Montana Department of Natural Resources and Conservation

State Forest Land Management Plan

Implementation Monitoring Report

Fiscal Years 2006-2010

May, 2011

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EXECUTIVE SUMMARY

Since the adoption of the State Forest Land Management Plan (SFLMP) in 1996 and the Administrative Rules for Forest Management (Forest Management Rules or Rules; *ARM 36.11.401 through 456*) in 2003, the Montana Department of Natural Resources and Conservation (DNRC), Forest Management Program has implemented the philosophy and intent of the SFLMP and the requirements set forth in the Rules primarily through project development and implementation, Montana Environmental Policy Act (MEPA) review, and monitoring. The following is a summary of accomplishments and monitoring results from fiscal years 2006 through 2010 (July 2005 through June 2010).

PLAN IMPLEMENTATION

- Completed SFLMP / Rules Implementation Checklists for 109 timber sales.

Timber Sale Inspection Reports

- 1,726 Timber Sale Inspection Reports were completed between fiscal year 2006 through 2010 for 194 sales. Of 17,820 items clearly inspected (items checked), 96.09 percent were recorded as Satisfactory, 3.63 percent as Needs Improvement, and 0.28 percent as Violation.
- About 68 percent of those items recorded as Need Improvement and about 40 percent of those items recorded as Violation related to one or more Forest Management Rules.
- About 34 percent of those items recorded as Need Improvement and about 26 percent of those items recorded as Violation related to one or more Montana Best Management Practices for Forestry (BMPs).

MONITORING

Biodiversity

- Biodiversity reviews were completed on two timber sales on both the Northwestern Land Office and the Southwestern Land Office. These reviews indicated that biodiversity objectives are not preventing DNRC from achieving forest management goals. Most treatments are effectively emulating natural disturbances, and biodiversity factors are being considered in the timber sale planning and design process.
- The amount of forest meeting DNRC's old-growth definition is decreasing, but the amount of older age classes, some of which do not meet the Department's old-growth definition, is increasing. The decrease in old-growth is primarily due to updated inventory information that verified stands meeting or not meeting the old-growth definition. The increase in older age classes is primarily due to updated inventory methods that use a new method to calculate age class, resulting in some younger forests being re-classified as older forests.

- DNRC is making slow progress toward desired future conditions, particularly in the western larch/Douglas-fir type; however, there is still significant excess acreage of shade tolerant forest types such as mixed conifer, subalpine fir, and Douglas-fir.

Post Wildfire Mortality Studies

Sula State Forest

- Tree mortality has been monitored in the Sula State Forest since wildfire burned the majority of the State forest in 2000. Eighty-five (65 percent) of the 130 monitored trees died. Seventy-eight percent of the Douglas-fir died and 51 percent of the ponderosa pine died. Ninety-six percent of the trees died between 2001 and 2004. Four trees died between 2005 and October 2009.
- Average bole scorch, crown kill, crown scorch and to a lesser degree diameter at breast height all affected the risk of tree mortality.
- Dead tree (snags) boles began to break in 2004. Sixty-nine percent of the snags have broken, 19 percent of the snags have fallen down, and 12 percent of the snags are intact as of October 2009.
- Wildlife use (primarily birds feeding) has occurred on 76 percent of the dead Douglas-fir and 45 percent of the dead ponderosa pine.

Jocko Lakes Fire

- In 2007 the Jocko Lakes fire burned thousands of forested acres west of Seeley Lake. In 2008 tree mortality study sites were established on a DNRC parcel that burned in the Jocko Lakes fire. Mortality has been monitored since 2009. As of October 2010, 46 (35 percent) of 132 trees are dead. Fifty-four percent of the Douglas-fir trees are dead. Sixty-seven percent of the ponderosa pine trees are dead. Twenty-one percent of the western larch trees are dead.
- Average bole scorch greater than 30 percent and any amount of crown kill appear to increase risk of mortality. Diameter at breast height and crown scorch also affect risk of mortality.
- Wildlife use (primarily birds feeding) has occurred on 41 (89 percent) of 46 dead trees and 48 (56 percent) of 86 live trees.

Silviculture

- Tree planting and regeneration surveys increased sharply from fiscal years 2006 through 2010 with efforts focused on reforesting areas burned by wildfires since 2000. This increase has resulted in a slight decrease in the amount of precommercial thinning done by DNRC due to field staff availability and budget constraints.
- Tractor-based harvesting systems were used on 85 percent of the area harvested during fiscal years 2006 through 2010. This is an increase from previous years and is due primarily to the cost-efficiency of using such systems and poor timber market conditions.

- The use of even-aged treatments increased from fiscal years 2006 through 2010 to levels above those forecast by the SFLMP. This is due to a number of factors, including an increase in the annual sustainable yield in 2004, and DNRC's offering of operationally efficient projects during poor timber markets.
- Salvage harvesting following wildfires and insect outbreaks continues to be an important part of DNRC's forest management program, although at a decreased level compared to the 2001 through 2005 monitoring period.

Road Management

- DNRC evaluated approximately 1,564 miles of existing road from fiscal year 2006 through fiscal year 2010. Maintenance measures and improvements to approximately 521 miles of existing roads were included in the 120 timber sales contracts sold from fiscal year 2006 to fiscal year 2010.
- Statewide BMP audits were conducted on various ownership groups in 2006, 2008 and 2010. In all three of these audit years DNRC was found to rank highest among ownership groups in BMP application and effectiveness.
- The results of both DNRC internal BMP audits and independently conducted statewide audits have demonstrated high levels of BMP application and effectiveness on DNRC timber harvest. The data shows that between 97 to 99 percent of the practices rated have met or exceeded BMP standards. In addition, 98 to 99 percent of the practices rated were found to be effective in protecting soil and water resources.

Watershed, Fisheries & Soils

- Watershed inventories were completed on 110,958 acres of State trust land between fiscal year 1999 and fiscal year 2005. Additional inventories were suspended in 2005 due to the ongoing negotiations between DNRC and the U.S. Fish and Wildlife Service (USFWS) for the development of the Montana DNRC Forested State Trust Land Habitat Conservation Plan (HCP). DNRC suspended the inventories because we did not want to risk having to redo the field evaluations once a specific method was agree to and finalized in the HCP. Watershed inventories will resume once a Record of Decision for the HCP is completed.
- Long-term water quality monitoring continued on the Stillwater State Forest.
- Three in-situ turbidity monitoring projects were implemented during various culvert removal, installation, and replacement projects designed to show the duration and magnitude of sedimentation impacts during these activities.
- Monitoring on the Swan River, Stillwater, and Coal Creek State Forests found spawning and rearing conditions for bull trout and westslope cutthroat trout to be outside thresholds of concern on 7 of 12 streams.
- DNRC completed soil disturbance monitoring on 16 individual timber sales which demonstrated slightly decreasing levels of detrimental soil impacts for ground based harvesting when compared to the previous seventeen years of monitoring.

- The amount of coarse and fine woody material retained postharvest was evaluated on 20 individual timber sales with results showing that recommendations within scientific literature was consistently met for the associated habitat type.
- Two retrospective soil monitoring projects were initiated and completed to validate or refute the assumption that 15 percent or less soil disturbance will maintain long term soil productivity.
- A four-year soil monitoring project designed to evaluate riparian harvest effects to soil temperature was competed and reported on.
- Bull trout redd count use as an indicator of species population status is trending similarly on both forested State trust lands and other ownerships throughout the Flathead River drainage.
- Fish habitat inventories were performed on 19 streams within forested State trust lands.
- The DNRC Fish Passage Assessment Project indicates 108 road-stream crossing sites on State trust lands limit connectivity to native salmonids.
- Stream temperature monitoring of 28 streams on forested State trust lands is now included in fisheries program monitoring database.

Threatened, Endangered, and Sensitive Species and Big Game

- DNRC biologists participated in 7 interagency committees and working groups in support of local and regional wildlife conservation efforts.
- DNRC biologists surveyed 4 to 6 bald eagle territories annually for recruitment and survival.
- DNRC biologists surveyed 9 to 10 lakes annually for recruitment, success and survival of common loons in western Montana.
- DNRC provided 5 required cooperator reports for the Swan Valley Grizzly Bear Conservation Agreement to the USFWS during the monitoring period and maintained full compliance.
- DNRC established monitoring protocols for checking gate closures annually on the Stillwater State Forest, and checked approximately 100 closures each year during 2007, 2008, and 2009.
- DNRC biologists conducted wildlife species presence surveys on the Sula State Forest (post-burn), and the Swan River State Forest (streamside habitat surveys).
- DNRC biologists participated in 2 Biodiversity Field Reviews for DNRC timber sales and assessed compliance with required wildlife mitigations.
- DNRC biologists conducted pre-harvest and post-harvest snag and downed woody debris monitoring on 9 projects during the monitoring period. Eight of the 9 projects examined met or exceeded retention requirements.

- DNRC biologists and staff documented and reported 105 wildlife observations, of which 55 were of threatened and endangered species, 18 sensitive species, and 32 other species of interest.
- DNRC provided field support and/or funding for 7 additional cooperative monitoring projects involving forest-associated wildlife species in western Montana

Grazing on Classified Forest Lands

- 250 classified forest grazing licenses were evaluated for riparian condition at midterm of the license and 78 percent of all classified forest grazing parcels had one or more riparian habitat features within the parcel.
- Results show that 28 percent of all forest grazing licenses did not meet standards for riparian variables adopted within the SFLMP which was higher than previous published results.
- 74.5 percent of all riparian areas within classified forest grazing parcels remained on a stable trend while 10 percent showed improving trends and 15.5 percent showed degrading trends.

Weed Management

- 120 timber sales were inspected and monitored for noxious weed presence, establishment, and spread.
- 17,970 acres of noxious weeds were treated by various means on DNRC lands and road right-of-ways.

PLAN MAINTENANCE

- 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 an HCP under Section 10 of the Endangered Species Act in cooperation with the USFWS. If the HCP is approved by the USFWS, DNRC will assess the need for any changes to the SFLMP and Rules.

INTRODUCTION

STATE FOREST LAND MANAGEMENT PLAN AND ADMINISTRATIVE RULES FOR FOREST MANAGEMENT

The State Forest Land Management Plan (SFLMP), approved by the State Board of Land Commissioners (Land Board) in June 1996, is the plan under which the Montana Department of Natural Resources and Conservation (DNRC) manages approximately 735,000 acres of forested State trust land. The SFLMP provides the philosophical basis and technical rationale for DNRC's forest management program. The SFLMP is based on the philosophy that the best way to produce long-term income for the trust is to manage intensively for healthy and biologically diverse forests as summarized in the following 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." (ROD page 2)

The DNRC Administrative Rules for Forest Management (Forest Management Rules or Rules; *ARM 36.11.401 through 456*) are the specific legal resource management standards and measures under which DNRC implements the SFLMP and subsequently its forest management program. The Rules were adopted in March 2003 and provide the legal framework for DNRC project-level decisions and provide field personnel with consistent policy and direction for managing forested State trust lands. The Rules subchapters correspond to resource areas identified by the SFLMP and incorporate language from the SFLMP Resource Management Standards (RMS). All forest management projects administered by DNRC on forested State trust lands must comply with both the SFLMP and the Forest Management Rules.

DNRC Land Offices, Administrative Units, and the Forest Management Bureau (FMB) continue to implement the philosophy and intent of the SFLMP and the requirements set forth in the Forest Management Rules primarily through project development and implementation, Montana Environmental Policy Act (MEPA) review, and monitoring.

PURPOSE OF THE MONITORING REPORT

According to the SFLMP (*Record of Decision, page 11*), beginning in 2000 and every five years thereafter, the Forest Management Bureau shall prepare a written report on the status and effectiveness of the SFLMP for the DNRC Director. ARM 36.11.448 reinforces this

requirement and also stipulates that DNRC shall monitor individual resources pursuant to the Forest Management Rules and compile the results of that monitoring into a report for the Land Board by 2005 and every five years thereafter. In October 2000 and 2005, DNRC published an Implementation and Monitoring Report that summarized SFLMP and Forest Management Rule monitoring results during fiscal years 1997 through 2000 and 2001 through 2005 respectively. This document summarizes SFLMP and Forest Management Rules monitoring results from fiscal years 2006 through 2010 and will be presented to the DNRC Director, Trust Land Administrator, and the Land Board.

IMPLEMENTATION CHECKLISTS

In January of 1997, an SFLMP Implementation Checklist was finalized for use in planning timber sales. The Checklist was comprised of specific RMS pertinent to timber sale preparation and issues often raised concerning timber harvest. 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 FMB 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 / Rule Implementation Checklist was filled out for all of the 109 timber sales that were sold from fiscal years 2006 through 2010. All sales complied with both the SFLMP and the Rules.

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.

Many sales sold *prior* to fiscal year 2006 were implemented on the ground within the monitoring period of this report (fiscal years 2006 through 2010). Therefore, inspection monitoring results within this report also cover some sales sold prior to 2006. During fiscal years 2006 through 2010, management foresters documented 1,726 timber sale inspections for 194 timber sales. Timber sale contract terms often have indirect ties to the SFLMP and Rules, and they reflect multiple observations of all operating timber sales. *See Biodiversity Monitoring – Timber Sale Inspection Reports for a complete summary of timber sale inspection reports and Road Management Monitoring and Watershed, Fisheries, and Soils Monitoring for brief discussions.*

MONITORING REPORT FORMAT

The monitoring report is divided into seven sections, corresponding to the Forest Management Rule Sub-Chapters (Threatened and Endangered Species, Sensitive Species, and Big Game are combined in one section as well as Watershed, Soils, and Fisheries). Under each heading is a brief summary of the management framework and monitoring standards, followed by the monitoring results. Most monitoring activities are 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 Rules between several of the resources, 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.

MONTANA DNRC FORESTED STATE TRUST LANDS HABITAT CONSERVATION PLAN

During fiscal years 2006 through 2010, DNRC spent considerable effort negotiating and developing a Habitat Conservation Plan (HCP) that would apply to forested trust lands. An HCP is a long-term management plan prepared under the Endangered Species Act (ESA) to conserve threatened and endangered species. Section 10 of the ESA, authorizes a landowner to develop a conservation plan to minimize and mitigate, to the maximum extent practicable, the impacts of related incidental take of threatened and endangered species while conducting lawful activities such as harvesting timber on State trust lands. The HCP is part of an application for obtaining an incidental take permit (Permit) from the USFWS in accordance with Section 10(a)(1)(B) of the ESA. The Permit would authorize DNRC to take federally listed species that are covered under the HCP. Monitoring is a requirement of the HCP, and DNRC dedicated a sizable level of staff resources during fiscal years 2006 through 2010 to the development of additional monitoring commitments that would be incorporated into the Forest Management Program following successful adoption of the HCP. Formal adoption is anticipated in Summer 2011. If the Permit is issued, it is envisioned that the subsequent SFLMP monitoring report will also incorporate the required 5-year monitoring components that are specified in the HCP.

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:

- **Use of silvicultural systems that are based on natural disturbance regimes and maintain long-term forest productivity by promoting diverse species, ages, and forest structures within and between stands.**
- **Identify a site-specific desired future condition in terms of cover type for each stand.**
- **Employ a "fine filter" approach for threatened, endangered, and sensitive species, which focuses on species' specific habitat requirements.**
- **On blocked tracts, 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 to meet biodiversity and fiduciary objectives.**
- **Use current references 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.

BIODIVERSITY IMPLEMENTATION

The SFLMP and Forest Management Rules rely on forest management for biodiversity to accomplish the Department's fundamental management premise. Adopting the SFLMP resulted in the DNRC adjusting its 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 conditions of our forests and for comparing them to current or existing conditions.

BIODIVERSITY FIELD REVIEW MONITORING PROCESS

Methods

An internal review team composed of the FMB Silviculturist/Forest Ecologist and Wildlife Biologist, a Land Office Wildlife Biologist, and a lead Management Forester was formed. The group was augmented with other observers from within the DNRC.

A sale from each of the Northwestern and Southwestern Land Offices (NWLO and SWLO) were selected for review. Prior to field review, the team reviewed the environmental documents for each project, applicable Forest Management Rules, and a field review form. After this review, the team conducted site visits to each project area guided by the Project Leader. The site visits were to examine first-hand the implementation of Forest Management Rules and stated project level commitments and to verify the conditions described. Following reviews and discussion, results were summarized in brief narratives.

Results

The biodiversity field review process focuses primarily on the following issues:

1. Emulation of natural processes
2. Old-growth
3. Cover type representation
4. Forest health issues
5. Patch characteristics
6. Rare/Unique habitats
7. Sensitive plants
8. Forest genetics
9. Nutrient retention
10. Forest density management
11. Wildlife (threatened, endangered, sensitive, and big game)

Field reviews indicated that DNRC was successfully implementing the direction from the SFLMP and Rules, and that biodiversity considerations typically did not preclude DNRC from meeting forest management objectives. Most silvicultural cutting treatments implemented by DNRC effectively emulated the natural disturbance regimes appropriate for the site; however, other considerations such as maintaining suitable habitat for threatened, endangered, or sensitive wildlife species, or the proximity to home sites or infrastructure such as roads may in some cases lead to the selection of a treatment that falls outside of the natural disturbance regime (e.g.- heavy stagnate forest cover retained to meet habitat objectives for lynx in one instance). Even so, in those cases where other important issues exist, foresters were typically able to accomplish vegetation management goals, and emulate, to an extent, the natural disturbance that would have occurred on the site. In some cases, this leads to the complete emulation of a disturbance occurring through multiple treatments and entries into a stand rather than a single treatment and entry; however, doing so can prolong the time to achieving desired cover types in stands that currently do not reflect the desired type.

Trees left in the cutting units were found to be generally those that would have survived disturbance (e.g. large trees of fire-resistant species such as western larch), were generally the best-formed trees of the appropriate species existing on the site, and were typically distributed irregularly rather than uniformly in a cutting unit. Cutting unit shapes were irregular and similar to natural shapes and take into account the influence of topography and other natural features. However, in scattered parcels consisting of a single section bordering other ownerships it can be difficult to blend the edges of cutting units into adjacent cut or uncut patches. Cutting units may be smaller than the patch size that natural disturbances would have created; but, when undertaken, efforts to blend multiple smaller patches into larger patches through cutting were successful.

When rare and unique habitats and sensitive plants were encountered in project areas, mitigations to protect those areas and species were considered by the review team to have had a high probability of being effective. Mitigations for such features and species are typically dealt with through cutting unit design or the establishment of buffers around those features within the cutting unit, as well as road system closures and timing restrictions.

When old-growth or unverified old-growth stands are encountered in a project area, those stands are verified through field data collection prior to considering and determining treatment options. Target amounts of snags and coarse woody debris were typically left on the site following treatment for both wildlife habitat and nutrient management considerations, although in some cases fewer snags and less coarse woody debris than the target amounts existed in the stands prior to treatment.

In many cases whole-tree skidding, which is not preferable from a standpoint of leaving nutrients on-site, is used during harvest operations. In those cases, return skidding was effectively used to return both fine and coarse woody debris to the cutting units we evaluated. The distribution of that material through the units was generally good, and was considered adequate for meeting retention objectives.

Expanded monitoring through the field review process is planned in the future in order to identify ongoing issues that the DNRC faces in integrating biodiversity measures into timber sale planning and layout.

OLD-GROWTH

The Forest Management Rules provide DNRC with a framework to manage old-growth stands in order to meet biodiversity and fiduciary objectives. This framework includes quantitative old-growth definitions adopted from Green et al. (1992) that require a minimum number and average age of large live trees for specific forest habitat types (Pfister et al., 1977) and cover types, and also specifies the types of silvicultural treatments that the DNRC must consider when managing old-growth stands.

ARM 36.11.418 describes three treatments—restoration, maintenance, and removal—that would be applied in old-growth stands depending on stand condition and other factors. Each of these treatments corresponds to a broad fire regime, with restoration treatments identified as appropriate for low severity/frequent fire interval sites, maintenance

treatments appropriate for mixed-severity fire regimes, and removal treatments appropriate for stand-replacing fire regimes. Under both restoration and maintenance treatments, the post-treatment stands would continue to meet the DNRC's old-growth definition; however, stands receiving removal treatments are no longer classified as old-growth. A caveat explained in the Rule is that the DNRC reserves the right to apply a removal treatment in any old-growth stand regardless of the appropriate disturbance regime. Because of this, questions arose internally regarding situations under which it would be appropriate to apply removal treatments on sites that do not have stand-replacing fire regimes, and how maintenance and restoration treatments should be applied on the ground.

The DNRC has clarified that removal treatments should only be applied on low-severity and mixed-severity sites when, using the best professional judgment, a stand would in the foreseeable future no longer meet the DNRC's old-growth definition. In other words, the first option for treatment in low-severity and mixed-severity regimes is always a restoration or maintenance treatment unless, due to mortality or other factors (such as insect and disease outbreaks), the stand is likely to "fall out" of old-growth status in the foreseeable future.

The FMB has also worked to assist foresters with the application of restoration and maintenance treatments in the field. Acknowledging concern from interested publics that the DNRC's old-growth definition would allow cutting down to the minimum number of large live trees required to be defined as old-growth, the DNRC has worked to develop sideboards for implementing restoration and maintenance treatments that describe the appearance and characteristics of managed old-growth stands after harvesting. Such treatments should go beyond simply leaving the minimum number of trees to meet the old-growth definition, and as much as possible given existing stand conditions, work to maintain other old-growth attributes such as multi-layered canopies, snags, and large woody debris while also accomplishing management objectives that promote the identified desired future condition for a stand.

The DNRC continues to address questions concerning the concept of "managed" old-growth, 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 these Land Offices. East of the Continental Divide forested lands and old-growth are relatively small components of State trust lands and many eastside lands are not legally accessible to DNRC. Thus, activities involving old-growth in eastern Montana are addressed at the project level. Due to data limitations, comparable data for lands east of the Continental Divide with those lands west of the Divide are not available for inclusion in this report.

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 Administrative Unit level in the appropriate MEPA documents.

Old-growth acreage declined over the five-year period from 2005 through 2010 (Table B-1; Figure B-1). Figure B-1 compares the old-growth amounts on lands owned by the State in both 2005 and 2010. The total old-growth acreages shown in Figure B-1 for 2005 and 2010 are different than the totals listed in Table B-1 because of transfer of land out of or into State ownership through land exchanges and acquisitions (i.e-old-growth acres in 2005 that were transferred from State ownership are not included in Figure B-1, and old-growth acres that were not in State ownership in 2005 but are now owned by the State are not included in Figure B-1). Figure B-2 displays the causes for the reduction of old-growth acres on lands owned by the State in both 2005 and 2010 and represents the difference in the gray bars in Figure B-1. As shown in Figure B-2, the reduction in old-growth acres is primarily due to improved inventory data that verified nearly 7,000 acres (62 percent of the acres that fell out of old-growth status from 2006 through 2010) previously identified as old-growth in 2005 as not meeting the requirements of DNRC's old-growth definition in 2010. However, inventory updating also identified 6,429 acres not classified as old-growth in 2005 as old-growth in 2010 (Figure B-1), offsetting all but 570 acres of the old-growth lost to inventory updates. Timber harvesting was the second largest factor in old-growth reductions, with 2,905 acres harvested from 2006 through 2010. Most harvesting in old-growth focused on decadent stands with insect and disease issues that were likely to fall out of old-growth regardless of harvesting. Of the harvested old-growth acres, 739 were harvested in the Swan River State Forest, and 565 acres were harvested in burned areas where fire may have removed the acres from old-growth classification prior to salvage operations. Insects and diseases accounted for 1,041 acres of old-growth reductions in stands where harvesting did not occur.

The age class data presented in Table B-2 provides an estimate of the predominant ages of the forest stands managed by the DNRC. Most old-growth acreage is over 150 years old; however, some lodgepole-pine stands between 140 and 150 years old may also be old-growth. In the 2005 monitoring report, old-growth stands were included in the 150 years or older age class; however, in this report we have separately listed old-growth and 150 years or older age classes in order to illustrate more clearly the percent of acreage with sufficient large live trees and age to meet DNRC's old-growth definition, as well as the percent of older forests that do not meet the minimum criteria of the old-growth definition. Although old-growth acreage decreased from 2005 to 2010, the amount of older-aged stands (the sum of the 150 years or older and old-growth age classes) increased from 34 percent to 37 percent. These data illustrate that over 75 percent of older-aged stands do not contain the number of large old trees per acre required to be classified as old-growth. The percentage of young stands (0 to 39 years old) slightly increased due to harvesting in older age classes, and successful regeneration of burned stands, particularly on the SWLO. The proportion of mid-aged stands from 40 to 99 years old decreased from 2005; this is due in part to harvesting, recruitment into older-aged classes, and updated inventory methodology that uses a different method to calculate stand age that has resulted in some stands that were

previously classified as 40 to 99 years old as older stands. Additionally, there is currently very little recruitment from the 0 to 39 age class into the 40 to 99 age class because of a lack of regeneration harvesting on State lands prior to 1970. Such harvesting would have resulted in a greater representation of young stands that would currently be moving from the youngest age class to the 40 to 99 age class.

Table B- 1: Summary of NWLO and SWLO current estimated old-growth acreages meeting the Green et al. definitions.

CURRENT TYPE*	SWLO		NWLO		Total	
	2005	2010	2005	2010	2005	2010
	Acres					
DF	4,104	2,674	800	876	4,904	3,550
LP	1,236	1,093	402	499	1,638	1,592
MC	143	157	11,718	11,088	11,861	11,245
PP	4,824	2,620	2,521	1,378	7,345	3,998
AF	422	479	5,867	5,506	6,289	5,985
WL/DF	1,637	1,699	8,637	7,737	10,274	9,436
WWP	0	0	2,956	2,936	2,956	2,936
Total	12,366	8,722	32,901	30,020	45,267	38,741

*DF=Douglas-fir; LP=lodgepole pine; MC=mixed conifer; PP=ponderosa pine; AF=subalpine fir; WL/DF=western larch/Douglas-fir; WWP=western white pine.

Figure B- 1: Old-growth amounts on lands in State ownership in both 2005 and 2010, and newly designated old-growth in 2010.

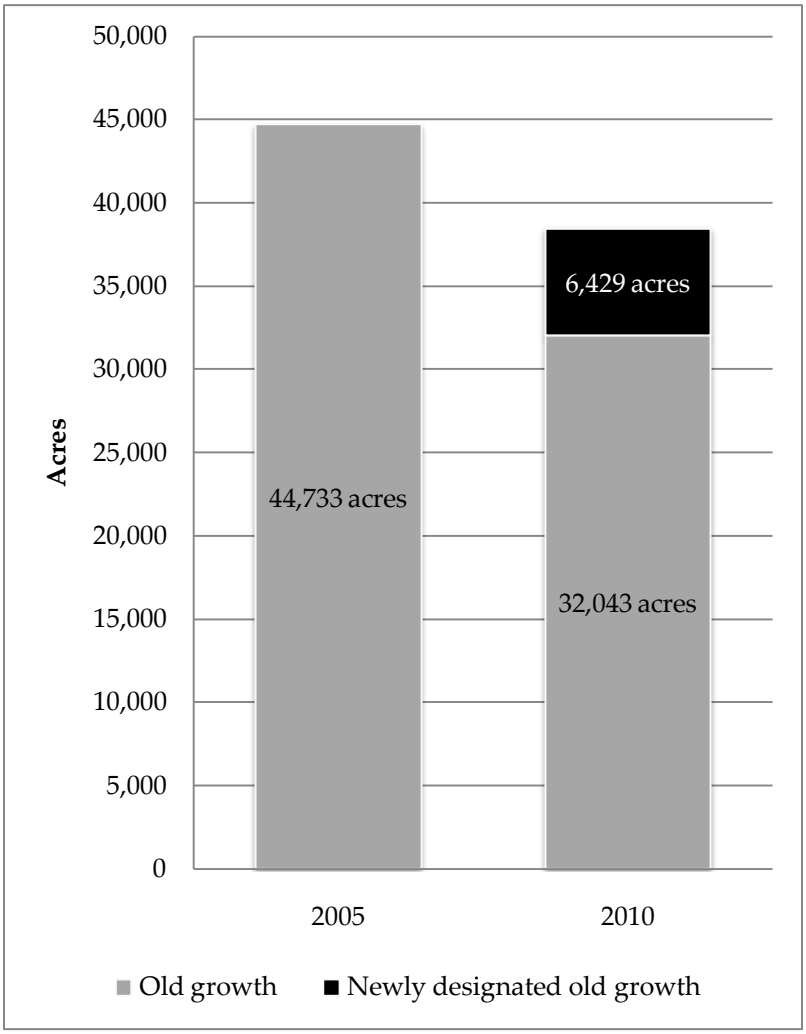


Figure B- 2: Causes of old-growth reductions on lands in State ownership in both 2005 and 2010.

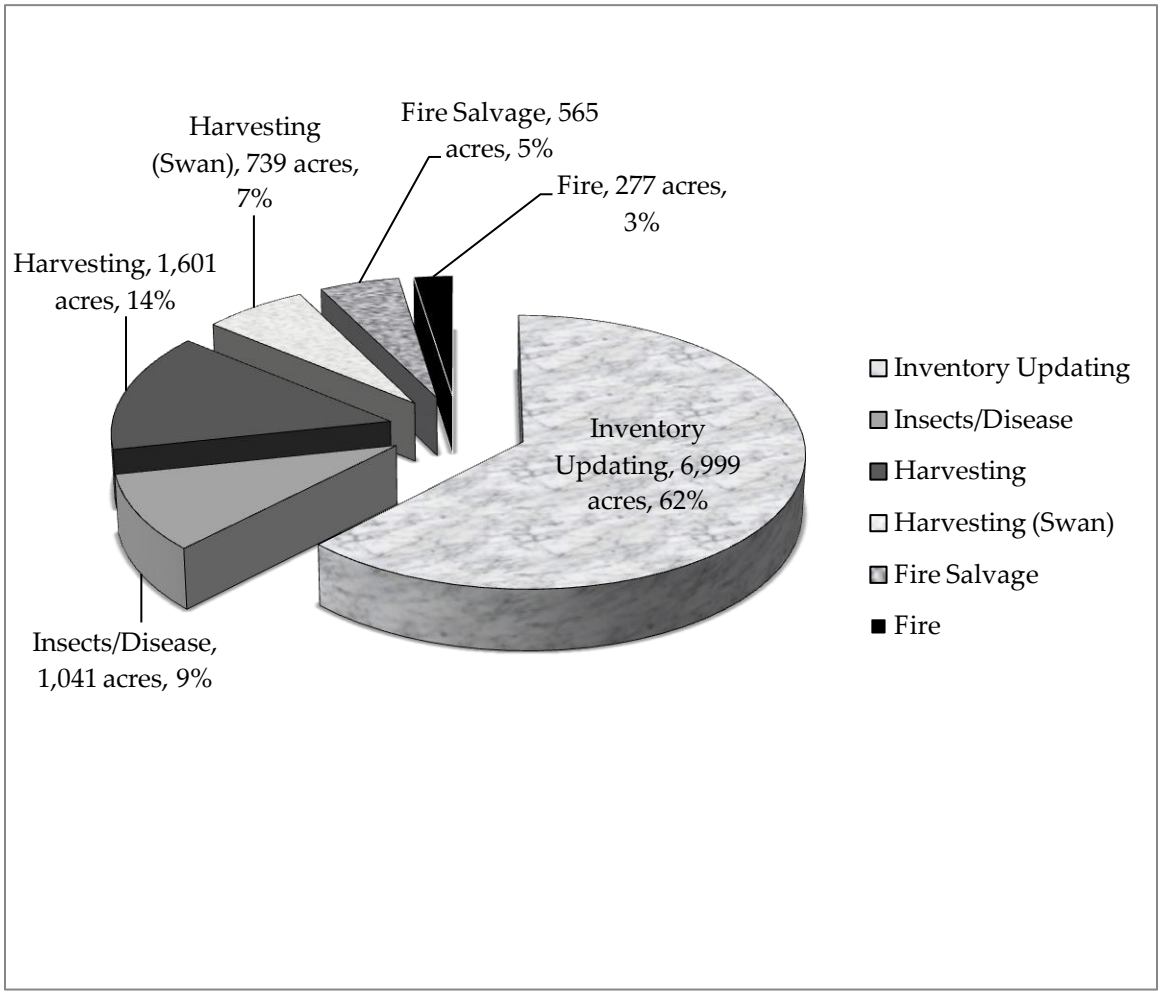


Table B- 2: Percentage of age class distributions on the NWLO and SWLO in 2005 and 2010 using the Stand Level Inventory (SLI).

AGE CLASS	SWLO		NWLO		Total	
	2005	2010	2005	2010	2005	2010
	Acres					
NO AGE DATA	5%	5%	2%	2%	3%	3%
000-039	11%	16%	12%	11%	12%	13%
040-099	27%	22%	24%	21%	25%	21%
100-150	33%	33%	23%	24%	27%	27%
150 years or older	16%	19%	28%	32%	24%	28%
Old-growth	8%	6%	11%	10%	10%	9%
Total	100%	100%	100%	100%	100%	100%

DESIRED FUTURE CONDITIONS

DNRC has defined a desired future condition (DFC) for State trust lands based on the cover types expected to exist with natural conditions as per the SFLMP and Forest Management Rules. The DFC helps the DNRC determine which stands to target for treatment and the types of treatments necessary to help move the landscape in the direction of the DFC. Movement toward or away from a pre-determined DFC can take substantial time, because it can take years or decades for regeneration of the appropriate species to initiate and become established. For example, in many cool and moist 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, due to the high proportional abundance of residual Douglas-fir, the stand may remain appropriately labeled as a Douglas-fir stand even though the long-term target stand composition is one dominated by western larch.

Table B-3 and Figures B-3 and B-4 show the percent of acres by cover type compared to the DFC for forested lands west of the Continental Divide on SWLO and NWLO. In the figures, the black bar represents the DFC target for the land office. On the SWLO, there is excess in Douglas-fir and non-stocked cover types and deficiency in the ponderosa pine cover type (Figure B-3). The non-stocked acres are burned areas, primarily in ponderosa pine types, that are in the process of regenerating or have regenerated, but have not been recently inventoried. On the NWLO (Figure B-4), there is a large excess in the mixed conifer type and deficiencies in the ponderosa pine, western larch/Douglas-fir, and western white pine cover types; however, the amount of mixed conifer forests is decreasing and the amount of western larch/Douglas-fir is increasing, indicating some progress toward the overall desired future conditions. While ponderosa pine and western white pine have remained stable compared to the previous monitoring period, we expect future increases in these types as non-stocked acres regenerate.

Progress toward a DFC is dependent on maintaining the desired cover type in stands that currently meet DFC and on encouraging the development of desired cover types in stands that do not currently meet the DFC. Timber harvesting can accomplish this in both cases by promoting the development of the appropriate species necessary to meet a DFC. In the absence of timber harvesting or other disturbance, most stands would generally be expected to move away from the identified DFC. For some cover types (e.g. WL/DF), progress toward the DFC is not readily apparent, primarily due to the time required for regenerated stands to become established, be re-inventoried, and then displayed as a different cover type (Table B-3). The relative amounts of even-aged and partial cutting treatments applied over time also influence the rate of progress toward a DFC. In addition, some partial harvests do not achieve a change in cover type that would move the stand toward DFC.

Table B- 3: Percent of acres by cover type, 2000 to 2010, compared to DFC target for DNRC managed lands.

Cover Type*	SWLO				NWLO			
	2000	**2005**	**2010**	**DFC Target**	**2000**	**2005**	**2010**	**DFC Target**
DF	21.5%	21.7%	23.8%	15.9%	2.4%	5.2%	5.2%	1.6%
HW	0.8%	0.7%	0.9%	0.7%	0.2%	0.4%	0.4%	0.4%
LP	8.8%	8.9%	6.9%	7.0%	8.2%	7.6%	6.8%	5.7%
MC	4.0%	4.2%	4.0%	0.6%	23.8%	25.1%	21.9%	5.1%
Noncomm	0.2%	0.2%	0.0%	N/A	0.1%	0.0%	0.0%	N/A
Nonstkd	0.7%	6.6%	11.0%	N/A	0.7%	1.8%	2.7%	N/A
PP	45.3%	39.0%	34.4%	57.3%	19.0%	18.6%	18.8%	26.0%
AF	3.7%	3.4%	3.5%	1.7%	13.6%	13.0%	13.0%	8.1%
WL/DF	14.8%	15.1%	15.4%	16.6%	26.3%	25.5%	28.4%	40.4%
WWP	0.2%	0.1%	0.1%	0.2%	5.6%	2.9%	2.9%	12.8%
Acres Included	157,271	158,157	157,746	157,746	284,647	293,223	293,169	293,169

*DF=Douglas-fir; HW=hardwoods; LP=lodgepole pine; MC=mixed conifer; Noncomm=Non-commercial; Nonstkd=non-stocked; PP=ponderosa pine; AF=subalpine fir; WL/DF=western larch/Douglas-fir; WWP=western white pine.

Figure B- 3: Trends in cover types compared to DFC, SWLO, 2000 to 2010.

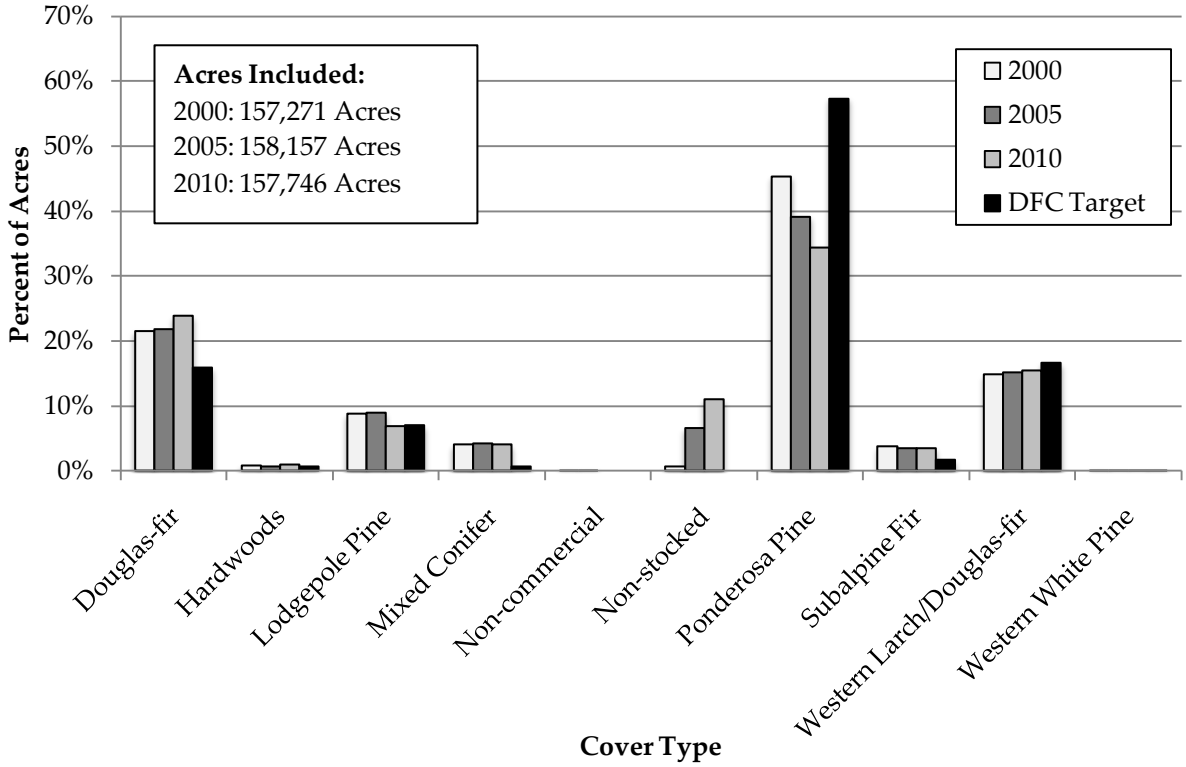
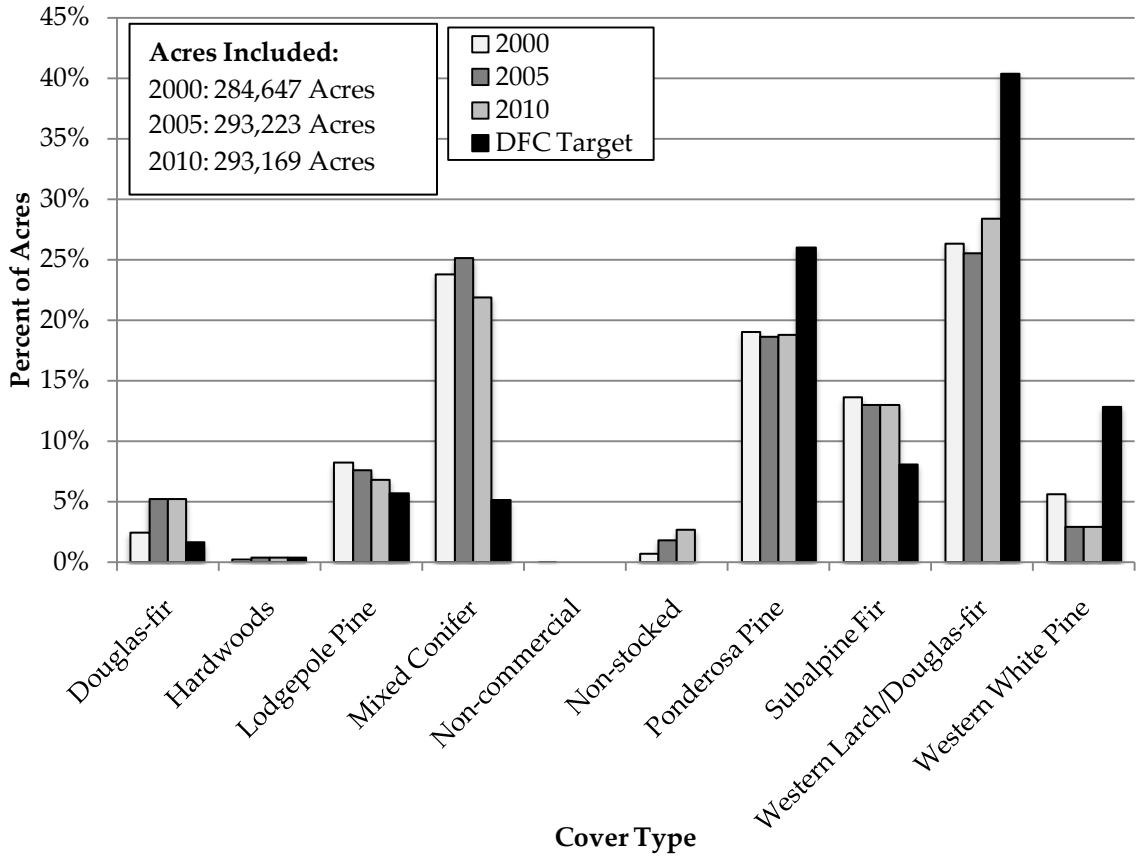


Figure B- 4: Trends in cover types compared to DFC, NWLO, 2000 to 2010.



COOPERATIVE PLANNING

Cooperative planning with major adjoining landowners is part of DNRC's strategy to manage for and promote biodiversity on both its lands and the larger landscape. Few opportunities have been present during this monitoring period to conduct large scale cooperative planning efforts such as those described under ARM 36.11.417. However, consideration of habitat and stand conditions on adjacent ownerships is provided by interdisciplinary teams in project level planning on timber sale projects. Cooperative planning efforts that DNRC is involved with have typically focused on wildlife habitat, land acquisition, recreation planning, and fire hazard reduction in wildland-urban interface settings. While biodiversity considerations may not be the primary focus of or reason to enter into a cooperative agreement, most cooperative agreements that DNRC is involved with have the effect of promoting biodiversity on a broader scale. The following are some major cooperative planning efforts that DNRC has participated in during the 2006 through 2010 monitoring period:

- Montana DNRC Forested State Trust Lands HCP: a proposed cooperative plan with the USFWS that would contribute to the maintenance of biodiversity by providing habitat protections for grizzly bears, Canada lynx, and bull trout for 50 years over

548,000 acres of forested trust land in western Montana. Additional specific monitoring components would be a part of that plan.

- Land acquisitions: DNRC has completed or is in the process of completing multiple acquisitions of former Plum Creek Timber Company lands, including Chamberlain (14,653 acres in Missoula and Powell Counties), Potomac (32,284 acres in Missoula County), and Swan (1,920 acres in Lake County), among others. Cooperators in these acquisitions have included The Nature Conservancy, the Trust for Public Lands, the Blackfoot Challenge, and the Montana Department of Fish, Wildlife, and Parks (FWP).
- Whitefish Neighborhood Plan: DNRC cooperated with numerous stakeholders in the Whitefish area to develop the Whitefish Neighborhood Plan, a land use plan for 13,000 acres of State land surrounding Whitefish, Montana. During this monitoring period, DNRC has collaborated in numerous projects that have come from the plan, including timber sale projects, the Goguen Land Exchange Project, and A Trail Runs Through It Project.

CLIMATE CHANGE

DNRC is aware of potential changes in forested ecosystems as a result of changing climatic influences. While the nature and magnitude of the changes in forests is uncertain, DNRC is able, through ongoing inventory efforts, timber sale cruise plot collection, regeneration and forest pest surveys, and consultation with other agencies conducting forest inventory (such as the USFS Inventory and Analysis program), to monitor and detect potential changes that would affect or influence its forest management philosophy and decisions. These tools assist DNRC in identifying changes in the species composition of vegetative communities and plant associations (habitat types) from established descriptions such as those provide by Pfister et al (1977) and Losensky (1997).

To date, DNRC has not identified through any of the above methods any changes to forest vegetation that would necessitate a shift in management philosophy. For the foreseeable future, DNRC will continue to manage for a desired future condition characterized by the species composition and distribution of historically occurring cover types, such as described by Losensky (1997). This approach promotes biodiversity as well as a wide range of options to manage for healthy and diverse forests that meet both biological and fiduciary objectives both now and into the future.

PHOTO POINT MONITORING

Following several large fires that occurred on school trust lands beginning in year 2000, a number of photo points were established by DNRC inventory staff to record observable changes to the forest over time. The Sula State Forest burned in 2000. It has 33 photo points with an average of four photos per point. On this forest, photos were collected in 2000, 2001, 2002, and 2007, with an estimated 528 photos taken to date. The Coal Creek State Forest burned in 2001. It has 18 photo points with an average of four photos per point. Photos were collected in 2001, 2002, 2003, and 2008, with an estimated 228 photos taken to

date. The photos have been valuable for documenting changes and recovery in forest conditions due to natural forest succession, tree planting, natural regeneration, rate of seedling growth and post-fire mitigation efforts. They have also been valuable for improving our understanding of post-fire tree mortality, and fall and breakage rates of trees and snags.

One new photo point project was established in 2010 in the Boorman Peak section west of Kalispell. Old-growth maintenance and restoration treatments were used in the Boorman Peak timber sale, and the Department established 29 photo points throughout the cutting units to track post-harvest stand conditions and development in order to better refine the use of those treatments. One hundred and thirty seven photos were taken in 2010, with at least 4 photos taken at each point. Points will be visited approximately every 10 years for several decades in order to establish a record of the forest's recovery, growth, and development.

TREE MORTALITY AND BREAKAGE 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 several permanent sites to track post-fire survival and mortality in relation to degree of individual tree damage, fire intensity, and to assess breakage and fall rates of newly created snags. The following information updates what was reported in the 2005 monitoring report using data collected from subsequent monitoring.

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 fire damage parameters that are easy to estimate and quickly observed. Two additional objectives were added to the study when the trees began to break and fall down. DNRC recognized this study could be modified to provide an opportunity to begin studying how fast the snags were breaking and falling down. In addition the monitored trees could provide information regarding wildlife use.

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 disturbance during the fires that burned through the Sula State Forest in August 2000.

A total of 130 Douglas-fir and ponderosa pine trees were painted and tagged. There were sixty-nine Douglas-fir trees which had an average diameter at breast height (dbh) of 16.5 inches (standard deviation = 4.0 inches). Douglas-fir diameters ranged from ten to twenty-five inches. There were sixty-one ponderosa pine trees which had an average dbh of 20.2

inches (standard deviation = 6.0 inches). Ponderosa pine diameters ranged from eleven to thirty-five inches. The selected trees have a wide range of crown scorch and bole scorch. While establishing the study sites the following information was collected for each tree: site number, tree number, species, diameter at breast height, tree height, distance from an established Reference Point (RP), azimuth from RP to tree, crown kill, crown scorch, crown ratio, uphill bole scorch, downhill bole scorch and comments. Each site was visited in the fall to record whether or not the trees had died, along with information on insect or disease presence. In 2004 the following information was collected in addition to whether the tree was alive or dead: tree bole status (broken or fell), bole height at point of breakage, did the bole break again or fall after the original breakage. Wildlife use was recorded for the first time in 2009 for each tree in the study.

Monitoring has been conducted annually from 2001 through 2009 with the exception of 2003. Annual site visits will continue for a few more years to monitor additional mortality, wildlife use, when the trees fall and tree bole breakage.

Photo Point Monitoring - Point 8, Azimuth 18

8/31/2000

9/24/2002

7/3/2001

7/25/2007

Mortality study site #39, Sula State Forest, photo taken 2008

Results and Recommendations for Identifying Trees Likely to Die Based on the Sula State Forest Mortality Study

When setting up fire salvage timber sales, DNRC foresters frequently mark trees that will be left on the site or mark trees that will be cut based on the fire damage suffered by the trees. Silvicultural and other management objectives are more likely to be met if the forester can accurately estimate burned trees that are likely to live or die. The following information helps the forester determine which trees are likely to die. The parameters tracked in this study are indicators of how much heat the tree's cambium and/or root collar endured during the fire. These parameters also indicate the level of stress and demand the fire damage has put on the tree's food reserves.

As a general rule mortality rates will be higher in mixed severity fire areas that burned hotter, than in mixed severity areas that burned cooler. Areas that burned hotter will have greater numbers of trees with crown kill (the needles are burned off of some of limbs in the crown), trees with the entire crown burned off, and trees with high levels of crown scorch (brown needles) and bole scorch (burned bark). Areas that burned hotter will also have few or no areas with unburned duff. Areas that burned cooler will have few trees with large amounts of crown scorch and bole scorch. There will not be any limb kill or black snags on the site.

- Ponderosa pine mortality indicators: Each of the following levels of fire damage by themselves indicate a high probability of tree mortality and consequently make them good candidates for salvage logging:
    - Average bole scorch ≥ 25 percent of tree bole. (Average bole scorch = (percent uphill side bole scorch + percent downhill side bole scorch)/2)
    - Crown kill > 10 percent of total crown
    - Crown scorch ≥ 90 percent of total crown
- Douglas-fir mortality indicators: Each of the following levels of fire damage by themselves indicates a high probability of tree mortality and consequently make them good candidates for salvage logging. and consequently the tree should be salvaged logged:
    - Average bole scorch ≥ 10 percent of tree bole
    - Crown kill > 5 percent of total crown
    - Crown scorch ≥ 40 percent of total crown
    - dbh ≤ 10 inches combined with any amount of bole scorch and crown scorch

Mortality study site #33, Sula State Forest, photo taken 2008

Results, Mortality Amount by Species

Douglas-fir had a greater amount of mortality than did ponderosa pine. Seventy-eight percent of the Douglas-fir trees monitored are dead and 51 percent of the ponderosa pine trees have died. Overall 65 percent of the trees were dead as of October 2009 (Table B-4).

Table B- 4: Number and percent of live and dead trees by species post fire on the Sula State Forest 2000 to 2009.

SPECIES	LIVE	DEAD	TOTAL
Douglas-fir	15 (22%)	54 (78%)	69 (100%)
Ponderosa Pine	30 (49%)	31 (51%)	61 (100%)
All Trees	45 (35%)	85 (65%)	130 (100%)

Results, Mortality Amount by Species and DBH Class

Douglas-fir had slightly less mortality in the Large 22-27 inch diameter class than in the other two smaller diameter classes, 57 percent versus 79 and 82 percent. Ponderosa pine mortality was relatively consistent from one diameter class to the next (Table B-5).

Table B- 5: Number and percent of live and dead trees by species and dbh class post fire on the Sula State Forest 2000 to 2009.

Status	Species	DBH Class				
		Small: 10 – 15″	Medium: 16 – 21″	Large: 22 – 27″	Very Large: 28″+	Total
Dead	Douglas-fir	22	28	4	0	54
	Ponderosa Pine	7	14	4	6	31
	Total	29	42	8	6	85
Live	Douglas-fir	6	6	3	0	15
	Ponderosa Pine	6	14	6	4	30
	Total	12	20	9	4	45
All Trees	Douglas-fir	28	34	7	0	69
	Ponderosa Pine	13	28	10	10	61
	Total	41	62	17	10	130
Percent Dead Douglas-fir		79%	82%	57%		78%
Percent Dead Ponderosa Pine		54%	50%	40%	60%	51%
Percent Dead All Trees		71%	68%	47%	60%	65%

Results, Mortality Amount by Species and Year: Mortality has dropped to normal or endemic levels since 2004 for both Douglas-fir and ponderosa pine. By 2004, 96 percent of the tree mortality had occurred on the study sites. Only 4 trees died from 2005 to 2007. No additional trees died after September 2007 to October 2009.

No new beetle activity was observed during the period of 2005 to 2009. Bark beetles had been observed in 76 trees as of 2005. Forty Douglas-fir trees had been hit by Douglas-fir beetles and 36 ponderosa pine trees had been hit by mountain pine beetles, turpentine beetles, and possibly western pine beetles. A total of 55 of the trees (72 percent) hit by beetles had died by 2005 (Table B-6). The proportion of trees hit by beetles was nearly the same for both tree species in this study. Ponderosa pine had a slightly higher survival rate (33 percent) than did Douglas-fir (23 percent).

Table B- 6: Number of trees by year of mortality and species on the Sula State Forest.

Species	Year of Tree Mortality								Total
	2001	2002	2004	2005	2006	2007	2008	2009	
Douglas-fir	26	16	10	1	0	1	0	0	54
Ponderosa pine	11	7	11	0	2	0	0	0	31
All Trees	37	23	21	1	2	1	0	0	85
Percent of All Dead Trees	44%	27%	25%	1%	2%	1%	0%	0%	100%

Results: Amounts of Tree Bole Breakage by Species and Year the Bole Broke: The dead tree boles began breaking in 2004. A total of 56 trees or 69 percent of the dead trees have broken boles (Table B-7). Only 10 (12 percent) of the 81 dead trees are intact or have not fallen down. The number of new broken bole observations has been lower each year since 2006. Bole breakage was greatest in 2006 at 21 new broken boles. A total of 33 new broken bole observations (59 percent of all broken boles) were made during 2006 and 2007. As of 2009 no live trees have fallen down or have a broken bole.

Table B- 7: Number of combined Douglas-fir and ponderosa pine trees by year trees broke on the Sula State Forest.

Year Tree Bole Broke	Intact	Fell	Broken Bole	Total
2004			1	1
2005			5	4
2006			21	21
2007			12	12
2008			9	9
2009			8	8
Fell		15		
Intact	10			
TOTAL	10	15	56	81
Percent of Total	12%	19%	69%	100%

Four broken Douglas-fir tree boles broke a second time. The second break occurred one year to three years after the first break. This phenomenon was first observed in 2008 once and three times in 2009 (Table B-8).

Table B- 8: List of trees whose bole broke twice on the Sula State Forest.

Species	dbh	Year First Break	Year Second Break	First Break Height	Second Break Height
Douglas-fir	19	2006	2009	50	29
Douglas-fir	11	2006	2009	26	5
Douglas-fir	19	2007	2008	61	12
Douglas-fir	16	2007	2009	49	26

It appears Douglas-fir is more likely to break than ponderosa pine. Eighty percent of the Douglas-fir has broken tree boles (Table B-9). Fifty-two percent of the ponderosa pine trees

have broken tree boles (Table B-10). It also appears that ponderosa pine is more likely to fall down or break below 6 feet in height than Douglas-fir. A closer look at the data revealed that 6 of the ponderosa pine trees that fell were located on one site. This site was located near the bottom of a hillside and not in an area that was exposed to more wind than any other site in the study but if did have shallower soils than most of the other sites. The other 5 trees were scattered among the other study sites and are equal to 16 percent of the 31 dead ponderosa pine trees. That is twice the percentage of Douglas-fir that fell down.

Table B- 9: Number of Douglas-fir trees by year trees broke on the Sula State Forest.

Year Tree Bole Broke	Intact	Fell	Broken Bole	Total
2004			1	1
2005			4	4
2006			16	16
2007			10	10
2008			6	6
2009			3	3
Fell		4		
Intact	6			
TOTAL	6	4	40	50
Percent of Total	12%	8%	80%	100%

Table B- 10: Number of ponderosa pine trees by year trees broke on the Sula State Forest.

Year Tree Bole Broke	Intact	Fell	Broken Bole	Total
2004				
2005			1	1
2006			5	5
2007			2	2
2008			3	3
2009			5	5
Fell		11		11
Intact	4			4
TOTAL	4	11	16	31
Percent of Total	13%	35%	52%	100%

Results: Number of Broken Trees by Height and Diameter Breast Height (dbh): Heights of broken dead trees (snags) ranged from 7 feet to 106 feet. Trees with dbh greater than 21 inches had a slightly lower frequency of breakage than trees with smaller dbh (Table B-11). There is a relationship between dbh and the height of the break point for both species of trees in this study. Linear regression analysis was conducted to examine the relationship between break point height (dependent variable) and tree dbh (independent variable). The coefficient of determination (r^2) for Douglas-fir and ponderosa pine combined was 0.87. For Douglas-fir trees $r^2 = 0.83$ and for ponderosa pine the $r^2 = 0.93$. The break point height was

predicted to increase 2.06 feet per inch of dbh for Douglas-fir and 2.44 feet per inch of dbh for ponderosa pine.

Table B- 11: Number of combined dead Douglas-fir and ponderosa pine trees by break point height class and dbh class on the Sula State Forest.

Height Class (feet)	dbh Class				
	Small: 10-15″	**Medium: 16-21″**	**Large: 22-27″**	**Very Large: 28″+**	**TOTAL**
Intact	1	5	3	1	10
6-9′	3	0	0	0	3
10-19′	7	4	1	0	12
20-29′	4	1	0	0	5
30-39′	3	14	1	0	18
40-49′	0	3	0	0	3
50-59′	1	4	0	0	5
60-69′	0	2	0	0	2
70′ +	0	1	3	4	8
TOTAL	21	36	8	5	66
Percent Broken Boles	95%	85%	63%	80%	85%

Fallen ponderosa pine trees, mortality site #33, Sula State Forest, photo taken 2009

Results: Number of Trees by Status and Diameter Breast Height (dbh) Class

Dbh did not appear to appreciably influence the proportion of tree bole breakage or falling. Nineteen percent of the dead trees fell down or broke below 6 feet of bole height. Smaller diameter trees fell down in about the same proportion as larger diameter trees (Table B-12). Sixty-nine percent of the dead trees have broken tree boles. When all dead trees are

considered smaller diameter trees broke at nearly the same proportion as larger diameter trees. Diameter at breast height did not influence the proportion of intact trees.

Table B- 12: Number of combined dead Douglas-fir and ponderosa pine trees by tree status and dbh class on the Sula State Forest.

Status	dbh Class				
	Small: 10-15″	Medium: 16-21″	Large: 22-27″	Very Large: 28″+	TOTAL
Intact	4	4	1	1	10
Broken Bole	18	29	5	4	56
Fell Down	5	7	2	1	15
Total	27	40	8	6	81
Percent Fell of Total	19%	18%	25%	17%	19%
Percent Broke of Total	67%	73%	63%	67%	69%
Percent Intact of Total	15%	10%	13%	17%	12%

Results: When Tree Boles Broke by Species

No live trees had broken boles as of 2009. The earliest that Douglas-fir tree boles begin to break was 3 years after the tree died (Table B-13). The range was 3 to 8 years after tree death. The mean number of years after death tree boles broke was 5.1 years.

Table B- 13. Number of dead Douglas-fir trees by the number of years it took the bole to break -- Sula State Forest.

Years	1	2	3	4	5	6	7	8	Total	Mean	Standard Deviation
Number of Trees	0	0	3	5	9	13	5	5	40	5.1	1.4

Ponderosa pine trees begin to break 4 years after the tree died (Table B-14). The range was 4 to 8 years after death. The mean number of years after death tree boles broke was 5.7 years.

Table B- 14. Number of dead ponderosa pine trees by the number of years it took the bole to break -- Sula State Forest.

Years	1	2	3	4	5	6	7	8	Total	Mean	Standard Deviation
Number of Trees				2	4	8	1	1	16	5.7	1

Results: When Trees Fell Down After Death

The first trees fell down or broke below 6 feet of bole height 3 years after death (Table B-15). The range was from 3 years to 9 years. The mean number of years after death that trees fell down was 5.8 years. None of the live trees had fallen down as of 2009.

Table B- 15: Number of Douglas-fir and ponderosa pine trees by the number of years it took the tree to fall down -- Sula State Forest.

Years	1	2	3	4	5	6	7	8	9	Total	Mean	Standard Deviation
Number of Trees			2	1	4	4	2	2	1	16	5.8	1.7

Wildlife use on Douglas-fir, mortality study site #36, Sula State Forest, photo taken 2009

Results: Wildlife Use by Species and Tree Status

Wildlife use of snags (dead trees) was much higher on Douglas-fir trees than ponderosa pine trees (Tables B-16 and B-17). Wildlife use was observed on 76 percent of dead Douglas-fir trees compared to 45 percent wildlife use of dead ponderosa pine. Large and small cavities were observed in dead Douglas-fir. No cavities were observed in dead ponderosa pine.

Wildlife feeding use was observed on 27 percent of the live trees for both Douglas-fir and ponderosa pine (Tables B-16 and B-17). No cavities were observed in live trees. Wildlife use was observed on 67 (52 percent) of the 130 trees in the study. Use of dead trees was observed on 55 (65 percent) of the 85 dead trees in the study. All 11 mortality sites had trees being used by wildlife.

Table B- 16: Wildlife use of Douglas-fir by status on the Sula State Forest 2000 to 2009.

Wildlife Use	Dead	Live	Total	Percent of Total
None	13	11	24	35%
Feeding	38	4	42	61%
Small Cavity (<2″)*	1		1	1%
Large Cavity (>2″)*	1		1	1%
Both Small & Large Cavity*	1		1	1%
Other Nest				0%
Total	54	15	69	100%
Percent Wildlife Use of Total	76%	27%	65%	

*Feeding was observed on all trees that contained cavities.

Table B- 17: Wildlife use of ponderosa pine by status on the Sula State Forest 2000 to 2009.

Wildlife Use	Dead	Live	Total	Percent of Total
None	17	22	39	64%
Feeding	14	8	22	36%
Other Nest				0%
Total	31	30	61	100%
Percent Wildlife Use of Total	45%	27%	36%	

Results: Wildlife Use of Snags by dbh Class: Wildlife use was observed on 65 percent of the snags. Smaller diameter snags had essentially the same amount of wildlife use as larger diameter snags (Table B-18).

Table B- 18: Wildlife use of Douglas-fir and ponderosa pine snags by dbh class on the Sula State Forest 2000 to 2009.

Wildlife Use	dbh Class				
	Small: 10-15″	**Medium: 16-21″**	**Large: 22-27″**	**Very Large: 28″+**	**TOTAL**
None	11	14	3	2	30
Feeding and Cavities	18	28	5	4	55
Total	29	42	8	6	85
Percent Wildlife Use of Total	62%	67%	63%	67%	65%

Conclusions

Mortality has dropped to endemic levels in the Sula State Forest. Only 4 trees died between 2005 and 2009 (Table B-5). Snags (dead trees) have been breaking and falling down since 2004. Only 12 percent of the dead trees have intact tree boles as of 2009. Nineteen percent of the dead trees have broken below six feet, broke near the root collar, or blew down pulling the roots out of the ground. Sixty-nine percent of the dead trees have broken tree boles. Four of the Douglas-fir snags broke twice within the 9-year monitoring period. All of the remaining live trees in the study have intact tree boles and none have fallen down. Among standing dead tree boles 9 years after the fire, the proportion of breakage across diameter classes was remarkably similar. And across all dead trees, dbh did not influence the proportion of broken tree boles, fallen trees, or intact trees. However, there is a strong relationship between diameter and height to bole break. Larger diameter trees will almost always have a taller remaining tree bole after the bole breaks than smaller diameter trees. Douglas-fir trees began to break about 6 months sooner than ponderosa pine trees after death. On average the tree boles in this study began to break 5 to 6 years after death. Wildlife used snags (65 percent) over twice as much as live trees (27 percent). Wildlife use of Douglas-fir snags was much higher (76 percent) than ponderosa pine snags (45 percent). Based on the wildlife use, breakage, and fall rate data in the first 9 years of this study, it appears Douglas-fir snags were providing usable habitat for wildlife post-fire and post-salvage logging. Given the different species specific decay attributes and levels of observed wildlife use, it may be beneficial to retain a diversity of size classes and tree species for wildlife in similar post-fire situations. The data indicate larger diameter snags and live snag recruits may provide more habitat for longer periods than smaller diameter snags and live snag recruits because they will typically result in taller tree boles after breakage. Larger tree boles provide more surface area for wildlife feeding and for building cavities.

TREE MORTALITY AND BREAKAGE MONITORING IN THE JOCKO LAKES FIRE

In August of 2007 the Jocko Lakes Fire started near Seeley Lake, Montana. Several DNRC parcels were burned before the fire was controlled. Approximately 2,000 acres of DNRC forest land had been burned by early September 2007. The Jocko Lakes Fire provided an opportunity for DNRC to study western larch (Larix occidentalis) tree mortality and snag breakage. Western larch is a major commercial tree species for DNRC but it does not occur in the Sula State Forest. Monitoring of tree mortality and breakage on another fire located in a different part of the State provided an opportunity to substantiate observations and recommendations made as a result of the Sula State Forest study.

Methods

In the spring and summer of 2008, DNRC established eleven tree mortality monitoring sites on a DNRC parcel that straddles the Finley and Buck Creek drainages west of Placid Lake. Like the Sula State Forest study all sites were located in areas that experienced mixed severity fire behavior.

A total of 132 western larch, Douglas-fir, and ponderosa pine trees were painted and tagged. The selected trees have a wide range of crown scorch, bole scorch and dbh. The following

information was collected for each tree: site number, tree number, species, dbh, distance from an established RP, azimuth from RP to tree, tree height, presence of beetles, height to bottom of crown, crown kill, crown scorch, length of uphill bole scorch, length of downhill bole scorch, fire intensity at base of tree, and comments. Crown ratio and average length of bole scorch were calculated based on data recorded for each tree. Data was collected a little differently to provide an opportunity to conduct different and more detailed analysis of fire damage. Specifically bole scorch was recorded in feet rather than as a percentage of bole length, tree height was recorded for each tree, and height to the bottom of the crown was recorded. Beginning in the fall of 2008 and each subsequent fall through October 2010 the following information was collected: mortality status (live or dead), wildlife use, tree bole status (broken or fell), bole height at point of breakage, and if the bole broke again or fell after the original breakage. Each mortality site will be visited annually for at least 10 years to determine which trees have died, broken, or fallen down.

Description of Trees in the Study: There are 80 western larch, 46 Douglas-fir, and 6 ponderosa pine being monitored in the Jocko Lakes study (Table B-19). Western larch dbh ranges were from 8 to 32 inches (mean = 14.6 inches, standard deviation = 5.0). Douglas-fir dbh ranges were from 8 to 21 inches (mean = 13.1 inches, standard deviation = 3.6). Ponderosa pine dbh ranges were from 12 to 26 inches (mean = 22.2 inches, standard deviation = 4.9).

Table B- 19: Number of trees by dbh and species on the DNRC Jocko Lakes Study Area -- 2008.

	Species			
dbh	**Douglas-fir**	**Ponderosa Pine**	**Western Larch**	**Total**
8	4	0	2	6
9	3	0	6	9
10	6	0	8	14
11	5	0	6	11
12	6	1	9	16
13	4	0	6	10
14	3	0	12	15
15	1	0	8	9
16	4	0	3	7
17	3	0	4	7
18	3	0	3	6
19	2	0	3	5
20	1	0	3	4
21	1	1	1	3
23	0	1	0	1
24	0	0	1	1
25	0	1	1	2
26	0	2	0	2
28	0	0	2	2
31	0	0	1	1

dbh	Species			Total
	Douglas-fir	Ponderosa Pine	Western Larch	
32	0	0	1	1
Total	46	6	80	132

Western larch crown ratios ranged from 18 to 82 percent (mean = 47%, standard deviation = 13.1) (Table B-19). Douglas-fir crown ratios ranged from 26 to 84 percent (mean = 64%, standard deviation = 15.0). Ponderosa pine ranged from 57 to 70 percent (mean = 64%, standard deviation = 4.6).

Table B- 20: Number of trees by crown ratio and species on the DNRC Jocko Lakes Study Area -- 2008.

Crown Ratio	Species			Total
	Douglas-fir	Ponderosa Pine	Western Larch	
1 – 9%	0	0	0	0
10 – 19%	0	0	1	1
20 – 29%	2	0	3	5
30 – 39%	3	0	20	23
40 – 49%	3	0	25	28
50 – 59%	7	2	20	29
60 – 69%	12	3	3	18
70 – 79%	13	1	7	21
80 – 89%	6	0	1	7
90 – 100%	0	0	0	0
Total	46	6	80	132

Results, Number of Live and Dead Trees by Species and Year: Western larch trees have the lowest mortality rate of the 3 species (Table B-21). Seventeen (21 percent) of the western larch have died, 25 (54 percent) of the Douglas-fir have died, and 4 (67 percent) of the ponderosa pine have died. The greatest number of trees died between 2008 and 2009 (22 trees) which was 2 years after the fire. Tree mortality dropped to 9 trees between 2009 and 2010. A total of 46 trees (35 percent) have died (Table B-20).

Table B- 21: Number of trees by year dead and species on the DNRC Jocko Lakes Study Area.

Year Dead	Species			Total
	Douglas-fir	Ponderosa Pine	Western Larch	
Dead 2008	10	4	1	15
Dead 2009	11	0	11	22
Dead 2010	4	0	5	9
Live 2010	21	2	63	86
Total	46	6	80	132
Percent Dead	54%	67%	21%	35%

Mortality Site JL6, photo taken June 2008

Results, Number of Live and Dead Trees by Mortality Site: The number of trees being monitored at a mortality site ranged from 7 to 18 trees (Table B-22). The highest percentage of dead trees was recorded at site JL11 where 75 percent of the trees have died. The lowest percentage of dead trees was recorded at JL4 where only 14 percent of the trees have died.

Table B- 22: Number of trees by mortality site and status on the DNRC Jocko Lakes Study Area -- 2008 to 2010.

Mortality Site	Dead	Live	Total	Percent Dead
JL1	4	7	11	35%
JL2	6	8	14	43%
JL3	7	3	10	70%
JL4	1	6	7	14%
JL5	7	8	15	47%
JL6	4	14	18	22%
JL7	2	11	13	15%
JL8	3	13	16	19%
JL9	2	11	13	15%
JL10	4	3	7	57%
JL11	6	2	8	75%
Total	46	86	132	35%

Results, Number of Live and Dead Trees by Species and dbh: Smaller diameters at breast height have higher amounts of mortality than larger diameters for Douglas-fir and western larch (Table B-23). There is a high amount of mortality for Douglas-fir trees less than 12 inches dbh (14 dead of 18 trees or 78 percent). Overall western larch mortality is lower than Douglas-fir but there appears to be a relationship between mortality and dbh for western larch. None of the 13 western larch trees that had a dbh greater than 18 inches are dead. The mortality rate for trees less than 12 inches dbh was 40 percent (9 dead of 22 trees). The mortality rate for trees greater than or equal to 12 inches dbh was 14 percent (8 dead of 58 trees).

Table B- 23: Number of trees by dbh, species, and mortality status on the DNRC Jocko Lakes Study Area -- 2008 to 2010.

dbh	Species						Total
	Douglas-fir		Ponderosa Pine		Western Larch		
	Dead	Live	Dead	Live	Dead	Live	
8	3	1	0	0	1	1	6
9	2	1	0	0	5	1	9
10	4	2	0	0	1	7	14
11	5	0	0	0	2	4	11
12	2	4	1	0	1	8	16
13	0	4	0	0	3	3	10
14	2	1	0	0	1	11	15
15	1	0	0	0	1	7	9
16	2	2	0	0	0	3	7
17	2	1	0	0	1	3	7
18	1	2	0	0	1	2	6
19	1	1	0	0	0	3	5
20	0	1	0	0	0	3	4
21	0	1	0	1	0	1	3
23	0	0	0	1	0	0	1
24	0	0	0	0	0	1	1
25	0	0	1	0	0	1	2
26	0	0	2	0	0	0	2
28	0	0	0	0	0	2	2
31	0	0	0	0	0	1	1
32	0	0	0	0	0	1	1
Total	25	21	4	2	17	63	132

Results, Number of Live and Dead Trees by Crown Scorch and Species: Western larch appears to be able to tolerate a large amount of crown scorch before the mortality is greater than 50 percent. Western larch did not have any dead trees until crown scorch reached the 30 – 39 percent class and only had 5 dead trees out of 63 trees (8 percent mortality) for crown scorch amounts up to 79 percent (Table B-24). Crown scorch had to be equal to or greater than 80 percent of the crown before mortality was greater than half of the trees. Douglas-fir is less able to tolerate crown scorch than western larch. Mortality consistently exceeded or equaled 50 percent for Douglas-fir trees that had greater than or equal to 60 percent crown scorch. Mortality of Douglas-fir also exceeded 50 percent for the 10 – 19 percent and the 30 – 39 percent crown scorch classes. It appears there are other factors that work in concert with crown scorch that will kill Douglas-fir.

Table B- 24: Number of trees by crown scorch, species, and mortality status on the DNRC Jocko Lakes Study Area -- 2008 to 2010.

Crown Scorch	Species						Total
	Douglas-fir		Ponderosa Pine		Western Larch		
	Dead	Live	Dead	Live	Dead	Live	
1 – 9%	4	5	1	0	0	15	25
10 – 19%	3	1	0	0	0	6	10
20 – 29%	1	2	0	1	0	5	9
30 – 39%	3	1	0	0	1	7	12
40 – 49%	1	2	1	0	0	10	14
50 – 59%	2	5	0	1	1	8	17
60 – 69%	4	2	1	0	1	4	12
70 – 79%	1	1	1	0	2	3	8
80 – 89%	4	2	0	0	6	3	15
90 – 100%	2	0	0	0	6	2	10
Total	25	21	4	2	17	63	132

Results, Number of Live and Dead Trees by Average Bole Scorch and Species: Average bole scorch is calculated by adding the uphill bole scorch percent to the downhill bole scorch percent and dividing the sum by two. Western larch can tolerate a large amount of bole scorch when compared to Douglas-fir and ponderosa pine. Western larch mortality rates increased once average bole scorch reached the 30–39 percent class, but still was much lower than the mortality exhibited by Douglas-fir and ponderosa pine (Table B-25). None of the Douglas-fir or ponderosa pine survived an average bole scorch of greater than or equal to 30 percent.

Table B- 25: Number of trees by average bole scorch, species, and mortality status on the DNRC Jocko Lakes Study Area -- 2008 to 2010.

Average Bole Scorch	Species						Total
	Dougals-fir		Ponderosa Pine		Western Larch		
	Dead	Live	Dead	Live	Dead	Live	
1 – 9%	7	8	1	0	0	11	27
10 – 19%	6	8	0	0	2	12	28
20 – 29%	2	5	1	2	3	11	24
30 – 39%	4	0	1	0	6	13	24
40 – 49%	4	0	0	0	4	8	16
50 – 59%	0	0	0	0	2	5	7
60 – 69%	1	0	0	0	0	3	4
70 – 79%	1	0	0	0	0	0	1
80 – 89%	0	0	1	0	0	0	1
90 – 100%	0	0	0	0	0	0	0
Total	25	21	4	2	17	63	132

Results, Number of Live and Dead Trees by Percent Crown Kill: Crown kill was observed on 32 trees (Table B-26). Twenty of the 32 trees (63 percent) that experienced crown kill are

dead. Percent crown kill in this study is defined as the proportion of the crown that had the needles burned black or burned off of the limb. Crown kill appears to be a good predictor of tree mortality for Douglas-fir and ponderosa pine trees. A total of 13 (87 percent) of the 15 Douglas-fir and ponderosa pine trees that experienced any amount of crown kill died. Western larch that exhibited evidence of crown kill had a lower mortality rate of 41 percent (seven dead, ten live). Crown kill had a similar effect on Douglas-fir and ponderosa pine mortality in the Sula State Forest Mortality Study. In the Sula State Forest study none of the trees experiencing greater than ten percent crown kill survived (2005 SFLMP Monitoring Report).

Table B- 26: Number of trees by percent crown kill, species, and mortality status on the DNRC Jocko Lakes Study Area -- 2008 to 2010.

Percent Crown Kill	Species						Total	
	Douglas-fir		Ponderosa Pine		Western Larch			
	Dead	Live	Dead	Live	Dead	Live		
None	15	20	1	1	10	53	100	
2	1	0	0	0	1	2	4	
3	1	0	0	0	1	3	5	
5	1	1	2	0	4	1	9	
10	1	0	0	0	0	4	5	
15	3	0	0	0	1	0	4	
20	0	0	0	1	0	0	1	
30	1	0	0	0	0	0	1	
45	0	0	1	0	0	0	1	
50	2	0	0	0	0	0	2	
Totals for trees with crown kill	10	1	3	1	7	10	Dead	Live
							20	12

Mortality Site JL10, photo taken August 2008

Results, Number of Live and Dead Trees by Species, Beetles Presence, and Mortality Status: Bark beetles were found in 9 Douglas-fir and 5 ponderosa pine trees (Table B-27). Sixty-four percent of the trees that had been attacked by bark beetles died compared to 53 percent of the trees that had not been attacked by bark beetles. Western larch is not normally killed by bark beetles. One western larch tree had bark beetles and it is still alive.

Table B- 27: Number of trees by species, beetle presence, and mortality status on the DNRC Jocko Lakes Study Area -- 2008 to 2010.

Species	No Beetles			Percent Dead
	Dead	Live	Total	
Douglas-fir	19	18	37	51%
Ponderosa Pine	1	0	1	100%
Total	20	18	38	53%
Species	**Beetles**			**Percent Dead**
	Dead	**Live**	**Total**	
Douglas-fir	6	3	9	67%
Ponderosa Pine	3	2	5	60%
Total	9	5	14	64%

Results, Number of Trees by Species, Year of Wildlife Use, and Mortality Status: In 2009 and 2010 each tree was examined for use by wildlife. At this time, detectable wildlife use has been by birds feeding on the trees. There was one exception in 2010, a bird had created a cavity (< 2 inches diameter) in a Douglas-fir tree. Wildlife use was observed on 89 of the 132 trees (Table B-28). Wildlife use was higher proportionally on the dead trees than the live trees. All of the dead western larch trees were used by birds and 24 (83 percent) of 29 dead Douglas-fir and ponderosa pine trees were used by birds. Forty-eight (56 percent) of the 86 live trees were used by birds. Wildlife use of live western larch trees (59 percent) was proportionally higher than use of live Douglas-fir (48 percent).

Table B- 28: Number of trees by species, wildlife use (2010), and mortality status on the DNRC Jocko Lakes Study Area.

Species	Mortality Status				Total All Trees	Total Wildlife Use 2010
	Dead Wildlife Use	Dead No Wildlife Use	Live Wildlife Use	Live No Wildlife Use		
Douglas-fir	20	5	10	11	46	30
Ponderosa Pine	4	0	1	1	6	5
Western Larch	17	0	37	26	80	54
Total	41	5	48	38	132	89

Wildlife use increased from 16 trees in 2009 to 89 trees in 2010 (Table B-28). Eight of the 16 trees used by wildlife in 2009 were dead. Seven of the 8 dead trees used by wildlife in 2009 were Douglas-fir. The other dead tree was a ponderosa pine.

Table B- 29: Number of trees by species and wildlife use by year on the DNRC Jocko Lakes Study Area.

Species	Wildlife Use 2009	Wildlife Use 2010	No Wildlife Use	Total
Douglas-fir	9	30	16	46
Ponderosa Pine	2	5	1	6
Western Larch	5	54	26	80
Total	16	89	43	132

The presence of detectable bark beetle hits did not appear to increase the proportion of trees used by wildlife. Wildlife used 10 of 14 trees (71 percent) that had bark beetles. Wildlife used 25 of 38 trees (66 percent) that had no evidence of bark beetles.

Table B- 30: Number of trees by species, wildlife use, and presence of beetles on the DNRC Jocko Lakes Study Area.

Species	Wildlife Use 2010		No Wildlife Use 2010		Total
	No Beetles	Beetles	No Beetles	Beetles	
Douglas-fir	24	6	13	3	46
Ponderosa Pine	1	4	0	1	6
Total	25	10	13	4	52

Salvaged logs from Jocko Lakes Fire, near mortality site JL9, photo taken August 2008

Conclusions

Based on the Sula State Forest mortality study, tree mortality in the Jocko Lakes Fire will probably be elevated for another year or two before the amount of mortality drops to endemic levels. Consequently mortality trends or relationships based on fire damage, insects, and disease are being established, but are not complete. Based on the data collected so far, the following relationships seem to be developing. Western larch will have a much lower amount of mortality than Douglas-fir and ponderosa pine. This is not surprising because it has been well documented that western larch can survive wildfire better than most other tree species that occur naturally in Montana. Smaller diameter Douglas-fir trees have a high proportion of mortality, which is an important economic consideration when making choices about trees to retain when setting up salvage projects. They also, however, appear to receive a considerable level of use by wildlife. Smaller diameter western larch has a higher proportion of mortality than large diameter western larch. It is beginning to appear that large diameter western larch trees are a low risk tree to leave during salvage projects. In addition live western larch trees have a high level of wildlife use. Crown scorch appears to have limited ability to predict tree mortality by itself in western larch and Douglas-fir trees, but it might be relevant when used in combination with bole scorch and

crown kill. Average bole scorch greater than 30 percent and any amount of crown kill appears to increase the amount of mortality.

As of 2010, none of the tree boles have broken. Based on bole breakage data collected in the Sula State Forest study, Douglas-fir and ponderosa pine trees should start breaking at peak levels four to six years after death. One live Douglas-fir tree blew down in 2009.

After mortality drops to endemic levels, further analysis of the mortality data should be conducted to establish the amount of crown scorch, bole scorch, and crown kill related to dbh that predict risk for tree mortality. The results of this analysis will allow the foresters to better predict which trees are likely to die by assessing tree species, size, and easily observed damage parameters when setting up salvage projects, or other projects that require predicting levels of tree mortality.

TIMBER SALE INSPECTION REPORTS

As indicated in the Introduction section of this report, DNRC field personnel oversee and inspect the implementation of timber sale contracts. The Timber Sale Inspection Report is the tool by which the DNRC Forest Officer reports on each individual inspection conducted. The report serves as a communication tool to convey important information to the timber sale operator and also serves as a monitoring tool by which the DNRC tracks if timber sales are in compliance with certain standard operating procedures, Forest Management Rules, and Montana Best Management Practices for Forestry (BMPs).

The report lists 33 items covering 'Business, Roads, Logging,' and 'Other' procedures related to timber sales. Items covering Business and some Other procedures directly relate to DNRC standard operating procedures. The remaining inspection items roughly follow some of the subchapters of the Forest Management Rules. Some of these items may pertain to more than one Rule and may also relate to one or more BMP.

Methods

DNRC Forest Officers regularly inspect many of the 33 items listed and record them as 'Satisfactory, Needs Improvement,' or 'Violation'. For those items recorded as Need Improvement or Violation, the Forest Officer conveys in writing how the operator must amend the infraction.

During timber sale inspections, not every item in the report is inspected and thus recorded. Some sales do not require inspection of all items (*i.e.* Forest Officers do not need to inspect procedures that are not included as a part of the sale). Also, Forest Officers regularly go to the site with the intent of following up only on a few items within the list (*i.e.* some visits to the field are made with the intention of solely inspecting items that were recorded as Needs Improvement or Violation in preceding reports). Lastly, Forest Officers may choose to indicate the monitoring results in writing rather than check items as Satisfactory, Needs Improvement, or Violation. Depending on the intent of the individual inspections, the number of procedures inspected, and the inspection style of the Forest Officer, many inspection reports may be submitted with only a limited number of items checked as Satisfactory, Needs Improvement, or Violation.

Reports are delivered to the contractors soon after the inspection is complete. Operators are expected to correct any areas in need of improvement or in violation according to the stipulations conveyed by the Forest Officer. At the end of each fiscal year, Forest Officers compile reports and deliver them to the FMB.

At the FMB, each report is entered into a timber sale inspection monitoring database. For those items within the forms that were clearly inspected (checked), recorders note if that item appeared as Satisfactory, Needs Improvement, or Violation. For those items not clearly inspected, recorders note them as 'NA' within the database. For items entered as Needs Improvement or Violation, recorders indicate which, if any, Rule(s) or BMPs were affected and whether or not infractions were fixed prior to the end of the sale. As previously noted, items may affect more than one Rule or BMP – one item recorded as Needs Improvement or Violation may list up to 3 affected Rules and/or 3 affected BMPs.

As mentioned earlier, many inspection reports may be submitted with only a limited number of items checked. Blank items in these reports are consequently entered into the database as NA even if written information accompanying the report indicates that items were inspected. Recorders found it very difficult to interpret from the written reports which items should have been checked Satisfactory, Needs Improvement, or Violation. Thus, results are only compiled and inferred from reports whose items are clearly checked as Satisfactory, Needs Improvement, or Violation.

Results

According to Table B-31, 1,726 Timber Sale Inspection Reports were completed between fiscal years 2006 to 2010 for 194 sales. Of the total items listed in all of the reports submitted, only 32.85 percent (17,820) were clearly inspected (items checked) while 67.15 percent (36,429) were not clearly inspected. Of 17,820 items clearly inspected, 96.09 percent were recorded as Satisfactory (17,123), 3.63 percent as Needs Improvement (647), and 0.28 percent as Violation (50).

Table B- 31: Fiscal years 2006 to 2010 Timber Sale Inspection Report results.

Fiscal Year	Number of Sales	Number of Reports	Satisfactory	Needs Improvement	Violations	Blanks
2006	45	377	4,276	177	14	7,974
2007	37	284	3,138	92	3	5,602
2008	40	377	3,666	148	10	7,145
2009	29	321	2,702	134	13	7,734
2010	43	367	3,341	96	10	7,974
Totals	**194**	**1,726**	**17,123**	**647**	**50**	**36,429**

According to Table B-32, about 68 percent (439) of those items recorded as Need Improvement affected one or more Forest Management Rule. Of these items, most (70 to 95 percent) were fixed prior to the end of the sales.

Table B- 32: Items recorded as Needs Improvement that affected Forest Management Rules.

Fiscal Year	Needs Improvement	Needs Improvement Affecting Rules	NI Affecting Rules Fixed Prior to End of Sale
2006	177	130	—*
2007	92	59	44
2008	148	99	79
2009	134	87	60
2010	96	64	60
Totals	**647**	**439**	**243**

*No data was available for 2006 to determine how many needs improvements were fixed prior to the end of the sale.

Rule subcategories affected by items recorded as Needs Improvement included Biodiversity, Silviculture, Road Management, Watershed, and Weed Management (Table B-33).

Most Needs Improvement affecting:

- Biodiversity and Silviculture Rules involved the operator:
  1) not leaving enough slash on site for nutrient cycling,
  2) leaving cut salable logs behind in the harvest unit, slash piles, or landings, and/or
  3) cutting down or damaging trees designated to be left in the harvest units.
- Road Management and Watershed Rules involved the operator:
  1) not installing proper erosion control and/or surface drainage devices or designs in roads or skid trails,
  2) skidding or hauling in wet conditions, and/or
  3) cutting trees intended to be left in the SMZ.
- Weed Management Rules involved the operator:
  1) not properly cleaning equipment prior to coming on site and/or
  2) improperly re-vegetating roads and disturbed areas with grasses or not doing so in a timely manner.

Table B- 33: Forest Management Rule Subcategories affected by items recorded as Needs Improvement.

Rule Subcategory	2006	2007	2008	2009	2010
Biodiversity	22	7	21	22	19
Silviculture	29	20	42	35	25
Road Management	27	30	29	38	21
Watershed	51	15	27	38	26
Weed Management	1	2	9	3	5

According to Table B-34, about 40 percent (20) of those items recorded as Violation affected one or more Forest Management Rule. Of those items, over half were fixed prior to the end of the sales.

Table B- 34: Items recorded as Violations that affected Forest Management Rules.

Fiscal Year	Violations	Violations Affecting Rules	Fixed Prior to End of Sale
2006	14	9	—*
2007	3	1	1
2008	10	1	0
2009	13	4	2
2010	10	5	3
Totals	**50**	**20**	**6**

*No data was available for 2006 to determine how many violations were fixed prior to the end of the sale.

Items recorded as Violations affected the same Rule Subcategories as items recorded as Needs Improvement (Table B-35).

Most Violations affecting:

- Biodiversity and Silviculture Rules involved the operator:
  1) cutting or damaging trees designated to be left in the harvest units,
  2) wasting merchantable pieces of trees, and/or
  3) not properly dispersing slash at the landing sites.
- Road Management and Watershed Rules involved the operator:
  1) not installing proper erosion control and/or surface drainage devices or designs in roads or skid trails,
  2) skidding or hauling in wet conditions, and/or
  3) operating equipment in the Streamside Management Zone (SMZ) and cutting trees intended to be left in the SMZ.
- Weed Management Rules involved the operator:
  1) not properly cleaning equipment before coming on site and/or
  2) improperly re-vegetating roads and disturbed areas with grasses.

Table B- 35: Forest Management Rule Subcategories affected by items recorded as Violation.

Rule Subcategory	2006	2007	2008	2009	2010
Biodiversity	1	0	0	0	1
Silviculture	2	0	1	0	1
Road management	1	0	0	2	2
Watershed	3	1	0	3	5
Weed management	2	0	0	1	0

According to Table B-36, about 34 percent (221) of those items recorded as Need Improvement affected one or more BMP. Of these items, most (78 to 93 percent) were fixed prior to the end of the sales.

Table B- 36: Items recorded as Needs Improvement that affected BMPs.

Fiscal Year	Needs Improvement	Needs Improvement Affecting BMPs	NI Affecting BMPs Fixed Prior to End of Sale
2006	177	72	—*
2007	92	33	26
2008	148	40	33
2009	134	45	34
2010	96	31	29
Totals	**647**	**221**	**122**

*No data was available for 2006 to determine how many needs improvements were fixed prior to the end of the sale.

BMP categories affected by items recorded as Needs Improvement included Streamside Management, Roads, Timber Harvesting and Site Preparation, Stream Crossings, and Winter Logging (Table B-37).

Needs Improvement items affecting:

- Streamside Management BMPs involved the operator falling trees in the SMZ.
- Road BMPs involved the operator not installing proper erosion control and/or surface drainage devices or designs in roads.
- Timber Harvesting and Site Preparation BMPs involved the operator:
    1) placing skid trails in improper places,
    2) not properly dispersing slash within harvest units and at landing sites, and
    3) skidding during wet conditions.
- Stream Crossing BMPs involved the operator not installing a culvert according to contract specifications.
- Winter Logging BMPs involved the operator using skid trails during the winter time in unfrozen conditions.

Table B- 37: BMP categories affected by items recorded as Needs Improvement.

BMP Category	2006	2007	2008	2009	2010
Streamside Management	0	0	0	2	1
Roads	52	26	21	30	20
Timber Harvesting and Site Preparation	20	7	19	13	11
Stream Crossings	0	0	1	0	0
Winter Logging	0	1	1	1	0

According to Table B-38, about 26 percent (13) of those items recorded as Violation affected one or more BMP. Of these items, over half were fixed prior to the end of the sale.

Table B- 38: Items recorded as Violations that affected BMPs.

Fiscal Year	Violations	Violations Affecting BMPs	Violations Affecting BMPs Fixed Prior to End of Sale
2006	14	3	—*
2007	3	0	0
2008	10	3	0
2009	13	3	2
2010	10	4	3
Totals	**50**	**13**	**5**

*No data was available for 2006 to determine how many violations were fixed prior to the end of the sale.

BMP categories affected by items recorded as Violation included Streamside Management, Roads, and Timber Harvesting and Site Preparation (Table B-39).

Violation items affecting:

- Streamside Management BMPs involved the contractor operating equipment in the SMZ and cutting trees intended to be left in the SMZ.
- Road BMPs involved the operator not installing proper erosion control and/or surface drainage devices or designs in roads.
- Timber Harvest and Site Preparation BMPs involved the operator skidding during wet conditions.

Table B- 39: BMP categories affected by items recorded as Violations.

BMP Category	2006	2007	2008	2009	2010
Streamside Management	0	0	0	1	0
Roads	1	0	0	2	2
Timber Harvesting and Site Preparation	2	0	3	0	2

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 RMS: 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

This section reports on stand treatments associated with timber harvesting and those applied to younger forest stands that are intended to improve revenue generation potential. This section also reports on activities conducted under the DNRC forest improvement program, which uses fees from harvested timber to improve the health and productivity of forested lands. 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.

Summary

Accomplishments for fiscal years 2006 through 2010 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: The long-term productivity of school trust lands depends on the success of regeneration efforts. Our natural regeneration prescriptions and planting programs are designed to meet goals related to the Biodiversity 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). Two methods are customarily used to assess the regeneration success on DNRC lands: survival surveys and regeneration or inventory surveys. Regeneration surveys aid in determining stocking levels, species composition, and additional or future treatments that may be needed to produce appropriately stocked stands and species compositions in accordance with biodiversity objectives. Survival surveys are used to quantify plantation success.

Regeneration surveys were completed on 11,531 acres from 2006 to 2010. The increasing trend in acres surveyed among the three monitoring periods since 1996 is primarily attributable to increased survey effort in areas that have burned since 2000, including continued efforts at the Sula State Forest (Table S-1).

Survival surveys indicate good to excellent results for most planting efforts. As with the previous monitoring period, average survival ranged from 80 to 85 percent 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.

Tree Planting: The average number of acres planted from 2006 to 2010 increased compared to average from previous monitoring reports (Table S-1). Most of this increase was a continuation of planting efforts in response to the large fires of 2000, 2001, 2003, as well as new planting efforts following large fires in 2007. 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 amount of browse protection applied (Table S-1) reflects increased planting in areas used by big game, including winter range areas. Browse protection methods include netting and the use of various repellents.

Precommercial Thinning: The slight decrease in precommercial thinning from 2006 to 2010 compared to previous reporting periods is the result of an increased focus of available field staff to complete planting efforts in areas affected by fires. The annual acreage of pre-commercial thinning completed is expected to continue to range from about 1,000 to 1,700 acres given work priorities and available spending authorization allow.

Noxious Weed Spraying: The average amount of noxious weed spraying increased slightly compared to previous monitoring periods. Noxious weed spraying is expected to continue near current levels or slightly increase as on-going issues with noxious weeds on State lands are dealt with and new areas needing treatment are identified. The acreage of weeds

sprayed from year to year varied widely during the 2006 to 2010 monitoring period and ranged from 593 acres in 2007 to 7,702 acres in 2009 (Table S-1).

Brush Piling: From 2006 to 2010, the amount of tractor logging by the Department increased, resulting in an increase in the amount of brush piling (Table S-1). The increased use of tractor logging was, in part, due to poor timber market conditions. Because tractor logging occurs on flat to gently sloping terrain, treatments are more efficient in terms of both cost and the removal of material from the forest than other types of harvesting, resulting in an increase of material to pile following harvesting. Brush piling typically would not occur when logging on terrain where cable or helicopter yarding is necessary, and the use of such logging systems decreased during this monitoring period.

Pile Burning: Pile burning closely follows brush piling, and as the amount of brush piling increases, the amount of pile burning would also increase. Pile burning acres were over double than any other reporting period, which is primarily attributable to the elevated levels of tractor logging that occurred on DNRC projects.

Broadcast Burning: The amount of broadcast burning has decreased slightly from previous monitoring periods (Table S-1). Broadcast burning is typically done on steeper terrain where mechanical site preparation or treatment is not possible; this terrain is typically harvested using cable or helicopter yarding systems. As the use of these systems declined from 2006 to 2010, the amount of broadcast burning would also be expected to decrease.

Cone Collection: The amount of cone collection remained steady compared to the 2001 to 2005 reporting cycle, but is highly variable from year to year (Table S-1). Increases in the amount of tree planting require seed from both species and elevation zones appropriate for the sites being planted. Collection of ponderosa pine seed from DNRC's Missoula Seed Orchard accounts for the bulk of harvested cones. DNRC also collects cones from stands on other State trust lands, particularly western larch and ponderosa pine, as well as lesser amounts of Douglas-fir and lodgepole pine as needed. Cone collection is also done to maintain a seed inventory used to grow planting stock for future reforestation projects in response to both timber harvesting and wildfires. Low levels of cone collection in fiscal year 2009 and 2010 are the result of poor cone crops in the Missoula Seed Orchard that were not harvested.

Bio-control Bug Releases: The use of insects to control noxious weeds increased substantially compared to the previous reporting period and is likely to be a continuing and growing component of noxious weed management programs, particularly in areas where herbicide use is not a viable option (Table S-1).

Table S- 1: Forest improvement accomplishments in fiscal years 2006 through 2010.

		Fiscal Year					Average 2006-2010	Average 2001-2005	Average 1996-2000
Activity	**units**	**2006**	**2007**	**2008**	**2009**	**2010**			
Plantation regeneration surveys	acres	502	8,105	871	1,012	1,041	2,306	1,484	295
Tree planting	acres	2,106	2,761	2,282	1,578	1,673	2,080	1,021	679
Tree browse prevention[1]	acres	1,084	867	1,139	1,086	1,203	1,076	567	1,523
Precommercial thinning	acres	1,537	869	478	1,096	1,283	1,053	1,732	1,188
Noxious weed spraying	acres	4,731	593	2,697	7,702	2,248	3,594	3,434	702
Herbicide application[2]	acres	1,260	600	500	-	-	472	417	140
Brush piling	acres	1,654	1,668	1,989	967	2,002	1,656	613	1021
Pile burning	acres	3,792	3,127	5,649	4,450	5,061	4,416	2,014	1,339
Broadcast burning	acres	417	71	73	248	30	168	241	329
Tree improvement areas managed	acres	32	13	13	36	36	26	19	20
Road maintenance[3]	miles	139	19	113	97	39	81	44	25
Hand brush work	acres	187	22	148	72	654	217	54	123
Cone collection	bushels	629	230	406	-	17	256	247	65
Bio-control Bug Releases	acres	360	90	415	433	10	262	32	0

[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.

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-to-cost ratio is the primary cash accounting metric used to monitor cash flow from operating activities. The ratio measures FMB records of collected revenue, including forest improvement revenue, in proportion to year end operating expenses, including program administration costs (excluding division administration costs). The revenue-to-cost ratio is a cash, rather than accrual, accounting metric and because timber projects takes place over multiple years of time, the ratio is not used to portray profits or profitability.

The revenue-to-cost ratio is a split reflection of both the FMB's operational efficiency and the vitality of a much larger private timber market in which the Bureau sells a legally determined supply of timber (sustainable yield). Short term variance in FMB revenue-to-cost ratio is mainly caused by external markets which dictate the price and time in which timber is harvested (limited by multi-year timber sale contracts). This means that year to year the revenue-to-cost ratio is limited in its ability to measure FMB or trust land performance. However, over time these variations tend to average out and present a more legible indicator of efficiency in the FMB.

Results

Table S-2 compares total costs and total revenue for the forest management program statewide. In fiscal years 2006 to 2010, the revenue-to-cost ratios ranged from 1.87 to approximately 3.93, and the average ratio was 2.56. This is somewhat lower than the average ratio from the previous 5-year monitoring period (3.07).

Conclusions

One objective is to maintain a 2 to 1 or better revenue-to-cost ratio over the long term. The Department is working to ensure a reasonable rate of return for the program by controlling costs to the degree seen fit by area and program management. Projected revenues and costs will continue to be evaluated to ensure that the forest management program remains economically viable.

Table S- 2: Revenue/cost summary for the forest products sales.

Fiscal Year	Gross Revenue	Program Expenditures	Revenue/Cost Ratio
2001	$8,578,175	$3,065,345	2.80
2002	$9,686,844	$3,286,469	2.95
2003	$8,278,792	$3,776,429	2.19
2004	$10,870,985	$3,619,219	3.00
2005	$16,585,882	$3,747,131	4.43
2006	$15,875,626	$4,036,348	3.93
2007	$8,799,298	$4,171,023	2.11
2008	$11,099,302	$3,992,313	2.78
2009	$8,450,677	$4,039,831	2.09
2010	$9,241,157	$4,943,408	1.87

Fiscal Year	Gross Revenue	Program Expenditures	Revenue/Cost Ratio
Average			
2001-2005	$10,800,136	$3,498,919	3.07
2006-2010	$10,693,212	$4,236,585	2.56

Table S-2 from last page.

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 a mechanical ground-based system and a cable (skyline) system for a typical harvesting scenario yields a moderate increase in logging cost, while using a helicopter system versus a mechanical ground system for the same harvest scenario results in a substantial increase in logging cost.

Results

Table S-3 compares the percentage of various logging systems applied to DNRC timber sales sold in 1998 to 2000, 2000 to 2005, and 2006 to 2010. This information is compiled from DNRC timber sale contracts. From 2006 to 2010, the amount of tractor logging increased from 79 percent to 85 percent, while the amounts of cable and helicopter logging decreased.

Table S- 3: Estimated percentage of average acreages logged by logging system and monitoring period.

Fiscal Year	Tractor	Cable	Ground-Lead	Helicopter
1998-2000	91%	7%	0%	2%
2001-2005	79%	16%	1%	4%
2006-2010	85%	13%	<1%	1%

Conclusions

The decrease in the use of cable and helicopter logging systems from the 2001 through 2005 monitoring period was likely influenced by poor timber markets during 2006 through 2010, particularly in the later years of that period. Cable and helicopter logging is more costly than tractor logging, and sales containing large areas requiring such systems can be less attractive to prospective bidders, resulting in lower bid prices. As timber markets recover,

the use of cable and helicopter systems would be expected to increase toward 2001 through 2005 levels.

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 to 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 to 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. Continuing a trend seen during the 2001 to 2005 period, salvage harvests following beetle outbreaks, windfall, or wildfire contributed substantially to DNRC's production from 2006 to 2010. 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 left as a seed source. Shelterwood harvesting retains more trees than a seed tree, to provide shade that moderates the microclimate within a stand to facilitate 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 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 2006 through 2010, the DNRC collected data on acreages that would be treated under the various silvicultural systems. This information comes from the silvicultural prescriptions prepared for each timber sale.

Results

A review of the silvicultural treatment methods used from 2006 to 2010 indicated a continued increase in the application of even-aged regeneration treatments (clearcut, seed tree, and shelterwood) and a corresponding decrease in the use of uneven-aged management treatments (selection treatments) since the previous monitoring period (Table S-4). As in previous monitoring periods, selection treatments are still applied to the greatest percentage of harvest area; however, the amount of seed tree and shelterwood harvesting increased substantially. Intermediate treatments continue to be applied on a sizable portion of acres, although their percentage of application remained constant compared to the

previous period. Although the percentages of each harvest method do not precisely equal those forecasted in the SFLMP by each silvicultural method, they do closely reflect the general intent of the Omega Alternative estimates to apply regeneration treatments (clearcut, seed tree and shelterwood) at a combined level of about 40 percent, and partial harvest treatments (selection and intermediate) at a combined level of approximately 60 percent. It is important to note that 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]	Actual FY 06-10[3]
Clearcut	10%	4%	5%	2%
Seed Tree	25%	8%	18%	28%
Shelterwood	5%	2%	8%	18%
Selection	40%	55%	47%	29%
Intermediate	20%	31%	22%	22%

[1] FY 98-00 percentages from 2000 Monitoring Report (DNRC).
[2] FY 01-05 percentages from 2005 Monitoring Report (DNRC).
[3] FY 06-10 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 in that greater amounts of residual material (trees, snags, and down woody material) are typically left following treatment. 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 and objectives broadly accepted within the forestry profession for silvicultural treatments have been applied.

While positive movement toward the proportions anticipated in the SFLMP compared to the results demonstrated in the first monitoring report (Table S-4) was shown from 2005 through 2010, the Department is now implementing even-aged systems on a slightly higher level (48 percent) than forecast by the SFLMP (40 percent). However, the combined clearcut and seed tree acreages harvested between 2006 and 2010 totaled 30 percent, which remains slightly lower than the Omega combined estimate of 35 percent (Table S-3). Based on historical disturbance regimes as described in the SFLMP, one would expect about 40 percent 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.

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. In previous monitoring periods, the level of even-aged harvesting was less than described in the SFLMP and what historical disturbance patterns suggest. These results show positive step toward meeting biodiversity goals. Although these results now indicate that even-aged treatments are being applied at a higher level, biodiversity field reviews indicate that the treatments applied are for the most part emulating appropriate disturbance regimes for the sites. This indicates that during the five-year period, DNRC focused treatments on areas where even-aged harvesting was appropriate. An increase in the sustainable yield from 50 million board feet per year to 53.2 million board feet per year in 2004 is also a likely factor in the increased use of even-aged methods, as even-aged harvesting removes more volume per acre than uneven-aged harvesting. Even-aged harvesting would also be more favorable during poor market conditions as were seen in the most recent monitoring period, as it is often more cost-efficient than uneven-aged harvesting. DNRC will continue to work towards the proportion of harvest treatments in the SFLMP.

Salvage

From 2006 to 2010 wildfires burned approximately 14,824 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 5,720 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.

From 2006 to 2010, fire salvage timber sales have been completed on approximately on 17 percent of the total acres harvested (Table S-5). Although these harvests have similarities to prescribed regeneration methods, they were designed in reaction to unplanned events. Without those events, timing of treatments would have been planned differently and type of treatment may have differed. Many of these stand replacement and mixed severity burn sites will regenerate as even aged stands; over time, these stands would continue to be managed as even-aged stands, or uneven-aged characteristics would be promoted (e.g.- in ponderosa pine stands on the Sula State Forest that burned at stand-replacement intensity) in order to meet biodiversity objectives.

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: Comparison of the percent average acres harvested by silvicultural treatment method by monitoring period to SFLMP Omega Alternative estimates from 1996. Estimates include fire salvage acres.

Silvicultural Method	Omega Alternative Estimates	Actual FY 98-00	Actual FY 01-05	Actual FY 06-10
Fire Salvage	N/A	N/A	26%	17%
Clearcut	10%	4%	4%	2%
Seed Tree	25%	8%	13%	23%
Shelterwood	5%	2%	6%	15%
Selection	40%	55%	34%	24%
Intermediate	20%	31%	17%	19%

Table S- 6: Percentage of silvicultural treatment method by DNRC Land Office based on harvest acreage for sales sold fiscal years 2006 through 2010.

Silvicultural Method	Actual FY 2006-2010					
	Central	Eastern	Northeast	Northwest	Southern	Southwest
Fire Salvage	13%	89%	38%	10%	69%	15%
Clearcut	3%	0%	5%	1%	0%	3%
Seed Tree	21%	0%	5%	38%	0%	6%
Shelterwood	25%	0%	52%	16%	0%	12%
Selection	34%	11%	0%	7%	31%	51%
Intermediate	4%	0%	0%	28%	0%	13%

Conclusions

When planning timber sales, DNRC management foresters must consider site-specific characteristics as well as landscape level objectives. From 1998 to 2005, DNRC shifted from applying even-aged treatments that emulate stand-replacement disturbances less frequently than estimated in the SFLMP to applying them slightly more often than predicted in the SFLMP during the 2006 to 2010 monitoring period. This can be attributed to the Department's continued efforts to implement more even-aged harvest treatments as forecasted by the SFLMP, an increase in the annual sustainable yield in 2004, and poor timber markets during the most recent monitoring period, which encouraged the use of more efficient harvesting systems. Although increasing the use of even-aged treatments was advocated in the previous monitoring report (MT DNRC 2005), uneven-aged treatments are now being applied less frequently than described in the SFLMP. However, it does not appear that even-aged treatments are being applied inappropriately or on sites where uneven-aged management would be more appropriate. Fluctuations in the proportions of silvicultural treatments from one five year period to another is likely to continue as DNRC forest managers respond to catastrophic wildfire and insect/disease epidemics by salvaging dead and dying trees. Also, treatment trends aggregated over longer periods of time provide a more relevant comparison to predictions made in the SFLMP because DNRC annually harvests trees on a small fraction of the total forest acreage

(about 1.2 percent). In the future, we would expect the use of uneven-aged treatments to increase to levels forecast in the SFLMP.

In recent years, the DNRC has harvested a substantial amount of volume through salvaging after fires and insect infestations. 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. In the last 5 years, the DNRC has responded to many such fire and insect events and adjusted sale planning accordingly.

ROAD MANAGEMENT

Under Road Management, the 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 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:

- **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.**

ROAD MONITORING

During timber sale project planning and analysis DNRC hydrologists and foresters evaluate existing roads and stream crossing structures within the proposed project areas to identify maintenance needs, BMP status and potential sources of erosion and sediment delivery to streams. This information is used to identify problem areas and prioritize road maintenance measures and needed road improvements that are integrated into timber sale contracts (See Table R-1 for figures detailing the amount of road maintenance completed under timber sale contracts). These evaluations also assessed the status of road closure structures.

The NWLO and SWLO also have ongoing monitoring programs for inventorying existing road conditions on forested State trust lands. In addition, during fiscal year 2009 and fiscal year 2010 the Technical Services Section of the FMB initiated road inventories on parcels that were proposed for acquisition by DNRC.

Methods

During timber sale development, roads, stream crossings and other drainage structures located on State trust parcels and those roads used to access State trust parcels, are evaluated. These evaluations focus on identifying BMP status, safety concerns, erosion problems and potential sources of sediment delivery to streams. The information is used to

prioritize road maintenance needs and to design site specific prescriptions to address problem road segments.

The Land Office and Technical Services Section initiated road inventories that also evaluated existing roads to collect information on stream crossings, relief drainage structures, problem areas, and general maintenance needs. These inventories also evaluated the status of road closures. DNRC primarily utilizes contracted services to complete these inventories and assessments.

Results

Approximately 1,564 miles of existing road were evaluated by DNRC from fiscal years 2006 through 2010. Maintenance measures and improvements to approximately 521 miles of existing roads were included in the 120 timber sales contracts sold from fiscal years 2006 through 2010. Information collected on existing roads during timber sale project development was used to prioritize and develop site-specific prescriptions designed to address maintenance needs, BMP upgrades and other needed road improvements. Priority is given to measures that address erosion problems and to restore water quality.

A majority of the road maintenance and improvement activities that have been implemented to date have been funded through timber sale contracts. Other road improvement projects were funded through a portion of the forest improvement funds annually allocated for road maintenance. The forest improvement program funds are used for activities such as road grading, culvert replacement, gate replacement, etc. In fiscal years 2006 through 2010, DNRC forest improvement funds were used to complete maintenance activities on approximately 406 miles of forest roads.

During fiscal year 2010 DNRC acquired $120,000 of federal funding through the American Recovery and Reinvestment Act to complete fire restoration activities in the Fish Creek drainage in Mineral County. These funds are currently being used to implement road improvements, BMP upgrades, and to obliterate and/or relocate roads that are not needed or are poorly located and cannot be brought up to BMP standards.

DNRC has also acquired approximately $70,000 in grant and collaborative funding for 9 individual projects addressing road stream crossings and riparian habitat restoration during fiscal years 2006 through 2010.

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 2006 through 2010. The DNRC also collected information about estimated development costs, timber volume sold, area to be logged, and road activities on sold contracts.

Table R- 1: Road Development for Timber Sale Contracts Sold fiscal years 2006 through 2010 (All Land Offices).

Road Development	5 Year Total	Average Per Sale	Average Per MMBF
Roads Constructed (mi)	146.74	1.22	0.59
Roads Reconstructed (mi)	193.67	1.61	0.78
Road Maintenance (mi)	520.59	4.34	2.09
Roads Obliterated (mi)	34.37	0.29	0.14
Development Costs ($)	$4,616,738	$38,473	$18,534
Net Timber Volume Sold (MMBF)	249.1	2.08	--
Total Harvest Acres	34,751	289	139--

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.

Conclusions

These conclusions are based on a comparison between road construction and timber volume harvested. The SFLMP forecasts 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/million board feet (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 0.87. The actual miles/ MMBF for fiscal years 2006 through 2010 were 0.59 (Table R-1), which is considerably lower than both the expected average from the SFLMP and the actual average in previous years. The miles/MBF reported for fiscal years 2000 through 2005 was 0.65 (DNRC 2005). The primary reason for low amounts of road building is the number of sales in previously accessed sites, including many of the salvage sales. Overall, planned road construction is occurring statewide at a lower rate than forecasted in the SFLMP.

INTERNAL BMP AUDITS

A total of 141 internal BMP audits were completed on ongoing and recently completed DNRC timber sales between fiscal years 1999 and 2010[1]. Audits were conducted by DNRC hydrologists, soil scientists and fisheries biologists from the FMB, the NWLO and the

[1] Some audit data is included from the first half of Fiscal Year 2011.

SWLO. During fiscal years 2009 and 2010, foresters were included on the teams conducting internal BMP audits on the NWLO. 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 (DNRC 2010). 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 road planning and design, road construction and maintenance, timber harvesting, slash treatment and site preparation, installation of stream crossing structures, and operations in streamside management zones

Results

In the 11 years of audits, 13,813 harvest acres of DNRC land had internal audits conducted on them. Approximately 79.6 MMBF of harvest volume was contained in the audited areas. Auditors also evaluated approximately 113 miles of new road construction, 103 miles of road reconstruction, and 118 miles of road re-conditioning during this 11-year period.

The following information is based on the 4,611 practices rated during the 141 internal audits. The internal audits revealed that over the eleven-year period, monitored BMPs were properly applied by DNRC on approximately 97 percent of the practices rated. There were 145 minor departures and 15 major departures of all the practices rating application of BMPs. The internal audits also revealed an effectiveness rate of approximately 98 percent on protecting soil and water resources. There were 94 minor departures and 18 major departures in all practices rating effectiveness of BMPs. Only minor and temporary impacts to soil and water resources result 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 Forestry Division. 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 2006, 2008 and 2010. In all 3 of these audit years DNRC was found to rank highest among ownership groups in BMP application and effectiveness.

In 2010, statewide audits rated 227 practices from six DNRC timber sales. Their results showed that 99 percent of the applications met or exceeded standards, and were effective in protecting soil and water resources. 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 both DNRC internal BMP audits and independently conducted statewide audits have demonstrated high levels of BMP application and effectiveness on DNRC timber harvest. The data shows that between 97 to 99 percent of the practices rated have met or exceeded BMP standards. In addition, 98 to 99 percent of the practices rated were found to be effective in protecting soil and water resources. Departures in application and effectiveness 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 SMZ laws and rules were also evaluated during both the DNRC Internal and Statewide BMP audits. In the 11-year data set of DNRC internal audits, there were 25 SMZ departures in application and 8 SMZ departures in effectiveness. All departures were found to be minor. The statewide audits conducted in 2006, 2008 and 2010 found no SMZ departures on DNRC sites.

The results from the contract inspection reports, internal, and statewide BMP audits are being used to identify specific or recurring problems. *See Biodiversity Monitoring – Timber Sale Inspection Reports for complete monitoring results associated with timber sale inspection reports.* 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 sediment control on erodible fill slopes, and directing road drainage to stream crossing sites.

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 scientists have modified the BMPs or designed new ones to address the problems.

WATERSHED, FISHERIES AND SOILS MONITORING

The SFLMP established general goals for watershed and fisheries related monitoring. DNRC developed a comprehensive approach to watershed and fisheries 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 number 2 is being accomplished primarily through Timber Sale Contract Inspections and Internal BMP Audits. To meet Goal number 3, DNRC is maintaining long-term water quality monitoring sites in the Stillwater State Forest as well as numerous other short-term site-specific monitoring projects.

To accomplish Goal number 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 number 5 is being accomplished through various fisheries and fish habitat related watershed monitoring projects. The results of fisheries related watershed monitoring are addressed in this section under the sub-heading "Fisheries Monitoring".

Additional watershed related monitoring is addressed in the section on monitoring of Grazing on Classified Forest Lands.

WATERSHED INVENTORY

Watershed inventories were completed for 23 project watersheds between fiscal years 1999 and 2005 by DNRC hydrologist and contractors. These inventories were summarized in both the 2000 and 2005 SFLMP Implementation Monitoring Reports.

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.

Approximately 110,958 acres of State trust lands have been inventoried within these watershed project areas. The areas inventoried include approximately 681 miles of existing road, 313 miles of stream channel and 584 stream crossing or drainage feature 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.

Additional watershed inventories were curtailed in 2005 due to the ongoing negotiations between DNRC and the USFWS for the development of the proposed HCP. The HCP negotiations included the development of aquatic conservation strategy that focused on identifying and remediating existing road sources of sediment delivery to streams using specific methods and subject to specific timelines. DNRC suspended the inventories because we did not want to risk having to redo the field evaluations once a specific method was agree to and finalized in the HCP. Watershed inventories will resume once a Record of Decision for the HCP is completed.

INTERNAL BMP AUDITS

A total of 141 internal BMP audits were completed on ongoing and recently completed DNRC timber sales between fiscal years 1999 and 2010. Audits were conducted by DNRC hydrologists, soil scientists and a fisheries biologist from the FMB, the NWLO and the SWLO. During fiscal years 2009 and 2010, foresters were also included on the teams conducting internal BMP audits on the NWLO. 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 (DNRC 2010). 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 road planning and design, road construction and

maintenance, timber harvesting, slash treatment and site preparation, installation of stream crossings structures, and operations in SMZ.

Over the past 11 years, DNRC has conducted internal BMP audits on approximately 13,813 acres of timber harvest. Approximately 79.6 MMBF of timber was harvested from the area included in the audits. Also evaluated during the audits for this same period of time were approximately 113 miles of new road construction, 103 miles of road reconstruction, and 118 miles of re-conditioned road. Re-conditioned roads are existing roads where BMP upgrades or improvements were installed

The following results are based on the 4,611 practices rated during the 141 internal BMP audits. The internal audits revealed that over the 11-year monitoring period, BMPs were properly applied by DNRC on approximately 97 percent of the practices rated. There were 145 minor departures and 15 major departures of all the practices rating application of BMPs. Most of these departures were associated with road related BMPs, with only a few departures associated with harvest related practices. Thirteen of the 15 major departures and 126 of the 145 minor departures in BMP application were associated with road related BMPs. The most common departures found were practices addressing road surface drainage.

The internal audits also revealed an effectiveness rate of approximately 98 percent on protecting soil and water resources. There were 94 minor departures and 18 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 DNRC Forestry Division. 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 2006, 2008 and 2010. In all three of these audit efforts DNRC was found to rank highest among ownership groups in BMP application and effectiveness.

The results of the 2006 statewide audits were compiled from 205 practices rated on 5 different DNRC timber sales. The data shows that 98 percent of the application practices rated met or exceeded standards. Ninety-eight percent of the practices rated, and 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.

In 2008 the statewide audits rated 252 practices from 6 DNRC timber sales. The results showed that 98 percent of the applications met or exceeded standards, and effectiveness in protecting soil and water resources was rated at 98 percent. In 2008 all of the DNRC departures were rated as minor, with no major departures or cases of gross neglect reported.

The results of the 2010 statewide audits were compiled from 227 practices rated on 6 DNRC timber sales. The data shows that 99 percent of the application practices rated met or exceeded standards. Ninety-nine 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 SMZ laws and rules were also evaluated during both the DNRC Internal and Statewide BMP audits. In the 11-year data set of DNRC internal audits, there were 891 SMZ practices rated. There were 25 departures in application of SMZ practices and eight departures in SMZ effectiveness. Only 1 departure in application was found to be major and all departures in effectiveness were found to be minor. The statewide audits conducted in 2006, 2008 and 2010 found no departures in SMZ practices on DNRC sites.

The results from the contract inspection reports and internal and statewide BMP audits are being used to identify specific or recurring problems. *See Biodiversity Monitoring – Timber Sale Inspection Reports for complete monitoring results associated with timber sale inspection reports.* 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 in the internal or statewide BMP audits. The most frequent of these types of problems were poor design and location of skid trails, use of skid trails during less than favorable conditions, failure to retain adequate amounts of slash throughout harvest units, and failure to properly disperse slash left on site. Timber sale inspection reports revealed that the majority of these problems were resolved prior to the end of the sale possibly explaining 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.

DNRC IN-SITU TURBIDITY MONITORING

The transport rate of suspended sediment in forested watersheds can be a response variable useful for detecting impacts of land management. Suspended sediment concentration and its subsequent rate of transport can rapidly and naturally change by orders of magnitude within forested watersheds making long-term changes in sediment yield resulting from land management impacts a difficult, time consuming and expensive endeavor.

Understanding these fiscal and workload constraints, DNRC has employed new technology and methodologies to monitor impacts to water quality from suspended sediment resulting from discrete land management actions on DNRC lands. Recent technology advances in turbidity sensors provide the opportunity to record in-situ turbidity values during a range of land management activities such as culvert removal and replacement, road construction, riparian timber harvest and summer riparian grazing management. When this data is paired with physical sampling techniques, further analysis of sediment concentration and transport estimates can be calculated providing critical data to help refine mitigations and environmental effect forecasts.

DNRC has acquired two individual turbidity recording instruments to further refine the data collected on specific management activities. Multiple instruments allow a particular reach of stream to be bracketed with turbidity instrumentation to assess the net change through a monitored stream reach or also can be arranged at a specified downstream location to assess how turbidity impacts are diffused. To date DNRC has conducted three monitoring projects focusing on the duration and magnitude of turbidity events resulting from culvert removal, stream simulation culvert installations and armored ford installations. The design of this monitoring technique incorporates hi-tech instrumentation, rapid installation and site adaptability that will allow DNRC to conduct in-situ turbidity monitoring on a variety of land management projects throughout the State. The data collected from these monitoring efforts will be adaptively incorporated into future project implementation with goals of reducing environmental effects as well as maintaining environment effects assessment credibility.

Water Quality Monitoring – Stillwater State Forest

DNRC began monitoring water quality at selected sites on the Stillwater State Forest near Olney, Montana, in 1976 (Table W-1). Sampling locations have been 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- 1: 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 2006-PRESENT
Chicken Creek	STSF03	1976-PRESENT
Middle Swift Creek	STSF05	1980-PRESENT
Lower Swift Creek	STSF06	1976-PRESENT
Chepat Creek	STSF08	1976-2007
Lower Fitzsimmons Creek	STSF09	1976-2007
Lazy Creek	STSF10	1985-1997
Upper Fitzsimmons Creek	STSF11	1995-1997

In 1998, monitoring on 4 of the above stations 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. In 2006, DNRC re-established the West Fork Swift Creek monitoring site due to timber harvest planned in the watershed. In 2008, monitoring in Chepat and Lower Fitzsimmons Creeks was ceased due to harvest plans and little variation in data. 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 planned to monitor these 4 stations for a 3-year period to determine if any change has occurred since the earlier monitoring was discontinued. Variation in nutrient and TSS data from the 1980's to the 2003 to 2005 period indicated no change in water quality. Because no water quality monitoring in the Swan River State Forest was conducted in the 2006 to 2010 period, the information is not included in this report; however, the data is available from DNRC hydrologists at the NWLO in Kalispell or the FMB in Missoula.

Water Yield

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 the average of 15.27 inches at Kalispell 6 of the last 9 years. The general trend shown is that the water yield in the 5-year averages was near or below the pre-1998 average for the 2001 to 2005 and 2006 to 2010 periods. This trend is reflected in the discharge data depicted in Figure W-1. 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. The fact that this trend is seen consistently at all stations including Chicken and Chepat Creeks, which are essentially un-roaded and without timber harvest, is evidence that the cause of these changes is dependent upon natural fluctuations in precipitation and drought conditions.

Sediments

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 a detrimental effect on the spawning cycle of fish.

The 5-year averages for total suspended solids (TSS) concentrations on monitored streams in the Stillwater State Forest for the 2001 to 2005 and 2006 to 2010 sample periods are shown in Figure W-2. Average values for all sites over the last two 5-year periods are near or below the period of record average. Lower Swift Creek shows the highest average 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. Higher levels at the Lower Swift Creek site in 2006 to 2010 may be explained by the lack of flushing flows in several previous years and to some higher spring runoff levels than realized in recent years. Sediment values in the upper parts of the watershed remain very low.

Nutrients

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

Phosphorus

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-3 shows the values for average soluble reactive phosphorus (SRP) concentrations collected during the period of record for each station. There appears, from this data, to be poor correlation between forest management activities 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.

Currently, Montana does not have a numeric standard for phosphorous and other nutrients in surface water because adequate information is not yet available to develop specific numeric standards. The Environmental Protection Agency (EPA) recognizes that numerical water quality standards for phosphorus must be developed on a site-specific basis. For comparison purposes, the Voluntary Nutrient Reduction Program target for the Clark Fork River below the confluence with the Blackfoot River is 39 parts per billion (Tristate Implementation Council 1998). Throughout the period of record there have been 62 exceedances (approximately 3.5 percent of the samples) of this standard at the monitoring sites on the Stillwater State Forest; since 2000, this standard has been exceeded 17 times or on 2.5 percent of the samples. The exceedance dates occurred in the spring and early summer, during high flow. These have occurred at most sampling locations including the locations in effectively undisturbed basins, although site STSF06 has the vast majority (49 of the 62).

Nitrogen

From the data collected, nitrate and nitrite values do not correlate with TSS, discharge or phosphorus. They do vary throughout the season however. The 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.

Since 2000, DNRC has collected 753 samples on the Stillwater State Forest at the 6 monitoring sites. Approximately 29.8 percent of these samples (225 of 753) had nitrates+nitrates levels below the reporting level of 0.05 milligrams per liter (also reported as parts per million). All of the samples exhibited levels well below the limit for drinking water standards in Montana, which is 10 milligrams per liter (parts per million) or 10,000 micrograms per liter (parts per billion).

Figure W- 1: Average Discharge Per Acre.

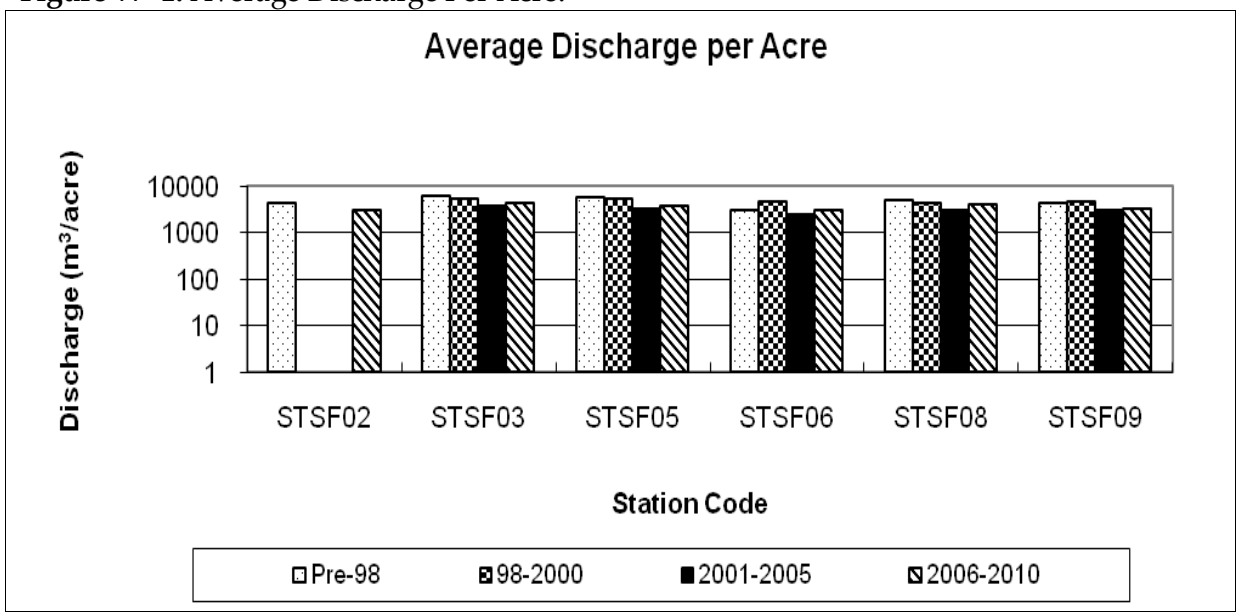


Figure W- 2: Total Suspended Solids Concentration.

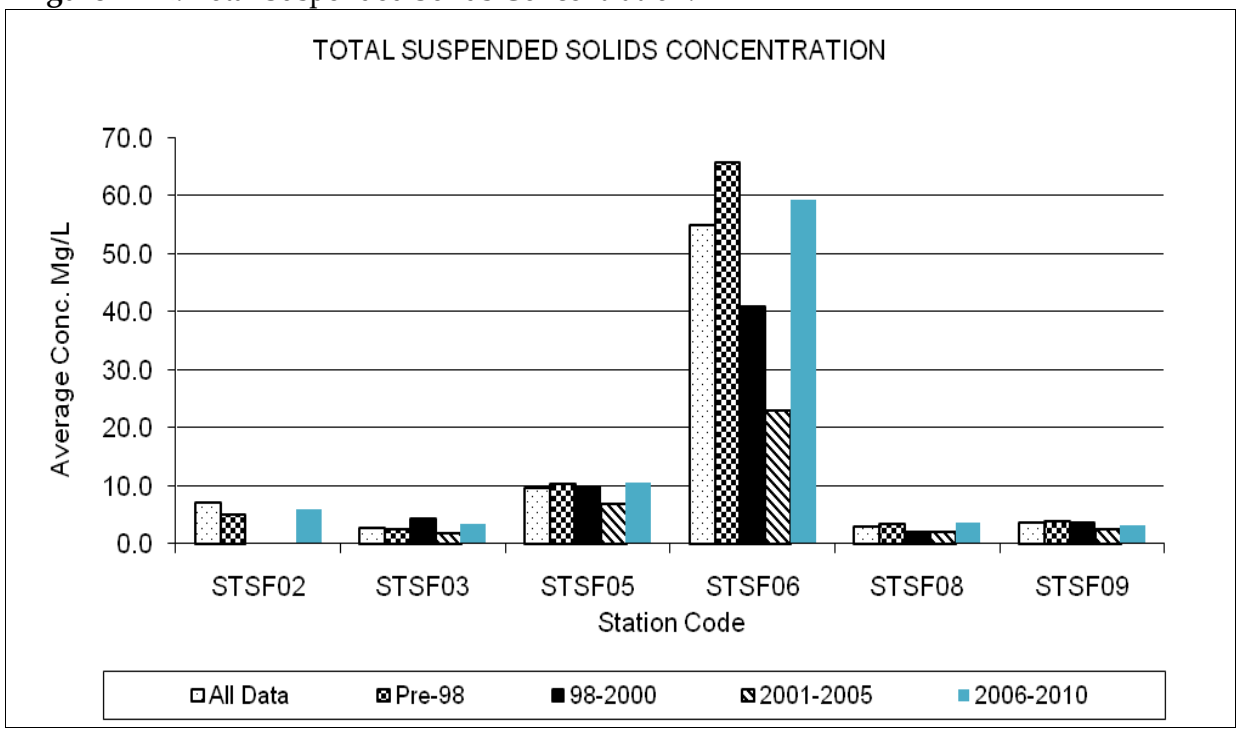


Figure W- 3: Soluble Reactive Phosphorus Concentration.

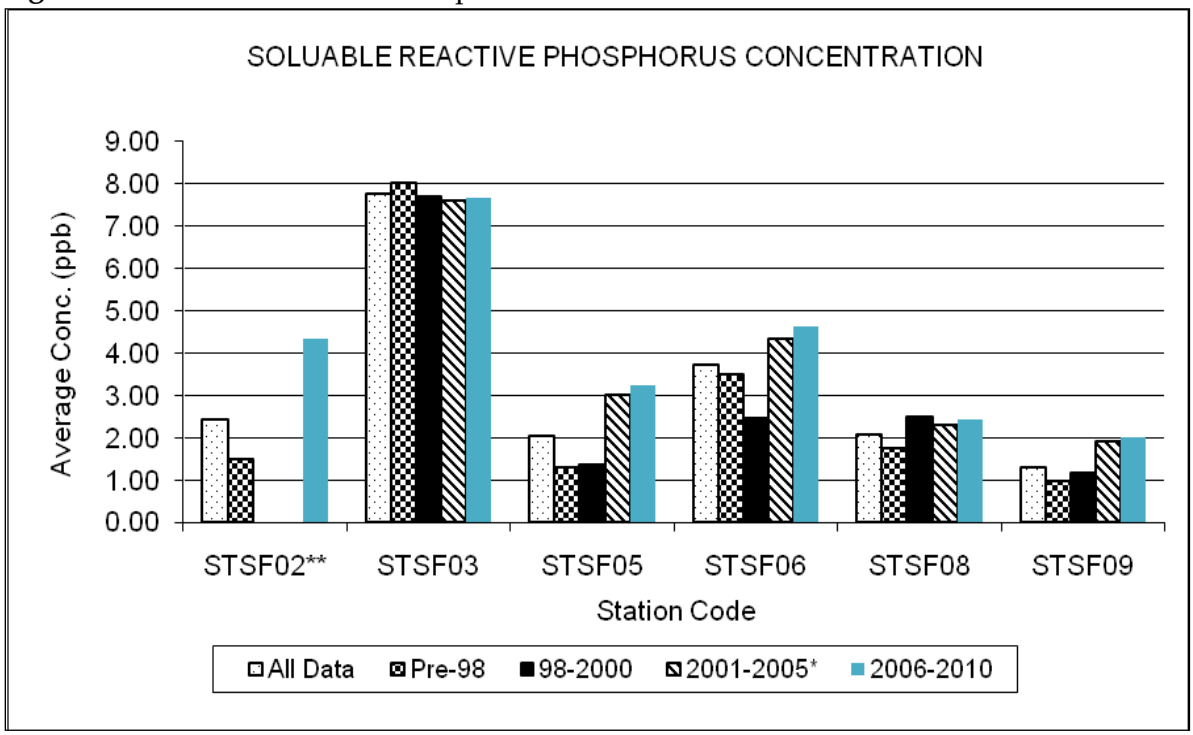


Figure W- 4: Total Phosphorus Concentration.

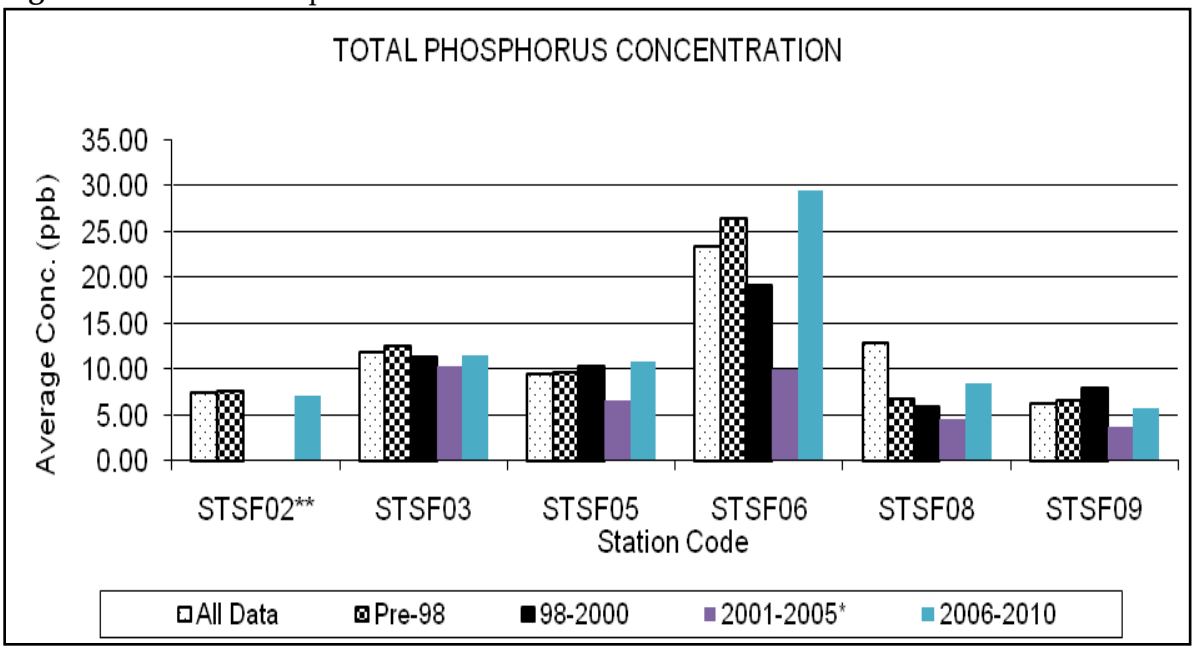
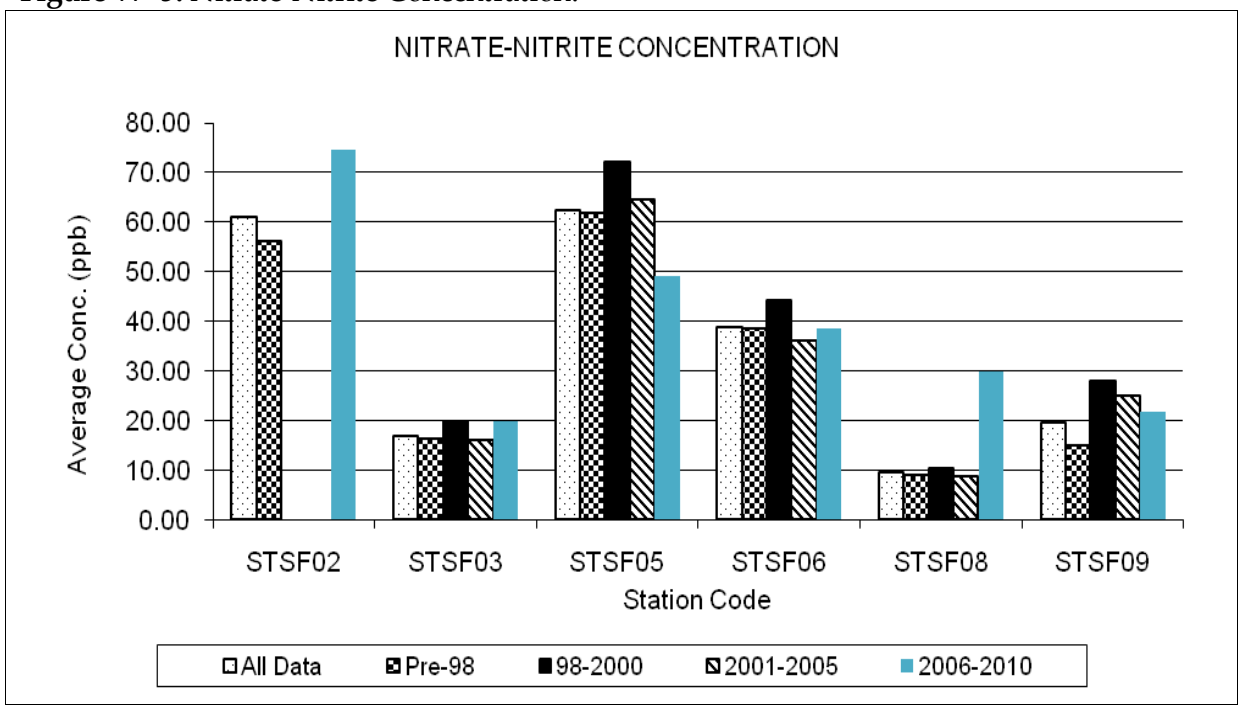


Figure W- 5: Nitrate-Nitrite Concentration.



FISHERIES MONITORING

The SFLMP established general goals for fisheries management, and these goals are implemented through application of Forest Management 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 BMPs, 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 1988 the Flathead Basin Commission sponsored a study to address questions regarding potential impairment of water quality and fisheries from past and present forest management in the Flathead Basin. The fisheries study module was completed in 1991 and suggested direct or indirect linkages between measures of on-the-ground activity and fish habitat parameters and fish populations. These results formed the basis for a monitoring agreement between DNRC and FWP on July 1, 1992. Results from fiscal years 2006 to 2010 are detailed in this subsection. *Earlier monitoring results and descriptions of monitoring methods are reported separately in the following documents: FWP 1997 and SFLMP Monitoring Reports for fiscal years 1997 to 2000 and fiscal years 2001 to 2005.*

Substrate score is an assessment of streambed surface conditions. Particle size and the percentage of fine materials filling interstitial spaces (embeddedness) at the streambed surface are visually assessed. Low substrate scores occur with smaller streambed particles and greater embeddedness. Substrate scores are an indicator of general rearing 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.

McNeil coring is a measurement of the proportion of various particle sizes within streambed gravels (McNeil and Ahnell 1964). McNeil core results are an indicator of risk of bull trout alevin entombment and general bull trout and westslope cutthroat trout spawning habitat quality. 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 percent or 40 percent, respectively.

Species composition was collected from over 30 streams to establish presence/absence information in locations where this information was lacking. Spawning redd counts were conducted in streams where spawning by bull trout and westslope cutthroat trout is known or suspected. The collection of redd count data for westslope cutthroat trout has been scaled back during fiscal years 2006 to 2010 in order to re-focus a portion of monitoring efforts for westslope cutthroat trout on species presence and genetics, which are major components of the 1999 and 2007 Interagency Memorandum of Understanding and Conservation Agreement for Cutthroat Trout in Montana.

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 fiscal years 2006 to 2010 are described in Tables F-1 and F-2. Streambed habitat conditions for bull trout rearing (substrate score) during this monitoring period were outside thresholds of concern, except in Coal, Squeezer, Soup, Woodward, and South Woodward creeks. However, substrate scores in Coal, Squeezer, Woodward, and South Woodward creeks increased throughout the monitoring period, and all 4 streams improved to non-threatened status by fiscal year 2010. Substrate scores in Soup Creek remained in threatened status during the monitoring period.

At this time determining long-term substrate score trends on forested State trust lands is still imprecise, although evolving datasets from many continuously surveyed reaches allow for limited inferences. Average annual substrate scores for streams within or immediately adjacent to forested State trust lands appear to be consistently lower than those found in streams adjacent to other ownerships in the Flathead River headwaters (Big, North Coal, South Coal, Whale, Red Meadow, and Morrison creeks) and Swan River drainage (Lion and Elk creeks). This result may be the consequence of variations in sample size, unique stream geomorphologies, recent fire, sample location, forest management history, or a combination of one or more of these and other factors. While average scores from the Flathead River headwaters improved from 1996 to 1999, average scores from this area and nearby forested State trust lands both declined from 2000 to 2009. Average scores from both forested State trust lands and other ownerships in the Swan drainage declined from 1997 to 2004 but increased from 2005 to 2009.

McNeil core samples during this monitoring period were outside thresholds of concern, except in Coal, Squeezer (fiscal year 2008 only), and Soup creeks. Core sample results from Coal Creek generally indicate an impaired status in that stream, while Soup Creek remained in threatened status during the monitoring period.

Similar to substrate score, determining long-term McNeil core trends on forested State trust lands is still imprecise, although evolving datasets from many continuously surveyed reaches allow for limited inferences. Average annual McNeil core results for streams within or immediately adjacent to forested State trust lands appear to be consistently lower than those found in streams adjacent to other ownerships in the Flathead River headwaters (Big, North Coal, South Coal, Whale, Trail, Granite, Challenge, Langford, and Meadow creeks) and Swan River drainage (Lion, Jim, and Elk creeks). Again, this result may be the consequence of those variables described above for substrate score. While average McNeil core results from the Flathead River headwaters have generally increased from 2001 to 2009, average scores from nearby forested State trust lands have remained stable during the same period. Average McNeil core results from other ownerships in the Swan drainage have steadily declined from 1996 to 2009, but results from forested State trust lands during the same period have steadily increased.

Bull trout redd counts are one measure of the species' population status, and results from fiscal years 2006 to 2010 monitoring period are shown in Table F-3. Total redd counts from both the Flathead River headwaters area [other ownerships] and nearby forested State trust lands generally increased from 1993 to 2005 and then declined from 2006 to 2009. Total redd counts from both the Swan River drainage area [other ownerships] and nearby forested State trust lands generally increased from 1991 to 1999 and then declined from 2000 to 2009.

The general consistency in average substrate score and total redd count trends between forested State trust lands and other ownerships suggests that these fisheries habitat and population indicators may be a function of one or more variables independent of either land ownership area (e.g. regional weather or climate patterns or nonnative fish species interactions). Furthermore, general long-term trends in both average substrate score and

McNeil core results do not appear to correlate to redd count trends in either land ownership area, but this particular assessment should be interpreted with caution due to the still evolving long-term datasets.

Trends between average and site-specific substrate score and McNeil core would be expected to exhibit an inverse relationship (i.e. as percent fine materials increase the general substrate score is expected to decrease [increase in level of embeddedness]). Very generally, this relationship has been observed throughout the Flathead River drainage with the evolving long-term datasets. However, McNeil core results from Goat and Squeezer creeks have dramatically increased approximately 10 percentage points between 2002 and 2009, but corresponding substrate scores have remained relatively stable or even improved (Squeezer Creek). These results indicate not only that Goat and Squeezer creeks merit critical evaluation over the next 5-year monitoring period, but that the accuracy and relevance of the semi-quantitative substrate score assessment of rearing habitat should be reevaluated.

Table F- 1: Substrate scores (fiscal years 2006 to 2010) from the Swan River, Stillwater, and Coal Creek State Forests.

		Substrate score				
State Forest	**Stream**	**FY06**	**FY07**	**FY08**	**FY09**	**FY10**
Coal Creek	Coal	8.7	9.0	9.6	10.0	10.4
Coal Creek	Cyclone	10.1	10.4	10.8	10.6	10.3
Stillwater	Swift	12.4	12.5	12.1	12.1	12.6
Stillwater	West Swift	11.1	11.3	11.8	12.0	11.9
Stillwater	Lower Stillwater	11.7	11.9	11.3	11.7	11.7
Stillwater	Upper Stillwater	nd	nd	nd	13.8	13.4
Swan	Sqeezer	9.1	9.4	10.2	9.8	10.3
Swan	Goat	11.1	11.2	11.4	11.1	11.6
Swan	Soup	9.2	9.4	9.1	9.0	9.2
Swan	South Lost	11.6	11.9	11.7	11.4	11.8
Swan	South Woodward	9.6	9.9	10.6	10.7	11.2
Swan	Woodward	9.3	9.5	10.1	10.3	10.7

Table F- 2: McNeil core results (fiscal years 2006 to 2010) from the Swan River, Stillwater, and Coal Creek State Forests.

		McNeil core result (%)				
State Forest	**Stream**	**FY06**	**FY07**	**FY08**	**FY09**	**FY10**
Coal Creek	Coal	41.3	40.1	39.6	41.5	nd
Coal Creek	Cyclone	33.8	34.6	32.9	33.1	nd
Stillwater	Swift	31.0	32.6	34.0	33.2	nd
Stillwater	West Swift	30.3	30.9	31.6	30.1	nd
Stillwater	Lower Stillwater	25.0	24.3	25.4	26.1	nd
Stillwater	Upper Stillwater	25.7	28.1	29.6	28.9	nd
Swan	Sqeezer	31.0	33.6	35.8	32.8	nd
Swan	Goat	31.6	33.7	34.0	33.2	nd
Swan	Soup	35.9	36.6	36.1	35.2	nd
Swan	South Lost	31.6	32.3	30.2	29.6	nd
Swan	South Woodward	28.0	31.2	32.8	29.8	nd
Swan	Woodward	34.2	35.0	34.1	33.3	nd

Table F- 3: Bull trout redd counts (fiscal years 2006 to 2010) from the Swan River, Stillwater, and Coal Creek State Forests.

		Redd count				
State Forest	**Stream**	**FY06**	**FY07**	**FY08**	**FY09**	**FY10**
Coal Creek	Coal	4	17	4	2	0
Coal Creek	Cyclone	4	nd	5	0	2
Stillwater	Swift	nd	nd	7	6	6
Stillwater	West Swift	nd	nd	9	5	6
Stillwater	Lower Stillwater	nd	nd	28	16	9
Stillwater	Upper Stillwater	nd	nd	6	6	nd
Swan	Sqeezer	103	113	123	59	60
Swan	Goat	65	62	75	69	72
Swan	Soup	10	12	11	3	5
Swan	South Lost	21	26	25	14	19
Swan	South Woodward	nd	nd	10	20	9
Swan	Woodward	67	69	104	72	49

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. All data has been georeferenced for the fisheries program monitoring database - especially for rapid utilization in project-level assessments, the Fish

Passage Assessment Project, and pre- and post- project Riparian Management Zone (RMZ) monitoring.

Nineteen streams were surveyed between fiscal years 2006 and 2010:

- Antice Creek (25,167 feet surveyed),
- Chicken Creek (10,686 feet surveyed),
- Coal Creek (9,142 feet surveyed),
- North Fork Coal Creek (7,718 feet surveyed),
- South Fork Coal Creek (6,122 feet surveyed),
- Herrig Creek (12,838 feet surveyed),
- Lazy Creek (19,274 feet surveyed),
- Meadow Creek (9,298 feet surveyed),
- Rock Creek (8,659 feet surveyed),
- Rock Creek, Trib B (10,923 feet surveyed),
- Spring Creek 1 (3,383 feet surveyed),
- Stryker Creek (24,533 feet surveyed),
- Whitetail Creek (21.767 feet surveyed),
- Dog Creek, Trib A (25,656 feet surveyed),
- Dog Creek, Trib B (15,318 feet surveyed),
- Dog Creek, Trib C (2,734 feet surveyed),
- Swede Creek (3,546 feet surveyed),
- Andrews Creek (6,309 feet surveyed), and
- North Fork Praine Creek (5,572 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 various DNRC project-level environmental assessments. For example, inventory data collected during fiscal years 2006 through 2010 has been applied as important components of fisheries analyses in the Duck to Dog, Antice Chicken, Swedish Chicken, SE Stryker, Point of Rocks, and White Porcupine Multiple timber sale environmental assessments. Large woody debris data from all of the stream inventories has been integral in the development of aquatic conservation strategy analysis for the proposed HCP for forested State trust lands. *See DNRC Internal Report, J. Bower: LWD Trends and Channel Type in Five Regions of Western Montana, March 2009*. 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 [*see DNRC Internal Report, J. Bower: Stream Habitat Complexity and LWD Frequency in Northwest Montana, March 2009*]. Inventory data from Swede, Chicken, Andrews, and North Fork Praine Creeks was used in the application process for successful cost-share grant acquisitions for the South Sula and Swede-Chicken-Whitetail Native Fish Conservation Projects.

Fish Passage Assessment Project

The DNRC Fish Passage Assessment Project was initiated in June 2003, and the project area includes 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 4 ongoing main objectives of the Fish Passage Assessment Project: (1) maintain 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) perform detailed modeling 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.

The current database contains 899 records of road-stream crossings on State trust lands, 354 of which are confirmed to intersect known and potential native salmonid habitat. Three hundred and twenty of these 354 road-stream crossing sites are candidates for technical surveys since those sites may affect native salmonid connectivity and DNRC may have jurisdiction and control of the site. To date, 95 percent of the candidate technical surveys have been completed. Through the technical survey and detailed analysis process, 108 road-stream crossing sites on State trust lands have been determined to limit connectivity to one or more native salmonid life stages. Within the current prioritization schedule, future road-stream maintenance involving fish passage restoration is rated by species presence, genetics and existing levels of connectivity.

An additional new component of the DNRC Fish Passage Assessment Project has been the development of a technical survey and design protocol for the construction of fish passage structures on State trust lands. *See DNRC Internal Report, J. Bower: Fish Passage Design and Construction Protocol, August 2009.* The purpose of this document is to provide an effective and cost-efficient framework for consistent implementation of SFLMP standards for fish passage.

Stream Temperature Monitoring

The DNRC stream temperature monitoring program on State trust lands began June 2001 and continues today. Temperature monitoring through fiscal year 2010 includes ongoing or discontinued efforts on 28 streams, which fall into the following 5 categories:

- Pre- and Post- Timber Sale RMZ Monitoring (ongoing)

  - Beaver Creek
  - Dick Creek
  - Dingley Creek
  - North Unnamed Trib to Dog Creek
  - South Unnamed Trib to Dog Creek
  - South Fork Lost Creek
  - South Lyons Creek
- Pre- and Post- Timber Sale RMZ Monitoring – DISCONTINUED
  - Cilly Creek
  - Flower Creek
  - Soup Creek
  - Whitetail Creek
- Special Land Management RMZ Monitoring (Post-Fire) – ONGOING
  - Lyman Creek
  - North Fork Cameron Creek
  - Praine Creek
- Special Land Management RMZ Monitoring (Grazing) – ONGOING
  - (Mainstem) Blanchard Creek
  - North Fork Blanchard Creek
- Single Point/Other Monitoring – ONGOING and DISCONTINUED
  - Gird Creek
  - Chepat Creek
  - Chicken Creek
  - Fitzsimmons Creek
  - East Fork Swift Creek
  - Middle Swift Creek
  - West Fork Swift Creek
  - North Unnamed Trib to West Fork Swift Creek
  - Main Unnamed Trib to West Fork Swift Creek
  - Soup Creek
  - South Fork Lost Creek
  - Goat Creek
  - Squeezer Creek
  - Woodward Creek

Opportunities to begin post-timber sale RMZ monitoring have only occurred at the North and South Unnamed Tribs to Dog Creek. While this monitoring is incomplete, preliminary data indicates that peak seasonal stream temperature regimes in the two streams (post-RMZ and SMZ harvest) are remaining within the general ranges observed during pre-harvest monitoring.

Ongoing post-fire monitoring of North Fork Cameron and Praine creeks indicates that these streams are both generally cooling and contributing to lower rates of change in stream temperature. No temperature trends have become apparent in Lyman Creek.

Ongoing monitoring of the grazing exclosure in North Fork Blanchard Creek indicates that this stream is generally cooling and contributing to significantly lower rates of change in stream temperature. Temperatures trends have remained stable in mainstem Blanchard Creek since construction of a grazing exclosure.

Complete status reports for all stream temperature monitoring on State trust lands can be found in *DNRC Internal Report, J. Bower: Stream Temperature Monitoring Reports and Summary, January 2010.*

Looking Forward to Fiscal Year 2011 Through 2015

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. The continued implementation of the Fish Passage Assessment Project and associated prioritization schedule will help watershed specialists identify road-stream crossings that need improved fisheries connectivity.

Streams previously inventoried during the fiscal years 2001 to 2005 monitoring period should be scheduled for resurveys in order to begin analyzing temporal and spatial trends in fish habitats and large woody debris on forested State trust lands. Stream temperature data will also continue to be collected to better evaluate the range of temperatures regimes that occur throughout forested State trust lands and the effects of forest management activities. 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 and biodiversity responsibilities.

SOILS RESOURCE 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 disturbance associated with forest management projects and thus the need for an adaptive soils monitoring program.

The FMB currently monitors the effects of DNRC timber harvest on forest soils on approximately 5 different timber sales per year. Past monitoring efforts (1988 to 2005) were solely focused on soil disturbance monitoring, but new approaches and techniques have been incorporated to further investigate potential impacts of forest management projects on a range of forest soil processes. Specific objectives for soil monitoring projects for the past five years include:

1. **To assess the area and degree of harvest effects on common forest soils following timber harvest on DNRC lands and if those effects fell within or exceeded those predicted in environmental assessments and/or recommendations outlined in the SFLMP.**
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 verify assumptions made in the SFLMP regarding the acceptable extent of soil disturbance within a harvest to maintaining site productivity.**
5. **To assess potential changes to soil temperature regime following forest management within streamside management zones.**

From 2006 to 2010 DNRC has completed 15 soil monitoring projects on individual forest management projects, 4 of which spanned two or more years. Eleven of these projects focused on objectives one thru 3 listed above. The results of these projects are summarized below.

Table SO- 1: Soil disturbance monitoring results from monitoring projects designed to address soil objectives one through 3.

Project Name	Harvest Unit	Land Office	Unit	Objective	Equipment Used	Detrimental Distrubance (%)	Woody Material (Tons/Acre)	Woody Material Recommendation (Graham et al.)
Dog Meadow North	9	NWLO	Stillwater	Post Havrest Distrubance	Ground Based, Traditional	21.2	24.1	17-33 tons/acre
Brown's Gulch T. S., C2	2	CLO	Dillon	Post Havrest Distrubance	Cable Yarding	11.4	10.4	12-24 tons/acre
Brown's Gulch T.S., C1	1	CLO	Dillon	Post Havrest Distrubance	Cable Yarding	9.4	11.9	12-24 tons/acre
Deadman T.S., Unit #3	3	SWLO	Missoula	Post Havrest Distrubance	Cable Yarding	8.3	12.9	12-24 tons/acre
Lemhi Pass T.S., Unit #1	1	CLO	Dillon	Pre-Harvest Woody Debris Data	NA	NA	22.6	12-22 tons/acre
Lemhi Pass T.S., Unit #2	2	CLO	Dillon	Pre-Harvest Woody Debris Data	NA	NA	22.6	12-24 tons/acre
Lemhi Pass T.S., Unit #4	4	CLO	Dillon	Pre-Harvest Woody Debris Data	NA	NA	22.6	12-24 tons/acre
Lemhi Pass T.S., Unit #5	5	CLO	Dillon	Pre-Harvest Woody Debris Data	NA	NA	22.6	12-24 tons/acre
Tyler Creek	4	SWLO	Missoula	Post Havrest Distrubance	Cable Yarding	2.3	53.6	12-24 tons/acre
Tyler Creek	5	SWLO	Missoula	Post Havrest Distrubance	Cable Yarding	2.9	24.6	12-24 tons/acre
Jocko Lakes - Double Beaver	2	SWLO	Clearwater	Pre/Post Fire Salavge Disturbance	Ground Based, Traditional	14.2	27.8	12-24 tons/acre
Jocko Lakes - Double Beaver	1	SWLO	Clearwater	Pre/Post Fire Salavge Disturbance	Ground Based, Traditional	13.0	27.8	12-24 tons/acre
Weimer Creek	1	CLO	Helena	Post Havrest Distrubance	Ground Based, Forwarder	0.6	20.0	12-22 tons/acre
Shingle Butte	1	CLO	Helena	Post Havrest Distrubance	Ground Based, Traditional	20.5	5.1	5-10 tons/acre
Bug Chuck	3	SWLO	Clearwater	Post Havrest Distrubance	Ground Based, Traditional	8.3	10.6	5-9 tons/acre
Shorts Meadows	6	NWLO	Stillwater	Post Havrest Distrubance	Inwoods Processor	1.0	31.5	17-33 tons/acre
Shorts Meadows	9	NWLO	Stillwater	Post Havrest Distrubance	Ground Based, Traditional	2.6	26.9	17-33 tons/acre
Peterson Creek	3	SWLO	Anaconda	Post Havrest Distrubance	Ground Based, Traditional	4.3	8.9	12-24 tons/acre
Peterson Creek	1	SWLO	Anaconda	Post Havrest Distrubance	Ground Based, Traditional	14.8	15.3	12-24 tons/acre
Peterson Creek	2	SWLO	Anaconda	Post Havrest Distrubance	Ground Based, Traditional	4.5	13.0	7-13 tons/acre

Soil Disturbance Monitoring Summary (Objectives #1 & #3)

The results from monitoring projects focused on assessing soil disturbance for the last 5 years are consistent with the results and recommendations previously reported by DNRC (DNRC 2005) and are shown in Table SO-2. Monitoring methods have remained consistent through this 22-year period and are summarized in the DNRC Complied Soil Monitoring

Report on Timber Harvest Projects (DNRC, 2005). The application of BMPs and site specific mitigations designed during project development has repeatedly been shown to limit detrimental soil disturbance to 15 percent of a harvest unit as recommended by the SFLMP. Two DNRC forest management projects that were monitored for soil disturbance exceeded this recommendation due to BMP departures for skid trail planning. Even though the recommendation was exceeded within these two projects, the long-term productivity of the site was still maintained. This reinforces the notion that strict interpretation of limiting soil disturbance to 15 percent of a harvest unit is not practical for all sites (Page-Dumroese et al. 2000). Site sensitivity to disturbance and biological resiliency must be considered. The productivity of some sites will be reduced well before 15 percent disturbance is achieved while other sites have a much higher threshold of disturbance before a loss in productivity occurs. Thorough site review by a trained soil scientist, good communication with the forest officer administering the timber sale contract and flexibility within management recommendation regarding soil disturbance have proven to be paramount in protecting long-term soil productivity during timber harvest projects.

Table SO- 2: Soil disturbance monitoring trends, 1988 to 2010.

Harvest Method	Soil Disturbance Reporting Period			
	Sites	2006-2010	Sites	1988-2005
Ground Based, Traditional	9	11.5%	66	13.2%
Cable Yarding	5	6.9%	2	4.7%
Forwarding/In-woods Processing	2	0.8%	1	1.0%

Coarse and Fine Woody Material Retention (Objective #2)

Timber harvest should retain a proportion of coarse and fine woody material within the natural range of variability for the habitat type and fire regime of the stand. DNRC has consistently relied on the recommendation of Graham et al. (1994) and will continue to do so in the future. Every soil disturbance monitoring project has measured the amount and distribution of coarse and fine woody material that was retained after harvest activities were completed and are summarized in Table SO-1 above. One monitoring project (Lemhi Pass) was specifically designed to document this natural range of variability for the specific habitat type in question. A geodatabase has also been created to collect coarse and fine woody material data collected during project development of existing conditions through DNRC lands. This data, along with recommendations within the scientific literature, assist DNRC specialists when prescribing coarse and fine woody material retention recommendations on a project level basis. Over the past 5 years DNRC has been highly successful in meeting prescribed levels of coarse and fine woody material through contract administration and monitoring.

Long-term Productivity Verification Monitoring (Objective #4)

As previously mentioned, the SFLMP (DNRC 1997) has recommended that detrimental soil disturbance not exceed 15percent within any harvest unit of a forest management activity to

maintain the long-term productivity of the soil. This guideline has been accepted by other land management agencies (USDA BC Ministry of Forests) but little quantitative data exists to support the assumption that long-term productivity will be maintained if this guideline is met. Many published studies have documented the declined growth rate of individual trees due to soil compaction or displacement, but few have shown this effect at the stand scale.

Two retrospective studies have been conducted by DNRC over the past 5 years with an objective to verify the effect of severe soil disturbance on stand initiation and growth as well as the natural amelioration rate of disturbed soil. These two selected soil monitoring sites were originally completed in 1988 with results being the highest levels soil disturbance documented by DNRC. These two sites, Davis Point (Unit #2) and Coal Creek (Unit #8), were then revisited 20 years later.

The Davis Point monitoring project (DNRC, 2007) showed that while the soil disturbance from the original timber harvest was high (26.2 percent), 20 years of freeze-thaw processes and root penetration has naturally ameliorated much of the impacts and replication of the original transects resulted in 14 percent detrimental disturbance. Regeneration surveys were not completed, but walk through observations noted well stocked conditions and vigorous tree growth. Conclusions from this study support that on soils with very high coarse fragment content, soil disturbance thresholds maybe slightly higher than the recommended 15 percent before reductions in long-term productivity will be observed.

The Coal Creek monitoring project also retrospectively reviewed a previously completed soil monitoring study with very high soil disturbance reported (33.6 percent). Highlights of this monitoring project include bulk density values on primary skid trails significantly higher than undisturbed soils twenty years post harvest with very little recovery shown. While soil impacts still remain elevated, regeneration surveys evaluating tree species, diameter, height and age of the regenerating stand show no significant loss of trees per acre or basal area but a significant difference in tree height between areas of low and high soil disturbance. A more detailed report on these findings will be published internally in the spring of 2011.

Riparian Soil Temperature Monitoring (Objective #5)

Forest management activities within riparian areas present an elevated risk of environmental impacts and thus a need for long-term monitoring of the effects of such actions. Within the Duck-2-Dog timber sale project area, a selective harvest was implemented within the SMZ for 1,500 feet of a Class I stream. Two years prior to the select harvest 15 temperature loggers were placed on alternating sides of the stream, 150 feet apart at six inches depth in the soil, 30 feet from the high water mark. Angular canopy density (shade) was measured at each location directly above the logger. This methodology was repeated for 4 years; two years before the harvest and two years post harvest. Pre and post timber inventories were also completed and showed the select harvest reduced both the Basal Area (ft^2) and Trees Per Acre of the riparian stand by 23 percent and 19 percent respectively. After the harvest was completed, where individual trees were removed, shade measurements were reduced significantly but did not affect maximum daily soil

temperature or the magnitude of daily temperature change post harvest. Preliminary findings suggest that the level of tree retention obtained with this selective harvest was adequate to protect the temperature regime of these particular riparian soils in northwest Montana. It is speculated that at very high harvest intensity, soil temperatures would respond but that current SMZ tree retention requirements restrict harvest before this threshold is achieved. A more detailed report on these findings will be published internally in the spring of 2011.

Summary of Soil Monitoring Efforts

Over 20 years of quantitative soil monitoring has shown that current BMPs and mitigation measures, when adequately applied during DNRC timber sales, have significantly reduced detrimental soil disturbance. The fact remains that anytime large, heavy equipment is used during forest management projects, soil impacts will occur but that these impacts can be minimized to a reasonable degree so as not to reduce the overall productivity of the land. New techniques, equipment, and mindset regarding light-on-the-land harvesting methods have and will continue to reduce detrimental soil impacts during timber harvest as operator skills progress and monitoring techniques become more refined.

Data collection on the natural range of variability of coarse and fine woody material within various habitat types throughout Montana continue to aid project implementation so that site nutrient pools are maintained and that protection of the organic forest floor is achieved. Continued site reconnaissance of woody material during project development as well as monitoring reference conditions will help facilitate progression in making informed prescriptions regarding woody material retention.

Continuing to retrospectively examine historic soil monitoring projects with the objective of tying physical soil disturbance to biological response variables (e.g. tree growth) remains a crux within the scientific community. With a soil monitoring database spanning 22 years, critical information is readily available to DNRC to verify and refine assumptions regarding thresholds of detrimental soil disturbance from timber harvest as it relates to maintaining long-term site productivity.

THREATENED, ENDANGERED, SENSITIVE SPECIES AND BIG GAME MONITORING

The SFLMP and Rules established several standards and general goals for management of threatened, endangered and sensitive species and big game. These are to:

- **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 are to:

- **Conduct periodic surveys to assess the effectiveness of management actions to support wildlife;**
- **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. [See Biodiversity Monitoring]**

DNRC PARTICIPATION IN WILDLIFE WORKING GROUPS

During the monitoring period from 2006 to 2010, DNRC biologists participated on the following interagency committees and working groups: the Grizzly Bear Northern Continental Divide Ecosystem (NCDE) Subcommittee, NCDE Conservation Strategy Team, the Swan Valley Grizzly Bear Conservation Agreement Technical Monitoring Team, Swan Lands Coordinating Committee--Wildlife Subcommittee, Montana Bald Eagle Working Group, Montana FWP R-2 Interagency Fisher Monitoring Working Group, and the Montana Common Loon Working Group.

Bald Eagle Monitoring

DNRC is a participant in the 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 statewide surveys to ensure coverage. DNRC biologists have assisted with nest monitoring from 2000 to 2010. The bald eagle was delisted as a threatened species on June 28, 2007, but will continue to be monitored and receive protections afforded by the federal Bald and Golden Eagle Protection Act.

During the 2006 to 2010 monitoring period for this report, DNRC biologists surveyed 4 to 6 territories annually. All results were submitted to the DFWP bald eagle monitoring coordinator for inclusion in interagency annual reports.

Bald Eagle Working Group Monitoring

Results: The bald eagle population in Montana has increased from approximately 12 nesting pairs in 1978 to over 526 territories surveyed statewide in 2009. The population still appears to be increasing with new nests found each year. In 2009, work group participants monitored 421 out of the 526 known bald eagle territories and documented 503 young fledged. In 2009 average production for the State was good, with nesting success for active nests at about 77.5 percent. Results compiled up to 2009 indicate that the nesting population continues to increase (FWP 2010). Tracking of active territories and nests has continued to offer challenges for available staff and budgets due to the high growing numbers of eagles and nests.

Montana Common Loon Working Group Monitoring

DNRC biologists on the NWLO and SWLO have actively participated in the Montana Common Loon Working Group and monitoring from 2001 to 2010. This working group supports activities related to the conservation and management of common loons. During the monitoring period, DNRC biologists participated in monitoring efforts for chick survival, capturing and tagging studies, nest platform construction, and information/education efforts. Monitoring information was reported to the Montana Common Loon Working Group annually. During the monitoring period from 2006 to 2010, DNRC monitored 9 to 10 lakes annually in northwest Montana and assisted with the development of a draft interagency management plan.

In 2002, DNRC became a cooperator in the Loon Ranger Program and has continued to support these efforts through 2010. The Loon Ranger Program provides support and direction for several Loon Rangers that regularly monitor loon activity on over 30 lakes in western Montana, provide public education at lakes where nesting has been documented, and provide evening fireside talks for the public. Field reports are completed at the end of the season. This program has been successful in providing valuable monitoring information and public outreach. From 1999 to 2008 the population of common loons in Montana has remained relatively stable with an average of 62 pairs observed annually and average production of about 41 chicks (Hammond 2009).

Northern Continental Divide Ecosystem

The U.S. Geological Survey Northern Divide Grizzly Bear Project, in cooperation with the NCDE Subcommittee, was conducted from 2001 to 2004 to estimate the population size of grizzly bears in the NCDE. Data collection was completed in 2004 and results were published in 2008 (Kendall et al. 2008). The study resulted in an estimate of 765 grizzly bears that has established a baseline for the ecosystem. In a related but separate study, trend data collected and analyzed by Montana DFWP indicate that this population of approximately 765 individuals continued to grow at about 3 percent annually from 2004 to 2009 (R. Mace, DFWP, pers. comm. 2010). DNRC has maintained representation on the NCDE Subcommittee, which has provided oversight for these efforts. DNRC also currently has representation on a team that is developing a conservation strategy intended to facilitate delisting of grizzly bears in the NCDE.

Swan Valley Grizzly Bear Conservation Agreement Monitoring

The Swan Valley Grizzly Bear Conservation Agreement [SVGBCA] (June 6, 1997) is a strategy that enables multi-jurisdictional land owners to comply with the ESA, while continuing to practice forestry and multiple use management on their timberlands in the Conservation Area. To ensure compliance with the Agreement, the cooperating parties agreed to monitor the application and effectiveness of the conservation measures, and provide results to the USFWS on an annual basis. Monitoring commitments are documented in the *Monitoring Agreement for the Swan Valley Conservation Agreement* (August 21, 1998). A Technical Monitoring Team comprised of 4 biologists employed by the cooperating entities during the 2006 to 2010 monitoring period developed 5 monitoring reports (covering years 2005 to 2009). The reports were distributed annually to the USFWS, all cooperators, and interested publics.

Effectiveness Monitoring

Summary Results: Through SVGBCA cooperative research conducted in the Swan Valley since 2000, over 35 individual grizzly bears have been identified using the valley. In summer 2000, Agreement cooperators began additional 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 FWP.

From 2001 to 2004, 12 grizzly bears in the Swan Valley were fitted with satellite radio collars, of which 10 ultimately provided more than one month of data. Of these 10, 6 were males and 4 were females. In total, 20,000 hourly telemetry points for these bears were obtained and analyzed. In 2006, results were presented at a managers meeting for cooperators. Findings of this monitoring effort indicated that:

- the biological goal of providing connectivity between the Mission Mountains and the Bob Marshall Wilderness was being met,
- bears spend considerable time in the valley bottom during all seasons when bears are active,
- bears used all ownerships in the valley,
- bears exhibited greater rates of movement during the night than in daytime, and
- bears continued to suffer high levels of mortality due to human caused factors.

From 2005 to 2009, at least 8 bears were known to have died in the Swan Valley. Two were illegally shot, two were hit by cars on Highway 83, one cub drowned in the Swan River, 1 was euthanized following cabin break-ins, and two died of unknown causes (sources -- annual Swan Monitoring Reports 2005 to 2009).

To address ongoing concerns related to high mortality levels, DNRC and other Swan Agreement cooperators have established a reward program for information leading to the arrest of poachers. Cooperators also established and have supported the Bear Ranger Program aimed at educating and informing residents in the valley on living successfully with bears and improving efforts to reduce risk associated with unnatural bear foods and other attractants.

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 provide important information about commercial activity and disturbance in the valley, and human induced changes in baseline habitat conditions. Specific details are contained in a complete set of published monitoring reports for years 2005 to 2009. Each annual report was provided to the USFWS for their review and files. All of the land management cooperators fully complied with the Swan Agreement during the 2006 to 2010 monitoring period.

Stillwater State Forest Road Closure Monitoring

In 2006, efforts were initiated to systematically inventory and check all primary gates and road closure devices (eg. berms, barriers, dense brush etc.) on an annual basis on the Stillwater State Forest (the portion within the NCDE grizzly bear recovery zone) to help provide security for grizzly bears and other wildlife. During the monitoring period, closure structures found to be non-functional were prioritized for maintenance annually and were repaired as funding was available. Closure effectiveness for the years examined averaged 85.3 percent. Improvements will continue to be made in expediting repairs and in the road closure data inventory during the next monitoring period to ensure that closure devices are effectively restricting legal and illegal public motorized access as intended. Summary results for the current monitoring period are provided in Table TES-1 below.

Table TES- 1: Summary of road closure device monitoring conducted from 2006 to 2010 on DNRC lands within the Stillwater State Forest.

Year	Total Closures Checked	Number Determined Functional	Percent Functional
2007	88	77	87.5%
2008	129	107	82.9%
2009	121	105	86.7%
2010	165	139	84.2%

Fisher Buffer Monitoring on the Swan River State Forest 2008 to 2009

In 2008, DNRC contracted with Northwest Connections to conduct systematic track surveys on the Swan River State Forest. The surveys were designed to collect baseline information regarding the presence of wildlife in select harvested and non-harvested sites on the Goat Squeezer and Three Creeks timber sale areas. Evidence of wildlife use in winter was documented at 5 survey sites (3 logged and 2 unlogged). Winter surveys resulted in 1,263 observations of 21 wildlife species. Deer and red squirrels were the most common species

detected, and their tracks were consistently found in greater numbers in unlogged retention areas than in adjacent logged sites. Other notable observations made in winter were of snowshoe hares, weasel species, small rodents, coyotes, bobcats and mountain lions. In 2009, DNRC conducted additional surveys on the same sites in summer and collected vegetation data to aid in the interpretation of recorded observations. Summer surveys resulted in 168 total observations of 28 species -- predominantly birds. The most common species detected during summer surveys included: dark-eyed juncos, hermit thrushes, mountain chickadees, red-breasted nuthatches, and red squirrels. Differences in the number of observations and species that were noted between the two seasons were likely attributable to the different detection probabilities of the methods used and different seasons surveyed. The number of observations of wildlife in summer varied less between unlogged and logged sites than that observed in winter surveys. Additional surveys of recently logged sites on the Three Creeks Timber Sale are tentatively planned for winter 2012 to complete this monitoring project.

Post Burn Wildlife Survey on the Sula State Forest 2009

In spring 2009, DNRC conducted a 4-day survey to document the presence of wildlife species on the Sula State Forest 8 years following an intense wildfire event and subsequent salvage logging activities. Wildlife observations, tracks and other distinguishing evidence were recorded along 17 miles of roads that served as survey routes. Over the 4 days, the surveys resulted in 324 wildlife observations of 38 species. These included one amphibian, 8 mammals, and 29 bird species. The species most frequently encountered during surveys included Columbia ground squirrels, northern flickers, mountain bluebirds, Clark's nutcrackers, dark-eyed juncos, Lewis' woodpecker, and American robins. Of the 38 individual species detected, 13 (34 percent) were either primary or secondary cavity-nesting species, which accounted for 142 (44 percent) of all 324 observations. Further, of the 324 total observations, 88 (27 percent) were of northern flickers (46) and mountain bluebirds (42), suggesting the importance of retaining fire-killed snags as mitigation associated with salvage logging.

PROJECT REVIEWS OF WILDLIFE MITIGATION

The intent of this component is to assess the application and potential effectiveness of project-level commitments made in MEPA documents regarding wildlife mitigation. Two projects were reviewed in fall of 2010 in conjunction with biodiversity field reviews (see the Biodiversity Monitoring subsection of this report for further details). The reviews involved 13 individuals that included managers, field foresters, and other resource specialists. Mitigations for various species were discussed and evaluated for effectiveness. The species mitigations evaluated included those for: Canada lynx, grizzly bears, several bat species, goshawks, Cooper's hawks, pileated woodpeckers, fishers, white-tailed deer/elk winter range and elk security. All reviewing members concurred that the measures evaluated for both projects met or exceeded requirements of applicable Forest Management Rules.

Snag, Snag Recruitment and Coarse Woody Debris Monitoring

This monitoring component allows 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 wide variety of forest-dwelling species. Results are used to evaluate compliance with minimum retention levels for snags, residual live trees, and CWD specified in the Biodiversity Rules (ARM 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 2006 to 2010 sampling was conducted on 13 stands within 13 sale areas (one stand per sale area). The stands were located on different field offices, and occurred within various cover types and treatment types. Pre-harvest data for snags, CWD, and large live trees (potential recruitment trees >21 inches dbh) were collected on each selected project. The same data were then also collected on the same identical sites for comparison relatively soon after logging had taken place. Nine 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). Consistent with prior monitoring from 2000 to 2005, methods similar to those used by Bevis (1996) were used. DNRC stand-level inventory (SLI) data collection procedures with increased sample transect length (660 ft.) were used to estimate CWD amounts. Tonnage calculations for CWD follow those developed by Brown (1974).

Results - Snags: Consistent with earlier findings, reported snags/acre values by size class suggest that existing snag densities on pre-harvest sites are occasionally lower than guidance recommendations even before logging occurs. 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 range of stand types and harvest intensities across Units on the NWLO and SWLO.

Pre-harvest: Of the 13 stands sampled prior to harvest, only 4 had one or more snags greater than 21 inches dbh per acre -- hereafter termed "Large Snags" (Table TES-2). Of these 4 stands, only 2 of them contained two or more Large Snags per acre. Three of the 13 stands contained no Large Snags. Thus, nine stands prior to scheduled harvest were limited in their ability to provide minimum required numbers of Large Snags. Medium-sized snags (16 to 21 in. dbh) were generally more abundant on sample plots within sample stands (Table TES-2). Seven of the 13 stands sampled (ie., 53 percent) possessed averages of ≥ 2.5 snags per acre in this size class, 5 of which supported averages ≥4.5 snags per acre. As expected, very large snags ≥27 inches dbh were more rare and only one stand possessed densities of greater than one per acre (Table TES-2).

Table TES- 2: Summary results of pre-harvest and post-harvest sampling of snags on DNRC timber sales during 2006 to 2010.

Sale Name (sample date) -- Harvest Status	Area Office	Cover Type*	Plots Sampled	Total Snags Recorded	Snags/acre 16"-21" dbh (sd)	Snags/acre 22"-27" dbh (sd)	Snags/acre ≥27" dbh (sd)
Big Prairie (2005) -- Pre-harvest	NWLO	PP	6	24	0 (na)	0.3 (0.5)	0 (na)
Big Prairie (2010) -- Post-harvest	NWLO	PP	6	5	0 (na)	0.2 (na)	0 (na)
Ewing Mid. Ridge (2006) -- Pre-harvest	NWLO	MC	4	119	9.8 (1.5)	1.0 (1.4)	0 (na)
Ewing Mid. Ridge (2009) -- Post-harvest	NWLO	MC	4	45	2.5 (2.4)	1.0 (2.0)	0.3 (0.5)
Goat Squeezer I (2004) -- Pre-harvest	NWLO	MC	3	33	3.0 (2.6)	2.0 (1.7)	0.7 (0.6)
Goat Squeezer I (2006) -- Post-harvest	NWLO	L/DF	3	16	2.0 (2.6)	0.3 (0.6)	0.3 (0.6)
McKillop (2004) -- Pre-harvest	NWLO	MC	4	37	2.5 (3.8)	0.5 (1.0)	0 (na)
McKillop (2006) -- Post-harvest	NWLO	L/DF	4	7	0.5 (0.6)	0 (na)	0 (na)
Taylor South (2001) -- Pre-harvest	NWLO	MC	2	73	4.5 (2.1)	1.0 (1.4)	0 (na)
Taylor South (2006) -- Post-harvest	NWLO	MC	2	16	2.5 (0.7)	1.0 (1.4)	0 (na)
Fish Sticks (2004) -- Pre-harvest	SWLO	GF	2	40	13.0 (4.2)	3.0 (0.0)	3.0 (2.8)
Fish Sticks (2005) -- Post-harvest	SWLO	GF	2	10	2.5 (0.7)	2.5 (2.1)	0 (na)

Sale Name (sample date) -- Harvest Status	Area Office	Cover Type*	Plots Sampled	Total Snags Recorded	Snags/acre 16"-21" dbh (sd)	Snags/acre 22"-27" dbh (sd)	Snags/acre ≥27" dbh (sd)
Bert Creek (2006) -- Pre-harvest	SWLO	DF	3	8	0.7 (1.2)	0 (na)	0.7 (0.6)
Bert Creek (2008) -- Post-harvest	SWLO	DF	3 **	6	0.7 (1.2)	0 (na)	0.3 (0.6)
Evans Lake (2004) -- Pre-harvest	SWLO	PP	2	5	0 (na)	0 (na)	0.5 (0.7)
Evans Lake (2006) -- Post-harvest	SWLO	PP	2	1	0 (na)	0 (na)	0.5 (0.7)
Sleeping Child (2008) --Pre-harvest	SWLO	PP	2	3	1.0 (1.4)	0.5 (0.7)	0 (na)
Sleeping Child (2009) --Post-harvest	SWLO	PP	2	1	0.5 (0.7)	0 (na)	0 (na)
Additional Projects Sampled Pre-harvest Only During Monitoring Period							
Wild Horse (2005) -- Pre-harvest	NWLO	L/DF	4	184	7.0 (4.2)	0 (na)	0 (na)
Cliff Lake (2008) --Pre-harvest	NWLO	DF	4	15	0.3 (0.5)	0.3 (0.5)	0 (na)
Shiloh Road (2009) -- Pre-harvest	NWLO	PP/DF	4	19	1.0 (0.8)	0.3 (0.5)	0.3 (0.5)
80 Acre Salvage (2009) -- Pre-harvest	SWLO	LP	2	16	6.0 (1.4)	0.5 (0.7)	0 (na)

* Cover type codes: GF = grand fir, L/DF = western larch/Douglas-fir, LP = Lodgepole Pine, MC = mixed conifer, PP = ponderosa pine, PP/DF = ponderosa pine/Douglas-fir.
(sd) = standard deviation
** Two of the three plots sampled pre-harvest on this project area were not logged due to operability constraints.

Post-harvest: Of the 4 sample stands that contained one or more Large Snags per acre prior to harvest, 3 either maintained or were close to their pre-harvest levels (Ewing Mid. Ridge, Taylor South, Fish Sticks -- Table TES-2). Post harvest medium-sized (16-21 in. dbh) snag densities ranged from 0 to 2.5 per acre and averaged 1.2 per acre. Density of the combined large and very large snag classes (≥22 inches dbh) also ranged from 0 to 2.5 snags per acre, but averaged 0.7 snags per acre (calculated from Table TES-2).

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: Of the 13 stands sampled pre-harvest, one had no large live trees present (Fish Sticks fire salvage), 3 had densities of large live trees of less than 2 per acre, and 9 had densities of greater than 2 per acre. Densities of large, live trees suitable for future snag recruitment on the 13 sample stands (Table TES-3) generally indicated that ample numbers were present to meet snag recruitment requirements; however, all large trees are not necessarily healthy and/or desirable for retention. Large live tree density on the 13 stands ranged from 0 to 14.3 trees per acre and averaged 4.4 per acre.

Post-harvest: Eight of the 9 stands that were sampled after logging during the monitoring period maintained an average of at least one large live tree per acre. The one stand that had no live trees retained was burned at high intensity and no live trees were present on the site prior to logging. Retained tree density estimates for the 8 stands that supported some large live trees ranged from 1.0 to 7.0 trees per acre and averaged 3.3 per acre. Additional smaller live trees were retained in the 15 to 21 in dbh class on all of the 8 stands sampled after logging. Species composition of retained trees was weighted to those species that tend to make desirable future snags (Table TES-3).

Conclusions and Recommendations Regarding Snag and Recruitment Tree Retention: Consistent with previous findings, results from this monitoring period suggest that Large Snags are not abundant even prior to logging on stands selected for sampling. Thus, continued attention by forest managers to the retention of Large Snags over time remains an important consideration. In general, total snags of all sizes recorded in logged stands are reduced considerably from pre-harvest levels (fifth column -- Table TES-2, Figure TES-1). Such reductions are not unexpected as snags are often removed for their commercial value, are inadvertently knocked over by equipment during harvest operations, are felled for human safety reasons, are vulnerable to windthrow, and are lost to firewood cutting etc. Thus, balancing these attrition factors and demands in managed forests will likely remain a reoccurring challenge for managers.

Given the relatively low density and availability of large snags to retain in harvest units, ARM 36.11.411 provides flexibility to retain the next smaller-sized snags and recruitment trees when larger ones are not available. Rule 36.11.411 also allows for some substitution of snags and large trees for one another if availability is poor. For example, in stand replacement burns with no live trees, the entire recruitment tree requirement may be met with charred snags, because live trees are often not available under these circumstances (eg. the Fish Sticks salvage project). Given these factors, our analysis of compliance considers the collective post-harvest abundance of all snags >15 inches dbh and all live recruitment trees ≥ 21 inches dbh.

All 9 of the projects where both pre and post-harvest snag and recruitment tree sampling was conducted complied with the requirements of ARM 36.11.411. Four projects including, Goat Squeezer, Bert Creek, Evans Lake, and Sleeping Child projects easily met retention requirements through the number of retained Large Snags and large live trees ≥22 inches dbh alone. Because of the relative rarity of large trees and snags and the reference to 21 inch trees in ARM 36.11.411, analyses were also conducted that included 21 inch dbh trees and snags, and 15 to 21 inch dbh snags (results further summarized in Table TES-3 -- columns 6 and 7, and Figure TES-1). Considering the addition of the 21 inch trees and snags alone to the dataset (Table TES-4 -- column 6), both the Big Prairie and Taylor South stands also exceeded retention requirements. All of the stands sampled, but one ("McKillop") clearly exceeded numeric snag requirements when medium sized snags 15 to 21 inches dbh were included in retention estimates following logging (Table TES-4 -- column 7). Upon further evaluation of the McKillop project, it was evident that a number of the existing large trees prior to logging were grand fir, which were removed to encourage the presence of other tree species such as western larch, and promote desired future conditions in the residual stand. Following logging it was also noted that this stand contained an ample density of medium-sized (15 to 21 inch dbh) live trees (average 8.5 per acre), which were deemed, upon further evaluation, adequate to ensure that long-term snag recruitment objectives would be achievable. In sum for the McKillop project, an average density of medium-sized and greater live trees and snags totaling 11.3 per acre was present after logging.

Table TES- 3: Summary results of pre-harvest and post-harvest sampling of live snag recruitment trees on DNRC timber sales during 2006 to 2010.

Sale Name (sample date) -- Harvest Status	Area Office	Cover Type*	Plots Sampled	Total Large Trees >21" dbh Recorded	Ave Lg. Trees/Acre >21" dbh (sd)	Species Composition of Large Trees ≥15" dbh
Big Prairie (2005) -- Pre-harvest	NWLO	PP	6	8	1.3 (2.2)	DF 50%, PP 30%, WL 20%
Big Prairie (2010) -- Post-harvest	NWLO	PP	6	7	1.2 (1.5)	PP 48%, DF 35%, WL 18%
Ewing Mid. Ridge (2006)-- Pre-harvest	NWLO	MC	4	21	5.3 (2.1)	DF 84%, GF 12%, CD 4%
Ewing Mid. Ridge (2009)-- Post-harvest	NWLO	MC	4	8	2.0 (0.8)	DF 81%, CD 19%
Goat Squeezer I (2004) -- Pre-harvest	NWLO	MC	3	43	14.3 (2.1)	CD 36%, WL 28%, SP 13%, BR 8%, DF 6%, GF 6%, CW 3%
Goat Squeezer I (2006)-- Post-harvest	NWLO	L/DF	3	21	7.0 (5.3)	WL 46%, SP 17%, BR 15%, DF 10%, CW 7%, CD 5%
McKillop (2004)-- Pre-harvest	NWLO	MC	4	8	2.0 (0.8)	DF 32%, WL 27%, GF 24%, WP 10%, WH 5%, SF 2%, SP 1%
McKillop (2006)-- Post-harvest	NWLO	L/DF	4	4	1.0 (0.8)	WL 61%, DF 29%, WP 11%
Taylor South (2001)-- Pre-harvest	NWLO	MC	2	3	1.5 (2.1)	GF 55%, WL 30%, DF 10%, SP 5%
Taylor South (2006)-- Post-harvest	NWLO	MC	2	3	1.5 (2.1)	GF 67%, WL 13%, DF 13%, WP 7%
Fish Sticks (2004)-- Pre-harvest	SWLO	GF	2	0	0 (na)	Na (stand replacement burn - no live trees)
Fish Sticks (2005)-- Post-harvest	SWLO	GF	2	0	0 (na)	Na (stand replacement burn - no live trees)
Bert Creek (2006)-- Pre-harvest	SWLO	DF	3	10	3.3 (0.6)	DF 98%, PP 2%
Bert Creek (2008)-- Post-harvest	SWLO	DF	3 **	7	2.3 (0.6)	DF 94%, PP 6%
Evans Lake (2004) -- Pre-harvest	SWLO	PP	2	22	11.0 (1.4)	PP 63%, DF 37%
Evans Lake (2006) -- Post-harvest	SWLO	PP	2	12	6.0 (4.2)	PP 81%, DF 19%

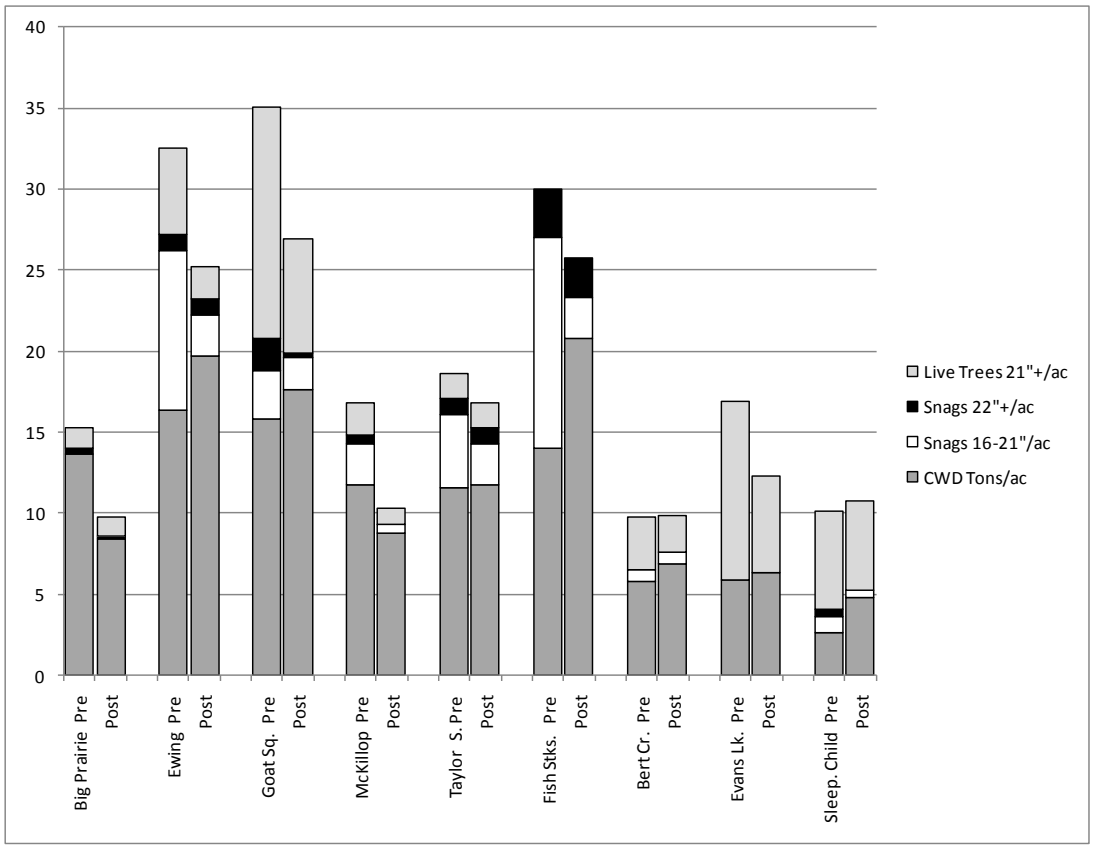
Sale Name (sample date) -- Harvest Status	Area Office	Cover Type*	Plots Sampled	Total Large Trees >21" dbh Recorded	Ave Lg. Trees/Acre >21" dbh (sd)	Species Composition of Large Trees ≥15" dbh
Sleeping Child (2008)--Pre-harvest	SWLO	PP	2	12	6.0 (5.7)	PP 100%
Sleeping Child (2009)--Post-harvest	SWLO	PP	2	11	5.5 (4.9)	PP 97%, DF 3%
Additional Projects Sampled Pre-harvest Only During Monitoring Period						
Wild Horse (2005) -- Pre-harvest	NWLO	L/DF	4	10	2.5 (1.3)	DF 100%
Cliff Lake (2008)--Pre-harvest	NWLO	DF	4	7	1.8 (1.5)	DF 85%, WL 13%, PP 3%
Shiloh Road (2009)-- Pre-harvest	NWLO	PP/DF	4	8	2.0 (1.4)	DF 64%, PP 25%, WL 8%, GF 3%
80 Acre Salvage (2009)-- Pre-harvest	SWLO	LP	2	13	6.5 (4.9)	DF 50%, PP 46%, LP 4%

* Cover type codes: GF = grand fir, L/DF = western larch/Douglas-fir, LP = Lodgepole Pine, MC = mixed conifer, PP = ponderosa pine, PP/DF = ponderosa pine/Douglas-fir.
(sd) = standard deviation
** Two of the three plots sampled pre-harvest on this project area were not logged due to operability constraints.

The combined densities of Large Snags and large trees ≥22 inches dbh on the 9 projects sampled ranged from 1.0 to 14.9 stems per acre and averaged 4.5 per acre (Table TES-4). When the analysis was expanded to also include 21 inch dbh trees, the densities for the 9 projects ranged from 2.3 to 15.9 stems per acre and averaged 5.6 per acre (Table TES-4).

Given the general rarity of large snags and numerous attrition factors that influence the presence of snags in managed stands, we recommend that foresters continue to work diligently to meet Large Snag and live tree recruitment density requirements on each project. We also recommend only substituting between snags and live recruitment trees when necessary to help ensure ample densities of larger snags and replacements are present over time. We also continue to stress retention of the larger snags and recruits when available on each site. That is, leaving 18 inch dbh live trees or snags in stands where trees greater than 21 inches dbh are present should not be the norm. Leaving smaller material should generally be incorporated *only* when larger trees and snags are not available. Preference should always be given first on any site to larger snags and recruits of desirable species, particularly given their apparent rarity.

Figure TES- 1. Comparison of pre and post harvest results for amounts of large live trees, snags and coarse woody debris, which were sampled on nine DNRC timber sales from 2004 to 2010.



Results – Coarse Woody Debris: Downed logs and woody material are important for providing long-term soil structure, nutrients, and habitat structures important for many species of wildlife. ARM 36.11.414 specifies that DNRC 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: Only one stand of the 13 sampled (Sleeping Child) had a pre-harvest CWD estimate that was less than that recommended by Graham et al. (1994) for maintenance of site productivity (Table TES-5). The remaining stands had estimates that fell well within or exceeded Graham et. al.'s recommended ranges. 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. The average weight of material found on each site before logging ranged from 2.6 tons per acre to 16.4 tons per acre with an overall average of 10.1 tons per acre (Table TES-5). The total number of large logs (≥15 inch diameter of large end) found on the 13 sites pre-harvest ranged from 0.5 to 5.3 per transect and averaged 2.6 large logs per transect. The total number of small logs (<15 inch large end diameter) found on the 13 sites pre-harvest ranged from 9.3 to 47.0 logs per transect and averaged 26.5 small logs per transect (Table TES-5).

Table TES- 4: Summary results for post-harvest compliance with measures pertaining to snag and recruitment tree retention for harvest units on DNRC timber sales during 2006 to 2010. Highlighted cells indicate stands that met or exceeded Rule requirements.

Sale Name (sample date) -- Harvest Status	Area Office	Cover Type*	No. Plots	Combined Total of Live Trees & Snags/Acre ≥22" dbh	Combined Total of Live Trees & Snags/Acre ≥21" dbh (includes 21" dbh trees)	Combined Total of Live Trees & Snags/Acre ≥21" dbh & Medium Sized Snags 15"-21"dbh (no. required per acre)
Big Prairie (2010) -- Post-harvest	NWLO	PP[b]	6	1.4[a]	2.6	2.6 (2)
Ewing Mid. Ridge (2009)-- Post-harvest	NWLO	MC[c]	4	3.3	3.9	6.1 (4)
Goat Squeezer I (2006)-- Post-harvest	NWLO	L/DF[c]	3	14.9	15.9	17.6 (4)
McKillop (2006)-- Post-harvest	NWLO	L/DF[c]	4	1.0[a]	2.3	2.8[d] (4)
Taylor South (2006)-- Post-harvest	NWLO	MC[c]	2	2.5	4.5	7.0 (4)
Fish Sticks (2005)-- Post-harvest	SWLO	GF[c]	2	2.5	3.0	5.0 (4)
Bert Creek (2008)-- Post-harvest	SWLO	DF[b]	3 **	2.6[a]	3.9	4.6 (2)
Evans Lake (2006) -- Post-harvest	SWLO	PP[b]	2	6.5[a]	8.0	8.0 (2)
Sleeping Child (2009)--Post-harvest	SWLO	PP[b]	2	5.5[a]	6.0	6.5 (2)

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

(sd) = standard deviation

** Two of the three plots sampled pre-harvest on this project area were not logged due to operability constraints.

[a] These stands possessed less than 1 snag per acre greater than 21 inches dbh prior to logging.

[b] ARM retention requirements in these cover types are an average of one snag and one live recruitment tree per acre that are greater than 21 inches dbh.

[c] ARM retention requirements in these cover types are an average of two snags and two live recruitment trees per acre that are greater than 21 inches dbh.

[d] This stand averaged 2 large snags and 2.5 large recruitment-sized trees per acre prior to logging -- a number of which were grand fir that were removed by logging to promote desired future conditions in the residual stand. While this stand did not average at least 4 large trees and/or snags per acre following logging, a considerable number of medium-sized live trees 15 to 21" dbh of desirable species were also retained post-harvest (8.5/acre), which would provide for potential long-term snag recruitment.

Table TES- 5: Summary results of pre-harvest and post-harvest sampling of downed logs and CWD on DNRC timber sales during 2006 to 2010.

Sale Name (sample date) -- Harvest Status	Area Office	Cover Type*	No. 660 ft. Transects Sampled	Total CWD ≥3 in Dia. Tons/Acre (sd)	Ave. No. Large Logs/660 ft. Transect {>15.5 in. Large End Dia.} (sd)	Ave. No. Small Logs/660 ft. Transect {≤15.4 in. Large End Dia.} (sd)
Big Prairie (2005) -- Pre-harvest	NWLO	PP	6	13.7 (5.9)	3.2 (1.6)	44.0 (21.3)
Big Prairie (2010) -- Post-harvest	NWLO	PP	6	8.4 (2.8)	0.3 (0.5)	54.2 (13.8)
Ewing Mid. Ridge (2006) -- Pre-harvest	NWLO	MC	4	16.4 (8.2)	5.3 (2.5)	30.3 (9.5)
Ewing Mid. Ridge (2009) -- Post-harvest	NWLO	MC	4	19.7 (7.4)	4.8 (3.8)	47.8 (12.0)
Goat Squeezer I (2004) -- Pre-harvest	NWLO	MC	3	15.8 (4.6)	5.3 (1.5)	24.0 (6.2)
Goat Squeezer I (2006) -- Post-harvest	NWLO	L/DF	3	17.6 (10.0)	6.3 (2.5)	34.3 (10.5)
McKillop (2004)-- Pre-harvest	NWLO	MC	4	11.8 (4.8)	1.5 (1.7)	32.5 (12.8)
McKillop (2006)-- Post-harvest	NWLO	L/DF	4	8.8 (2.8)	3.0 (6.0)	42.0 (11.6)
Taylor South (2001)-- Pre-harvest	NWLO	MC	2	11.6 (2.1)	4.0 (0.0)	21.5 (3.5)
Taylor South (2006)-- Post-harvest	NWLO	MC	2	11.8 (2.6)	0.5 (0.7)	47.0 (11.3)
Fish Sticks (2004)-- Pre-harvest	SWLO	GF	2	14.0 (1.6)	4.5 (0.7)	19.5 (4.9)
Fish Sticks (2005)-- Post-harvest	SWLO	GF	2	20.8 (5.8)	6.0 (1.4)	40.0 (1.4)
Bert Creek (2006)-- Pre-harvest	SWLO	DF	3	5.8 (5.0)	2.3 (1.2)	14.3 (5.0)
Bert Creek (2008)-- Post-harvest	SWLO	DF	3 **	6.9 (3.9)	2.7 (0.6)	17.0 (2.0)
Evans Lake (2004) -- Pre-harvest	SWLO	PP	2	5.9 (2.5)	1.5 (2.1)	12.5 (9.2)
Evans Lake (2006)-- Post-harvest	SWLO	PP	2	6.3 (0.6)	1.0 (0.0)	31.0 (1.4)
Sleeping Child (2008)--Pre-harvest	SWLO	PP	2	2.6 (0.7)	0.5 (0.7)	14.5 (6.4)
Sleeping Child (2009)--Post-harvest	SWLO	PP	2	4.8 (0.1)	0.0 (na)	24.5 (0.7)

Sale Name (sample date) -- Harvest Status	Area Office	Cover Type*	No. 660 ft. Transects Sampled	Total CWD ≥3 in Dia. Tons/Acre (sd)	Ave. No. Large Logs/660 ft. Transect {>15.5 in. Large End Dia.} (sd)	Ave. No. Small Logs/660 ft. Transect {≤15.4 in. Large End Dia.} (sd)
Additional Projects Sampled Pre-harvest Only During Monitoring Period						
Wild Horse (2005) -- Pre-harvest	NWLO	L/DF	4	15.1 (2.9)	2.5 (2.4)	47.0 (10.5)
Cliff Lake (2008)--Pre-harvest	NWLO	DF	4	4.4 (2.5)	1.3 (1.0)	9.3 (2.6)
Shiloh Road (2009)-- Pre-harvest	NWLO	PP/DF	4	5.7 (3.3)	0.5 (0.6)	31.5 (2.4)
80 Acre Salvage (2009) -- Pre-harvest	SWLO	LP	2	8.3 (1.8)	1.5 (0.7)	43.5 (9.2)

* Cover type codes: GF = grand fir, L/DF = western larch/Douglas-fir, LP = Lodgepole Pine, MC = mixed conifer, PP = ponderosa pine, PP/DF = ponderosa pine/Douglas-fir.
(sd) = standard deviation
** Two of the three plots sampled pre-harvest on this project area were not logged due to operability constraints.

Post-harvest: As for snag and recruitment tree monitoring described above, 9 of the 13 stands sampled during the 2006 to 2010 monitoring period were also sampled following logging (Table TES-5). On 7 of the 9 stands sampled following logging, a greater amount of woody material was left than that observed on the same sites before harvest (Table TES-5, Figure TES-1)). Woody debris weight estimates following logging ranged from 4.8 to 20.8 tons per acre and averaged 11.7 tons per acre. The total number of large logs (≥15 inch diameter of large end) found on the 9 sites post-harvest ranged from 0.0 to 6.3 per transect and averaged 2.7 large logs per transect. The total number of small logs (<15 inch large end diameter) found on the 9 sites post-harvest ranged from 17.0 to 54.2 logs per transect and averaged 37.5 small logs per transect (Table TES-5).

Consistent with monitoring conducted from 2001 to 2005, retained logs post-logging were primarily in the smaller diameter class (Table TES-5).

Conclusions and Recommendations Regarding Retention of Coarse Woody Debris: Given current practices, forest managers are generally meeting or exceeding recommendations of Graham et al. (1994). Of the 9 stands sampled after logging, 8 stands met or exceeded values in the ranges provided by Graham et al. (Table TES-6). The McKillop project averaged 8.8 tons per acre following logging which was slightly below the minimum of 12 tons recommended by Graham et al. (1994). This result coupled with the finding of few remaining large and medium-sized snags (Table TES-2) indicated that the residual material left following logging was probably lower than desirable levels in that unit.

Overall and consistent with findings displayed in the 2001 to 2005 monitoring report, results indicate that more woody material is often deposited on the ground after logging than is present prior to logging (Tables TES-5 and TES-6, Figure TES-1), and the distribution of woody material across units following logging was adequate. However, the number of large logs retained in stands following timber harvesting operations tends to be relatively low (Table TES-5), which stresses the importance of retaining ample large snags and snag recruitment trees, and the need for foresters to continue exploring creative means of retaining additional large logs in harvest units.

Table TES- 6: Summary results for post-harvest compliance with measures pertaining to CWD retention for harvest units on DNRC timber sales during 2006 to 2010. Highlighted cells indicate stands that met or exceeded Rule requirements following logging.

Sale Name (sample date) -- Harvest Status	Area Office	Cover Type*	No. 660 ft. Transects Sampled	Approximate Range in Tons/Acre Recommended for Retention (Graham et al. 1994)	Average Tons/Acre Post Logging
Big Prairie (2010) -- Post-harvest	NWLO	PP	6	4 to 13[a]	8.4
Ewing Mid. Ridge (2009)-- Post-harvest	NWLO	MC	4	7 to 14	19.7[c]
Goat Squeezer I (2006)-- Post-harvest	NWLO	L/DF	3	12 to 25[b]	17.6[c]
McKillop (2006)-- Post-harvest	NWLO	L/DF	4	12 to 25[b]	8.8
Taylor South (2006)-- Post-harvest	NWLO	MC	2	7 to 14	11.8[c]
Fish Sticks (2005)-- Post-harvest	SWLO	GF	2	7 to 14	20.8[c]
Bert Creek (2008)-- Post-harvest	SWLO	DF	3 **	4 to 21	6.9[c]
Evans Lake (2006) -- Post-harvest	SWLO	PP	2	4 to 13[a]	6.3[c]
Sleeping Child (2009)--Post-harvest	SWLO	PP	2	4 to 13[a]	4.8[c]

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

(sd) = standard deviation

** Two of the three plots sampled pre-harvest on this project area were not logged due to operability constraints.

[a] Estimated using Douglas-fir types within Montana and ponderosa pine types in Arizona.

[b] Estimated using the subalpine fir/twinflower vegetation type for Montana.

[c] Denotes stands that possessed a greater weight of downed material after logging than prior to logging.

REPORTING OF TERRESTRIAL SPECIES OBSERVATIONS

Methods: During the monitoring period, DNRC 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) January 2011 for inclusion in the state-wide database. Observation data will continue to be collected and reported in a cooperative effort to improve understanding of the distribution and occurrence of various species of interest.

Results: A total of 105 records were reported during the monitoring period, which contained sightings obtained from 2006 to 2010. Of the 105 records reported, 55 were of threatened and endangered species, 18 were of DNRC listed sensitive species, and 32 were of other species of interest. A summary list of the species reported and number of records is as follows:

T&E Species

Grizzly Bear (19)
Gray Wolf (32)
Canada Lynx (4)

DNRC Sensitive Species

Bald Eagle (4)
Pileated Woodpecker (13)
Black-Backed Woodpecker (1)

Other Species

American Marten (1)
Black Bear (4)
Bobcat (1)
Great Blue Heron (1)
Great Gray Owl (1)
Great Horned Owl (1)
Mountain Lion (1)
Northern Goshawk (13)
Osprey (1)
Red-Tailed Hawk (5)
Ruffed Grouse (1)
Sharp-Shinned Hawk (1)
Three-toed Woodpecker (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 two project sites 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.). The project biologist was responsible for developing and maintaining a monitoring schedule, and compiling results of monitoring efforts.

-Headquarters Timber sale eagle nest monitoring (eagles were successful and remained in the area during and following project completion) -- 2006 to 2007.

-Follow up monitoring of Goat Creek goshawk nest (goshawk pair remained in nesting stand during and following operations) -- 2004 to 2006.

OTHER WILDLIFE MONITORING

During the monitoring period, DNRC biologists and staff participated in a number of additional monitoring efforts, and provided various contributions for efforts involving species associated with forested habitats in western Montana. A listing of these efforts is provided below.

Cooperator -- Sophie Lake Prescribed Burn for Habitat Enhancement. Rocky Mountain Elk Foundation, U.S. Forest Service (Rexford Ranger District), Montana Fish, Wildlife and Parks. -- 2006.

DNRC Pilot Project -- Monitoring Wildlife Use of Fisher Buffers on the Stillwater State Forest -- 2006.

Cooperator -- Sampling Mercury and other Contaminants in Bald Eagles and Osprey in Southwestern Montana. Montana State University -- 2006 to 2007.

Participant -- Location reporting for porcupine ecology project. University of Montana -- 2006 to 2007.

Participant -- Blackfoot Watershed Wolf Survey. Montana Fish, Wildlife and Parks, BLM, U.S. Forest Service, Blackfoot Challenge, USFWS, and Nature Conservancy. – 2008 to 2010.

Cooperator -- Developing Wolf Population Monitoring Techniques -- Evaluation of a Computer-based Howlbox. Montana Cooperative Wildlife Research Unit; Nez Perce Tribe; Idaho Dept. of Fish and Game; University of Idaho; Montana Fish, Wildlife and Parks; and U.S. Fish and Wildlife Service -- 2008 to 2009.

DNRC Project -- Data Collection for Habitat Conservation Plan Lynx Habitat Model Assessment. U.S. Fish and Wildlife Service cooperator -- 2010.

GRAZING ON CLASSIFIED FOREST LANDS MONITORING

The SFLMP 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 percent and healthy riparian function is maintained;**
- **No percentage of shrubs will be in the heavily hedged form class and less than 25 percent of the shrubs will be in the moderately hedged form class;**
- **Streambank disturbance induced by livestock trampling will be limited to less than 10 percent 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 227 grazing licenses issued on 430 parcels of classified forest.

GRAZING EVALUATIONS

Methods

The SFLMP and ARM 36.11.444 require the DNRC to inspect all parcels contained within a grazing license issued on classified forestlands before renewal date and during mid-term (usually 4 to 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 to 5 percent), Light (5 to 25 percent), Moderate (25 to 50 percent), Heavy (>50 percent), 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 to 10 stems), Mature (>10 stems), Decadent (>30 percent of canopy dead) or Dead (100 percent of canopy dead).

Supplemental grazing evaluations were completed at the midterm and renewal period for licenses on classified forest grazing lands of the NWLO, SWLO, and Central Land Office (Table G-1). Between 2006 and 2010, mid-term supplemental grazing evaluations were performed on 127 grazing licenses encompassing 250 individual parcels administer by DNRC. These mid-term evaluations were usually performed four to six years prior to license expiration or renewal.

Table G- 1: Midterm grazing evaluations performed on DNRC classified forest parcels between 2006 and 2010 by land office. Individual parcels exceeding standards is also presented.

Year	SWLO		NWLO		CLO		All Lands	
	Parcels Evaluated	Exceeding Standards	Parcels Evaluated	Exceeding Standards	Parcels Evaluated	Exceeding Standards	Parcels Evaluated	Exceeding Standards
2006	44	68.2% (30)	15	0% (0)	1	0.0%	60	50.0% (30)
2007	73	17.8% (13)	17	11.8% (2)	1	0.0%	91	16.5% (15)
2008	29	17.2% (5)	28	28.6% (8)	5	100% (5)	62	29.0% (18)
2009	9	11.1% (1)	3	0% (0)	7	0.0%	19	5.2% (1)
2010	11	36.4% (4)	7	28.6% (2)	0	0.0%	18	33.3% (6)
5 Year Summary	**166**	**31.9% (53)**	**70**	**17.1% (12)**	**14**	**35.7% (5)**	**250**	**28.0% (70)**

Results: Of the 250 parcels that were evaluated, 195 parcels (78 percent) had either riparian areas or streams located within the license boundary. Of these 195 parcels containing riparian habitats, 104 parcels support a fisheries resource. In total, approximately 27.9 miles of stream and/or riparian area were surveyed. The lengths of stream that were surveyed varied from representative reaches (20 to 500 ft.) to the entire stream segment within the allotment (up to 5,500 feet).

Out of 195 parcels containing riparian areas, 125 (64 percent) 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 to 9 percent, forage utilization 0 to 59 percent and no or light levels of browse utilization or less than 25 percent in the moderate browse class.

Within the 70 parcels containing riparian areas exceeding numeric standards, 29 parcels (41 percent) supported a fisheries resource.

Browse utilization was the most common cause of departure from the SFLMP criteria followed closely by streambank disturbance. The moderate browse utilization standard was exceeded in 18 individual inspections and exceeded the heavy browse utilization standard in 34 individual inspections. Combined, there were 52 individual inspections where levels of browse utilization exceeded the criteria, 11 of which exceeded both numeric standards for browse utilization. Streambank disturbance ranged from 0 to 100 percent, and exceeded the 10 percent allowable level in 28 individual parcels. 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 4 parcels.

Table G- 2: Supplemental riparian monitoring during license inspections from 1997-2010.

Report Period	Parcels Evaluated	Parcels with Riparian Habitats	Parcels Exceeding Standards
1997-2000*	30	83%	30%
2001-2005**	228	80%	22%
2006-2010	250	78%	28%

* SWLO evaluations not reported due to fire closures

** No midterm evaluations were completed in 2005

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 recommendations ranged 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 50 inspections where previous condition is "unknown," the majority (149 of 200) of the inspections had conditions that remained unchanged from that of the previous inspections. There were, fortunately, 20 inspections where the general condition was upgraded from a previous lower classification. However, there were 31 inspections where the general condition class was dropped one rank.

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.

Table G- 3: Condition class trends for midterm grazing evaluations on classified forest trust lands, 2006 to 2010.

Conditon Class	Parcels	% of Total
Stable	149	74.5%
Improved	**20**	10.0%
Good to Excellent	11	5.5%
Fair to Good	8	4.0%
Poor to Good	1	0.5%
Degraded	**31**	15.5%
Excellent to Good	27	13.5%
Good to Fair	4	2.0%

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 cooperative agreements with all County Weed Districts where both forested and non-forested State lands occur. These plans typically span a 6 year period and are updated every two years. These cooperative agreements must include:

- a 6-year integrated noxious weed management plan
- the goals for noxious weed management
- a specific plan of operations and a budget for the biennium
- a biennial performance report, completed by the district weed board and submitted to the Department of Agriculture's State Weed Coordinator regarding the success of the plan.

DNRC Area Offices have also developed weed management plans under the guidance of the Montana Weed Management Plan which was revised in 2008. These plans 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 twenty (120) timber sale project records were reviewed for noxious weeds for the period of 2006-2010. Results indicate that approximately 17,970 acres of noxious weeds were treated by various means on DNRC lands and road right-of-ways. 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 proactively manages timber sale contracts to avoid excessive soil disturbance and thus the aerial extent of potential noxious weed establishment and spread.

All new roads (average 29 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.

EDUCATION

DNRC has cooperated with County Weed Districts to provide training in weed identification, safe herbicide application and weed management to field personnel.

As of 2010, 17 DNRC personnel are certified herbicide applicators for spot and field infestations of noxious weeds and numerous other employees have attended training on how to evaluate and oversee weed control projects.

TREATMENT

DNRC has adapted an integrated weed management plan that uses various treatment methods to prevent the establishment and spread of noxious weeds. All DNRC timber sale contracts included stipulations and control measures with the intent of controlling the spread of noxious weeds.

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.

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.

DNRC administrators also record weed infestations with grazing licenses on classified forest land 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 licensee.

RECOMMENDATIONS

The ROD for the 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 FMB Chief can change management direction as long as the change is compatible with the fundamental intent as reflected in the SFLMP. 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 Land Board, 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 2006 to 2010 of implementation are discussed below.

BIODIVERSITY MONITORING

The biodiversity field review process is a valuable tool for identifying challenges that forest managers face in including biodiversity considerations in the timber sale planning process. Biodiversity field reviews should be conducted every year, and should be expanded to a statewide level in order to more effectively identify issues and develop and respond with solutions in a timely manner.

Timber sale inspection reports are an important tool by which the DNRC tracks if timber sales are in compliance with certain standard operating procedures, Forest Management Rules, and BMPs. In order to draw more reliable and conclusive results from these reports, DNRC should look for ways to provide for greater consistency in its tracking and reporting methods.

OLD-GROWTH MANAGEMENT

Questions regarding the Department's old-growth management philosophy continue to exist, and clarification of those issues both internally and externally will continue. As the use of old-growth maintenance and restoration treatments increases, continued direction and field assistance will be necessary to refine the use of those treatments.

SOILS MONITORING

Considering soil disturbance data collected during timber harvest projects within the past five years, recommendation to the soil monitoring program would primarily focus on continuing soil monitoring efforts on projects that implement new harvest techniques, employ specialized equipment or use untested or unique mitigation measures or strategies. Continuing to use monitoring data adaptively into project design and implementation will

help to insure that harvest objectives are met while providing necessary protective measures to soil resources to insure long term productivity of the site and in-turn, revenues to trust beneficiaries.

WEEDS MONITORING

Improvements in how noxious weed data is collected and tracked throughout all DNRC lands would be the only programmatic recommendation at this time. With the advent of digital data recorders and the ability to pair spatial information with collected data, a more robust inventory system of noxious weed establishment, spread and treatment should be implemented.

ROADS MONITORING

The road monitoring data is used to implement corrective actions that address road related impacts. However, the large volume of information and data collected exists primarily 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. A common data format is needed to make sure information is consistently collected. A GIS based information system is currently being developed by the FMB.

GRAZING

Three recommendations can be made to improve riparian health and programmatic efficiency within the classified forest grazing program considering the past five years of data as well as information gathered since implementation of the State Forest Land Management Plan. These recommendations are listed below.

1. Refine and standardized DNRC's training program for seasonal or temporary employees conducting midterm grazing evaluations. Adequate and consistent training for individuals conducting assessments of stream bank alteration and other riparian health indicators results in reduced observer variability and impact estimates closer to actual field conditions (Heitke et al., 2008). Collecting better information with reduced observer variability during midterm evaluations will provide a more consistent view of riparian health trends and will assist managers to make more informed decision making.
2. Automate the collection of midterm grazing evaluations to include spatially explicit data and integrated this data with the Trust Land Management System (TLMS). This will facilitate Range Specialists easy access to midterm evaluation data during license renewal, consistently define problem areas and assist informed decision making when considering potential changes to licenses criteria at license renewal.
3. Continue to monitoring classified forest grazing parcels where corrective actions have been applied to document affective techniques to rehabilitate impaired riparian areas resulting from cattle grazing.

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ACRONYMS AND 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
HCP	Habitat Conservation Plan
Land Board	Board of Land Commissioners
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
RP	reference point
ROD	Record of Decision
Rules	Administrative Rules for Forest Management
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

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