes the two bole scorch estimates for each tree were averaged to create one bole scorch value per tree.

Table B-7. Number of dead and live trees by average bole scorch class.

Avg. Bole Scorch %	Dead		Alive		
	#	%	#	%	Sum
0	0	--	0	--	0
1-5	2	40%	3	60%	5
6-10	4	40%	6	60%	10
11-15	6	46%	7	54%	13
16-20	6	50%	6	50%	12
21-25	11	69%	5	31%	16
26-50	27	69%	12	31%	39
51-75	20	69%	9	31%	29
76-100	8	100%	0	0%	8
Totals	84	--	48	--	132

Mortality increases with increasing average bole scorch until it reaches 21 percent average bole scorch. Then mortality levels off and maintains a high level. All trees with greater than 75 percent average bole scorch died. It appears the risk of tree mortality increases as average bole scorch increases (Table B-7).

Douglas-fir was more sensitive to the amount of bole scorch than was ponderosa pine. A greater percentage of Douglas-fir trees died in each average bole scorch class above 10 percent than the percentage of ponderosa pine. Both species had an increased risk of dying as bole scorch increased. See Figures B-3 and B-4 on the following page.

Figure B-3. Percent of dead and live Douglas-fir trees by average bole scorch.

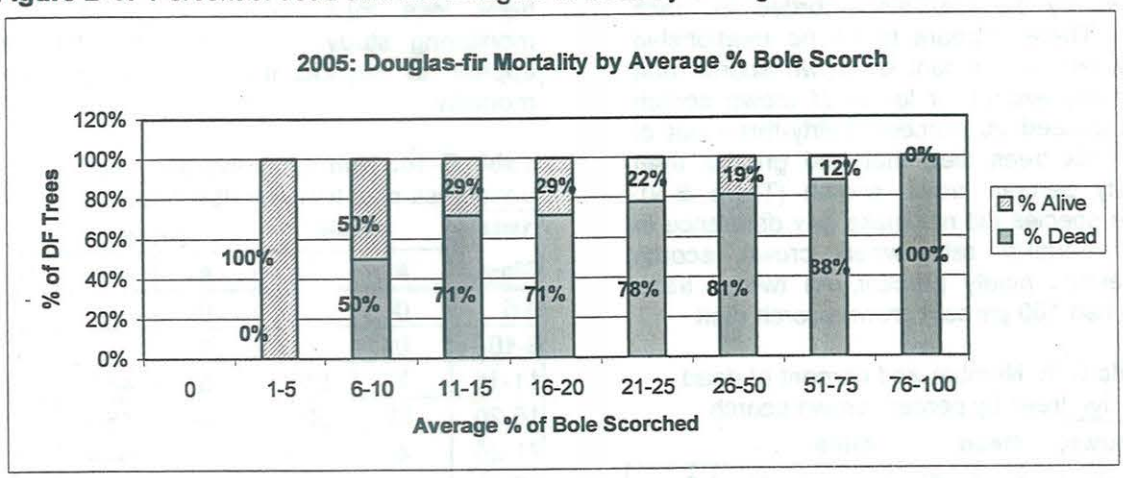
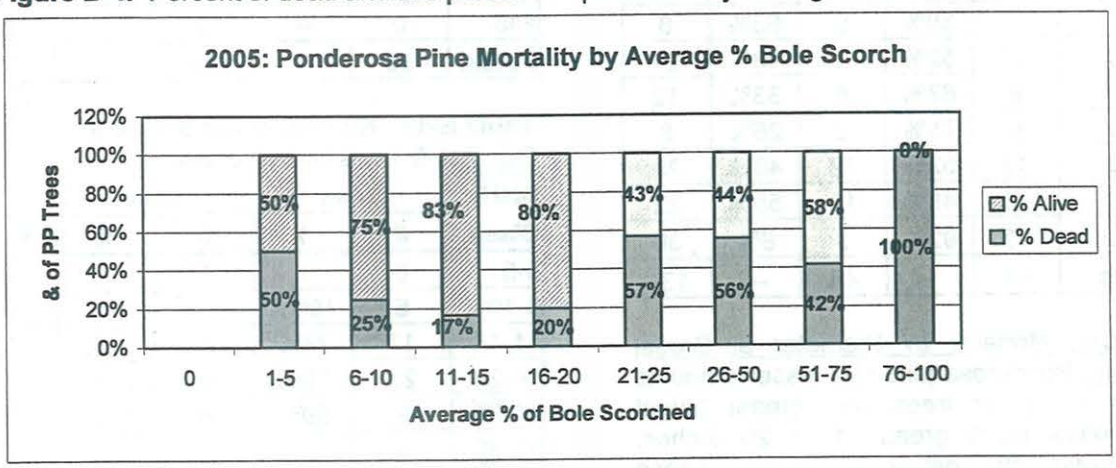


Figure B-4. Percent of dead and live ponderosa pine trees by average bole scorch.



Results, Percent Crown Kill and Mortality: The percent of the crown where the needles were either burned black or burned off the limb was recorded for each tree. This was described as crown kill because there was no chance that the needles or the buds would be able to recover from that amount of fire damage. A small percentage of the crown experiencing crown kill indicates a greatly increased risk of mortality. Only six to ten percent crown kill increased the amount of mortality. No trees with greater than ten percent crown kill survived (Table B-8).

Only two ponderosa pine trees had more than ten percent crown kill so the data is less conclusive regarding the effects of crown kill on ponderosa pine mortality due to the small sample. The available data does indicate the same relationship exists but not to the same degree that it applies to Douglas-fir.

Table B-8. Number of dead and live trees by percent crown kill.

% Crown	Dead		Alive		
Kill	#	%	#	%	Sum
0	33	56%	26	44%	59
1-5	23	56%	18	44%	41
6-10	10	71%	4	29%	14
11-15	5	100%	0	0%	5
16-20	3	100%	0	0%	3
21-25	2	100%	0	0%	2
26-30	4	100%	0	0%	4
31-35	1	100%	0	0%	1
>35	3	100%	0	0%	3
Totals	51	--	48	--	132

Results, Mortality by Crown Scorch: The percentage of the tree's crown scorched brown by the fire was recorded for each tree. There appears to be no relationship between the amount of crown scorch and mortality except for levels of crown scorch that exceed 90 percent. Thirty-three out of thirty-six trees died that had greater than ninety percent crown scorch (Table B-9). Tree species did not make any difference in the mortality rate when crown scorch exceeded ninety percent. All twelve trees that had 100 percent crown scorch died.

Table B-9. Number and percent of dead and live trees by percent crown scorch.

% Crown	Dead		Alive		
Scorch	#	%	#	%	Sum
0	0		0		0
1-25	3	38%	5	63%	8
26-50	11	52%	10	48%	21
51-60	8	67%	4	33%	12
61-70	6	75%	2	25%	8
71-80	13	52%	12	48%	25
81-90	10	45%	12	55%	22
91-100	33	92%	3	8%	36
Totals	84	--	48	--	132

Results, Mortality by Diameter at Breast Height: Ponderosa pine had lesser amounts of mortality for trees with breast height diameters (dbh) greater than 20 inches. Otherwise dbh below twenty-one inches appears to have no affect on ponderosa pine's ability to survive fire in this study (Table B-10). Ponderosa pine trees greater than thirty inches dbh showed an increase in mortality. However a closer inspection of the tree data showed three of the six trees in the greater than 30 inch dbh class had more than 84 percent crown scorch. The high level of mortality in ponderosa pine trees greater than thirty inches dbh was primarily due to very high levels of crown scorch in half the trees rather than something related to tree diameter. It is unknown why these large trees showed higher fire effects than smaller trees.

Douglas-fir trees less than eleven inches dbh appear to be more likely to die than larger diameter Douglas-fir trees (Table B-11). This relationship between dbh and mortality could not be seen in ponderosa pine because there were no ponderosa pine trees less than eleven inches in this monitoring study. Otherwise dbh did not appear to significantly affect Douglas-fir mortality.

Table B-10. Number of live and dead ponderosa pine trees by dbh class.

DBH	Dead		Alive		
Class	#	%	#	%	Sum
0-5	0	--	0	--	0
6-10	0	--	0	--	0
11-15	7	54%	6	46%	13
16-20	13	52%	12	48%	25
21-25	4	36%	7	64%	11
26-30	1	14%	6	86%	7
31-35	5	83%	1	17%	6
>35	0	--	0	--	0
Totals	30	--	32	--	62

Table B-11. Number of live and dead Douglas-fir trees by dbh class.

DBH	Dead		Alive		
Class	#	%	#	%	Sum
0-5	0		0		0
6-10	5	100%	0	0%	5
11-15	17	74%	6	26%	23
16-20	23	79%	6	21%	29
21-25	9	69%	4	31%	13
26-30	0	--	0	--	0
31-35	0	--	0	--	0
>35	0	--	0	--	0
Totals	54	--	16	--	70

Results, Bark Beetles: Bark beetle activity was observed on a total of 76 trees or 58% of the 132 trees being monitored. Douglas-fir beetle, turpentine beetle and mountain pine beetle were observed in the trees being monitored. Other species of beetles could have been feeding on the trees but were not identified by the monitoring team. Beetle activity was minor immediately after the fire, but activity increased during each subsequent year until 2004.

A total of 55 trees (72%) of the 76 trees hit by beetles were dead in 2005. The proportion of Douglas-fir trees (57%) attacked by beetles was the nearly the same

as the proportion of ponderosa pine trees (58%) attacked by beetles. Ponderosa pine has a slightly higher survival rate (33%) than does Douglas-fir which has a 23% survival rate. Beetle activity and mortality in these ponderosa pine and Douglas-fir trees are summarized in tables B-12 and B-13, respectively. This difference could be due to ponderosa pine inherently being better able to cope with the effects of fire than Douglas-fir and therefore less stressed on average than the Douglas-fir. It also could be related to higher proportions of Douglas-fir beetle compared to mountain pine beetle.

Table B-12. Number of Douglas-fir trees by mortality status and beetle activity 2001 to 2005.

Status in 2005	Attacked by Beetles	No Beetle Activity	Total
Live	9 (13%)	7 (10%)	16 (23%)
Dead	31 (44%)	23 (33%)	54 (77%)
Total	40 (57%)	30 (43%)	70 (100%)

Table B-13. Number of ponderosa pine trees by mortality status and beetle activity 2001 to 2005.

Status in 2005	Attacked by Beetles	No Beetle Activity	Total
Live	12 (19%)	20 (32%)	32 (52%)
Dead	24 (39%)	6 (10%)	30 (48%)
Total	36 (58%)	26 (42%)	62 (100%)

Results, Fall Rates and Breakage: DNRC employees have noticed a significant increase in fallen trees and broken tree stems in 2005. In 2004 only one monitored tree had fallen down and another tree had the top break off at forty feet above the ground. In 2005 another two trees had fallen over and six more trees suffered broken stems at various heights above the ground. Increasing numbers of falling trees and broken stems are expected for several more years. In summary as of June 2005, a total of three trees have fallen down (all ponderosa pine) and seven trees have broken stems (six Douglas-fir and one ponderosa pine). The mortality monitoring sites will continue to be visited annually to gather information on snag survival rates in the Sula State Forest.

Conclusions: A smaller proportion of ponderosa pine trees have died (48%) since 2000 than Douglas-fir trees (77%). Overall sixty-four percent of the trees being monitored have died since 2000. Mortality has nearly ceased on the monitoring sites. Only one tree had died between 2004 and 2005.

Mortality monitoring following the fires that burned through the Sula State Forest in August of 2000 was conducted to discover how many trees were going to die due to fire damage and subsequent insect and disease activity. Another reason for monitoring the post fire mortality was to look for observable signs of damage that might allow foresters to predict whether or not a fire damaged tree would survive. Based on the monitoring data it appears certain levels of bole scorch, crown kill and crown scorch will by themselves indicate a very high probability of mortality. It is likely that combinations of various amounts of bole scorch, crown kill, crown scorch and dbh would also indicate a very high probability of tree mortality. However the data has not been analyzed to discover those relationships at this time.

The dead trees on the Sula State Forest are beginning to fall down and many more tree stems are breaking off at various heights above the ground. Monitoring will continue to collect information about snag longevity in addition to tree mortality.

SILVICULTURE MONITORING

Silviculture is, by definition, the art and science of accomplishing management objectives on forest lands. Thus, accomplishment of commitments associated with any forest resource occurs through silvicultural practices. The SFLMP and Rules (ARM 36.11.420) establish 4 main goals for resource management on forest lands.

- ***Biological: Silvicultural treatments will be designed to protect forest soils and maintain long-term productivity, genetic quality and diversity of forest stands. (This is accomplished through project design and review, and tree plantings.)***
- ***Silvicultural Prescriptions: Written prescriptions will clearly guide the implementation of treatments and provide a record of conformity with the SFLMP. (These records are kept in the project files.)***
- ***Financial: Silvicultural treatments must produce a net return higher than the "no action" alternative; financial merit will be a factor in their selection. (Financial records are maintained in the project files and by the Forest Management Bureau.)***
- ***Integration with Other Resource Management Standards: Treatments will meet other resource management standards in a manner consistent with the other silvicultural standards. (This relates directly to the Biodiversity standards.)***

These goals are monitored through Regeneration and Survival Surveys, Forest Improvement Accomplishment Records, Financial Information on revenues and costs, and Stand Evaluations (refer to* BIODIVERSITY MONITORING*).

Silviculture Accomplishments

Silviculture is the art and science of accomplishing management objectives on forest lands. For the purposes of this report, it is divided into stand treatments associated with timber harvesting (dealt with in the biodiversity monitoring section) and those treatments applied to younger forest stands that are intended to improve the revenue generation potential of those forested stands. The forest improvement program uses fees from harvested timber to improve the health and productivity of trust forests. Uses of these fees, authorized by statute, include disposal of logging slash, reforestation, acquiring access and maintaining roads necessary for timber harvest, other treatments necessary to improve the condition and income potential of state forests, and compliance with other legal requirements associated with timber harvest.

Methods: Accomplishments are tracked by year and activity. Specific activities include piling of logging slash, prescribed burning, site preparation, seed collection, seedling production, tree planting, pre-commercial thinning, genetic tree improvement, erosion control, and culvert replacement. Net maintenance includes replacing, maintaining, or removing seedling netting used to protect against damage by big game browsing. Also included are various road maintenance activities, such as grading, snowplowing, and gate replacement.

Results: Accomplishments for fiscal years 2001 to 2005 are reported in Table S-1. Although not tied to specific RMSs or Rules, this information is included to indicate the numeric accomplishments associated with silvicultural activities that implement the SFLMP.

Regeneration Surveys: Our natural regeneration prescriptions and planting programs are designed to meet goals related to the Biodiversity Administrative Rules, in particular the coarse filter

approach of favoring an appropriate mix of stand structures and compositions (ARM 33.11.407 to 36.11.419). Harvest and site preparation methods are designed to favor desired species for an area. Generally, seral species are selected for planting due to their decreased representation on the landscape through various causes such as selective harvesting, introduced insect and disease problems, and fire suppression.

The large increase in 2000 to 2004 reflects primarily the efforts to survey the Sula State Forest following the fires of 2000. The increase also reflects stake lines associated with the planting of various burned areas in the last five years.

Tree Planting: The last reporting cycle witnessed a substantial increase in planted acres. Most of this increase occurred in response to the large fires of 2000, 2001, and 2003. In several of these fires there was no seed source remaining that was in proximity such that natural regeneration could be expected which makes planting a necessity.

Browse Protection: The reduction in the amount of browse protection reflects lesser planting in big game winter range areas. Browse protection methods include netting and the use of various repellents.

Precommercial thinning: The increase in thinning reflects higher annual spending authorization. The sustained yield calculation of 1996 identified the need for more thinning to realize greater volumes and revenue from trust lands.

Noxious Weed Spraying: The large increase in this program reflects the on-going problems with noxious weeds on state lands. It is expected to continue rising.

Brush piling: This activity has decreased as the department has developed procedures designed to leave more organic matter in the woods for nutrient cycling, moisture retention, and wildlife considerations rather than burning it.

Pile Burning: This activity closely follows Brush piling, though over time one would expect less burning than piling because some piles go unburned for various reasons.

Cone Collection: Increases in this activity reflect the greater amount of tree planting that has and will occur through implementing the SFLMP. It also reflects an effort to replenish stores of seed that would be available for future reforestation in response to either typical harvesting or following wildfire. FY05 reflects the fact that it was a very poor year for cone crops.

Bio-control Bug Releases: This is a new and growing program in an Integrated Pest Management approach to noxious weed control.

Table S-1. Forest Improvement Accomplishments in Fiscal Years 2001 through 2005.

	Units	FY05	FY04	FY03	FY02	FY01	Average 96 - 00	Average 01 - 05
Regeneration surveys	acres	602	963	4,992	735	129	295	1,484
Tree planting	acres	1,173	1,171	1,184	735	840	679	1,021
Tree browse prevention[1]	acres	870	650	221	202	893	1,523	567
Precommercial thinning	acres	1,642	2,125	170	2,357	2,365	1,188	1,732
Noxious weed spraying	acres	3,935	5,449	2,000	3,181	2,605	702	3,434
Herbicide application[2]	acres	680	350	354	100	600	140	417
Brush piling	acres	273	1,721	448	364	258	1,021	613
Pile burning	acres	3,163	1,220	1,964	2,049	1,676	1,339	2,014
Broadcast burning	acres	74	351	170	93	519	329	241
Tree improvement areas	acres	13	27	13	31	13	20	19
Road maintenance[3]	miles	51	17	25	15	115	25	44
Hand brush work	acres	116	102		50		123	54
Cone collection	bushels	0	397	412	28	400	65	247
Bio-control Bug Releases	acres	32						32

[1] Tree browse prevention includes replacing, maintaining, or removing seedling netting, or applying a chemical repellent.

[2] Herbicide application is associated with tree planting.

[3] Road maintenance includes grading, snowplowing, bridge removal and upkeep, installing culverts, etc. Many of these activities do not lend themselves to reporting by miles.

Regeneration/Survival Surveys

The long-term productivity of school trust lands depends on the success of regeneration efforts. Two methods are customarily used to assess the regeneration success on DNRC lands: survival surveys used to quantify plantation success and regeneration or inventory surveys designed to provide information on natural regeneration efforts.

Results: Survival surveys indicate good to excellent results for most planting efforts. On average survival ranges in the 80 to 85% range for individual planted sites. There are occasional sites that show lower survival rates that can often be attributed to heavy big game use in the winter and spring months.

In addition to survival surveys the department completed regeneration surveys on over 4,200 acres of the Sula State Forest to determine future planting needs. The results indicated that the fires of 2000 left many burned areas with no live tree seed source, thus requiring the planting of several thousand acres.

Other on-going inventory efforts sampled approximately 21,000 acres of previously harvested land. Results suggest that approximately 97% of those acres are currently stocked and only 3% remain classified as non-stocked. There are, however, additional acres that have burned in the last five years that are not accounted for in that total.

Financial Information

Montana's constitution and the Enabling Act requires that state-owned trust lands be managed for the support of public schools and state institutions. DNRC operates under a legal mandate to generate the "largest reasonable and legitimate advantage" from the management of trust lands. This mandate was an important consideration in the development of the SFLMP and forest management rules.

Methods: The revenue/cost summary is based on fiscal year-end costs and Forest Management Bureau records of collected revenue. A single year's revenue/cost ratio is not an accurate measure of program performance because the ratio is comprised

of harvest revenue from sales that have been purchased over several years.

DNRC sales constitute a small part of the Montana timber market; consequently, DNRC is a "price taker" in the market. This means that the revenue component of the revenue/cost ratio is largely outside of DNRC control. The volume of timber sold is within DNRC control and is determined by the annual sustained yield as required by law. When the timber is harvested, however, is under much less control since timber sale contracts can be 2 to 3 years in duration. The timer purchaser can generally choose to harvest the timber at any time during this period. Harvests by purchasers are largely driven by market conditions and manufacturing requirements that are totally outside of DNRC control. This means that the revenue cost ratio will vary substantially year-to-year depending on market conditions and purchaser needs. Thus the revenue cost ratio for a single year may better reflect current market conditions than DNRC efficiency. Over time these variations tend to average out and present a better indication of how efficiently the department is operating. Revenue includes both stumpage value and forest improvement fees.

Results: Table S-2 compares total costs and total revenue for the forest management program statewide. In fiscal years 2001 to 2005, the revenue/cost ratios ranged from 1.61 to approximately 2.44, and the average ratio was 1.94. This is slightly higher than the average ratio from the previous monitoring period (1997-2000).

Conclusions: One objective is to maintain a 2:1 or better revenue cost ratio over the long term. The department has taken steps to help ensure a high rate of return for the program by controlling costs and striving to improve efficiency. Projected revenues and costs will continue to be evaluated and adjustments made to ensure that the forest management program remains economically viable.

Table S-2. Revenue/Cost Summary for the Forest Products Sales Program

Fiscal Year	Total Revenue	Total Cost	Revenue/ Cost Ratio
2001	$8,578,175	$5,046,942	1.70
2002	$9,686,844	$4,690,832	2.07
2003	$8,278,792	$5,140,093	1.61
2004	$11,043,525	$5,810,145	1.90
2005[1]	$15,384,487	$6,309,477	2.44
Average			
1997-2000	$8,709,113	$4,642,110	1.90
2001-2005[1]	$10,594,365	$5,399,498	1.94

[1]FY 2005 Revenue/Cost numbers are preliminary calculations.

Logging Systems and Silvicultural Prescriptions

Major factors that affect the economic return of the timber sale program are the types of logging systems used and the types of silvicultural prescriptions applied. As a general rule, ground-based logging systems are more economical than cable systems, and both are cheaper than helicopter logging. Steep slopes and lack of adequate road access can preclude ground-based logging and require the more expensive systems. Given similar sites and stand characteristics, silvicultural prescriptions that result in larger amounts of timber removed per acre (clearcut) are generally more economical than prescriptions that remove less volume per acre (commercial thinning or intermediate harvests).

Logging Systems: The difference between the mechanical ground-based system to a cable (skyline) system for a typical harvesting scenario yields a moderate increase in logging cost. Going from a

mechanical ground system to a helicopter system for the same harvest scenario results in a very substantial increase in logging cost.

Results: Table S-3 compares the percentage of various logging systems applied to DNRC timber sales sold in 1998-2000 and sales sold in 2000-2005. This information is compiled from DNRC timber sale contracts.

Table S-3. Estimated Percentage of Area Logged by Logging System

Fiscal Year	Tractor	Cable	Ground-Lead	Helicopter
1998-2000	91%	7%	0%	2%
2001-2005	79%	16%	1%	4%

As evident in Table S-3, there has been a shift in the percentages between past and current sales toward higher cost logging systems. During the period of 2001-2005, approximately 79% of planned logging was from tractor-based systems; this was a considerable decrease from 91% for 1998-2000. The remaining area was planned for harvesting with cable (16%), ground-lead (1%), and helicopter systems (4%).

Conclusions: The increased application of cable and helicopter logging systems corresponds to timber sale planning on steep or difficult to access sites, as well as transportation planning that minimizes road construction. Continued increases in the amount of cable and helicopter-logging systems used would decrease the amount of stumpage value realized. Traditionally, easier and lower cost ground was the first harvested so in the near term it is expected that trends toward higher cost logging systems will continue.

Harvest Acreage by Silvicultural Treatment Method

Information on harvest area by silvicultural treatment method was compiled during the analysis for the SFLMP, from timber sales sold during fiscal years 1990-1994. This information was used to quantify the "current condition" and to make forecasts for each management alternative. This information was presented in Appendix SCN of the SFLMP under Silvicultural Treatment Methods. The DNRC collected similar data for timber sales sold after adoption of the plan, in fiscal years 1998-2005. This information was compiled in order to make a direct comparison between what was forecast and what has actually occurred.

Methods: Silvicultural treatment methods were separated into the following categories in the SFLMP: clearcut, seed tree, shelterwood, selection, and intermediate cutting. For the period 2001 to 2005, salvage harvests following beetle outbreaks, windfall, or wildfire contributed substantially to DNRC's production. A clearcut is the harvest of an entire stand in order to regenerate and grow a new stand. A seed tree is the cutting of all trees except for a few dispersed trees as a seed source. Shelterwood harvesting retains more trees than a seed tree, to provide shade that moderates the microclimate for regeneration. Selection is the partial harvest of a stand in order to regenerate and grow new trees as well as manage the remaining stand. Intermediate cutting is the partial harvest of a stand to enhance the growth, quality, vigor, or composition of the remaining stand, without the objective of regeneration. Each of these three methods retains snags and reserve trees per the Forest Management rules to provide wildlife habitat, structural diversity, and visual mitigation. The choice of treatment method is based on the objectives they are designed to achieve, emulation of natural disturbance regimes, and consideration of other resource goals. Complete descriptions can be found in the SFLMP (MT DNRC 1996a: Appendix SCN, p. 17-18).

For all timber sales sold from fiscal years 2001-2005, the DNRC collected data on silvicultural treatments to planned harvest areas. This information comes from the silvicultural prescriptions prepared for each timber sale.

Results: A review of the silvicultural treatment methods from 2001-2005 indicated an increase in the application of even aged regeneration harvests (clearcut, seed tree, and shelterwood) from 14% to 31% since the previous monitoring period (Table S-4). This corresponds to a decrease in the use of selection and intermediate cuttings. Forest managers apply selection harvest methods to the greatest percentage of harvest area, and intermediate treatments continue to play a substantial role. Although the percentages of each harvest method don't equal those forecast in the SFLMP, they do show that we are moving towards those proportions over time. In order to make reasonable comparisons to prior years' harvest trends, these evaluations do not include fire salvaged acres.

Table S-4. Percentage of Silvicultural Treatment Method based on Harvest Acreage, compared to Estimates in SFLMP

Silvicultural Method	Omega Alternative Estimates	Actual FY 98-00[1]	Actual FY 01-05[2]
Clearcut	10%	4%	5%
Seed Tree	25%	8%	18%
Shelterwood	5%	2%	8%
Selection	40%	55%	47%
Intermediate	20%	31%	22%

[1] FY 98-00 percentages from 2000 Monitoring Report (DNRC).
[2] FY 01-05 percentages do not include fire salvaged acres.

Under the SFLMP and Rules, the choice of treatments is based on both landscape level (biodiversity) and site-specific conditions. A primary consideration when selecting a silvicultural method is the emulation of natural disturbance regimes. The past 15 years has seen a change in how traditional silvicultural systems are applied. Generally, greater amounts of residual material (trees, snags, and down woody material) are left standing and on the ground. These may be clumps of advanced regeneration, or clumped or scattered snags and mature trees. Often, several prescriptions are applied to a single unit. Despite the new landscape level focus and the greater amounts of material left behind, the traditional terms for silvicultural treatments have been applied and they convey the same silvicultural objectives.

The results show a positive movement toward the proportions anticipated in the SFLMP compared to the results demonstrated in the first monitoring report (Table S-4). Based on historical disturbance regimes as described in the SFLMP, one would expect about 40% of these natural disturbances to be stand replacement events. Even-aged harvest treatments such as clearcut, seed tree and shelterwood harvests are meant to emulate these natural stand replacing events. Even-aged harvest treatments were applied to 14% of the acreage during the previous monitoring period (98-00) and to 31% during the most recent monitoring period (01-05).

The silvicultural method applied is important in meeting our biodiversity goals, especially as it relates to the coarse filter approach of favoring an appropriate mix of stand structures and compositions on state lands. While the current level of even-aged harvesting is still less than described in the SFLMP and what historical disturbance patterns suggest, the increase from the previous monitoring period demonstrates a positive step towards meeting our biodiversity goals. DNRC will continue to work towards the proportion of harvest treatments in the SFLMP.

Salvage: In 2000, 2001, and 2003, wildfires burned approximately 23,000 acres of state-owned forestlands. These acres are located within various large fire complexes that burned across mixed ownerships in Montana during each of those years. Many of those acres were included in subsequent forest management projects. Following those fires, DNRC prepared salvage timber sales on approximately 10,000 acres that had experienced stand replacement and mixed severity burns. Because these harvest acreages do not fall within the standard categories defined in the SFLMP, they were tracked separately and described in this report as "fire salvage" treatment.

In order to examine the role of these fire salvage treatments, percentages of silvicultural methods were compiled both with and without those acres.

Within the last 5 years, fire salvage timber sales have been completed on approximately one quarter of the total acres harvested (Table S-5). Although these harvests have similarities to prescribed regeneration methods, they were designed in reaction to unpredictable events. Without those events, timing of treatments would have been planned differently and type of treatment may have differed. However, many of these stand replacement and mixed severity burns sites will regenerate as even aged stands. This further contributes to meeting our estimates from the SFLMP.

This trend can be further clarified by looking at each Land Office, or Area (Table S-6). In most Areas, fires and subsequent timber sales played a considerable role in their program. Almost half of the harvested acres on the Southwest area were fire salvage timber sales, following several very active fire seasons.

Table S-5. Percentage of Silvicultural Treatment Method based on Harvest Acreage, Including Fire Salvage

Silvicultural Method	Omega Alternative Estimates	Actual FY 98-00	Actual FY 01-05
Fire Salvage	N/A	N/A	26%
Clearcut	10%	4%	4%
Seed Tree	25%	8%	13%
Shelterwood	5%	2%	6%
Selection	40%	55%	34%
Intermediate	20%	31%	17%

Table S-6. Percentage of Silvicultural Treatment Method based on Harvest Acreage for Sales Sold Fiscal Years 2001-2005

Silvicultural Method	Actual FY 2001-2005					
	Central	Eastern	Northeast	Northwest	Southern	Southwest
Fire Salvage	20%	14%	0%	17%	0%	43%
Clearcut	11%	0%	10%	4%	0%	3%
Seed Tree	15%	0%	0%	22%	0%	3%
Shelterwood	3%	0%	12%	8%	0%	4%
Selection	41%	75%	23%	30%	42%	36%
Intermediate	20%	11%	55%	19%	58%	11%

Conclusions: When planning timber sales, DNRC management foresters must consider site-specific characteristics as well as landscape level objectives. Treatments that emulate stand-replacement disturbance are not applied as often as was forecast in the SFLMP. This can be attributed to the department's response to other resource considerations as well as public concerns over clearcut and other even-aged harvest treatments. Since the previous monitoring period, there has been a notable increase in regeneration harvesting. This is a positive shift towards the proportions in the SFLMP, but clearcut and seed tree treatments continue to be used less frequently than predicted, potentially with corresponding decreases in the long-term sustainable yield. This may also be reducing the regeneration and growth of desirable seral species, key components of the state's long-term forest management goals.

In recent years, the DNRC has harvested a substantial amount of volume through salvaging after fires. The salvage program has been successful in logging dead and dying timber before substantial value is lost, and this volume contributes toward the department's annual volume targets. Salvage harvesting does require that some adjustments be made to regular sale planning, such as postponing green projects to future years. In the last 5 years, the DNRC has responded to many such fire events and adjusted sale planning accordingly.

ROAD MANAGMENT

Under Road Management, the State Forest Land Management Plan (SFLMP) identified two main goals for Road Management on state classified forest lands:

- ***Transportation Planning: Transportation systems would be designed for the minimum number of road miles needed for current and near-term management needs. Road densities and road closures would be planned to meet wildlife, threatened and endangered species and biodiversity needs.***
- ***Road Design and Maintenance: The location, design, construction and maintenance of all roads would be consistent with Best Management Practices (BMPs), Streamside Management Zone (SMZ) rules and other standards and permits. Road construction and maintenance would be implemented primarily under timber sale contract administration.***

Monitoring methods were outlined under the SFLMP and Rules. They included:

- ***Watershed Inventory – to identify road-related problems;***
- ***Road Monitoring – to assess road maintenance and repair needs;***
- ***Road Construction and Maintenance, and Road Inspections (accomplished as part of timber sale contracts) - to implement maintenance and remedial actions; and***
- ***Internal BMP Audits – to evaluate the application and effectiveness of the actions.***

Watershed Inventory

Under the watersheds monitoring program (ARM 36.11.424), DNRC identifies the causes of watershed degradation and sets priorities for restoration. To accomplish this DNRC has been conducting systematic inventories of watershed conditions on forested state trust lands. These inventories are coordinated by the Forest Management Bureau and are conducted statewide by DNRC hydrologists and contracted consultants. The watershed inventories include comprehensive evaluations of existing road systems and stream crossing structures (See Watershed Inventory, under the Watershed Monitoring Section of this report for more detailed information).

Methods: During the watershed inventories, all roads, stream crossing and other road drainage structures are evaluated in order to identify existing or potential sources of erosion and sediment delivery to streams or other water resources. Road closure status and maintenance needs are also noted.

Results: Ten watershed inventories were completed during FY2001 and FY2002. Approximately 58,423 acres of school trust lands have been inventoried within these watershed project areas. The areas inventoried include approximately 456 miles of existing road and 325 stream crossing structures. Information collected during inventories regarding existing and potential sources of water quality impacts are being used to prioritize and develop site-specific prescriptions designed to address erosion problems and restore water quality. A majority of the remedial actions implemented to date consist of road and stream crossing structure improvements, road abandonment and other existing road mitigation measures that have been funded primarily through timber sale contracts. Other watershed improvement projects including the Sula Fire Restoration Activities were funded through DNRC road maintenance and forest improvement funds as well as federal watershed and fire restoration sources. Each of the watershed inventories is summarized in Table W-1 in the Watershed Monitoring section of this report.

Recommendations: As a result of the watershed inventories, corrective actions to treat road related impacts are being planned or implemented. Unfortunately the large volume of information and data collected only exist in printed data forms making full use of this information difficult and cumbersome. DNRC plans to fully automate the road inventory information in a database and associated GIS format. Watershed inventories will be renewed once the development of the database and GIS have been completed.

Road Monitoring

In addition to road inventories conducted by the watersheds monitoring program, the Northwestern Land Office and the Southwestern Land Office also have ongoing road monitoring programs for inventory of existing road conditions on forested state trust lands.

Methods: These Land Office initiated road inventories evaluate existing road to collect information on stream crossings, relief drainage structures, problem areas, and general maintenance needs; they also assess the status of road closure structures. DNRC primarily utilizes contracted service to complete these inventories and assessments.

Results: Approximately 1465 miles of existing road have been evaluated under these programs in Fiscal Years 2001 through 2005. A common data format is needed to make sure information is consistently collected. The information collected by the land office needs to be included in the GIS based information system being developed by the FMB.

Road Construction and Maintenance

Methods: Statistics for road construction, reconstruction, maintenance, and obliteration were compiled from timber sale contracts that were sold during the period of fiscal years 2001 through 2005. The DNRC also collected information about estimated development costs, timber volume sold, area to be logged, and number of units on sold contracts.

Results: The numbers of road miles scheduled for construction, reconstruction, maintenance actions and obliteration in timber sale contracts are listed in Table R-1. There is some variability in classification and reporting of "reconstruction" versus "maintenance," and routine blading and grading is not specifically listed in the contract prospectus. Consequently, "road maintenance" listed in Table R-1 only reflects maintenance beyond routine actions, and the miles of road receiving routine maintenance is much higher.

Table R-1. Road Construction for Timber Sale Contracts Sold FY00-FY05 (All Land Offices)

	# of Sales	5 Year Total	Average Per Sale	Average Per MMBF
Roads Constructed (mi)	98	149.04	1.52	0.65
Roads Reconstructed (mi)	98	206.9	2.11	0.91
Road Maintenance (mi)	43	411.66	9.57	1.81
Roads Obliterated (mi)	30	34.32	1.14	--
Development Costs ($)	98	4,2479,10.59	43,346.03	18,667.27
Net Timber Volume Sold (MMBF)	108	227.56	2.11	--
Total Area to be Logged (acres)	108	38,741.20	358.71	--
# of Units	108	709	6.56	--

In addition to timber sale contracts, the forest improvement program funds some road maintenance activities, such as grading, culvert replacement, gate replacement, etc. In FY2001-2005, 172 miles of roads were maintained with Forest Improvement funds.

Conclusions: These conclusions are based on a comparison between road construction and timber volume harvested. The SFLMP forecast the expected number of miles of new road construction that would occur under the selected alternative (MT DNRC 1996a: Appendix SCN, *Road Scenario*).

The miles/MMBF are lower in more productive (wetter) climatic zones, where timber volumes are higher. By applying a weighted average, based on percent volume sold by land office, to the forecasted rates, the expected average miles/MMBF was calculated to be 0.8722. The actual miles/ MMBF for 2001-2005 was 0.65 (Table R-1), which is considerably lower than both the expected average from the SFLMP and the actual average in previous years. The primary reason for low amounts of road building is the number of sales in previously accessed sites, including many of the salvage sales. It is also partially due to increased use of helicopter and cable logging systems. Overall, planned road construction is occurring statewide at a lower the rate forecasted in the SFLMP.

Timber Sale Contract Inspections

Methods: DNRC field personnel oversee the implementation of timber sale contracts. Management foresters spend a substantial amount of time on the ground, visiting active sales to ensure contract compliance. Foresters communicate with purchasers and contractors, and direct them in meeting stipulations and requirements of the contract. These site inspections are documented through inspection reports that cover 23 standard items, with opportunity to customize for specific requirements. For the standard items, status is recorded as "Satisfactory", "Needs Improvement", or "Violation," with an explanation for deficient items and requirements for improvements. Foresters identify items as "Needs Improvement" or "Violation" if the purchaser must adjust their operations. These are commonly situations for which the forester prescribes a corrective action in order to avoid contract deviations or impacts.

Inspection reports are delivered to the purchaser and maintained in department records as verification of ongoing contract administration. The feedback information from these reports was reviewed and compiled for each fiscal year (Table R-2).

Results: During fiscal years 2001 through 2005, foresters documented 2,224 timber sale inspections. For 405 items, direction was given to improve an area of operations. Foresters documented 47 violations of contract terms (Table R-2).

Table R-2. Inspection Report Summary by Fiscal Year

	Documented Items			
Fiscal Year	**Number of Reports**	**Satisfactory**	**Needs Improvement**	**Violations**
2001	397	2609	113	7
2002	404	3625	77	11
2003	491	3546	92	9
2004	530	3656	63	2
2005	402	2993	60	18
Total	**2224**	**16429**	**405**	**47**

In FY2001, 22 practices that were reported as in need of improvement, and 2 contract violations, were directly related to road Best Management Practices (BMPs). The BMPs most often associated with those items were related to maintenance of road surface drainage and erosion control features. During FY2002, 18 items reported as in need of improvement were related to BMPs, primarily installation and maintenance of adequate road surface drainage. In FY2003, 21 needs improvement items and 1 violation were associated with BMPs. As with prior years, they were most commonly associated with BMPs for installation and maintenance of road drainage. Inspection reports noted 12 practices in need of improvement related to BMPs during FY2004. BMPs related to maintenance of drainage and erosion control features were most often tied to those practices.

Conclusions: As recognized by the SFLMP, field foresters are responsible for on the ground implementation of timber sale projects. Effective road management requires site inspections that direct contractors and identify problems early on.

Through modification of operations, those problems can be solved and resources are protected.

See **Timber Sale Contract Inspections** under **WATERSHED MONITORING** for additional information.

Internal BMP Audits

A total of 83 internal BMP audits were completed on ongoing and recently completed DNRC timber sales between Fiscal Years of 1999 and 2004[1]. DNRC hydrologists and soil scientists from the Forest Management Bureau and the Northwest Land Office conducted these audits. All DNRC field units with active timber sale programs participated in the audits.

Methods: The DNRC internal audits utilized the same methods and rating systems used by the Statewide BMPs that are conducted biannually across the state on all ownership groups (MT DNRC 2004). During the BMP audits, the auditors evaluate ongoing and recently completed DNRC timber sales to determine whether BMPs were properly applied and whether those same BMPs were effective in preventing erosion and sediment delivery. Practices rated include those used in harvesting, yarding, site preparation, slash treatment and road use operations.

Results: In the six years of audits, 11,454 harvest acres of DNRC land had internal audits conducted on them. Approximately 48 MMBF of harvest volume was contained in the audited areas. Auditors also evaluated approximately 101 miles of new road constructed, 54 miles of road reconstructed, and 114 miles of road re-conditioned during this six-year period.

The following information is based on the 3141 practices rated during the 83 internal audits. The internal audits revealed that over the six-year period monitored BMPs were properly applied by DNRC on approximately 97 percent of the practices rated. There were 90 minor departures and 10 major departures of all the practices rating application of road related BMPs. The internal audits also revealed an effectiveness rate of approximately 98 percent on protecting soil and water resources. There were 66 minor departures and 6 major departures in all practices rating effectiveness of road related BMPs. Only minor and temporary impacts to soil and water resources results in a minor departure rating. A major departure rating is given when major and temporary, or minor and prolonged, impacts to soil and water resources are observed. There were no observed occurrences of gross neglect.

The results shown by the DNRC internal audits are equivalent to the results from the DNRC timber sales assessed by the statewide audits, coordinated by the Service Forestry Bureau. Interdisciplinary teams, representing people from the government, industry, and the conservation community, conducted the statewide audits. The audits were conducted on various ownership groups in 2002 and 2004. In 2002 both the DNRC and industry ranked highest in application and effectiveness.

In 2002 the statewide audits rated 215 practices from five DNRC timber sales. There results show that 98 percent of the applications meet or exceeded standards, and effectiveness in protecting soil and water resources was rated at 99 percent. Almost all of the departures were rated as minor, with only less than one percent in the major category of application. There were no cases of gross neglect reported.

Conclusions: The results of the 2004 statewide audits were compiled from 173 practices rated on four DNRC timber sales. The data shows that 97 percent of the application practices rated met or exceeded standards. Ninety eight percent of the practices rated aimed to effectively protect soil and water resources were satisfactory. For effectiveness, departures reported were mostly in the minor category, with only less than one percent in the major category. There were no cases of gross neglect.

Implementation and effectiveness of the Montana Streamside Management Zone (SMZ) laws and rules were also evaluated

[1] Some audit data is included from the first half of Fiscal Year 2005.

during both the DNRC Internal and Statewide BMP audits. In the six-year data set of DNRC internal audits, there were 23 SMZ departures in application and two SMZ departures in effectiveness. All departures were found to be minor. The statewide audits conducted in 2002 and 2004 found no departures.

The results from the contract inspection reports, internal, and statewide BMP audits are being used to identify specific or recurring problems. The majority of the BMP departures that were noted on the DNRC timber sale inspections and on the Internal and Statewide BMP audits were associated with inadequate road surface drainage and insufficient sediment control on erodible fill slopes. Other common BMP departures noted during these audits were failure to maintain erosion control features, not stabilizing erodible soils, lack of prevention of downslope movement of sediment, and directing road drainage to the stream crossing site.

The BMP implementation monitoring results are used to develop topics addressed during annual BMP training sessions conducted for field staff by the DNRC hydrologists and soil scientist, and to focus specialist design needs. In those cases where BMPs have been determined to be ineffective, the DNRC hydrologists and soil scientist have modified the BMPs or designed new ones to address the problems.

WATERSHED MONITORING

The State Forest Land Management Plan established general goals for watershed related monitoring. DNRC developed a comprehensive approach to watershed monitoring and implemented such a program under the SFLMP in 1999. This monitoring program continues to be implemented through application of the Watershed Management – Monitoring Administrative Rules (ARM 36.11.424). The monitoring program includes the following strategies:

- ***Inventory and analyze watershed impacts on State Trust lands to identify causes of watershed degradation and set priorities for watershed restoration.***
- ***Conduct qualitative assessments, such as BMP audits, on most projects with a substantial amount of soil disturbance.***
- ***Complete site-specific monitoring projects using quantitative assessment methods on selected sites to determine the effectiveness of BMP's and other commonly applied mitigation measures.***
- ***Evaluate the effects of forest management activities on soils at selected harvest sites, and***
- ***Assess habitat conditions on selected streams identified as supporting fish species listed as threatened or endangered under the Endangered Species Act, and sensitive fish species.***

To accomplish the first goal, DNRC is systematically completing watershed inventories throughout the state in priority drainage basins. Goal #2 is being accomplished primarily through Timber Sale Contract Inspections and Internal BMP Audits. To meet Goal #3, DNRC is maintaining long-term water quality monitoring sites on the Stillwater State Forest and has implemented a three-year water quality monitoring program on the Swan State Forest, as well as numerous other short-term site-specific monitoring projects.

To accomplish Goal #4, DNRC uses qualitative assessments, such as BMP Audits and Timber Sale Contract Inspections and site-specific quantitative studies to assess how effective BMPs and other site-specific mitigation measures are at minimizing detrimental physical and biological effects of forest management operations to soils. The results of site-specific quantitative monitoring studies are reported under in this section under the sub-heading " Soils Monitoring".

Goal #5 is being accomplished through various fisheries and fish habitat related watershed monitoring projects. The results of fisheries related watershed monitoring is addressed in the Fisheries Monitoring Section of this report. Additional watershed related monitoring is addressed in the section on Monitoring of Grazing on Classified Forest Lands.

Watershed Inventory

DNRC has been systematically completing watershed inventories throughout the state in drainages that have been identified as high priority. Highest priority is given to those watersheds that support sensitive fisheries, contain streams on the State's 303(d) list of impaired water bodies, have proposed DNRC forest management activities, and/or there are opportunities to participate in cooperative inventory or restoration programs with other landowners in the watershed.

During these inventories all roads, stream crossings and reaches of stream channel and associated riparian areas are surveyed in order to identify existing or potential sources of erosion and sediment delivery to streams or other water resources. Road closure status and maintenance needs are also noted.

Watershed inventories were completed in 10 watershed project areas between FY2001 and FY2002 by DNRC hydrologist and contractors. These inventories are summarized in Table W-1. Approximately 58,423 acres of school trust lands have been inventoried within these watershed project areas. The areas inventoried include approximately 456 miles of existing road, 159 miles of stream channel and 325 stream crossing structures. Information collected during inventories regarding existing and potential sources of water quality impacts are being used to prioritize and develop site-specific prescriptions designed to address erosion problems and restore water. A majority of the remedial actions implemented to date consist of road and stream crossing structure improvements, road abandonment and other existing road mitigation measures that have been funded primarily through timber sale contracts. Other watershed improvement projects including the Sula South and Sula East/West project areas were funded through DNRC road maintenance and forest improvement funds as well as federal watershed and fire restoration sources.

Table W-1. Watershed Inventories Conducted by DNRC (2001-2002)

Watershed Inventory Project	DNRC Area Office	DNRC Unit Office	Watershed Acres Inventoried	Stream Miles Inventoried	Road Miles Inventoried	Stream Crossing Inventoried
Lower Thompson River	NWLO	Plains	15,000	22.7	89.7	34
Upper Thompson River	NWLO	Plains	7,680	12.1	55.1	27
Fitzsimmons Creek	NWLO	Stillwater	10,000	21.5	13.9	29
Middle Swift Creek	NWLO	Stillwater	11,000	22.4	60.2	71
Lower Swift Creek	NWLO	Stillwater	10,774	20.0	46.3	62
Goat-Squeezer	NWLO	Swan	3,370	18.0	35.0	3
Fish Creek	SWLO	Missoula	8,320	18.4	46.3	40
Sula East / West	SWLO	Hamilton	9,166	12.5	65.8	30
Sula South	SWLO	Hamilton	3,080	5.6	39.8	22
Bear Canyon	CLO	Bozeman	5,445	5.3	3.7	7
Totals:	All	All	58,423	158.5	455.8	325

A summary of the findings from each watershed inventory project areas is given below. The comprehensive results of each inventory project are contained in the individual inventory reports contained in the FMB files.

Lower Thompson River: Stream channel stability in the Lower Thompson River project area was considered "fair" overall. Occurrences of channel instability were attributed to channelization from roads, mass wasting and seasonal irrigation ditch diversions. Other sources of impairment were plugged culverts, inadequate road surface drainage, and road fill erosion. In 2004, DNRC removed 1 bridge on the Little Thompson River and restored the bridge site. The purpose for the bridge removal was (1) to eliminate the risk failure and subsequent impact to water quality, and (2) provide for public safety.

Upper Thompson River: In general stream channels were found to be largely stable. Three site-specific problem areas that are

considered sediment sources were identified in the project area. These sites include a partially plugged stream crossing culvert that was also noted as being barrier to fish migration, an irrigation diversion and an unstable reach of stream with recent down cutting. Several plugged and improperly installed culverts were also noted. Improvements to the existing road system were implemented during the Big Prairie/Semen Creek and Richards Peak Timber Sales.

Fitzsimmons Creek: Stream channel conditions were predominately rated as "good" and no major channel instability was identified. Areas for concern in the road inventories include failing or partially plugged culverts. Although these areas are not considered major sources of sediment at this time, future run-off events may cause culvert failure and road fill erosion.

Middle Swift Creek: Channel stability for the Middle Swift Creek watershed area primarily rated as "good". Four major sediment sources were identified on roads that included culvert washouts or sites at risk of failure, and native material crossings (constructed from logs and earth fill) that are also considered at risk of failure. The most frequent problems were related to stream crossing and ditch relief culverts that were in poor condition or in need of maintenance. Many of these culverts were partially plugged by sediment or debris. Road maintenance activities have been conducted at several of the sites identified in need of remedial action. Additional road improvements within the watershed project area are being included in the proposed West Fork Swift Timber Sale and are planned for the Lower Chicken/Antice Knob Timber Sale.

Lower Swift Creek: This project area includes numerous steep gradient headwater tributaries to the lower mainstem of Swift Creek. Channel stability of these tributaries generally rated as "good". The mainstem of Swift Creek was not evaluated during this watershed inventory (see Lower Swift Creek Streambank Inventory). Road stream crossing sites were identified as the primary sediment sources in this inventory. Numerous stream crossing structures were found to have inadequate capacity and/or length, outlets above stream grade or eroding fill slopes. Other common road problems contributing to surface erosion and sediment included inadequate surface drainage, improperly functioning dip drains, and insufficient filtration zones. The Werner Peak Road was found to have severe surface drainage problems. Surface drainage feature were essentially absent from this road system with erosion and gully occurring in several places.

The Lower Swift Creek Watershed Inventory was instrumental in identifying necessary BMP upgrades to the road system located within the watershed. These upgrades were implemented under the Taylor South and Chicken Werner Timber Sales. The Taylor South Timber Sale resulted in 9.6 miles of road improvements, 0.3 miles of road reclamation and road abandonment. These road improvements included replacement of 9 stream crossing culverts, installation or repair of numerous ditch relief culverts, maintenance of existing surface drainage features and installation of additional road surface drainage features. The Chicken Werner Timber Sale implemented improvements to 6.2 miles of the Werner Peak Road. These improvements were designed to upgrade ditch relief and road surface drainage, and reduce sedimentation risk. Additional road upgrades will be included in the proposed King-Bear Timber Sale.

Goat-Squeezer: In general, all of the streams in this project are stable and do not contain substantial sources of sediment. Several road segments including stream-crossing sites were identified as sources contributing sediment to streams. Upgrades to the road systems in the Goat and Squeezer Creek watersheds are being implemented under the Goat-Squeezer I and Goat-Squeezer II Timber Sales. Included in these sales are the improvement and reconstruction of approximately 16.5 miles of existing road and 6 stream crossings.

Fish Creek: Sixteen problem sites were identified within the watershed project area that were associated with stream channel instability. Specific problem reaches were mostly related to bank erosion, excessive

levels of sediment deposition and channel braiding. Road related problems identified as primary sediment sources in this watershed included partially plugged and incorrectly installed stream-crossing culverts. Improvements to the existing road system were implemented within the Fish Creek watershed during fire restoration and salvage activities in 2004.

Sula East-West and Sula South: Watershed inventories completed for Sula East/West and Sula South were completed during the preparation of the Sula State Forest Fire, Mitigation, Salvage and Recovery Project EA in the fall of 2000. Restoration activities were implemented where feasible on all road and stream crossing locations that were identified at high risk for accelerated rates of sediment delivery. Restoration activities included approximately 65.5 miles of existing road improvement, 4.5 miles of road obliterations, 4.3 miles of road abandonment 0.6 miles of road relocation. Road improvements included replacement and upgrades of four large stream crossing structures and numerous draw crossings and ditch relief culverts.

Bear Canyon: Overall stream channel stability within this project area rated as "good". Several direct sources of sediment delivery were identified that are associated with the road system located within this project area.

Additional watershed inventories were not conducted between 2003-2005 because funding and workload priorities were shifted to the DNRC Fish Passage Assessment Project. Under the Fish Passage Assessment Project all DNRC stream crossing structures where native salmonid connectivity may be affected are being inventoried and surveyed (see the Fisheries Monitoring section for a more detailed description of this project). Future watershed inventory priorities will focus on developing GIS information and associated databases to more effective manage and utilize existing and future watershed inventory data.

Lower Swift Creek Stream Bank Inventory

A total of 63 stream bank sites located on the mainstem of Swift Creek in the Stillwater State Forest were inventoried in 2001. These stream banks are located in the lower portion of the watershed on stream reaches that have exhibited extreme instability due to recent or past mass wasting events. A similar inventory conducted in 1984 identified that the majority of sediment being directly delivered to Swift Creek comes from the mass wasting of these stream banks. The inventory included 47 sites that were originally surveyed in 1984. Four of the 1984 sites were not re-surveyed because they were now completely re-vegetated and are no longer considered a substantial sediment source. A total of 16 new sites were measured in 2001 that were not included in the 1984 inventory. Some of these 16 sites were likely present in 1984, but were not measured due to their smaller size. Although some error can be contributed to differences in measurement methodologies, a comparison of the 47 common sites reveals some definite trends. For example 34 of the 47 sites had a larger area in 1984 than in 2001. Many sites had re-vegetated or stabilized considerably since 1984.

Internal BMP Audits

A total of 83 internal BMP audits were completed on ongoing and recently completed DNRC timber sales between Fiscal Years of 1999 and 2004[2]. DNRC hydrologists and soil scientists from the Forest Management Bureau and the Northwest Land Office conducted these audits. All DNRC field units with active timber sale programs participated in the audits.

The DNRC internal audits utilized the same methods and rating systems used by the Statewide BMPs that are conducted biannually across the state on all ownership groups (MT DNRC 2004). During the BMP audits, the auditors evaluate ongoing and recently completed DNRC timber sales to determine whether BMPs were properly

[2] Some audit data is included from the first half of fiscal year 2005.

applied and whether those same BMPs were effective in preventing erosion and sediment delivery. Practices rated include those used in harvesting, yarding, site preparation, slash treatment and road use operations.

In the six years of audits, 11,454 harvest acres of DNRC land had internal audits conducted on them. Approximately 48 MMBF of harvest volume was contained in the audited areas. Auditors also evaluated approximately 101 miles of new road constructed, 54 miles of road reconstructed, and 114 miles of road re-conditioned during this six-year period.

The following information is based on the 3141 practices rated during the 83 internal audits. The internal audits revealed that over the six-year period monitored BMPs were properly applied by DNRC on approximately 97 percent of the practices rated. There were 90 minor departures and 10 major departures of all the practices rating application of road related BMPs. The internal audits also revealed an effectiveness rate of approximately 98 percent on protecting soil and water resources. There were 66 minor departures and 6 major departures in all practices rating effectiveness of road related BMPs. Only minor and temporary impacts to soil and water resources results in a minor departure rating. A major departure rating is given when major and temporary, or minor and prolonged, impacts to soil and water resources are observed. There were no observed occurrences of gross neglect.

The results shown by the DNRC internal audits are equivalent to the results from the DNRC timber sales assessed by the statewide audits, coordinated by the Service Forestry Bureau. Interdisciplinary teams, representing people from the government, industry, and the conservation community, conducted the statewide audits. The audits were conducted on various ownership groups in 2002 and 2004. In 2002 both the DNRC and industry ranked highest in application and effectiveness.

In 2002 the statewide audits rated 215 practices from five DNRC timber sales. There results show that 98 percent of the applications meet or exceeded standards, and effectiveness in protecting soil and water resources was rated at 99 percent. Almost all of the departures were rated as minor, with only less than one percent in the major category of application. There were no cases of gross neglect reported.

The results of the 2004 statewide audits were compiled from 173 practices rated on four DNRC timber sales. The data shows that 97 percent of the application practices rated met or exceeded standards. Ninety eight percent of the practices rated aimed to effectively protect soil and water resources were satisfactory. The departures reported were mostly in the minor category, with only less than one percent in the major category of effectiveness. There were no cases of gross neglect.

Implementation and effectiveness of the Montana Streamside Management Zone (SMZ) laws and rules were also evaluated during both the DNRC Internal and Statewide BMP audits. In the six-year data set of DNRC internal audits, there were 23 SMZ departures in application and two SMZ departures in effectiveness. All departures were found to be minor. The statewide audits conducted in 2002 and 2004 found no departures.

The results from the contract inspection reports, internal, and statewide BMP audits are being used to identify specific or recurring problems. The majority of the BMP departures that were noted on the DNRC timber sale inspections and on the Internal and Statewide BMP audits were associated with inadequate road surface drainage and insufficient sediment control on erodible fill slopes. Other common BMP departures noted during these audits were failure to maintain erosion control features, not stabilizing erodible soils, lack of prevention of downslope movement of sediment, and directing road drainage to the stream crossing site.

There were a few problems that were noted during the timber sale inspections that were not observed at all in the Internal or Statewide BMP audits. The most frequent of these types of problems were poor design and location of skid trails, failure to apply

seed or water bars on skid trails, and abandoned roads not in a condition to provide adequate drainage without further maintenance. It is possible these problems were observed early on and corrected before further damage was done, which would explain why the Internal and Statewide audits did not note these problems.

The BMP implementation monitoring results are used to develop topics addressed during annual BMP training sessions conducted for field staff by the DNRC hydrologists and soil scientist, and to focus specialist design needs. In those cases where BMPs have been determined to be ineffective, the DNRC hydrologists and soil scientist have modified the BMPs or designed new ones to address the problems.

Water Quality Monitoring - Stillwater and Swan River State Forests

DNRC began a monitoring water quality at selected sites on the Stillwater State Forest near Olney, Montana, in 1976 (Table W-2). Sampling sites are located in both the Whitefish Lake and Stillwater River basins. The objective of the monitoring program is to detect trends in discharge, nutrients, and sediments, to identify relationships between management activities and water quality, and to establish baseline values for comparison over time.

Table W-2. Period of Record for Water Quality Monitoring Stations on the Stillwater State Forest

STATION NAME	STATION CODE	PERIOD OF RECORD
East Fork Swift Creek	STSF01	1976-1997
West Fork Swift Creek	STSF02	1976-1997
Chicken Creek	STSF03	1976-PRESENT
Middle Swift Creek	STSF05	1980-PRESENT
Lower Swift Creek	STSF06	1976-PRESENT
Chepat Creek	STSF08	1976-PRESENT
Lower Fitzsimmons Creek	STSF09	1976-PRESENT
Lazy Creek	STSF10	1985-1997
Upper Fitzsimmons Creek	STSF11	1995-1997

In 1998, monitoring of East Fork Swift Creek, West Fork Swift Creek, Lazy Creek and Upper Fitzsimmons Creek was ceased. It was decided that a sufficient period of record had been established and the data showed little variation between years. DNRC wanted to focus their efforts on the stations that would show direct input of the parameters sampled into Whitefish Lake. DNRC's goal was to decrease the number of sites and increase the number of samples in a given year, thereby strengthening the dataset. Chepat Creek and Chicken Creek are considered to be indicative of undisturbed watersheds due to the negligible amount of timber harvest and road building within the basins.

In 2003, DNRC began monitoring in the Swan River Drainage at four locations: Goat Creek, Soup Creek, South Fork Lost Creek and Woodward Creek. These streams were monitored in the late 1970's to early 1980's. The monitoring was discontinued in 1983 because very little variation was evident in the data. DNRC plans to monitor these four stations for a three-year period to determine if any change has occurred since the earlier

monitoring was discontinued. Discharge data for the Swan River State Forests sites are not included in this report, however the nutrient and TSS data are included.

Water Yield Results: Increases in water yield from a given drainage may result from either greater precipitation or a reduction in water usage by vegetation as a result of timber harvest or fire. Precipitation levels in the Flathead Valley were below normal in 2003 and 2004. This trend is reflected in the discharge figures depicted in Figure 1. Discharge values were below pre- and post 1998 averages 2003 and in 2004.

Assuming that the drainages in the Stillwater have similar geology, water yield per unit area should be relatively constant for areas with similar snow accumulation and melt regimes. Water yield per acre figures are shown in Figure W-2. The general trend shown is that the water yield in 2003 and 2004 was near or below the pre-1998 average. The fact that this trend is seen consistently at all stations including Chicken and Chepat Creeks, which are essentially unroaded and without timber harvest, is evidence that the cause of these changes is natural.

Sediment Results: Streams naturally carry a certain sediment load. This load is determined to a large extent by the type of soil, which the stream flows through, the nature and extent of the streamside vegetation, and the amount of flow in the stream. Changes in any of these factors will change the amount of sediment available to the stream. Hydrologists look for variation in suspended sediment concentration over time to indicate changes in water quality. Phosphorus has been shown to be associated with sediment so, by monitoring the sediment levels we may also be able to draw conclusions about the nutrient loading to downstream waterbodies. In addition to carrying nutrients, fine sediment in large amounts can have detrimental effect on fish habitat and the spawning cycle of fish.

The ranges of total suspended solids (TSS) concentrations for the biennial sample period values for all the monitored streams on the Swan and Stillwater Forests are shown in Figure W-3. All sites in 2003 and 2004 showed the average maximum values below the period of record average. Soup Creek shows the highest average and maximum values on the Swan River Forest. Lower Swift Creek shows the highest average and maximum values on the Stillwater followed by Middle Swift Creek. The large sediment concentrations observed at the Lower Swift Creek station are a result of mass wasting banks occurring naturally in the lower reaches of Swift Creek. Previous reports detail the relationship between the higher suspended sediment values in Swift Creek and the presence of large volumes of erosive glacial till in the lower part of the drainage basin. Sediment values in the upper parts of the watershed remain very low.

The two higher gradient streams in the Swan Forest, Goat Creek and South Fork Lost Creek, show the best correlation between discharge and suspended sediment (r-squared 0.85; 0.88 respectively). These streams mobilize sediment in response to increased velocity and tractional force on the streambed and banks. Woodward Creek has the poorest correlation (r-squared 0.58) presumably due to the fact that it behaves more like a spring creek, with very little variation in the flow through the season. Suspended sediment and discharge in Woodward Creek do not vary much through the sampling season.

Nutrients Results: Studies of Whitefish and Flathead Lakes have concluded that increases in nutrient concentrations will stimulate increased algal productivity and should be minimized. The nutrients of concern in this system are phosphorus and nitrogen, which will be discussed in turn.

Phosphorus: It has been speculated that the primary sources of phosphate in the Stillwater River and Whitefish Lake drainages are decomposed organic matter and phosphorus compounds stored on sediments. Numerous previous studies have shown a high correlation between phosphorus concentrations and both sediment concentration and stream discharge.

One of the primary objectives of the water quality monitoring on the Stillwater State Forest is to attempt to understand the relationship between forest management activities and phosphorus concentrations being delivered to downstream waterbodies. To date this relationship continues to be poorly understood. Figure W-4 shows the values for average soluble reactive phosphorus (SRP) concentrations collected during 2003 and 2004. There appears, from this data, to be poor correlation between forest management and SRP concentrations. For example, Chicken Creek (STSF03) and Chepat Creek (STSF08), which have had very little timber harvest and road building activity show concentrations near or above those of streams where recent timber harvest and road construction have taken place.

The EPA recognizes that numerical water quality standards for phosphorus must be developed on a site-specific basis. For comparison purposes, the standard for the Clark Fork River below the confluence with the Blackfoot River is 39 ppb. No exceedance of this standard occurred in the 2003-2004 biennial period. W-5 shows range of total phosphorus (TP) concentrations through during 2003-2004. Throughout the period of record there have been numerous exceedances of this standard. The exceedance dates occurred in the spring and early summer, during high flow. These have occurred at all sampling locations, including the locations in effectively undisturbed basins.

Nitrogen: Nitrate and Nitrite values are highest in the Swan Forest. Average and maximum values are highest in South Fork Lost Creek, Goat and Soup Creek. Woodward Creek has the lowest nitrate and nitrite values in the Swan Forest (W-6). Stillwater Forest stations show very low nitrate and nitrite values with headwater streams generally below detectable levels.

Nitrate and Nitrate values do not correlate with TSS, Discharge or Phosphorus. They do vary throughout the season however. Both the Swan and Stillwater Monitoring stations show the general decrease through the season, independent of Discharge. This presumably reflects the ability of riparian plants to take up nitrates and nitrites as the growing season progresses.

Figure W-1. Annual Discharge Values for Stillwater State Forest Monitoring Stations

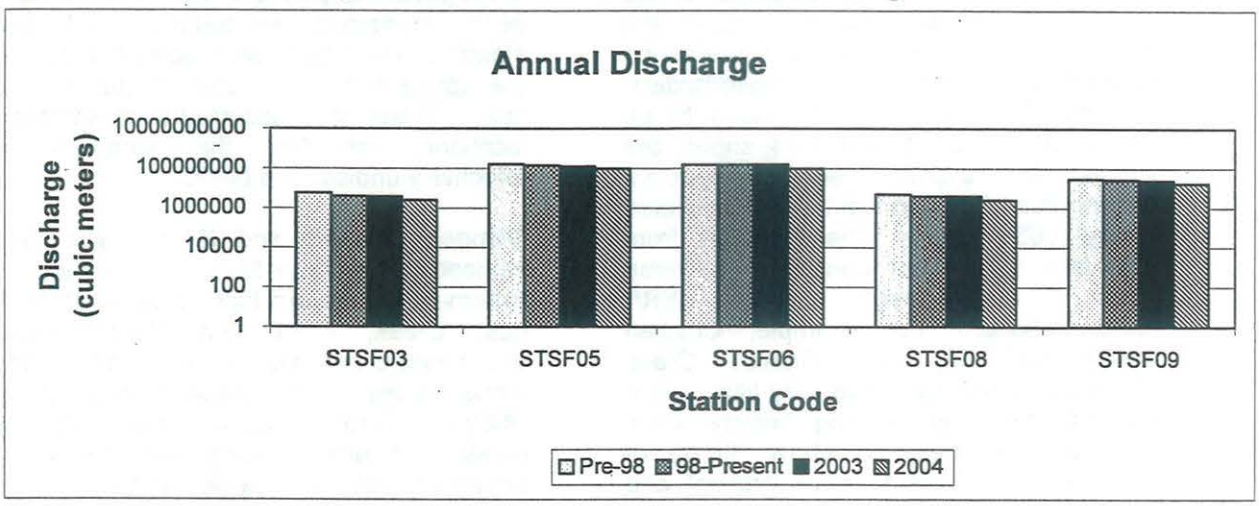


Figure W-2. Average Discharge per Acre for Stillwater Forest Monitoring Stations

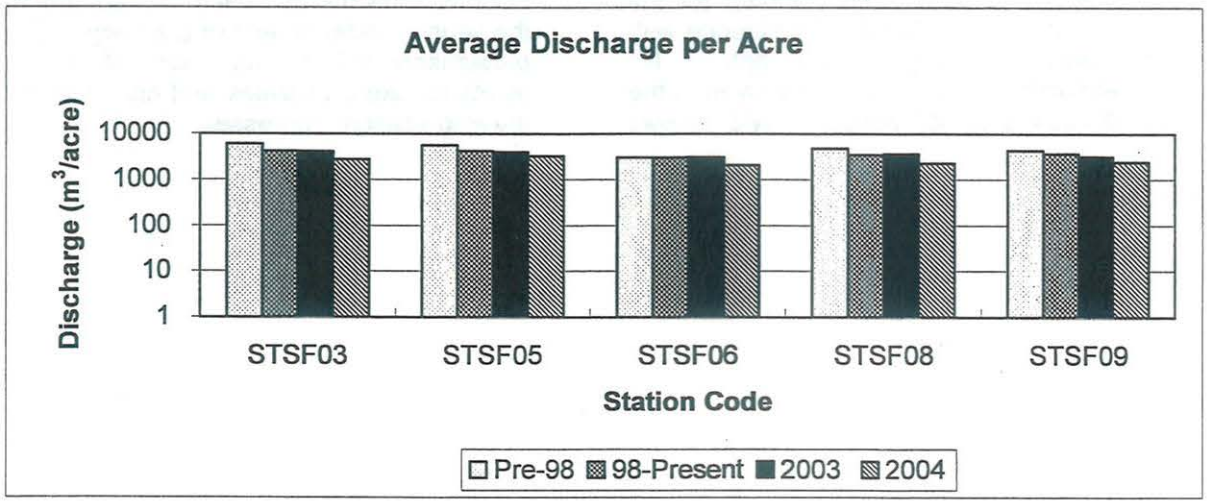


Figure W-3. Range of Total Suspended Solid Values on Monitored Streams

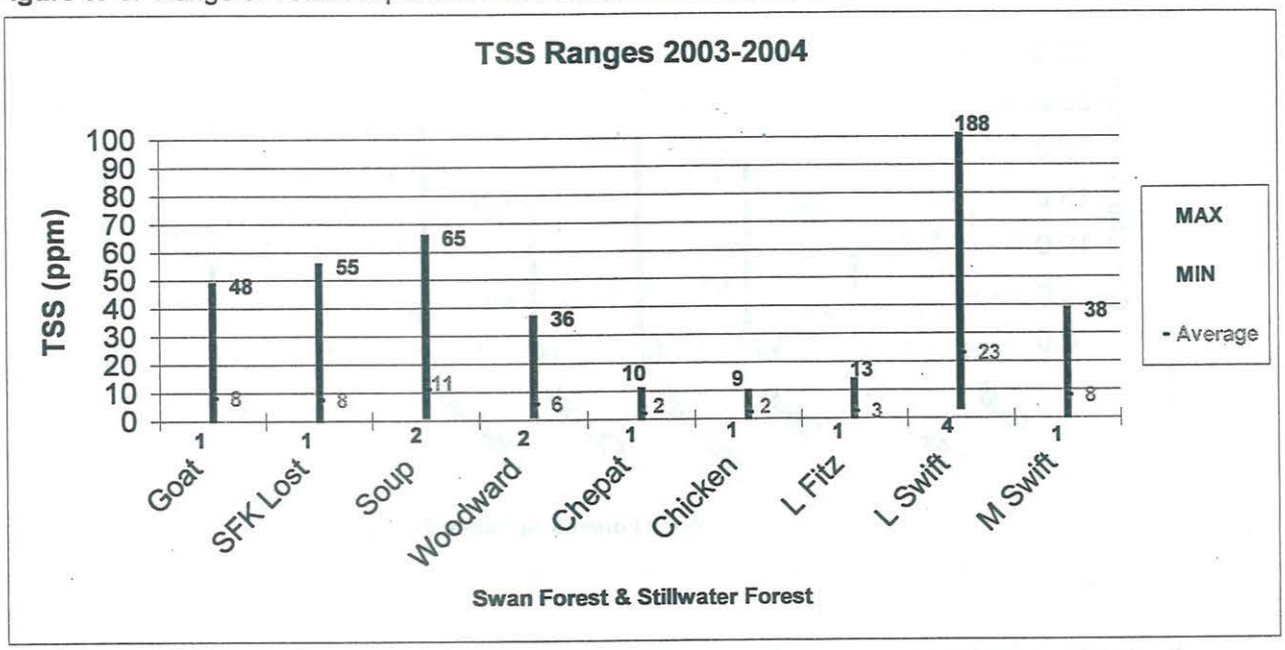


Figure W-4. Range of Soluble Phosphorus Concentrations in Monitored Streams

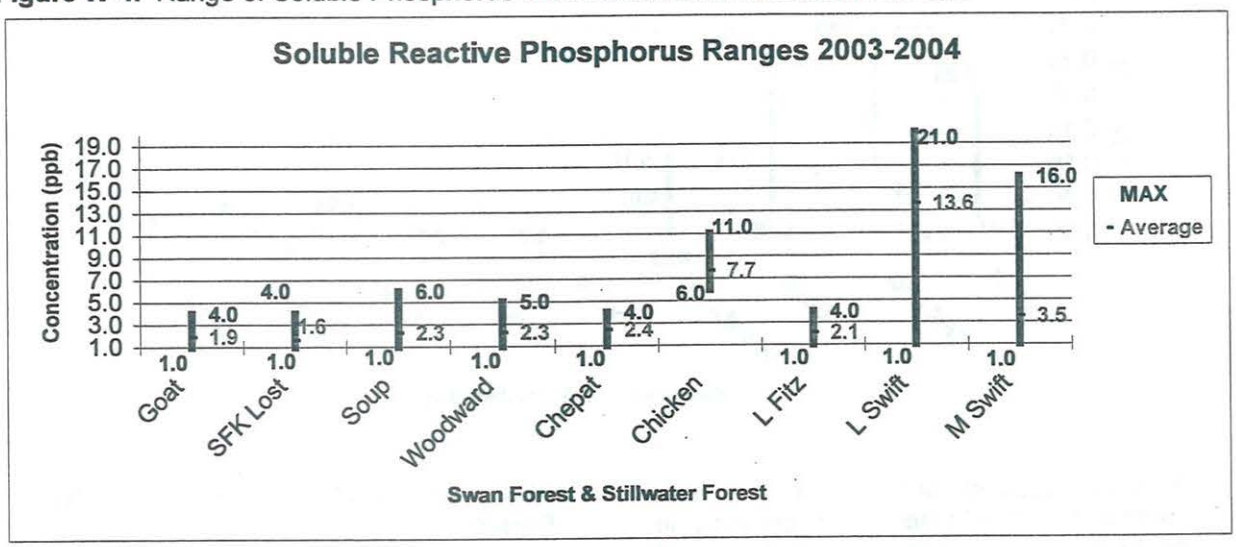


Figure W-5. Range of Total Phosphorus Concentrations in Monitored Streams

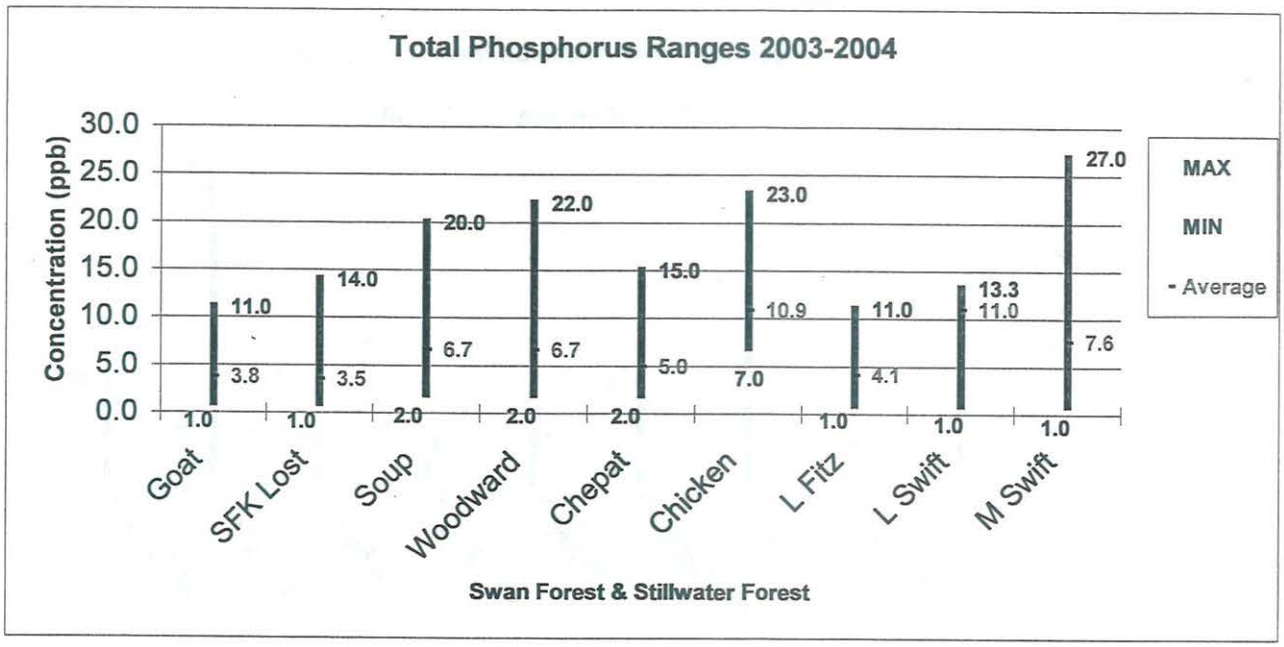
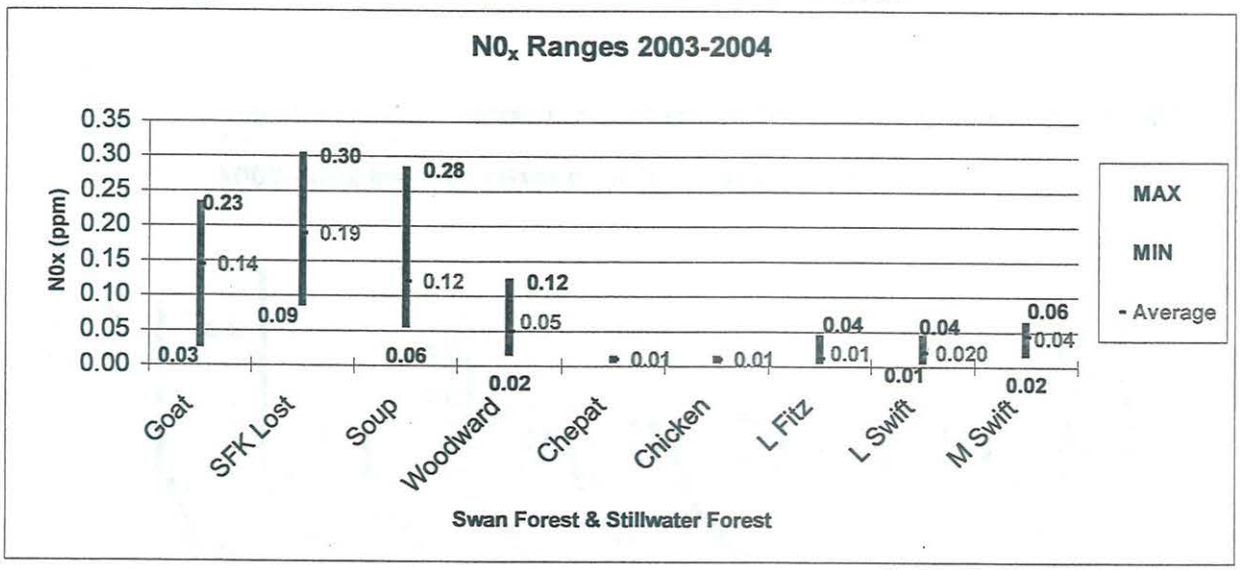


Figure W-6. Range of Total Nitrate and Nitrite Values in Monitored Streams



A more detailed analysis of the data summarized in this section is currently in progress. An updated reported entitled "Surface Water Quality of the Stillwater State Forest and Swan River State Forest (1976-2004)" will be available in the near future.

Water Quality Monitoring – Sula State Forest

A water quality monitoring project was initiated on the Sula State Forest following the wildfires of 2000. Streamflows and water quality were monitored in 2001 and 2002 on three streams during the peak runoff periods following the wildfires. Private consulting firms were contracted with DNRC to complete the streamflow measurements,

water quality sampling, analysis and reporting. The three streams that were monitored are Lyman Creek, Cameron Creek, and Praine Creek. Water quality variables that were measured in both years include: pH, total suspended sediment, soluble phosphates, total phosphates and nitrates.

In the 2001 study of Lyman Creek, the concentration of soluble and total phosphorus, as well as the total suspended sediment, far exceeded any other peak phosphate or sediment levels in the study area. It was also noted in the 2001 study that the pH and nitrate levels varied minutely, but overall remained relatively stable. In the 2002 study, nitrate concentrations could not accurately be predicted, but there appears to be a general increase of concentration with an increased flow. In addition, there is no definite correlation between the 2002 and 2001 nitrate concentrations, but it appears that concentration is lower in 2002.

In mid-May of 2001, the discharge quantities for Cameron Creek peaked. During this event, the level of total suspended sediment rose, but only a small amount. Phosphorous concentrations, both soluble and total, coincided inversely with the amount of total suspended sediment during the peak event. Even though nitrate and pH levels fluctuated throughout the study period, they remained relatively stable. In the 2002 study of Cameron Creek, the correlation between flow and nitrate concentration could not be accurately predicted, but a weak trend suggests an increase in nitrate concentration with an increased flow.

Praine Creek also experienced a peak event in mid-May of 2001. During this event, the amount of total suspended sediment spiked as well the amount of total phosphates. Nitrates and pH remained relatively static throughout the study period. In the 2002 study of Lyman Creek, a stronger correlation between the higher flows and increased nitrate concentration became apparent, yet there is no definite reduction of nitrate concentration between 2001 and 2002.

Other Site Specific Water Quality Monitoring Projects

DNRC has implemented several other site-specific monitoring projects designed to quantitatively determine the effectiveness of BMPs and other mitigation measures in reducing non-point source pollution. Several of these closely related monitoring projects are describe in the Fisheries Monitoring section of this report. The findings of the Quiet Stems Timber Sale Road Crossing Monitoring Project are summarized below:

Quiet Stems Timber Sale: This project was designed to evaluate mitigation measures used to prevent sediment delivery at several temporary road crossings of ephemeral draws. Sediment traps were installed to capture any material eroding from road fill slopes at temporary culvert installations both following installation and crossing de-commissioning. The results of this study concluded that no detectable sediment was delivered to the draw bottoms below the road crossing sites either following crossing installation or following crossing obliteration. Mitigation measures used to reduce erosion, trap sediment and buffer the draw bottom from sediment delivery were determined to be highly effective.

Soils Monitoring

DNRC and the public are concerned about maintaining long-term productivity of forest soils to sustain future forest growth and State trust revenues. Forest growth can be enhanced or reduced depending on the area and degree of soil effects associated with forest management projects.

The Forest Management Bureau currently monitors the effects of DNRC timber harvest on forest soils on approximately 5 different timber sales per year. The specific objectives of these soils monitoring projects are:

1. To assess the area and degree of harvest effects on common forest soils following timber harvest on DNRC lands.
2. To assess the levels of coarse and fine woody debris retained for nutrient cycling and seedling protection following harvest in comparison to historic ranges.

3. To determine if BMPs and recommended soil conservation practices were applied, and if so, how effective they were. For inadequate practices, recommend revised mitigation measures.
4. To determine if impact on soils fell within or exceeded those predicted in environmental assessments.
5. To recommend a soil monitoring protocol for DNRC forest management projects.

To date, soils monitoring studies have been completed on 74 timber sale projects since 1988. In December 2004, DNRC issued a report summarizing these soils monitoring studies (DNRC 2004). DNRC also completed two other specific soil monitoring studies following the 2000 wildfire and salvage operations in the Sula State Forest and the 2001 Moose Fire in the Coal Creek State Forest. The results of these studies were published in the *2001 Soil Monitoring Report for the Sula State Forest Fire Mitigation, Salvage and Recovery Project (DNRC 2001)* and the *2003 Soils Monitoring Report for the Moose Fire Salvage & Reforestation Project on the Coal Creek State Forest (DNRC 2003)*.

Methods: Soils monitoring evaluations are completed using site-specific quantitative assessments and field transects. These evaluations are used to help quantify both physical effects of harvest operations on soils and the levels of retention of woody debris for nutrient cycling and biodiversity. The results are used to assess the soil and watershed effects of harvest and provide information for improving the effectiveness of future silvicultural practices (ARM 39.11.420(9)).

Three sampling methods were used from 1988-2004 that evolved over time with changes in research and application. The general levels of survey used were: 1) Random surveys using high intensity transects; 2) Purposeful surveys using moderate intensity transects across representative areas, and 3) Skid trail mapping and spacing measurements on selected sites.

The data compiled for each site was: area of soil conditions and amounts of woody debris on site in tons/acre to compare with environmental assessments and silvicultural goals. All monitoring methods involve soil condition class surveys using ground transects (pace and line transects) to visually classify soil surface conditions and levels of disturbance into defined soil condition classes. In some cases we sub-sampled areas of concern such as short steep slopes or landings, to quantify harvest effects on these specific areas and identify more beneficial treatments.

The detrimental soil condition classes are: soil displacement, erosion, compaction, puddling and severely burned. The non-detrimental soil condition classes are undisturbed, slight disturbance and slightly burned. We tested for soil compaction by probing the undisturbed and disturbed areas of soil for resistance to probe penetration. The spots that were more difficult to probe (than undisturbed) and showed soil platiness were considered compacted. The spots that were considered compacted were then sub sampled for soil density to validate method. The choice of sampling method used for each project was based on the level of precision desired, soil sensitivity to impacts, levels of disturbance and time available. The general sampling methods and soil condition definitions followed the "Guidelines for Sampling Some Physical Conditions of Surface Soils" (Howes, Hazard and Geist 1983), with some modifications. In 2003 DNRC monitored two projects using the new protocol of Howes 2003, which classifies types of disturbances into modified categories.

On the South Wood and Chicken Werner projects, the soil transects lines zigzag across the harvest units and the soil condition class was recorded at each pace along the transect line. The sum of points in each soil condition class is then divided by the total transect points to calculate the percentage of area for each soil condition class. On these sites we also determined the pattern and distribution of soil disturbance by measuring the spacing between skid trails crossing the transect

line, and the condition of each skid trail was recorded. Measuring the skid trail spacing was in addition to Howe's method. This combined procedure is closer to answering the following questions: what is the total area of impacts, do trails have adequate drainage, what is the pattern and distribution of those impacts, what practices could be improved? Operationally it is easier to administer the level of disturbance by the pattern of skidding traffic using skid trail design and required spacing. For example, 20% soil damage may have different impacts if it is concentrated in one area, rather than being well distributed throughout a treatment area (Howes 2003).

Harvest methods should retain a historic proportion of coarse woody debris and litter, well distributed across harvest units, for nutrient cycling and seedling protection. Woody debris amounts were sampled by measuring the number and sizes of woody debris along a line transect and calculating the tons/acre of woody debris retained according to the methods of Brown 1974. The woody debris sample is located along the same line the soil condition transects. Woody debris amounts are then compared to historic range of woody debris levels estimated by Graham, et.al.1994 for common forest habitat types.

Soil Monitoring Results (Non Fire Salvage)

The results of soils monitoring completed on non-fire salvage timber harvest from 1988 to 2004 are summarized below. More detailed information can be obtained in the DNRC Compiled Soils Monitoring Report on Timber Harvest Projects (1988-2003) and the 2004 Addendum to the Soils Monitoring Report.

General Results

- Total detrimental soil impacts (Erosion, Displacement, Severe Compaction) ranged from 3 to 43.5 percent of the area of a harvest area on the 74 monitored sites.
- Soil disturbance and compaction varied by type of harvest equipment, terrain and soil types.
- 35 of the monitored sites had less than 10% of the harvest area impacted.
- 12 of the monitored sites had over 20% of the harvest are impacted
- Sites with higher impacts occurred in 1988 and 1989 just after adoption of BMPs, and harvest practices have since been revised to reduce detrimental effects.
- Where BMPs were implemented, harvest effects were reduced and soil productivity maintained.
- Soil impacts were greater where harvest methods departed from Best Management Practices (BMPs).
- Sites with the largest impacted area also occurred on fine textured soils and steep slopes with parent materials of lacustrine (Lake Missoula silts), loamy glacial tills and tertiary sediments.
- In general, soils effects observed where within the range disclosed in DNRC timber sale environmental assessments

Erosion

- Erosion observed on most "green" (not fire salvage) timber sales was minor.
- Erosion observed ranged from 0 to 3% of the harvest areas and occurred on only four of the monitored harvest sites. Erosion on these four sites occurred on skid trails and did not affect water quality.
- Erosion observed on fire salvage timber sales was low to high, but occurred on both logged and unlogged (control) sites.

Displacement

- Soil Displacement ranged from 0 to 43.5% displaced area on 74 sites.
- 50 of the 74 sites had less than 10% area of displaced soil
- 13 of the 74 sites had over 15% area of displaced soil.
- The sites with highest displacement were steep slopes over 40% and dozer-piled sites.

Soil Compaction

- Soil Compaction ranged from 0 to 56% severely compacted area on 74 sites.
- 67 sites had less than 10% severely compacted area.
- 4 sites had 19% or more severely compacted area.
- Harvest on gentle slopes on fine-textured soils generally produced the most compaction.

- Harvest in wet conditions produced greater area of severe compaction, while harvest during dry or frozen conditions reduced areas of severe compaction.
- Severe compaction most commonly occurred on sites that also showed displacement.

Slight Disturbance

- Slight Disturbance observed ranged from 0 to 59.7% disturbed area on the 74 sites monitored. Slight disturbance is shallow exposure of mineral soils, which can reduce plant competition, may improve seedling establishment, and was not considered detrimental, unless it occurred on more than a 10 ft. sq. area.
- 16 sites (21% of all 74 sites) had over 30% slight disturbed area.
- 78% of 74 sites had less than 30% slight disturbed area.
- 30-40% slightly disturbed area was a silvicultural goal for scarification to promote seral conifer species on many harvest sites.

Slight disturbance was lower on many sites than the desired goals for scarification. Higher scarification may not be needed for planting sites, but is desired for natural conifer regeneration of serial species. Silvicultural treatments should consider ways to achieve better distribution of scarification on sites where natural conifer regeneration is desired. Some already identified treatments that can achieve adequate slight disturbance (scarification) as well as protect surface soils are broadcast burning, excavator site preparation and prudent herbicide use.

Coarse and Fine Woody Debris Distribution

Harvest methods should retain a historic proportion of coarse woody debris and litter well distributed across harvest units for nutrient cycling and seedling protection. DNRC did not measure levels of coarse (>3"diameter) or fine woody debris on monitoring assessments before 2000. Since 2000, DNRC has evaluated levels of coarse and fine woody debris on 10 harvested sites and 27 fire salvage sites. Woody debris levels were within historic levels and adequate (according to Graham et al 1994) on 97% of recent sites reviewed. On several projects reviewed, the woody debris were primarily smaller diameters of 3-10 inch material and not as well distributed across all diameter classes as desired. Efforts will be made to retain a well-distributed range of size classes on current and future sales. One in-woods log processing harvest project was evaluated and all woody debris was retained on site and the slash adequately treated.

Soil Monitoring on the Sula Fire and Moose Fire Project Areas

Methods: The following results are summarized from the *2001 Soil Monitoring Report for The Sula State Forest Fire Mitigation, Salvage & Recovery Project* (105 transects) and the *2003 Soil Monitoring Report for The Moose Fire Salvage & Reforestation Project* (60 transects). The fire area monitoring project results are reported separately since fire areas are at higher risk of erosion due to loss of vegetative cover and forest floor litter that protect soils and promote water infiltration. Conservative mitigations were implemented to limit the degree and area of soil disturbance, including slope limitations for ground based harvest operations, season of use limitations and retaining woody debris to reduce erosion and sediment. Harvest operations were completed in the winter following the fires and the soil monitoring was completed the following summer, the first year after fire and harvest.

Monitoring methods on the fire areas were similar to above except for additional sampling of vegetative cover to compare with erosion observed. The soil and woody debris monitoring transects were located across representative areas of the fire project areas with a priority on severely burned sites with higher risks of impacts. The moderate and low severity burn sites are expected to have lower natural erosion rates, but were not sampled. Monitoring transects were located on both undisturbed and harvested areas for comparison of erosion and soil effects.

Results: Harvest related soil disturbance, displacement and compaction were all low on both the Sula and Moose fire project areas. Most harvest operations were

completed during the first winter after the fires. Erosion was extensive in the Sula Fire area on both unlogged and logged sites, due in part to naturally high erosion potential, granitic soils and several moderate to high intensity storms. The extent of erosion on the Sula logged sites was slightly higher than on some unlogged sites but the amounts of erosion overlapped. It is unclear why some of the 0-20% slopes had the highest erosion rates, possible due to hydrophobic soils and raindrop impact. The percentage of vegetative ground cover was low (<20%) on most of the severe burned sites and did not appear to reduce erosion until there was about 30% ground cover. On the Sula fire area, emergency fire rehabilitation measures were implemented on severely burned sites along segments of streams with steep slopes and high erosion risk soils to reduce erosion and protect sensitive watershed areas and fisheries. The Sula rehab sites that were grass seeded had highest ground cover and combined with log erosion barriers and other mitigations had the lowest erosion of all sites.

The Moose Fire logged sites had lower erosion than unlogged sites, but amounts were low overall in part due to no intense storms. Woody Debris levels were 2-3 times higher on logged sites versus the unlogged sites on both fire project areas. On harvested areas at least 2 trees per acre were felled and placed perpendicular to the slope gradient to help disperse surface runoff, reduce erosion and trap sediment.

Conclusions: In general, BMPs and mitigation measures used to minimize detrimental soil impacts were effective in protecting soil resources and controlling erosion and sedimentation. As a recommended goal, if existing detrimental soil effects exceed 15% of an area, then the proposed harvest should minimize additional impacts. Harvest proposals on areas with existing soil impacts in excess of 20% should avoid any additional impacts and should be evaluated to include restoration treatments as feasible. DNRC should look at degree of impacts, expected effectiveness and cost of treatment, and equipment availability in order to prioritize which sites to rehabilitate. Allowing damaged areas to recover on their own may also be an acceptable alternative in some cases.

General Recommendations:
Future timber harvest should continue to focus on limiting the area and degree of detrimental soil impacts by implementing BMPs, site-specific mitigations and innovative technologies to control soil and water effects. On sensitive sites, the rationale for the selection of harvest methods or contract modifications should be documented. DNRC should avoid ground-based operations on slopes over 40% unless those activities are not causing excessive impacts.

Continue to retain a proportion of fine litter (slash) and coarse woody debris on all harvest sites to return nutrients to the ground for future plant growth. Maintaining adequate levels of coarse woody debris and slash on-site for nutrient cycling may be a challenge when attempting to balance hazard reduction (slash treatment) requirements and improved wood harvest and utilization methods.

Emergency fire rehabilitation should continue to be considered on a watershed and site-specific basis with the highest priority review sites that are severely burned sites and are at high risk of water quality impacts. Monitoring results have shown that where rehabilitation is needed the selected measures must be promptly implemented to be effective in controlling erosion.

Past management on non-fire salvage sites may have caused excessive impacts prior to BMP implementation. As part of project design, consider rehabilitation measures for areas of excessive historic impacts and BMP departures, based on site review for feasibility and desired future conditions. Examples of ways to rehabilitate and restore soils include:

- Installing adequate drainage features.
- Redistributing slash, coarse woody debris.
- Ripping impacted soils, to 8-10 inches to restore hydrologic function and promote rooting.
- Reshaping temporary or excessive skid trails and redistributing topsoils as available.

- Planting conifers and revegetation as needed.

The emphasis of rehabilitation measures should be to restore forest growth potential and hydrologic function by prescribing restoration treatments on sites that have excessive impacts, and can be completed concurrent with proposed harvest.

Sale administrators should continue to monitor on-going harvest activities to meet contract requirements, silvicultural objectives and BMPs. Soil resource specialists should continue quantitative soil monitoring on representative timber sales, based on activity and soil related issues. It is useful to evaluate the extent of site preparation for scarification goals and restoration methods such as excavator piling, and to revisit selected monitored sites to assess how well trees are reestablishing and trails revegetating. The monitoring goal is one restoration project in the year. Future monitoring should employ a combination of techniques based on management issues, soils and site conditions that are in question, with an emphasis on cost-effective harvest options.

FISHERIES MONITORING

The State Forest Land Management Plan (SFLMP) established general goals for fisheries management, and these goals are implemented through application of forest management administrative rules for fisheries (ARM 36.11.427). These goals include:

- ***Protect fisheries habitat by maintaining fish passage through road-stream crossing structures, maintaining adequate levels of large woody debris in streams, maintaining adequate levels of stream shading, implementing Forestry Best Management Practices, complying with the Montana Streamside Management law, complying with the Montana Stream Preservation Act, and complying with other applicable regulations.***

- ***Implement interagency recommendations for fisheries management, such as the Flathead Basin Cooperative Study and the Governor's Bull Trout Restoration Team.***

Implementation and monitoring of the Fisheries standards is accomplished through contract administration, compliance with the Watershed and Grazing standards (see WATERSHED MONITORING and GRAZING ON CLASSIFIED FOREST LANDS MONITORING), and fisheries monitoring as prescribed in the "Flathead Basin Forest Practices and Fisheries Cooperative Program Final Report, Recommendation #17."

Fisheries Monitoring on the Swan River, Stillwater, and Coal Creek State Forests

In August 1998 the Flathead Basin Commission sponsored a study to address questions regarding potential impairment of water quality and fisheries from the past and present forest management in the Flathead Basin. The fisheries study module was completed in 1991, and showed direct linkages between measure of on-the-ground activity, fish habitat parameters, and fish populations. These results formed the basis for a monitoring agreement between the DNRC and the MFWP on July 1, 1992. Results from FY01 to FY05 are summarized here. (Earlier results and a description of monitoring methods are reported in MFWP 1997 and SFLMP Monitoring Report, FY97 to FY00).

The following parameters were selected for monitoring: substrate scores and streambed core samples within spawning gravels, redd counts, and fish species composition.

Methods: The substrate score is an overall assessment of streambed surface conditions. Particle size and the percentage of fine materials filling the interstitial spaces (embeddedness) at the streambed surface were visually assessed. Low substrate scores occur with smaller streambed particles and greater embeddedness. Substrate scores are an indicator of bull trout rearing habitat quality. McNeil coring is a measurement of the size range of materials within the streambed gravels (McNeil and Ahnell 1964). McNeil core results are indicative of bull trout and westslope cutthroat trout spawning habitat quality.

Bull trout rearing habitat may be "threatened" when substrate scores are below 10 and may be "impaired" when substrate scores are below 9. Bull trout and westslope cutthroat trout spawning habitat may be "threatened" or "impaired" when McNeil core results (percentage of fine particles) are greater than 35% or 40%, respectively.

Fish species composition was collected to establish species presence information for streams where this information was lacking. Counts of spawning redds were conducted in streams where spawning by bull trout and

westslope cutthroat trout is known or suspected.

Results: Since 1996, bull trout and westslope cutthroat trout spawning habitat conditions have been monitored in streams throughout the Swan River, Stillwater, and Coal Creek State Forests. Results from FY01 to FY05 are described in Tables F-1 and F-2. Streambed habitat conditions for bull trout rearing were within acceptable limits, except in the Squeezer Creek, Soup Creek (FY05 only), and Woodward Creek drainages. Squeezer Creek, Soup Creek, and Woodward Creek drainages exhibited substrate scores between 9 and 10, which indicates a "threatened" status. McNeil core samples were within acceptable limits, except in Cyclone Creek (FY01 and FY02 only), Meadow Creek, and Soup Creek. Cyclone Creek, Meadow Creek, and Soup Creek drainages exhibited results greater than or equal to 35%, which indicates a "threatened" status. Meadow Creek exhibited a result of 43.2% in 2004, which indicates an "impaired" status.

Bull trout and westslope cutthroat trout redd counts, which are one measure of the species' population status are shown in Tables F-3 and F-4. There is insufficient redd count data from FY01 to FY05 to estimate population trends.

Species composition surveys through electrofishing were conducted on Cilly Creek (2004), Upper Soup Creek (2004), and an unnamed tributary to Soup Creek (2005). Neither bull trout nor westslope cutthroat were found in any of the three creeks. Fish presence has been visually verified on many other unnamed tributaries throughout the forested state trust lands, and DNRC will be working with Fish, Wildlife and Parks and the Forest Service in the near future in order to capture detailed species composition data in those streams.

Substrate score data indicates a lower level of bull trout rearing habitat in Squeezer Creek, Soup Creek, and Woodward Creek, and McNeil core results indicate a lower level of bull trout and westslope cutthroat trout spawning habitat in Cyclone Creek, Meadow Creek, and Soup Creek. All of these drainages should be included in future monitoring activities, as the habitat measures need to be further analyzed for long-term trends relative to potential cause and effect relationships. In other words, data remains to be collected in order to determine if the habitat measures are representative of DNRC forest management activities, other activities, or the historic range of conditions. The data found in Tables F-1 through F-4, in conjunction with past and future information, will be instrumental in interagency cooperative efforts to track long-term bull trout and westslope cutthroat trout habitat population trends.

Table F-1. Substrate scores (FY01 - FY05) from the Swan River, Stillwater, and Coal Creek State Forests.

		Substrate score				
State Forest	**Stream**	**FY01**	**FY02**	**FY03**	**FY04**	**FY05**
Coal Creek	Cyclone	11.4	11.6	11.1	10.7	10.3
Stillwater	Swift	ND	ND	11.0	11.4	12.0
Stillwater	West Swift	11.6	11.9	12.1	12.0	11.4
Stillwater	Lower Stillwater	12.3	12.4	12.2	12.6	ND
Stillwater	Upper Stillwater	11.4	11.2	11.3	11.4	ND
Swan	Sqeezer	ND	9.5	9.1	9.0	9.4
Swan	Goat	ND	11.7	11.5	11.3	11.6
Swan	Soup	10.4	10.7	10.3	10.4	9.8
Swan	South Lost	11.5	11.6	11.1	11.8	11.9
Swan	South Woodward	9.9	9.3	9.0	9.0	9.1

Table F-2. McNeil core results (FY01 - FY05) from the Swan River, Stillwater, and Coal Creek State Forests.

		McNeil core result (%)				
State Forest	**Stream**	**FY01**	**FY02**	**FY03**	**FY04**	**FY05**
Coal Creek	Cyclone	35.2	35.2	33.9	34.7	in lab
Stillwater	Moose	ND	31.7	31.4	32.1	in lab
Stillwater	Meadow	38.1	39.6	39.7	43.2	in lab
Stillwater	Hornet	34.0	ND	ND	ND	ND
Stillwater	West Swift	33.7	33.4	31.0	32.2	in lab
Stillwater	Lower Stillwater	30.2	ND	ND	ND	ND
Stillwater	Upper Stillwater	23.9	ND	ND	ND	ND
Swan	Sqeezer	ND	24.2	23.6	25.0	in lab
Swan	Goat	ND	26.9	24.8	26.6	in lab
Swan	Soup	36.9	37.2	38.0	38.0	in lab
Swan	South Lost	30.4	29.6	30.1	30.1	in lab
Swan	South Woodward	28.7	27.8	25.1	24.9	in lab

Table F-3. Bull trout redd counts (FY01-FY05) from the Swan River, Stillwater, and Coal Creek State Forests.

		Redd count				
State Forest	**Stream**	**FY01**	**FY02**	**FY03**	**FY04**	**FY05**
Coal Creek	Cyclone	0	0	0	3	0
Stillwater	Swift	5	4	4	4	4
Stillwater	West Swift	5	2	1	2	3
Swan	Sqeezer	ND	114	122	85	94
Swan	Goat	ND	91	54	80	67
Swan	Soup	12	5	ND	2	3
Swan	South Lost	12	14	ND	27	10
Swan	South Woodward	76	55	54	116	ND

Table F-4. Westslope cutthroat trout redd counts (FY01-FY05) from the Swan River, Stillwater, and Coal Creek State Forests.

		Redd count				
State Forest	**Stream**	**FY01**	**FY02**	**FY03**	**FY04**	**FY05**
Coal Creek	Cyclone	19	10	20	16	17
Stillwater	Meadow	ND	4	3	11	9
Stillwater	Hornet	ND	6	ND	ND	ND
Stillwater	Moose	ND	36	30	ND	ND
Stillwater	West Swift	0	0	0	ND	ND
Swan	Soup	17	ND	ND	3	9
Swan	South Lost	16	ND	ND	18	13

R1/R4 Fish Habitat Inventories

The R1/R4 Fish Habitat Standard Inventory (Overton et al 1997) is a widely used protocol for describing existing conditions and temporal changes in the different stream habitats used by bull trout, westslope cutthroat trout, and other native fisheries. The variable amounts of slow and fast fish habitats, large woody debris frequency and volume, sediment class abundance, and streambank stability are some of the important variables assessed during the inventories.

Ten streams were surveyed between FY01 and FY05: South Fork Lost Creek (26,034 feet surveyed), Soup Creek (39,293 feet surveyed), Upper Soup Creek (15,385 feet surveyed), Woodward Creek (18,487 feet surveyed), South Fork Woodward Creek (23,483 feet surveyed), Cedar Creek (33,540 feet surveyed), Stillwater River (63,906 feet surveyed), Fitzsimmons Creek (32,055 feet surveyed), East Fork Swift Creek (35,428 feet surveyed), and West Fork Swift Creek (36, 891 feet surveyed).

The data obtained from the R1/R4 inventories is primarily from known bull trout and westslope cutthroat streams, and this information has been used in the analyses of existing conditions for various DNRC environmental assessments. For example, inventory data from West Fork Swift Creek, South Fork Lost Creek, Soup Creek, and Upper Soup Creek has been applied as integral components of fisheries analyses within the West Fork and Three Creeks Timber Sales. Large woody debris data from all of the stream inventories has been critical in the development of aquatic conservation strategy analysis for the proposed Habitat Conservation Plan for Forested State Trust Lands. The data will also be used in the future to monitor habitat and large woody debris trends, and therefore, the accuracy of past and present environmental analyses of potential impacts to bull trout and westslope cutthroat habitat.

Fish Passage Assessment Project

The DNRC Fish Passage Assessment Project was initiated in June 2003, and the project area includes forested state trust lands providing known and potential habitat for native salmonids; specifically bull trout, westslope cutthroat trout, Columbia redband trout, Yellowstone cutthroat trout, and fluvial arctic grayling. The focus of the project is the creation of an efficient mechanism to address issues of connectivity in native salmonid habitats. Connectivity is the capability of adult and juvenile fish to move among accessible habitats within normally occupied stream segments. For example, a culvert or dam may reduce connectivity by preventing upstream or downstream migration.

There are four main objectives of the Fish Passage Assessment Project: (1) create a GIS database of every road crossing that intersects known or potential native fisheries habitat on state trust lands, (2) either conduct a technical survey of those road-stream crossing sites where native salmonid connectivity may be affected or compile existing information from sites where connectivity is not affected, (3) using technical survey data, conduct a detailed analysis of native salmonid passage at road-stream crossing sites where connectivity

may be affected, and (4) develop a prioritization schedule, which focuses on the need to provide native fisheries connectivity at road-stream crossings and the maintenance status of those sites.

Objective 1 has been accomplished and a comprehensive GIS database has been created. This database indicates that there are approximately 806 road crossing sites on state trust lands that intersect known and potential native fisheries habitat. For objective 2, 470 of the 806 inventoried road-stream crossing sites were found to intersect known and potential native salmonid habitat. 277 out of the 470 road-stream crossing sites were candidates for technical surveys since those sites may affect native salmonid connectivity and DNRC may have jurisdiction and control of the road. To date, 264 (95.3%) of the 277 technical surveys have been completed. 193 out of the 470 road-stream crossing sites (not included in the technical surveys) were determined to either not affect native salmonid connectivity or were found to be sites where DNRC does not have jurisdiction and control of the road. For objective 3, 147 out of 264 road-stream crossing sites were determined to not affect native salmonid connectivity, are other sites where DNRC does not have jurisdiction and control of the road, or involve stream reaches that do not provide native salmonid habitat. The 117 road-stream crossings sites that were analyzed primarily include culverts, concrete pipes and boxes, and polyethelene pipes. Through the detailed analysis, 14 of the 117 road-stream crossing sites were determined to provide passage to all life stages of native salmonids. Therefore, at this time 103 road-stream crossing sites on state trust lands have been determined to limit connectivity to one or more native salmonid life stages. A first version of a prioritization schedule (Objective 4) of sites where native salmonid connectivity is limited was consequently developed during the spring of 2005. Within the prioritization schedule, future road-stream maintenance is rated by species sensitivity and existing levels of connectivity.

Stream Temperature Monitoring

DNRC stream temperature monitoring began in June of 2001 and continues today. The temperature monitoring includes 18 streams on state trust lands: the mainstem and North Fork reaches of Blanchard Creek, Dingley Creek, Chepat Creek, Chicken Creek, East and West Fork Swift Creeks, Middle Swift Creek, Fitzsimmons Creek, Praine Creek, North Fork Cameron Creek, Lyman Creek, Soup Creek, Goat Creek, South Fork Lost Creek, Cilly Creek, Squeezer Creek, and Woodward Creek. The three objectives of this monitoring are: (1) to examine the change in stream temperature before and after timber harvest in order to validate the analyses of DNRC environmental assessments, (2) monitor stream and riparian recovery after the construction a cattle exclosure, (3) observe stream and riparian recovery after a major fire event (Sula SF) (see Table F-5), and (4) establish baseline stream temperature conditions for select reference stream reaches (see Table F-6).

Temperature data loggers are installed in deep, shaded pools, to minimize the risk of dewatering and to negate any increase in temperature due to solar radiation. Temperature data loggers are installed in the same stream locations during successive surveys. Two or more data loggers are typically deployed per stream in order to capture information of the rate of change in stream temperature through a study reach. The stream temperature monitoring effort includes 93 data sets through 2004, however information accurately describing the range of stream temperature conditions at the 18 stream reaches is not yet available. Preliminary data describing the range of stream temperature conditions through the study reaches will begin to be available within two years.

Table F-5. Stream temperature results from Sula SF (FY01-FY05).

SULA SF - Stream Temperature Site Name	7-Day Averages			Days >	Days >	Days >
	Maximum (degrees C)	Minimum (degrees C)	Δ T	10.0 C	15.0 C	21.1 C
Lyman Cr (Lower Site) - 2001	19.4	12.7	6.7	87	58	0
Lyman Cr (Lower Site) - 2002	20.7	14.0	6.7	75	40	3
Lyman Cr (Lower Site) - 2003	21.3	13.9	7.4	82	62	7
Lyman Cr (Lower Site) - 2004	21.0	14.5	6.5	104	69	4
Lyman Cr (Middle Site) - 2001	22.6	10.5	12.1	89	68	14
Lyman Cr (Middle Site) - 2002	21.5	12.5	9.0	76	47	6
Lyman Cr (Middle Site) - 2003	22.3	13.4	8.9	88	62	12
Lyman Cr (Middle Site) - 2004	21.3	13.4	7.9	107	70	7
Lyman Cr (Upper Site) - 2001	19.9	12.1	7.8	87	59	0
Lyman Cr (Upper Site) - 2002	20.2	12.9	7.3	77	46	2
Lyman Cr (Upper Site) - 2003	22.1	13.0	9.1	92	62	13
Lyman Cr (Upper Site) - 2004	20.0	13.2	6.8	103	67	3
N Fk Cameron Cr (Lower Site) - 2001	18.9	11.7	7.2	86	54	0
N Fk Cameron Cr (Lower Site) - 2002	19.8	13.4	6.4	86	43	0
N Fk Cameron Cr (Lower Site) - 2003	20.8	12.9	7.9	83	60	2
N Fk Cameron Cr (Lower Site) - 2004	19.7	13.5	6.2	103	61	1
N Fk Cameron Cr (Middle Site) - 2001	17.3	12.3	5.0	87	50	0
N Fk Cameron Cr (Middle Site) - 2002	17.8	13.0	4.7	83	32	0
N Fk Cameron Cr (Middle Site) - 2003	19.0	12.7	6.3	78	54	0
N Fk Cameron Cr (Middle Site) - 2004	18.0	13.2	4.8	97	53	0
N Fk Cameron Cr (Upper Site) - 2001	17.1	11.4	5.7	87	48	0
N Fk Cameron Cr (Upper Site) - 2002	17.0	11.8	5.2	86	26	0
N Fk Cameron Cr (Upper Site) - 2003	18.3	11.8	6.5	68	46	0
N Fk Cameron Cr (Upper Site) - 2004	16.8	12.1	4.7	98	40	0
Praine Cr (Lower Site) - 2001	19.2	11.6	7.6	87	57	0
Praine Cr (Lower Site) - 2002	19.3	11.2	8.1	80	48	0
Praine Cr (Lower Site) - 2003	21.9	12.4	9.5	99	63	17
Praine Cr (Lower Site) - 2004	21.0	11.8	9.2	107	78	11
Praine Cr (Middle Site) - 2001	17.7	10.4	7.3	88	51	0
Praine Cr (Middle Site) - 2002	16.3	10.6	5.7	75	19	0
Praine Cr (Middle Site) - 2003	18.3	11.1	7.2	88	60	0
Praine Cr (Middle Site) - 2004	17.6	10.7	6.9	104	53	0
Praine Cr (Upper Site) - 2001	15.4	9.3	6.2	85	15	0
Praine Cr (Upper Site) - 2002	14.1	9.4	4.7	69	0	0
Praine Cr (Upper Site) - 2003	15.0	9.7	5.3	87	9	0
Praine Cr (Upper Site) - 2004	14.8	8.9	5.9	93	3	0

Table F-6. Stream temperature results from Chepat Creek and Chicken Creek; reference reaches (FY01).

Stillwater SF - Stream Temperature Site Name	7-Day Averages			Days >	Days >	Days >
	Maximum (degrees C)	Minimum (degrees C)	Δ T	10.0 C	15.0 C	21.1 C
Chepat Cr (Lower Reach) - 2001	11.6	9.4	2.1	25	0	0
Chepat Cr (Upper Reach) - 2001	11.6	9.1	2.5	26	0	0
Chicken Cr (Lower Reach) - 2001	9.9	7.8	2.1	6	0	0
Chicken Cr (Upper Reach) - 2001	10.0	7.9	2.0	2	0	0

Analysis of Riparian Function Pre- and Post- Timber Harvest

Four separate studies have been initiated to quantify riparian function pre- and post-riparian timber harvest along bull trout and westslope cutthroat trout streams. The goal of these studies is to test the analyses of environmental risk to fisheries habitat associated with adjacent timber harvest. More specifically, the studies will be used to verify the accuracy of environmental risk assessments (e.g. low or high risk of an adverse impact to a fisheries habitat resource as a result of an action alternative) and ensure that project level decision makers continue to have the best information available for making informed decisions.

The four studies currently underway include potential riparian harvest areas along Dingley Creek, South Fork Lost Creek, Cilly Creek, and Soup Creek. Data collected for the analyses include large woody debris frequency and volume, recruitable large woody debris as measured by riparian trees per acre and basal area, angular canopy density (stream shading during critical months), and change in stream temperature through the project area. The primary study hypotheses are: (1) the riparian harvest prescriptions will maintain adequate levels of in-stream and recruitable large woody debris, (2) the riparian harvest prescriptions will maintain adequate levels of stream shading, and (3) the riparian harvest prescriptions will not adversely affect adjacent stream temperatures. These are ongoing studies, and therefore data addressing the study hypotheses is not yet available.

Blanchard Creek Monitoring Project

In 1995, portions along Blanchard Creek and North Fork Blanchard Creek were identified as extremely degraded. Both drainages have historically supported bull trout, westslope cutthroat trout, and other native cold-water fisheries. At these site approximately 50 to 60% of the stream banks were severely eroded with up to 5-foot vertical banks in places. The riparian vegetation was noted to be in a seriously deteriorated condition, and historic livestock grazing was noted as the primary cause of streambank instability and poor fisheries habitat conditions. In 1996, DNRC Trust Lands Management Division proposed a restoration project along approximately 10,000 feet of stream, which included plans to construct an upper livestock exclosure on approximately 3,600 feet of North Fork Blanchard Creek. Minor bank reshaping along vertical slumps and riparian shrub planting was also planned to help increase streambank stability and accelerate recovery on North Fork Blanchard Creek. A lower livestock exclosure would also be built on approximately 6,000 feet of Blanchard Creek. Permanent monitoring sites were created to observe changes in the channel over time. Temperature loggers were also installed to monitor the riparian recovery after installation of the cattle exclosures. The objectives of this project are to improve channel stability, native fish habitat, water quality, and riparian vegetation.

The project consists of upper and lower cattle exclosures, which include approximately 10,000 feet of stream channel. A short, unfenced area in the upper exclosure was maintained for public access. Overhanging banks within the upper

exclosure were laid back to a stable angle with a backhoe. Following excavation, coconut fabric and native grass seed was applied to the exposed banks to help with bank stabilization. The upper exclosure was completed and functional in 1997. The lower exclosure was completed in 2003 and made function in 2004. Permanent monitoring sites were established in both the upper and lower exclosure areas and have since been monitored during the 1997, 1998, 1999 and 2003. In 2004, stream temperature loggers were also deployed throughout the exclosures in order to begin capturing information for the analysis of trends in stream temperature recovery.

Preliminary results from the permanent monitoring stations on both creeks indicate the frequency of slow habitat features for fisheries are increasing and stream width to depth ratios are slightly decreasing. (Between 1997 and 2003, 62% of the permanent monitoring stations showed decreasing width to depth ratios, which may indicate a greater quantity of slow fish habitat and a mechanism for reduced stream temperatures.) Visual assessments of both creeks indicate streambank stability is increasing, sediment budgets appear to be stabilizing, and recruitable large and small woody debris is increasing. Overall, monitoring indicates there is positive trend toward accomplishing the objectives of this project.

Looking forward to FY06 through FY10

Substrate score, McNeil core, and bull trout and westslope cutthroat redd count surveys will continue throughout the different project areas of the Swan River, Stillwater, and Coal Creek State Forests. These specific efforts will be one part of DNRC's programmatic fisheries commitment to participate in interagency cooperative efforts, such as those outlined in the Flathead Basin Commission recommendations and Montana Restoration Plan for Bull Trout.

Native fish species presence and composition surveys will also continue to take place in all areas throughout forested state trust lands. Through the Fish Passage Assessment Project, a prioritization schedule will help watershed specialists identify road-stream crossings that need improved fisheries connectivity. These efforts will also efficiently move DNRC towards meeting fisheries resource objectives for identifying previously unknown bull trout and westslope cutthroat trout habitat and providing fish passage.

New R1/R4 fish habitat inventories are scheduled for streams such as Coal Creek (mainstem, North Fork, and South Fork), Herrig Creek, Stryker Creek, Chicken Creek, Antice Creek, and Whitetail Creek. Other previously inventoried streams may be resurveyed in order to begin analyzing temporal trends in fish habitats and large woody debris on state trust lands. Stream temperatures data will also continue to be collected in order to build a database of the range of stream temperatures that occur throughout forest state trust lands. Currently ongoing and additional studies involving the pre- and post- timber harvest analysis of riparian function will provide DNRC with the site-specific information needed to support the long-term stewardship of high quality fisheries habitat resources while enabling the department to meet its fiduciary responsibilities.

THREATENED, ENDANGERED, SENSITIVE SPECIES AND BIG GAME MONITORING

The State Forest Land Management Plan and Rules established several standards and general goals for management of threatened, endangered and sensitive species and big game. These included:

- ***participate in recovery of threatened and endangered plant and animal species, including interagency working groups;***
- ***support populations and habitat needs of sensitive species on state land;***
- ***promote a diversity of stand structures and landscape patterns to provide good habitat for wildlife populations, and manage for big game habitat to the extent possible.***

Monitoring standards were also established. These included:

- ***monitor compliance with (mitigation for wildlife species) requirements indicated in project environmental documents;***
- ***participate in annual interagency monitoring of bald eagles and grizzly bears;***
- ***track the health of forest ecosystems through the Biodiversity monitoring standards, as an indicator of the health of wildlife populations. (Refer to* BIODIVERSITY MONITORING.*)***

DNRC Participation in Wildlife Working Groups

During the monitoring period from 2001 to 2005 (2005 partial year), DNRC biologists participated on the following interagency committees and working groups: the Grizzly Bear Northern Continental Divide Ecosystem Subcommittee, the Swan Valley Grizzly Bear Conservation Agreement Technical Monitoring Team, Level 1 Biologists Team, the Bald Eagle Working Group, Public Lands Linkage Task Force, Living with Wildlife Working Group, the Blackfoot Challenge Wildlife Committee, and the Montana Common Loon Working Group.

Bald Eagle Monitoring

As a part of DNRC's commitment to participate in recovery efforts of Federally listed threatened and endangered species, DNRC is a participant in Montana Bald Eagle Working Group monitoring efforts and assists with the identification and location of new nests (T&E Species RMS 1, 2, and 4). The Working Group is comprised of interagency members and coordinates state-wide surveys to ensure coverage. Methods and reporting forms are standardized in accordance with the Bald Eagle Management Plan (Montana Bald Eagle Working Group 1994).

DNRC Area Biologists monitored approximately 4 nests annually as a part of this effort during the monitoring period. In 2005, DNRC also conducted two aerial surveys of nest sites in addition to ground surveys to assess production and chick survival, and look for new nests. In April 2005 DNRC located 1 new nest and territory on the Swan River State Forest. A total of 2 new nests were located by DNRC personnel during the monitoring period [Smith Lake (2000) and Van Lake (2005)]. Cooperative efforts were also undertaken with USFS personnel to locate a nest along the Stillwater River. The precise location of this nest has not yet been determined at the time of this writing. All results were submitted to the DFWP bald eagle monitoring coordinator for the Bald Eagle Working Group.

Bald Eagle Working Group Monitoring

Results: DNRC biologists conducted nest surveys for 5 nest territories in 2001 to 2005 (Table T-1). Across all ownerships in Montana, the Bald Eagle population has increased from approximately 12 nesting pairs in 1978 to over 300 territories in 2002.

The population still appears to be increasing with about 10-15 new nests found each year. In 2003, work group participants monitored 303 out of 331 known bald eagle territories in Montana. Participants documented 357 young fledged. In 2003 average production for the state was very good, with nesting success for active nests at about 78.7%. In 2004, work group participants monitored 344 out of 358 known bald eagle territories in Montana. Participants documented 405 young fledged. Latest results from 2004 indicate that the nesting population continues to increase and average production for the state was excellent, with nesting success for active nests at about 80.2%. Tracking of active territories and nests has been getting more difficult each year, due to the relatively high numbers of eagles and nests.

Table T-1. DNRC Bald Eagle Nest Surveys, FY 2001-2005

Territory Name	Year Surveyed	Successful/ Unsuccessful	Number of Juveniles Fledged	Comments
Cyclone Lake	2001	Unknown	Unknown	2 Osprey
Cyclone Lake	2002	Unknown	Unknown	No eagles/nest detected
Cyclone Lake	2003	Successful	Unknown	1 immature detected
Cyclone Lake	2004	Successful	Unknown	Total of 5 eagles on lake in May (3 adults; 2 imm.)
Cyclone Lake	2005	Successful	1	
Upper Whitefish Lake	2001	Successful	Successful	
Upper Whitefish Lake	2002	Successful	Unknown	
Upper Whitefish Lake	2003	Unknown	Unknown	Re-growth of harvest units precluded detection without aerial surveys
Upper Whitefish Lake	2004	Unknown	Unknown	Vegetation management needed
Upper Whitefish Lake	2005	Unknown	Unknown	Nest in poor condition; vegetation management didn't resolve viewing difficulties
Whitefish Lake/Smith Lake	2001	Successful	Unknown	
Whitefish Lake/Smith Lake	2002	Unknown	Unknown	
Whitefish Lake/Smith Lake	2003	Nest on State not used	Unknown	Eagles detected in territory
Whitefish Lake/Smith Lake	2004	Nest on State not used	Unknown	
Whitefish Lake/Smith Lake	2005	Nest on State not used	No Birds Detected	Eagles detected in territory
Lower Stillwater	2001	Unknown	Unknown	
Lower Stillwater	2002	Successful	Unknown	
Lower Stillwater	2003	Unknown	Unknown	
Lower Stillwater	2004	Successful	Unknown	
Lower Stillwater	2005	Successful	2	
Farm to Market	2004	Potential Nest	Unknown	
Farm to Market	2005	Potential Nest	Unknown	Multiple potential locations

Note: DNRC biologists are assigned and monitor known nests that are part of established territories. Eagles were observed in most territories during most years. Although nesting or production was not observed in some nests, undetected nesting elsewhere in a territory may have occurred.

Montana Common Loon Working Group Monitoring

DNRC biologists on the NWLO actively participated in the Montana Common Loon Working Group from 2001 to present. This working group supports activities related to the conservation and management of common loons, and coordinates efforts with other wildlife managers along the west coast. Common loons present an interesting management challenge in our region. Montana loons spend winters on the Pacific Ocean. Juvenile birds also migrate to wintering areas off of the west coast where they mature for approximately 3 years before returning inland to breeding areas.

During the monitoring period, DNRC biologists participated in monitoring efforts for chick survival, capturing and tagging studies, nest platform construction, and information/education efforts. On 3 occasions DNRC biologists aided in rescue captures of loons trapped by rapid ice formation or entanglement in fishing line. During the monitoring period, DNRC biologists evaluated reproduction and nesting success of loons on 17 lakes in northwest Montana and contributed approximately 4 man days to these efforts annually. In recent years, 7 lakes (Kuhn's/Cliff Lake area) have been dropped from the surveys because loons have not been detected on these lakes and the lakes possess low quality habitat. Monitoring information gathered by DNRC biologists is reported to the Montana Common Loon Working Group annually.

In 2002, DNRC became a cooperator in the Loon Ranger Program and supports these efforts annually. The Loon Ranger Program provides salaries for several local Loon Rangers that regularly monitor loon activity on over 30 lakes, provide public education at lakes where nesting has been documented, and provide evening fireside talks for the public. Public education of boaters and fisherman is crucial to prevent nest failures. At Upper Whitefish Lake, a pair of loons inhabited the lake for years, however, no chicks were produced. In 2001, the Loon Ranger Program expanded into the Stillwater area, which includes Upper Whitefish Lake. That year was the first documented successful reproduction on this lake (2 chicks). This pair successfully hatched and raised 2 chicks the following year. Unfortunately, later that year, a bald eagle killed one of the adult loons and a pair has not re-established as of 2005. Field reports are completed at the end of the season. This program has been very successful in providing valuable monitoring information and public outreach. The program has also contributed to improved success for locally breeding pairs of common loons.

Results: The Common Loon Working Group has been successful in monitoring breeding loons in western Montana. However, the status of the breeding population is for the most part unknown. To understand the status of the Montana loon population, several graduate research projects were initiated in cooperation with the Common Loon Working Group. To date, the graduate students with the help of working group members have banded 77 loons (28 adults and 49 juveniles). Some of the interesting preliminary findings of this research include: 1) documentation by work group members and California researchers of a 5.5 day migration journey of an adult female from her breeding area on Lower Stillwater Lake, adjacent to DNRC ownership in northwest Montana, to the west coast near Morro Bay, CA – approximately 1,000 miles distant, 2) a loon nest with 4 eggs (nests typically contain 1 - 2 eggs), 3) numerous mortalities of adults and juvenile loons through band returns, 4) pair switching, and 5) longer than expected dispersal distances. These research projects are expected to continue into the future to further our understanding of loon ecology and population dynamics.

In addition, Common Loon Working Group members are trying to document spring and autumn migration routes. Several loons banded have been found dead off the coast elsewhere in Washington and California, however, the route of migration to these areas remains unknown. Specific results of DNRC monitoring efforts for common loons during the monitoring period are contained in Table T-2 on the following page.

Table T-2. DNRC common loon monitoring results from 2000 to 2005 Surveys.

	2000		2001		2002		2003		2004		2005	
LAKE	May (5/19)	July (7/14)	May (5/22)	July (7/20)	May (5/17)	July (7/18)	May (5/17)	July (7/18)	May (5/17)	July (7/16)	May (5/13)	July (7/16)
Bainey	0	0	0	0	--[1]	0	--	--	--	--	--	--
Beaver	Pair	Pair, 1 subadult	Pair	Pair	Single	0	Single	0	0	4 - Singles	1-Single	0
Bowser	0	0	0	0	--	0	--	--	--	--	--	--
Boyle	--	Pair	Pair	Pair	Pair	Pair	Pair	Pair, 1-chick	2-Pair	Pair, 1-chick	1-Single	Pair, 2-chick
Cliff	0	0	0	0	--	0	--	--	--	--	--	--
Cyclone	Pair (5/31)	Pair, 1 chick	0	Pair, single	0 (6/12)	Single	Single	Pair, 1-chick	Pair	Pair, 1-chick	1-Single	2-Pair, 1-chick
Dollar	0	0	0	0	0	0	0	0	0	0	0	0
Little Beaver	0	0	0	0	0	Single	0	0	0	0	Pair	0
Lore	0	--	0	0	--	--	--	--	--	--	--	--
Meadow	0	Pair	0	0	0	--	Pair	0	0	1-Single	0	1-Single
Murray	Single	0	0	0	0	Single	0	0	0	1-Single	0	0
Northwestern	0	0	0	0	--	--	--	--	--	--	--	--
Rainbow	0	0	0	0	--	--	--	--	--	--	--	--
Skyles	0	0	0	0	0	0	0	0				
Spenser	0	Pair	Single	Single	Single	Single	Single	Single				
Upper Whitefish	0	0	Pair	Pair, 2 chick	Pair (6/14)	Pair, 2 chick	Single	4-Singles		1-Single	1-Single	0
Woods	0	0	0	0	0	0	0	0		0		0
TOTAL	**1 Pair 1 Single**	**5 Pair 1 Subadult 1 Chick**	**3 Pair 1 Single**	**4 Pair 2 Single 2 Chick**	**2 Pair 2 Single**	**2 Pair 4 Single 2 Chick**	**2 Pair 4 Single**	**2 Pair 5 Single 2 Chick**	**3 Pair 0 Single**	**2 Pair 7 Single 2 Chick**	**1 Pair 4 Single**	**3 Pair 1 Single 3 Chick**

[1]A dash in the table (--) indicates that a location was not surveyed on the specified date.

Swan Valley Grizzly Bear Conservation Agreement Monitoring

The purpose of the Swan Valley Grizzly Bear Conservation Agreement [SVGBCA] (June 6, 1997) is to outline and implement a strategy through which multi-jurisdictional land owners can comply with the Endangered Species Act as it regards the grizzly bear, while continuing to practice forestry and multiple use management on their timberlands in the Conservation Area. To help ensure continued compliance with the Agreement, the involved parties agreed to cooperatively monitor the application and effectiveness of the conservation measures and provide the U.S. Fish and Wildlife Service (USFWS) with results on an annual basis. Monitoring commitments for the Conservation Agreement are documented in the *Monitoring Agreement for the Swan Valley Conservation Agreement* (August 21, 1998). A Technical Monitoring Team comprised of four biologists employed by the cooperating entities during the monitoring period developed five monitoring reports addressing all commitments. The reports were distributed annually to the USFWS and all other cooperators. These complete reports are available from the Forest Management Bureau.

Effectiveness Monitoring

Summary Results: In summer 2000, cooperators began efforts to opportunistically radio collar a sample of grizzly bears in conjunction with a black bear project that was being initiated in the Swan Valley by DFWP. The cooperators along with DFWP met in February 2001 to discuss options for monitoring grizzly bears in the Swan Valley Conservation Agreement Area and portions of the Mission Mountains. A technical research and monitoring team made up of SVGBCA Cooperators and DFWP was formed in August 2002. A memorandum of understanding (MOU) was signed by all parties to outline the roles and responsibilities of the parties. The MOU provides for a cooperative, unified approach to grizzly research and monitoring in the Swan Valley.

In summer 2001 cooperators established about 170 hair-snagging stations in a cooperative effort with DFWP to gather hair samples for DNA analysis to estimate a minimum population size of grizzly bears using the Agreement Area and adjacent areas to the south and west. DNRC personnel assisted with determining locations for snag stations, set up and monitored a subset of snagging stations, and funded the analysis of a portion of the hair samples. Final results determined that 7 unique grizzly bears were sampled by this technique. These 7 grizzlies were different from 5 other known grizzlies trapped in the valley in 2000 and 2001.

Bear trapping results during the monitoring period are as follows. In 2001, four different grizzlies were captured during the DFWP Swan Valley black bear study. In 2002, four grizzlies were captured for research and monitoring purposes. Three additional grizzlies were caught in the Swan Valley by DFWP while conducting black bear research. In 2003, six grizzly bears were captured by DFWP researchers in the Swan Valley, which were fitted with radio collars. Eight grizzly bears were captured by DFWP in or adjacent to the Agreement area in 2004. In addition, two female grizzly bears trapped by DFWP for human-bear management reasons outside the Agreement area in 2003 continued using areas inside the Agreement area in 2004. Of the ten collared grizzlies in 2004, three ended the summer as mortalities, either illegal (1) or of unknown cause (2). Four additional grizzly mortalities were known in 2004 from the Swan Valley (i.e., two illegal mortalities and two via human-bear management). DNRC personnel supported these efforts by assisting with trapping, locating shed collars, and assisting with collection of ground and aerial telemetry locations of collared bears (approximately 10 man days). DNRC also funded six flights for the collection of aerial telemetry locations during the monitoring period.

Thirty-three individual grizzly bears have been identified using the Swan Valley since 2000 through the SVGBCA cooperative research and monitoring program, DFWP black bear hair-snagging DNA project, or other opportunistic encounters. Hourly GPS data collected on a total of 10 grizzlies (including one male for two seasons) from the last 4 years has provided about 15,000

successful satellite telemetry locations. Preliminary evaluation of this data indicate that the primary biological objective of the SVGBCA is being met: use of the valley bottom by bears is facilitating linkage between the Bob Marshall Wilderness and Mission Mountain Wilderness bear populations.

The Research and Monitoring Team has developed a study and analysis design to further evaluate the Agreement's biological objectives and management guidelines. A preliminary analysis of the monitoring data from 2000 to 2004 will be initiated in 2005. Grizzly bear monitoring efforts will continue in 2005 to support the study design.

SVGBCA Implementation Monitoring

Summary Results: The SVGBCA Monitoring Agreement requires cooperators to report information pertaining to the Agreement Area on Open Road Densities, Total Road Densities, Secure Habitat, Cover, levels of Administrative Use in Inactive Subunits, closure effectiveness, Commercial Activity in Active Subunits, levels of Administrative Use on Restricted Roads within Linkage Zones during the Spring Period, road amounts in Preferred Habitat and exceptions to the Agreement. Two of these parameters (i.e., Open road densities and Cover) are monitored to ensure that cooperators are managing within specific identified standards contained in the Agreement. The remaining parameters that are monitored do not address specific numeric standards that must be met, but rather provide important information about commercial activity and disturbance in the valley, and human induced changes in baseline habitat conditions. Specific details may be viewed in the complete set of monitoring reports (years 2000 to 2004), available from the Forest Management Bureau.

In 2000, the Open Road Density (ORD) standard of <33% by grizzly bear Subunit was being met in all but two Subunits (i.e., the South Fork Lost Soup Subunit and the Porcupine-Woodward Subunit). In 2000-2001 DNRC and Plum Creek Timber Company made efforts to reduce Open Road Densities by closing several open roads in these two Subunits to be in full compliance with the Agreement standards. Additional gates and barriers were installed on several roads by July 1, 2001 and both Subunits were brought down to 31% ORD -- fully complying with the <33% standard. Since 2001, all grizzly bear Subunits have been managed in full compliance with the <33% ORD Agreement standard.

The Swan Agreement requires that each grizzly bear Subunit maintain a minimum of 40% cover. For the five Subunits that DNRC has ownership in, cover values on DNRC lands have ranged from 58 to 99% with an average for each Subunit of about 78%, which has met this requirement.

During the monitoring period DNRC staff checked between 181 and 211 road closure devices on the Swan River State Forest annually (average = 202). A visual inspection of each closure structure was conducted, and notes about the likely effectiveness of each closure to effectively restrict motorized access were recorded and reported annually in SVGBCA monitoring reports. DNRC closure effectiveness levels reported by field staff during the monitoring period ranged from 88% to 99% and averaged 95%. Where breeches or vandalized devises were detected, DNRC bolstered or made repairs to the structures within one year of detection.

Northern Divide Grizzly Bear Project

Data collection for the multi-cooperator U.S. Geological Survey's Northern Divide Grizzly Bear Project, which included the SVGBCA area, was completed in 2004. The field collection of hair samples from snagging sites occurred in the approximately 8-million-acre area between Glacier National Park to the north and the Blackfoot River to the south. Approximately 34,000 hair samples were collected. DNA analyses, to be completed in 2006, will allow determination of the species, gender, and unique bear identity. These data will allow a statistically rigorous population estimate to be calculated for the Northern Continental Divide Ecosystem and will further our understanding of grizzly bear numbers and distribution throughout this area. DNRC is also a cooperator in this project and has provided some assistance with locating hair-snagging stations, and has assisted crews with acquiring access to study sites.

Project Reviews of Wildlife Mitigation

Methods: The intent of this effort is to assess the application and effectiveness of project-level commitments made in MEPA documents concerning wildlife mitigation. DNRC biologists examined pertinent environmental documents for each completed project that was selected for monitoring. DNRC Area Biologists as necessary to assist with the evaluation of mitigation implementation and the likelihood of effectiveness conducted follow-up field reviews.

Results: DNRC wildlife biologists reviewed five timber sale projects during the monitoring period. Sales reviewed on the NWLO included: Keeler Mountain, Young Creek, and Weeksville. Sales reviewed on the SWLO included: Avon East, and McKay Creek. Approximately 1,325 total acres were treated for all of these sales combined at the time of reviews.

For the five sales, a total of 111 wildlife habitat-related mitigations were reviewed by biologists (Table T-3). In some cases one mitigation was applied, but was included for several species. For example, where flammulated owls and pileated woodpeckers were likely to occur sympatrically, a snag retention mitigation targeted to benefit both species was recorded as one mitigation in both the pileated woodpecker and flammulated owl rows.

Table T-3. Number of Timber Sale Mitigations for T&E and Sensitive Species Reviewed by Biologists, 2001 to 2005

	Project Name					
Mitigation Subject	**Keeler Mountain**	**Young Creek**	**Weeks-ville**	**Avon East**	**McKay Creek**	**Total**
Bald Eagle	1	n/a	1	1	n/a	3
*Gray Wolf	2	1	1	1	1	6
Grizzly Bear	3	1	n/a	4	1	9
Canada Lynx	1	n/a	n/a	n/a	n/a	1
Pileated Woodpecker	1	1	1	2	2	7
Flammulated Owl	2	1	1	2	2	8
Boreal Owl	1	n/a	n/a	n/a	2	3
Fisher	n/a	n/a	n/a	n/a	2	2
Elk	1	3	3	0	3	10
Mule Deer	1	3	3	0	3	10
White-Tailed Deer	1	3	3	0	3	10
Other Coarse Filter Mitigation (e.g. corridors)	9	10	6	9	8	42
Total	23	23	19	19	27	111

* Mitigation for this species was also addressed in standard contract language for these identified projects.

Of the reviewed mitigations, 87% were deemed by DNRC biologists to have reasonable likelihood of effectiveness. It was uncertain if 7% of the mitigations reviewed would be effective. These mitigations were primarily associated with a prescribed burn that had not yet recovered at the time the monitoring review was conducted, so vegetation responses could not be evaluated precisely. The remaining 5% of the mitigations reviewed were considered inadequate. Where applicable, biologist recommendations were provided for corrective action or improvement. Identified areas of improvement included improved road closure effectiveness on some closures, and improved retention of snags – particularly in line and helicopter units.

Snag, Snag Recruitment and Coarse Woody Debris Monitoring

The intent of this effort is to obtain information that would allow us to compare pre-harvest and post-harvest abundance of snags, snag recruits and coarse woody debris (CWD), which are important habitat elements for a variety of endangered, threatened, sensitive and common terrestrial wildlife species. Information will be used to evaluate compliance with minimum retention levels for snags, residual live trees, and CWD specified in the Biodiversity Rules (36.11.411), and to gain broader insight into the effects of our management activities on these habitat components.

Methods: During the monitoring period from 2001 to 2004 sampling was conducted on thirteen stands within 13 sale areas (1 stand per sale area). The stands were located on different field offices, and occurred within various cover types and planned treatment types. Pre-harvest data for snags, CWD, and large live trees (potential recruitment trees ≥21 inches dbh) were collected on each selected project. Some of the stands monitored post harvest from were also monitored prior to their harvest in 2000 during the previous monitoring period. Seven sales/stands were sampled both pre-harvest and post-harvest.

Snags are typically not evenly distributed (Harris 1999), and accurate snag estimates are difficult to obtain with reasonable levels of sampling effort due to their distribution and relatively low density across the landscape (Bull et al. 1990). DNRC's snag and snag recruitment tree monitoring procedures incorporate about three, 1-acre plots per harvest unit to help improve estimation power. Additional plots are sampled on harvest units that exceed 40 acres. One-acre plots were recommended for snag monitoring by Bull et al. (1990) to optimize accuracy of estimates and sampling efficiency. A plot layout scheme similar to the one described by Bevis (1996) was incorporated to improve sampling efficiency, accuracy and increase analysis options. DNRC SLI data collection procedures with increased sample transect length were used to estimate CWD amounts. Tonnage calculations for CWD follow those developed by Brown (1974). Detailed methodology is available upon request.

DNRC acknowledges that data variance levels as indicated by reported standard deviations are relatively high -- primarily due to the clumped distribution of snags and low sample sizes. Low sample sizes are a trade-off one must acknowledge when using very large 1-acre plots in order to be time efficient. DNRC considers reported snag per acre averages as reasonable estimates of snag density, but acknowledges the high variation associated with the reported estimates.

Results - Snags: Reported snags/acre values by size class suggest that existing snag densities on pre-harvest sites are occasionally lower than guidance recommendations before planned treatments occur. This is not surprising as factors that may contribute to this include (but are likely not limited to): past harvest in some stands that emphasized the removal of unhealthy and larger trees, stand age, firewood cutting, and natural variation in distribution such as that noted by Harris (1999). The stands sampled reflect a broad range of stand types and harvest intensities across Units on the NWLO and SWLO. Several were associated with large fire salvage projects, severe mistletoe, and normal green tree harvest. One stand associated with the Sour Fish Timber Sale occurred on flat ground lying adjacent to a well-used open road; firewood cutting is common in this area. This stand was not considered further for post-harvest monitoring, because it would have provided little insight into DNRC's snag and coarse woody debris retention practices. Note: During the monitoring period, snag data were recorded according to stand "cover type" and not habitat type group. During the next monitoring period corrections to data collection forms will be made to include Habitat Type to allow improved assessment of compliance with Forest Management Rules and assessment by Habitat Type Group. Also note that results presented under the heading "Total Snags Recorded" includes all snags encountered on plots that were greater than 6 ft. tall and greater than 8 inches dbh.

Pre-harvest: Of the 13 stands sampled prior to harvest, six had one or more snags greater than 21 in. dbh per acre – hereafter termed "Large Snags" (Table T-4). Of these six stands, three contained more than two Large Snags per acre. Three stands contained no Large Snags. Thus, seven stands prior to scheduled harvest were limited in their ability to provide minimum numbers of Large Snags. Having relatively few Large Snags initially within a high proportion of sampled stands, suggests the importance of retaining Large Snags wherever opportunities are present to help ensure that desirable snag densities are maintained. Medium-sized snags (16 to 21 in. dbh) were generally more abundant than large snags within the sample stands. Ten of the 13 stands sampled (ie., 77%) contained averages of ≥ 1.7 snags per acre in this size class (Table T-4).

Post-harvest: Of the six sample stands that contained one or more Large Snags per acre prior to harvest, three were sampled again following harvest. Only one of these stands that was re-sampled (Sula Salvage) maintained one or more Large Snags per acre following harvest (Table T-5). The marking prescription on this project was for two Large Snags per acre to be left (or the next larger size available) because very few live trees remained in this fire salvage area. The Cyclone Ridge stand contained less than 1 Large Snag per acre pre-harvest, however, post-harvest estimates were 1.1 per acre – suggesting that some improvements were made to marking to increase retained densities. The Red Owl stand also had post harvest densities greater than pre-harvest densities, suggesting that additional trees may have been retained that died between the period of sampling and re-sampling. Large snags were retained on both the Fish Trap and Evaro stands, however, some Large Snags were apparently lost between pre-harvest and post-harvest sampling, which put these stands below the desirable level of one Large Snag per acre. Exact causes of these deficiencies are uncertain. Additional medium-sized snags (16 to 21 in. dbh) were retained on all stands at levels that ranged from 0.3/acre to 2.2 per acre.

Recommendations: With the exception of fire salvage projects, these results suggest that large snags were not overly abundant on the stands sampled. Greater attention to retention of Large Snags and snag recruitment trees over time given current policies may improve this situation on DNRC lands. However, the results also suggest that continued attention to retaining Large Snags is important as several projects that may have been able to meet the ≥1 Large Snag rule pre-harvest did not following completion of harvest. It may also be important to continue to emphasize retaining smaller non-merchantable snags as feasible under ARM 36.11.413(1). Total snags were reduced considerably from pre-harvest levels on two non-fire salvage projects (ie., Quiet Stems and Evaro). Such reductions are not completely unexpected as snags are often inadvertently knocked over by equipment during harvest operations, are felled for human safety reasons, they are vulnerable to windthrow, and also are lost to firewood cutting etc. Greater attention to providing these smaller non-merchantable snags where opportunities exist may generally improve densities on DNRC lands. Given the interval that many DNRC lands are managed (ie., re-entered every 20 to 30 years), smaller snags may not have time to be created and replaced in appreciable numbers prior to subsequent entries.

Regarding future monitoring, efforts should be continued to re-sample stands that have been harvested to assess if retention policies are met and results should be compiled for stands by Habitat Type (Pfister et al. 1977).

Table T-4. Summary Results of Pre-harvest Sampling of Snags for Timber Sales -- 2000 to 2004 (Note: sale names highlighted in bold have corresponding post-harvest data presented in Table T-5 below.)

Area	Sale Name (date)	Cover Type*	No. of Plots	Total Snags	Snags/ac 8"-15" dbh (sd)	Snags/ac 16"-21" dbh (sd)	Snags/ac 22"-27" dbh (sd)	Snags/ac ≥27" dbh (sd)
NWLO	**Fish Trap** (2000)	L/DF	4	11	6.8 (2.5)	1.3 (1.3)	1.0 (0.8)	0.7 (0.6)
	Good Long Boyle (2000)	L/DF	4	1	1.0 (0)	0.3 (0.5)	0	0
	Red Owl (2000)	PP	4	12	9.0 (7.9)	3.0 (1.2)	0	0
	Bald Hill (2001)	L/DF	3	89	25.3 (17.5)	2.7 (2.3)	1.7 (1.5)	0
	Cyclone Ridge (2001)	MC	4	219	48.8 (28.2)	5.0 (2.4)	0.5 (0.6)	0.3 (0.6)
	Goat Squeezer (2004)	MC	3	33	5.3 (2.1)	3.0 (2.6)	2.0 (1.7)	0.7 (0.6)
	McKillop (2004)	MC	4	37	6.3 (2.5)	2.5 (3.8)	0.5 (1.0)	0
SWLO	**Quiet Stems** (2001)	L/DF	3	29	7.7 (2.1)	1.7 (1.2)	0.3 (0.6)	0
	**Sour Fish (2001)	PP/DF	4	4	1.0 (0.8)	0	0	0
	Sula Salvage (2001)	PP/DF	5	414	59.2 (19.2)	18.2 (8.1)	4.2 (2.8)	1.2 (1.3)
	Evaro (2002)	L/DF	2	24	9.0 (0)	2.0 (2.8)	1.0	0
	Evans Lake (2004)	PP	2	5	2.0 (1.4)	0	0	0.5 (0.7)
	Fish Sticks (2004)	GF	2	40	0.5 (0.7)	13.0 (4.2)	3 (0.0)	3.0 (2.8)

* Cover type codes are as follows: GF = grand fir, L/DF = western larch/Douglas-fir, MC = mixed conifer, PP = ponderosa pine, PP/DF = ponderosa pine/Douglas-fir.
(sd) = standard deviation
** This stand was situated in a location along an open road that received frequent firewood cutting.

Table T-5. Summary Results of Post-harvest Sampling of Snags for Timber Sales -- 2001 to 2004 (Note: sale names highlighted in bold have corresponding post-harvest data presented in Table T-4 above.)

Area	Sale Name (date)	Cover Type*	No. of Plots	Total Snags	Snags/ac 8"-15" dbh (sd)	Snags/ac 16"-21" dbh (sd)	Snags/ac 22"-27" dbh (sd)	Snags/ac ≥27" dbh (sd)
NWLO	**Fish Trap** (2003)	L/DF	4	13	2.3 (1.5)	0.5 (1.0)	0.3 (0.5)	0.3 (0.5)
	Good Long Boyle (2003)	L/DF	4	1	0.0 (0)	0.3 (0.5)	0	0
	Red Owl (2002)	PP	4	9	1.3 (1.0)	1.0 (1.2)	0.3 (0.5)	0
	Cyclone Ridge (2001)	MC	4	41	8.3 (3.8)	1.0 (0.8)	0.8 (1.0)	0.3 (0.5)
SWLO	**Quiet Stems** (2002)	L/DF	2**	10	4.5 (4.9)	0.5 (0.7)	0	0
	Sula Salvage (2001)	PP/DF	5	123	20.6 (6.3)	2.2 (1.3)	1.0 (1.0)	0.8 (0.8)
	Evaro (2003)	L/DF	2	3	0.0 (0)	1.0 (1.4)	0.5 (0.7)	0

* Cover type codes are as follows: GF = grand fir, L/DF = western larch/Douglas-fir, MC = mixed conifer, PP = ponderosa pine, PP/DF = ponderosa pine/Douglas-fir.
(sd) = standard deviation
** One less plot was sampled when data was collected post-harvest on this stand. Reference markers could not be found to re-sample the 3rd plot following harvest.

Results – Snag Recruitment Trees: ARM 36.11.411 (a) and (b) requires DNRC to retain an average of two snag recruitment trees greater than 21 inches dbh on stands in the "warm and moist," and the "wet" Habitat Type Groups (Green et al. 1992). For all other Habitat Type Groups retention of an average of one snag recruitment tree >21 in. dbh is required. Retention of snag recruitment trees is intended to ensure that Large Snags will be recruited and available through time on managed lands.

Pre-harvest: Results for existing pre-harvest levels of large, live trees suitable for future snag recruitment (Table T-6) indicate that ample numbers were present to meet snag recruitment guidelines for most stands sampled (ie., they contained a minimum of 1 to 2

large trees per acre depending on Habitat Type Group (ARM 36.11.411). Stands that did not have ample large live trees present included two fire salvage stands that burned at stand-replacement intensity (ie., Sula Salvage and Fish Sticks). Large live tree density estimates on the remaining 11 stands sampled ranged from 1.0 to 14.3 trees/acre (Table T-6).

Post-harvest: Five of the seven stands that were sampled after logging during the monitoring period met or exceeded 1 to 2 large live trees per acre. Retained tree density estimates for these five stands ranged from 1.3 to 6.5 trees/acre. Additional smaller live trees were retained in the 15 to 21 in dbh class on most stands sampled (2000 to 2004 DNRC unpub. data summaries). The Sula Salvage and Evaro stands both contained less than one large live tree per acre following timber harvest. However, in both of these stands, relatively few large trees were present prior to logging. On the Sula stand the only large live tree that was found, was retained. On the Evaro stand, 4 large live trees were found pre-harvest. This stand contained no large live trees following logging, which may have been due to an inexperienced operator felling large grand fir trees. Improved administrator/operator communication and increased administration effort might have reduced this apparent loss. The presence of dwarf mistletoe in this stand may also have been a factor. As a future consideration to help meet snag retention commitments in such areas, girdling or killing infected target snag recruitment/retention trees (particularly western larch) with a chemical such as "Pronone" could allow retention of important structural snag components, while controlling mistletoe spread. One tree/acre between 15 and 21 in. dbh was retained on the Evaro stand. Species composition of retained trees was heavily weighted to desirable snag species (Table T-7).

Recommendations: Continue to meet large live tree snag recruitment density requirements, and substitute among snags and recruitment trees wherever necessary to help ensure ample densities of large snags are present over time.

Table T-6. Summary Results of Pre-harvest Sampling of Potential Snag Recruitment Trees for Timber Sales, -- 2000 to 2004 (Note: sale names highlighted in bold have corresponding post-harvest data presented in Table T-7 below.).

Sale Name (Year)	Total Large Trees Recorded on Plots	Ave. Live Trees/acre ≥21" dbh (sd)	Species Composition Live Trees Sampled >21" dbh
Fish Trap (2000)	12	3.0 (2.5)	DF 83%, PP 17%
Good Long Boyle (2000)	16	4.0 (2.2)	WL 75%, DF 25%
Red Owl (2000)	43	10.8 (3.5)	DF 58%, PP 42%
Bald Hill (2001)	7	1.0 (1.0)	DF 43%.PP 43%, WL 14%
Cyclone Ridge (2001)	35	3.5 (4.0)	SP 49%, SF 26%, WL 20%, DF 6%
Goat Squeezer (2004)	43	14.3 (2.1)	CD 36%, WL 28%, SP 13%, BR 8%, DF 6%, GF 6%, CW 3%
McKillop (2004)	8	2.0 (0.8)	DF 32%, WL 27%, GF 24%, WP 10%, WH 5%, SF 2%, SP 1%
Quiet Stems (2001)	26	3.3 (2.0)	DF 50%, WL 42%, SP 4%, SF 4%
**Sour Fish (2001)	17	2.8 (1.7)	PP 53%, DF 47%
Sula Salvage (2001)	1	0.2 (0.4)	DF 100%
Evaro (2002)	4	2.0 (0.0)	DF 34%, GF 34%, WL 32%
Evans Lake (2004)	22	11.0 (1.4)	PP 63%, DF 37%
Fish Sticks (2004)	0	0	n/a

* Tree species codes are as follows: GF = grand fir, WL = western larch/Douglas-fir, MC = mixed conifer, PP = ponderosa pine, SP = spruce, WP = white pine, SF = subalpine fir, CD = western red cedar, BR = Birch, CW = Cottonwood, WH = western hemlock.

(sd) = standard deviation

Table T-7. Summary Results of Post-harvest Sampling of Potential Snag Recruitment Trees for Timber Sales, – 2001 to 2004 (Note: sale names highlighted in bold have corresponding post-harvest data presented in Table T-6 above.)

Sale Name (Year)	Total Large Trees Recorded on Plots	Ave. Live Trees/acre ≥21" dbh (sd)	Species Composition Live Trees Sampled >21" dbh
Fish Trap (2003)	5	1.3 (1.9)	DF 55%, PP 25%, WL 20%
Good Long Boyle (2003)	8	2.1 (1.4)	WL 77%, DF 23%
Red Owl (2002)	26	6.5 (3.7)	DF 55%, PP 45%
Cyclone Ridge (2001)	9	2.3 (3.3)	WL 73%, DF 18%, SF 9%
Quiet Stems (2002)	8	4.0 (2.8)	WL 63%, DF 37%
Sula Salvage (2001)	1	0.2 (0.4)	DF 100%
Evaro (2003)	0	0	n/a

* Tree species codes are as follows: GF = grand fir, WL = western larch/Douglas-fir, MC = mixed conifer, PP = ponderosa pine, SP = spruce, WP = white pine, SF = subalpine fir, CD = western red cedar, BR = Birch, CW = Cottonwood, WH = western hemlock.

(sd) = standard deviation

Results – Coarse Woody Debris: Downed logs and woody material are important for providing long-term soil structure, nutrients, and habitat structure important for many species of wildlife. ARM 36.11.414 specifies that will maintain adequate levels of coarse woody debris at the project level using scientifically accepted technical references. For this purpose, DNRC considers suitable amounts to be those based on Graham et al. (1994).

Pre-harvest: Pre-harvest coarse woody debris estimates suggest that possibly four of the 13 stands sampled maintained lower amounts of downed wood than that recommended by Graham et al. (1994) for maintenance of site productivity (i.e., Good Long Boyle, Red Owl, Bald Hill, and Sula Salvage) (Table T-8). The remaining stands had estimates that fell well within or exceeded Graham et. al.'s recommended ranges (Graham et al. recommended range is from 4.5 to 24.5 tons/acre). Factors that may have contributed to lower levels of coarse woody debris detected on some sites include (but are likely not limited to): past harvest in some stands that emphasized the removal of unhealthy trees and older trees; stand age, amount, type and timing of past natural disturbances; firewood cutting; and natural variation in distribution of downed wood.

Post-harvest: Following logging, coarse woody debris estimates met or exceeded ranges described by Graham et al. (1994) on all sample stands. On all stands sampled following logging, additional woody material was left following timber harvesting. Additional material accumulated through logging averaged 6.0 tons/acre and ranged from 2.6 to 9.5 tons/acre (sd = 2.74). Retained logs were primarily in the smaller diameter class (Table T-9 and Fig. T-1).

Recommendations: Given current practices and material that is commonly already available on many stands, it appears that we can generally anticipate leaving about 6 tons of material per acre. This typically appears to be sufficient to meet ranges provided by Graham et al. (1994).

A preponderance of smaller diameter logs on most sites is generally expected, because younger age classes are typically more common than the oldest cohorts (ie., larger trees and logs)--particularly in managed stands. Further, larger diameter material is generally the most commercially valuable, thus, less is available to leave on the ground as woody debris. However, while guides are currently lacking regarding the proportion of large to small material that should be retained following logging, it is evident that relatively few large logs are retained in stands following treatment.

Retaining medium and large sized snags serves to help ensure that such material, which is important for providing distinct habitat structures, will be maintained over time. Greater attention by sale administrators to restrict removal of medium and large-sized snags and downed wood could help improve retention of this material. Also, opportunities may be present to require that snags felled for human safety reasons be maintained on site and restricting firewood permits to landing piles.

Table T-8. Summary Results for Pre-harvest Sampling of Coarse Woody Debris for Timber Sales, -- 2000 to 2004

Sale Name	Cover Type*	CWD Tons/acre (standard deviation)	Ave. No. Large Pieces/660 ft Transect {≥15.5" Large End Dia.} (sd)	Ave. No. Small Pieces/660 ft Transect {≤15.4" Large End Dia.} (sd)
Fish Trap (2003)	L/DF	14.5 (4.0)	3.0 (2.2)	50.3 (18.2)
Good Long Boyle (2003)	L/DF	5.6 (2.6)	2.0 (2.3)	23.0 (14.2)
Red Owl (2002)	PP	1.5 (0.2)	0.3 (0.5)	5.5 (2.6)
Bald Hill (2001)	L/DF	1.4 (1.0)	0.3 (0.6)	3.0 (1.7)
Cyclone Ridge (2001)	MC	19.9 (6.4)	5.0 (2.9)	43.5 (12.7)
Goat Squeezer (2004)	MC	15.8 (4.6)	5.3 (1.5)	24.0 (6.2)
McKillop (2004)	MC	11.8 (4.8)	1.5 (1.7)	32.5 (12.8)
Quiet Stems (2001)	L/DF	6.5 (0.7)	1.3 (0.6)	20.3 (2.9)
**Sour Fish (2001)	PP/DF	5.3 (3.1)	3.0 (2.7)	10.8 (2.9)
Sula Salvage (2001)	PP/DF	1.8 (1.0)	1.0 (1.2)	5.8 (4.3)
Evaro (2002)	L/DF	13.4 (5.5)	6.5 (2.1)	31.5 (9.2)
Evans Lake (2004)	PP	5.9 (2.5)	1.5 (2.1)	12.5 (9.2)
Fish Sticks (2004)	GF	14.0 (1.6)	4.5 (0.7)	19.5 (4.9)

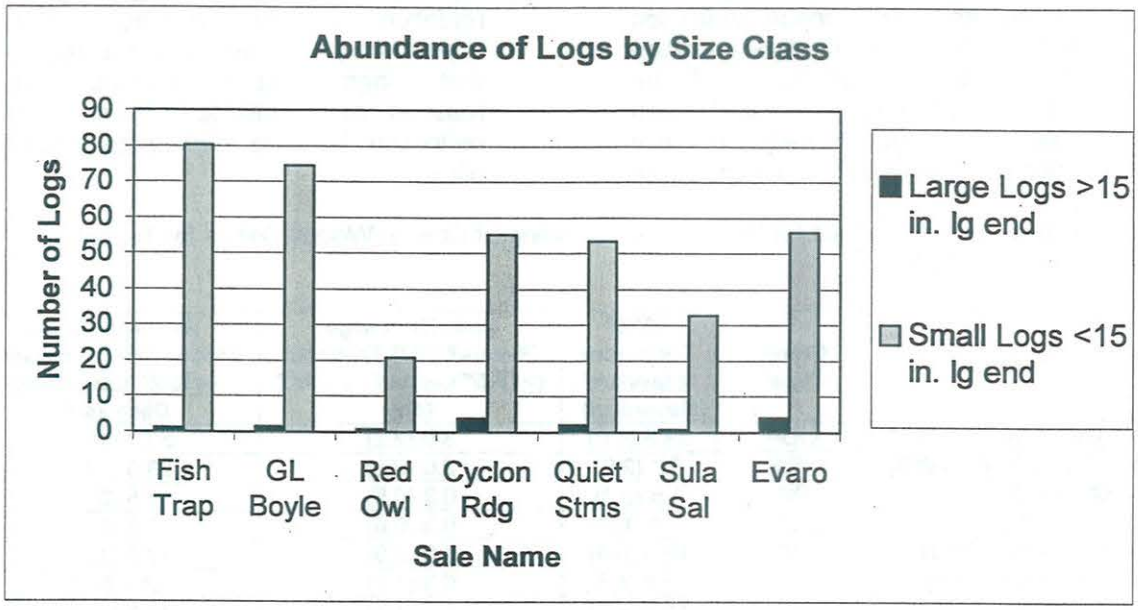
* Cover type codes are as follows: GF = grand fir, L/DF = western larch/Douglas-fir, MC = mixed conifer, PP = ponderosa pine, PP/DF = ponderosa pine/Douglas-fir.

Table T-9. Summary Results for Post-harvest Sampling of Coarse Woody Debris for Timber Sales, -- 2001 to 2004

Sale Name	Cover Type*	CWD Tons/acre (standard deviation)	Ave. No. Large Pieces/660 ft Transect {≥15.5" Large End Dia.} (sd)	Ave. No. Small Pieces/660 ft Transect {≤15.4" Large End Dia.} (sd)
Fish Trap (2003)	L/DF	19.7 (9.2)	1.0 (1.4)	80.3 (35.8)
Good Long Boyle (2003)	L/DF	14.6 (6.4)	1.5 (1.7)	74.5 (25.8)
Red Owl (2002)	PP	5.6 (2.2)	0.8 (0.5)	20.8 (4.3)
Cyclone Ridge (2001)	MC	22.5 (5.7)	3.8 (5.0)	55.3 (4.9)
Quiet Stems (2002)	L/DF	16.0 (3.5)	2.0 (0.0)	53.5 (4.9)
Sula Salvage (2001)	PP/DF	9.6 (5.8)	0.8 (0.4)	32.8 (17.2)
Evaro (2003)	L/DF	17.2 (2.9)	4.0 (1.4)	56.0 (11.3)

* Cover type codes are as follows: GF = grand fir, L/DF = western larch/Douglas-fir, MC = mixed conifer, PP = ponderosa pine, PP/DF = ponderosa pine/Douglas-fir.

Figure T-1. Abundance of Logs by Size Class on Seven Timber Sales Following Timber Harvest.



Reporting of Terrestrial Species Observations

Methods: During the monitoring period, DNRC gathered and compiled notable terrestrial species observations reported by DNRC biologists and field personnel. Most of these observations were obtained incidentally while conducting normal work-related activities. Data entries documenting: species, observation date, observer, number of adults and young, general habitat association, location of sighting, associated project area and unit office were reported to the Montana Natural Heritage Program (MNHP) on April 30, 2003 for the period between 1999 to 2002 for inclusion in their state-wide database. Observations reported from 2003 to 2005 were submitted to the MNHP in August 2005. Observation data will continue to be collected and reported in a cooperative effort to improve understanding of the distribution and occurrence of terrestrial species of interest.

Results: Fifty-five records were reported during the monitoring period, which contained sightings obtained from 2001 to July 2005. Of the 55 records reported, 26 were of threatened and endangered species, 9 were of DNRC listed sensitive species, and 19 were of other species of interest. A summary list of the species reported and number of records is as follows:

T&E Species
Bald Eagle (3)
Grizzly Bear (18)
Gray Wolf (3)
Canada Lynx (2)
DNRC Sensitive Species
Pileated Woodpecker (6)
Black-Backed Woodpecker (2)
Harlequin Duck (1)
Flammulated Owl (1)
Other Species
Northern Goshawk (5)
American Marten (1)
Mountain Lion (1)
Blue Grouse (1)
Cooper's Hawk (4)
Golden Eagle (1)
Great Gray Owl (1)
Merlin (1)
Red-Tailed Hawk (1)
Sharp-Shinned Hawk (2)
Barred Owl (1)
Little Brown Myotis (1)
Long-Eared Myotis (3)
Big Brown Bat (5)
California Myotis (2)
Long-Legged Myotis (1)

Follow-up Monitoring for Miscellaneous Mitigation

Occasionally, situations arise where mitigations are developed for specific habitat elements such as nest sites, foraging areas, rookeries etc. Reviewing the application and effectiveness of such mitigations is important for determining if adjustments are necessary to recommendations made in the future in order to achieve desired results. During the monitoring period, DNRC monitored and collected information on select sites following treatment to evaluate the application and effectiveness of specified mitigations pertaining to wildlife habitat. Methods and timing of monitoring efforts were tailored to the specific species, site and habitat element (e.g. nest, cover patch, etc.) to be monitored by the DNRC biologist on the project ID Team. The project biologist was responsible for developing and maintaining a monitoring schedule, and compiling results of monitoring efforts. Summarized results are in Table T-10.

Table T-10. Summary of Monitoring of Mitigation for Special Habitat Elements

Area Office	Project Name	Target Species	Habitat Element Monitored	Review Period	Estimated Man Days Spent	Mitigation Evaluated	Effectiveness
NELO	Middle Bench Timber Sale	Great Blue Heron	Rookery within harvest unit	6/30/00 to 4/03/04	7.0	No-harvest nest buffer and timing restrictions for operations	Partial*
NWLO	Goat Squeezer Timber Sale	Northern Goshawk	Active nest	7/14/04 to 7/14/05	4.5	Nest site buffers and activity restrictions	Adults and young present one week following disturbance. Birds in area following year, but nest not used. Further monitoring will be considered for this area.
NWLO	Weeksville Timber Sale	General	Vegetation and Access	12/03/04 to 7/22/05	2.0	Prescribed burn effectiveness and road closure effectiveness	Both burn and closure agreements appeared effective
SWLO	Dry Gulch Timber Sale	Bat spp.	Cave Occupancy	5/1/05 to 8/2/05	6.0	Evaluate necessity of disturbance buffer near cave entrance	Bats detected --12 individuals of 5 different species -- mitigation deemed necessary.
SWLO	Rock Creek Salvage	Golden Eagle	Active Nest	April 2005	1	Nest site buffer and activity restrictions	No birds present the following year

* The rookery was experiencing relatively high juvenile mortality prior to implementation of harvest activities. Six to eight nesting birds were observed in the rookery on May 3, 1999, following project completion. All nests apparently failed that spring and no activity has been observed on the rookery since June 15, 1999. In 2001 and 2002 one to four birds were detected periodically during visits, indicating some continued use. No birds were observed on the rookery in 2003 or 2004, but whitewash was observed at the base of one nest tree, possibly indicating some use both springs. Some sporadic attempts at use of the rookery appears to be occurring by a few individuals. Consistent successful fledgling of young birds is doubtful. Prescribed activity restrictions were deemed effective for minimizing disturbance during the year that harvest activity took place as nesting birds were not disturbed that spring. The rookery buffer mitigation was also deemed effective for minimizing any loss of nests to windthrow. Few trees within the rookery stand have blown down following harvest.

Other Wildlife Monitoring

During the monitoring period, DNRC biologists and staff participated in a number of additional monitoring efforts, contributions, and projects. Summaries of this work are included below in bullets.

- Canada Lynx -- Cooperative DNRC/University of Montana -- snowshoe hare habitat use project (2001 to 2003) examining the response of hares to pre-commercial thinning treatments on the DNRC Stillwater State Forest -- Dave Ausband -- DNRC intern. This project resulted in the publication of a peer-reviewed research note in the Canadian Journal of Forest Research. Results indicated that use of young conifer stands by hares was lower after thinning, but hares continued to use dense retention patches, regardless of size. Publication title: Effects of precommercial thinning on snowshoe hare habitat use during winter in low-elevation montane forests (2005) (available upon request).
- Grizzly Bear Monitoring -- Miscellaneous -- Annual contributions to NCDE subcommittee for cooperative grizzly bear GIS analyst position; and cooperative contribution to DFWP R-2 for 7 radio collars for the purpose of monitoring bears in the Blackfoot River Valley;
- Wolf Pack Monitoring of the Lazy Creek Pack near the Stillwater State Forest 2005 -- NWLO Area biologist participated for 1 day in assisting with capture of members of the Lazy Creek Pack.
- DFWP Region 2 Grouse Surveys -- SLWO Area Biologist participated in this cooperative effort in 2003 and 2005 to assist in collecting information on population status of 3 species of mountain grouse.
- Wolf Pack Monitoring on the Sula State Forest 2005 -- SWLO Area Biologist participated in efforts to trap and collar members of newly established wolf packs on the Sula State Forest.
- Effects of Sheep Grazing on Leafy Spurge (2003 to 2005) -- SWLO Area Biologist and hydrologist established 10 paired long-term study sites to evaluate the effectiveness of sheep grazing on leafy spurge as a control measure (Anaconda Unit - Race Track parcel - T6N, R10W, section 16). Results are suggestive but inconclusive that there may be an effect of sheep grazing on leafy spurge stem densities. Results to date are inconclusive regarding sheep grazing as an effective long-term control measure.

Sensitive Plant Species Monitoring

Results: One hundred eight timber sale project records were reviewed; these were all the sales sold from FY2001 through FY2005. On all 108 sales, the Montana Natural Heritage Program (MNHP) database was referenced for sensitive species occurrence in proposed project areas. The MNHP database noted sensitive plant species in the vicinity of 22 timber sales. Through project review, four of those occurrences were found to be outside project areas. On an additional four projects, field surveys found no sensitive plants within timber harvest areas. Wetlands, where species were likely to occur, were excluded from harvest on 14 sites. For one sale, a road location was moved to avoid sensitive plant populations. Ten sale projects avoided herbicide use near areas where sensitive plant species were indicated. Three projects included additional mitigations through timber sale contract provisions such as season of use, skidding design, and notification if plants were found. Mitigation measures were designed and implemented on all sites where sensitive species occurred to avoid potential disturbance of plants.

GRAZING ON CLASSIFIED FOREST LANDS MONITORING

The State Forest Land Management Plan and Rules (ARM 36.11.444) established the goals of maintaining healthy and functional riparian areas and preventing non-point source pollution on State Trust Lands licensed for grazing. Specific objectives under these goals include:

- ***Minimize loss of riparian and streambank vegetation;***
- ***Minimize structural damage to streambanks;***
- ***Maintain or restore healthy and vigorous riparian-wetland plant communities;***
- ***Leave sufficient vegetation to filter sediment and protect streambanks from erosion; and***
- ***Minimize physical damage to streambanks to maintain channel stability and morphological characteristics.***

These objectives were quantified into a set of numeric criteria that are utilized as a course filter to indicate the potential for unacceptable adverse impacts. The numeric criteria are as follows:

- ***Continuous season-long grazing will only be authorized when the levels of forage utilization do not exceed 59% and healthy riparian function is maintained;***
- ***No percentage of shrubs will be in the heavily hedged form class and less than 25% of the shrubs will be in the moderately hedged form class;***
- ***Streambank disturbance induced by livestock trampling will be limited to less than 10% alteration.***

Grazing licenses are only issued by DNRC on trust lands that are classified as forest land. Grazing leases, on the other hand, are issued by DNRC on trust lands that are classified as grazing or agriculture. Both grazing licenses and leases are issued, administered, and managed by the Agriculture and Grazing Bureau of DNRC. The SFLMP and associated ARMs only apply to grazing licenses issued on classified forest trust land. Therefore, the monitoring described in this report is only conducted on grazing licenses issued on classified forest trust land. This monitoring is coordinated by the Forest Management Bureau. There are currently approximately 251 grazing licenses issued on 445 parcels of classified forest.

Grazing Evaluations

Methods: The SFLMP and ARM 36.11.444 require the DNRC to inspect all grazing licenses issued on classified forestlands before renewal date and during mid-term (usually 4-6 years prior to expiration or renewal) to determine range, riparian, and streambank conditions. The SFLMP recommends that the following standardized methods and procedures be used for renewal and mid-term supplemental inspections of grazing licenses on classified forestlands.

Range Evaluation for Stocking Rates: Existing plant species composition is estimated by weight and compared to the potential climax species expected to occupy a specific range site. This is based on methods referenced by the USDA Natural Resources Conservation Service in their publications *Guide for Determining Range Condition and Initial Stocking Rates*, *Range Site Criteria*, and *Guides to Determine Forest Understory Vegetation Condition and Recommended Stocking Rates*.

Range condition: This is visually assessed to compare current conditions to the results of the previous detailed range evaluation (see above) completed at the last renewal inspection. Problems are noted, such as the presence of noxious weeds, erosion, and the condition of range improvements (water developments and fencing).

Riparian area evaluation: Either the entire stream within the licensed area or a representative segment is surveyed. Ocular assessments are made within a 6 ft. band centered on the Green Line (the first perennial vegetation above the stable low water line of a stream or water body; Bauer and Burton 1993). Riparian forage utilization, woody browse utilization, streambank disturbance, and riparian tree and shrub age classes are recorded, using standardized methods (Bauer and Burton 1993, Kinney and Clary 1994).

Riparian woody vegetation is recorded where it occurs or has the potential for occurring. Browse utilization is placed into 1 of 5 classes: None (0-5%), Light (5-25%), Moderate (25-50%), Heavy (>50%), and Unavailable (due to location or too high). The percentage of woody vegetation in each of 5 classes is recorded: Seedlings (1 stem), Young/sapling (2-10 stems), Mature (>10 stems), Decadent (>30% of canopy dead) or Dead (100% of canopy dead).

Supplemental grazing evaluations were completed at the midterm and renewal period for licenses on classified forest grazing lands of the Northwest, Southwest, and Central Land Offices (Table G-1). Between 1998 and 2004, mid-term supplemental grazing evaluations were performed on 181 grazing licenses administer by DNRC. These mid-term evaluations were usually performed four to six years prior to license expiration or renewal. In comparison, 47 supplemental grazing evaluations were performed during license renewal inspections on classified forest lands. In total, 228 supplemental grazing evaluations were completed during the seven-year span.

Table G-1. Supplemental Grazing Evaluations performed on classified forest grazing licenses between 1998 and 2004

Land Office	10 Year License Renewals	5 Year Midterm Inspections	Total Number of Grazing Evaluations
NWLO	13 inspections between 10 licenses	44 inspections between 27 licenses	57
SWLO	34 inspections between 20 licenses	109 inspections between 53 licenses	143
CLO	None	28 inspections between 13 licenses	28
		Grand Total	228

Results: Of the 228 total evaluations, 183 licenses had either riparian area or streams located within the grazing licensed parcel. Of these, 174 licenses had one or more stream(s), 9 licenses had another type of riparian area (e.g. marsh, wetland, bog, very low flow spring, etc.), and 3 licenses had both stream(s) and other riparian area(s) on the licensed parcel. A total of approximately 30.6 miles of stream and/or riparian area were surveyed. The lengths of stream that were surveyed varied from representative reaches (20-500 ft.) to the entire stream segment within the allotment (up to 5,500 feet).

Out of 183 licenses with riparian areas, 132 had riparian conditions that within the numeric criteria established in the SFLMP (Table G-2). In most cases, these inspections showed little or no impacts at all, with streambank damage 0-9%, forage utilization 0-59% and no or light levels of browse utilization or less than 25% in the moderate browse class.

There were 51 licenses where grazing effects surpassed the numeric criteria and more substantive impacts were noted. Overall, there were 77 individual assessments where the SFLMP numeric criteria were not met. This is due to the fact that several of the 51 inspections not meeting criteria had two, three, or all four criteria exceeded.

Streambank damage was the most common cause of departure from the SFLMP criteria. Streambank damage ranged from 0% to 100%, and exceeded the 10% allowable level in 39 individual inspections. Streambank damage is generally considered the most sensitive parameter and the most difficult criteria to meet. Levels of riparian forage utilization exceeded the SFLMP numeric criteria on only 6 licenses, a statistic that remains unchanged since the 2000 report. Levels of browse utilization exceeded the moderate browse utilization criteria in 11 individual inspections and exceeded the heavy browse utilization criteria in 21 individual inspections. Combined, there were 32 individual inspections where levels of browse utilization exceeded the criteria.

Table G-2. Results of Supplemental Riparian Monitoring during license inspections

Result	Frequency
Licenses with no riparian area(s)	45
Licenses with riparian conditions within numeric criteria	132
Licenses with riparian conditions that did not meet criteria	51
Licenses with changes in grazing management recommended	39
Licenses without recommendations	189

In the license inspections that included management recommendations, noxious weed invasion was most often cited and pesticide or biological control applications were suggested. Inspectors reported frequent sightings of spotted knapweed (*Centaurea maculosa*) and less frequent occurrences of Dalmatian toadflax (*Linaria dalmatica*), houndstongue (*Cynoglossum officinale*), and oxeye daisy (*Chrysanthemum leucanthemum*). Livestock management suggestions were slightly less prevalent which included suggestions ranging from lowering animal unit months (AUMs), shortening the season of use, more evenly distributing livestock presence across the license, or installing livestock exclosures around streams/riparian areas because riparian impacts had exceeded one, two, three, or all four guidance categories (streambank damage, forage utilization, moderate/heavy browse utilization).

In terms of overall trends, ignoring the 107 inspections where previous condition is "unknown," the vast majority (96 of 121) of the inspections had conditions that remained unchanged from that of the previous inspections. There were, fortunately, 14 inspections where the general condition was upgraded from a previous lower classification. However, there were 5 inspections where the general condition class was dropped one rank, and 3 inspections where general condition dropped at least 2 levels (one went from "Excellent" to "Poor" because of severe fire damage).

The Supplemental Riparian Monitoring Form is an effective tool to document impacts in riparian areas. Continued monitoring and follow up will be done for the licenses where riparian impacts were noted, to ensure that changes in management are implemented and effective in improving riparian conditions.

WEED MANAGEMENT MONITORING

As defined in the SFLMP and forest management rules (ARM 36.11.445), on classified forest lands the department shall use an integrated pest management approach for noxious weed management that includes prevention, education, cultural, biological, chemical and revegetation methods as appropriate.

To comply with this requirement and those of the County Noxious Weeds Laws (MCA 7-22-2101 through 2153) DNRC entered into Cooperative agreements with all county weed districts. Progress to date on these requirements is summarizes by the following DNRC activities:

Cooperative Agreements & Weed Management Plans

DNRC completed 6 year Cooperative Integrated Management Agreements (CINWA's) with all County Weed Districts where both forested and non-forested State lands occur. The CINWA's outlined DNRC's weed management goals, treatments and available budget; these are updated every two years based on accomplishments, new weed threats, cooperative projects and revised plans for weed control. DNRC Area Offices have also developed weed management plans that are used to prioritize follow up reviews and inspections of weed infestations, and to help prioritize what weed management projects are funded with our limited financial resources.

One hundred eight (108) timber sale project records were reviewed for the period of 2001-2005. Existing noxious weeds occurred on 85 timber sales project areas and adjacent lands. Weeds were principally located along roadside edges and timber harvest landing areas. Most projects that had existing noxious weed infestations occurred on Western Montana timber project areas. Noxious weeds are less extensive on forest sites in the Central and Eastern Montana.

Prevention

All timber sale projects focused on use of weed-free equipment by requiring washing and inspection of equipment prior to entry to sale areas. DNRC was one of the first agencies to require clean equipment as part of harvest operations. Compliance is recorded on timber sale inspection forms.

DNRC also required cleaning of weeds from fire equipment prior to mobilization to other fire areas starting in 2000. Several of the recent larger scale fires had temporary equipment wash stations to ensure equipment was cleaned of weeds.

Education

DNRC has cooperated with County Weed Districts to provide training in weed identification, safe herbicide application and weed management to field personnel.
From 2003-2005, an additional 18 DNRC personnel attended training and became licensed herbicide applicators for spot and field infestations of noxious weeds and to evaluate and oversee weed control projects.

Cultural, Biological, Chemical and Revegetation methods

All DNRC timber sale contracts included stipulations and control measures with the intent of controlling the spread of noxious weeds. Cultural treatments include road grading and some limited hand pulling of weeds.

All new roads (average 30 miles/year) and newly disturbed reconstructed roads were revegetated with site-adapted grasses to provide competition with weeds and reduce erosion. All grass seed mixtures utilized included native species. On weed competitive sites, more resilient introduced grasses comprised a higher percentage of grass mixes.

Herbicide treatments for roadside weed control have been primarily completed through contracts with County Weed Districts and licensed applicators. Priorities for herbicide treatment are new invaders, small infestations of new weeds and to control or contain the leading edge of established weeds based on site evaluation.

DNRC has an active role in establishing new insectectories of approved biocontrol insects on State lands to aid in the control of noxious weeds and seed production. Most biocontrol agents are better adapted to open forest or range sites. DNRC continues to redistribute insects on state lands and share available insects with County Weed Districts, Montana FWP and private landowners.

Cooperative Efforts

Following the wildfires of 2000 there was an immediate concern for the spread of noxious weeds across ownerships surrounding the Sula State Forest. DNRC rehabilitation and harvest measures minimized soil disturbance and include revegetation of existing roads, aerial seeding of high erosion and weed infestation risk sites. Approximately 100 acres of spot treatment of herbicide was completed to help control post-fire spread of noxious weeds, stabilize soils and to promote native species, as part of a cooperative effort with Ravalli County and adjacent private landowners. Re-vegetation efforts and herbicide treatments continued on about 70 miles of roadside for several years to control noxious weeds.

Monitoring

As part of ongoing forest management activities, DNRC project administrators monitor the implementation of noxious weed control measures on all timber sales. Through sale administration DNRC attempts to minimize the levels of ground disturbance to those that are needed to achieve silvicultural objectives.

On forest management projects where noxious weeds are a concern, DNRC periodically monitors for new invaders and follow-up treatments as needed, or may enlist the assistance of County Weed Districts.

In 2004 an entomologist evaluated 5 DNRC biocontrol release sites as part of a cooperative monitoring effort. Insects were found on all sites, yet were only well established on 4 sites. This information will help us to improve our site selections for release of insects on their best-adapted sites.

DNRC administrators also record weed infestations, as part of lease renewal and midterm inspections. (See **GRAZING ON CLASSIFIED FOREST LANDS MONITORING**.) When weeds are noted during these reviews, administrators are to fill out a Weed Monitoring form and complete a weed control plan with grazing licensees.

RECOMMENDATIONS

The Record of Decision (ROD) for the State Forest Land Management Plan (SFLMP), under *Managing the Plan* (ROD page 10), described circumstances under which the SFLMP might be revised. The SFLMP recognizes the importance of adaptive management and identifies that that the Forest Management Bureau Chief can change management direction as long as the change is compatible with the fundamental intent as reflected in the SFLMP and EIS. The SFLMP supports the use of new scientific information to adjust management.

The SFLMP can be reviewed and changed to comply with new legislation, new direction from the State Board of Land Commissioners, or if the FMB Chief judges that original assumptions supporting the Plan no longer apply. Part of our responsibilities are to identify emerging issues and challenges to implementing the SFLMP, and evaluate the potential need for amendments to the SFLMP to adapt to these circumstances. Issues that have been encountered during the years 2001-2005 of implementation are discussed below.

Adoption of Administrative Rules

When the DNRC considered adopting forest management rules in 2003, an environmental review of the proposed rules examined potential changes in effects compared to the SFLMP. The rules are based on the SFLMP resource management standards, with additional details from guidance adopted by the department. These additions and revisions made to address trust mandate considerations, species status changes, and other improvements in knowledge were all found to be consistent with the SFLMP premise and philosophy (DNRC 2003b).

Forest Inventory

In addition to collecting and analyzing monitoring data, the Forest Management Bureau must make recommendations based on updated results. Providing useful information requires ongoing mapping and data management in order to address the volume of available information. The DNRC plans to continue improving the usability of data for planning and implementing forest management projects. This will include the incorporation of monitoring data into inventory databases and GIS format.

Threatened and Endangered Species

The DNRC is currently in the process of developing a Habitat Conservation Plan (HCP) in cooperation with the U.S. Fish and Wildlife Service. In conjunction with the environmental review of this project, DNRC will examine if the HCP is consistent with the intent of the SFLMP and assess the need for programmatic review of the rules. An initial assessment may occur during development and review of the Draft Environmental Impact Statement associated with the HCP.

Old Growth Management

The DNRC has altered its underlying philosophy regarding old growth retention and management since signing of the SFLMP. To several interested publics the department's current direction remains somewhat unclear on a number of fronts of interest including future old growth amounts, types and intensities of anticipated treatments compatible with old growth, and spatial considerations regarding patch size, shape and location on the landscape. Clarification of some aspects of old growth management is anticipated over the next five years.

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ABBREVIATIONS

ALPFIR	subalpine fir
ARM	Administrative Rules of Montana
BMP	Best Management Practices
CWD	coarse woody debris
dbh	diameter at breast height
DF	Douglas-fir
DFC	Desired Future Conditions
DNRC	Montana Department of Natural Resources and Conservation
ESA	Endangered Species Act
FI	Forest Improvement
FIA	Forest Inventory and Analysis
GIS	geographic information system
LP	lodgepole pine
MBF	thousand board feet
MC	mixed conifer
MEPA	Montana Environmental Protection Act
MFWP	Montana Department of Fish, Wildlife and Parks
MNHP	Montana Natural Heritage Program
MMBF	million board feet
MOU	Memorandum of Understanding
NWLO	Northwest Land Office
PP	ponderosa pine
RMS	Resource Management Standards
ROD	Record of Decision
sd	standard deviation
SFLMP	State Forest Land Management Plan
SLI	stand-level inventory
SMZ	streamside management zone
SWLO	Southwest Land Office
T&E	threatened and endangered (species)
TMDL	total maximum daily load
USFWS	United States Fish and Wildlife Service
WL	western larch
WWP	western white pine

LIST OF PREPARERS

Ross Baty	Wildlife Biologist, Forest Management Bureau
Jim Bower	Fisheries Biologist, Forest Management Bureau
Jeff Collins	Soil Scientist, Forest Management Bureau
Paul Engelman	Economist, Forest Management Bureau
Gary Frank	Resource Management Supervisor, Forest Management Bureau
Brian Long	Technical Services Supervisor, Forest Management Bureau
Mike McGrath	Wildlife Biologist, Southwestern Land Office
Scott McLeod	Forest Ecologist, Forest Management Bureau
Norm Merz	Wildlife Biologist, Northwestern Land Office
Tony Nelson	Hydrologist, Northwestern Land Office
Sarah Pierce	Forest Planner, Forest Management Bureau
Garrett Schairer	Wildlife Biologist, Northwestern Land Office
Frank Sherman	Inventory Forester, Forest Management Bureau
Dana Spanjer	Watershed Intern, Forest Management Bureau
Marc Vessar	Hydrologist, Northwestern Land Office

APPENDIX

SNAG, SNAG RECRUITMENT AND COARSE WOODY DEBRIS MONITORING

Introduction

The objective of this effort is to obtain information that would allow us to compare pre-harvest and post-harvest abundance of snags, large live trees (snag recruitment trees) and coarse woody debris (CWD), that are important habitat elements for a variety of endangered, threatened, sensitive and common terrestrial wildlife species. Information will be used to evaluate compliance with minimum retention levels for snags, residual live trees, and CWD specified in the Biodiversity Guidance (MT DNRC 1998c: 38-43), and to gain broader insight into the effects of our management activities on these habitat components.

Refer to the Monitoring Report under **THREATENED, ENDANGERED AND SENSITIVE SPECIES AND BIG GAME MONITORING**, for a summary and discussion of these results.

Data Summaries

Three sets of tables displaying pre-harvest data for snags, coarse woody debris, and large live trees are given for each of the following timber sales:

Bald Hill Timber Sale
Cyclone Ridge Timber Sale
Evans Lake Timber Sale
Evaro Timber Sale
Fish Sticks Timber Sale
Goat Squeezer Timber Sale
McKillop Timber Sale
Quiet Stems Timber Sale
Sour Fish Timber Sale
Sula Timber Sales

In addition, three sets of tables displaying post-harvest data for Snags, Coarse Woody Debris, and Large Live Trees (snag recruitment trees) are given for each of the following timber sales:

Cyclone Ridge Timber Sale
Evaro Timber Sale
Fishtrap Timber Sale
Good Long Boyle Timber Sale
Quiet Stems Timber Sale
Red Owl Timber Sale
Sula Timber Sales

The tables in this appendix are presented in alphabetical order by sale name.

Abbreviations:

The following abbreviations for tree species are used in species composition tables throughout this appendix:

Abbreviation	Common Name
ABGR	grand fir
ABLA	subalpine fir
BEPA	paper birch
LAOC	western larch
PICO	lodgepole pine
PIEN	Engelmann spruce
PIMO	western white pine
PIPO	ponderosa pine
POBA or POTR	black cottonwood
PSME	Douglas-fir
THPL	western redcedar
TSHE	western hemlock

Table A-1. Snag Pre-harvest Data, All Snags – Bald Hill Salvage Timber Sale Project Area (121 acres, DF/WL cover type)

All snags: n = 89
Average dbh: 12.0"/ sd = 4.4 (range: 8"- 27")
Average height: 57.8'/ sd = 15.6 (range: 35' - 110')

Species Composition	
PSME	66.3%
PIPO	31.5%
LAOC	2.2%

Wildlife Usage	
No use:	84.2%
Feeding:	15.7%
Small cavity (<2"):	0.0%
Large cavity (>2"):	0.0%
Other nest:	0.0%

Top Condition	
Broken	3.4%
Intact	96.6%

Decay Class	
Hard new	98.8%
Hard old	1.1%
Soft new	0.0%
Soft old	0.0%

	Small: 8"- 15"	Medium: 16 - 21"	Large: 22 - 27"	Very Large: 27+"
Plot 1	6	0	0	0
Plot 2	30	4	2	0
Plot 3	40	4	3	0
Avg/Acre	25.3	2.7	1.7	0.00
Std. Dev.	17.5	2.3	1.5	0.00

Table A-2. Snag Pre-harvest Data, Snags >15" Only – Bald Hill Salvage Timber Sale Project Area (121 acres, DF/WL cover type)

Snags greater than 15" only: n = 13
Average dbh: 20.5"/ sd = 3.9 (range: 16"-27")
Average height: 80.8'/ sd = 18.2 (range: 55' - 110')

Species composition	
PSME	15.4%
PIPO	69.2%
LAOC	15.4%

Wildlife Usage	
No use	30.8%
Feeding	69.2%
Small cavity (<2")	0%
Large cavity (>2")	0%
Other nest	0%

Top Condition	
Broken	15.4%
Intact	84.6%

Decay Class	
Hard new	92.3%
Hard soft	7.7%
Soft new	0.0%
Soft old	0.0%

Table A-3. Coarse Woody Debris Pre-harvest Data -- Bald Hill Salvage Timber Sale Project Area (121 acres, DF/WL cover type)

	Hard Pieces	Decayed Pieces
Plot 1	4	0
Plot 2	3	1
Plot 3	2	0
Total pieces	9	1
average	3.0	0.3
sd	1.0	0.6

	Large Pieces	Small Pieces
Plot 1	0	4
Plot 2	0	4
Plot 3	1	1
Total pieces	1	9
average	0.3	3.0
sd	0.6	1.7

Average diameter at intersect	
Hard	6.7"
sd	4.7"
Soft	4.0"
sd	0

Table A-4. Coarse Woody Debris Pre-harvest Data, Variability of Piece Distribution -- Bald Hill Salvage Timber Sale Project Area (121 acres, DF/WL cover type)

	Plot 1	Plot 2	Plot 3
subunit 1	1	0	0
subunit 2	0	0	0
subunit 3	0	1	0
subunit 4	0	1	0
subunit 5	0	1	0
subunit 6	1	0	1
subunit 7	0	0	0
subunit 8	0	1	1
subunit 9	1	0	0
subunit 10	1	0	0
avg/ subunit	0.4	0.4	0.2
sd	0.5	0.5	0.4

Table A-5. Coarse Woody Debris Pre-harvest Data, Tons/Acre -- Bald Hill Salvage Timber Sale Project Area (121 acres, DF/WL cover type)

	Plot 1	Plot 2	Plot 3
Hard	0.67	0.95	2.51
Soft	0.00	0.09	0.00
Total	**0.67**	**1.14**	**2.51**

Total avg. for all plots - hard:	1.38 (sd 1.0)
Total avg. for all plots - soft:	0.03 (sd 0.05)
Total avg. all plots - hard and soft	1.41 (sd 1.0)

Table A-6. Large Live Tree Pre-harvest Data -- Bald Hill Salvage Timber Sale Project Area (121 acres, DF/WL cover type)

All trees: n = 7
Average dbh: 23.5"/ sd = 5.5 (range: 17"- 31")
Average height: 100.0'/ sd = 15.0 (range: 70' - 110')

Species composition	
PSME	42.8%
PIPO	42.8%
LAOC	14.3%

Wildlife Usage	
No use	42.8%
Feeding	42.8%
Small cavity (<2")	14.3%
Large cavity (>2")	0.0%
Other nest	0.0%

Top Condition	
Broken	14.3%
Intact	85.7%

Attributes	
Top dead but intact	0%
Insect/ Disease evident	28.6%
Scars/ Cat faces	14.3%
Conks present	8.3%

	Medium: 16 - 21"	**Large: 22 - 27"**	**Very Large: 27+"**	**Total**
Plot 1	0	0	1	**1**
Plot 2	3	0	2	**5**
Plot 3	1	0	0	**1**
Avg/Acre	1.3	0.0	1.0	**2.3**
Std. Dev.	1.5	0.0	1.0	**2.3**

Table A-7. Snag Pre-harvest Data, All Snags – Cyclone Ridge Timber Sale Project Area (Unit 3B, 58 acres, MC cover type)

All snags: n = 219
Average dbh: 11.8"/ sd = 3.7 (range: 8"- 37")
Average height: 58.8'/ sd = 17.3 (range: 8' - 150')

Species Composition	
PSME	2.7%
PIEN	6.4%
PICO	2.7%
LAOC	1.8%
ABLA	85.8%
N/A	0.4%

Wildlife Usage	
No use:	73.0%
Feeding:	21.9%
Small cavity (<2"):	1.8%
Large cavity (>2"):	3.2%
Other nest:	0.0%

Top Condition	
Broken	5.0%
Intact	95.0%

Decay Class	
Hard new	81.7%
Hard old	5.9%
Soft new	10.5%
Soft old	1.8%

	Small: 8"- 15"	**Medium: 16 - 21"**	**Large: 22 - 27"**	**Very Large: 27+"**
Plot 1	49	6	1	0
Plot 2	84	8	0	1
Plot 3	15	3	0	0
Plot 4	47	3	1	1
Avg/Acre	48.8	5.0	0.5	0.3
Std. Dev.	28.2	2.4	0.6	0.6

Table A-8. Snag Pre-harvest Data, Snags >15" Only -- Cyclone Ridge Timber Sale Project Area (Unit 3B, 58 acres, MC cover type)

Snags greater than 15" only: n = 24
Average dbh: 19.7"/ sd = 5.2 (range: 16"-37")
Average height: 73.5'/ sd = 23.4 (range: 20' - 150')

Species composition	
PSME	16.7%
PIEN	16.7%
PICO	12.5%
LAOC	8.3%
ABLA	45.8%

Wildlife Usage	
No use	50.0%
Feeding	50.0%
Small cavity (<2")	0%
Large cavity (>2")	0%
Other nest	0%

Top Condition	
Broken	8.3%
Intact	91.7%

Decay Class	
Hard new	62.5%
Hard soft	0.0%
Soft new	33.3%
Soft old	4.2%

Table A-9. Coarse Woody Debris Pre-harvest Data -- Cyclone Ridge Timber Sale Project Area (Unit 3B, 58 acres, MC cover type)

	Hard Pieces	Decayed Pieces
Plot 1	24	37
Plot 2	20	40
Plot 3	11	23
Plot 4	16	23
Total pieces	71	123
average	17.8	30.8
sd	5.6	9.0

	Large Pieces	Small Pieces
Plot 1	9	52
Plot 2	4	56
Plot 3	5	29
Plot 4	2	37
Total pieces	20	174
average	5.0	43.5
sd	2.9	12.7

Average diameter at intersect	
Hard	7.9"
sd	0.4"
Soft	7.6"
sd	0.2"

Table A-10. Coarse Woody Debris Pre-harvest Data, Variability of Piece Distribution -- Cyclone Ridge Timber Sale Project Area (Unit 3B, 58 acres, MC cover type)

	Plot 1	Plot 2	Plot 3	Plot 4
subunit 1	4	8	1	6
subunit 2	11	12	4	7
subunit 3	3	6	4	3
subunit 4	8	3	2	5
subunit 5	7	5	3	3
subunit 6	5	3	4	2
subunit 7	1	4	4	0
subunit 8	2	6	3	4
subunit 9	8	7	5	2
subunit 10	12	6	4	7
avg/ subunit	6.1	6.0	3.4	3.9
sd	3.7	2.7	1.2	2.3

Table A-11. Coarse Woody Debris Pre-harvest Data, Tons/Acre -- Cyclone Ridge Timber Sale Project Area (Unit 3B, 58 acres, MC cover type)

	Plot 1	Plot 2	Plot 3	Plot 4
Hard	12.43	11.20	5.68	7.38
Soft	13.74	13.43	8.05	7.63
Total	**26.17**	**24.63**	**13.73**	**15.01**

Total avg. for all plots - hard:	9.17 (sd 3.17)
Total avg. for all plots - soft:	10.71 (sd 3.32)
Total avg. all plots - hard and soft	19.9 (sd 6.42)

Table A-12. Large Live Tree Pre-harvest Data -- Cyclone Ridge Timber Sale Project Area (Unit 3B, 58 acres, MC cover type)

All trees: n = 35	
Average dbh: 21.5"/ sd = 5.4	(range: 16"- 36")
Average height: 98.3'/ sd = 14.4	(range: 70' - 150')

Species composition	
PSME	5.7%
PIEN	48.6%
LAOC	20.0%
ABLA	25.7%

Wildlife Usage	
No use	68.6%
Feeding	28.6%
Small cavity (<2")	0%
Large cavity (>2")	2.9%
Other nest	0.0%

Top Condition	
Broken	0.0%
Intact	100.0%

Attributes	
Top dead but intact	0%
Insect/ Disease evident	25.7%
Scars/ Cat faces	65.7%
Conks present	5.7%

	Medium: 16 - 21"	**Large: 22 - 27"**	**Very Large: 27+"**	**Total**
Plot 1	1	0	0	**1**
Plot 2	1	0	0	**1**
Plot 3	16	6	1	**23**
Plot 4	3	2	5	**10**
Avg/Acre	5.3	2.0	1.5	**8.8**
Std. Dev.	7.2	2.8	2.4	**10.4**

Table A-13. Snag Post-harvest Data, All Snags – Cyclone Ridge Timber Sale Project Area (Unit 3B, 58 acres, MC cover type)

All snags: n = 41	
Average dbh: 12.4"/ sd = 6.1	(range: 8"- 38")
Average height: 57.1'/ sd = 22.1	(range: 8' - 115')

Species Composition	
ABLA	82.9%
LAOC	7.3%
PICO	2.4%
PIEN	2.4%
PSME	4.9%

Wildlife Usage	
No use:	78.0%
Feeding:	22.0%
Small cavity (<2"):	0%
Large cavity (>2"):	0%
Other nest:	0.0%

Top Condition	
Broken	14.6%
Intact	85.4%

Decay Class	
Hard new	82.9%
Hard old	9.8%
Soft new	4.9%
Soft old	2.4%

	Small: 8"- 15"	Medium: 16 - 21"	Large: 22 - 27"	Very Large: 27+"
Plot 1	11	2	2	0
Plot 2	11	0	0	1
Plot 3	8	1	0	0
Plot 4	3	1	1	0
Avg/Acre	8.3	1.0	0.8	0.3
Std. Dev.	3.8	0.8	1.0	0.5

Table A-14. Snag Post-harvest Data, Snags >15" Only – Cyclone Ridge Timber Sale Project Area (Unit 3B, 58 acres, MC cover type)

Snags greater than 15" only: n = 24	
Average dbh: 22.8"/ sd = 7.2	(range: 16"-38")
Average height: 69.8'/ sd = 36.7	(range: 8' - 115')

Species composition	
ABLA	37.5%
LAOC	37.5%
PSME	25.0%

Wildlife Usage	
No use	50.0%
Feeding	75.0%
Small cavity (<2")	0%
Large cavity (>2")	0%
Other nest	0%

Top Condition	
Broken	25.0%
Intact	75.0%

Decay Class	
Hard new	75.0%
Hard soft	12.5%
Soft new	0.0%
Soft old	12.5%

Table A-15. Coarse Woody Debris Post-harvest Data -- Cyclone Ridge Timber Sale Project Area (Unit 3B, 58 acres, MC cover type)

	Hard Pieces	Decayed Pieces
Plot 1	59	0
Plot 2	60	3
Plot 3	44	8
Plot 4	52	10
Total pieces	215	21
average	53.8	5.3
sd	7.4	4.6

	Large Pieces	Small Pieces
Plot 1	0	59
Plot 2	3	60
Plot 3	1	51
Plot 4	11	51
Total pieces	15	221
average	3.8	55.3
sd	5.0	4.9

Average diameter at intersect	
Hard	6.7"
sd	0.6"
Soft	5.4"
sd	4.0"

Table A-16. Coarse Woody Debris Post-harvest Data, Variability of Piece Distribution -- Cyclone Ridge Timber Sale Project Area (Unit 3B, 58 acres, MC cover type)

	Plot 1	Plot 2	Plot 3	Plot 4
subunit 1	6	9	2	9
subunit 2	13	11	4	10
subunit 3	7	8	2	5
subunit 4	8	6	5	6
subunit 5	2	4	4	9
subunit 6	8	4	6	4
subunit 7	3	3	3	1
subunit 8	1	5	5	2
subunit 9	3	6	11	10
subunit 10	8	7	10	6
avg/ subunit	5.9	6.3	5.2	6.2
sd	3.7	2.5	3.1	3.3

Table A-17. Coarse Woody Debris Post-harvest Data, Tons/Acre -- Cyclone Ridge Timber Sale Project Area (Unit 3B, 58 acres, MC cover type)

	Plot 1	Plot 2	Plot 3	Plot 4
Hard	19.8	27.7	12.5	22.1
Soft	0.0	0.4	3.3	4.3
Total	**19.8**	**28.1**	**15.8**	**26.4**

Total avg. for all plots - hard:	20.5 (sd: 6.3)
Total avg. for all plots - soft:	2.0 (sd: 2.1)
Total avg. all plots - hard and soft	22.5 (sd: 5.70)

Table A-18. Large Live Tree Post-harvest Data -- Cyclone Ridge Timber Sale Project Area (Unit 3B, 58 acres, MC cover type)

All trees: n = 11
Average dbh: 28.6"/ sd = 6.1 (range: 19"- 38")
Average height: 96.8'/ sd = 20.2 (range: 70' - 130')

Species composition	
ABLA	9.1%
LAOC	72.7%
PSME	18.2%

Wildlife Usage	
No use	27.3%
Feeding	72.7%
Small cavity (<2")	0.0%
Large cavity (>2")	0.0%
Other nest	0.0%

Top Condition	
Broken	0.0%
Intact	100.0%

Attributes	
Top dead but intact	9.1%
Insect/ Disease evident	0.0%
Scars/ Cat faces	9.1%
Conks present	18.2%

	Medium: 16 - 21"	**Large: 22 - 27"**	**Very Large: 27+"**	**Total**
Plot 1	0	0	0	**0**
Plot 2	0	0	0	**0**
Plot 3	1	1	1	**3**
Plot 4	1	1	6	**8**
Avg/Acre	0.5	0.5	1.8	**0.9**
Std. Dev.	0.6	0.6	2.9	**1.3**

Table A-19. Snag Pre-harvest Data, All Snags – Evans Lake Timber Sale Project Area (Unit Dry East, 11 acres, PIPO cover type)

All snags: n = 5		
Average dbh:	14.8"/ sd = 7.1	(range: 9.4" - 27.9")
Average height:	41.2'/ sd = 6.0	(range: 35' - 48')

Species Composition	
POTR	60.0%
PIPO	40.0%

Wildlife Usage	
No use:	40.0%
Feeding:	60.0%
Small cavity (<2"):	0.0%
Large cavity (>2"):	0.0%
Other nest:	0.0%

Top Condition	
Broken	80.0%
Intact	20.0%

Decay Class	
Hard new	80.0%
Hard old	0.0%
Soft new	20.0%
Soft old	0.0%

	Small: 8"- 15"	Medium: 16 - 21"	Large: 22 - 27"	Very Large: 27+"
Plot 1	3	0	0	1
Plot 2	1	0	0	0
Avg/Acre	2.0	0.0	0.0	0.5
Std. Dev.	1.4	0.0	0.0	0.7

Table A-20. Snag Pre-harvest Data, Snags >15" Only -- Evans Lake Timber Sale Project Area (Unit Dry East, 11 acres, PIPO cover type)

Snags greater than 15" only: n = 1	
dbh:	27.9"
height:	35'

Species composition	
PSME	100%

Wildlife Usage	
No use	100.0%
Feeding	
Small cavity (<2")	
Large cavity (>2")	
Other nest	

Top Condition	
Broken	100%
Intact	

Decay Class	
Hard new	
Hard soft	
Soft new	100%
Soft old	

Table A-21. Coarse Woody Debris Pre-harvest Data -- Evans Lake Timber Sale Project Area (Unit Dry East, 11 acres, PIPO cover type)

	Hard Pieces	Decayed Pieces
Plot 1	14	8
Plot 2	6	0
Total pieces	20	8
average	10	4
sd	5.7	5.7

	Large Pieces	Small Pieces
Plot 1	3	19
Plot 2	0	6
Total pieces	3	25
average	1.5	12.5
sd	2.1	9.2

Average diameter at intersect	
Hard	5.1"
sd	2.3"
Soft	9.0"
sd	N/A

Table A-22. Coarse Woody Debris Pre-harvest Data, Variability of Piece Distribution -- Evans Lake Timber Sale Project Area (Unit Dry East, 11 acres, PIPO cover type)

	Plot 1	Plot 2
subunit 1	3	1
subunit 2	1	0
subunit 3	3	3
subunit 4	6	1
subunit 5	4	0
subunit 6	3	0
subunit 7	0	0
subunit 8	1	1
subunit 9	0	--
subunit 10	1	--
avg/ subunit	2.2	0.8
sd	1.9	1.0

Table A-23. Coarse Woody Debris Pre-harvest Data, Tons/Acre -- Evans Lake Timber Sale Project Area (Unit Dry East, 11 acres, PIPO cover type)

	Plot 1	Plot 2
Hard	0.99	4.14
Soft	6.73	0.00
Total	**7.72**	**4.14**

Total avg. for all plots - hard:	2.57 (sd = 2.23)
Total avg. for all plots - soft:	3.37 (sd = 4.76)
Total avg. all plots - hard and soft	5.93 (sd = 2.53)

Table A-24. Large Live Tree Pre-harvest Data -- Evans Lake Timber Sale Project Area (Unit Dry East, 11 acres, PIPO cover type)

All trees: n = 24
Average dbh: 25.2"/ sd = 3.9 (range: 21.1"- 37.0")
Average height: 89.6'/ sd = 10.9 (range: 76' - 113')

Species composition	
PSME	37.5%
PIPO	62.5%

Wildlife Usage	
No use	79.2%
Feeding	20.8%
Small cavity (<2")	0%
Large cavity (>2")	0%
Other nest	0.0%

Top Condition	
Broken	0.0%
Intact	100.0%

Attributes	
Top dead but intact	0%
Insect/ Disease evident	0%
Scars/ Cat faces	4.2%
Conks present	0%

	Medium: 16 - 21"	**Large: 22 - 27"**	**Very Large: 27+"**	**Total**
Plot 1	2	8	4	**14**
Plot 2	0	9	1	**10**
Avg/Acre	1.0	8.5	2.5	**12.0**
Std. Dev.	1.4	0.7	2.1	**2.8**

Table A-25. Snag Pre-harvest Data, All Snags – Evaro Timber Sale Project Area (Unit 1397, 30 acres, LAOC cover type)

All snags: n = 24	
Average dbh: 13.1"/ sd = 3.8	(range: 8.1"- 22.5")
Average height: 41.8'/ sd = 27.2	(range: 7' - 80')

Species Composition	
PSME	8.3%
ABGR	70.8%
LAOC	20.8%

Wildlife Usage	
No use:	16.7%
Feeding:	62.5%
Small cavity (<2"):	29.2%
Large cavity (>2"):	25.0%
Other nest:	0.0%

Top Condition	
Broken	45.8%
Intact	54.2%

Decay Class	
Hard new	29.2%
Hard old	33.3%
Soft new	25.0%
Soft old	12.5%

	Small: 8"- 15"	**Medium: 16 - 21"**	**Large: 22 - 27"**	**Very Large: 27+"**
Plot 1	9	0	1	0
Plot 2	9	4	1	0
Avg/Acre	9.0	2.0	1.0	0.0
Std. Dev.	0.0	2.8	0.0	0.0

Table A-26. Snag Pre-harvest Data, Snags >15" Only – Evaro Timber Sale Project Area (Unit 1397, 30 acres, LAOC cover type)

Snags greater than 15" only: n = 6	
Average dbh: 18.1"/ sd = 3.4	(range: 15.3"-22.5")
Average height: 41.7'/ sd = 35.6	(range: 7' - 80')

Species composition	
LAOC	33.3%
ABGR	66.7%

Wildlife Usage	
No use	33.3%
Feeding	66.7%
Small cavity (<2")	33.3%
Large cavity (>2")	33.3%
Other nest	0%

Top Condition	
Broken	50.0%
Intact	50.0%

Decay Class	
Hard new	16.7%
Hard soft	50.0%
Soft new	33.3%
Soft old	0.0%

Table A-27. Coarse Woody Debris Pre-harvest Data -- Evaro Timber Sale Project Area (Unit 1397, 30 acres, LAOC cover type)

	Hard Pieces	Decayed Pieces
Plot 1	33	10
Plot 2	15	18
Total pieces	48	28
average	24.0	14.0
sd	12.7	5.7

	Large Pieces	Small Pieces
Plot 1	5	38
Plot 2	8	25
Total pieces	13	63
average	6.5	31.5
sd	2.1	9.2

Average diameter at intersect	
Hard	6.4"
sd	4.2"
Soft	6.3"
sd	3.0"

Table A-28. Coarse Woody Debris Pre-harvest Data, Variability of Piece Distribution -- Evaro Timber Sale Project Area (Unit 1397, 30 acres, LAOC cover type)

	Plot 1	Plot 2
subunit 1	5	2
subunit 2	7	1
subunit 3	5	2
subunit 4	0	5
subunit 5	4	2
subunit 6	6	3
subunit 7	7	0
subunit 8	4	5
subunit 9	1	5
subunit 10	4	8
avg/ subunit	4.3	3.3
sd	2.3	2.4

Table A-29. Coarse Woody Debris Pre-harvest Data, Tons/Acre -- Evaro Timber Sale Project Area (Unit 1397, 30 acres, LAOC cover type)

	Plot 1	Plot 4
Hard	8.04	11.79
Soft	1.47	5.56
Total	**9.51**	**17.35**

Total avg. for all plots - hard:	9.92 (sd 2.7)
Total avg. for all plots - soft:	3.51 (sd 2.9)
Total avg. all plots - hard and soft	13.4 (sd 5.5)

Table A-30. Large Live Tree Pre-harvest Data -- Evaro Timber Sale Project Area (Unit 1397, 30 acres, LAOC cover type)

All trees: n = 44	
Average dbh: 17.8"/ sd = 2.2	(range: 15.0"- 24.2")
Average height: 84.3'/ sd = 12.1	(range: 60' - 115')

Species composition	
PSME	34.1%
ABGR	34.1%
LAOC	31.8%

Wildlife Usage	
No use	61.4%
Feeding	36.4%
Small cavity (<2")	0%
Large cavity (>2")	2.3%
Other nest	2.3%

Top Condition	
Broken	2.3%
Intact	97.7%

Attributes	
Top dead but intact	4.5%
Insect/ Disease evident	15.9%
Scars/ Cat faces	18.2%
Conks present	9.1%

	Medium: 16 - 21"	**Large: 22 - 27"**	**Very Large: 27+"**	**Total**
Plot 1	14	2	0	**16**
Plot 2	26	2	0	**28**
Avg/Acre	20.0	2.0	0.0	**22.0**
Std. Dev.	8.5	0.0	0.0	**8.5**

Table A-31. Snag Post-harvest Data, All Snags – Evaro Timber Sale Project Area (Unit 1397, 30 acres, LAOC cover type)

All snags: n = 3
Average dbh: 18.0"/ sd = 3.5 (range: 15.7"- 22.0")
Average height: 41.3'/ sd = 47.4 (range: 13' - 96')

Species Composition	
ABGR	66.6%
LAOC	33.3%

Wildlife Usage	
No use:	33.3%
Feeding:	66.6%
Small cavity (<2"):	33.3%
Large cavity (>2"):	33.3%
Other nest:	0.0%

Top Condition	
Broken	66.6%
Intact	33.3%

Decay Class	
Hard new	0.0%
Hard old	33.3%
Soft new	66.6%
Soft old	0.0%

	Small: 8"- 15"	Medium: 16 - 21"	Large: 22 - 27"	Very Large: 27+"
Plot 1	0	0	0	0
Plot 2	0	2	1	0
Avg/Acre	0.0	1.0	0.5	0.0
Std. Dev.	0.0	1.4	0.7	0.0

Snag Post-harvest Data, Snags >15" Only – Same as above for Evaro Timber Sale Project Area (Unit 1397, 30 acres, LAOC cover type)

Table A-32. Coarse Woody Debris Post-harvest Data -- Evaro Timber Sale Project Area (Unit 1397, 30 acres, LAOC cover type)

	Hard Pieces	Decayed Pieces
Plot 1	54	13
Plot 2	40	13
Total pieces	94	26
average	47.0	13.0
sd	9.9	0.0

	Large Pieces	Small Pieces
Plot 1	3	64
Plot 2	5	48
Total pieces	8	112
average	4.0	56.0
sd	1.4	11.3

Average diameter at intersect	
Hard	5.3"
sd	3.1"
Soft	7.7"
sd	2.8"

Table A-33. Coarse Woody Debris Post-harvest Data, Variability of Piece Distribution -- Evaro Timber Sale Project Area (Unit 1397, 30 acres, LAOC cover type)

	Plot 1	Plot 2
subunit 1	4	2
subunit 2	6	3
subunit 3	10	4
subunit 4	3	5
subunit 5	7	4
subunit 6	3	10
subunit 7	10	3
subunit 8	14	9
subunit 9	5	5
subunit 10	5	8
avg/ subunit	6.7	5.3
sd	3.6	2.8

Table A-34. Coarse Woody Debris Post-harvest Data, Tons/Acre -- Evaro Timber Sale Project Area (Unit 1397, 30 acres, LAOC cover type)

	Plot 1	Plot 2
Hard	10.67	14.47
Soft	4.47	4.79
Total	**15.14**	**19.26**

Total avg. for all plots - hard:	12.57 (sd 2.7)
Total avg. for all plots - soft:	4.63 (sd 0.2)
Total avg. all plots - hard and soft	17.2 (sd 2.9)

Table A-35. Large Live Tree Post-harvest Data -- Evaro Timber Sale Project Area (Unit 1397, 30 acres, LAOC cover type)

All trees: n = 2
Average dbh: 18.7"/ sd = 3.2 (range: 16.4"- 20.9")
Average height: 88.5'/ sd = 6.4 (range: 84' - 93')

Species composition	
PSME	100.0%

Wildlife Usage	
No use	50.0%
Feeding	50.0%
Small cavity (<2")	0.0%
Large cavity (>2")	0.0%
Other nest	0.0%

Top Condition	
Broken	0.0%
Intact	100.0%

Attributes	
Top dead but intact	0.0%
Insect/ Disease evident	50.0%
Scars/ Cat faces	50.0%
Conks present	0.0%

	Medium: 16 - 21"	**Large: 22 - 27"**	**Very Large: 27+"**	**Total**
Plot 1	0	0	0	**0**
Plot 2	2	0	0	**2**
Avg/Acre	1.0	0.0	0.0	**1.0**
Std. Dev.	1.4	0.0	0.0	**1.4**

Table A-36. Snag Post-harvest Data, All Snags – Fishtrap Timber Sale Project Area (Unit 2, 98 acres, WL/DF cover type)

All snags: n = 13
Average dbh: 14.9"/ sd = 6.3 (range: 8.0"- 32.0")
Average height: 45.1'/ sd = 37.5 (range: 7' - 120')

Species Composition	
LAOC	23.1%
PICO	23.1%
PIPO	7.7%
PSME	46.1%

Wildlife Usage	
No use:	23.1%
Feeding:	53.8%
Small cavity (<2"):	15.4%
Large cavity (>2"):	7.7%
Other nest:	0.0%

Top Condition	
Broken	69.2%
Intact	30.8%

Decay Class	
Hard new	15.3%
Hard old	15.3%
Soft new	69.2%
Soft old	0.0%

	Small: 8"- 15"	Medium: 16 - 21"	Large: 22 - 27"	Very Large: 27+"
Plot 1	4	2	0	0
Plot 2	1	0	1	1
Plot 3	1	0	0	0
Plot 4	3	0	0	0
Avg/Acre	2.3	0.5	0.3	0.3
Std. Dev.	1.5	1.0	0.5	0.5

Table A-37. Snag Post-harvest Data, Snags >15" Only – Fishtrap Timber Sale Project Area (Unit 2, 98 acres, WL/DF cover type)

Snags greater than 15" only: n = 4
Average dbh: 21.8"/ sd = 7.3 (range: 16.0"- 32.0")
Average height: 57.5'/ sd = 45.0 (range: 20' - 120')

Species composition	
LAOC	50.0%
PIPO	25.0%
PSME	25.0%

Wildlife Usage	
No use	0.0%
Feeding	25.0%
Small cavity (<2")	50.0%
Large cavity (>2")	25.0%
Other nest	0%

Top Condition	
Broken	100.0%
Intact	0.0%

Decay Class	
Hard new	0.0%
Hard soft	25.0%
Soft new	75.0%
Soft old	0.0%

Table A-38. Coarse Woody Debris Post-harvest Data -- Fishtrap Timber Sale Project Area (Unit 2, 98 acres, WL/DF cover type)

	Hard Pieces	Decayed Pieces
Plot 1	43	15
Plot 2	28	16
Plot 3	78	32
Plot 4	91	22
Total pieces	240	85
average	60.0	21.3
sd	29.4	7.8

	Large Pieces	Small Pieces
Plot 1	3	55
Plot 2	0	44
Plot 3	1	109
Plot 4	0	113
Total pieces	4	321
average	1.0	80.3
sd	1.4	35.8

Average diameter at intersect	
Hard	5.4"
sd	1.8"
Soft	6.9"
sd	2.6"

Table A-39. Coarse Woody Debris Post-harvest Data, Variability of Piece Distribution -- Fishtrap Timber Sale Project Area (Unit 2, 98 acres, WL/DF cover type)

	Plot 1	Plot 2	Plot 3	Plot 4
subunit 1	16	7	5	9
subunit 2	7	7	5	8
subunit 3	5	3	9	15
subunit 4	5	3	13	20
subunit 5	5	3	10	11
subunit 6	6	3	10	1
subunit 7	6	6	12	11
subunit 8	5	1	17	6
subunit 9	1	2	16	17
subunit 10	2	9	13	15
avg/ subunit	5.8	4.4	11.0	11.3
sd	4.0	2.6	4.1	5.6

Table A-40. Coarse Woody Debris Post-harvest Data, Tons/Acre -- Fishtrap Timber Sale Project Area (Unit 2, 98 acres, WL/DF cover type)

	Plot 1	Plot 2	Plot 3	Plot 4
Hard	8.40	5.67	18.16	22.35
Soft	5.11	4.45	9.69	5.00
Total	**13.51**	**10.12**	**27.85**	**27.35**

Total avg. for all plots - hard:	13.64 (sd = 7.9)
Total avg. for all plots - soft:	6.06 (sd = 2.4)
Total avg. all plots - hard and soft	19.71 (sd = 9.2)

Table A-41. Large Live Tree Post-harvest Data -- Fishtrap Timber Sale Project Area (Unit 2, 98 acres, WL/DF cover type)

All trees: n = 20	
Average dbh: 20.2"/ sd = 3.1	(range: 15.4"- 29.0")
Average height: 102'/ sd = 8.9	(range: 85' - 130')

Species composition	
PSME	55.0%
LAOC	20.0%
PIPO	25.0%

Wildlife Usage	
No use	75.0%
Feeding	25.0%
Small cavity (<2")	0.0%
Large cavity (>2")	0.0%
Other nest	0.0%

Top Condition	
Broken	0.0%
Intact	100.0%

Attributes	
Top dead but intact	0.0%
Insect/ Disease evident	0.0%
Scars/ Cat faces	40.0%
Conks present	15.0%

	Medium: 16 - 21"	**Large: 22 - 27"**	**Very Large: 27+"**	**Total**
Plot 1	3	0	0	**3**
Plot 2	7	1	0	**8**
Plot 3	3	0	0	**3**
Plot 4	1	3	1	**5**
Avg/Acre	3.5	1.0	0.3	**5.0**
Std. Dev.	2.5	1.4	0.5	**2.4**

Table A-42. Snag Pre-harvest Data, All Snags – Fish Sticks Timber Sale Project Area (Cable Unit, 385 acres, ABGR/ LIBO-LIBO cover type)

All snags: n = 40	
Average dbh: 20.2"/ sd = 4.2	(range: 15.0" - 30.7")
Average height: 83.1'/ sd = 21.5	(range: 33' - 120')

Species Composition	
LAOC	52.5%
PIPO	10.0%
PSME	37.5%

Wildlife Usage	
No use:	92.5%
Feeding:	7.5%
Small cavity (<2"):	0.0%
Large cavity (>2"):	0.0%
Other nest:	0.0%

Top Condition	
Broken	30.0%
Intact	70.0%

Decay Class	
Hard new	97.5%
Hard old	2.5%
Soft new	0.0%
Soft old	0.0%

	Small: 8"- 15"	Medium: 16 - 21"	Large: 22 - 27"	Very Large: 27+"
Plot 1	0	10	3	1
Plot 2	1	16	3	5
Avg/Acre	0.5	13.0	3.0	3.0
Std. Dev.	0.7	4.2	0.0	2.8

Snag Pre-harvest Data, Snags >15" Only – Same as above for Fish Sticks Timber Sale Project Area (Unit 1397, 30 acres, LAOC cover type)

Table A-43. Coarse Woody Debris Pre-harvest Data -- Fish Sticks Timber Sale Project Area (Cable Unit, 385 acres, ABGR/ LIBO-LIBO cover type)

	Hard Pieces	Decayed Pieces
Plot 1	17	4
Plot 2	26	1
Total pieces	43	5
average	21.5	2.5
sd	6.4	2.1

	Large Pieces	Small Pieces
Plot 1	5	16
Plot 2	4	23
Total pieces	9	39
average	4.5	19.5
sd	0.7	4.9

Average diameter at intersect	
Hard	7.9"
sd	4.5"
Soft	9.8"
sd	5.3"

Table A-44. Coarse Woody Debris Pre-harvest Data, Variability of Piece Distribution -- Fish Sticks Timber Sale Project Area (Cable Unit, 385 acres, ABGR/ LIBO-LIBO cover type)

	Plot 1	Plot 2
subunit 1	3	5
subunit 2	0	1
subunit 3	1	5
subunit 4	3	3
subunit 5	1	2
subunit 6	3	2
subunit 7	2	1
subunit 8	5	3
subunit 9	1	2
subunit 10	2	3
avg/ subunit	2.1	2.8
sd	1.4	1.6

Table A-45. Coarse Woody Debris Pre-harvest Data, Tons/Acre -- Fish Sticks Timber Sale Project Area (Cable Unit, 385 acres, ABGR/ LIBO-LIBO cover type)

	Plot 1	Plot 2
Hard	12.44	12.35
Soft	2.70	0.55
Total	**15.14**	**12.90**

Total avg. for all plots - hard:	12.40 (sd = 0.06)
Total avg. for all plots - soft:	1.63 (sd = 1.52)
Total avg. all plots - hard and soft	14.02 (sd = 1.58)

***Large Live Tree Pre-harvest Data -- Fish Sticks Timber Sale followed a Stand-replacement fire -- no live trees remaining**

Table A-46. Snag Pre-harvest Data, All Snags – Goat Squeezer Timber Sale Project Area (Unit 4, 51 acres, MC cover type)

All snags: n = 33		
Average dbh:	16.9"/ sd = 6.1	(range: 8.0" - 31.8")
Average height:	43.1'/ sd = 29.1	(range: 7.0' - 110')

Species Composition	
BEPA	9.1%
THPL	3.0%
PSME	9.1%
PIEN	30.3%
ABGR	24.2%
LAOC	24.2%

Wildlife Usage	
No use:	30.3%
Feeding:	63.6%
Small cavity (<2"):	6.1%
Large cavity (>2"):	0.0%
Other nest:	0.0%

Top Condition	
Broken	66.7%
Intact	33.3%

Decay Class	
Hard new	18.2%
Hard old	42.4%
Soft new	27.3%
Soft old	12.1%

	Small: 8"- 15"	Medium: 16 - 21"	Large: 22 - 27"	Very Large: 27+"
Plot 1	6	2	3	1
Plot 2	3	1	0	0
Plot 3	7	6	3	1
Avg/Acre	5.3	3.0	2.0	0.7
Std. Dev.	2.1	2.6	1.7	0.6

Table A-47. Snag Pre-harvest Data, Snags >15" Only – Goat Squeezer Timber Sale Project Area (Unit 4, 51 acres, MC cover type)

Snags greater than 15" only: n = 17		
Average dbh:	21.7"/ sd = 4.3	(range: 16.0" - 31.8")
Average height:	43.9'/ sd = 32.1	(range: 7.0' - 110')

Species composition	
BEPA	17.6%
PSME	5.9%
PIEN	29.4%
ABGR	5.9%
LAOC	41.2%

Wildlife Usage	
No use	29.4%
Feeding	64.7%
Small cavity (<2")	5.9%
Large cavity (>2")	0%
Other nest	0%

Top Condition	
Broken	76.5%
Intact	23.5%

Decay Class	
Hard new	23.5%
Hard soft	35.3%
Soft new	29.4%
Soft old	11.8%

Table A-48. Coarse Woody Debris Pre-harvest Data -- Goat Squeezer Timber Sale Project Area (Unit 4, 51 acres, MC cover type)

	Hard Pieces	Decayed Pieces
Plot 1	9	22
Plot 2	4	17
Plot 3	9	27
Total pieces	22	66
average	7.3	22.0
sd	2.9	5.0

	Large Pieces	Small Pieces
Plot 1	5	26
Plot 2	4	17
Plot 3	7	29
Total pieces	16	72
average	5.3	24.0
sd	1.5	6.2

Average diameter at intersect	
Hard	7.6"
sd	4.6"
Soft	8.3"
sd	5.7"

Table A-49. Coarse Woody Debris Pre-harvest Data, Variability of Piece Distribution -- Goat Squeezer Timber Sale Project Area (Unit 4, 51 acres, MC cover type)

	Plot 1	Plot 2	Plot 3
subunit 1	1	2	4
subunit 2	4	3	2
subunit 3	5	2	2
subunit 4	1	1	4
subunit 5	3	3	2
subunit 6	2	1	2
subunit 7	2	2	5
subunit 8	3	2	6
subunit 9	7	3	5
subunit 10	3	2	4
avg/ subunit	3.1	2.1	3.6
sd	1.9	0.7	1.5

Table A-50. Coarse Woody Debris Pre-harvest Data, Tons/Acre -- Goat Squeezer Timber Sale Project Area (Unit 4, 51 acres, MC cover type)

	Plot 1	Plot 2	Plot 3
Hard	2.55	0.69	8.82
Soft	11.44	11.65	12.15
Total	**13.99**	**12.34**	**20.97**

Total avg. for all plots - hard:	4.02 (sd = 4.26)
Total avg. for all plots - soft:	11.75 (sd = 0.36)
Total avg. all plots - hard and soft	15.77 (sd = 4.58)

Table A-51. Large Live Tree Pre-harvest Data – Goat Squeezer Timber Sale Project Area (Unit 4, 51 acres, MC cover type)

All trees: n = 110			
Average dbh:	20.3"/ sd = 5.9	(range:	15.0"- 37.6")
Average height:	91.1'/ sd = 17.8	(range:	14' - 125')

Species composition	
BEPA	8.2%
THPL	36.4%
POBA	2.7%
PSME	6.4%
PIEN	12.7%
ABGR	5.5%
LAOC	28.2%

Wildlife Usage	
No use	80.9%
Feeding	18.2%
Small cavity (<2")	0.0%
Large cavity (>2")	0.0%
Other nest	1.0%

Top Condition	
Broken	4.5%
Intact	95.4%

Attributes	
Top dead but intact	6.4%
Insect/ Disease evident	1.8%
Scars/ Cat faces	10%
Conks present	3.6%

	Medium: 16 - 21"	**Large: 22 - 27"**	**Very Large: 27+"**	**Total**
Plot 1	29	11	5	**45**
Plot 2	13	8	4	**25**
Plot 3	25	9	6	**40**
Avg/Acre	22.3	9.3	5.0	**36.7**
Std. Dev.	8.3	1.5	1.0	**10.4**

Table A-52. Snag Post-harvest Data, All Snags – Good Long Boyle Timber Sale Project Area (Unit 15, 41 acres, WL/DF cover type)

All snags: n = 1	
Average dbh: 18.0"/ sd = (range:)	
Average height: 30.0'/ sd = (range:)	

Species Composition	
LAOC	100.0%

Wildlife Usage	
No use:	0.0%
Feeding:	100.0%
Small cavity (<2"):	0%
Large cavity (>2"):	0%
Other nest:	0.0%

Top Condition	
Broken	100.0%
Intact	0.0%

Decay Class	
Hard new	0.0%
Hard old	0.0%
Soft new	100.0%
Soft old	0.0%

	Small: 8"- 15"	Medium: 16 - 21"	Large: 22 - 27"	Very Large: 27+"
Plot 1	0	0	0	0
Plot 2	0	1	0	0
Plot 3	0	0	0	0
Plot 4	0	0	0	0
Avg/Acre	0.0	0.3	0.0	0.0
Std. Dev.	0.0	0.5	0.0	0.0

Snag Post-harvest Data, Snags >15" Only – Same as above for Good Long Boyle Timber Sale Project Area (Unit 15, 41 acres, WL/DF cover type)

Table A-53. Coarse Woody Debris Post-harvest Data -- Good Long Boyle Timber Sale Project Area (Unit 15, 41 acres, WL/DF cover type)

	Hard Pieces	Decayed Pieces
Plot 1	85	9
Plot 2	89	5
Plot 3	34	3
Plot 4	73	6
Total pieces	281	23
average	70.3	5.8
sd	25.1	2.5

	Large Pieces	Small Pieces
Plot 1	1	93
Plot 2	4	90
Plot 3	0	37
Plot 4	1	78
Total pieces	6	298
average	1.5	74.5
sd	1.7	25.8

Average diameter at intersect	
Hard	4.5"
sd	1.3"
Soft	10.1"
sd	4.7"

Table A-54. Coarse Woody Debris Post-harvest Data, Variability of Piece Distribution -- Good Long Boyle Timber Sale Project Area (Unit 15, 41 acres, WL/DF cover type)

	Plot 1	Plot 2	Plot 3	Plot 4
subunit 1	10	13	2	9
subunit 2	11	12	3	9
subunit 3	3	6	1	6
subunit 4	11	10	2	13
subunit 5	8	12	7	4
subunit 6	16	3	3	14
subunit 7	9	13	0	4
subunit 8	6	19	11	8
subunit 9	9	5	4	4
subunit 10	11	1	4	8
avg/ subunit	9.4	9.4	3.7	7.9
sd	3.4	5.5	3.2	3.6

Table A-55. Coarse Woody Debris Post-harvest Data, Tons/Acre -- Good Long Boyle Timber Sale Project Area (Unit 15, 41 acres, WL/DF cover type)

	Plot 1	Plot 2	Plot 3	Plot 4
Hard	14.72	12.68	5.47	10.27
Soft	5.50	5.54	0.26	3.76
Total	**20.22**	**18.22**	**5.73**	**14.03**

Total avg. for all plots - hard:	10.79 (sd = 4.0)
Total avg. for all plots - soft:	3.77 (sd = 2.5)
Total avg. all plots - hard and soft	14.55 (sd = 6.4)

Table A-56. Large Live Tree Post-harvest Data – Good Long Boyle Timber Sale Project Area (Unit 15, 41 acres, WL/DF cover type)

All trees: n = 34	
Average dbh: 20.2"/ sd = 35.5	(range: 15.0"- 48.0")
Average height: 102.8'/ sd = 10.5	(range: 80' - 130')

Species composition	
PSME	23.5%
LAOC	76.5%

Wildlife Usage	
No use	58.8%
Feeding	41.2%
Small cavity (<2")	0.0%
Large cavity (>2")	0.0%
Other nest	0.0%

Top Condition	
Broken	2.9%
Intact	97.1%

Attributes	
Top dead but intact	0.0%
Insect/ Disease evident	0.0%
Scars/ Cat faces	23.5%
Conks present	5.9%

	Medium: 16 - 21"	**Large: 22 - 27"**	**Very Large: 27+"**	**Total**
Plot 1	5	0	0	**5**
Plot 2	4	3	0	**7**
Plot 3	7	3	0	**10**
Plot 4	10	1	1	**12**
Avg/Acre	6.5	1.8	0.3	**12.0**
Std. Dev.	2.6	1.5	0.5	**3.1**

Table A-57. Snag Pre-harvest Data, All Snags – McKillop Timber Sale Project Area (Unit 1, 223 acres, MC cover type)

All snags: n = 37		
Average dbh: 14.6"/ sd = 3.5	(range: 8.9" - 22.8")	
Average height: 47.7'/ sd = 37.2	(range: 7.0' - 130.0')	

Species Composition	
ABLA	13.5%
PSME	40.5%
ABGR	18.9%
PICO	13.5%
LAOC	10.8%
PIMO	2.7%

Wildlife Usage	
No use:	24.3%
Feeding:	64.9%
Small cavity (<2"):	10.8%
Large cavity (>2"):	0.0%
Other nest:	0.0%

Top Condition	
Broken	54.1%
Intact	45.9%

Decay Class	
Hard new	13.5%
Hard old	37.8%
Soft new	40.5%
Soft old	8.1%

	Small: 8"- 15"	Medium: 16 - 21"	Large: 22 - 27"	Very Large: 27+"
Plot 1	9	8	2	0
Plot 2	3	0	0	0
Plot 3	7	2	0	0
Plot 4	6	0	0	0
Avg/Acre	6.3	2.5	0.5	0.0
Std. Dev.	2.5	3.8	1.0	0.0

Table A-58. Snag Pre-harvest Data, Snags >15" Only -- McKillop Timber Sale Project Area (Unit 1, 223 acres, MC cover type)

Snags greater than 15" only: n = 12		
Average dbh: 18.9"/ sd = 2.2	(range: 16.3" - 22.8")	
Average height: 68.6'/ sd = 39.2	(range: 15.0' - 130.0')	

Species composition	
PSME	58.3%
ABLA	8.3%
ABGR	25.0%
LAOC	8.3%

Wildlife Usage	
No use	25.0%
Feeding	75.0%
Small cavity (<2")	0%
Large cavity (>2")	0%
Other nest	0%

Top Condition	
Broken	25.0%
Intact	75.0%

Decay Class	
Hard new	16.7%
Hard soft	58.3%
Soft new	25.0%
Soft old	0.0%

Table A-59. Coarse Woody Debris Pre-harvest Data -- McKillop Timber Sale Project Area (Unit 1, 223 acres, MC cover type)

	Hard Pieces	Decayed Pieces
Plot 1	14	12
Plot 2	14	9
Plot 3	16	37
Plot 4	10	24
Total pieces	54	82
average	13.5	20.5
sd	2.5	12.8

	Large Pieces	Small Pieces
Plot 1	3	23
Plot 2	0	23
Plot 3	3	50
Plot 4	0	34
Total pieces	6	130
average	1.5	32.5
sd	1.7	12.8

Average diameter at intersect	
Hard	6.7"
sd	3.0"
Soft	7.3"
sd	2.8"

Table A-60. Coarse Woody Debris Pre-harvest Data, Variability of Piece Distribution -- McKillop Timber Sale Project Area (Unit 1, 223 acres, MC cover type)

	Plot 1	Plot 2	Plot 3	Plot 4
subunit 1	6	1	4	4
subunit 2	3	2	2	5
subunit 3	4	1	4	5
subunit 4	3	5	4	0
subunit 5	2	1	8	4
subunit 6	2	1	7	6
subunit 7	2	1	6	4
subunit 8	2	6	7	1
subunit 9	1	4	7	0
subunit 10	1	1	4	5
avg/ subunit	2.6	2.3	5.3	3.4
sd	1.5	1.9	1.9	2.2

Table A-61. Coarse Woody Debris Pre-harvest Data, Tons/Acre -- McKillop Timber Sale Project Area (Unit 1, 223 acres, MC cover type)

	Plot 1	Plot 2	Plot 3	Plot 4
Hard	8.52	4.02	3.94	4.41
Soft	2.60	3.20	14.65	5.80
Total	**11.12**	**7.22**	**18.59**	**10.21**

Total avg. for all plots - hard:	5.22 (sd = 2.21)
Total avg. for all plots - soft:	6.56 (sd = 5.57)
Total avg. all plots - hard and soft	11.79 (sd = 4.83)

Table A-62. Large Live Tree Pre-harvest Data -- McKillop Timber Sale Project Area (Unit 1, 223 acres, MC cover type)

All trees: n = 108
Average dbh: 17.8"/ sd = 2.5 (range: 12.3"- 26.2")
Average height: 99.4'/ sd = 13.0 (range: 50.0' - 130.0')

Species composition	
PSME	31.5%
ABLA	1.9%
ABGR	24.1%
PIEN	1.0%
TSHE	4.6%
LAOC	26.9%
PIMO	10.2%

Wildlife Usage	
No use	83.3%
Feeding	16.7%
Small cavity (<2")	0%
Large cavity (>2")	0.0%
Other nest	0.0%

Top Condition	
Broken	1.0%
Intact	99.0%

Attributes	
Top dead but intact	1.9%
Insect/ Disease evident	1.9%
Scars/ Cat faces	18.5%
Conks present	18.5%

	Medium: 16 - 21"	**Large: 22 - 27"**	**Very Large: 27+"**	**Total**
Plot 1	17	1	0	**18**
Plot 2	27	2	0	**29**
Plot 3	27	2	0	**29**
Plot 4	26	3	0	**29**
Avg/Acre	24.3	2.0	0.0	**26.3**
Std. Dev.	4.9	0.8	0.0	**5.5**

Table A-63. Snag Pre-harvest Data, All Snags – Quiet Stems Timber Sale Project Area (Unit 3608, 25 acres, WL/DF cover type)

All snags: n = 29
Average dbh: 12.3"/ sd = 4.7 (range: 8"- 27")
Average height: 37.2'/ sd = 16.7 (range: 8' - 65')

Species Composition	
PSME	69.0%
PICO	13.8%
LAOC	10.3%
ABLA	6.9%

Wildlife Usage	
No use:	3.4%
Feeding:	65.5%
Small cavity (<2"):	24.1%
Large cavity (>2"):	6.9%
Other nest:	0.0%

Top Condition	
Broken	55.2%
Intact	44.8%

Decay Class	
Hard new	31.0%
Hard old	48.3%
Soft new	20.7%
Soft old	0.0%

	Small: 8"- 15"	Medium: 16 - 21"	Large: 22 - 27"	Very Large: 27+"
Plot 1	7	1	0	0
Plot 2	6	1	1	0
Plot 3	10	3	0	0
Avg/Acre	7.67	1.67	0.33	0.0
Std. Dev.	2.08	1.15	0.58	0.0

Table A-64. Snag Pre-harvest Data, Snags >15" Only – Quiet Stems Timber Sale Project Area (Unit 3608, 25 acres, WL/DF cover type)

Snags greater than 15" only: n = 6
Average dbh: 19.8"/ sd = 3.7 (range: 17"-27")
Average height: 33.5'/ sd = 13.0 (range: 16' - 50')

Species composition	
PSME	83.3%
LAOC	16.6%

Wildlife Usage	
No use	0.0%
Feeding	50.0%
Small cavity (<2")	50.0%
Large cavity (>2")	0%
Other nest	0%

Top Condition	
Broken	66.7%
Intact	33.3%

Decay Class	
Hard new	16.7%
Hard soft	33.3%
Soft new	50.0%
Soft old	0.0%

Table A-65. Coarse Woody Debris Pre-harvest Data -- Quiet Stems Timber Sale Project Area (Unit 3608, 25 acres, WL/DF cover type)

	Hard Pieces	Decayed Pieces
Plot 1	16	2
Plot 2	18	5
Plot 3	21	3
Total pieces	55	10
average	18.3	3.3
sd	2.5	1.5

	Large Pieces	Small Pieces
Plot 1	1	17
Plot 2	1	22
Plot 3	2	22
Total pieces	4	61
average	1.3	20.3
sd	0.6	2.9

Average diameter at intersect	
Hard	5.8"
sd	2.4"
Soft	7.3"
sd	3.5"

Table A-66. Coarse Woody Debris Pre-harvest Data, Variability of Piece Distribution -- Quiet Stems Timber Sale Project Area (Unit 3608, 25 acres, WL/DF cover type)

	Plot 1	Plot 2	Plot 3
subunit 1	1	5	3
subunit 2	0	3	1
subunit 3	1	4	4
subunit 4	6	3	3
subunit 5	2	2	7
subunit 6	0	2	1
subunit 7	0	2	2
subunit 8	2	2	1
subunit 9	3	0	1
subunit 10	3	0	1
avg/ subunit	1.8	2.3	2.4
sd	1.87	1.57	1.96

Table A-67. Coarse Woody Debris Pre-harvest Data, Tons/Acre -- Quiet Stems Timber Sale Project Area (Unit 3608, 25 acres, WL/DF cover type)

	Plot 1	Plot 2	Plot 3
Hard	6.07	3.92	6.03
Soft	0.19	2.01	1.33
Total	**6.26**	**5.93**	**7.36**

Total avg. for all plots - hard:	5.34 (sd 1.2)
Total avg. for all plots - soft:	1.18 (sd 0.9)
Total avg. all plots - hard and soft	6.52 (sd 0.7)

Table A-68. Large Live Tree Pre-harvest Data – Quiet Stems Timber Sale Project Area (Unit 3608, 25 acres, WL/DF cover type)

All trees: n = 26
Average dbh: 19.5"/ sd = 3.9 (range: 15"- 27")
Average height: 78.7'/ sd = 14.7 (range: 40' - 100')

Species composition	
PSME	50.0%
PIEN	3.8%
LAOC	42.3%
ABLA	3.8%

Wildlife Usage	
No use	73.1%
Feeding	26.9%
Small cavity (<2")	0%
Large cavity (>2")	0.0%
Other nest	0.0%

Top Condition	
Broken	0.0%
Intact	100.0%

Attributes	
Top dead but intact	0.0%
Insect/ Disease evident	0.0%
Scars/ Cat faces	7.7%
Conks present	3.8%

	Medium: 16 - 21"	**Large: 22 - 27"**	**Very Large: 27+"**	**Total**
Plot 1	7	0	0	**7**
Plot 2	5	4	0	**9**
Plot 3	4	5	1	**10**
Avg/Acre	5.3	3.0	0.3	**8.7**
Std. Dev.	1.5	2.6	0.6	**1.5**

Table A-69. Snag Post-harvest Data, All Snags – Quiet Stems Timber Sale Project Area (Unit 3608, 25 acres, WL/DF cover type)

All snags: n = 10	
Average dbh: 11.4"/ sd = 3.0 (range: 8.1"- 17.5")	
Average height: 45.0'/ sd = 19.8 (range: 14' - 75')	

Species Composition	
PSME	80.0%
PICO	10.0%
LAOC	10.0%

Wildlife Usage	
No use:	20.0%
Feeding:	50.0%
Small cavity (<2"):	30.0%
Large cavity (>2"):	0.0%
Other nest:	0.0%

Top Condition	
Broken	30.0%
Intact	70.0%

Decay Class	
Hard new	40.0%
Hard old	60.0%
Soft new	0.0%
Soft old	0.0%

	Small: 8"- 15"	Medium: 16 - 21"	Large: 22 - 27"	Very Large: 27+"
Plot 1	8	1	0	0
Plot 2	1	0	0	0
Avg/Acre	4.5	0.5	0.0	0.0
Std. Dev.	4.9	0.7	0.0	0.0

Snag Post-harvest Data, Snags >15" Only – Quiet Stems Timber Sale Project Area (Unit 3608, 25 acres, WL/DF cover type): n=1 (17.5" PSME) Summary Not Applicable

Table A-70. Coarse Woody Debris Post-harvest Data -- Quiet Stems Timber Sale Project Area (Unit 3608, 25 acres, WL/DF cover type)

	Hard Pieces	Decayed Pieces
Plot 1	35	24
Plot 2	40	12
Total pieces	75	36
average	37.5	18.0
sd	3.5	8.5

	Large Pieces	Small Pieces
Plot 1	2	57
Plot 2	2	50
Total pieces	4	107
average	2.0	53.5
sd	0.0	4.9

Average diameter at intersect	
Hard	5.6"
sd	3.7"
Soft	5.7"
sd	2.7"

Table A-71. Coarse Woody Debris Post-harvest Data, Variability of Piece Distribution -- Quiet Stems Timber Sale Project Area (Unit 3608, 25 acres, WL/DF cover type)

	Plot 1	Plot 2
subunit 1	2	3
subunit 2	5	7
subunit 3	12	5
subunit 4	9	4
subunit 5	3	1
subunit 6	3	4
subunit 7	3	1
subunit 8	5	8
subunit 9	10	5
subunit 10	6	14
avg/ subunit	5.8	5.2
sd	3.4	3.8

Table A-72. Coarse Woody Debris Post-harvest Data, Tons/Acre -- Quiet Stems Timber Sale Project Area (Unit 3608, 25 acres, WL/DF cover type)

	Plot 1	Plot 2
Hard	8.2	16.2
Soft	5.4	2.3
Total	**13.5**	**18.6**

Total avg. for all plots - hard:	12.2 (sd 5.7)
Total avg. for all plots - soft:	3.8 (sd 2.1)
Total avg. all plots - hard and soft	16.0 (sd 3.5)

Table A-73. Large Live Tree Post-harvest Data – Quiet Stems Timber Sale Project Area (Unit 3608, 25 acres, WL/DF cover type)

All trees: n = 30	
Average dbh: 19.3"/ sd = 4.3	(range: 14.8"- 30.7")
Average height: 63.2'/ sd = 15.7	(range: 50' - 100')

Species composition	
PSME	36.7%
LAOC	63.3%

Wildlife Usage	
No use	60.0%
Feeding	36.7%
Small cavity (<2")	3.3%
Large cavity (>2")	0.0%
Other nest	0.0%

Top Condition	
Broken	13.3%
Intact	86.7%

Attributes	
Top dead but intact	0.0%
Insect/ Disease evident	0.0%
Scars/ Cat faces	6.7%
Conks present	0.0%

	Medium: 16 - 21"	**Large: 22 - 27"**	**Very Large: 27+"**	**Total**
Plot 1	6	1	1	**8**
Plot 2	16	6	0	**22**
Avg/Acre	11.0	3.5	0.5	**15.0**
Std. Dev.	7.1	3.5	0.7	**9.9**

Table A-74. Snag Post-harvest Data, All Snags – Red Owl Timber Sale Project Area (Unit 3, 68 acres, PP/DF cover type)

All snags: n = 9
Average dbh: 16.1"/ sd = 4.8 (range: 11.0"- 25.0")
Average height: 39.6'/ sd = 37.4 (range: 8' - 100')

Species Composition	
PSME	66.7%
PIPO	22.2%
N/A	11.1%

Wildlife Usage	
No use:	33.3%
Feeding:	55.5%
Small cavity (<2"):	11.1%
Large cavity (>2"):	0%
Other nest:	0.0%

Top Condition	
Broken	66.7%
Intact	33.3%

Decay Class	
Hard new	33.3%
Hard old	22.2%
Soft new	33.3%
Soft old	11.1%

	Small: 8"- 15"	Medium: 16 - 21"	Large: 22 - 27"	Very Large: 27+"
Plot 1	0	0	0	0
Plot 2	1	0	0	0
Plot 3	2	2	0	0
Plot 4	2	2	1	0
Avg/Acre	1.3	1.0	0.3	0.0
Std. Dev.	1.0	1.2	0.5	0.0

Table A-75. Snag Post-harvest Data, Snags >15" Only – Red Owl Timber Sale Project Area (Unit 3, 68 acres, PP/DF cover type)

Snags greater than 15" only: n = 5
Average dbh: 19.4"/ sd = 3.7 (range: 16.0"-25.0")
Average height: 59.6'/ sd = 40.5 (range: 8' - 100')

Species composition	
PIPO	40.0%
PSME	60.0%

Wildlife Usage	
No use	40.0%
Feeding	60.0%
Small cavity (<2")	0%
Large cavity (>2")	0%
Other nest	0%

Top Condition	
Broken	40.0%
Intact	60.0%

Decay Class	
Hard new	60.0%
Hard soft	40.0%
Soft new	0.0%
Soft old	0.0%

Table A-76. Coarse Woody Debris Post-harvest Data -- Red Owl Timber Sale Project Area (Unit 3, 68 acres, PP/DF cover type)

	Hard Pieces	Decayed Pieces
Plot 1	21	4
Plot 2	11	5
Plot 3	14	7
Plot 4	14	10
Total pieces	60	26
average	15.0	6.5
sd	4.2	2.6

	Large Pieces	Small Pieces
Plot 1	1	24
Plot 2	1	15
Plot 3	1	20
Plot 4	0	24
Total pieces	3	83
average	0.8	20.8
sd	0.5	4.3

Average diameter at intersect	
Hard	5.3"
sd	3.1"
Soft	6.4"
sd	3.1"

Table A-77. Coarse Woody Debris Post-harvest Data, Variability of Piece Distribution -- Red Owl Timber Sale Project Area (Unit 3, 68 acres, PP/DF cover type)

	Plot 1	Plot 2	Plot 3	Plot 4
subunit 1	0	1	3	0
subunit 2	0	1	2	0
subunit 3	0	0	4	3
subunit 4	1	0	2	2
subunit 5	3	5	3	2
subunit 6	6	3	1	1
subunit 7	1	0	4	5
subunit 8	8	1	1	7
subunit 9	1	2	1	1
subunit 10	5	3	0	3
avg/ subunit	2.5	1.6	2.1	2.4
sd	2.9	1.6	1.4	2.2

Table A-78. Coarse Woody Debris Post-harvest Data, Tons/Acre -- Red Owl Timber Sale Project Area (Unit 3, 68 acres, PP/DF cover type)

	Plot 1	Plot 2	Plot 3	Plot 4
Hard	5.50	1.30	3.80	4.80
Soft	0.80	1.70	1.00	3.40
Total	**6.30**	**3.00**	**4.80**	**8.20**

Total avg. for all plots - hard:	3.85 (sd 1.8)
Total avg. for all plots - soft:	1.73 (sd 1.2)
Total avg. all plots - hard and soft	5.6 (sd 2.2)

Table A-79. Large Live Tree Post-harvest Data – Red Owl Timber Sale Project Area (Unit 3, 68 acres, PP/DF cover type)

All trees: n = 73	
Average dbh: 20.8"/ sd = 4.0	(range: 15"- 37")
Average height: 89.5'/ sd = 7.3	(range: 75' - 105')

Species composition	
PIPO	45.2%
PSME	54.8%

Wildlife Usage	
No use	98.6%
Feeding	1.4%
Small cavity (<2")	0.0%
Large cavity (>2")	0.0%
Other nest	0.0%

Top Condition	
Broken	0.0%
Intact	100.0%

Attributes	
Top dead but intact	0.0%
Insect/ Disease evident	0.0%
Scars/ Cat faces	2.7%
Conks present	0.0%

	Medium: 16 - 21"	**Large: 22 - 27"**	**Very Large: 27+"**	**Total**
Plot 1	17	8	3	**28**
Plot 2	7	6	1	**14**
Plot 3	17	2	0	**19**
Plot 4	6	6	0	**12**
Avg/Acre	11.8	5.5	1.0	**18.3**
Std. Dev.	6.1	2.5	1.4	**7.1**

Table A-80. Snag Pre-harvest Data, All Snags – Sour Fish Timber Sale Project Area (Unit 34-1, 91 acres, DF/PP cover type)

All snags: n = 4
Average dbh: 8.3"/ sd = 0.7 (range: 8"- 9")
Average height: 30.5'/ sd = 13.8 (range: 12 ' - 45')

Species Composition	
PICO	75.0%
PIPO	25.0%

Wildlife Usage	
No use:	25.0%
Feeding:	50.0%
Small cavity (<2"):	25.0%
Large cavity (>2"):	0.0%
Other nest:	0.0%

Top Condition	
Broken	50.0%
Intact	50.0%

Decay Class	
Hard new	75.0%
Hard old	0.0%
Soft new	0.0%
Soft old	25.0%

	Small: 8"- 15"	Medium: 16 - 21"	Large: 22 - 27"	Very Large: 27+"
Plot 1	2	0	0	0
Plot 2	1	0	0	0
Plot 3	0	0	0	0
Plot 4	1	0	0	0
Avg/Acre	1.0	0.0	0.0	0.0
Std. Dev.	0.82	0.0	0.0	0.0

Snag Pre-harvest Data, Snags >15" Only -- Sour Fish Timber Sale Project Area (Unit 34-1, 91 acres, DF/PP cover type) n=0, Summary Not Applicable

Table A-81. Coarse Woody Debris Pre-harvest Data -- Sour Fish Timber Sale Project Area (Unit 34-1, 91 acres, DF/PP cover type)

	Hard Pieces	Decayed Pieces
Plot 1	9	7
Plot 2	13	5
Plot 3	5	3
Plot 4	9	4
Total pieces	36	19
average	9.0	4.8
sd	3.3	1.7

	Large Pieces	Small Pieces
Plot 1	2	14
Plot 2	7	11
Plot 3	1	7
Plot 4	2	11
Total pieces	12	43
average	3.0	10.8
sd	2.7	2.9

Average diameter at intersect	
Hard	5.8"
sd	3.2"
Soft	9.2"
sd	5.0"

Table A-82. Coarse Woody Debris Pre-harvest Data, Variability of Piece Distribution -- Sour Fish Timber Sale Project Area (Unit 34-1, 91 acres, DF/PP cover type)

	Plot 1	Plot 2	Plot 3	Plot 4
subunit 1	2	1	3	2
subunit 2	1	2	2	0
subunit 3	2	1	1	2
subunit 4	1	3	0	1
subunit 5	1	3	2	1
subunit 6	1	2	0	2
subunit 7	3	3	0	1
subunit 8	2	2	0	2
subunit 9	1	1	0	1
subunit 10	2	0	0	1
avg/ subunit	1.6	1.8	0.8	1.3
sd	0.7	1.0	1.1	0.7

Table A-83. Coarse Woody Debris Pre-harvest Data, Tons/Acre -- Sour Fish Timber Sale Project Area (Unit 34-1, 91 acres, DF/PP cover type)

	Plot 1	Plot 2	Plot 3	Plot 4
Hard	2.48	5.16	0.70	2.75
Soft	3.11	4.27	1.50	1.33
Total	5.59	9.43	2.20	4.08

Total avg. for all plots - hard:	2.77 (sd 1.83)
Total avg. for all plots - soft:	2.55 (sd 1.40)
Total avg. all plots - hard and soft	5.32 (sd 3.07)

Table A-84. Large Live Tree Pre-harvest Data – Sour Fish Timber Sale Project Area (Unit 34-1, 91 acres, DF/PP cover type)

All trees: n = 17
Average dbh: 21.2"/ sd = 3.2 (range: 15"- 28")
Average height: 91.8'/ sd = 6.6 (range: 80' - 105')

Species composition	
PSME	47.1%
PIMO	52.9%

Wildlife Usage	
No use	82.4%
Feeding	17.7%
Small cavity (<2")	0.0%
Large cavity (>2")	0.0%
Other nest	0.0%

Top Condition	
Broken	5.9%
Intact	94.1%

Attributes	
Top dead but intact	0.0%
Insect/ Disease evident	0.0%
Scars/ Cat faces	11.8%
Conks present	0.0%

	Medium: 16 - 21"	**Large: 22 - 27"**	**Very Large: 27+"**	**Total**
Plot 1	0	1	0	**1**
Plot 2	3	5	0	**8**
Plot 3	2	3	0	**5**
Plot 4	1	1	1	**3**
Avg/Acre	1.5	2.5	0.3	**4.3**
Std. Dev.	1.3	1.9	0.5	**3.0**

Table A-85. Snag Pre-harvest Data, All Snags – Sula Salvage West Timber Sale Project Area (PP/DF cover type)

All snags: n = 414
Average dbh: 12.8"/ sd = 4.5 (range: 8.0"- 33.0")
Average height: 55.1'/ sd = 12.5 (range: 15.0 ' - 90.0')

Species Composition	
PSME	82.9%
PIPO	15.7%
PICO	1.2%
N/A:	0.2%

Wildlife Usage	
No use:	99.8%
Feeding:	0.2%
Small cavity (<2"):	0.0%
Large cavity (>2"):	0.0%
Other nest:	0.0%

Top Condition	
Broken	1.5%
Intact	98.5%

Decay Class	
Hard new	99.5%
Hard old	0.0%
Soft new	0.2%
Soft old	0.2%

	Small: 7.5"-14.4"	Medium: 14.5-20.4"	Large: 20.5-26.4"	Very Large: 26.5+"
Plot 1	47	13	3	2
Plot 2	41	12	7	3
Plot 3	48	18	5	0
Plot 4	78	16	0	0
Plot 5	82	32	6	1
Avg/Acre	59.2	18.2	4.2	1.2
Std. Dev.	19.2	8.1	2.8	1.3

Table A-86. Snag Pre-harvest Data, Snags >15" Only -- Sula Salvage West Timber Sale Project Area (PP/DF cover type)

Snags greater than 15" only: n = 118
Average dbh: 18.6"/ sd = 3.7 (range: 15" - 33")
Average height: 67.8'/ sd = 8.1 (range: 40' - 90')

Species composition	
PSME	81.4%
PIPO	17.8%
PICO	0.9%

Wildlife Usage	
No use	100.0%
Feeding	0.0%
Small cavity (<2")	0%
Large cavity (>2")	0%
Other nest	0%

Top Condition	
Broken	2.5%
Intact	97.5%

Decay Class	
Hard new	100.0%
Hard soft	0.0%
Soft new	0.0%
Soft old	0.0%

Table A-87. Coarse Woody Debris Pre-harvest Data -- Sula Salvage West Timber Sale Project Area (PP/DF cover type)

	Hard Pieces	Decayed Pieces
Plot 1	2	0
Plot 2	6	0
Plot 3	8	0
Plot 4	12	0
Plot 5	5	1
Total pieces	33	1
average	6.6	0.2
sd	3.7	0.4

	Large Pieces	Small Pieces
Plot 1	1	1
Plot 2	1	5
Plot 3	0	8
Plot 4	0	12
Plot 5	3	3
Total pieces	5	29
average	1.0	5.8
sd	1.2	4.3

Average diameter at intersect	
All Pieces	5.6"
sd	2.5"

Table A-88. Coarse Woody Debris Pre-harvest Data, Variability of Piece Distribution -- Sula Salvage West Timber Sale Project Area (PP/DF cover type)

	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5
subunit 1	0	0	1	0	0
subunit 2	0	0	0	0	0
subunit 3	1	1	0	3	0
subunit 4	0	1	0	4	2
subunit 5	0	0	3	0	2
subunit 6	1	0	0	2	1
subunit 7	0	0	2	2	0
subunit 8	0	0	0	0	0
subunit 9	0	0	1	0	0
subunit 10	0	4	1	1	1
avg/ subunit	0.2	0.6	0.8	1.2	0.6
sd	0.4	1.3	1.0	1.5	0.8

Table A-89. Coarse Woody Debris Pre-harvest Data, Tons/Acre -- Sula Salvage West Timber Sale Project Area (PP/DF cover type)

	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5
Hard	0.7	1.6	1.6	1.7	3.0
Soft	0.0	0.0	0.0	0.0	0.3
Total	**0.7**	**1.6**	**1.6**	**1.7**	**3.4**

Total avg. for all plots - hard:	1.7 (sd = 0.8)
Total avg. for all plots - soft:	0.1 (sd = 0.2)
Total avg. all plots - hard and soft	1.8 (sd = 1.0)

Table A-90. Large Live Tree Pre-harvest Data – Sula Salvage West Timber Sale Project Area (PP/DF cover type)

All trees: n = 5	
Average dbh: 16.4"/ sd = 1.5	(range: 15.0"- 18.0")
Average height: 65.0'/ sd = 3.5	(range: 60.0 ' - 70.0')

Species composition	
PSME	100.0%
PIPO	0.0%
PICO	0.0%

Wildlife Usage	
No use	80.0%
Feeding	20.0%
Small cavity (<2")	0%
Large cavity (>2")	0.0%
Other nest	0.0%

Top Condition	
Broken	100.0%
Intact	0.0%

	Small: 7.5"-14.4"	Medium: 14.5-20.4"	Large: 20.5-26.4"	Very Large: 26.5+"	Total
Plot 1	0	5	0	0	**5**
Plot 2	0	0	0	0	**0**
Plot 3	0	0	0	0	**0**
Plot 4	0	0	0	0	**0**
Plot 5	0	0	0	0	**0**
Avg/Acre	0.0	1.0	0.0	0.0	**1.0**
Std. Dev.	0.0	2.2	0.0	0.0	**2.2**

Table A-91. Snag Post-harvest Data, All Snags – Sula Salvage West Timber Sale Project Area (PP/DF cover type)

All snags: n = 123
Average dbh: 11.1"/ sd = 4.9 (range: 8.0"- 33.0")
Average height: 48.7'/ sd = 13.3 (range: 12.0 ' - 80.0')

Species Composition	
PSME	68.3%
PIPO	29.3%
PICO	2.4%

Wildlife Usage	
No use:	65.0%
Feeding:	35.0%
Small cavity (<2"):	0%
Large cavity (>2"):	0%
Other nest:	0.0%

Top Condition	
Broken	8.9%
Intact	91.1%

Decay Class	
Hard new	96.7%
Hard old	1.0%
Soft new	1.6%
Soft old	1.0%

	Small: 7.5"-14.4"	Medium: 14.5-20.4"	Large: 20.5-26.4"	Very Large: 26.5+"
Plot 1	23	4	2	1
Plot 2	21	1	1	2
Plot 3	12	1	2	0
Plot 4	29	3	0	0
Plot 5	18	2	0	1
Avg/Acre	20.6	2.2	1.0	0.8
Std. Dev.	6.3	1.3	1.0	0.8

Table A-92. Snag Post-harvest Data, Snags >15" Only – Sula Salvage West Timber Sale Project Area (PP/DF cover type)

Snags greater than 15" only: n = 20
Average dbh: 20.8"/ sd = 5.2 (range: 15" - 33")
Average height: 66.1'/ sd = 15.4 (range: 12' - 80')

Species composition	
PSME	45.0%
PIPO	55.0%
PICO	0.0%

Wildlife Usage	
No use	35.0%
Feeding	65.0%
Small cavity (<2")	0%
Large cavity (>2")	0%
Other nest	0%

Top Condition	
Broken	25.0%
Intact	75.0%

Decay Class	
Hard new	100.0%
Hard soft	0.0%
Soft new	0.0%
Soft old	0.0%

Table A-93. Coarse Woody Debris Post-harvest Data -- Sula Salvage West Timber Sale Project Area (PP/DF cover type)

	Hard Pieces	Decayed Pieces
Plot 1	8	2
Plot 2	22	0
Plot 3	42	0
Plot 4	34	7
Plot 5	50	2
Total pieces	156	11
average	31.2	2.2
sd	16.6	2.9

	Large Pieces	Small Pieces
Plot 1	1	9
Plot 2	1	21
Plot 3	1	42
Plot 4	0	41
Plot 5	1	51
Total pieces	4	164
average	0.8	32.8
sd	0.4	17.2

Average diameter at intersect	
All Pieces	6.0"
sd	2.5"

Table A-94. Coarse Woody Debris Post-harvest Data, Variability of Piece Distribution -- Sula Salvage West Timber Sale Project Area (PP/DF cover type)

	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5
subunit 1	0	6	6	0	3
subunit 2	0	2	2	4	1
subunit 3	0	1	4	7	8
subunit 4	4	3	10	4	13
subunit 5	2	4	10	1	2
subunit 6	3	1	0	2	3
subunit 7	0	1	6	11	1
subunit 8	0	2	1	4	2
subunit 9	0	1	1	5	9
subunit 10	1	1	2	3	10
avg/ subunit	1.0	2.2	4.2	4.1	5.2
sd	1.5	1.7	3.7	3.1	4.4

Table A-95. Coarse Woody Debris Post-harvest Data, Tons/Acre -- Sula Salvage West Timber Sale Project Area (PP/DF cover type)

	Plot 1	Plot 2	Plot 3	Plot 4	Plot 5
Hard	1.8	4.2	11.7	9.7	13.9
Soft	1.3	0.0	0.0	2.6	2.8
Total	**3.1**	**4.2**	**11.7**	**12.3**	**16.7**

Total avg. for all plots - hard:	8.3 (sd: 5.1)
Total avg. for all plots - soft:	1.3 (sd: 1.4)
Total avg. all plots - hard and soft	9.6 (sd: 5.8)

Table A-96. Large Live Tree Post-harvest Data -- Sula Salvage West Timber Sale Project Area (PP/DF cover type)

All live trees: n = 4	
Average dbh: 13.3"/ sd = 6.0	(range: 8.0"- 21.0")
Average height: 55.8'/ sd = 11.1	(range: 43.0 ' - 65.0')

Species composition	
PSME	100.0%
PIPO	0.0%
PICO	0.0%

Wildlife Usage	
No use	100.0%
Feeding	0.0%
Small cavity (<2")	0.0%
Large cavity (>2")	0.0%
Other nest	0.0%

Top Condition	
Broken	0.0%
Intact	100.0%

	Small: 7.5"-14.4"	**Medium: 14.5-20.4"**	**Large: 20.5-26.4"**	**Very Large: 26.5+"**	**Total**
Plot 1	2	1	1	0	**4**
Plot 2	0	0	0	0	**0**
Plot 3	0	0	0	0	**0**
Plot 4	0	0	0	0	**0**
Plot 5	0	0	0	0	**0**
Avg/Acre	0.4	0.2	0.2	0.0	**0.8**
Std. Dev.	0.9	0.4	0.4	0.0	**1.8**

Department of Natural Resources
and Conservation
2705 Spurgin Road
Missoula, MT 59804-3199
(406) 542-4331

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