2006/2007 MONITORING PROGRAM ANNUAL REPORT

USDA FOREST SERVICE

LAKE TAHOE BASIN MANAGEMENT UNIT

Ecosystem Conservation Department
Adaptive Management Monitoring Program

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Chapter I
Introduction

This report contains a summary of monitoring activities implemented on the LTBMU during the field season of 2006 and analysis results produced during the fall/winter/spring of 2006/2007. This production of this report was delayed by the increased workload due the Angora Fire, so although this report was not published until February of 2008, this report does not include 2007 data collection activities and subsequent analysis. This information will be presented in the 2007/2008 monitoring report, scheduled for June of 2008.

The Lake Tahoe Basin Management Unit (LTBMU) Monitoring Program provides information to decision makers about the impacts of forest management activities on desired conditions for LTBMU resources. The Monitoring Program will provide monitoring direction needed for the Forest Plan Revision, the Forest Environmental Management System (EMS), and NEPA Decision documents. The Program is continuing to evolve to follow monitoring guidelines established in FSH 1901.12, CH. 19 and 20 (Land Management Plan and Adaptive Planning Process), and FSM 1331 (EMS directives), the Adaptive Management Strategy (AMS) as described in Appendix E of the Sierra Nevada Forest Plan Amendment (SNFPA), and strategy developed by the National USFS Monitoring and Evaluation Team (MET).

We are also continuing to work with our partners in the Basin to ensure a coordinated and prioritized program is developed to meet both the particular needs of the LTBMU as well as the larger Lake Tahoe Basin community.

The LTBMU monitoring program addresses four main categories of information needs:

- **Implementation monitoring**: Determines the degree and extent to which application of standards and guidelines met management direction and intent (what, when, where, and how management direction has been followed).

- **Status-and-change monitoring** of ecosystem conditions and management activities: Assesses important biophysical and socio-cultural conditions, to gauge if desired conditions are being achieved and to describe correlative relationship between management activities and conditions to identify potential causal factors for observed changes.

- **Effectiveness monitoring**: Provides a better understanding of how ecosystem components, structures, and processes respond to management activities, and how ecosystem components interrelate.

- **Research**: Designed to support land management by generating new information to address key information gaps related to the fundamental workings of ecosystem processes, interrelationships between processes, development and testing of different management approaches, and development and validation of habitat relationships, ecological indicators, and thresholds.

This report describes the 2006 monitoring accomplishments and key findings of analysis conducted during the fall/winter of 2006/2007, as it relates to the four above described categories of information. Many of the analysis reports identified can be found at the following website: http://www.fs.fed.us/r5/ltbmu/publications.

This report is organized by key resource issue areas which include some of those identified in the Region 5 AMS, as well as resource issue areas unique to the Lake Tahoe Basin. The issue areas are listed below.

1. Lake Tahoe Clarity
2. Aquatic, Riparian, and Meadow Ecosystems
3. Old Forest Ecosystems /General Forest Ecosystems (includes WUIs)
4. Fire and Fuels
6. Noxious Weeds
7. Recreation/Social Resources.

Chapter II
Lake Tahoe Clarity

In 2006, LTBMU Adaptive Management Monitoring Staff collected data to evaluate the effects of management activities and practices that have the potential to affect Lake Tahoe clarity through impacts to soils and water quality. These include ski resort operations, road obliteration and road best management practices (BMP) retrofit, and temporary construction BMPs. Impacts related to fuels reduction practices are presented separately, in Chapter VI.

II.1 Heavenly Ski Resort

Effectiveness Monitoring Question:

Are watershed conditions at the resort continuing to improve as a result of ski resort management activities?

The Heavenly Ski Resort Monitoring Plan requires a variety of monitoring elements, including water quality, BMP effectiveness, effective soil cover, and channel condition. Contractors hired by Heavenly Resort implement the monitoring and analysis. BMP monitoring is conducted through Resource Concepts Incorporated, (RCI) and the remainder of the monitoring program is conducted through Entrix, Inc. The LTBMU maintains a strong oversight role in the implementation of this program. The contractors have demonstrated a high level of performance in data collection, analysis, and evaluation, particularly in the area of BMP effectiveness monitoring. Key findings from the 2006 Annual Report is presented below.

Key findings from 2006 Annual Monitoring Report for Heavenly Ski Resort (Entrix, 2007)

- Annual stream discharges for 2006 were significantly higher than for 2005, even though the accumulated annual precipitation was only slightly higher. Higher spring snow pack created snowmelt in larger amounts than in 2005, and created higher peaks in the 2006 hydrographs. Annual suspended sediment load increased at the property line for Heavenly Creek from 33 tons/year in 2005 to 39 tons/year in 2006. This amount is still below the TMDL standard for suspended sediment (50 tons/yr, 3 yr rolling average).

- Water Quality parameters were measured at three locations on Heavenly Valley Creek and an undisturbed reference station on Hidden Valley Creek and two locations on Edgewood Creek. Exceedances of Lahontan standards for Phosphorous, Chloride and Iron were measured at all stations on Heavenly creek including the reference station. California effluent standards for Bijou Park Creek (California Parking Lot) were exceeded for Total Suspended Sediment and Chloride. Edgewood Creek (below the Boulder Parking Lot) exceeded the Nevada Department of Environmental Protection effluent “not to exceed” standard for turbidity, suspended solids and total phosphorus.

- Permanent BMPs were evaluated for implementation and effectiveness at 27 sites in 2006. Implementation was rated fully successful on 21 (78 percent) of the 27 sites evaluated. One BMP evaluation was scored as not implemented but was

subsequently improved to a minor departure. The remaining five sites also had minor departures from full implementation. The percentage of fully implemented permanent BMPs again increased in 2006 compared to 2004 and 2005. Areas of needed improvement are cited as 1) Gravel and riprap need to be designed and engineered to site specific specification and 2) Geotextile fabrics were installed incorrectly at some sites.

Effectiveness scoring for the 27 BMP evaluations rated 23 (85 percent) as effective. There were three sites (9 percent) determined to be "at risk" of effecting water quality and one site evaluated to be not effective at protecting water quality. Areas of needed improvement are cited as 1) follow-up monitoring on fabric installations on steep slopes need to be performed, and 2) effective soil cover is the most commonly identified deficiency which should be more effectively addressed in the future.

- A total of 37 Temporary BMP evaluations were conducted in 2006.

Monitoring indicated temporary BMPs were full implemented at 29 sites (78 percent). Minor departures from full implementation were noted at 7 sites (19 percent) and 1 site was evaluated as not implemented. Issues related to Temporary BMP implementation monitoring included 1) runoff from BMPs such as sediment fences, and stabilization should be addressed with greater specificity in design plans and specifications, 2) temporary BMPs scheduled for a single season are sometimes extended throughout the winter without being specifically designed to accommodate winter conditions, and 3) potential for discharge from muddy ponded areas during SEZ restoration and the potential for oil/fuel leakage from heavy equipment storage in staging areas. All 37 Temporary BMPs evaluated were scored as effective.

- During 2006, SCI surveys were conducted on 10 stream reaches. Three of which are pre-established on Heavenly Creek, and two on Hidden Valley Creek (the control site). Five new SCI reaches were established in 2006 to assess effects of ski area management on the Nevada side of Heavenly including two reaches on Edgewood, two reaches on Daggett Creek and one on Mott Creek. The results of this monitoring indicate that Mott, Heavenly, and Daggett Creek are in a relatively stable/good condition, whereas Edgewood Creek is in a poor/unstable condition. Restoration activities are currently being implemented in Edgewood Creek. The monitoring on the upper reach of Hidden also indicates that there was a major natural sediment moving event that deposited a lot of material into this reach. Because of this event the consultants recommend that this reach no longer continue to be monitored for comparison with Heavenly Creek.

II.2. Best Management Practices (BMP) Monitoring

The LTBMU has two components to its water quality BMPs monitoring program. The first is a regional Best Management Practices Evaluation Program (BMPEP) which has been established for about 7 years under an agreement with the State Water Quality Control Board and addresses permanent BMPs for forest management activities. The second component was added this year, as part of the Lahonton State Water Quality Control Board Stormwater Protection Plan (SWPP) requirement for construction projects. This component addresses

monitoring of temporary construction BMPs. Both of these monitoring components use a systematic qualitative assessment of BMP implementation and effectiveness.

II.2.a. Best Management Practice Evaluation Program (BMPEP)

Implementation Monitoring Question:

To what degree are best management practices implemented and effective in protecting soil and water resources?

The Best Management Practices Evaluation Program (BMPEP) is a qualitative monitoring program implemented throughout US Forest Service (USFS) Region 5 (Pacific Southwest Region). The objectives of this program are to: (i) fulfill USFS monitoring commitments to the State Water Resources Control Board (SWRCB), as described in the SWRCB/USFS Management Agency Agreement and *Water Quality Management for National Forest System Lands in California (USFS, 2000),* (ii) assess and document the efficacy of the USFS water quality management program, specifically the implementation and effectiveness of BMPs, and (iii) facilitate adaptive management by identifying program successes and shortcomings.

Region 5 has developed standardized protocols and forms for onsite evaluations to assess soil and water protection BMP implementation and effectiveness for Timber, Engineering, Recreation, Grazing, Prescribed Fire, and Revegetation. Implementation evaluations determine the extent to which planned, prescribed and/or required water quality protection measures were actually put in place on project sites. Effectiveness evaluations gauge the extent to which the practices met their water-quality protection objectives.

Evaluations are scored utilizing a rule set developed by regional staff, and are placed into one of four categories: implemented and effective (I-E); implemented, but not effective (I-NE); not implemented, but effective (NI-E); and not implemented and not effective (NI-NE). Not implemented can include BMPs installed, but not implemented correctly according to designs/standards. This type of "hill slope monitoring" uses indirect measures to evaluate BMP effectiveness, so poor scores represent *potential*, rather than *actual*, impairment of beneficial uses by a given activity.

A random number of evaluations to be completed each year are assigned to the National Forests by the Regional Office based on: (i) the relative importance of the BMP in protecting water quality in the Region, and (ii) those management activities most common on the individual Forest.

In 2006, the LTBMU fell slightly short of its Regional target of 43 evaluations by completing only 33 BMPEP evaluations. This was the result of a shortage of projects meeting the criteria for the evaluation of Road Surface & Slope Protection (E08), In-Channel Construction (E13) projects, Dispersed Recreation Sites (R30), and Prescribed Fire (F25).

Key Findings from 2006 BMPEP (Christensen and Harris, 2007)

- Of the 33 total evaluations completed in 2006, 28 (85%) rated BMPs effective and five (15%) rated BMPs not effective. Of these 33 evaluations (29) 87 % were rated as implemented (i.e. installed and installed as designed). This is an improvement

- Documented failures are summarized below
    - Two Engineering evaluations: 1) unauthorized opening of the gate on road 16N93 while road conditions were too wet, and 2) the lack of design plans incorporating BMPs for a chip-sealing project on Angora Road.
    - One Timber evaluation due to the lack of proper drainage from a landing located in Agate unit 22A. The sediment deposited before reaching the SEZ and a maintenance request has been submitted to repair this problem.
    - Two Recreation evaluations: 1) due to drainage from a parking lot entering Echo Lake and the outlet stream and 2) Watson Lake dispersed camping area BMPS due to the lack of restrictions preventing vehicles from approaching the lake shore.
    - One Revegetation evaluation due to a small amount of sediment entering Trout Creek from a section of rip-rap.
    - One Grazing evaluation due to bank trampling and overgrazing in crucial areas within the Baldwin Allotment.

Of these failures only the last one (Baldwin Allotment) is considered to present a high risk related to amount of potential sediment delivery.

II.2.b. Temporary BMP Monitoring

Temporary Best Management Practices are required during all construction in the Tahoe Basin that involves soil disturbance. Temporary BMPs differ from permanent BMPs as they are designed to remain effective only until construction is complete and permanent BMPs can be applied. Depending on the nature of the activity and site characteristics, a variety of different BMPs may be employed to keep sediment from being mobilized. The LTBMUs Temporary BMP Monitoring program is designed to monitor BMP's applied to forest construction and restoration projects which have the potential for short term adverse impact to soil and water quality. Patterned after the Region 5 BMPEP process, protocols were developed to systematically assess and document whether temporary BMPs were implemented, maintained, and effective at preventing adverse impacts to water quality. Protocols for this program are documented in the LTBMU Temporary BMP Monitoring Plan and were incorporated into all Storm Water Pollution Prevention Plans (SWPP) for construction and restoration projects on the Lake Tahoe Basin Management Unit in 2006.

This was the first year that temporary BMP monitoring was formally documented on the LTBMU. Six projects implemented by the Engineering and Ecosystem departments were monitored (Blackwood Canyon Bridge Replacement, Cookhouse Meadow Channel Reconstruction, Lam Watah Trail Construction, Meeks Bay Resort Campground Retrofits, Pope Beach Parking Area Retrofits, Ward Creek Trail Bridge Construction). The results of this monitoring are summarized below:

Key Findings from 2006 TBMPEP (Harris and Norman, 2007)

- Temporary BMP monitoring for 2006 showed varying degrees of success relative to implementation and effectiveness. One major implementation failure was documented on the Ward Creek Trail Project. Major effectiveness failures (meaning sediment did or had potential to reach stream) were documented on Blackwood Canyon and Cookhouse Meadow Projects. There were also a number of minor departures. Of the types of BMP failures observed, the most common failure was improper management of fine grained sediment stockpiles. This failure occurred on 5 out of the 6 projects evaluated.

- Recommendations relative to implementation include better management of stockpiles and addressing effectiveness failures within 48 hours of documentation. Additionally, on-going projects should be monitored during spring runoff in order to ensure that winterized BMPs are remaining effective.

II.4 Roads and Trails Monitoring

Three separate efforts are implemented for the roads and trails monitoring program. These efforts include monitoring protocols for roads, trails, and Off-Highway Vehicle (OHV) routes. The roads and trails monitoring programs are similar in their implementation; each uses a qualitative assessment of water quality risk, Region 5 BMPEP protocols, and WEPP modeling, to determine BMP effectiveness in protecting water quality. The OHV monitoring uses a qualitative soil loss monitoring assessment to determine the condition of the OHV road or trail.

The primary goals of monitoring roads and trails, as outlined by the 5-Year LTBMU Inventory, Monitoring and Evaluation Plan, are to (i) evaluate the impacts of road decommissioning and BMP upgrades in reducing pollutant loading to Lake Tahoe and (ii) evaluate the effectiveness of road BMP utilization as it relates to proper implementation and water quality protection.

II.4.a Road Decommissioning and BMP Upgrade Program Monitoring

Implementation Monitoring Question:

Has the implementation of Road Decommissioning and BMP Upgrades reduced the potential for water quality impacts, and to what degree were road BMPs successfully implemented and effective?

Effectiveness Monitoring Question:

What impact do forest roads have on sediment loading to Lake Tahoe, and how successful are BMP retrofits and decommissioning in mitigating those impacts?

The final Forest Roads BMP Upgrade Monitoring Report was completed in March of 2007 and provides a comprehensive evaluation of all the data collected over the past several year on 150 miles of National Forest System roads. Results from the Draft report were presented in last years annual monitoring report. However some major revisions were made between the draft and the final, as a result of locating some "lost" data. Updated and additional results are presented below.

Key Findings from 2003-2005 Forest Road BMP Upgrade Monitoring Report *(Harris and Norman, 2007)*

BMPEP Monitoring

- Road surface, drainage and slope protection (E08) evaluations determined that 93% (49 of 52) of road surface, drainage and slope protection upgrades were effective. Where it occurred, diminished effectiveness resulted from various plugged cross-drains and ditches. Sedimentation and any negative effects on beneficial use were minor and only affected the stream near the crossings. These concerns were submitted to the Engineering Department for resolution in a comprehensive list of 2005 road-related issues. As of the writing of this report, not all of these concerns have been addressed.

- Stream crossings evaluations (E09) determined that all 52 stream crossing upgrades were effective in preventing plugging and reducing diversion potential, throughout the project area.

- Side cast material evaluations (E11) determined that 85% (44 of 52) of the sites were rated effective with regard to side cast material. All 8 problem areas were the result of placing vegetative debris from downed trees into stream channels of SEZs. It should be noted that recreational users are likely responsible for disposing of the debris from wind-blown downed trees which were blocking the road, prior to planned removal by Forest personnel.

Water Quality Risk Monitoring (WQRAP)

- Of the total 150 road miles evaluated, 17.4 miles were rated as moderate to high risk to water quality prior to BMP upgrades. Basin wide BMP upgrades reduced the moderate to high risk roads to 10.7 miles. These roads are currently considered hydrologically connected to surface water bodies and present some level of water quality risk. The most common causes of moderate to high risk evaluations are attributed to long connected road lengths, steep road gradients and close proximity of roads to SEZs.

WEPP - Road Batch

- Modeling with WEPP is used as a comparative tool for evaluating the effectiveness of road upgrades. Modeled results indicate that upgrades to the road system resulted in a decrease in erosion from 44.8 tons to 32.6 tons, and overall sediment yield decreased from 23.4 to 10.5 tons.

- Though there was a significant reduction in predicted sediment yield and high and moderate risk roads, roads which still have moderate to high erosion potential should be evaluated through follow-up field assessments to determine whether predicted erosion and sediment transport is occurring, and if so, can these be mitigated through additional treatment measures. These are listed below

    - Third Creek watershed, Road 17N85
    - Burk Creek watershed, Roads 13N78, 13N80, 13N82, 13N82A & 14N32
    - Logan House Frontal watershed, Road 14N33
    - Skyland-Cave Rock-Lincoln Creek Frontal, Road 13N78

- Tahoe Vista-Griff Creek,16N86, 16N87
- Watson Creek- Carnelian Frontal, 16N73

II.4.b Trails Decommissioning and BMP Upgrades Monitoring

Implementation Monitoring Question:

Has the implementation of Trail Decommissioning and BMP Upgrades reduced the potential for water-quality impacts?

Effectiveness Monitoring Question:

What impacts do forest trails have on sediment loading to Lake Tahoe, and how successful are BMP retrofits and decommissioning in mitigating those impacts?

During 2006, trails were monitored using a protocol similar to that used to evaluate forest roads. A total of 10 miles of trail were monitored on Christmas Valley (2 miles, pre-project), Hartoonian (1 mile, post-project), Lam Watah (1 mile, pre-project), and Power Line Trails (6 miles, post project).

Preliminary examination of post project monitoring results for 2006 indicate a reduction in potential erosion and sediment delivery to streams flowing into Lake Tahoe. For example: Prior to BMP implementation, 243 linear meters of the Powerline Trail were hydrologically connected to Heavenly Creek. Drainage dips were installed which eliminated connectivity. As a result, overall connected length of trail decreased from 203 meters to 40 meters which significantly reduced potential erosion and sediment transport.

Monitoring staff are currently planning trails monitoring for the 2007 field season. Trail data collected in 2007 and all previous years will be analyzed and reported in an interim progress report in the spring of 2008.

II.4.c Off-Highway Vehicle (OHV) Program Monitoring

Implementation Monitoring Question:

What is the potential for soil loss on OHV routes, and what are the current maintenance needs?

Because of staffing shortages in the Engineering program, no funds were procured for this program through the State of California OHV grant program. Therefore, this monitoring was not conducted in 2006. Grant funds are expected to be received in 2007 and this monitoring program will pick up again in the 2007 field season.

II.4 Urban Erosion Control Grant Program Monitoring

Effectiveness Monitoring Question:

What is the effectiveness of specific urban stormwater treatment best management practices (BMPs) in treating particulates, fine sediments, and dissolved nutrients?

The LTBMU Erosion Control Grants program has awarded grant funding to local governments for Comprehensive Urban Runoff Treatment Effectiveness Monitoring (CURTEM) since 2000. The resulting projects focus on evaluating the effectiveness and

feasibility of various stormwater treatment BMPs, including but not limited to sediment source control, dry detention basins, constructed wetlands, mechanical treatment structures, and chemically enhanced BMPs. The final reports for these monitoring projects contribute to our understanding of the effectiveness of current BMPs for treating stormwater runoff pollution. In 2005 a consultant was contracted to review and synthesize the methods and results of the CURTEM reports submitted to date. The goal of the report was to provide a synthesis of the existing science presented in these studies, on the performance of a suite of BMP treatment techniques employed around the Tahoe Basin. It was hoped that this synthesis would inform better design and implementation for future monitoring programs and urban stormwater BMPs. Some of the key findings from this report are provided below.

Key Findings, Lake Tahoe BMP Monitoring Evaluation Process – Synthesis of Existing Research (2nd Nature, October 2006):

- The study identified a current problem with the discontinuity between stormwater pollutant reduction goals and our ability to track and measure the benefit of current BMP solutions to achieve those goals. There is a need to standardize monitoring practices, the constituents analyzed, and interpretation and presentation of results so that the findings of BMP effectiveness monitoring can be compared, compiled, and utilized more effectively to inform erosion control project design and stormwater treatment modeling efforts.

- One common issue with all of the treatment types analyzed was maintenance, or lack thereof. The lack of proper maintenance for several of the BMPs reviewed led to difficulties in determining their effectiveness, inconsistencies between BMPs of different "ages", and poor reported treatment effectiveness. Below are the results of the synthesis report for detention basins, constructed wetlands, and mechanical treatment structures.

- Water quality treatment associated with **dry detention basins** occurs as a result of particle settling, soil/water interactions due to infiltration, and vegetation nutrient uptake. The dry detention basins analyzed were found to provide the following benefits to stormwater quality treatment.
    - Reduced flow velocities, increased water storage time, and enhanced capture of particulate pollutants such as sediment and nutrients,
    - Reduced total suspended sediment (TSS) concentrations,
    - Reduced TKN and particulate phosphorus,
    - A significant physical impact on groundwater flow dynamics,
    - Vertical soil column was effective at retaining and removing hydrophobic hydrocarbon contaminants, and
    - Only potentially detrimental impact to shallow groundwater quality is where stormwater concentrations of nitrate are elevated, or where stormwater is routed directly to the shallow groundwater without sufficient soil interaction.

  In addition, these systems are more effective with greater surface area to volume ratio (i.e. greater soil/water interactions and pollutant retention potential), and greater depth to groundwater. Reductions in TSS and nutrient concentrations resulting from dry detention basin treatment were found to be greater with increased influent concentrations, and there appears to be an effluent limit below which detention basin

structures cannot provide a treatment benefit to dissolved and/or biologically available nutrients.

- **Constructed wetlands, wet retention basins, and natural meadows** were also reviewed for their effectiveness at treating urban stormwater. The key pollutants of concern for wetland treatment are dissolved nutrients. These BMPs remain inundated for a much greater portion of the year, and the fraction of water loss via infiltration is less than a dry basin due to higher localized shallow groundwater tables, finer sediment grain size distribution at the base of the BMP, and reduced soil permeabilities. The following treatment benefits were reported for these BMPs.
  - Dissolved nitrate and ammonium reductions,
  - Dissolved phosphorus treatment from wetland BMPs was variable, but reductions were measured in several wetlands studied,
  - Organic N is more difficult to consistently remove because of high rates of organic production in a wetland environment,
  - Perennial baseflow conditions enhance oxygenation and contribute to consistent reductions in dissolved N and P species,
  - Wetland vegetation may provide a greater dissolved nutrient treatment to stormwater with relatively low sediment loads, and
  - Extended complex flow paths enhance sediment and particle retention, especially during larger runoff events.

- **Mechanical stormwater treatment systems** consist of engineered flow through structures. These typically require a small footprint and involve below-ground installation, therefore eliminating common surface area coverage issues. The following are some highlights of the compiled results for mechanical treatment structures.
  - Vault structures were successful at retaining high fractions of event sediment loads and reducing TSS event mean concentrations (EMC),
  - Biologic activity within vaults is a likely contributor to occasionally increased N loads released from organic material trapped and decomposing within,
  - Some mechanical treatment structures showed substantial load reductions for all constituents monitored, and others resulted in little to no outflow from the structure suggesting complete pollutant and stormwater reductions,
  - The sediment trap was less effective at treating dissolved N species, appearing to be a net source of DKN, NOx, and DP over the duration of the study. This, and the net increase measured in TSS mass load during several of the monitored storms, was attributed mostly to the lack of adequate cleaning and maintenance.

  Finally, little treatment of dissolved N and P can be expected from a mechanical structure that performs physical separation of material, so where dissolved nutrient loads are a concern, secondary treatment BMPs should be implemented downstream of these features.

- **Low intensity chemical dosing (LICD) of coagulants** was studied for its ability to increase the size of fine particles in the system, thus increasing the mass and associated settling velocities of particles in standing waters. Below are some preliminary findings from the LICD report.

- Coagulant treated stormwater exhibited one to two order of magnitude increases in the average particle settling velocities compared to the untreated control, leading to immediate reductions in turbidity and TP,
- Residence times of stormwater retention structures could be an order of magnitude shorter in systems treated with coagulants, and the effluent will be more likely to satisfy water quality objectives for turbidity and TP,
- Some coagulant dosing increased ecotoxicity, however the untreated stormwater itself was found to be toxic under several of the toxicity metrics used, and
- The greatest toxicity risk of LICD with the selected coagulants would be from increased aluminum concentrations in the system, and these effects will be more pronounced with reductions in pH.

II.5 Meyers Landfill Monitoring and Maintenance

Implementation Monitoring Question:

1) ***Does the administration of the Meyers Landfill hazardous waste clean up site meet mandatory health and safety standards and environmental regulatory standards?***

Effectiveness Monitoring Questions:

2) ***Does the Meyers Landfill hazardous waste clean up site pose a significant threat to drinking water sources?***

3) ***What is the extent of the plume of ground-water contamination originating from the Meyers Landfill?***

The Meyers Landfill site (MLF) is a closed municipal landfill located on Federal land that is administered by the Forest Service. In the mid-1990s contaminants in groundwater aquifers were identified as originating from the site. The primary Constituent of Potential Concern (COPC) is vinyl chloride.

The site is currently administered under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA). A Remedial Investigation and a Feasibility Study (RI/FS) has been initiated to characterize the nature and extent of risks posed by hazardous waste on site and to evaluate potential remedial actions. Multiple litigation actions have been initiated by Potentially Responsible Parties (PRP).

An Administrative Record file containing site related information is available for public review at the Supervisor's Office, Lake Tahoe Basin Management Unit.

Monitoring which occurred in 2006 included on-going ground water investigations focused on delineation of the contaminant plume and better understanding of site specific ground water flow characteristics **(GeoMatrix, 2006)**. This monitoring includes collection and analysis of ground water samples from monitoring wells and the injection of a bromine tracer to help determine gradient, direction and velocity of subsurface flow. These activities were to provide data used in decisionmaking with regards to a remedial design for an existing treatment facility. The contaminant plume extends approximately1600 feet north of the landfill and is advancing downgradient very slowly but the velocity has not been fully

determined. Results of the bromine injection were found to be inconclusive as this tracer did not arrive in downgradient monitoring wells as predicted.

Development of a Remedial Investigation and Feasibility Study (RI/FS) was the primary (MLF) activity in 2006 for the landfill cap and is currently nearing completion. A Record of Decision (ROD), signed in 2007, established the remedial technology, outlined in the RI/FS.

II.8 Watson Creek Water Quality Monitoring

Cause and Effect Question:

Have road retrofits and forest health treatments in the Watson Creek drainage had a measurable change in Watson Creek water quality?

The LTBMU recently completed an analysis of water quality data collected between 1996 and 2001. This analysis had not been completed previously primarily due to staffing shortages. Water Quality was monitored from 1990 to 1994 during the Watson Creek Salvage Timber Sale. Preliminary review of this data indicated that the timber sale activity had negligible effects on water quality. Monitoring on Watson Creek began again in 1996 because of planned forest health treatments. In actuality, only 50 acres were thinned in 1999 in the Dollar 11 timber sale. Road decommissioning and Best Management Practice (BMP) upgrade projects were implemented from 1998-2000 in the Watson Creek watershed, with actual construction primarily occurring in August and September of these years. The two sites monitored were located above and below some of the described management activities. However about half of the roads receiving BMP upgrades were located above the upper monitoring site.

Key Findings from Watson Creek Water Quality Monitoring Report, Water Years 1996-2001 (Norman and Valentine, 2007)

- The state standard for total phosphorus (.15 mg/l annual average) was exceeded every year from 1996 through 2001 at sites both above and below the treatment area. Total nitrogen was exceeded at the Lower site in 1997 and at both sites in 1999. However, the magnitude of this increase over state standards falls within the standard deviation of the data. Data collected by both the LTBMU and the Tahoe Research Group indicate that the standard for total phosphorus is frequently exceeded even in relatively undisturbed watersheds. No other applicable state standards were exceeded.

- The results of this analysis indicate that the management activities in the Watson Creek watershed appear to have had negligible effects on water quality. Water quality constituents were generally higher at the lower site then the upper site, but this was true for pre-project years as well as post project.

- It is difficult to measure the impact of one ground disturbing or restoration project in a watershed over time, let alone several different projects of varying types and level of impacts. We recommend that future monitoring efforts carefully consider the ability to isolate discrete project impacts, and consideration of monitoring strategies that do not rely on water quality data (such as BMP evaluations, soil

quality monitoring, and macro-invertebrate sampling). No future monitoring is recommended at these sites or for the projects described in this report.

Chapter III
Aquatic, Meadow, and Riparian Ecosystems

Monitoring associated with aquatic, meadow, and riparian ecosystems primarily includes status and trend biological monitoring. In addition, hydrologic function (floodplain connectivity, sediment transport regimes, and channel stability) and biological monitoring (wildlife habitat and species) are conducted to evaluate the success of ecosystem restoration efforts. And finally, range monitoring is implemented at grazing allotments that are located within meadow and riparian ecosystems. Hydrologic function monitoring described under this resource area is also closely linked to the Lake Tahoe clarity resource area. Restoring hydrologic function (reconnecting channels to floodplains) results in multiple ecosystem benefits, including reducing stream channel erosion, increasing fine sediment deposition and nutrient uptake within the floodplain, and improving conditions for many riparian plant and animal species.

III.1 Aquatic Amphibian, Reptile and Plant Status and Trend Monitoring

III.1.a Aquatic Multi-Species Inventory and Monitoring

Status-and-Change Monitoring Questions:

What is the current status of aquatic amphibians, reptiles and habitat condition at lentic sites throughout Lake Tahoe Basin and how have populations or habitat conditions changed?

What are current habitat/environmental associations of amphibians/reptiles in the Lake Tahoe Basin?

No comprehensive surveys for aquatic amphibians and reptiles were conducted throughout the Lake Tahoe basin during 2006. Results of the most recent survey effort 2002-2004 (Manley and Lind, unpublished report 2005), reported in last year's 2005/2006 Monitoring Program Annual report are being used to assist in the development of a Tahoe basin-wide long-term biological resources monitoring and evaluation program.

III.1.b Aquatic Associated Plant (Fen) and Animal (MYLF) TES Status and Trend Monitoring

Status-and-Change Monitoring Questions:

What is the current status of mountain yellow legged frog populations in the Lake Tahoe Basin and how are they changing over time?

What is the current status of special status aquatic plant communities and associated TES plant species (fens,bogs, marshes)?

Mountain Yellow Legged Frog

LTBMU aquatic biologists assessing special status amphibian community status in the Lake Tahoe Basin. Annual vertebrate encounter surveys (VES) for mountain yellow legged frogs at the known population site in the headwaters of Trout Creek have been conducted in 2001,

2002, 2004, and 2005 and 2006. We are still in the process of developing an effective protocol to monitor populations that does not result in undo stress on this fragile population.

Additional surveys were conducted in Desolation Wilderness during the 2006 field season to determine future opportinites to expand a source population found in Lake Aloha, located on the El Dorado National Forest. Another small populations was detected in a small pond near Cagwin Lake, although this is considered to be very poor habitat due to the small size and shallow depth of the pond.

Surveys and analysis for genetic makeup and Chytridiomycosis, an infectious disease that affects amphibians worldwide, also began in 2006. Results from UC Berkeley determine that Chytridiomycosis is found in the Trout Creek population. Genetic samples, from toe clips, were taken from the Trout Creek population and from the Aloha population. Because these efforts began late in the season when frogs are more difficult to locate and the small population size in Trout Creek, only one toe clip was taken from each location. These surveys will continue in 2007.

Mountain yellow legged frog survey results from 2006 are presented below.

Key Findings, Mountain Yellow Legged Frog Surveys (Sarah Muskopf, LTBMU Biologist, 2007)

- One adult, 5 subadults, and 15 larvae were detected in July 2006 in the headwaters of Trout Creek. The population seems to be declining in comparison to the 36 sub adults found in 2005 (which was the greatest number of sub-adults detected across the past five years of survey data).
- MYLF were detected in a small pond near Cagwin Lake in Desolation Wilderness, however this is not considered to be good habitat due to the shallow depth. The pond contained approximately 10-15 tadpoles and 3 adults. Survey efforts will continue in 2007 and potential fish removal is planned for 2008.

Fen Assessment

In 2006, The LTBMU botany program became involved in the R5 fen assessment to determine the presence and type of fens present primarily in forests within the Sierra Nevada region. The goal of the assessment is to provide data for a regional conservation assessment to be completed in 2008. During 2006 aerial photographs were used in combination with ArcMap software in order to identify 180 potential fens on LTBMU land. Three fen assessments were completed, which brings a total of five known fens within LTBMU. The five fens currently known include, Grass Lake, Hell Hole, a fen located off Armstrong Pass trail in Meadows, Angora Restoration Project, and Bear Glade located in High Meadows. Data from fen assessments was entered into the regional fen geodatabase, which will aid in the conservation assessment. During the 2007 field season a target goal of 25% of the 180 potential fens will be visited and assessed.

Within the fens assessed, one additional location of *Meesia triquetra* and *Meesia uliginosa* were located at the Angora Restoration Project fen. Because, the restoration project caused disturbance to the fen, four 15 meter transects were set up to monitor the cover of *Meesia*. These transects were installed in order to detect a change in *Meesia* cover that could be

associated with management actions within the area. Monitoring was completed June 6, 2006. It will be repeated in early June of 2007 and then again in 2008. If the percent cover of *Meesia* does not change more than 25% then monitoring will end. If at any point there is a 25% change in *Meesia* cover then management action to prevent the drainage of the fen will need to occur.

Sphagnum species were identified from known fens. Currently LTBMU known species include: *S. tenellum, S. squarrosum,* and *S. lescurii*. Additional species are expected to occur as more sites are visited.

The LTBMU botany program initiated an effort to assess the presence and extent of two special status aquatic-associated moss species (*Sphagnum spp. and Meesia triquetra*) in Grass Lake at Luther Pass during 2004 and 2005. Additionally, in 2005, botany staff revisited pilot monitoring plots established in 2004 at six threshold plant community sites: Taylor Creek, Pope Marsh, Osgood Swamp, Hell Hole, Grass Lake, and Freel Peak. Photo monitoring was also established at Grass Lake. Data collected on the six threshold plant communities within the Tahoe Basin were entered into both Excel and a meadow condition program. Data have not yet been analyzed and further monitoring will not occur until data are analyzed and monitoring plans are complete. Future monitoring depends on whether the outcome of the P7 and Forest Plan Revision process result in continued interest in these particular plant communities.

III.2 Range Allotment Monitoring

Implementation Monitoring Question:

Are USFS range utilization standards and State fecal coliform standards being achieved at the Baldwin Grazing Allotment?

During the 2006 grazing season, two herbaceous utilization transects were measured using Region 5 Landscape Appearance Protocols, streambank trampling was measured at one key area using the Streambank Alteration Point Method (approximately 40% of the area surveyed was enclosed with temporary fencing to exclude grazing), and fecal coliform was measured at three locations: upstream of all grazing pressure (control sample), directly downstream of the private in-holding, and at the downstream end of the allotment, near the mouth of Tallac Creek.

Additionally, willow flycatcher surveys were conducted on the Baldwin Grazing Allotment to determine occupancy and success of two historic and currently occupied nest sites, to comply with standards set in the Sierra Nevada Forest Plan Amendment Record of Decision (2004). Results of the willow flycatcher nest occupancy and success monitoring will be reported in the 2006/2007 report produced for this project (see section III.3.d).

Key Findings, Letter to Permittee (Marceron, 2007)

- None of the herbaceous utilization transects in grazed pasture areas met herbaceous utilization standards according to the guidelines of 40% [maximum] utilization set by the SNFPA Record of Decision. Pasture D and E were closed for the season because range readiness surveys indicated unfavorable soil moisture conditions. Transect results for the two grazed pastures were as follows: pasture B was 73%, pasture C was 80%.

- Of the 3 locations sampled for fecal coliform during the grazing season, only the "control" site, placed above grazing influence, met the state standards throughout 2006 (40 colonies per 100mL). Fecal coliform levels at the other two sampling locations below the grazing allottment exceeded state standards while utilized by stock animals. Lahontan Regional Water Quality Control Board intends to issue a Notice of Noncompliance. Fecal coliform concentrations have exceeded standards annually since 1999 for this allotment.

- Streambank trampling measurements did not meet the standard for maximum trampling, although more than 40% of the stream was protected with temporary fencing. It is suspected that horses were entering the stream from the left bank, which was not fenced, and crossing the stream. Additionally, in the portion of stream on the right bank that was not fenced, livestock disturbance occurred.

III.3 Aquatic, Meadow, and Riparian Ecosystem Restoration Monitoring

A variety of ecosystem elements are monitored as part of the effort determine the effects and effectiveness of restoration projects in aquatic and riparian ecosystems. These include physical components related to geomorphology and habitat, as well as biotic components including fisheries, macro-invertebrates, and wildlife species monitoring.

III.3.a USFS Hydrologic/Geomorphic Restoration Monitoring

Implementation Monitoring Question:

Are state sediment and turbidity standards being achieved during the first three years post-construction, for channel restoration projects?

Effectiveness Monitoring Question:

To what degree have restoration efforts been successful in restoring floodplain connectivity, stabilizing stream banks, and re-establishing natural sediment transport regimes?

Blackwood Creek Channel Restoration

The Blackwood Creek Channel Restoration is a three-phase project designed to enhance and restore stream and floodplain function. Phase I was the removal of the grade-control structure (a.k.a. the "fish ladder") and rehabilitation of the associated stream channel. Phase II was the replacement of the Barker Pass Road crossing and rehabilitation of associated stream channel and floodplain. Phase III (currently undergoing a redesign) will restore channel and floodplain function downstream of the Barker Pass Road, and restore flows to a section of historic channel upstream of the fish ladder.

Phase I, removal of the fish ladder and construction of a sequence of step pools and riffles, occurred in 2003. Phase II, construction of a new bridge, floodplain, and stream channel where Barker Pass Road crosses the creek, occurred in 2006. Phase III is currently scheduled for implementation in 2008.

Photo points were established at the Phase I: Fish Ladder in 2003, and have been repeated annually. Installation of photo points at the Phase II: Bridge Replacement occurred in 2006. Sampling for macro invertebrates was initiated at all restoration sites in 2004, and repeated in 2005 and 2006 (see section II.3.d for more details). Pre-project wildlife trend surveys in support of Phase III restoration actions were conducted from 2004 thru 2006 (see section III.3.c for more details). A monitoring plan for Phase III restoration was completed in 2006, but will need updating pending completion of the Phase III redesign; additional parameters may be included as part of a joint effort between the LTBMU and LRWQCB to develop the Blackwood Creek TMDL.

Visual observations and turbidity sampling conducted during the construction of Phase II: Bridge Replacement in 2006, documented some short term impacts to water quality. These are described in the Key Findings section below.

Installation of permanent cross sections and a survey of the longitudinal profile at the Phase I and Phase II sites will be conducted in 2007, to document post construction channel adjustments. This monitoring protocol had not been effectively implemented at the Phase I site previously.

Key Findings, Phase II: Bridge Replacement Implementation Monitoring (Personal Communication, Craig Oehrli, Restoration Project Leader, May, 2007)

- Construction activities at the Phase II site triggered the release of ground water into the creek, from the excavation of a 10-15 ft deep trench along the footprint of the bridge. This action lowered the local ground water table, causing surface flow at the upstream end of the construction site to cease, and stranding the diversion pipe structure designed to transport surface water around the site. These conditions induced seepage flow (~1 CFS) along the upstream wall of the trench. Additionally, excavation activities at an area located below the bridge on the left bank of the side channel triggered the release of 0.5CFS of ground water. The two flows overwhelmed the sediment control BMP's at the downstream end of the project site, designed only to accommodate storm flow periodically. Recognizing the problem, Forest Service officials met with LRWQCB staff and agreed to installation of additional BMPs to control sediment discharge. These efforts included:

    - Placement of additional sand bags to raise the outlet elevation of the cofferdam and increase settling times in the two sediment basins.
    - Installing a series of silt fences across both channels, downstream of the control basins, to treat water exiting at the downstream end of the project site.
    - Pumping to distribute water evenly between the two catch basins

- Even with the added BMPs, turbidity in excess of 4 NTU (25% above a reference turbidity level of 3 NTU) occurred periodically. Turbidity measures at the outflow point ranged between 9 and 20 NTU. These violations occurred daily during construction activities over a five-week period. Typically, turbidity problems did not begin until early afternoon, usually about 5-hours after daily construction activities commenced. Then turbidity levels would fall back below violation levels approximately 2-hours after construction activities for that day ceased. Therefore, turbidity violations occurred in a 1.5CFS flow over a 4-hour period, five days a week,

for five weeks. Turbidity fell back below the violation level as the fines settled out of the water column, at a distance of 200 to 400 feet below the site. Once the channel was constructed, turbidity at the outflow point returned to reference levels and no known violations have occurred since.

Lonely Gulch Project

The goal of the Lonely Gulch rehabilitation project was to stabilize a reach of Lonely Gulch creek that was exhibiting a high degree of bank instability as a result of excessive wind throw in a forest stand in poor condition along the channel banks. The project implemented in 2002 included the removal of excessive downed logs, the obliteration of an old road segment next to the channel, and the installation of grade-control structures. A monitoring plan was established to evaluate the effectiveness of restoration measures, and to ensure that significant adverse impacts to water quality did not occur as a result of restoration activity.

Two water quality sampling sites, measuring discharge, sediment, and turbidity, were established above and below the site in 2002, as well as photopoints. This data has been collected annually through 2006 which constitutes the final year of data collection for this project. Cross sections were established in 2003, and retaken in 2004 and 2006. Macroinvertebrate data were collected once, in 2003.

A final report is being prepared that presents the results of these monitoring data. The findings below are from a draft of that report. The final report will be available on the USFS website later this summer.

Key Findings - Draft, Monitoring Report for Lonely Gulch Watershed Restoration Project (Brill, USFS, 2007)

- Water quality data do not indicate any pulse in sediment and turbidity as a result of project activities, and values were well below state standards for the period of record.

- Cross section measurements and photopoints indicate that the project was largely successful in stabilizing the stream channel. Some lateral adjustment has occurred, probably during the December 2005 flood. However, flows have not outflanked any of the rock and log grade control structures.

- Macroinvertebrate data indicates that Lonely Gulch metric scores ranked in the top 20% of the 172 sites sampled basin-wide in the same year.

Taylor Creek and Tallac Creek

Taylor Creek and Tallac Creek jointly support a large wetland complex adjacent to Lake Tahoe that is both a popular recreation area and an important wildlife and rare plant habitat. Rehabilitation planning will be focused on identifying an appropriate balance between human use and the natural values of the site. Pre-project ground-water monitoring was initiated in 2002. This monitoring included the installation of ten piezometer sites in the Tallac wetland area along Tallac Creek and adjacent to Baldwin Beach. In 2003, these sites were measured 14 times. In the summer of 2004, these sites were measured 12 times and an additional 5 piezometers were installed. These sites were measured only six times in 2005,

because restoration program staff resources were diverted to implementation work midway through the year. These data were collected to establish a baseline in order to assess the effectiveness of potential future rehabilitation efforts. A full season of ground-water data was collected in 2006 (12 samples at each site) in order to capture the effects of this above-normal water year. These data indicate that groundwater was near the ground surface or within one foot of the ground surface for much of 2006. During drier years, the lowest levels of groundwater recorded within this area were 6 feet below the ground surface, with most values measured between 2 to 5 feet below the ground surface. Baseline groundwater data will be collected again in 2007. Future groundwater monitoring will be dependent on proposed restoration efforts, still to be determined.

Cookhouse Meadow Restoration Project

The Cookhouse Meadow Restoration Project was designed to raise ground-water table levels, reduce seasonal ground-water fluctuations, reestablish over-bank flooding, and reestablish natural sedimentation patterns by abandoning the existing incised channel and constructing a new channel with characteristics of a Rosgen "C" channel type. New channel construction was implemented in 2005. In the summer of 2006, flow was completely diverted from the old channel to the new channel. A series of earth dams were constructed to block tributary flow from entering the old channel and to create a series of ponded areas that fill from intercepted groundwater.

During the field analysis phase in 2003, ground-water levels and streamflows were monitored, meadow plant community surveys were conducted, macroinvertebrate data were collected, and wildlife resources were inventoried. Photo points were also established in 2004 to provide a visual record of change and continue to be monitored annually. The only monitoring conducted in 2005 was as built surveys, groundwater wells, wildlife surveys, and macroinvertebrates in the old channel.

In Spring 2006, the *Cookhouse Meadow Restoration Monitoring Plan* was finalized and post implementation monitoring is scheduled through 2010. The LTBMU conducted the following monitoring protocols during 2006; installation of channel cross sections to monitor geomorphic performance in the new channel, installation of three Weixelman plots to measure response of the plant community to elevated ground water levels, sod bank monitoring (second season), macroinvertebrate surveys (1st season, new channel), groundwater levels (2nd season), wildlife surveys (see section III.3.c), low scale air photo, and photopoints (3rd Season).

In addition, the Lahontan RWQCB required that turbidity measurements be collected after channel flow was diverted to the new channel. This monitoring was required to continue until it could be established that turbidity fell below the pre-project background level of five NTUs.

Below are key findings from the turbidity sampling that occurred during construction once flows began in the new channel, as well as visual observations.

Key Findings (Personal Communication, Craig Oehrli, Restoration Project, May 2007)

- Turbidity levels exceeded 5-NTU during three periods of channel construction after the tributary flow was diverted from the old channel to the new channel. First, introduction of water into the new channel at the upstream end generated a flushing of sand and fines. A series of in-channel holding ponds trapped much of this sediment; however, NTU's of between 11 and 15, in a 1.5 CFS flow occurred at the outtake of the new channel over approximately a 3 to 6 hour period. Second, completion of channel construction at the downstream end elevated turbidity. This occurred when the crew introduced flow into the final 20-foot section of channel. Turbidity levels in a flow of 1 CFS rose to 20NTU for 1-hour period and returned to background levels 1 hour later. Third, during removal of the culvert and construction access road fills in the new channel. Turbidity levels in a flow of 1 CFS rose to 15NTU at the outtake of the new channel for 3-hour period and returned to background levels after the 4th hour. No violations occurred thereafter, and turbidity sampling ceased.

- December 31, 2005 flood flows breached the native sod plug where the two channels meet at the downstream end of the project site. Deposition of sand and fines from flood flows overland occurred and deposited on the bed of the new channel. Trapping of this sediment occurred in coarse particle interstitial spaces on the new streambed and very little (estimated to be less than 0.5 yd^3) may have entered Big Meadow Creek.

Cold Creek/High Meadows Project

The acquisition of the High Meadows property by the Forest Service was finalized during the winter of 2003. A pre-project baseline water-quality monitoring effort was initiated during the late spring of 2003. Two water-quality sites were established on Cold Creek, one immediately below the Meadow (43-21) and one at the lower LTBMU property boundary (43-22). Samples obtained at these sites were analyzed for a full complement of sediment and nutrient water-quality parameters. Twenty-six samples were taken at each site in 2006, starting on March 15 and ending on November 8. Roads within the Cold Creek watershed were assessed in 2004 using the Water Quality Risk Assessment Protocol. Road upgrades and a channel restoration project is scheduled for 2009. Macroinvertebrate samples were also collected during the summer of 2005 and 2006, as a part of baseline pre-project monitoring. A pre-project fisheries population survey was also conducted in 2006. The monitoring plan will be finalized in 2007.

Marlette Dam Removal and Restoration Project

In August 2003, the U.S. Forest Service removed an earthen dam on the South Fork of Marlette Creek in an effort to restore channel morphology, hydrologic functions, and riparian vegetation, and to improve fisheries habitat and water quality. Two water quality monitoring sites were established in 2002 for pre-project monitoring, one above the dam (24-2E) and one below the dam (24-2D). Discharge, turbidity, and suspended sediments were measured at these sites. Water samples were collected in 2003, but were not collected in 2004 except for August and September. In 2005 and 2006, 22 water-quality samples were collected at each site, starting on March 15 and ending on September 28. Effective cover transects have been measured from 2002 through 2005. Cross-section measurements and photopoints were taken in 2003 through 2006.

In July 2004, monitoring staff noted that the northern tributary to the South Fork of Marlette Creek had begun undercutting the restored streambanks. In addition, down-cutting of approximately 6 to 18 inches in the channel substrate was observed. In response to these observations, the Restoration Field Crew re-contoured the streambanks, planted sod, and installed coconut matting for erosion control. In the winter of 2006, an interim report was completed using data and observations collected in 2005 to evaluate the success of these attempts to stabilize the channel. This report noted some continued channel adjustments, however most of the channel appears to have responded well to stabilization attempts. The results from the final monitoring report for this project are presented below.

Key Findings from Draft Final Monitoring Report for Marlette Creek Dam Removal and Restoration Project (Loupe and Norman, 2007)

- Cross section data from 2006 indicate some minor channel adjustments continue to occur within the reach, resulting in a relatively minor amount of lateral movement of the channel and scour. However, several transects also indicate that deposition has also occurred, and several of the transects indicate virtually no change from 2005.

- When comparing the differences between the above and below dam water quality sampling results for pre- and post-project, the dam removal seems to have resulted in increased suspended sediment concentrations and turbidity values. However, pre-project data was not collected at the same frequency as post project data (spring flows not well represented in pre-project data), and pre-project data collection occurred during dry years, post project during wet years. These issues make comparisons of pre- vs. post-project sediment yield for this creek very difficult, and these circumstances should be considered when reviewing the results contained in the report.

- Management recommendation is to maintain annual visual and photo point monitoring of the channel, including an existing head cut, to determine whether the channel will stabilize or degrade.

III.3.b Fisheries Restoration Monitoring

Status-and-Change Monitoring Questions:

What is the current status of native and non-native fish and aquatic macro-invertebrates in the following five stream systems with future planned restoration activity: Upper Truckee, Big Meadow, Blackwood, Taylor and Tallac Creeks and Cold Creek?

What is the current status of warm-water invasive fish species (species and extent of invasion) in Lake Tahoe and associated wetlands?

Effectiveness Monitoring Questions:

Does periodic physical removal of brook trout effectively reduce brook trout long –term abundance in the Meiss Meadow reach of the Upper Truckee drainage?

What is the most effective hatch box design for producing healthy Lahontan Cutthroat trout fry in Glen Alpine Creek?

The Ecosystem Department is planning stream channel restoration projects in the Upper Truckee, Blackwood, Taylor.Tallac, and Cold Creek watersheds to improve fisheries habitat, hydrologic connectivity to floodplains, and stream channel function. During 2006, the Aquatic Program staff collected data on aquatic macro-invertebrates (using R5 protocol) in these priority streams to establish pre-restoration status of stream macro-invertebrate communities, and on the status of native or non-native fish. LTBMU Aquatics staff have conducted surveys on warm-water fish invasions in the upper Taylor Creek drainage and in the Tahoe Keys (reviewed available CDFG data) in order to identify species present and the need for future removal efforts. Summary findings have been produced with regard to warm water invasive species status at this time, and are presented below. A contract with University of Nevada, Reno to conduct a warm water invasive fish species assessment and invasion model for Lake Tahoe and associated wetlands is still underway and will be completed in 2007.

The Ecosystem Department also conducts annual restoration efforts contributing specifically to Lahontan Cutthroat Trout (LCT) recovery in the Tahoe Basin. As part of an annual effort initiated in collaboration with California Department of Fish and Game (CDFG) in 1989, LTBMU continued electroshock efforts during 2006 in the Upper Truckee Drainage to eradicate non-native brook trout in order to reduce competition and potential predation with LCT. Additionally in recent years (2003-2005), LTBMU has attempted to raise fertilized LCT eggs in hatch boxes in Glen Alpine Creek so that resultant fry, upon release, would imprint on Glen Alpine Creek and return to spawn there in the future. The ultimate goal of the effort is to develop a sustainable, spawning population of LCT in the Fallen Leaf watershed. Lahontan Cutthroat hatch box project for the summer of 2006 yielded a success rate (number of eggs that hatched) of approximately 72%, compared to a 25% success rate in 2005. The different design of the hatch boxes and lower flow through the boxes definitely aided in the increased survival rate of the eggs.

Only some of these data have been summarized in final report format while others are summarized based on draft reports and analyses. Results will be summarized in conjunction with a future effort to develop an index of biological integrity (IBI) for streams using the macro-invertebrate data.

Key findings, Effectiveness of Brook trout removal (CDFG, 2006):

- Brook trout removal appears to be effective at reducing numbers of brook trout in the Upper Meiss meadows area of the Upper Truckee drainage. Estimated numbers of adult and juvenile brook trout based on captures/removals from electroshock efforts are quite variable, but appear to be declining after annual removal efforts began in 1996. In 2006, only 2 male brook trout from the same age class were captured in Meiss meadow, suggesting that the population is on the verge of being eradicated. Surveys/removals will continue for the next 2 years to insure complete removal.

Key findings, 2006 LCT Report (Shemai, 2006)

- Lahontan Cutthroat hatch box project for the summer of 2006 yielded a success rate (number of eggs that hatched) of approximately 72%, (17,000 out of 24,000) compared to a 25% success rate in 2005. The different design of the hatch boxes and lower flow

through the boxes definitely aided in the increased survival rate of the eggs. Unless the intakes got knocked out of the water, stopping the gravity feed, flow was always constant keeping fresh water circulating through the boxes. Through further research we found that the flow was actually too high through the boxes. The eggs, while still green, should have very little flow running over or through them. Too much movement early on in the egg stage was the main reason for mortality in 2005.

Key findings, 2006 Warm-water invasive fish Report (Shemai, 2006)

- Beginning in May of 2006, efforts have been made to research the distribution of warm water non-native fish species. These neo non-natives include largemouth bass, bluegill, black crappie, white crappie, goldfish, and brown bullhead catfish; which have all been identified to date in the Tahoe Keys Marina. Thus far, smallmouth bass have not been sighted or caught during electrofishing events.

- Fifteen locations were monitored bi-weekly from 11 May through 06 November 2006. Some localities contain more than one site; for example, 4 sites are surveyed within Tahoe Keys. To date 9 of the 15 localities contain warm water non-natives; 3 locations are along the northwest shore, 2 on the west shore, and 4 on the south shore. In lieu of their widespread distribution it is apparent these fish are capable of spreading along the littoral zone. Marinas and embayments that contain non-natives have elevated water temperatures (Figure 1) and in some cases aquatic vegetation like Eurasian milfoil or curly leaf pondweed that provide prime habitat. Based on snorkeling observations and electrofishing Tahoe Keys, Taylor Creek, and Meeks Bay have the greatest abundance of warm water non-native species. Numbers of warm water non-natives outside of the 3 sites mentioned above are significantly lower and may be easily managed or possibly extirpated at these locations.

- Electrofishing within Tahoe Keys and Taylor Creek occurred in May, June, August, and September.. Native to non-native fish captured during electrofishing appear to be inversely proportional. September was a partial sampling effort due to a clogged fuel line on the boat. From our fish shocking and snorkeling observations the total length size ranges for each non-native warm water fish is as follows: Bluegill range from 5.5-16.5 cm; largemouth bass range from 5.0-45.0 cm; black crappie range from 12.0-36.0 cm; and brown bullhead catfish range from 10.2-34.0 cm. Most of the larger fishes in these ranges are found in the Tahoe Keys. Largemouth bass and the bluegill have the most extensive geographic range with the brown bullhead following close behind. Brown bullhead catfish were present in Taylor Creek, Tahoe Keys, Lakeside, and Ski-Run Marina. Black crappie has yet to be sighted outside of Tahoe Keys.

III.3.c Riparian Terrestrial Wildlife Restoration Monitoring

Status-Trend Monitoring Question:

What are existing conditions for wildlife at restoration project sites and how might they help us identify opportunities for improving ecological conditions at restoration sites?

Effectiveness Monitoring Question:

How effective will the restoration efforts by LTBMU staff be at restoring ecosystem function within the project areas to achieve the desired historic conditions for wildlife species?

Four meadow and three creek systems within the Lake Tahoe Basin are in various stages of planning for restoration of ecosystem function; and one additional meadow system (Cookhouse meadow) was recently restored during summer 2006. Monitoring wildlife before and after restoration is useful for evaluating the success of restoration, and for guiding future restoration projects. In 2006 surveys were conducted for birds, reptiles and amphibians, owls, bats, small mammals, medium to large mammals, and butterflies at the following restoration project sites and accompanying reference sites (reference sites are in parenthesis): 1. Cookhouse Meadow (Grass Lake), 2. Big Meadow (Grass Lake), 3. Meeks (General) 4. Blackwood (McKinney), 5. Ward Creek (Burton Creek), and 6. Taylor/Tallac Marsh (Truckee Marsh), 7. Upper Truckee Marsh (Truckee-Trout Marsh) and 8. High Meadows (Fountain Place). These surveys are conducted to (i) assess relative abundance of wildlife species prior to restoration activities and (ii) establish baseline wildlife data to assist with developing desired conditions and (iii) to use in post-project evaluations.

Surveys have been conducted at each of the restoration project sites and control sites in varying capacities over the past several years based on funding availability and anticipated project implementation. Control sites are used to help identify if changes observed on project sites are due to restoration activities. The exact number of years desired for pre- and post-project monitoring of wildlife species and population metrics is not yet known, however, these ongoing surveys are intended to inform us about this and other recommendations for status and trend monitoring design.

Data have been summarized from all sites monitored within the Basin, and for all years monitored, in the following two 2006 reports which are available upon request: 1) Restoration and wildlife inventory and monitoring within meadow complexes in the Lake Tahoe Basin (Borgmann et al., 2006) Restoration and wildlife inventory and monitoring within six creek complexes in the Lake Tahoe Basin (Borgmann et al., 2006). Some key findings from these reports are presented below.

Key Findings from Restoration wildlife monitoring reports (Borgmann et al., 2006)

Butterflies:

- Surveys at restoration and control sites detected more butterfly species (59 species detected at meadows and 50 species at creeks) than have been detected in previous efforts in the Tahoe basin. These surveys provide baseline data for meadow/creek systems in the basin.
- Important host plant species for focal butterfly species in meadow and creek sites include: western asters, wandering daisy, pussy paws, yarrow, clover and bistort.

Amphibians and Reptiles:

- Species richness was fairly low at restoration and control sites; two of the most frequently encountered species were the western terrestrial garter snake and the pacific tree frog, detected at 66% of sites.
- Surveys conducted for amphibians and reptiles (e.g., Visual encounter surveys) were considered inadequate for trend monitoring. Additional sampling protocols or more

intensive sampling may be needed to adequately sample reptile and amphibian populations for trend monitoring at restoration and control sites.

Owls:

- Cavity nesting owl species richness and number of detections were fairly low across restoration and control sites, the most commonly detected species at restoration and control sites were the northern saw-whet and great horned owls, both of which do not have highly specialized habitat preferences.
- Due to low detection frequencies, population estimates for owls were not possible. Limited owl detections may be due to initiating surveys after the peak of the breeding season, therefore, surveys should and will occur earlier in the season in future efforts.

Songbirds:

- Birds detected at restoration and control sites were primarily common species, with very limited detections of species associated with wet meadows (e.g., Yellow Warbler and Willow Flycatcher) at meadow and creek sites.
- Notable trends observed in bird abundance
    - Two cavity nesting species declined in abundance from 2004-2006, potentially indicating that the availability of suitable nest sites (cavities and/or snags) may have diminished and deserve attention.
    - Four wet-meadow associated species also declined in abundance, causes for decline in these species are unknown, but may include lack of sufficient deciduous shrub cover for nesting sites, cowbird nest parasitism and increases in vertebrate predation pressures.
- Cowbirds were present at most restoration and control sites. Brood parasitism rates by cowbirds were particularly high (>30%) and of concern in terms of their impacts to host songbird species at the following sites: McKinney Creek, General Creek, Taylor Marsh, Tallac Marsh and Grass Lake.
- Predation risk appears to be more influential to the nest success of focal songbird species than vegetation elements (e.g., foliage cover), suggesting that productivity metrics must be monitored if improvements in ecological conditions specific to focal songbirds are to be measured.
- Preliminary analyses suggest that small mammal nest-predators may be most responsible for low songbird nest survival rates.

Bats:

- Little brown bats and silver-haired bats occurred regularly throughout restoration and control sites, similar to historic records.
- Detection frequencies of bats were not sufficient to estimate trends in species abundance or occurrence.
- Little is known about the habitat needs of bat species in the Lake Tahoe basin, and intensive studies to locate and quantify roosting and maternity sites using radio telemetry are needed.

Small Mammals:

- Large fluctuations in small mammal capture rates were observed from 2004-2006, and were likely linked to winter/spring conditions during these years.
- Two species associated with wet-meadow conditions were noticeably absent or in low abundance at restoration and control sites (broad-footed mole and long-tailed vole) during 2004 and 2006. This suggests a lack of sufficient meadow wetness at restoration sites, a condition targeted for restoration at most restoration sites.

- Pocket gophers were not detected frequently at meadow restoration or control sites, despite being recorded as the second most frequently occurring species among aquatic-riparian-meadow associated sites in a recent study (Manley and Schlesinger 2001); reasons for this are being explored, including whether the trapping methods employed were appropriate for detection of this fossorial species
- Yellow-pine chipmunks, often indicative of disturbed site conditions, were detected at the greatest abundances at the Blackwood restoration site relative to other restoration and control sites.
- The highest small mammal diversity was observed at High Meadows restoration site and it's associated control, Fountain Place.

Recommendations for Restoration Design

- Promote a diverse array of native trees and shrubs within the understory to mimic the structural diversity associated within healthy riparian communities, focusing in areas where natural regeneration is limited.
- Create conditions that will result in an increase flowering herbaceous ground cover focusing on plant families associated with focal butterfly species.
- Plant vegetation in a clumped arrangement rather than in a uniform design.
- Retain old trees with existing cavities, and provide for recruitment of trees that can be managed as snags.
- Create gradual transition zones between habitat types by planting early successional species along transitions between habitat types.
- Maintain wet conditions across 75% of meadow until at least 1 August in selected meadow areas.
- Develop willow thickets (and associated shrub species) $\geq$2-m tall occupying 5,000 feet^2 (0.1 acre) per ha.

III.3.d. Restoration Macro-invertebrate Monitoring

Cause and Effect Monitoring Question:

Are stream channel restoration practices effective in improving water quality and the biological condition of stream systems, as measured by a Benthic macro-invertebrate Index of Biological Integrity (B-IBI)?

The LTBMU has been collecting Benthic macro-invertebrate samples related to planned and active restoration projects within Blackwood Creek, Cold Creek and Big Meadow Creek and Lonely Gulch since 2003. The purpose of this monitoring is to 1) characterize pre-project baseline Benthic macro-invertebrate community composition and habitat conditions, 2) improve LTBMU's ability to monitor and detect change in biological conditions after the project, especially for trends over time, and 3) to compare pre- and post-restoration data to the Tahoe Basin B-IBI (see below). None of these data have been analyzed and reported previously. During the summer of 2006, pre-project data were collected at Cold Creek, Big Meadow Creek, and four sites at Blackwood Creek. Post project data were collected at one site at Cookhouse Meadow. Post project sampling is scheduled annually for five years after the completion of a restoration project.

The Tahoe Regional Planning Agency (TRPA) and the Forest Service, contracted Statistical Design, to analyze existing data in order to assist in the development of index of biological

integrity specific to the Lake Tahoe Basin (Fore 2007), also called multi-metric index (MMI). Based on Fore (2007) results, the LTBMU and partner agencies are collaboratively developing a basin-wide status and change (trend) monitoring program to assess biological conditions and water quality of Lake Tahoe's streams.

The following are key findings for a report prepared this spring to summarize the pre-project data collected to date, as well as interim results for post-project sampling.

Key findings, Draft Macro-invertebrate Monitoring to Evaluate Restoration Project Effectiveness, 2006 Report (Brill and Shemai, 2007)

- In Big Meadow Creek (Cookhouse Meadow Restoration Project), samples were collected in 2001, 2003, 2004 in the old channel, and early 2006 in the old channel for baseline data. Later in 2006, one post-restoration sample was collected in the new channel one month after the flow was diverted from the old channel into the new channel. The immediate post-restoration result showed a strong "imbalance" in the macro-invertebrate community structure in the new channel. In 2006, the multi-metric score was 76.3 in the old channel before flow was diverted, and after the flow was diverted to the new channel the score was 16.7 in the new channel, with *Simuliidae* (blackfly) dominating the community by 91%.. It is expected the multi-metric score will improve in the new channel over time.

- In Cold Creek (High Meadow Restoration Project), samples were collected in 2003, 2005, and 2006 for baseline data. The multi-metric score 76.9 in 2003, 49.5 in 2005, and 79.4 in 2006. The 2005 score was low because the sample contained an insufficient sample size (136 bugs, which did not meet the 500 minimum number of bugs required to score). Pre-project sampling will continue in Cold Creek until the restoration begins in 2008

- Blackwood Creek was sampled in 2003, 2004, 2005, and 2006 at all four sites (control, fish ladder, Barker Road bridge, and downstream). The control site, which is upstream from the project area of Blackwood Creek had a high MMI score of 95 in 2006.

    - The fish ladder site improved since the restoration including the removal of fish ladder in 2003. There is no pre-restoration data but MMI score show improvement from 25 in 2003 to 51 in 2006. We expect to see post restoration monitoring to continue to show improvement for the next couple of years.

    - Barker Road bridge and the downstream site show a flat trend from 2003 to 2006 with the score averaging 32 for Barker Road bridge and 30 for the downstream site. The Barker Road bridge was replaced in the fall of 2006, therefore, post restoration monitoring will begin in 2007, and repeated for the next 5 years. Pre-restoration monitoring will continue for the downstream site until the phase III restoration begins in 2008.

- Lonely Gulch restoration took place in 2003 and macro-invertebrates were sampled shortly after the completion of the restoration project during the same year. Lonely Gulch received a score of 80.7 out of 100. When compared to other 172 sampling sites that were sampled in the Lake Tahoe Basin in 2003, Lonely Gulch MMI score placed in

the top 20%. This indicates that the restoration did not have a negative impact on the stream condition and that the stream condition is good. No other macro-invertebrate sampling has occurred in this stream

III.4 Water Rights Program Monitoring

Status and Change Monitoring Question:

What is the current status of Forest Service water rights in the Lake Tahoe Basin in terms of compliance with state laws and regulations?

The Forest Service is required to protect water rights owned by the United States on National Forest System (NFS) lands. Our goals are to ensure the water rights are maintained in accordance with State forfeiture or abandonment laws and regulations, water is applied to the purpose of use and in the manner specified in the water right permit, license, or decree, and water use is monitored under special use authorization. The Forest Service began its water rights field verification program during the summer of 2004 to ensure that all water rights are being put to the stated beneficial use and all documents are updated and recorded in NRIS (Natural Resource Information System). During the summer of 2006, field verification was completed on 47 Forest Service water rights. To date, 66 water rights have been field verified out of the total existing 162 water rights. These water rights were considered to be the highest priority for verification and focused on FS facilities such as day use areas, campgrounds, resorts operating under special permits, and visitor centers.

Key Findings, Water Rights Status Report December, 2006 (Brill, 2006)

- Of the 47 domestic water rights that were field verified during the summer of 2006, 5 water rights in Nevada and 22 water rights in California are no longer being put to the beneficial use stated in the permit or license. Changes to the beneficial uses for these water rights will submitted to the state agencies (to instream fish/wildlife enhancement) in 2008.

- Future work will include field verification of 43 recreational cabin (permittees) appropriative water rights, 43 recreational cabin (permittees) reserved water rights, 2 municipal appropriative water rights, 3 erosion control statement water rights, 1 fire protection appropriative water right in California and 5 surface water rights in Nevada. Field verification of all existing LTBMU water rights is expected to be completed by the end of 2008.

Chapter IV
Old Forest Ecosystems and General Forest Ecosystems (includes WUIs)

In order to engage in a more comprehensive monitoring strategy for the Lake Tahoe Basin Management Unit, the Ecosystem Conservation Department has broadened its scope of monitoring biological resources. In addition to the regional TES species monitoring historically conducted in the Lake Tahoe Basin, efforts focusing on biological resources have been implemented to provide better information on the overall health of the Basin's biological resources, the impact of various restoration activities in restoring habitats and populations, and the effects of ecosystem fragmentation and other anthropogenic disturbances.

IV.1 Terrestrial Multi-Species Inventory and Monitoring

Status-and-Change Monitoring Questions:

What is the current distribution and status of terrestrial vertebrates and associated habitats throughout the Lake Tahoe Basin Management Unit?

Which indicator species or metrics are strong representatives of forest condition?

Which habitat associations were observed for "focal" wildlife species in LTBMU?

Effectiveness Monitoring Questions:

What is the most effective and efficient strategy for multiple species monitoring and monitoring of biological integrity in Lake Tahoe Basin?

- ***What are the most efficient protocols for detecting vertebrate species, focal species, and habitat conditions?***
- ***What are the recommended sample size and monitoring metrics to be used for a long-term multi-species monitoring program?***
- ***What are the expected costs of future monitoring activities?***

The Multi Species Inventory and Monitoring (MSIM) Project was a comprehensive forest-wide multiple species inventory and monitoring effort intended to establish baseline conditions for a wide range of wildlife, plants and their habitats within the Lake Tahoe Basin Management Unit (LTBMU) and to inform the development of a long-term status and trend monitoring and evaluation program. This effort marks the first attempt to evaluate MSIM monitoring protocols (originally developed for the Sierra Nevada Forest Plan Amendment, (USDA 2001) in terms of their ability to monitor changes in population metrics (e.g., site occupancy and abundance) for groups of species at the forest-wide scale based on empirical data.

The primary objectives of this project were to:

- Establish baseline status of wildlife, plants and their habitats in the Lake Tahoe basin, including many species of concern
- Evaluate the effectiveness of the project design for long term status and change monitoring
- Determine whether there are species or species groups that can serve as biological indicators for long-term monitoring

- Identify wildlife habitat relationships

The project was implemented in the Lake Tahoe basin, in California and Nevada, from 2002 to 2005. Eighty-percent of the land area in the basin is managed by the US Forest Service - Lake Tahoe Basin Management Unit; approximately 180,000 acres. The Lake Tahoe basin contains the largest alpine lake in North America and is located on the east–west boundary of 2 major biogeographic provinces. The basin encompasses an elevational range from 2000 to nearly 3500 m (6229 to 10881 ft).

Seven terrestrial wildlife, plant and habitat sampling protocols were implemented at 105 representative sites on national forest lands throughout the Lake Tahoe basin (forest-wide network), and 3 aquatic vertebrate and habitat sampling protocols that were implemented at 148 representative lake, pond and meadow sites throughout the basin (lentic-aquatic network).

Site occupancy (or proportion of sites occupied) and average abundances (for some species groups) were calculated to describe current population status of wildlife and plant species. Probability of detection (or detectability) was the metric used to evaluate the effectiveness of MSIM protocols for detecting species targeted by each protocol. Sampling adequacy and short-term changes (i.e., annual) in site occupancy were also evaluated to assist in forming recommendations for the sampling design of future long-term monitoring.

A final report was completed this year but the key findings are too extensive to present in this annual summary. The full report is posted on the LTBMU public website. The recommendations from this report are presented below.

Recommendations ,Multi-Species Inventory and Monitoring Final Report, Roth et al., 2007

Monitoring Design and Protocols

Overall design

- Monitoring should be designed for maximum flexibility over time, meaning it is able to adapt to changing species of concern and interest, changing landtype and planning unit delineations, and even changing vegetation types (conversions of white fir stands back to Jeffrey pine).
- The spatially stratified random sampling design used in this project facilitates the use of the data in a diversity of applications useful to management, thus it is recommended that this type of design be retained as the core of a future basin-wide monitoring program.
- The proportion of sites occupied by individual species highly influences the statistical power to detect population change over time. Further evaluation of pre and post-stratification options for improving statistical power through changes in proportion of sites occupied is recommended. Post-stratification should be used in lieu of pre-stratification whenever possible to maximize flexibility in applications of the dataset.
- Additional monitoring sites should be allocated to habitats/strata with few samples in the MSIM dataset, (e.g., wetlands, marshes, riparian, lower montane forests) if future monitoring is intended to detect and monitor the complete assemblage of species in the Tahoe basin, primarily in reference to birds and plants.

- Incorporate non-USFS land ownership types in the sample of monitoring sites, and form partnerships with other agencies and land owners to develop a comprehensive monitoring plan for the entire Tahoe basin.
- Retention of all or most of the existing MSIM sites in future monitoring designs will enable change detection with the next round of data collection.

Animal species

- At a minimum only species with high probabilities of detection (> 80% chance of being detected when present) should be considered for incorporation into a monitoring program and as potential indicators of ecosystem integrity.
- Bird point counts, small mammal trapping, and baited camera and trackplate stations yielded valuable and reliable information for three major species groups. These survey protocols provide data on species with a breadth of life history characteristics, habitat associations, and trophic levels. They are recommended as core elements in the future monitoring program.
- Raptor surveys were not evaluated as part of MSIM, but they represent an important component of the forest ecosystem. Existing single-species surveys should consider expanding the suite of species solicited during surveys, such as the full suite of owl species occurring in the basin.
- One comprehensive survey protocol, acoustic surveys for bats, should be considered for inclusion into a monitoring program as the technology progresses (e.g., capability for more accurate identification of individual species).
- Consider a stratified sampling scheme (with known probability of selection) for aquatic-associated amphibians, targeting known occupied sites and other sites to improve precision of estimates of occupancy and population size and statistical power to detect change.
- Retain some documentation of fish occurrence and relative abundance as part of aquatic monitoring programs.
- Integrate lentic, lotic and forestwide monitoring programs so that monitoring data on biota can be combined to provide a more complete picture of distribution, occupancy, and population status for species that use both types of aquatic habitats.

Plant species and vegetation

- Keep the basic design used in MSIM to retain consistency with the nationwide Forest Inventory and Analysis program (FIA), but add quadrat sampling along additional transects to improve detection probabilities for herbaceous species (thereby improving accuracy of composition and richness metrics).
- Include some measure of fine fuels (< 3 inch diameter) in vegetation measurements in response to concerns about fire risk and threat.
- Utilize measurements of plant frequency (e.g., number of occupied quadrats) in leui of estimates of cover at individual sites as the primary monitoring metric when suitable to meet program monitoring objectives for plants; frequency measures proved to be less variable and more powerful for detecting change.
- The frequency of occurrence, range of conditions, or variability of particular vegetation variables (e.g., coarse woody debris, tree/snag densities, etc.) should be considered potential metrics in addition to the standard “average” for a vegetation or wildlife habitat monitoring program. Habitat variability at many scales is important to the biological integrity of a functioning ecosystem.

Additional data analysis opportunities

- Evaluate statistical power of detecting changes in the various richness and abundance components of the recently proposed Index of Biological Integrity-IBI (Manley and McIntyre 2006) with various levels of sampling effort.
- Estimate detectability (i.e., probability of detection) and sampling adequacy for species in riparian ecosystems (based on an existing dataset) to determine if riparian habitats are a suitable strata for monitoring population status of species not well sampled at either terrestrial or lentic aquatic sites as determined in this project.
- Evaluate the proportion of the landscape and each vegetation type exhibiting various levels of old growth characteristics, and use these results to derive desired conditions for old growth in the basin.
- Generate reference conditions for primary habitat characteristics in each major vegetation type, and again use these results to derive desired conditions for wildlife habitats in the Tahoe basin.
- Explore how MSIM and Forest Inventory and Analysis (FIA) data can be used to improve vegetation mapping in the basin using state-of-the-art statistical techniques for assigning vegetation characteristics to landscape pixels being developed and tested by the FIA program.

Adaptive management: monitoring the monitoring program

- Develop an analysis plan as part of the future monitoring strategy that specifically identifies remaining uncertainties and how new monitoring data can be used to reduce uncertainties and improve monitoring.
- Validate estimates of statistical power and sample size requirements as soon as possible as monitoring progresses.
- Evaluate the statistical power and sample size requirements of trend analysis as an alternative to change analysis as soon as monitoring progresses and sufficient repeat observations exist at monitoring sites.

Information gaps

- A decision support mechanism has yet to be designed and tested as part of a forest-wide monitoring strategy. Decision support tools are critical part of monitoring programs in that they typically require explicit documentation of assumptions and uncertainties associated with the selection and interpretation of monitoring metrics, and identify how managers and decision makers can use monitoring results to inform management.

IV. 2 TES and Threshold Wildlife Species Monitoring

Status-and-Trend Monitoring Questions:

What is the status and trend of presence and what is the reproductive status of identified TES species in the Sierra Nevada?

What are the status and trend of species composition and richness for wetland birds, and is the TRPA standard for 18 sites with occupancy being met?

LTBMU Wildlife Staff in cooperation with other federal, state, academic and private organizations conduct an ongoing status and trend monitoring program for the following TES species: California spotted owl (*Strix occidentalis occidentalis*), northern goshawk (*Accipiter gentili*s), osprey (*Pandion haliaetus*), willow flycatcher (*Empidonax traillii*), and bald eagle (*Haliaetus leucocephalus*). In 2006, LTBMU personnel and cooperators monitored a total of 25,920 acres of California spotted owl habitat; 21,787 acres of northern goshawk habitat, 15,807 acres of suitable osprey habitat including 132 nest sites, 26 locations for bald eagle, and multiple willow flycatcher territories.

Key Findings, 2006 Annual Wildlife Monitoring Report (Lyon, 2006)

California spotted owl - The LTBMU and its partners detected a total of 14 individual spotted owls in the Lake Tahoe Basin in 2005: down from 16 detected in 2005. Five territories were active in 2006: down from nine detected in 2005. Fewer spotted owl pairs were detected in 2006 than in 2005 (3 versus 6). The number of territories where reproductive activity was detected and where juveniles fledged increased from zero in 2005 to one in 2006. The number of young fledged increased from zero in 2005 to three in 2006.

Northern goshawk - The number of individual northern goshawks detected in 2006 was greater than in 2005 (40 versus 36 total) and the number of active territories in 2006 increased compared to 2005 (26 versus 23). The number of territories where reproductive activity was detected declined compared to 2005 (5 versus 10). Similarly, the number of territories that successfully fledged young declined from 9 to 3 over the same period. Finally the number of juveniles fledged in 2006 is less than in 2005 (7 versus11).

Osprey - The 2006 survey effort was similar to that in 2005. In 2006, LTBMU and its partners detected 40 osprey nests (versus 33 in 2005), 25 active nests (versus 22 in 2005), and 8 fledged juveniles (versus 15 in 2005).

Bald eagle - The number of wintering bald eagles detected during the 2006 count was less than in 2005 (7 versus 18). Adult bald eagles were detected on the northern and eastern shores of Lake Tahoe. The nest in Emerald Bay was the only active nest observed in the Lake Tahoe Basin, and fledged two juveniles. This nest has been active in six of ten years between 1997 and 2006 and successfully fledged an average of 1.5 juveniles in those six years.

Wetland Birds - Surveys for wetland birds were conducted from 1999 through 2004. However, in 2005 and 2006 no wetland bird surveys were conducted due to a lack of funding and the need to revise the protocol for future seasons.

Willow flycatcher – As part of this Central Sierra study, 14 sites were surveyed throughout the Lake Tahoe Basin. Willow flycatchers were detected at four of these sites (in Antone Meadow, Blackwood Canyon, Tallac Creek, and at the Uppermost Upper Truckee site). Antone Meadows is the first known detection in recent history of this species on the north shore of Lake Tahoe. The number of detections in 2006 relative to 2005 changed as follows: territories decreased from 7 to 5, adults decreased from 8 to 7, nests decreased from 5 to 1, successful nests decreased from 2 to 0, and the number of juveniles fledged decreased from 5 to 0.

IV.3 Threatened Endangered and Sensitive (TES) Plant Species Monitoring

Status-and-Trend Monitoring Question:

What is the status and trend of TRPA rare plant community richness at threshold sites?

Cause-and-Effectiveness Monitoring Questions:

How effective is the LTBMU Tahoe yellow cress outplanting project at increasing the population of Tahoe yellow cress in the Lake Tahoe Basin?

How effective is the transplanting of Tahoe draba to protect individuals and maintain population size?

Status-and-Trend Monitoring Question:

What is the status and trend of TRPA rare plant community richness at threshold sites?

LTBMU botany staff, in cooperation with other federal, state and county agencies and non-governmental organizations, monitor TES plant species and six rare plant community threshold sites on a regular basis.

Six Tahoe Regional Planning Agency rare plant community threshold sites originally set up in 2004 were monitored in 2005 for status and trend of species richness and have not yet been analyzed. No monitoring occurred in 2006. These six sites were distributed among three fens (Grass Lake, Hell Hole, Osgood Swamp), a marsh (Pope Marsh), a meadow (Taylor Creek) and a cushion plant community (Freel Peek).

In August 2006, the Global Observation Research Initiatives in Alpine Environments (GLORIA) with the help of the Forest Service established three plant monitoring plots on Freel Peak and surrounding ridges. The monitoring plots extend from the summit down to a ten meter elevation contour line. The plots will be read every five years to monitor the trend of the Freel Peak cushion plant communities through time and changing conditions.

Tahoe yellow cress (*Rorippa subumbellata*) monitoring consisted of monthly effectiveness monitoring of container-grown plants outplanted at 11 sites around Lake Tahoe from 2003 through 2006. In 2006 1,175 plants were outplanted at 7 locations bringing the total outplanting number to 7,500 plants.

Key Findings: Executive Summary, Draft Annual Tahoe Yellow Cress Report (BMP Ecosciences, 2006)

- In 2006, during the annual survey period the first week of September, the lake level (6,228 feet LTD) was three feet higher than the previous year. Earlier in June, the lake reached the maximum permissible elevation (6229.1 ft) established by Federal Court Decree. Consequently, the number of occupied sites was cut in half by 24 and these sites supported less than one quarter of the stems from the previous season. Nevertheless, for the fifth consecutive year, Tahoe yellow cress is at Level 1 of the

Imminent Extinction Contingency Plan as defined in the Conservation Strategy (Pavlik *et al*. 2002a). Level 1 is indicative of a stable or increasing population trend.

No monitoring was conducted on Tahoe draba (*Draba asterophora var asterophora)* and Cup Lake draba (*Draba asterophora var macrocarpa)* in 2006. The LTBMU continues to support research by the Denver Botanical Garden on propagation and germination of Tahoe draba, which may lead to an effective transplant strategy.

Tahoe draba seed was collected at Mount Rose Ski Area and germinated at the Denver Botanical Gardens. There was no germination of seed in native soil shipped to the garden and a nine percent germination success rate of seeds in horticultural soil mix.

Approximately 200 plants from the Mt. Rose Bonanza Ski Run were transplanted in pots in July 2004 prior grading. These were over-wintered at the May Arboretum, Reno. Sixty two plants were placed back on the run in July 2005. A nine percent success rate (seventeen plants) is reported in September, 2006.

Tahoe draba and Cup Lake draba genetic research conducted by Brigham Young University in 2005 and 2006 is continuing in 2007. No genetic determinations have been made at this time.

IV.4 Aspen Restoration Wildlife Monitoring

Status-and-Change Monitoring Question:

What is the current status or condition of aspen stands in Lake Tahoe Basin, with particular attention to avian and small mammal community composition?

Effectiveness Monitoring Question:

Is aspen restoration effective at restoring expected avian and small mammal communities within aspen stands in Lake Tahoe Basin?

In 2004, the LTBMU initiated a study to: (i) review the status of wildlife associated with aspen stands in Lake Tahoe Basin, (ii) quantify the species richness and abundance of birds and rodents in aspen stands scheduled for restoration through the removal of conifer, (iii) make recommendations on the specific restoration treatments to be applied to the stands, (iv) monitor the response of birds and rodents to aspen restoration, and (v) make recommendations for large-scale application of aspen restoration in the Basin.

Avian point count surveys and small mammal trapping surveys were conducted by a contractor within eleven aspen stands (one stand was added compared to previous years) in 2006. These data constitute the third year (2004, 2005, and 2006) of monitoring. The cumulative results have been summarized in a final report; and key findings addressing objectives (i) and (ii) and a preliminary discussion of objectives (iii) ad (iv) are presented below. We plan to continue the study in 2008 and thereafter to fully address objectives (iii), (iv), and (v).

Key Findings, 2006 Report, Avian and Small Mammal Communities in Aspen Stands in Lake Tahoe Basin (Borgmann, Groce, and Morrison 2006)

- Status, Species Richness, and Abundance:
    - The avian community in aspen stands was characterized by few (~4-6) relatively abundant bird species and ~15-20 additional species.
    - Woodpeckers that prefer deciduous trees relative to other forest stands were infrequently observed across the arrays; especially the red-breasted sapsucker and downy woodpecker. Additional work is necessary to determine why abundances of these species are low.
    - Results with regard to birds inhabiting the herbaceous-shrub layer still remain unclear. Some herbaceous-shrub inhabiting species were abundant (e.g., MacGillivray's warbler and Wilson warbler), but others were rare (e.g., Lincoln's sparrow and orange-crowned warbler). Further investigation to understand what may be limiting some herbaceous-shrub nesting species is recommended.
    - Cowbirds were present in most aspen stands surveyed. Additional evaluation of nesting success in aspen stands is needed to determine the extent to which nest parasitism by cowbirds is occurring, and whether cowbird control measures would be recommended.
    - The small mammal community species richness remained constant from year to year, though capture numbers varied. The variation in capture numbers is not unusual; small mammal populations often show large annual fluctuations.
    - The same five of 19 focal species; including the northern flying squirrel, long-tailed vole, yellow-pine chipmunk, Douglas squirrel, and western jumping mouse, were detected in each year of the study.

- (Preliminary) Management Recommendations :
    - Low- to moderate-intensity burning in and around aspen areas that mimics natural fire regimes would perpetuate aspen communities, by improving soil conditions and eliminating encroaching conifer saplings (however, not recommended in stands with high fuel loading).
    - Mechanical or hand removal of encroaching conifers using subsequent pile burning with caution (may kill aspen roots) to increase regeneration of aspen.

- (Preliminary) Response to Aspen Treatment:
    - Avian species richness did not differ within one year of treatment, although a focal species (red-breasted sapsucker) was discovered following treatment.
    - Avian species abundance increased for some species (e.g. MacGillivray's warbler and dusky flycatcher).
    - Small mammal species richness did not differ within one year of treatment.

IV.5 Urban Lot Biodiversity Project

Effectiveness Monitoring Question:

> *What are the effects of anthropogenic habitat fragmentation and disturbance on wildlife, plants, and habitat conditions within urban lots and the wildland urban interface?*

The urban lot biodiversity project was a collaborative effort between the Lake Tahoe Basin Management Unit, Sierra Nevada Research Center (Pacific Southwest), University of Nevada, Reno (UNR) and University of California, Davis. This project was designed to

better understand the effects of forest fragmentation and human disturbance on measures of biological diversity across an urbanization gradient and to document how urban lots purchased by the USFS and other agencies contribute to Lake Tahoe's biological diversity.

Field data were collected during dryer months between 2003 and 2005 on birds, small mammals, large mammals, ants, and plants. Analysis of the data and report writing was conducted between fall 2005 and spring 2007. Data and results of this project contributed to the Pathway 2007 collaborative forest and regional planning effort as well as provided insight into which biological metrics could be used to effectively track biological integrity of terrestrial ecosystems.

Key Findings of the Final Report (Manley et al. 2007; *The Role of Urban Forest in Conserving and Restoring Biological Diversity in the Lake Tahoe Basin*).

- Landscape modeling of various development scenarios (existing, infill 50%, infill 100%, etc) indicated that the quality of habitat in support of various measures of biological diversity will decline. A determination of whether this decline is significant is still needed
- Results showed that urban forest parcels support a rich array of native plant species, where more exotic species detected in more developed areas than less developed sites. Bird and ant species richness declined in more developed locations and where human activity was higher, but small mammal richness did not respond as strongly.
- Some small mammals appear to respond positively to moderate levels of development, as do a number of large mammals typically associated with areas of human habitation. However, most large mammals were negatively impacted by development, with forest carnivores and their allies particularly affected.
- Recreational use increased with development, but many areas with low development also got high use. Unrestrained dog prevalence was high everywhere, but in developed areas more were restrained.

Considerations and Recommendations Resulting from this Research:

- Many of the opportunities/recommendations revealed from this research include those that deal with improving our publics' understanding of how their land use affects biodiversity on public lands and how modifying their behavior can reduce impacts. Education/outreach opportunities resulting from this research primarily deal with noxious weeds and the control of domesticated pets. Education materials that deal with different issues should be provided in both Spanish and English (and potentially other languages depending on public land visitation patterns).
- Agencies responsible for the rate of urban growth and/or urban design should retain or incorporate policy to 1) improve education of forest users and home owners, 2) support the purchase urban parcels (especially riparian areas and areas that connect areas of open space), 3) retain important habitat features such as brush, snags and downed woody debris where fire and hazardous condition can be mitigated, 4) actively remove and treat areas infested with noxious weeds, and 5) retain existing land coverage standards by capability type.
- The retention of key habitat features on urban parcels can have a positive influence in maintaining many native species that would otherwise decline. The research recognized a need to balance reducing fuel loads and maintenance of snags, downed

woody debris, and shrub cover on urban lots. Additionally, reducing trail density while providing well-designed trails for forest access along with encouraging forest users to maintain control of dogs will benefit native wildlife diversity in and around urban areas.

- Reduce the extent of non-system roads and trails surrounding neighborhoods where appropriate. Provide logical and well-designed loop trails that discourage the creation of non-system roads and trails, especially in the vicinity of areas with high biological diversity, rare habitats, and areas that support sensitive species. Provide education/interpretation signage at trailheads to encourage users to stay on trail and to keep dogs under control.
- The report's results provide a number of variables (metrics) that could be used to assess environmental conditions in the Lake Tahoe basin. Biological response variables (e.g., abundance of different bird species) could assist the Forest Service in understanding to what extent desired conditions are being achieved at urban lots as well as for other areas the are not influenced by urban development. The results demonstrated reference conditions that should be expected in relatively undeveloped areas, and thus important for managers attempting understand to what extent are management activities are affecting biological integrity of Tahoe's forests.

Chapter V
Noxious Weed Monitoring

Status-and-Trend Monitoring Question:

What are the status and trend of the number of acres of noxious weeds located adjacent to roads, trails, and along the wildland/urban interface within the Lake Tahoe Basin?

Effectiveness Monitoring Question:

How effective are the efforts by LTBMU staff at reducing the number of acres of noxious weed infestation in Lake Tahoe Basin?

The LTBMU noxious weed program, in coordination with other federal, state and county agencies and non-governmental organizations, conducts both effectiveness monitoring of treated infestations and status and trend monitoring of noxious weed primarily around roads, trails, and along the wildland/urban interface within the Lake Tahoe Basin. This monitoring began in 2002 and has thus far inventoried 20% of the roads, trails, and wildland/urban interface within the Basin for noxious weeds.

Results from 2006 monitoring are presented in the 2006 Botany Year End Accomplishment Report. Key findings are presented below.

Key Findings, 2006 Botany Year End Accomplishment Report (Reed, 2006)

- There were a total of 82.61 gross acres and 4.64 infested acres of invasive weeds documented in 2006. Gross area decreased by by 40.45 acres (33%) since 2005, and infested area decreased by 2.71 acres (37%) as a result of treatment.

- Basin wide status and trend monitoring discovered 78 new infestation sites, increasing the total number of weed sites from 256 to 334 (an increase of 30%). Bull thistle (*Cirsium vulgare*) continues to be the most prevalent weed.

Chapter VI
Fire and Fuels Monitoring

A variety of monitoring efforts were implemented to evaluate the impacts of fuels reduction activities on ecosystem components such as soil quality, water quality, fuel loading, vegetation structure and diversity, and wildlife habitat.

VI.1 Programmatic Fuels Reduction Project Soil Monitoring

Effectiveness Monitoring Question:

What effects are fuels reduction projects having on soil characteristics that can affect runoff, erosion, and water quality?

To quantify the impacts of fuels reduction projects on soils, the LTBMU began monitoring these projects in more detail in 2005. A Soil Quality Monitoring Plan (Norman and Christensen, 2006) was developed to measure pre- and post-project soil characteristics that include saturated hydraulic conductivity, bulk density, soil cover, and soil disturbance. Primary soil characteristics such as saturated hydraulic conductivity and bulk density are measured to estimate the amount of compaction and the associated reduction in soil porosity as a result of fuels reduction projects. Measured soils characteristics are used in the Watershed Erosion Prediction Project (WEPP) Model to predict potential runoff and erosion impacts from changes in soil parameters.

In 2005 pre-project data was collected in the Twin Crags project. Post project data was not collected initially because only partial implementation of the project occurred in 2006. In addition it was determined that the application of the protocols used for the pre-project Ksat sampling were fundamentally flawed and will not allow statistically reliable comparison of pre-and post project results. Therefore post project sampling will not occur at this site.

In 2006 pre- and post-project data were collected at Ward Unit 5 (116 acres) located south of Tahoe City. This unit was treated using innovative "cut-to-length" (CTL) technology with a low ground pressure (6-13 psi). A total of 67 pre-project samples located along three transects were collected, 10 of which were located on native surface roads. Post-project samples were collected in adjacent locations along the same transect. Of the 67 post-project samples, 54 were located in the general CTL area, 6 were along native surface roads, and 7 were located in the landings. The results of this pre-project monitoring were analyzed in the Ward 5 Soil Monitoring Report (Christensen and Norman, 2007) and are summarized below.

Key Findings from Pre-Project Fuels Reduction Project Soil Quality Monitoring, Ward Unit 5. (Christensen and Norman, 2007)

- Median saturated hydrologic conductivity (Ksat), a surrogate for infiltration capacity, was 4.64 inches/hour at undisturbed sites before treatment and 3.70 inches/hour for the general CTL area. This difference (of 20%)was significant at P=0.126.

- Mean soil bulk density at the 6-10 inch depth was 0.835 gm/cm^3 for pre-project undisturbed sites and 0.880 gm/cm^3 for post-project CTL sites. This difference was statistically significant at P=0.047, and represents approximately a 2% decrease in porosity. The largest observed increase in soil bulk density (decrease in porosity) was

approximately 5% for areas that became landings. The Regional threshold for reduction in soil porosity is 10%.

- There was no appreciable change in the percent of ground cover or the depth of ground cover for pre- and post-project, and median cover was 100%. The type of ground cover changed from predominantly duff, needles, and decaying wood to coarse slash, generally under three inches in diameter, scattered over the relatively undisturbed pre-project duff layer. The regional standard for ground cover is 50%.

- Methodologies for collecting and analyzing quantitative data for many Regional soil standards (soil productivity, soil hydrologic function, soil buffering capacity) have not yet been developed. Therefore, the LTBMU will continue to focus on Ksat and soil cover measurements to provide meaningful information regarding impacts to soils from fuels reduction treatment activities.

- The measured soil properties described above were used in the Water Erosion Prediction Project (WEPP) model to compare sediment and runoff prediction between pre- and post-project conditions. The model used a 20-year climate simulation based on recorded weather data from Tahoe City, CA. Three separate hillslope profiles were modeled. The predicted average annual increase in sediment yield for the 20-year simulations was approximately 0.1 ton/acre/year. Pre-project sediment yield rates were predicted at 0.8 tons/acre/year compared to 0.9 tons/acre/year post-project.

VI.1.a Heavenly SEZ Demonstration Project Soils Monitoring

Cause and Effect Monitoring Question

What are the impacts of low impact mechanical equipment used to reduce fuels, on soil quality characteristics of land classified as SEZ?

The Heavenly Creek SEZ Demonstration Project will test the use of low impact mechanical equipment to reduce fuels in 23 acres of land classified as SEZ along Heavenly Creek. The *Heavenly Creek SEZ Demonstration Project Monitoring Plan* (O'Connell, Brenneman, Norman, 2006) was incorporated in the NEPA decision for this project, and requires daily/ weekly monitoring of measured soil quality parameters such as Ksat, bulk density, soil moisture, and soil cover during project operations. Project implementation is scheduled for fall 2007 if soil conditions permit. Standards for Ksat and soil cover were established in the monitoring plan, and project operations will be stopped and mitigation implemented if these standards are exceeded during the course of project implementation. These standards are:

- The Regional standard of 50% soil cover;
- The Regional standard of less than 10% reduction in soil porosity; and a standard of 1 in/hr for Ksat. This was the highest value for Ksat at which a sensitivity analysis utilizing the WEPP model predicted a runoff and erosion response, for the assumed post-project conditions of 40% canopy, 50% soil cover, and 5 to 10 % slopes, using a representative 50-year precipitation regime.

In 2006, pre project soil moisture monitoring was conducted on the 23-acre Heavenly Valley Creek SEZ demonstration project in an attempt to determine locations within the treatment

area that are likely to remain too wet to treat. Detrimental compaction may occur at 10 inches or less of soil depth, if soil moisture is too high. A qualitative "ball test" was used to determine the susceptibility of soil to compaction (at 10 inch depth) for different soil moisture compositions. The results of the 2006 monitoring indicated that only about half of the project area had adequately dry soils for mechanical operations. Because the snow pack is approximately 30% of normal for 2007, soil moisture sampling will be conducted again prior to project operations to determine if more areas achieve dry enough conditions for mechanical operations.

VI.2 Biomass Treatment Effects Study

Research Question:

1) ***What are the effects of fuels treatment practices (understory biomass thinnings and prescribed fire in the form of controlled underburns) on fuel loading, stand health and productivity in the mixed conifer forest.***

2) ***What are the effects of fuels treatment practices (understory biomass thinnings and prescribed fire in the form of controlled underburns), and wildfire on site nutrient status and discharge water quality.***

The data collection this three-year study was completed in 2005. This research project was conducted by the University of Nevada-Reno and resulted in the generation of 15 formal publications. In spring of 2007, LTBMU staff authored a management summary of the findings presented in this research.

The investigation included several forest management practices (cut to length thinning (CTL), whole tree thinning (WT), and prescribed fire), as well as one wildfire in an experimentally valid design. Two study sites are located in coniferous forest stands that received mechanical thinning treatment prior to prescribed fire treatment for the purpose of biomass removal to prevent wildfire. The two field sites, one located on the North Shore of the Lake Tahoe Basin and the other near Truckee, CA just outside of the Basin, both contain soils derived from andesitic parent material.

The original intent was to evaluate the effects of forest thinning and prescribed fire management strategies in both an andesitic soil and decomposed granite (the 2 major soil types present in the Lake Tahoe Basin). However, the granitic soil field site was burned in the Gondola wildfire in July of 2002. Therefore, two sites on andesitic soils were analyzed for the effects of mechanical and prescribed fire biomass removal techniques, and the granitic site was analyzed for the effects of wildfire.

The funding agreement for this study did not specify a final product be developed that would clearly summarize the results of this work for land use managers**.** A final report written specifically for land use managers should be specified in future funding agreements for research projects. As stated above, LTBMU staff prepared a management summary of this research which will be posted on our website. The following are just a few of the many findings presented in the disparate publications that resulted from this research.

Key Findings – Management Summary of recent UNR research regarding the Impact of Fuels Reduction Treatment Strategies and Wildfire on Lake Tahoe Basin Ecosystems, 2007, Loupe and Norman, LTBMU).

Fuels Reduction Treatments

- The increases in fuel loads and fuel bed depth associated with the CTL treatment may be problematic for wildfire threat and potential intensity when this treatment technique is used without following it with prescribed underburning.

- The forest conditions resulting from WT thinning may be more desirable for forest management where reduction in wildfire hazard is the primary project goal, whereas CTL thinning might be preferred where protection of soil resources is the primary concern because of the skidding process involved in WT thinning.

- The prescribed burn seems to have caused reductions in stand productivity in the un-thinned areas, while this effect was not observed in either of the thinned subunits.

- While thinning treatments did not affect tree mortality, the main impact of the prescribed fire was increases in standing dead basal area, percentage of total basal area in standing dead trees, and percent mortality. Pre-existing crown features were found to play an important role in shaping crown responses to fire. Consequently, the prescribed fire resulted in the greatest live crown losses (length and percentage) and increases in crown base heights within the un-thinned portion of the stand, where live crown length was greatest and crown base heights lowest prior to the fire.

- There is an obvious and stunning disparity in attack severity among host species, with the highest severity of the bark beetle problem in white fir, and every white fir tree inventoried exhibiting some extent of pitch tube formation. Bark beetle activity in Jeffrey and sugar pine, along with mortality, was minor. Actual pitch tube counts per tree averaged 94 for white fir, 3 for Jeffrey pine, and 2 for sugar pine.

- The results of this study suggest that in a Sierra Nevada mixed conifer forest growing on sites of marginal quality, white fir is likely to be subjected to far greater damage from bark beetle activity than other stand constituents, and that a dynamic might exist among the various host and beetle associations whereby a pronounced attack of the fir escalates the attacks on other species.

- During rainfall precipitation and snowmelt, water often seeps downslope through the organic horizon, never gaining enough momentum to cause much physical soil disturbance. In addition, for both NH_4-N and orthoP, soil solution collected from adjacent suction lysimeters was more than 3 orders of magnitude lower than levels detected in runoff, suggesting that this water is not infiltrating into the soil and that O horizon runoff may be potentially discharged to adjacent surface waters by way of overland/litter interflow

- Measured temperatures in this study were relatively high for a prescribed fire. Prescribed fire should be applied with caution in areas that are and have the potential to be nitrogen limited. Burn intensities should be low, particularly in CTL treated areas where

accumulated ground fuels are high. Intervals between prescribed fire treatments should be long enough to allow for nitrogen fixation through plant regeneration.

- While it is still largely unknown whether spring (wet soil) or fall (dry soil) burns would be preferable based on these findings, the intense heating of the surface soil horizons likely associated with burning in dry soil conditions may result in significant losses in total N and ultimately may sterilize the soil. On the other hand, while burning in wetter soil conditions would allow the soil heating to propagate to deeper soil layers, the intensity of the heat would not likely be great enough to lead to sterile soil conditions.

Gondola Fire Study Site

- The only statistically significant effects of the Gondola wildfire (South Shore) on soils were a decrease in N concentration and an increase in pH in the A11 (depth 0-10 cm) horizon, and increases in water extractable SO_4 in the A11 and A12 (depth 10-30 cm) horizons. Soil N contents summed over the entire profile did not differ significantly before and after the fire, although there was a statistically significant decrease in N concentrations in the A horizons.

- The Gondola wildfire (South Shore) caused significant increases in NH_4 and mineral N (NH_4 + NO_3) leaching, as measured by resin lysimeters. Soil solution NH_4 and SO_4 concentrations increased substantially in the burned plots in the fall and early winter collections after the fire. After this initial peak, NH_4 and SO_4 concentrations decreased and soil solution NO_3 and orthoP began to rise. Ammonium dropped to near control levels by early spring, but NO_3, SO_4, and orthoP remained elevated throughout the rest of the 3 year sampling period.

- The effects of fire on soil solution orthoP suggest that available P was higher in the early stages after the fire, but cumulative P leaching as measured by resin lysimeters was not significantly affected by fire.

- Following the Gondola wildfire event (South Shore), a substantive spike in discharge concentrations of NH_4-N and PO_4-P was observed, followed by mean discharge concentrations of both constituents rapidly declining to only slightly elevated levels.

- Phosphate P concentrations in the runoff were consistently greater from the burned areas the 1st year after the wildfire than the unburned areas.

- Wildfire clearly appears to affect the concentrations of nutrients in runoff discharge through enhanced mobilization, likely the result of temperature induced mineralization. Mineralization is defined as the conversion of organic nutrients to inorganic compounds. This process is typically accomplished by various soil microbes but may also be induced by fire. Once mineralized, such nutrients are present in soluble inorganic form and subject to biotic uptake, infiltration and leaching, and/or runoff discharge.

VI.3 Fire History and Fire Effects Study

Research Question:

What have been the impacts of historic wildfire and long-term fire suppression on discharge water quality, soil fertility, and forest health?

In January of 2005 a study was initiated with the University of Nevada, Reno to continue investigating some of the findings obtained through the Biomass Treatment Effects Study. Simulation modeling will be used to synthesize existing information concerning the ecosystem effects of wildland fire, prescribed fire, fuel treatments, and fire suppression. The primary objective of the project is to develop a landscape-level, simulation model for analyzing the effects of varying fire regimes (including fire suppression) on nutrient cycling for forests throughout the Tahoe Basin, and to conduct a basinwide analysis utilizing this model. This first phase of the project is complete in that a model has been developed and was applied on two scenarios (fire suppression, and historic fire) over the entire Tahoe Basin. The findings from this first phase have and will be documented in several research papers. The results have also been summarized in a final report submitted by the principal investigators to the LTBMU. Key findings are presented below. Funding is being pursued for a second phase of the project, to conduct the necessary field data collection to validate and calibrate the model. The authors warn that their confidence in the outputs from the model at this point is not robust, and model results should not be applied too literally to guide management actions until the second validation phase is completed.

Key findings from Final Progress Report for the Fire History and Fire Effects Study (Miller, 2007)

- Fire suppression has created a landscape that on the whole is more homogeneous with respect to nitrogen and carbon pools and fluxes. Soil nitrogen pools (and to a lesser extent, phosphorus) have increased over much of the landscape as a result of fire suppression. This may lead to increased delivery of these nutrients to the lake during surface flow events. Nutrient transport through the watershed, however, was not represented in our model.
- For certain eco-regions, fire is necessary to maintain nutrient cycling dynamics. Mechanical fuel treatments may not be adequate for this purpose, and may not serve to ameliorate a general increase in total and available soil nitrogen and carbon that has resulted from decades of fire suppression.
- Not all eco-regions are outside a historic range of variability with regard to nutrient cycling. Quantitative comparisons of simulated reference conditions with current or predicted future conditions can identify areas of greatest deviation from the historic range of variability.
- Ecosystem processes can react differently than vegetation to changes in fire regime, and we cannot assume that the historic range of variability for nutrient cycling mirrors that of vegetation. In Jeffrey pine forests, simulated fire suppression has resulted in decreased homogeneity of soil nitrogen but increased homogeneity and continuity of plant biomass and fuels.
- Our landscape simulation approach fosters delineation of areas that are furthest from historical reference conditions with respect to nutrient cycling, and predicts general patterns of nutrient flux and availability given alternative future disturbance and management scenarios. This information should be useful for prioritizing (and possibly mitigating) restoration management. An interesting future development

would be to link the NuCycling-Succession model to a hydrologic model for direct prediction of fire effects on water quality.

- The NuCycling-Succession model has been applied to the particular geography, landscape pattern and vegetation community composition of the Lake Tahoe Basin and produces results that are consistent with literature values and the small amount of quantitative information available at this spatial scale. However, the model will require additional field data collection and validation before its particular results can be considered robust.

VI.4 Fuels and Vegetation Fuels Reduction Project Monitoring

Cause and Effect Monitoring Question:

What are the effects and effectiveness of fuels reduction practices on vegetation, fuel loads, and wildlife?

In the fall 2005, agreements were established with UNR, PSW, and the Adaptive Management Services Enterprise Team to develop monitoring plans and to initiate data collection to monitor the effects of fuels reduction practices on vegetation, fuels, and wildlife. Pre-project monitoring was conducted on a variety of stands scheduled for fuels reduction treatments around Tahoe City, Kingsbury Grade, and the west shore of Lake Tahoe. A preliminary analysis of this pre-project monitoring was conducted this past winter and key findings are presented below.

The funding for this effort to date has been exhausted, and future funding for this project is uncertain. National direction regarding forest service expenditure on fuels reduction projects limits the amount of funding received for implementation that the Forest can spend on project level implementation and effectiveness monitoring. This level of monitoring is considered to be in excess of what is required for the Forest to document implementation and effectiveness of treatments. However. if outside funding is obtained the pre-project data is in place for post-treatment monitoring.

Key Findings from Upland Fuels Reduction Project Monitoring Project Analysis of Pre-Project Data

Wildlife (Manley, 2006)

- A total of 13 species of small mammals were captured on the sample sites (Table 4). Three species were detected at11-12 sites: deer mouse, long-eared chipmunk, and shadow chipmunk. Douglas squirrel was observed at eight sites, and northern flying squirrel at five sites; the remaining eight species were observed at 4 or fewer sites. Trap effort varied (up to 20%) among sites as a result of significant disturbance by bears.

- Small mammal species richness ranged from 3 to 11 species, with an average of 6.25 species per site. Paired sites had similar species richness with one exception. Observed abundances were consistent with expectations.

- Fifty species of birds were detected across all sample sites. Species richness and composition was similar between treatment and control sites. The average species richness at treatment sites was 21.5 species, and at control sites was 24.5 species. Four bird species (Band-tailed Pigeon, Common Raven, Mountain Quail, Rufous Hummingbird) were detected only at treatment areas, and six species (Black-backed Woodpecker, Black-throated Gray Warbler, Northern Flicker, Olive-sided Flycatcher, Red-winged blackbird, Yellow Warbler) were detected only at control areas. The most abundant species across all sites were Mountain Chickadee, Evening Grosbeak, and Steller's Jay.

- Carnivore surveys detected two species: black bear (Ursus americanus) and American marten (Martes americana). We detected one or both species at every sample site. In addition to carnivores, we detected mule deer at two sites.

Sampling Design

- The paired treatment-control design this study is very effective at isolating the effects of the treatments from other potential environmental influences (e.g., annual fluctuations in climate, changes in human use). Paired-sites enable the analysis to focus on relative differences in conditions between paired sites over time including at multiple time periods post-treatment.

- Sampling successfully described the small mammal communities. Birds were simple and inexpensive to sample. We expect significant changes in the bird community to occur in response to the treatments based on differences we observed between untreated and adjacent treated sites in the areas within which we were working.

- Based on sampling associated with other studies, the west side of the basin appears to have a higher density of bears – every site had an abundance of sign that bears were consistently using sites for denning, resting, and/or foraging. Fuel treatments are likely to significantly reduce the quality of habitat for bear and marten through the reduction of vegetation vertical diversity and overstory canopy cover, as well as ground-based food resources (shrubs) and cover(logs and shrubs).

- The gross effects of fuel treatments on habitat conditions for various wildlife species can be predicted without additional research data -- such as reducing canopy cover by 50% is likely to reduce the richness or abundance of canopy associates. However, more specific predictions than this can only be made using more quantitative data (as Holl suggests). Quantitative data provide two important functions.

    1. First, it provides a level of specificity that management can use in designing fuels treatments at the site scale – for example, providing site scale thresholds of structural needs (e.g., trees per acre, snags per acre) for achieving target probabilities of species retention.
    2. Second, it can inform the location and extent of treatments at the landscape scale for achieving target probabilities of species persistence in the basin or portions of the basin. This level of precision and accuracy in impact assessment would not be necessary if fuels treatments were implemented on a small portion of the basin; the current plans for broad-scale fuel treatments appears to present a risk to

species persistence at the site and landscape scale that warrants a relatively high level of precision in impact assessment.

- The study, if continued, has the potential to yield the many of the predictive capabilities described above. Once the short-term impacts are described and modeled, longer-term trajectories can be modeled using forest growth models and habitat associations. Understory growth models are not available, so it would be important for vegetation to monitored periodically to provide information on how understory vegetation will respond over time and provide some basis for predicting longer-term effects on understory associated species.

Vegetation and Fuels (Dailey and Stanton, 2007)

Forest Structure & Composition

- *CWHR Classification:* Within the un-treated PAC units on the west shore, canopy cover was greater than 50%, but wildlife habitat quality for late seral species like Northern Goshawk and Spotted Owl was only moderate since the majority of trees were small (<24 inches). The untreated Kingsbury units were very open, with small trees that provide low quality habitat for late seral species. Although the thinned units in Dollar5 had larger sized retained trees, the residual canopy cover was too low to provide late seral habitat.

- *Tree Density and Sizes:* Pre-treatment tree density was very high in the untreated units, ranging from 157 to 244 trees per acre (tpa) in the west shore units, and from 191 to 304 tpa in the Kingsbury units. Tree densities in the thinned Dollar5 units were considerably lower than the west shore units at 111 and 130 tpa, but these units are at higher elevation and more dominated by red fir. The lower density is presumed to be the result of thinning treatments, but that cannot be confirmed without pre-treatment data. In the west shore units, almost all trees were less than 24" and very few large trees (>30") were encountered in any of those units. Surprisingly, over 50% of the trees in the hand and mechanically thinned Dollar5 units were less than 6 inches, although these partially treated units did have more large trees (>30 inches).

- *Species Composition:* Although 5 conifer species were present, the mixed conifer forests in the west shore units were heavily dominated by white fir (75% of the trees on average were white fir). The Kingsbury units were composed of Jeffrey pine and white fir only in proportions ranging from 36:64 to 42:58. The Dollar5 units had very low proportions of pine and since the elevation was over 7,000 ft, red fir was the dominant species in those units.

- *Snag and Down Log:* The west shore units had very large quantities of snags (mean of 44 per acre), likely due to widespread insect damage that weakened trees. Snag counts in the Kingsbury units were moderately high (ranging from 14 to 22/acre). The number of retained snags in the thinned Dollar5 units was within prescription in the hand thinned unit (5/acre) and at 60% of the prescribed level in the mechanically thinned unit (2 per acre). Down log density was a mean of 7 per acre in the west shore units and 17 per acre in the Kingsbury units. The number of residual down logs per acre was high in the thinned Dollar5 units, (ranging from 39 to 43 acre).

- *Herbs and Shrubs Herbs and Shrubs:* The total mean species richness per plot declined as total mean duff/litter loads (r^2=0.65) and FWD loads (r^2=0.67) increased in the west shore units. The total number of species detected in the Kingsbury units on the east shore was fewer by 80%. Very few species were detected in the recently thinned Dollar5 units. Mean cover was less than 15% in the west shore units, less than 2% in the Kingsbury units, and less than 0.2% in the Dollar5 units. Without paired pre-post treatment samples it is unknown whether lower abundances and richness in the treated Dollar5 units are due to the treatment or to pre-treatment conditions. Non-native species were not detected on any of the west shore units or Dollar5 units. Cheatgrass was detected in small quantities in the Kingsbury units.

Fuel Loading and Configuration

- *Surface Fuel:* Pre-treatment surface fuel loadings were high across all of the untreated units. Mean total surface fuel loading (litter/duff, 1-100 hr, and 1000 hr) in the untreated units was 41 tons/acre. The hand thinned and mechanically treated Dollar5 units also had high surface fuel loading close to 40 tons/acre.

- *Vegetative Fuel Loading:* In the west shore units, understory live fuel loads ranged from 1 to over 4 tons/acre, which was similar to the load contributed by fine dead and downed fuels.

- *Residual Woodchips:* Percent cover of woodchips ranged from 14 to 27% at the Dollar5 units, the only location where woodchips existed from partial-treatment. The depth of woodchips ranged from 1.9 to 6.3 inches. Bulk density coefficients have not been determined for woodchips in the Lake Tahoe Basin so calculation of biomass is not currently possible.

- *Slash Piles:* Total mean biomass of slash piles located within the mechanically treated Dollar5 unit was 30 tons/acre. Fuel biomass estimates for slash piles could be used to perform smoke production modeling.

- *Canopy Fuels:* Mean pre-treatment canopy base height (CBH) values of 3 to 6 feet across the west shore and Kingsbury units were very low, indicating high risk for crown fire initiation. The mean CBH of 5 feet in the thinned Dollar5 project area was also very low. CBH targets in project plans are generally set at 12-25 ft to reduce the likelihood of crown fire initiation. Pre-treatment mean canopy bulk density (CBD) values were above 0.15 kg/m^3 for all of the pre-treatment west shore units and above 0.10 for the Kingsbury project. In the treated Dollar5 project site CBD's were 0.06 kg/m^3. Desired conditions for CBD are values below 0.1 kg/m^3. Conditions where CBH exceeds this threshold are considered capable of passive crown fire. When CBD values are at or above o 0.15 kg/m^3, a stand is likely to have active crown fire.

Implications for Management

- The monitoring protocol was specifically designed to detect significant changes in plant communities and fuel loadings in response to management activities over time, using a statistically valid approach. 10 Plots or less per unit (fixed area 0.1ha plots) were shown to be adequate to determine changes as small as 25% for most of the key characteristics required to evaluate desired conditions and address key management questions with 80% statistical certainty.

- Comparisons of the pre-treatment data with available estimates of the historic range of variability for key forest structure components confirm that existing conditions are severely departed from desired conditions. The overabundance of small trees less than 24” inches diameter and the dominance of fir species over pine are some of the primary departures.

- Differences in forest structure, fuel loads, and herbaceous and shrub species diversity were detected in the thinned units in Dollar5, but without pre-treatment data it is not possible to know how the thinning influenced these different elements. Implementing post-treatment monitoring in these units will provide the statistical strength necessary to determine the long-term response to treatment.

- Post-treatment data collection will be a critical part of this effort. The site-specific pre-treatment data from permanent plots is required as a reference point from which quantitative evaluation is made of 1) short-term project-level NEPA objectives on the implementation of fuels treatments and 2) the longer term effectiveness of treatments in meeting desired conditions for fire, forest health, and wildlife habitat.

- The data from this monitoring effort could be used in modeling software applications like Behave or Fuels Management Analyst in order to predict fire behavior scenarios under un-treated and different treatment conditions, but it was decided not to include fire behavior modeling in this monitoring effort.

Chapter VII
Recreation and Social Resources

Recreation monitoring continues to be an ongoing effort in the LTBMU recreation programs. These are performed by wilderness rangers and OHV patrollers who are primarily assigned the duty of providing education to the public and enforcing USFS regulations regarding recreation use. For the past decade, wilderness rangers and volunteers have actively been monitoring encounters and campsite conditions within the Desolation Wilderness. In 2006 and 2007 the LTBMU had 1400 hours of monitoring time generated by 30+ Wilderness Volunteers. Directed by David Roloff, Assistant Professor of Recreation from Sacramento State, the monitoring program is a direct response to the 1998 Desolation Wilderness Management Plan for annual social and resource monitoring. Social and resource modeling is being collected and summarized for a statistically valid trend analysis and evaluation, scheduled to be conducted in the winter of 2007/2008.

On the OHV/OSV side of the recreation program, throughout the summer and winter of 2005-2006 and into 2007, OHV patrollers have completed hundreds of daily OHV monitoring logs each year detailing such monitoring data as:

Patrol Areas
Duties Performed (nominally patrolling and monitoring)
Visitor Counts broken down into types of OHV & OSV vehicles
Vehicles in Compliance with Green Sticker Regulations
Citations Issued (for what)
Resource Damage (describe)
Any needed additional information

All data has entered into an electronic database, and the first quantitative analysis of this data is scheduled for 2008. In lieu of more formal monitoring results, informal observations from Recreation staff are presented below.

Key Findings, personnel communication, (Lane, 2007)

<u>Desolation Wilderness Monitoring</u>

- Permit Data indicates overall visitation has been steady with continuing increases in both day use and overnight use.

- There is a growing trend in the numbers of visitor encounters that are exceeding the established standards as described in the Desolation Wilderness Management Plan.

- Visitor compliance with established regulations appears to be steady.

- Expanded restoration efforts are needed to maintain the natural “wilderness” character of the Desolation Wilderness.

OHV/OSV Patrol Monitoring

- Winter over the snow vehicle (OSV) violations tend to occur in urban fringe areas like High Meadows, and along the urban interface with the National Forest.

- Summer off highway vehicle (OHV) violations tend to occur along the urban fringe areas like Saxon Creek, Fountain Place, and Twin Peaks.

- There is increasing growth in numbers and registered vehicles for both OHV and OSV use.

- Most OSV/OHV visitors generally have reported a positive experience. Reports of conflicts between residents and motorized recreation constitute the greatest conflict source (noise).

- Continued management presence is needed at concentrated OHV/OSV use areas such as the Sand Pit, Blackwood Canyon, McKinney-Rubicon Trail, Tahoe Meadows (OSV), High Meadows (closed but has frequent violations), and Genoa Peak Road.

- There is a continued need to educate OSV/OHV users and monitor OHV/OSV use, and effort should include working with volunteers to perform these functions.

Chapter VIII
Discussion

This past year continued to produce a large amount of new information related to wildlife species monitoring as analyses and reports from data collections over the past several years have started to come in. Biological Resources monitoring will continue to be a significant component of the LTBMU monitoring program, however the formulation of a comprehensive long-term biological resource evaluation and monitoring program was delayed this past year due to staff shortages and turnover. This will be a major focus in 2008.

Another continued focus will be evaluating the effects of fuels reduction practices on soil quality. Measured soils data will be used to predict project impacts to water quality utilizing the Watershed Erosion Prediction Project Model for simulating hydrologic and erosion response (WEPP). This approach has proven successful in providing a cost effective, quantitative evaluation of the specific impact of fuels reduction treatment practices on soils and water quality. The report discussed in this document for the Ward 5 Fuels Reduction project indicates that current fuels reduction treatment technology utilized at the LTBMU results in minimal impacts to soils and water quality. This monitoring approach will be repeated when different soil types or project conditions exists, and or different/treatment practices are utilized.

Desired conditions, management strategies, management approaches, and objectives will be identified in the LTBMU Forest Plan revision, due to be completed in 2008. Monitoring strategies will evolve to track and evaluate trends and the attainment of the desired conditions established through this process. The Forest Plan Revision will also present a comprehensive monitoring and evaluation program . This Plan is still being developed, and is anticipated to meet the agency requirements for monitoring as described in Forest Service Handbooks and Manuals for Land Management Planning, Adaptive Management, and Environmental Management Systems.

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