LTBMU FIVE YEAR SUMMARY OF MONITORING EFFORTS 2008-2012

USDA Forest Service, Lake Tahoe Basin Management Unit

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I. EXECUTIVE SUMMARY

This report summarizes key findings from 2008 through 2012. Monitoring questions are grouped into eight topic sections related to: 1. Physical sciences (soil/water/air), 2. stream ecosystem management, 3. aquatic resources, 4. meadows, 5. terrestrial resources, 6. forest resources, 7. fire (planned and unplanned ignition), and 8. Social monitoring. Seventy-six monitoring questions were investigated between 2008 and 2012; fifty-six of these have been summarized in this report. The majority of the questions investigated were focused on terrestrial resources and project effectiveness monitoring. Summaries provide information on how monitoring has changed and may influence management in the future.

Physical Sciences (Soil, Water, Air)

- Monitoring supports that the Lake Tahoe Basin Management Unit (LTBMU) management has been moving in the right direction, towards achieving the load reduction targets identified in the Tahoe total maximum daily load (TMDL).
- Monitoring has been effective in identifying areas that still need improvement, which helps inform an adaptive management response.
- In general, the LTBMU has been effective at implementing soil and water protection best management practices (BMPs) according to design, and that these BMPs are effective at preventing adverse impacts to soil and water quality.
- Monitoring has demonstrated that unpaved trails are not a significant source of potential sediment loading, when compared to unpaved roads.
- "Light on the land" equipment and treatment techniques used for mechanical vegetation treatments have not resulted in ecologically significant adverse effects on the Tahoe Basin soils evaluated.
- Heavenly Mountain Resort management has largely been effective at preventing and reducing adverse soil and water impacts, however some improvement is still shown to be needed in regards to managing parking area runoff at the base lodges, and technical improvements to water quality treatment systems are being explored.

Stream Ecosystem Management

- Stream channel floodplain restoration efforts implemented over the past decade have been largely successful in moving towards multiple restoration goals including: increasing channel stability, restoring hydrologic connectivity to floodplains, reducing sediment loading, and improving aquatic and riparian habitat.
- There will never be a one size fits all stream channel/floodplain restoration approach. Each restoration project needs to thoroughly consider the unique watershed conditions, constraints, and stressors affecting the stream channel reaches in which channel degradation has been documented.

Aquatic Resources

- Active gillnetting in Desolation Wilderness lakes has caused significant decline or eradication of fish populations within five years. The eradication of fish in these alpine lakes will provide an opportunity to increase amphibian populations, targeted at Sierra Nevada Yellow Legged Frog.
- Most streams in the Lake Tahoe Basin (LTB) have low diversity; some streams only have one species, which often is a non-native trout species.

- 13,661 non-native fish were removed from approximately 17 miles of stream during 2008 through 2012. Lahontan cutthroat trout (LCT) numbers are increasing in reaches where non-native species have been removed.
- An action plan is needed to address aquatic organism passage (AOP) in an efficient and effective manner that will provide migration but not spread non-desirable species into uninfected areas.
- Active treatment of newly introduced non-native species and small infestations of known species has been effective at containing or reducing the spread of these species. This reinforces the importance of Early Detection Rapid Response (EDRR) as a primary management technique for prioritizing invasive plant species of management concern.

Meadows

- The total number of fens is greatest in the South Basin region. These fens were in general more highly rated for conservation significance compared to other regions in the Basin (East Basin, Incline Village, Meiss Country, and West Basin).
- The majority of meadows are considered moderate to high functioning in the LTB.
- There was a significant increase in the presence and frequency of lodgepole pine (*Pinus contorta*) from 2004 to 2009.
- Future management (e.g. sub-soiling of compacted soil, periodic burning) might want to focus on methods to reduce the potential for lodgepole encroachment in project areas as well as in meadows in general.

Terrestrial Resources

- Current invasive plant prevention and treatment measures appear to be moderately effective at reducing spread from existing infestations and preventing new introductions. The majority of projects that were uninfested prior to project-implementation remained uninfested after implementation, suggesting that for most projects either the invasive plant risk was low or that prescribed measures were effective. However, project implementation still poses some risk for the introduction of invasive plants; new infestations were detected at 17% of projects and exponential spread was documented at several infestations.
- The majority of Forest Service sensitive plant species are either stable or increasing with population numbers having interannual variability.
- The long-term monitoring plots established for Tahoe draba and long-petaled lewisia suggest that there may be specific biotic conditions that compose each species suitable habitat (i.e. low vegetation cover).
- For Tahoe yellow cress, the 34-year survey record has been crucial in the identification of the cyclic nature of its distribution and abundance, how strongly occupancy is related to lake level, and its metapopulation dynamics. In general, there have been more occupied TYC sites when the lake is low and fewer when it is high. This knowledge of the basic biology of the species forms the very foundation of the Conservation Strategy which will be revised and is scheduled for administrative review in late 2014.
- The peregrine falcon population in the LTBMU appears to be on the rise.
- The willow flycatcher population in the LTBMU is declining.
- The status of the northern goshawk, California spotted owl and Townsend's big-eared bat population in the LTBMU is unknown. Based on population information for willow flycatcher and the fact that relatively little is known about the status and habitat associations of Pacific marten and Townsend's big-eared bat in the LTB, these species should be monitored closely. It may be beneficial to design restoration projects to support habitat for each of these species.

- As of 2010, nine of the ten management indicator species seem to be stable at the range wide, California, and Sierra Nevada Scales (Black-backed woodpecker , California spotted owl, Hairy woodpecker, mountain quail, and yellow warbler, Mule deer , Northern flying squirrel, Pacific Treefrog , Sooty (Blue) Grouse).

Forest Resources

- There is a large over-abundance of the white fir/mixed conifer type and under-representation of Jeffrey pine forests. Only the white fir-mixed conifer type is within the reference condition for mid-seral/open, late-seral/open, and late-seral/closed. Mortality levels of trees within the LTB have not warranted any concerns for treatment needs outside of ongoing fuels reduction and forest health projects.
- Project effectiveness monitoring has improved prescription efficiency and has identified areas where desired conditions are not feasible. Prescriptions for hand thin units have been simplified in areas without resource concerns. If diameter limits were not included in projects then desired conditions would be easier to meet while promoting uneven aged stands.
- Pile burns are a highly valuable management tool because they introduce fire to the landscape and are a necessary first step to being able to conduct maintenance and ecosystem burns. Piles should be recognized as contributing to meeting ecological as well as operational goals.

Fire (planned and unplanned)

- Fuel treatments in the Angora Fire generally performed as designed and substantially changed fire behavior and subsequent fire effects to forest vegetation.
- Steeper slopes in the Angora Fire burned at higher severity than adjacent flatter ground. This resulted in discussions on the limitations of mechanical thinning on steeper slopes. Over the long-term, simulations suggest that treated stands in the Angora study area will recover baseline carbon storage 10–35 years more quickly than untreated stands.

Social Monitoring

- The LTBMU has been able to consistently meet and/or exceed the regionally determined standard target with respect to compliance monitoring and inspections of special use permits.
- The LTBMU has identified a need to develop a local spreadsheet to track inspections by permit number, use code, date of inspection, and compliance status to help the program formulate conclusions about its compliance monitoring as a whole, areas where program administration could be improved, and to possibly find ways to apply a consistent and broader management strategy toward dealing with permittee noncompliance.
- The LTBMU recreation management program has been effective in promoting sustainable recreation and in meeting the visitor's expectations and preferences.
- The Desolation Wilderness has reported the highest score of attainment in the National Forest System in each of the last six years.
- Ninety-eight percent of visitors have given a rating of very satisfied or somewhat satisfied for their overall experience.
- Managers have improved the overcrowded feeling by maintaining camping capacity limits.
- Maintenance levels are not sufficient to support existing facility needs; the amount of deferred maintenance exceeds our ability to maintain facilities.

II. INTRODUCTION

The Lake Tahoe Basin Management Unit (LTBMU) Monitoring Program provides information to decision makers about the outcome of forest management activities on desired conditions for LTBMU resources. The goal of the Monitoring Program is to provide direction needed for the Forest Environmental Management System (EMS), NEPA decision documents, and investigate if we are meeting desired Forest Plan conditions. The Program has evolved to follow monitoring guidelines established in FSH 1901.12, CH. 19 and 20 (Land Management Plan and Adaptive Planning Process); FSM 1331 (EMS directives); the Adaptive Management Strategy (AMS) as described in Appendix E of the Sierra Nevada Forest Plan Amendment (SNFPA); and from the strategy developed by the National United States Forest Service (USFS) Monitoring and Evaluation Team (MET).

The LTBMU continues to work with our partners in the Basin to ensure that a coordinated and prioritized Monitoring Program is developed that meets both the particular needs of the LTBMU as well as the larger Lake Tahoe Basin community.

Monitoring included in this report falls under four categories. There is often overlap between the monitoring categories. For this report we choose the label that is the most descriptive of the monitoring effort.

- **Assessments**: Evaluation of system. The assessment is the baseline data that may lead to status and trend monitoring. (Examples: location and distribution of fens, current status of native non-game fish).
- **Status and trend monitoring**: Status is the baseline that trend will be based on. Trend is the directional change in a system/populations characteristics documented by a minimum of three sampling points. (Examples: special status species monitoring; meadow monitoring).
- **Project effectiveness monitoring**: Documents how well management practices meet project objectives or Forest Plan desired conditions. May suggest cause and effect relationships between management actions and resource conditions. (Examples: burn pile monitoring, restoration monitoring of stream channel conditions).
- **Compliance Monitoring:** Monitoring done to ensure that specific legal requirements are met. (Examples: short-term water quality during construction, and other implementation, forensic, and short term effectiveness monitoring requirements contained in Lahontan and Tahoe Regional Planning Agency (TRPA) permits).

Results from implementation monitoring are not provided in this report, except in the cases where there is overlap with another monitoring category. Reporting of this category of monitoring is primarily accomplished through internal contracting processes, and requirements contained in project regulatory permits from the Lahontan Regional Water Quality Control Board and/or the Tahoe Regional Planning Agency.

- **Implementation Monitoring:** Documents if management practices were implemented as stated in project design. (Examples: project or contract administration, monitoring to make sure project stays out of areas identified during design criteria).

This report describes monitoring accomplishments and key findings from the work conducted during 2008 through 2012. This report is grouped into eight topic sections related to: 1. Physical sciences (soil/water/air), 2. stream ecosystem management, 3. aquatic resources, 4. meadows, 5. terrestrial resources, 6. forest resources, 7. fire (planned and unplanned ignition), and 8. recreation resources. We acknowledge that in many cases there is overlap between the groups and sections, in these cases we have included the monitoring item under the section we feel is dominant. Many of reports synthesized in this report can be found at: http://www.fs.fed.us/r5/ltbmu/publications.

III. METHODS

Data was synthesized by 16 forest service staff in 2013 and 2014. Staff from the ecosystem, recreation, and vegetation-urban lots-forestry-fire departments synthesized their monitoring information. In addition, staff from engineering were consulted regarding monitoring accomplishments. Contributors were asked to identify monitoring that had been conducted during a five year period between 2008 to 2012, identify if future monitoring would occur if funding was available, and to summarize any of the results if those were available to summarize. Analysis of monitoring activities is ongoing. This document only summarizes key findings completed prior to 2014 that staff had the opportunity to summarize for this report. In most cases, abstracts, executive summaries, results, and or discussion from larger reports are summarized in this document, however for some of the monitoring questions this is the only summary.

At the start of each results section a summary table is presented that identifies monitoring efforts from 2008 through 2012, and identifies future monitoring that may be conducted is funding is available. The objective of these tables is to summarize data for this five year monitoring period so that partners understand the current LTBMU monitoring program and the wealth of data that has been collected.

III. RESULTS

Physical Resources (soil, water, air)

Nine physical resource monitoring questions were investigated between 2008 and 2012 (Table 1). All of these have been summarized in this report.

- *Is watershed condition improving in the Lake Tahoe Basin, as evaluated through Watershed Condition Ratings, particularly in priority watersheds?*

A full assessment of all 10 hydrologic unit code 5 (HUC5) watersheds within the Tahoe Basin was completed in 2011, utilizing recently completed National Watershed Condition Assessment Protocols (USFS 2011). A hydrologic unit is a drainage area identified based on topographic and hydrologic data nested within a hierarchical unit. (Current basin scale watershed boundary datasets provided by the US Geologic Survey divide HUC levels to 5th and 6th levels). Condition ratings were based on an assessment of twelve aquatic and terrestrial biological and physical process metrics. Assessments were conducted by a multi-disciplinary team, utilizing existing data and reports. Ratings were based on the condition of USFS lands only, and did not include an assessment of the condition of private lands within a watershed. Future assessments will occur at five year intervals (the next assessment is scheduled for 2016), or when watershed condition changes are expected sooner due to natural events (e.g. fire, flood) or restoration actions.

Results of Watershed Condition ratings for the USFS, including the Lake Tahoe Basin 2011 ratings, are posted on the National USFS website: http://www.fs.fed.us/publications/watershed/. Watershed condition is rated in a three tiered system: functioning properly, functioning at risk, or impaired. As a result of the 2011 assessment, three out of the ten Lake Tahoe HUC5 watersheds were rated as functioning properly: the upper part of the Upper Truckee River watershed (from the headwaters to the upper end of Christmas Valley), the entire east shore south of Mill Creek and east/north of Trout Creek. The remaining seven HUC5 watersheds that comprise the Tahoe Basin watershed were rated as Functioning at Risk. No watersheds were rated as impaired.

Table 1: Lake Tahoe Basin management Unit 2008-2012 Physical Science Monitoring Accomplishments.
The type of monitoring, measures used during monitoring, monitoring question, activities completed, and potential for future monitoring are all presented. Monitoring questions that are addressed in the report are notated with an x under summary.

Category*	Emphasis/ Measure	Monitoring/ Assessment Question	2008	2009	2010	2011	2012	Future	Summary
A	Tributary water quality, aquatic habitat condition, channel geomorphic condition, degree of watershed disturbance, forest health	Is watershed condition improving in the Lake Tahoe Basin, as evaluated through Watershed Condition Ratings, particularly in priority watersheds?			x			x	x
PE	Temporary BMP Monitoring during construction	Are Temporary BMPs being adequately designed, implemented and maintained during construction projects?	x	x	x	x	x	x	x
PE	Heavenly Ski Area BMP Effectiveness: WQ sampling, BMP effectiveness ratings, vegetation/soil cover evaluations, and SCI.	To what degree has the implementation of Ski Area BMPs been successful in protecting soil and water quality?	x	x	x	x	x	x	x
PE	Regional BMPEP Implementation and Effectiveness Monitoring	To what degree are BMPs implemented and effective in protecting soil and water resources for LTBMU management?	x	x	x	x	x	x	x
PE	WQRAP visual assessment and WEPP modeling protocols	Has the implementation of Road Decommissioning and BMP Upgrades reduced the potential for water quality impacts, and to what degree were BMPs successfully implemented and effective?		x	x				x
PE	WQRAP visual assessment and WEPP modeling protocols	Has the implementation of Trail Decommissioning and BMP Upgrades reduced the potential for water quality impacts, and to what degree were BMPs successfully implemented and effective?		x	x				x
PE	Soil porosity/infiltration capacity, bulk density, and soil cover	What are the impacts to soil quality, and the sediment and discharge loading potential from a variety of vegetation management mechanical treatment prescriptions for various site conditions?	x	x		x			x
ST	LTIMP Tributary Monitoring Program	What is the status and trend of stream water quality in the Lake Tahoe Basin?	x	x	x	x	x		x
ST	Maintain Improve Site at Bliss	What is the status and trend of air quality in the Lake Tahoe basin?	x	x	x	x	x	x	x

*C=compliance monitoring, I=inventory, PE=project effectiveness, ST=status and trend

Each National Forest was directed to identify two priority watersheds, which would be prioritized for management actions to improve condition. The two priority watersheds selected by the Lake Tahoe Basin Management Unit were Ward Creek Frontal (containing Blackwood and Ward Creek), and Upper Truckee/Angora (containing the lower half of the Upper Truckee river watershed from the upper end of Christmas valley to Lake Tahoe, and its tributaries). These watersheds were selected because they are the largest contributors of pollutant loading which affects Lake Tahoe Clarity and had documented impairment of aquatic habitat and forest health.

Watershed action plans were completed for the two priority watershed. These actions plans are internal documents, retained on the Forest and submitted to the USFS Washington Office. Information from these actions plans are available at the national website link provided above. These action plans identify ecosystem restoration projects anticipated to improve watershed condition. They include projects to restore stream channel/floodplain function, reduce fuels and improve forest health, reduce invasive species, and improve the condition of Forest roads and trails.

- *Are Temporary BMPs being adequately designed, implemented and maintained during construction projects?* **AND** *To what degree are best management practices implemented and effective in protecting soil and water resources for LTBMU management activities?*

Soil and water best management practices (BMPs) monitoring is conducted annually, based on regionally assigned targets. The LTBMU is typically assigned 40 evaluations a year. Evaluations from all Forests are compiled at the regional level.

Between 2008 and 2012 a total of 180 evaluations were performed on BMPs to protect soil and water related to vegetation management, recreation, and restoration management activities and infrastructure. Evaluations have shown that overall the LTBMU is very effective at implementing soil and water protection BMPs according to design, and that BMPs are effective at preventing adverse impacts to soil and water quality. From these evaluations, 87% were rated as effective in protection of soil and water quality, 9% were rated as “at risk” (meaning no water quality impact had occurred yet but the potential exists), and 4% were rated as not effective (meaning a water quality impact did occur).

The LTBMU has successfully implemented follow up actions and evaluations in a timely manner to ensure soil and water resources are protected when deficiencies have been observed. The Angora Hazard Tree project had inadequate installation of water bars on roads prior to a large storm event, which resulted in observations of direct delivery of sediment to Angora creek. This BMP failure occurred because the contractor did not implement the BMPs. The management change was 1) to ensure observed deficiencies in contractor performance are addressed more robustly in the future and 2) to plan for Forest service crew capacity to address contractor deficiencies if needed to protect water quality, particularly prior to large storm events.

Annual BMP monitoring is anticipated to continue into the foreseeable future. It is anticipated that Regional protocols will be replaced with National protocols around 2015. Additional project specific BMP monitoring will also be conducted as required by National Pollution Discharge Elimination System (NPDES) and Timber Waiver monitoring, as high risk sites. (Brill and Harris 2009a, Brill 2010a, Brill 2010b, Harris et al. 2011, Harris et al. 2012, Harris and Norman 2013)

- *To what degree has the implementation of Ski Area BMPs been successful in protecting soil and water quality?*

Heavenly Ski Resort monitoring has been required under the Lahontan NPDES permit since 2004. This monitoring has been conducted by contractors hired by the Resort. The USFS provides support to this monitoring by reviewing and commenting on revisions to monitoring plans, as well as the annual and 5-year comprehensive monitoring reports. There are 5 components to the monitoring program that address whether BMPs are protecting soil and water quality: water quality sampling, stream channel condition surveys, soil and water BMP implementation and effectiveness evaluations, and ski slope stabilization evaluations.

Reports are produced on a quarterly and annual basis. A five year comprehensive report completed in 2013 provided a comprehensive analysis of monitoring completed between 2006 through 2011 (Cardno Entrix 2012).

Monitoring has validated that Heavenly is maintaining the resort in a manner such that the Heavenly Total Maximum Daily Load (TMDL) is achieved, and stream channels, roads, and ski runs are stable. There are still deficiencies in urban runoff water quality impacts related to the management of large base lodge/parking areas, at the main lodge and Boulder lodge. The resort is continuing to optimize the performance of storm water treatment facilities as these locations. Monitoring will continue, as required by the Lahontan NPDES permit, for the foreseeable future. Efficiencies and reductions in scale are being pursued as it relates to stream channel condition, BMP, and ski slope stabilization monitoring, such as focusing on areas of high risk (i.e. roads and ski runs that have a high degree of hydrologic connectivity) and reducing the frequency of data collection for stream channel condition to once every 4 years.

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

Relatively few upgrades occurred during 2008 to 2012, compared to the 154 mile of upgrades evaluated between 2003 and 2005 (Breibart 2007, Brill and Harris 2009b). Monitoring provided a qualitative and quantitative validation of the anticipated effects of road retrofits. We believe this was useful to inform the development of the Tahoe TMDL for upland source areas. The Tahoe TMDL predicts that 12% of the total loading to Lake Tahoe for fine sediment comes from upland sources. The remainder comes from a combination of stream channel erosion, atmospheric, and urban sources, with urban sources the highest contributor at 77% of total load.

During 2006 through 2008, 4.21 miles of road upgrades were evaluated for their effectiveness based on BMP effectiveness evaluations and a qualitative Water Quality Risk Assessment Protocol (WQRAP). 2.08 miles were not rated because they were located outside an SEZ and had no risk of sediment delivery to a water body. The remaining 2.13 miles consisted of 0.54 miles of low risk and 1.59 miles of moderate risk road. All 1.59 miles of moderate risk road segments were located on Slaughterhouse Canyon road (18E22.5). This trail to road conversion received predominately moderate ratings due to the surface type and gradient. This road was upgraded because logging vehicles will use this road during proposed vegetation management activities. After vegetation management activities are completed the Forest plans to maintain this road as a level II road, closed to the public, but available for administrative use by the USFS. It is recommended to increase the coverage of gravel surfacing of the road from currently covering the area of the stream crossings, to include the length of the road segments (with gradients >5%) connected to the stream crossing. This would increase the total length of gravel surfacing from 44 feet to 364 feet, and would result in

reducing the rating from moderate to low risk for this road (Briebert et al. 2007, Brill and Harris 2009b).

Monitoring results continue to indicate that BMP retrofits overall have been effective at reducing the risk of road-borne sediment migration to water bodies in the Lake Tahoe Basin. We are not planning to continue monitoring using this level of effort in the future because the majority of road retrofit work has been completed on the LTBMU. Road condition will continue to be monitored by the Engineering department through the Units road maintenance program, in which road condition will be assessed at least every 5 years for road maintenance needs, with higher use roads being visited more frequently. Reporting of Environmental Improvement Program (EIP) performance measures for miles of forest roads retrofitted and decommissioned will continue in order to comply with TRPA and TMDL tracking and reporting requirements as well.

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

Trail monitoring in 2009 and 2010 included North Shore (post-project) and East Shore Beaches (pre-project and post-project) trails. Monitoring was conducted utilizing a combination of qualitative BMP effectiveness evaluations, WQRAP (a qualitative assessment of water quality risk), and erosion and runoff prediction modeling using water erosion prediction project (WEPP). WEPP modeling was performed on a selected sample of east shore trails, as well as modeling performed during the NEPA analysis for the North Shore Trail ATM Environmental Assessment which estimated yields on the scale of lbs/year.

The qualitative monitoring assessment suggests that trail upgrades resulted in substantially lower observations of erosion and subsequent risk to water quality compared to trails prior to upgrades (Harris et al 2010). The risk to water quality from trails was relatively low prior to upgrades when compared to the erosion and sediment transport potential from forest roads; the low potential for sediment delivery is not surprising, considering the dispersed nature and relatively small foot print of trails (average width 5 to 3 feet).

This monitoring effort validates that current management direction does not need to be changed. Because of the inherently low risk to water quality presented by forest trails, the LTBMU has decided to discontinue use of this protocol for future trails monitoring. Future monitoring will consist of routine trail condition surveys conducted by the LTBMU engineering department staff. This routine surveying will not be reported, but rather used internally by engineering staff to assess and schedule trail maintenance needs.

- *What are the impacts to soil quality, and the sediment and discharge loading potential from a variety of vegetation management mechanical treatment prescriptions for various site conditions?*

Between 2006 and 2011, the LTBMU collected data on soil quality at four separate fuel reduction projects that utilized low ground pressure harvesting and forwarding equipment and chippers and masticators. These fuels reduction projects were conducted on a variety of soil types around the Basin from the west shore (Ward Unit 5 – volcanic and granitic), south shore (Heavenly SEZ - granitic) and east shore (Roundhill - granitic and Slaughterhouse – granitic). The Heavenly SEZ fuels reduction project was conducted as a pilot project to evaluate mechanical treatments on granitic soils in an area classified as

stream environment zone (SEZ). The Roundhill Project included both an SEZ treatment unit and a whole-tree removal treatment where low tire pressure equipment was used to cut and remove the trees. In the whole tree operation the entire trees were removed from the site rather than trees being de-limbed on site and leaving the resulting material as ground cover.

Monitoring reports, which include executive summaries, from these four projects are posted on the LTBMU public website (http://www.fs.usda.gov/detail/ltbmu/maps-pubs/?cid=FSM9_046480), (Ward: Christensen and Norman 2007), (Heavenly SEZ: Norman 2008), (Roundhill: Cody and Norman 2011) and (Slaughterhouse: Cory and Norman 2012, Norman et al. 2012).

The following conclusions can be drawn from these monitoring efforts.

- "Light on the land" equipment and treatment techniques used for mechanical vegetation treatments have not resulted in ecologically significant adverse effects on the Tahoe Basin soils evaluated.
- Although saturated hydraulic conductivity was reduced by 30% to 67% as a result of management activities, median Ksat measurements post-project were still between 1.9 and 5. 7 inches per hour. Soil cover after treatments averaged around 90% and soil porosity decreases were less than 5%.
- The combination of robust soil cover, small decreases in soil porosity, and relatively high post-project soil permeability (i.e. saturated hydraulic conductivity) prevented increases in overland flow that resulted in accelerated erosion. Soil hydrologic function and soil productivity were maintained at levels adequate to sustain vegetation and maintain water quality.
- Soils in the Tahoe Basin are primarily coarse textured, with high sand content and naturally high infiltration capacities. The high sand content makes them less prone to compaction than finer textured soils. The soil moisture conditions during project implementation ranged from dry to very moist soil conditions.

Future monitoring may occur if work is conducted in more sensitive conditions (e.g. wetter soils), or if different mechanical treatment methods are utilized.

- *What is the status and trend of stream water quality in the Lake Tahoe Basin?*

During 2008 through 2012 the USFS has contributed funding from our Erosion Control Grants Program, to the United States Geologic Survey (USGS) to support the Lake Tahoe interagency monitoring program (LTIMP) for basin wide tributary water quality monitoring. This support has ranged from $125,000 to $250,000 a year. With the cessation of funding through the Sierra Nevada Public Lands Management Act (SNPLMA), the USFS will no longer be able to provide financial support to LTIMP on the behalf of the local governments which are awarded grants from the Erosion Control Grants program. The USFS has never been involved in the collection, analysis or reporting of this data. However the USFS has participated in interagency efforts to redefine the purpose, scope, and scale of this monitoring effort to adapt to reduced budgets and improve monitoring design efficiencies and effectiveness. The TRPA works with USGS and UC Davis to analyze and report out on Tahoe Basin air quality. The following are key findings from the 2011 TRPA Threshold Evaluation Report (Reuter et al. 2012).

The status and trend of concentrations and loads of suspended sediment, phosphorus, and nitrogen were evaluated for tributary water quality at ten streams. Overall the status of these three indicators was somewhat worse than target, with an overall trend of moderate improvement. Confidence in this

determination is moderate. For discussion of the terminology and methods please review the report at: http://www.trpa.org/regional-plan/threshold-evaluation/.

- *What is the status and trend of air quality in the Lake Tahoe basin?*

The USFS collects data at the Bliss IMPROVE site, but does not do the data analysis. The TRPA works with the California Air Resources Board, and other partners to analyze and report out on Tahoe Basin air quality. The following are key excerpts from the 2011 TRPA Threshold Evaluation Report (Green et al. 2012).

The TRPA has adopted threshold standards for carbon monoxide, ozone, visibility (atmospheric haze), nitrate deposition, and odor. Overall the Air Quality Index (AQI) for the Lake Tahoe area suggests that air quality conditions have improved since 2007. The number of days rated as "good" has increased (from 319 in 2007 to 361 in 2011) with a concurrent decrease in "moderate" dates (46 days in 2007 to 4 in 2011). Specific standard results for individual metrics are:

- Carbon monoxide – This metric is considerably better than the threshold standard, the trend is moderately or rapidly improving, and the confidence in this determination is high.
- Ozone- This metric is somewhat better than the threshold standards, with little to no change in trend, and the confidence in this determination is moderate.
- Visibility- Overall this metric is at or somewhat better that the threshold standard, with a moderately improving trend, however the confidence in this determination is low.
- Nitrate Deposition- There is insufficient information at this time to determine effectiveness of implemented policies, ordinances and environmental improvements.
- Odor- There is evidence that regulatory measures are effective in reducing diesel fuel emissions at Regional, State, and national scales.

For discussion of the terminology and methods please review the report at: http://www.trpa.org/regional-plan/threshold-evaluation/.

USFS will continue working with partner regulatory agencies to mitigate/reduce impacts from management activities on air quality, through existing practices for dust abatement during construction and prescribed fire management.

Stream Ecosystem Management

Three stream ecosystem management monitoring questions were investigated between 2008 and 2012 (Table 2). All of these have been summarized in this report.

- *To what degree have restoration efforts been successful in restoring floodplain connectivity and channel/riparian habitat, improving water quality, stabilizing stream banks and sediment transport regimes?*

During the summary period the LTBMU collected a variety of pre and post project monitoring data at seven projects (Table 2). The projects monitored include (implementation year is in parenthesis): South Fork Marlette Creek Dam Removal and Stream Channel Restoration (2003), Lonely Gulch Stream Channel Restoration (2003), Cookhouse Meadow Restoration (2005, 2006) , Blackwood Creek Stream Channel/Floodplain Restoration Phase I , II, and III (2003, 2006, 2008-2010, 2012), Cold Creek/High Meadows Restoration (2010-2012), Upper Truckee River Reach 5 Stream Channel and Floodplain restoration project (pre-project monitoring, scheduled for implementation 2013 through 2016), and the Angora Channel Restoration project (pre-project monitoring, scheduled for implementation in 2015).

Long term restoration effectiveness monitoring will continue at most of these projects. Data collected varied by project and has included: photopoints, stream channel condition survey metrics (following Regional stream condition inventory (SCI) protocols), cross section and longitudinal profile measurements, ground water and surface flow measurements, vegetation plots, and macro-invertebrates. Effectiveness Monitoring reports have been completed for Marlette Creek (Tolley and Loupe 2009) Lonely Gulch, (Oehrli 2013), Cookhouse (Norman et. al. 2009, Oehlri et. al. 2013), and Blackwood Creek (Oehlri and Norman 2009, Norman et al. 2012).

Construction monitoring is also conducted to ensure water quality is protected during construction activities. This includes in-stream turbidity monitoring, and daily BMP inspections, and post storm BMP inspections. As part of Lahontan permitting annual and final construction reports are prepared to report on the effectiveness of BMPs to protect water quality during construction.

Monitoring has shown that stream channel floodplain restoration efforts implemented over the past decade have been largely successful in achieving restoration goals. Through implementation and monitoring the program has been able to incorporate lessons learned in subsequent projects. Key deficiencies and successes that have been incorporated into the design approach for future projects are listed below:

1. Channel sinuosity and grade need to be considered relative to valley grade. Bank stabilization materials need to be adequately sized and keyed in to withstand the flow sheer stress. These considerations were inadequate at the Marlette Dam Restoration project, which resulted in continued channel bank and bed destabilization. At Lonely Gulch the use of sufficient sized and keyed in bank stabilization structures (rock and log) was effective in stabilizing the channel in a relatively steep and rocky channel type.
2. The reconstruction of a new channel at Cookhouse Meadow replaced an extremely incised channel in fine grained meadow soils. This project was successful in elevating ground water levels, reducing channel erosion, and improving aquatic habitat.
3. Utilization of native vegetation harvested on site (stacked sod and willow staking) during restoration at Cookhouse Meadow provided channel bank and floodplain surface stability within one growing season (Table 3).
4. The design approach at Blackwood Creek was effective in jump starting natural processes for restoring the bank full channel and adjacent floodplain. Blackwood is a flashy watershed, characterized by large flood events, which regularly and continually transport and deposit large rock and cobble channel bed material from the upper watershed.
    a. The design relied primarily on: removing man-made barriers (inadequate culvert crossing and obsolete fish ladder), constructing large scale flow deflection structures to slow down stream velocity and increase channel sinuosity, and building inset floodplain where possible.
    b. Channel geomorphic and habitat metrics (sinuosity, pool quality, bank stability, and channel substrate characteristics) have shown measurable improvement since restoration activities.
    c. The channel/floodplain has been transformed from one dominated by channel widening to processes of aggradation (floodplain deposition).
    d. Long term monitoring is needed to determine the degree and rate of restoration of channel bank and floodplain vegetation, and whether the restored reaches continue to maintain dynamic equilibrium through future large scale flood events.
5. In order to reduce the potential for increases in stream channel turbidity during construction as a result of project activities, projects should:

a. Improve planning for managing surface, subsurface, and storm runoff flow during in-channel construction by planning for backup and contingency pump capacity, evaluating potential for increased groundwater and subsurface during construction as a result of project activities, and designing adequate temporary water storage and treatment facilities.
b. Improve techniques for installing and removing temporary stream crossings to minimize potential for discharging sediment into the stream.
c. Improve techniques for managing fine sediment attached to construction substrate to reduce time needed and effectiveness of jetting and flushing of constructed channel/floodplain surfaces.

While lessons can be learned from past projects, watershed assessment analysis and monitoring show that each restoration project needs to thoroughly consider the unique watershed conditions, constraints, and stressors affecting the stream channel reaches in which channel degradation has been documented. There will never be a one size fits all stream channel/floodplain restoration approach. Developing an appropriate restoration approach will continue to require a robust understanding of geomorphic process, and thorough watershed analysis, utilizing a multi-disciplinary team of engineers, geomorphologists/hydrologists, biologists, botanists, and ecologists.

Table 2: Lake Tahoe Basin management Unit 2008-2012 Stream Ecosystem Management Monitoring Accomplishments.
The type of monitoring, measures used during monitoring, monitoring question, activities completed, and potential for future monitoring are all presented. Monitoring questions that are addressed in the report are notated with an x under summary.

Category *	Emphasis/ Measure	Monitoring/ Assessment Question	2008	2009	2010	2011	2012	Future	Summary
PE	SCI, Photopoints, Visual observations, ground and surface water measurements	To what degree have restoration efforts been successful in restoring floodplain connectivity and channel/riparian habitat, improving water quality, stabilizing stream banks and sediment transport regimes?	Marlette, Cookhouse, Upper Truckee, Blackwood, Cold Creek	Cookhouse, Blackwood, Cold Creek	Cookhouse, Blackwood, Cold Creek	Lonely, Gulch, Cookhouse, Blackwood, Cold Creek	Marlette, Cookhouse, Upper Truckee, Blackwood, Cold Creek	x	x
PE	vegetative cover by growth form, cover of invasive plants	What is the vegetation structure response to the Blackwood Creek restoration project? Did the restoration project change the cover of invasive plant species along Blackwood Creek? Do we need to vegetate after a stream channel construction project?	15 transects Phase IIIA		15 transects Phase IIIB; 15 transects Phase IIIA			x	x
PE	Cover of native herbaceous plants and shrubs, invasive plant cover, native plant diversity, proportion of wetland species	What is the vegetation response, measured through cover, diversity, wetland indicator status of native riparian SEZ vegetation and cover of invasive plant species, to stream zone fuels treatments at the Heavenly Creek SEZ project?	4 units, 12 transects		4 units, 12 transects		4 units, 12 transects	x	x

*PE=project effectiveness

Table 3: Cookhouse Sod Monitoring: One square meter plots were read at a distance of every 10 meters along both banks of the restored stream, over 1000 meters of the stream bank was monitored. Sod placement was completed in 2005.

Monitoring Date	%Vegetation Cover	%Sprouting Willow Stakes	%Living Willow mats
8/31/2005	50	21	79
9/16/2005	57	38	91
10/06/2005	66	39	90
6/5/2006	69	59	43
8/30/2006	88	86	91

- *What is the vegetation structure response to the Blackwood Creek restoration project? Did the restoration project change the cover of invasive plant species along Blackwood Creek? Do we need to vegetate after a stream channel construction project?*

Pre-project monitoring occurred in 2008 for Phase IIIA and in 2010 for Phase IIIB. One year post construction monitoring for Phase IIIA occurred in 2010. Monitoring will occur for up to ten years post restoration with the anticipation of capturing a ten year flood event. One monitoring report has been completed which addresses changes in riparian vegetation between 2008 (pre-project) and 2010 (one year post-project) for Phase IIIA, and summarizes the pre-project (2010) vegetation conditions for Phase IIIB (Engelhardt and Gross 2011c).

Specific project objectives related to vegetation included:

- 50% of cover is associated with woody and perennial graminoid plant species that stabilize floodplains.
- Maintain or reduce the cover of *H. perforatum* plants present along the creek and avoid the introduction of additional noxious or invasive species into the project area.

One year post project monitoring provides information on the impacts of construction. Future monitoring will provide information on the vegetation response to improved hydrologic and geomorphic conditions. One year post-project at Phase IIIA, the first management objective of increasing woody and perennial growth form percent cover had not yet been met while the second objective of maintaining or reducing invasive species cover was met (Engelhardt and Gross 2011c). Shrubs and perennial graminoid cover is comparable to pre-project conditions, although total vegetative cover declined. We believe that as recovery time increases project objectives will attain the 50% cover objective. We did not anticipate that we would meet this objective one year post project because there was not enough recovery time post construction. The greatest decreases in vegetation cover were at debris jam structures; this is probably due to the greater extent of modification at these sites compared to roughness and channel sites. Recovery at debris jam sites will be interesting to follow because while these locations may recover slower initially, they could eventually outpace recovery at the other structures as the debris jams are designed specifically to promote sediment deposition and vegetation establishment. Total invasive plant cover was reduced one year post project compared to pre-project, future monitoring will provide information regarding if we were successful in reducing invasive species in the project area or if this is an initial delayed response.

- *What is the vegetation response, measured through cover, diversity, wetland indicator status of native riparian SEZ vegetation and cover of invasive plant species, to stream zone fuels treatments at the Heavenly Creek SEZ project?*

Pre-project monitoring occurred in 2006 and 2007 when monitoring was established. One year post, three year post, and five year post project monitoring occurred in 2008, 2010, and 2012. Results were summarized and reported based on 12 transects in four units that were treated in 2007 (Gross 2009, Engelhardt and Gross 2013).

Specific project objectives related to vegetation included:

- Maintain or increase the pre-project cover of native herbaceous plants and shrubs between 2006 and 2012.
- Allow no more than a 25% increase in pre-project cover of invasive plant species between 2006 and 2012.
- Maintain or increase the pre-project native plant diversity between 2006 and 2012.
- Maintain or increase the pre-project proportion of obligate wetland and facultative wetland species relative to facultative, facultative upland, and upland species between 2006 and 2012.

While species diversity had increased by three years post project, overall vegetative recovery was slower than expected. As of 2012, three of the four project objectives for vegetation were met. Based on patterns in the data we suspect that with additional time, all objectives will be met. The mean cover of native herbaceous plant cover is less than pre-project cover, however an increase in cover was seen between 2010 and 2012 so we suspect this objective will be met during the final monitoring period (2015).

This fuel project was successful in minimizing the spread of invasive species; results suggest that project activities and annual weed treatments reduced the number and cover of invasive species at the project site. The overall number of invasive species decreased by two species five years post project, and the overall cover was less than pre-project. While these results are promising, future monitoring will determine if invasive species are responding similarly to overall herbaceous plant cover. There was an increase in invasive plant cover seen from 2010 to 2012, similar to native herbaceous cover, suggesting there may also be a lag in the response of invasive species. It is possible that when a site recovers with native vegetation it decreases the ability of non-native species to occupy the habitat.

Project monitoring suggests that fuel reduction in stream environment zones may promote wetland plants, especially wetland sedges. While the proportion of wetland plant species is lower than upland plant species, the cover of wetland plant species increased post restoration and accounts for approximately 75% of the total cover occurring at monitoring sites. This increased cover of wetland species was primarily due to an increase in sedge species (*Carex* spp.).

Vegetation response has been slow and therefore a final year of monitoring has been proposed for 2015 to provide an eight year post assessment of project effects on native herbaceous species cover and other indicators of vegetation response.

Figure 1: Heavenly Creek SEZ Unit 3 vegetation monitoring along transect 1. Photographs on the left (A, C) photos are pre-project; photographs on the right are five years post project (B, D). Photographs on the top (A, B) are looking from 0 to 60 meters, and photographs on the bottom (C, D) are looking 60 to 0 meters.

Aquatic Resources

Nine aquatic resource monitoring questions were investigated between 2008 and 2012 (Table 4). Seven of these have been summarized in this report.

- *What is the extent of road – stream crossings across the Tahoe basin (primarily on Forest Service system roads)? Which crossings are barriers to local fish species, specifically native fishes? Which culverts should be prioritized for replacement within the LTBMU Basin?*

Surveys for Aquatic Organism Passage were conducted in 2010 and 2011 (Vacirca et. al. 2010, Welz 2011). In the summer of 2010 the LTMBU evaluated 112 road/stream crossings. Of these, 61 had full assessments completed and 51 were partial assessments due to factors such as no flow, no structure, the crossing was a bridge, or the crossing was on a decommissioned road. Of the full assessments, 53 were on Forest Service system roads and 8 assessments were on CA and NV highways. In the summer of 2011, the LTMBU evaluated 204 road-stream crossings. Of these, 117 had full assessments completed

and 87 were partial assessments. Partial assessments occurred for the following reasons: no flow, ephemeral or intermittent channel status, continuous high channel gradient (>40 %) eliminating any fish habitat potential, no structure or actual crossing present, the crossing was a bridge, or inaccessible sites. Some sites were inaccessible due to conflict with private property access or active road construction. Of the full assessments, 93 were on local roads and 24 were on California and Nevada highways.

Approximately 82% (50 of 61) of the full assessment on all road crossings in 2010 do not meet the criteria for fish passage (Figure 2: RED) and are barriers for at least one life stage of salmonid or sculpin. Only 11% of the fully assessed crossings met the passage criteria (Figure 2: GREEN) to fish for both juvenile and adult salmonid life stages. The remaining 7% of fully assessed crossings were undetermined (Figure 2: GREY) for salmonid or sculpin and are candidates for further evaluation. Twenty six sites of the 112 road/stream crossings in 2010 were selected for Paiute sculpin analysis. Ten sites had full assessments completed and the remaining sixteen sites were partial assessments. Of the full assessments, 70% (7 of 10) of road crossings did not meet the criteria for sculpin passage (Figure 2: RED) while 20% of road crossings met the passage criteria (Figure 2: GREEN). One crossing (10%) was undetermined (Figure 2: GREY).

In 2011, similar percentages for AOP passage were seen. Approximately 82% (96 out of 117) of the full assessments on all road-stream crossings in the 2011 survey did not meet the criteria for fish passage (red) and were barriers for at least one life stage of salmonid or sculpin. Only 8% (9 out of 117) of the fully assessed crossings met the passage criteria (green) for both juvenile and adult salmonid life stages. The remaining 10% of fully assessed crossings were indeterminate (gray) for either salmonid or sculpin and are candidates for further evaluation. The 21 crossings evaluated to be either green or gray for juvenile salmonids were further evaluated utilizing additional criteria to determine passage potential for fish in the Cottidae and Cyprinidae families (to cover the swimming potential of Paiute sculpin and sucker species). For those given full assessments, 57% (12 out of 21) of the crossings were determined to be impassable (Figure 3: RED), 38% (8 out of 21) were indeterminate (Figure 3: Grey), and 5% (1 out of 21) were passable (Figure 3: Green).

Stream crossings by roads can pose serious threats to fishery ecosystems. The cumulative effect of culverts, fords, and other structures throughout a stream channel can significantly change the streams geomorphology and impair fish passage by blocking valuable spawning and rearing habitat. The majority (146 of 178) of the fully assessed existing crossing are barriers to migration, closing off large areas to spawning and rearing for native and non-native species. However, in some cases where recovery is under consideration, these existing barriers could be used as a management tool until recovery actions are complete (e.g. preventing upstream migration of non-native species targeted for removal). Additionally, some of these existing barriers also prevent the spread of warm-water invasive species.

An action plan is needed to address barriers in an efficient and effective manner that will provide migration but not spread non-desirable species into uninfected areas. From the monitoring results, a priority matrix should be developed to identify barriers needing restoration to aid in the recovery of Lahontan cutthroat trout and restore migration opportunities for native and desirable non-native species.

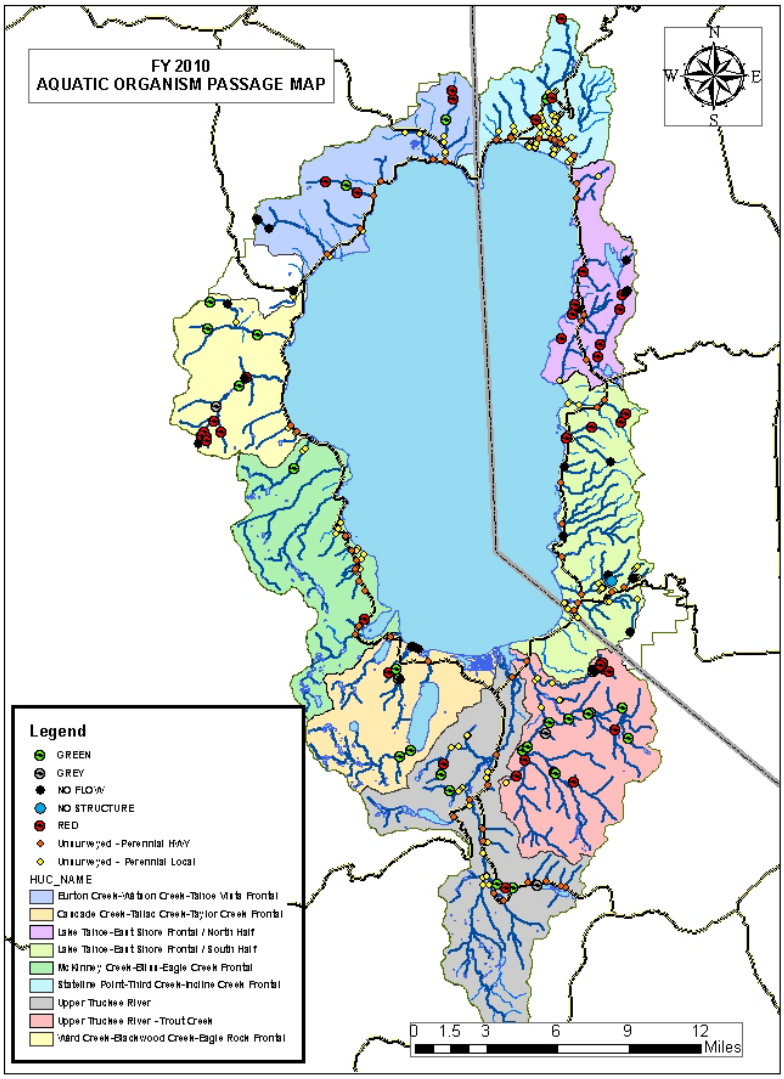

Figure 2: Results from 2010 Aquatic Organism Passage Surveys.

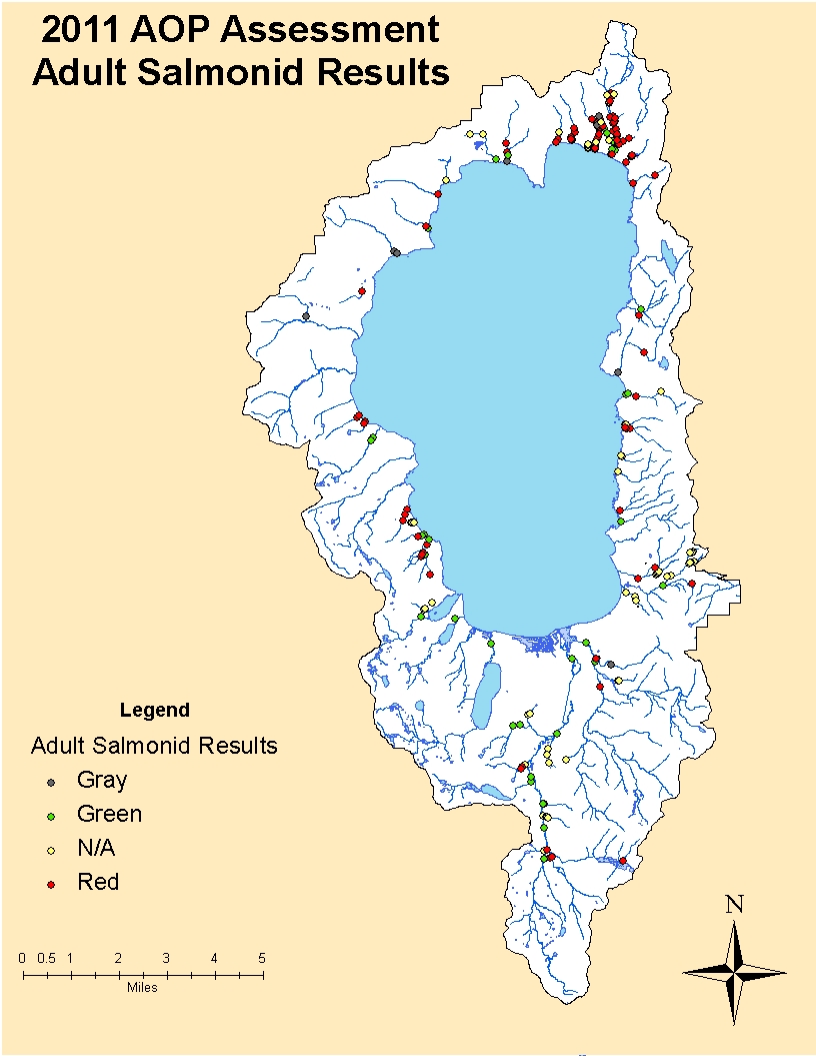

Figure 3: Results from 2011 Aquatic Organism Passage Surveys

Table 4: Lake Tahoe Basin management Unit 2008-2012 Aquatic Resources Monitoring Accomplishments.
The type of monitoring, measures used during monitoring, monitoring question, activities completed, and potential for future monitoring are all presented. Monitoring questions that are addressed in the report are notated with an x under summary.

Category *	Emphasis/ Measure	Monitoring/ Assessment Question	2008	2009	2010	2011	2012	Future	Summary
A	Aquatic Organism Passage	What is the extent of road – stream crossings across the Tahoe basin (primarily on Forest Service system roads)? Which crossings are barriers to local fish species, specifically native fishes? Which culverts should be prioritized for replacement within the LTBMU Basin?			112 road/ stream crossings	204 road/ stream crossings		x	x
PE	Ecological condition of streams using established protocols (e.g. SCI)	What are the current physical and biological condition of streams and associated floodplains in the Lake Tahoe basin, and how is that condition changing over time?	4 SCI surveys: UTR Sunset Reach, Cold Creek/ High Meadows, Angora Creek, Cookhouse	1 Bio-Assessment Survey: Big Meadow; 4 SCI surveys: Upper Saxon, West Fork Tallac, Burke, Upper Blackwood		1 Bio-Assessment Survey: Saxon; 1 SCI: Lower Blackwood	1 SCI: Cookhouse	x	
PE	# of frogs, demo-graphics, # of fish, presence of chytrid	What is the effectiveness of SNYLF habitat restoration measures (i.e fish removal) in alpine lakes and/or wet meadows in the Desolation Wilderness?	3 lakes	7 lakes	6 lakes	6 lakes	6 lakes	x	x
PE	Aerial Retardant	What are the direct and indirect environmental effects from wildland fire chemical use?					Elks Fire Drop	x	x
ST	Stream Temperature Monitoring	Are stream temperatures suitable for life history of native aquatic species? What is the status and trend of these native aquatic and			22 hobos, 11 streams	28 hobos, 17 streams	40 hobos, 15 streams	x	

Category *	Emphasis/ Measure	Monitoring/ Assessment Question	2008	2009	2010	2011	2012	Future	Summary
		nonnative aquatic species most susceptible to changing climate?							
ST	Non-game native fish assessment - Assessment piece - abundance and distribution	What is the current status (relative abundance and distribution) of Lahontan tui chub, mountain whitefish, Tahoe sucker, Lahontan redside shiner and Paiute sculpin populations in the Lake Tahoe basin?	x	x	2 miles (Incline, Trout, McFaul)	12 miles (UTR)	3 miles (Taylor creek)	x	x
ST	Amphibian visual encounter surveys: # of amphibians, demographics, presence of Bd (chytrid fungus); # of fish	What is the current status of amphibian, including Sierra Nevada (mountain) yellow-legged frog (SNYLF), populations and critical habitat in the Lake Tahoe basin and how are they changing over time? What is the distribution of Bd around the basin and infection level?	1 site: Hell hole	1 site: Hell hole	1 site: Hell hole	2 sites: Hell hole and Desolation (69 lake acres)	2 sites: Hell hole and Desolation (69 lake acres)	x	x
ST/PE	# of self sustaining sub-populations of LCT	Have recovery actions resulted in an increase in LCT abundance and associated native non-game species and decrease in non-native salmonides? Does the LCT population have multiple age and size classes as a positive population response to brook trout removal? Are we meeting recovery objectives?			1 population	1 population	1 population	x	x
ST/PE	Invasive species sites/acres, new detections	What is the status and trend of invasive species within the Lake Tahoe basin? Are education, prevention, and treatment measures effective at preventing and reducing the spread of aquatic and terrestrial nonnative	442 infestations treated or monitored; 2,639* acres infested; 60	392 infestations treated or monitored; 258 acres infested; 76 new	15 sites screened, 18 signs installed; 398 infestations treated or	15 sites screened, 19 signs installed; 301 infestations treated or	15 sites screened, 19 signs installed; 314 infestations treated or	x	x

Category *	Emphasis/ Measure	Monitoring/ Assessment Question	2008	2009	2010	2011	2012	Future	Summary
		invasive species?	new infestations	infestations	monitored; 512 acres infested; 17 new infestations	monitored; 405 acres; 18 new infestations	monitored; 371 infested acres; 10 new infestations		

*A=assessment, PE=project effectiveness, ST=status and trend

- *What is the effectiveness of Sierra Nevada Yellow Legged Frog (SNYLF) habitat restoration measures (i.e fish removal) in alpine lakes and/or wet meadows in the Desolation Wilderness?*

The LTBMU has been working to restore a portion of the Sierra Nevada Yellow-legged frog's habitat to a 'fishless' state within Desolation Wilderness since 2008. Implementation efforts were completed in 2011. In 2012 the LTBMU Aquatics Crew monitored the absence of non-native salmonids from seven lakes and one pond within the project area (Figure 4) (Doran et. all 2011).

Three thousand six hundred sixty-six fish have been removed since 2008: 3,637 brook trout, 28 rainbow trout and one Lahontan Redside shiner (Figure 5). Five years of active gillnetting has caused a significant decline or eradication of fish populations in all lakes. Margery, Jabu, and the Lucille Lagoon were rendered presumably fishless by the end of the 2009 season, while Ralston, Cagwin, and Tamarack Lake have been fishless since September 2010. The most recent fish detected were in Lake Lucille and Le Conte during the 2011 summer set. Lake Lucille yielded 75 fish in 2011, but zero fish have been detected since then. In 2012 no fish were detected in any of the 8 project lakes/pond. Maintenance monitoring will be crucial to ensure fish are not illegally introduced into restored lakes. This monitoring effort could include over-wintering a small amount of gillnets in select lakes within the project area.

Herpetofauna detections during visual encounter surveys in the Desolation project area were conducted at Tamarack Lake, Lake Lucille, Lake Margery, and Cagwin Lake, Tamarack Lake had the most individuals detected. Mountain garter snakes and Sierran treefrogs were detected at Tamarack, Lucille, Margery, and Cagwin Lakes. In 2011 one Sierra Nevada Yellow legged frog was detected nearby Cagwin Lake.

The eight lakes/ponds within the project area have been rendered ~99% fishless. The next step for the project is either independent re-colonization or active translocation of individual SNYLF sub-adults. Research starting in 2012 will test the effectiveness of both translocation and *Batrachochytrium dendrobatidis* (Bd) treatment to aid in the recovery of SNYLF within the restore lakes. These results will prove useful for other recovery efforts in the range of this species.

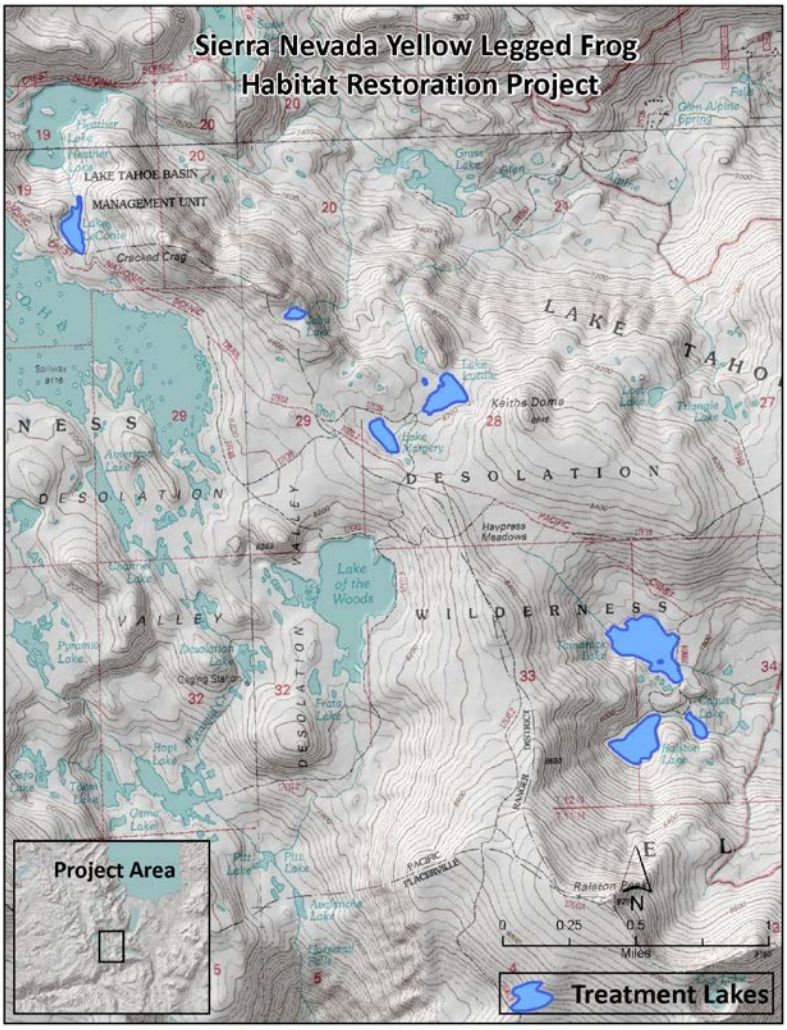

Figure 4: Location of Sierra Nevada Yellow Legged Frog Habitat Restoration Project.

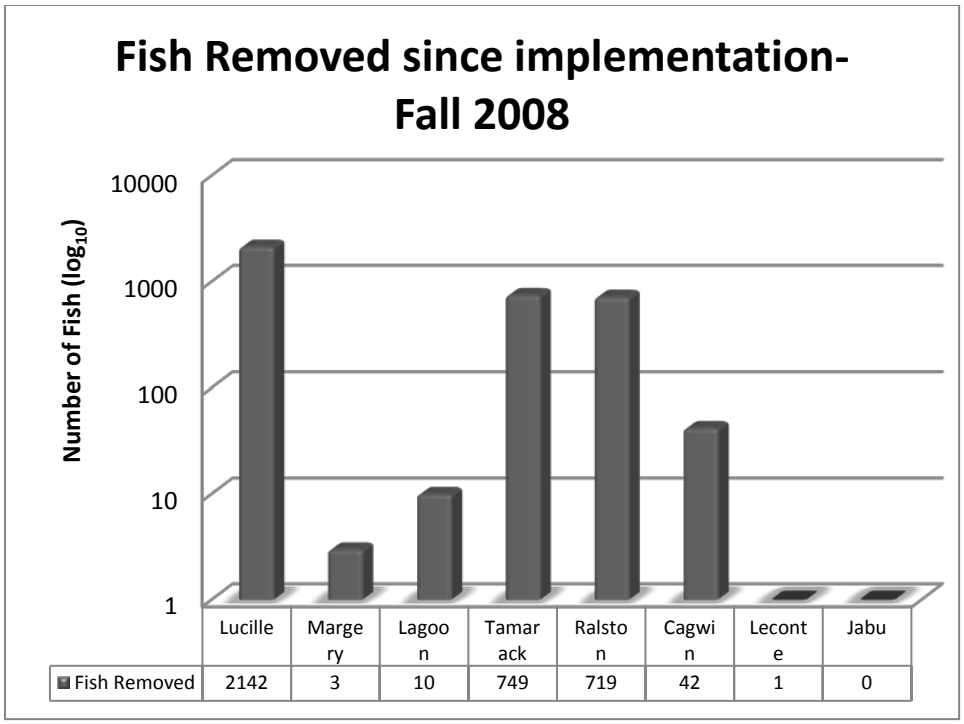

Figure 5: Total number of fish removed between 2008 and 2012 at seven lakes and one pond (Lagoon).

- *What are the direct and indirect environmental effects from wildland fire chemical use?*

Between 2008 and 2012 there was one accidental aerial retardant drop on the Elks Fire. Based on the location of the drop, there were no direct or indirect effects on Threatened, Endangered, or Sensitive species. The site is considered a dry brush and grass area, with no waterways within the vicinity of the drop. In 2012, the retardant could been seen coating rocks and ground cover. Notification of retardant drop was made to Fish & Wildlife Service informing them of the situation and that no Threatened or Endangered Species were affected.

We will continue to follow the Wildland Fire Chemical Misapplication Reporting (WFCMR) process. Between 2012 and 2013 – the online information from the Washington Office (WO) improved, providing a better understanding of what is needed to be reported and monitored when retardant is used in or near waterways and in species habitats. With updated guidance, the 2012 Elks Fire retardant drop would now be considered outside of a waterway.

- *What is the current status (relative abundance and distribution) of Lahontan tui chub, mountain whitefish, Tahoe sucker, Lahontan redside shiner and Paiute sculpin populations in the Lake Tahoe basin?*

The Lake Tahoe Basin Management Unit (LTBMU) conducted a fish assessment survey on state and federal lands within the basin to determine species presence, distribution, and relative abundance. These baseline conditions will provide information for future watershed and ecosystem level management decisions. To date 27 streams within the Lake Tahoe basin have been surveyed (Figure 6).

Preliminary results from the Fish Assessment survey in other creeks in the Lake Tahoe basin (2007-2012) indicate that the greatest species diversity (including both natives and non-natives) tends to be found in

low gradient downstream reaches in close proximity to Lake Tahoe. This trend was expected because many of Lake Tahoe's native non-game species prefer slow and/or deep waters, and some species only occur in streams temporarily when they leave the Lake Tahoe near shore environment to spawn. Additionally, the source populations of non-native warm water fish occur in near shore environments of Lake Tahoe and have not expanded upstream in great numbers at this point. Results from the Upper Truckee River (UTR) (2011 – 2013) surveys display similar trends; the lower four restoration sections of the UTR had greater native fish diversity than the most upstream portions surveyed. In FY14, after completion of the Upper Truckee River, a summary report will be completed.

Monitoring efforts from the Native Non-game Fish Assessment has provided insight on the current distribution and relative abundance of both native and non-native fish. These efforts will provide information to future restoration/recovery efforts for aquatic species, specifically Lahontan cutthroat trout. Most streams in the LTB have low diversity with some of the streams having only one species, a non-native trout species. The homogenous state of some streams warrants concern and without survey efforts of this project would be unknown.

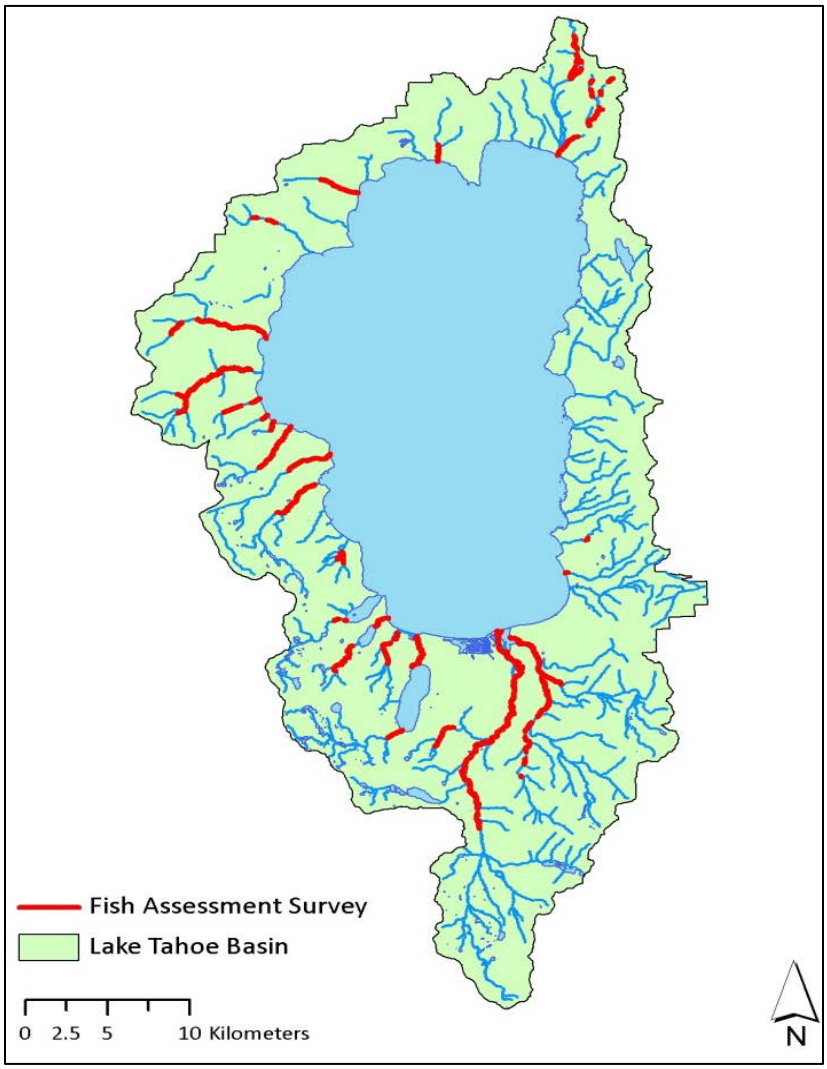

Figure 6: Fish Assessment survey locations (2007-2012).

Figure 7: 2011 Fish Assessment Survey in the Upper Truckee River, South Lake Tahoe, CA.

- *What is the current status of amphibian, including Sierra Nevada (mountain) yellow-legged frog (SNYLF), populations and critical habitat in the Lake Tahoe basin and how are they changing over time? What is the distribution of Bd around the basin and infection level?*

Aquatic ecosystems, especially lentic (non-flowing) ecosystems, are critical habitat for amphibian and reptile species. Within the Lake Tahoe basin lentic ecosystems that offer habitat for all life stages of amphibian and reptile species have become increasingly limited, causing the aquatic species primarily associated with those habitats to decline. Monitoring of these habitats and species occur regularly using visual encounter surveys (VES). Between 2008 and 2012, crews surveyed 21 separate areas of habitat, observing the presence of seven distinct herpetofauna species in various life stages and abundances. At two of these locations samples were taken to detect the presence of Chytridmycosis or (*Batrachochytrium dendrobatidis*, Bd); a disease extirpating amphibian species from their native ranges worldwide.

Monitoring efforts have informed the LTBMU that relatively few native species of amphibians and aquatic reptiles are present and of those species only the Sierran treefrog has a high occupancy rate (USFS LTBMU Aquatics 2009, 2010, 2011, 2012). Historically, populations of amphibians have been much greater throughout the basin (Manely & Lind 2005). Monitoring efforts have also informed the LTBMU that SNYLF population are in decline and that Bd is present in areas with existing and adjacent SNYLF populations. Results from these efforts will aid in future restoration and recovery actions for both SNYLF, Federally listed as Endangered on the Endangered Species Act, as well as habitat for native amphibian species. Monitoring efforts also provide information where invasive amphibians, specifically American bullfrog, need to be controlled/ removed.

Figure 8: Sierra Nevada Yellow Legged Frog detected in 2012 at Hell Hole meadow.

- *Have recovery actions resulted in an increase in LCT abundance and associated native non-game species and decrease in non-native salmonides? Does the LCT population have multiple age and size classes as a positive population response to brook trout removal? Are we meeting recovery objectives?*

From 2008 through 2012 approximately 17 miles of stream has been treated using a 3 –pass depletion methodology. In this time, approximately 19,364 fish have been sampled and 13,661 non-native fish removed. In reaches where non-native species have been removed, LCT numbers are increasing. Post effectiveness monitoring will begin after implementation efforts are complete (after 2016).

During implementation we have learned:

- Manual removal is challenging in the project terrain due to trees and rocks causing hiding spots and/or the inability of the electro-fisher to access spots.
- The lack of natural barriers makes removal challenging.
- Temporary barriers are necessary to phase the project treatment area into manageable sections, dependent on the stream features.

- *What is the status and trend of invasive species within the Lake Tahoe basin? Are education, prevention, and treatment measures effective at preventing and reducing the spread of aquatic and terrestrial nonnative invasive species?*

This summary is focused on the terrestrial plants portion of the above question only. Invasive plant monitoring has been a formalized component of the LTBMU botany program since 2001. There are currently 32 invasive plant species of management concern on the LTBMU; there are three additional aquatic plant species of management concern (Figure 9). With a few exceptions (e.g. cheatgrass, wooly mullein), these species are mapped and monitored when encountered. Annual infestation monitoring is

conducted in conjunction with treatment and pre-project surveys. Monitoring is quantitative measuring both the number of plants and acres infested; however, it is not systematic. Each year, there is substantial variation in the quantity of sites monitored as well as the type and quality of data collected at each infestation. For example, during invasive plant surveys after the Angora fire, the area estimated to be infested was 2,509 acres; however, intensive surveys of the fire in 2009 led to a revision of the infested area down to 128 acres—a substantial decrease. Since 2008, the invasive plant inventory has remained relatively constant, ranging from 397 to 443 known infestations (Table 5). Conversely, annual changes in area infested have ranged widely from 185 acres in 2008 to over 512 acres in 2010 (Table 5). These acreage changes may result more from mapping and effort disparities than from actual spread or contraction of infestations. Annual reports summarized outreach, prevention, coordination, treatment, and reporting efforts (Olin 2009, Reed 2009, Olin 2010, Rowe et al. 2013).

Invasive plants continue to be introduced and spread on LTBMU. Despite an active detection and prevention program, new infestations and occasionally new species are discovered each year. Furthermore, despite an active treatment program, the quantity of infestations has remained relatively constant since 2008. Due to continued propagule pressure or adjacent infested areas, most species that are already established on the LTBMU are not likely to be eradicated. However, active treatment of newly introduced species and small infestations of known species has been effective at containing or reducing the spread of these species. This reinforces the importance of Early Detection Rapid Response (EDRR) as a primary management technique for prioritizing invasive plant species of management concern. Furthermore, it highlights the need to continue implementing invasive plant prevention measures during activities managed by the USFS on LTBMU.

Table 5: Summary of invasive plant monitoring and inventory on the LTBMU 2008 through 2012.

Year	Number of monitored infestations	Number of known infestations	Acres infested[1]	Yearly change in area
2008	442	443	185[2]	
2009	392	397	258	+73
2010	385	416	512	+254
2011	301	425	405	-107
2012	314	437	371	-34

[1]This is gross area
[2]Does not include Angora fire due to likely overestimate (2,509 acres)
Data is from 2008-2010 annual reports and 2011-2012 annual field season summary spreadsheets.

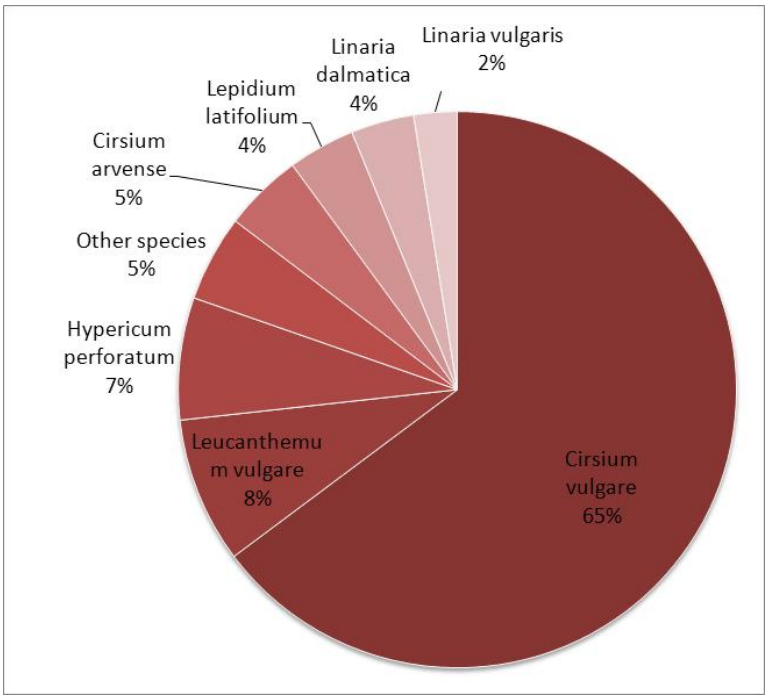

Figure 9: Summary of invasive plant inventory by species on LTBMU in 2012. Derived from 2012 NRIS TESP-IS data. Includes only species on LTBMU's most current (2012) list of invasive species of management concern that are currently inventoried and mapped by LTBMU staff.

Meadows

Six meadow monitoring questions were investigated between 2008 and 2012 (Table 6). Four of these questions have been summarized in this report.

- *Can fire be used to reduce lodgepole abundance in meadows while maintaining or increasing the abundance of herbaceous species?*

Research plots were established in seven meadows by UC Davis graduate researcher Erik Frenzel. At each meadow, two to four plots invaded by seedlings, saplings, or pole-sized lodgepole pine were established for a total of 21 plots. Plots were burned in 2008 and 2009. In addition, one half of eight USFS Region 5 Range Monitoring plots were burned in eight meadows. Using prescribed fire to restore tree-invaded mountain meadows: a case study from the Lake Tahoe Basin, California and Nevada USA (Frenzel 2012) was completed in 2012. The specific questions this study addressed were:

- Does reintroducing fire kill trees? What size trees?
- Does reintroducing fire free up resources that allow for the establishment of new trees or non-native species?
- Does reintroducing fire change the herbaceous plant community?
- How do the effects of fire differ across the landscape?

There were no significant changes in understory vegetation due to fire and no evidence that fire increases tree or non-native species invasion. The greatest mortality occurred where vegetation was continuous and dry, the trees were relatively small, and there was a hot flaming front. The most intense fire behavior was observed at lower elevation meadows, Baldwin Meadow and Slaughterhouse

Meadow. The lowest mortality occurred at high elevation meadows with sparse fuels that failed to carry the fire: Meiss Meadow plots and Big Meadow.

Fire reduced small lodgepole trees and seedling density at some sites. The number of small trees (>1 yr and <20 cm) decreased in treated plots by 78% and increased in control plots by 70%. Density of germinated seed was 45% lower in treatments compared to control plots. Sapling and pole-sized trees had low mortality rates because short flame lengths didn't reach the canopy and there was too little heat produced from smoldering combustion to cause bole damage. Even under the most optimal conditions in the study (high veg cover and high temperature) predicted probabilities of mortality are <50% for trees >5 cm diameter.

Although prescribed fire alone may be insufficient to reverse lodgepole invasion, periodic burning of meadows may kill trees before they grow large enough to escape mortality and/or before there is a loss of herbaceous fuels that may limit future fire effectiveness. Late fall prescribed fire will be of limited effectiveness at restoring meadows with large trees, but could prevent small trees from becoming established given frequent burning on sites with adequate fuels. The test plots in this study probably did not mimic a natural fire due to the small size and fires were of too low intensity to alter total or relative understory vegetation. Burning an entire meadow may increase fire intensity, increasing mortality.

Figure 10: Meiss Meadow (left) and Baldwin Meadow (right) meadow burns.

- *Cookhouse Meadow: Is the ground water level in the central meadow sufficiently shallow to support the colonization and maintenance of desired meadow species? Are dry meadow grass species and conifers in the central meadow being out competed and replaced with desired meadow species indicative of wetter hydrologic conditions?*

Five plots were monitored pre-restoration (2004 or 2005), 1 year post (2007), 3 years post (2009), and 5 years post (2011) (Oehrli et. al. 2013). Restoration goals of increasing meadow wetness are reflected by changes in the vegetation community pre to post restoration. There was an increase in the number of wetland species observed post restoration, as vegetation recovery continues we expect to also see an increase in the frequency of the wetland vegetation. Cookhouse Meadow has a diverse vegetation community, containing approximately one third of all species recorded in Lake Tahoe Basin meadow plots. In general, diversity increased while the frequency of individual species decreased. As the vegetation community recovers from restoration activities we expect that diversity may decrease as the frequency of individual species increases. This is based on the data that shows the frequency of ruderal species decreasing as longer lived competitor and intermediate-competitor species increased specifically

tied to an increase in number of rhizomatous sedges and rhizomatous grasses. While the increase in rhizomatous grasses is functionally beneficial for withstanding erosion and increasing plant cover, much of the increased frequency can be attributed to *Poa pratensis* - the only invasive species identified in the cookhouse meadow plots. Five years post restoration, the only plot without ground disturbing activity was also the only plot without *Poa pratensis*. It is unknown if the project activities increased the spread of this species, or simply reduced competition so that this species was able to colonize.

Unfortunately, we are unable to say anything conclusive about the presence and frequency of *Pinus contorta* in the established long term meadow plots due to removal of lodgepole seedlings by managers in 2007 and 2011. However, a count of *Pinus contorta* seedlings in the spring of 2012 suggests that conifer cover is almost four times greater in areas that experienced some soil compaction compared to areas of open undisturbed meadow. Future channel and meadow restoration may want to consider a conifer reduction plan if reduction in conifers is an objective.

Quantitative and qualitative results suggest there has been an increase in meadow species indicative of wet meadow conditions. Future monitoring could determine if either conifer encroachment or increasing frequency of *Poa pratensis* continues; this may provide some insight into management consideration for future projects. Potential considerations could include better sub-soiling of compacted soils to reduce conifer encroachment and potentially increase the spread of sod or native seed within the project area to reduce *Poa pratensis*.

Figure 11: Cookhouse Meadow Plot 0411. Photograph on the left is from 2004 (pre-restoration) and photograph on the right is from 2011 (5 years post-restoration).

Table 6: Lake Tahoe Basin management Unit 2008-2012 Meadow Monitoring Accomplishments.
The type of monitoring, measures used during monitoring, monitoring question, activities completed, and potential for future monitoring are all presented. Monitoring questions that are addressed in the report are notated with an x under summary.

Category *	Emphasis/ Measure	Monitoring/ Assessment Question	2008	2009	2010	2011	2012	Future	Summary
PE	Species composition, ground cover, wetland score, functional score, lodgepole abundance, fire characteristics	Can fire be used to reduce lodgepole abundance in meadows while maintaining or increasing the abundance of herbaceous species?	UC Davis: 7 sites; USFS: 8 sites	UC Davis: 7 sites; USFS: 8 sites	UC Davis: 7 sites; USFS: 8 sites				x
PE	Species composition, ground cover	Cookhouse Meadow: Is the ground water level in the central meadow sufficiently shallow to support the colonization and maintenance of desired meadow species? Are dry meadow grass species and conifers in the central meadow being out competed and replaced with desired meadow species indicative of wetter hydrologic conditions?		5 plots		5 plots			x
PE	Species composition, ground cover	What is the vegetation response to restoration at High Meadows?	1 plot	5 plots	1 plot			x	
ST	# of Fens, condition (vegetation, hydrology, soil)	How many fens are found on FS land in the LTB? What is the status of these fens?	8 sites, 14 plots	96 sites, 61 plots	20 sites, 21 plots; CNPS: 15 sites, 57 plots	4 sites, 2 plots		x	x
ST	R5 Range monitoring protocol: Species composition, ground cover, wetland score, functional score	What are the current conditions and ecological status and trend of meadows in the Lake Tahoe basin and how is that condition changing over time? Are changes in climate influencing wetland trends? What is the ecological condition and trend in meadow systems where grazing has been removed?	10 plots	58 plots	12 plots	9 plots	6 plots	x	x
ST	Photo-monitoring, cover/presence of key	What is the status and trend of Grass Lake (RNA) and Hell hole (critical habitat) fen		Grass Lake	Grass Lake	Hell Hole	Grass Lake;	x	

Category *	Emphasis/ Measure	Monitoring/ Assessment Question	2008	2009	2010	2011	2012	Future	Summary
	indicator species	ecosystems? Are changes in climate influencing community trends?					Hell Hole		

*PE=project effectiveness, ST=status and trend

- *How many fens are found on FS land in the LTB? What is the status of these fens?*

An assessment of fens in the Lake Tahoe Basin began in 2006. Sixty-four sites and 110 plots were visited between 2006 through 2012 to determine if sites identified as potential fens were fen ecosystems. In 2010, the California Native Plant Society (CNPS) worked in collaboration with LTB agencies to establish a system for quantitatively ranking fens. In 2010, they visited 15 sites and completed 57 individual stand surveys.

To date there are approximately 204 acres of fen ecosystem known in the Lake Tahoe Basin. There are a total of 59 fen units that have been verified in the field. Fen units can be noncontiguous units within a larger meadow complex, or standalone units. Future work will define what units contribute to an individual fen system. The CNPS identified ten new fen associations in the LTB; 20 out of the 30 associations in their classification are considered rare.

The CNPS ranked 49 fens in the LTB based on eight conservation significance criteria (uniqueness, quality, rarity, biodiversity, physical diversity, viability, defensibility, and value) to assist managers in making management decisions, including identifying restoration opportunities. The analysis was based upon a comparison of the entire set of sites, with ranks for each criterion based on the position of other sites in the continuum. While a framework was developed, inclusion of additional fens would require analysis of the entire fen dataset. Depending on the purpose, managers could consider individual certain ranking criteria when comparing fens and setting priorities for management (Sikes et al. 2011).

Fens were greatest in the South Basin region and were in general more highly rated for conservation significance compared to other regions in the Basin (East Basin, Incline Village, Meiss Country, West Basin). The three subwatersheds (HU-12) of the Truckee River Watershed had the three highest average Conservation Ranks, in addition to being the subwatersheds with the most fens currently recorded. Grass Lake East and Dave Immeker fen has the highest conservation significance ratings (Sikes et al. 2011).

Figure 12: Left photo: Fen 705-146-1 soil pit and soil column, note depth to saturation; right photo: Shay Fen – Lonley Gulch taking conductivity in the soil pit, note bryophyte rich substrate

- *What are the current conditions and ecological status and trend of meadows in the Lake Tahoe basin and how is that condition changing over time? Are changes in climate influencing wetland trends? What is the ecological condition and trend in meadow systems where grazing has been removed?*

The majority of meadow monitoring plots in the Lake Tahoe Basin (LTB) were established in 2004. During 2008 through 2012 we established plots and revisited established plots. New plot establishment occurred at sites with planned restoration in order to monitor project effectiveness and occasionally at additional meadows where we felt there was a gap (e.g. in a meadow within the Incline land acquisition). In 2009 all established plots were revisited in order to capture a five year reread.

As of 2009, the majority of meadows in the LTB were considered to be moderate to high functioning moist to wet meadows. Plant species diversity increased from 2004 to 2009. While the majority of meadow plots are located away from the meadow edge, we documented a significant increase in the presence and frequency of lodgepole pine (*Pinus contorta*) from 2004 to 2009. Climate and disturbance variables correlated with the plant communities include: wetland score, depth to saturation, litter cover, elevation, average annual maximum temperature, precipitation, and number of invasive species.

Preliminary analysis provided an initial look at meadow conditions in the LTB. A ten year reread of plots will occur in 2014. During this monitoring period additional data will be collected on stream incision, distance to meadow edge, distance to nearest conifer seed source and seedling. Collection of these additional variables will help guide restoration actions to maintain meadow condition related to conifer encroachment and stream incision. After the 2014 data collection, meadow condition trend can be assessed because meadow plots will have at least three points in time to establish a trend from.

Figure 13: Meadow monitoring in the Lake Tahoe Basin – Cookhouse Meadow.

Terrestrial Resources

Eighteen terrestrial resource monitoring questions were investigated between 2008 and 2012 (Table 7). Thirteen of these questions have been summarized in this report.

Table 7: Lake Tahoe Basin management Unit 2008-2012 Terrestrial Resources Monitoring Accomplishments.
The type of monitoring, measures used during monitoring, monitoring question, activities completed, and potential for future monitoring are all presented. Monitoring questions that are addressed in the report are notated with an x under summary.

Category *	Emphasis/ Measure	Monitoring/ Assessment Question	2008	2009	2010	2011	2012	Future	Summary
PE	acres, # of sites, management treatment and design criteria	What effect do projects have on spreading invasive non-native plants? What mitigation measures for prevention of establishment and spread are working and which measures need to be improved or added?	6 projects	21 projects	25 project	38 projects		x	x
PE	Acres/sites restored; number of Willow Flycatcher sites	What is our progress towards maintaining and improving willow and aspen habitats within the Basin?		82.7 acres of aspen treated	170 acres of aspen treated	53 acres of aspen treated	49 acres of aspen treated	x	
PE	Wildlife monitoring - measures of: bird point counts, bird nest success, butterflies, small mammals, herps, bats, meadow wetness	What are the short term/immediate wildlife response to stream/meadow/aspen restoration?	Cookhouse (post); Aspen (post, mammals); High Meadows (pre); Sunset Reach (pre); Taylor Tallac (pre)	Cookhouse (post); Aspen (pre, birds; post mammals); Sunset Reach (pre)	Aspen (post birds)	x	Aspen (post birds)	x	
PE	Angora Fen Meesia monitoring: Meesia cover	What is the status of Meesia populations in Angora fen where both sod collection and the Angora fire occurred?	4 transects			4 transects			x

Category *	Emphasis/ Measure	Monitoring/ Assessment Question	2008	2009	2010	2011	2012	Future	Summary
ST	GLORIA monitoring: Biodiversity, vegetation patterns, temporal changes in patterns, current patterns of mountain biota along elevation gradients	What is the status and trend of high elevation communities and risks to these communities due to changing climates?				x		x	
ST	Long term fungi plots: fungal diversity	What fungi occur in the Basin? What are the fungal diversity (species richness) trends in the Basin?	x	x	3 sites	x	x	x	x
ST	TEPCS Census Counts	What is the status and trend in TEPCS plant populations and communities within the Lake Tahoe Basin?	x	x	68 sites	x	x	x	x
ST	Draba asterophora long term monitoring: Density & Plant Size, Population Viability, demographic structure	What is the status and trend of TES plant species most likely impacted by changing climate?			8 populations, 26 transects, 167 plots	x	x	x	x
ST	Lewisia longipetala long term monitoring:	What is the status and trend of TES plant species most likely impacted by changing			2 populations, 6 transects, 37 plots		x	x	x

Category *	Emphasis/ Measure	Monitoring/ Assessment Question	2008	2009	2010	2011	2012	Future	Summary
	Density, Population Viability, demographic structure	climate?							
ST	TYC population estimate and habitat assessment	What is the status and trend of Tahoe yellow cress? Are core sites adequately protected?	61 sites monitored	62 sites monitored	Not monitored due to low lake level	62 sites monitored	62 sites monitored	x	x
ST	Bald eagle detections and nests	What is the status and trend of Bald Eagle populations in the Basin?	15,171 acres (summer), 26 survey points (winter)	17,411 acres (summer), 26 survey points x2(winter)	17,033 acres (summer), 26 survey points (winter)	17,033 acres (summer), 26 survey points (winter)	TINS		
ST	Townsend's big-eared bat detections and roost sites	What is the status and trend of bats in the Basin?	3 sites	4 sites	6 sites	2 sites	2 sites	x	x
ST	Goshawk detections and nests	What is the status and trend of Goshawk populations in the Basin?	14,465 acres (16 PACs)	54,045 acres (27 PACs)	31,889 acres (13 PACs)	28,280 acres (11 PACs)	30,869 acres (14 PACs)	x	x
ST	Osprey nests	What is the status and trend of Osprey populations in the Basin?	15,171 acres	17,411 acres	17,033 acres	17,033 acres	TRPA		
ST	Peregrine falcon detections and nests	What is the status and trend of Peregrine Falcon populations in the Basin?	3 sites, 12 visits	3 sites, 7 visits	3 sites, 10 visits	3 sites, 8 visits	4 sites, 9 visits	x	x
ST	Spotted owl detections and nests	What is the status and trend of Spotted Owl populations in the Basin?	17,911 acres (12 PACs)	33,262 acres (11 PACs)	35,795 acres (12 PACs)	39,395 acres (19 PACs)	26,154 acres (15 PACs)	x	x

Category *	Emphasis/ Measure	Monitoring/ Assessment Question	2008	2009	2010	2011	2012	Future	Summary
ST	Willow flycatcher territories, adults, fledglings, nests	What is the status and trend of willow flycatcher in the Basin?	11 sites	7 sites	12 sites	10 sites	8 sites	x	x
ST	MIS habitat and population distribution at the bioregional scale	What are the trends for Management Indicator Species at the bioregional (Sierra Nevada) scale?	Monitoring ongoing on MIS; 2008 MIS Bio-Regional Monitoring report released for data collected before 2008	Monitoring ongoing on MIS	2010 Bio-Regional MIS report released regarding trends in MIS for data collected before (or for some MIS during) 2010 (see summary)	Monitoring ongoing on MIS (will be reported in 2014 Bio-Regional MIS report)	Monitoring ongoing on MIS (will be reported in 2014 Bio-Regional MIS report)	x	x

*PE=project effectiveness, ST=status and trend

- *What effect do projects have on spreading invasive non-native plants? What mitigation measures for prevention of establishment and spread are working and which measures need to be improved or added?*

In 2008, LTBMU initiated a post-implementation project inspection program to better understand the effectiveness of the invasive plant prevention and treatment measures as prescribed during project planning. From 2008-2012, invasive plant surveys were conducted one, two, and three years after implementation at 46 projects, including fuels treatments, stream restorations, erosion control improvements and road, trail, and ski area maintenance and improvements. Results of these surveys were summarized in a 2013 assessment (Rowe and Engelhardt 2013).

The 2013 assessment indicated that current prevention and treatment measures appear to be moderately effective at reducing spread from existing infestations and preventing new introductions. Although, project implementation still poses some risk for the introduction of invasive plants. The majority of projects that were uninfested prior to project implementation remained uninfested after implementation, suggesting that for most projects either the invasive plant risk was low or that prescribed measures were effective. However, new infestations were detected at 17% of projects and exponential spread was documented at several infestations. With the exception of bull thistle, the new detections are species that are uncommon in the Lake Tahoe Basin; the introduction of even a single infestation represents a substantial risk for further spread.

A monitoring plan for out-year post-project monitoring is funded and scheduled for completion in FY14. The plan will likely include provisions to expand monitoring to include additional project types and track additional project attributes, while simultaneously focused monitoring efforts down to a single post-project inspection two years after implementation for each project.

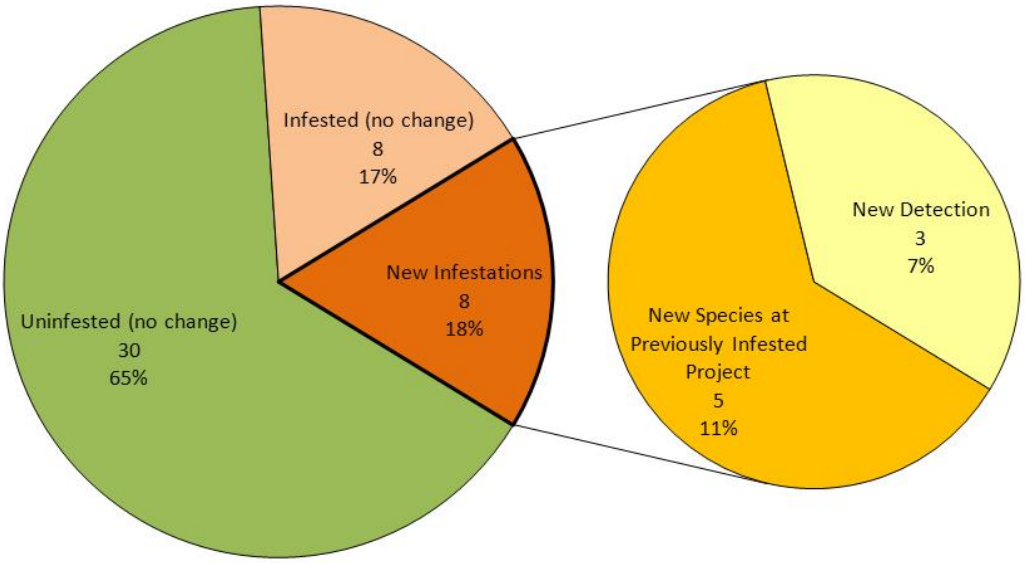

Figure 14: Percentage of projects infested post-project implementation, 2008-2012.

- *What is the status of Meesia populations in Angora fen where both sod collection and the Angora fire occurred?*

The cover of *Meesia* spp. were measured in 2006, twice in 2007 (before and after the Angora Fire), once in 2008, and again in 2011. Monitoring will not likely occur in the future, unless additional disturbance occurs at the site in which case we will utilize these plots as long term plots. *Meesia triquetra* was removed from the R5 sensitive plant list, while *Meesia uliginosa* remains on the R5 sensitive species list it is very low in abundance along established transects.

No impacts were detected from sod harvest or from the Angora wildfire. Transects were established after sod harvest, so direct impact of *Meesia* removal may have occurred, but remaining plants were not impacted. As of 2011, there was no detectable change in the cover of *M. triquetra* (averaged across all four transects) since the initial survey (Engelhardt and Gross 2011b, 2012a).

Figure 15: One year post sod harvest and restoration of the sod borrow area.

- *What fungi occur in the Basin? What are the fungal diversity (species richness) trends in the Basin?*

In the fall of 2008, three long-term fungi plots were established on the LTBMU by the Mycological Society of San Francisco following the Forest Service's Region 5 fungi monitoring protocol in modeled suitable habitat for sensitive fungi species. Plots are located at Fountain Place, Page Meadow, and Blackwood Canyon. At each location, fungi are searched for in two concentric circular plots that are 1/10th acre and 1/5th acre in size. Plots were visited annually from 2008-2012, typically in October or November, following the first precipitation of the fall.

Between 2008 and 2012, a total of 73 unique species have been identified from the plots (Engelhardt and Gross 2011b; Engelhardt and Gross 2012a; McKnight and Engelhardt 2013). No fungi were found in

the plots in 2008 or 2009, while in 2010 through 2012, the number of fungi species per plot ranged from a low of three (Fountain Place in 2011) to a high of 29 (Blackwood in 2010). Only two species (*Dasycyphus bicolor* and *Strobilurus albipilatus*) have been collected in every year from 2010 to 2012, and only four species (*Dasycyphus bicolor, Heterotextus alpinus, Strobilurus albipilatus*, and *Trichaptum abietinum*) have occurred in every plot at least once. These results indicate substantial spatial and temporal variation in fungi diversity as well as high turnover of species in each plot.

Both precipitation and temperature have been correlated with fungal phenology and species richness (Straatsma 2001). Qualitatively, October precipitation appears to correlate positively with fungi species richness within a given year (Figure 16). Precipitation data is from local Remote Automated Weather Stations (RAWS) from the Western Regional Climate Center. The Homewood RAWS station is near the Blackwood and Page Meadows plots, and the Meyers RAWS station is near the Fountain Place plot.

Only one sensitive fungi species, *Dendrocollybia racemosa*, is known to occur in the Lake Tahoe Basin- from a 1982 herbarium specimen collected near Tahoe City. This species was not observed in the fungi plots in any monitoring year. The results of the fungi monitoring are important in helping managers understand the persistence of fungi species at a given site, the site characteristics that support high fungi diversity, and the climate characteristics that affect fungi diversity. This information can be used to interpret project effects in fungi habitat or identify locations for protection or habitat structure retention that will protect the greatest diversity of fungi species.

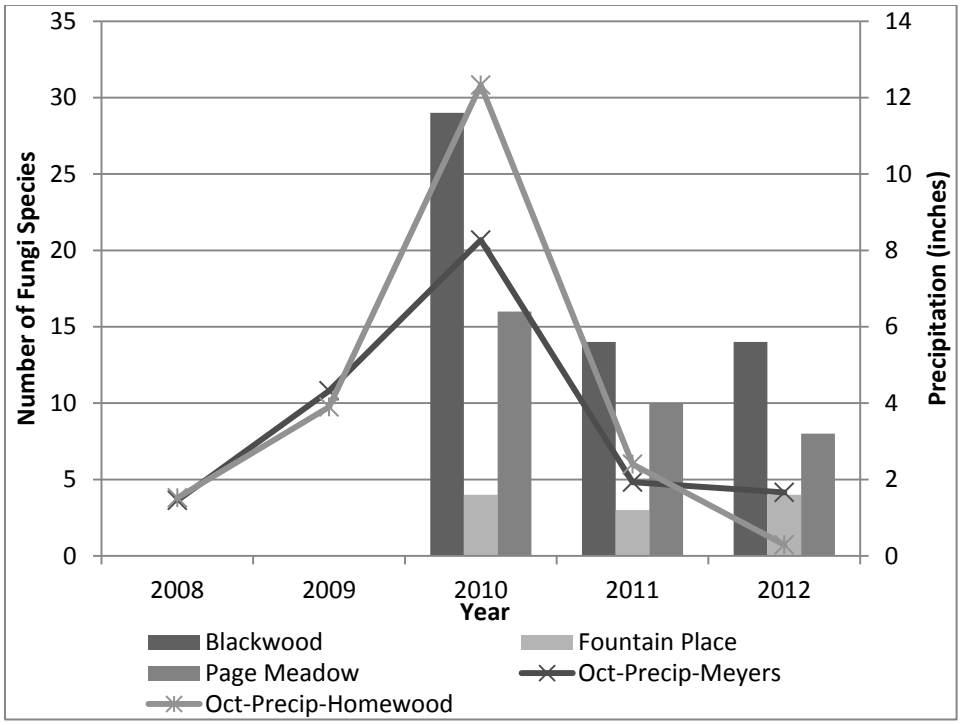

Figure 16. Number of fungi species observed at three permanent plots during surveys in 2008-2012. Precipitation for the month of October is from local RAWs stations.

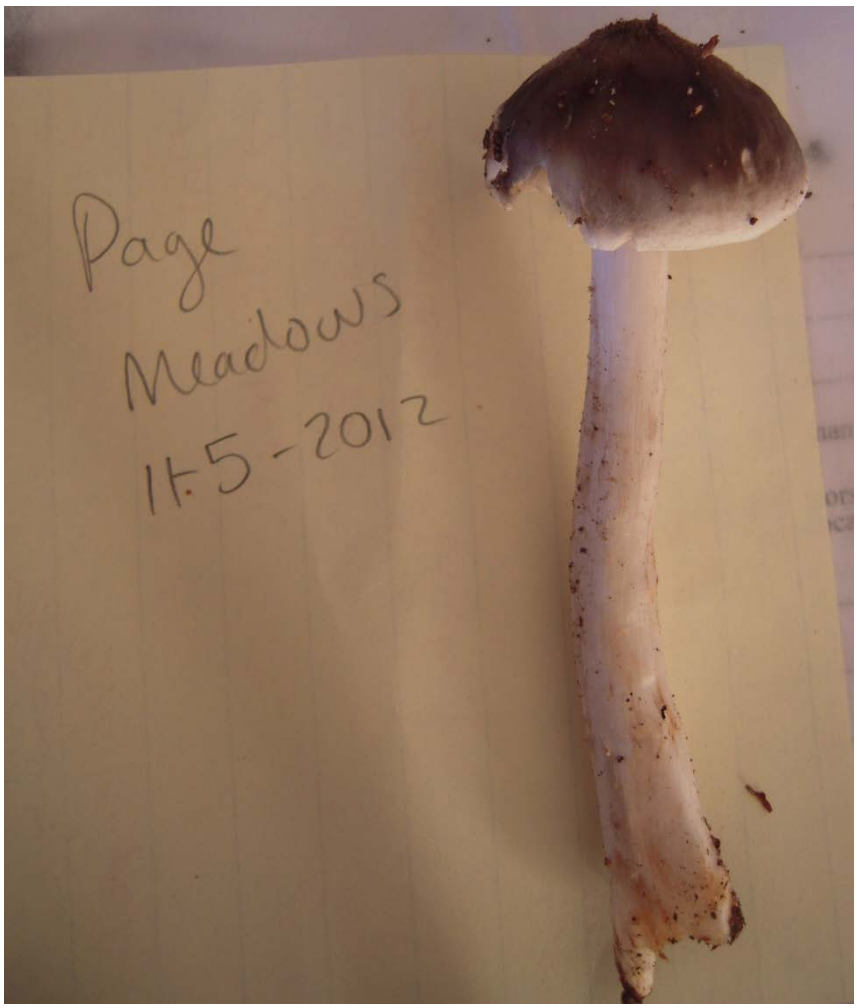

Figure 17. A collection of *Pluteus cervinus* (Deer Mushroom) from the Page Meadows plot in November 2012.

- *What is the status and trend in federally Threatened, Endangered, Proposed, Candidate, and Forest Service Sensitive (TEPCS) plant populations and communities within the Lake Tahoe Basin?*

A comprehensive monitoring program to track the status and trend of TEPCS and LTBMU watch list species was initiated in 2004. Each sub-element occurrence is visited at least once every five years and the number of plants is counted. In addition, occurrences are visited more frequently when: 1) new occurrences or sub-element occurrences are discovered (a minimum of two years of baseline data is obtained); 2) data suggests that an occurrence or sub-element is decreasing; or 3) the occurrence or sub-element occurrence status is in question (e.g. occurrence could not be relocated, species identification could not be confirmed, large unexplained year-to-year fluctuation in number of plants). The most recent comprehensive monitoring occurred in 2009. In 2010-2012, revisits were made to occurrences that were 1) declining based on previous year's visits; or 2) new occurrences where an additional year of baseline data was desired.

Results of TECPS monitoring are included in the Rare Plants Annual Reports from 2009 through 2012 (Gross 2010a and 2010b; Engelhardt and Gross 2011b; Engelhardt and Gross 2012a; McKnight and

Engelhardt 2013). From 2008 to 2012, approximately 360 visits to TECPS and watch list plant species occurrences were made. Of these visits, 110 were newly discovered sites (69 new TECPS sites and 41 new watch list sites). The identification of these additional 110 sites will improve our ability to protect and/or enhance populations of these species via management actions. They also contribute to our understanding of the population status of the species across its entire range, providing an improved context for analyzing project effects on specific occurrences.

Based on 2012 census data of sensitive plant occurrences 41% were stable, 24% were increasing, 18% were decreasing, 11% were of unknown status, and 6% were new in 2012. Based on 2012 census data of watch list plant occurrences, 74% were stable, 6% were increasing, 10% were of unknown status, and 10% were new in 2012. The large percentage of occurrences with unknown status is related to difficulty in quantifying the size of bryophyte occurrences. These results show that the majority of occurrences are either stable or increasing, for both sensitive and watch list plant species (Table 8).

Many species-specific findings have also resulted from TECPS and watch list species monitoring:

- Monitoring of *Epilobium howellii* and *Meesia triquetra* on the LTBMU and other Region 5 forests indicates that these species are more common and stable than previously thought; therefore both species are being removed from the Region 5 sensitive plant list in 2013 (Figure 18).
- Revisits to *Arabis rigidissima* var. *demota* and *Arabis rectissima* var. *simulans* sites have provided a better understanding of the distinguishing characteristics of these species. This has resulted in better accuracy surveying for these species and the removal of several sites due to mis-identification.
- Monitoring at *Bruchia bolanderi* occurrences at two meadow restoration projects (Cookhouse Meadow and High Meadow) indicates that the species is still present post-restoration. This suggests that the project design features were successful in preventing deleterious effects on these occurrences and that the species is at least somewhat tolerant of disturbance within the same meadow ecosystem. Similarly, monitoring at a *Meesia uliginosa* occurrence in the Angora Fen indicates that this species is persisting at the site following downstream disturbance that occurred in 2007.
- Monitoring of *Sphagnum* occurrences has indicated that this species is stable and fairly numerous on the LTBMU. However, Sphagnum occurrences have so far only been identified to genus, and there is currently an effort underway to identify occurrences to species. Depending on the findings from this study, this genus could potentially be removed from the LTBMU watch list if there is low diversity in *Sphagnum* species present on the LTBMU and/or if no rare *Sphagnum* species occur on the LTBMU.

Table 8: Overall change* of sensitive and LTBMU watch list species known to occur on the Lake Tahoe Basin Management Unit.

Species	Legal Status[2]	Total EO & Sub-EOs	New 2012	Stable	Increase	Decrease	Unknown
Arabis rectissima var. *simulans*	W	5	0	0	1	0	4
Arabis rigidissima var. *demota*	S, TRPA	7	0	1	3	3	0
Botrychium ascendens	S	8	1	2	2	3	0
Botrychium crenulatum	S	4	0	2	0	2	0
Botrychium minganense	S	2	0	1	0	1	0
Botrychium montanum	S	3	2	0	0	1	0
Bruchia bolanderi	S	8	1	0	0	0	7

Species	Legal Status[2]	Total EO & Sub-EOs	New 2012	Stable	Increase	Decrease	Unknown
Chaenactis douglasii var. *alpina*[4]	W	9	4	0	0	0	5
Claytonia megarhiza	W	3	0	1	1	0	1
Dendrocollybia racemosa	S	1	0	0	0	0	1
Draba asterophora var.	S, TRPA	40	1	25	9	3	2
Draba asterophora var.	S,TRPA	9	0	4	3	1	1
Epilobium howellii	S	10	2	1	4	3	0
Helodium blandowii[3]	S	3	0	3	0	0	0
Lewisia longipetala	S, TRPA	12	1	4	5	2	0
Meesia triquetra[3]	S	27	0	17	0	0	10
Meesia uliginosa[3]	S	2	0	2	0	0	0
Orthotrichum shevockii	W	3	0	0	0	0	3
Peltigera gowardii	S	4	2	0	0	0	2
Pinus albicaulis[5]	S, C	-	-	-	-	-	-
Scutellaria galericulata	W	5	0	3	2	0	0
Sphagnum spp.[3]	W	29	1	28	0	0	0

[1]Overall change was determined by comparing the total number of plants from the date the occurrence was first observed to the total number of plants observed during the most recent census. All occurrence visits were within two weeks of the date the occurrence was first observed.
[2]S—R5 Regional Forester's Sensitive Species List; W—LTBMU Watch List, TRPA—Tahoe Regional Planning Agency Sensitive; C—Candidate for Federal listing under Endangered Species Act.
[3]Overall status of these bryophyte species are listed as either unknown (the occurrence was still present) or decrease (the occurrence was absent).
[4]Tracking for this species began in 2011.
[5]A monitoring protocol for status and change of this species has yet to be developed.

Figure 18. Photographs of *Epilobium howellii* and *Meesia triquetra*- two species proposed for removal from the Region 5 Sensitive Species List.

- *What is the status and trend of TES plant species most likely impacted by changing climate?: What is the status and trend of Draba asterophora density and plant size within the Lake Tahoe Basin? What is the relationship between plant size and reproductive success? What is the status and trend of Draba asterophora demographic structure (life history stages: vegetative, flowering, fruiting, and dehiscent) within the Lake Tahoe Basin? What are the transition rates between four stage classes (small-vegetative, large-vegetative, small-reproductive, and large-reproductive)? How much do these rates change annually? Are changes in climate (total snowfall, timing of spring runoff) influencing the density, demographic structure or transition rates of D. asterophora populations? Are changes in inter-specific competition (total vegetative cover) or habitat suitability (ground cover, erosion features) related to density, demographic structure or transition rates of D. asterophora populations? Are there noticeable differences in density, demography, population viability, competition, or habitat characteristics of D. asterophora populations that occur at ski areas compared to those that occur in remote locations?*

Long-term monitoring plots were established in 2010 at nine sub-element occurrences within four Tahoe Draba (*Draba asterophora*) Element Occurrences on the LTBMU (Figure 19). The populations are located in the vicinity of Freel Peak/Star Lake (DRASA 1a, 1b, 1d, 1j), Heavenly Ski Area (DRASA 2b, 2f), Mt. Rose (DRASA 3b), and Saucer Lake/Ralston Peak (DRASM 1b, 1e). The Freel Peak/Star Lake and Saucer Lake/Ralston Peak populations are located in non-motorized backcountry areas. The population at Mt. Rose is fairly remote and in a summer non-motorized area. The populations at Heavenly Ski area are located at a ski resort that is used in the summer and winter, however sites are fenced in the summer to prevent damage and snow cover should protect the plants from damage during the winter.

At each population, two to four permanent transects were established within the boundaries of the population. Approximately 20 plots were located randomly along the transects, with the goal of capturing a minimum of 100 *D. asterophora* plants in total within the plots at each population. Within each plot, plants size, number of inflorescences, and phenology (flowering, fruiting, dehiscent) were collected. The location within the plot of each plant was mapped for relocation during future visits. Percent cover of *Draba* plants, other vegetation, and groundcovers were also recorded for each plot (Engelhardt and Gross 2012b). All nine sites were revisited in 2011 and 2012. Monitoring occurred for two years after plot establishment to collect baseline data, and then will occur every three to five years until a decision is made to cease monitoring this species (i.e. this species is no longer considered sensitive, rare, imperiled, etc.). Assuming a revisit every four years, the plots would be revisited next in 2016. The actual schedule may change given the three to five year range.

All sites increased in the total number of live plants from 2010 to 2011, for an average of a 20% increase overall. From 2011 to 2012, five sites increased while four sites decreased in the total number of live plants, for an average of a 0.02% increase or essentially no change overall (Figure 20). Similarly, the total canopy cover of *Draba* plants increased at all sites from 2010 to 2011, for an average of a 27.9% increase overall, and the total cover of *Draba* plants increased at eight of nine sites from 2011 to 2012, for an average of 12.5% increase overall. All populations had a larger birth rate than death rate between 2010 and 2011, while five of nine populations had a larger death rate than birth rate between 2011 and 2012. The average rate was positive from 2010 to 2011, and was exactly zero from 2011 to 2012.

In all three years, the majority of plants were vegetative (69.5%, 78.2%, and 69.8% averaged across all sites in 2010, 2011, and 2012, respectively). The ratio of vegetative to reproductive plants was fairly constant over the three years, with a slight increase in the proportion of vegetative plants in 2011, a year with a very large and persistent snowpack which may have delayed plant phenology. The relationship between plant size and number of inflorescence stems is not directly linear. The majority of

plants have less than 10 inflorescence stems and these plants range in size up to ~50cm^2. Some plants had over 20 inflorescence stems, and one plant had 46 inflorescence stems; however there were also a few large plants that had none or just a few inflorescence stems.

At eight of nine populations, snow-water-equivalent (SWE) and number of plants were related. The longer the snow remained at the site (later date of greatest SWE), the fewer plants were observed at the site. The date that SWE reached zero was not related to the number of plants observed at the population. Average plant size was not related to the date of greatest SWE or the date that SWE reached zero.

At the DRASA sites, bare ground and rock comprised approximately 90% cover on average, with litter cover averaging less than 10%. Litter cover was somewhat higher at the two Cup Lake Draba (DRASM) sites- averaging 10% to 15% at DRASM1b, and 22% to 32% at DRASM1e. *Draba* cover was highest when litter cover was 15% or less, although *Draba* still occurred even when litter cover reached up to 100%. The number of *Draba* plants in a plot was typically highest when litter cover was less than 10%, although plots with higher litter cover still supported 20+ plants in some cases.

The total cover of non-*Draba* vegetation in the plots averaged less than 10% in all years at all sites. *Draba* cover was highest in plots when the cover of other vegetation was 10% or less, and *Draba* only occurred a few times at plots with greater than 30% vegetation cover. Plots with the largest number of *Draba* plants typically had 10% or less cover of other vegetation.

From 2010 to 2011, the two sites at ski areas (DRASA2b and DRASA2f) had the second and fourth greatest increase in population density of all nine sites. From 2011 to 2012, these two sites had the two greatest increases in number of plants per site of all nine sites. In all three monitoring years, the proportion of the population that was reproductive was higher at the ski area sites, compared to non-ski area sites.

Litter cover was similar between ski area sites (both of which are DRASA) and other DRASA sites not at ski areas. However, litter cover was much higher at the two DRASM sites than at DRASA sites (ski and non-ski). Cover of other vegetation was slightly lower at ski area sites (both of which are DRASA), compared to both DRASA and DRASM sites not at ski areas. These preliminary results suggest that ski area management is not currently impacting these populations compared to populations at non-ski areas.

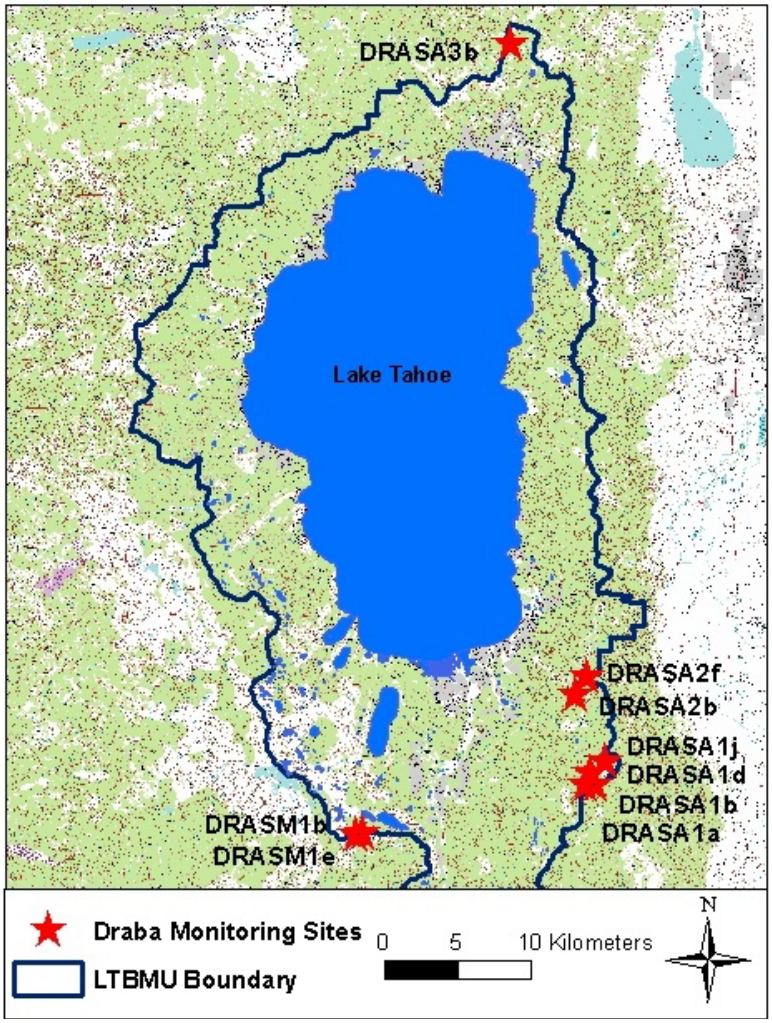

Figure 19. General location of populations selected for long-term monitoring plots on the Lake Tahoe Basin Management Unit.

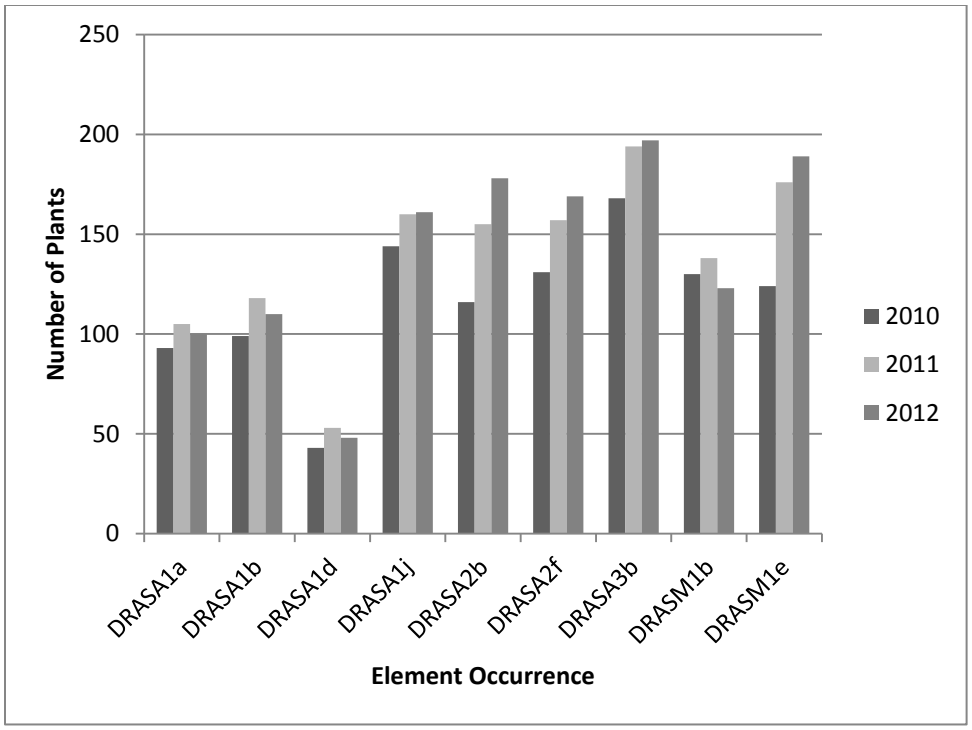

Figure 20. Total number of Draba plants at nine populations 2010, 2011, and 2012.

- *What is the status and trend of TES plant species most likely impacted by changing climate? What is the status and trend of Lewisia longipetala density within the Lake Tahoe Basin? What is the status and trend of L. longipetala demographic structure within the Lake Tahoe Basin? Are changes in climate (snowpack persistence, total snowfall, timing of spring runoff) influencing the density or demography of L. longipetala populations? Are changes in inter-specific competition (associated species, total vegetative cover) influencing the density or demography of L. longipetala populations?*

The two populations selected for long-term monitoring of long-petaled lewisia (*Lewisia longipetala*) are located in Desolation Wilderness. Plots were established at LELO 1a above Dicks Lake in 2009 and at LELO3a above Triangle Lake in 2010 (Figure 21). LELO1a was also re-monitored in 2010. Both sites were re-monitored in 2012 due to an extensive summer snowpack which prevented monitoring in 2011. At each population, three permanent transects were established within the boundaries of the population. Transects were systematically placed such that at least one *L. longipetala* plant occurred in plots placed every five meters along the transect. All plants that occurred completely within the plot were counted. Each rosette was counted as one individual. Counts of the number of individual plants were made by life stage: seedling, vegetative, budding, flowering, fruiting, and withered. Canopy cover was recorded for all other plant species (including moss and lichen) that occurred in each plot (Engelhardt and Gross 2011a).

Monitoring occurred for two years to collect initial baseline data, and then will occur every three to five years until a decision is made to cease monitoring this species (i.e. this species is no longer considered sensitive, rare, imperiled, etc.). Assuming a revisit every four years, the plots would be revisited next in 2016. The actual schedule may change given the three to five year range.

Data collected in 2012 has not yet been fully analyzed. A preliminary summary from 2009 through 2012 suggests that LELO1A density increased while LELO3A density decreased slightly (Figure 22). At both

sites, there were smaller proportions of budding and flowering plants and a larger proportion of withered plants in 2012 compared to 2010, likely due to the low amount of snow that fell during 2011-2012. Many plants appeared not to have flowered at all during 2012. However, there were a large number of seedlings observed in 2012 at LELO1A.

Based on data from 2009 and 2010, average vegetation cover at plots was 16% at LELO1A, and 38% at LELO3A. *Lewisia longipetala* did not typically occur in plots with greater than 60% cover of other vegetation. Seedlings were never observed in plots with greater than 60% cover of other vegetation.

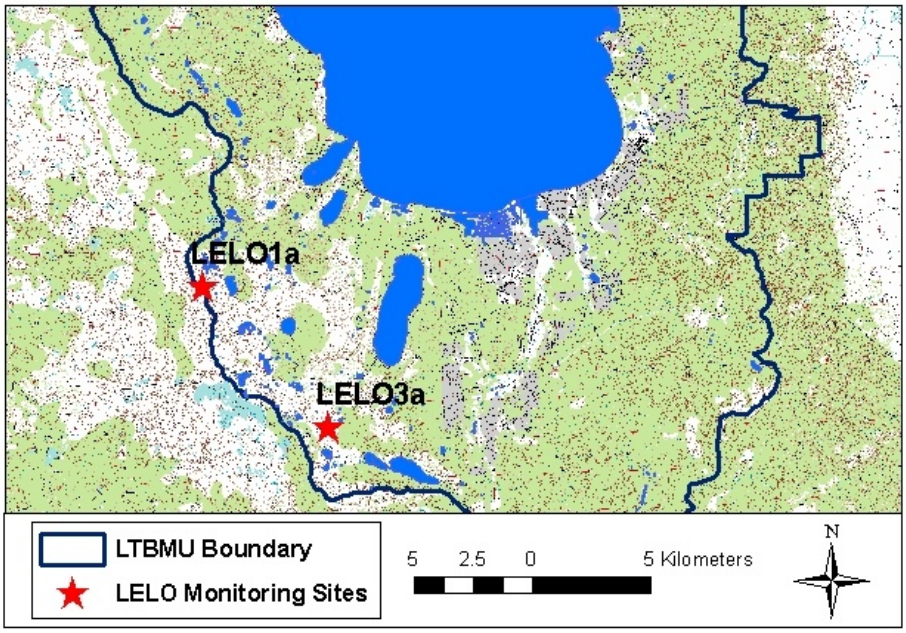

Figure 21. General location of populations selected for long-term monitoring plots on the Lake Tahoe Basin Management Unit.

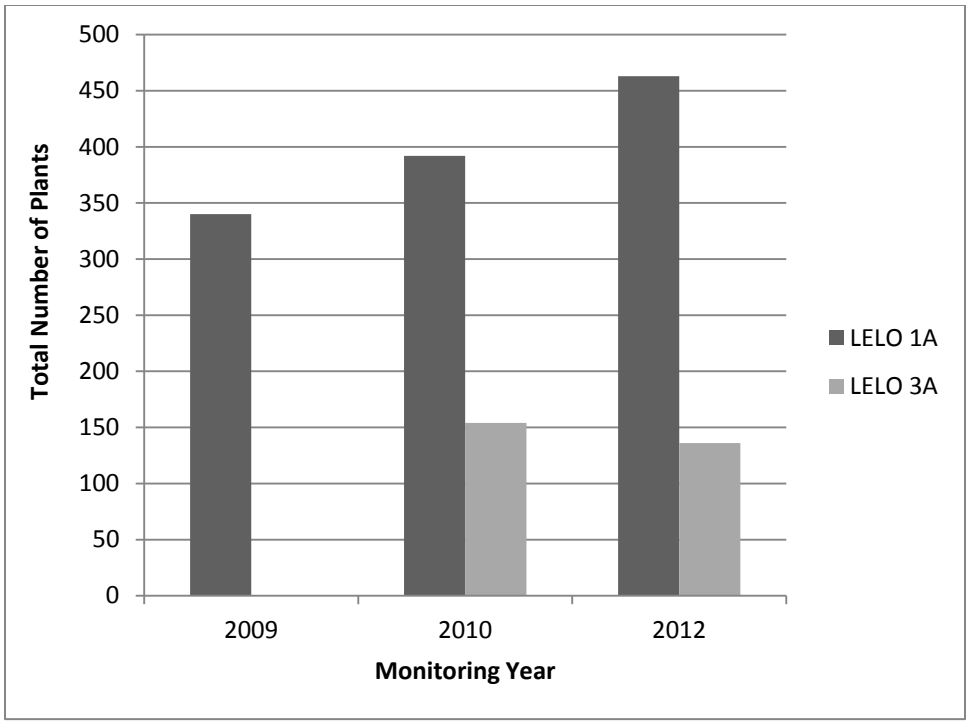

Figure 22. Total number of Lewisia plants at two populations 2009, 2010, and 2012 (monitoring at LELO3A was not established until 2010).

- *What is the status and trend of Tahoe yellow cress? Are core sites adequately protected?*

Field surveys to determine the number of occupied sites with TYC date back to 1979. These surveys are conducted over two days in early September, include all known Tahoe yellow cress occurrences on public and private lands, and consist of estimation of population numbers within set areas designated as occurrences by the Nevada Natural Heritage Program. From 2008-2012 interagency population-wide surveys were conducted four times in 2008, 2009, 2011 & 2012 (Table 9).

Annual monitoring reports were published in 2008 and 2009 (Pavlick and Stanton 2009, 2010). The annual reports provide a record of all conservation activities related to Tahoe yellow cress, including survey, outplanting, funding, and various other member activities. Draft reports were developed in 2010 and 2012, but were never moved through the final approval process with the TYC Executive Committee (Pavlick and Stanton 2011, Tahoe Yellow Cress Adaptive Management Working Group 2013).

The 34-year survey record of population-wide surveys has been crucial in the identification of the cyclic nature of TYC distribution and abundance, how strongly occupancy is related to lake level, the apparent metapopulation dynamic of the species, and opportunities and constraints based on land management type. In general, there have been more occupied sites when the lake is low and fewer when it is high (Figure 23). During years in which lake level in September is 6226 LTD, there tends to be sufficient site occupancy to operate under Level 1 (normal conditions) of the Imminent Extinction Contingency Plan defined in the Conservation Strategy (CS) (Pavlik and Murphy 2002). At Level 1, no changes to the normal policies and guidelines for protection of existing occurrences and potentially suitable habitat are required. This led to the development of the adaptive survey strategy, in which survey frequency is tied to lake level, with more frequent survey in high water years. In 2010, the TYC Adaptive Management Working Group (AMWG) revised the frequency of surveys. Instead of annual surveys, monitoring is

linked to lake level. At lake levels of 6,226 ft Lake Tahoe Datum (LTD) and above, monitoring is conducted annually. Below 6,226 ft LTD, surveys may be conducted every other year. In 2013, a new Memorandum of Understanding (MOU) was signed by nine agencies and entities that agree to continue the current adaptive monitoring strategy, in which survey frequency is tied to lake level, for the next ten years.

Total stem counts have not been as closely tied to lake level as site occupancy, but still tend to follow lake level, with high stem counts observed in years with lower lake levels (Figure 24). The range of stems per site is quite large, with the number of stems counted at any one site ranged from 1 to over 10,000 from 2008-2012. The stem count data was fundamental in developing a quantitative site ranking methodology and Minimum Viable Population sizes (MVP). Relative abundance, persistence and variability among sites have been used to create a composite index upon which sites are ranked for conservation priority. While this ranking will likely be updated when the Conservation Strategy is updated, it will likely continue to use the monitoring results as ranking factors. Taken together this knowledge of the basic biology of the species forms the very foundation of the Conservation Strategy. A revised conservation strategy has been funded through the Southern Nevada Public Lands Management Act (SNPLMA) funds. It is scheduled for administrative review in late 2014.

Table 9: Summary of Tahoe Yellow Cress population-wide interagency surveys, 2008-2012

	2008	2009	2011	2012
Sites Not Surveyed	2	1	3	3
Sites Surveyed	59	61	59	59
Sites Occupied	43	46	25	32
Sites Unoccupied	17	14	37	30
Total Sites	61	62	62	62

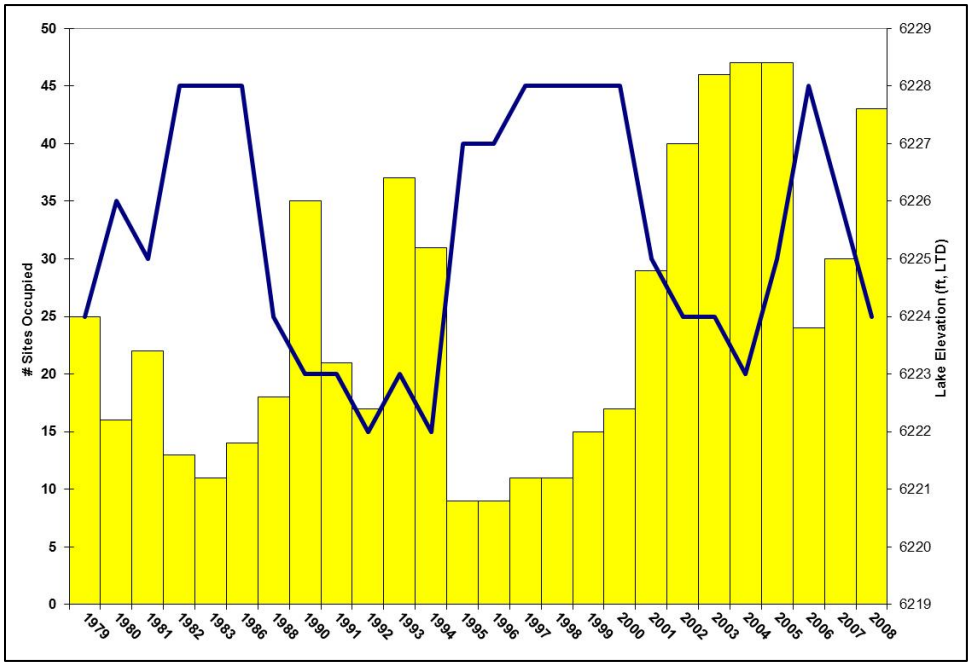

Figure 23. Lake level and number of Tahoe yellow cress sites occupied by survey year, 1979-2008.

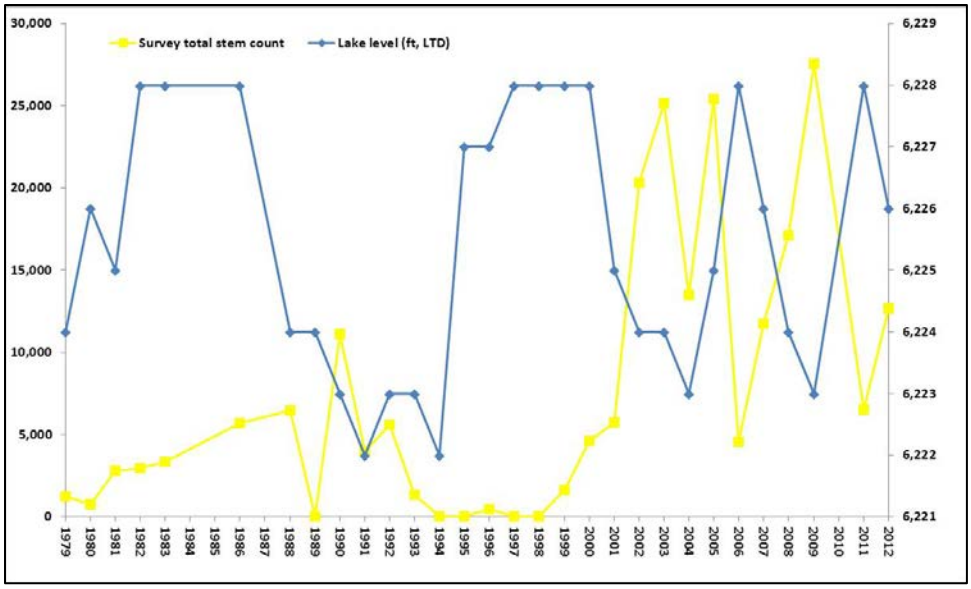

Figure 24. Lake level and total stem count for surveyed sites by survey year, 1979-2012.

- *What is the status and trend of bats in the Basin?*

Townsend's big-eared bat surveys in the LTBMU have been an evolving process throughout the summary period. In 2008 the LTBMU initiated plans to assess mines for bat habitat suitability and conduct protocol surveys where appropriate. Potentially suitable mines were visually surveyed with the intent to categorize them as suitable or unsuitable for cave/mine dwelling bat roosting habitat. Mines that were determined to be suitable were surveyed using the protocol detailed in Tuttle and Taylor (1998). In addition to the historic mine locations surveyed in 2008, the 2009 surveys also included the historic Newhall house on the east shore of Lake Tahoe. For the 2010 through 2012 seasons the LTBMU internal protocol "Townsend's Big-eared Bat in the Lake Tahoe Basin" was used for surveys.

Of the eight sites investigated in 2008, three were determined to be possible bat habitat, Tahoe Treasure I and II and Mountain Top Mine. Over the course of the summary period, an additional five Forest Service owned buildings were surveyed because they were reported to have bat colonies (Newhall House, Taylor Creek Visitor Center, The Boathouse Theater and Old Mill).

Townsend's big-eared bat was detected acoustically at both of the Tahoe Treasure mine adits and at Newhall House in 2009 but not again during the summary period. Because echolocation data were recorded outside of these structures, it can't be determined if the species was roosting in the structure or simply foraging or moving through the area. Internal surveys of roosting bats were never conducted at the Tahoe Treasure mine adits because of safety concerns but were conducted at Newhall house during 2011 and 2012. Townsend's were not identified inside the structure during the 2011 and 2012 surveys. However, the Newhall house is home to the largest known bat roost in the LTBMU with approximately 300-400 bats. This colony is likely comprised of little brown bats (*Myotis lucifugus*) and/or Yuma myotis (*Myotis yumanensis)*. Taylor Creek Visitor Center and Valhalla Boat House were both found to contain sizeable bat colonies. However, the habitat at these sites was not suitable for Townsend's big-eared bat, so they have not been further surveyed. The colony at Taylor Creek Visitor Center was approximately 70-100 individuals and was thought to be comprised primarily of little brown bats even though external recordings also detected several other species. This area was near a large marsh, so these other species may well be foraging in the area but be unassociated with the roost. Individuals

collected from inside the building have all been little brown bats. Valhalla Boat House is a historic building that is currently used as a small theater. Although exit surveys detected approximately the same number of individuals as those at the visitor center, this site, along with Newhall House had the highest species diversity compared to the other sites surveyed. Old Mill was surveyed as part of an effort to determine if this building should be demolished or repaired. Bats were found exiting the building during roost exit surveys but Townsend's big-eared bat was not identified. One to five bats were found leaving this roost over the course of three surveys.

The status of the Townsend's big-eared bat population in the LTBMU is unknown. Townsend's big-eared bats are a cave/cave-surrogate obligate species. The LTBMU is primarily made up of granitic substrates which are not conducive to the formation of caves and there are relatively few mines. Although Townsend's have been found to roost in hollows of large decadent trees in the Pacific Northwest (Fellers and Pierson 2002), large decadent trees are relatively uncommon in the LTBMU compared to the Pacific Northwest, partially because of the difference in dominant tree species (redwood trees can grow substantially larger than the tree species in the LTBMU) and partially because many of the trees in the LTBMU are secondary growth following heavy logging during the Comstock Era. Therefore, Townsend's big-eared bat would not be expected to be plentiful in the LTB due to a lack of roosting habitat.

Surveys for Townsend's have brought us a better understanding of bat populations in the LTBMU. Although we already had a dataset from the 2002-2005 Multi-Species Inventory and Monitoring project (MSIM) and the 2004-2009 restoration monitoring effort both of these were solely aimed at species composition in general habitat. The surveys during the summary period have given us a better idea of population numbers and species composition at cave/cave-surrogate sites.

We have evaluated all potential structures on USFS lands that could be considered suitable habitat for Townsend's big-eared bats and have identified calls of this species at three of these sites. We recommend continuing to place echolocation recorders at these sites periodically. However, because we have not identified Townsend's at these sites since 2009 and we are not currently learning new information about the bats using the sites we survey, we may find more value in placing echolocation recorders in suspected foraging habitat, especially foraging habitat near recently completed restoration projects where pre-restoration bat surveys have been conducted.

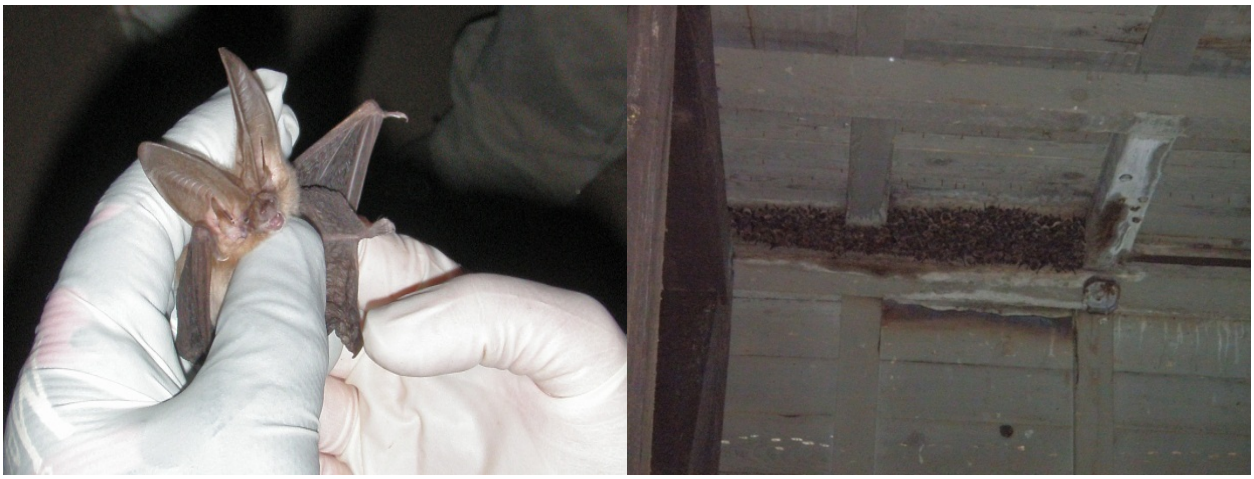

Figure 25: Left photo of a Townsend's big-eared bat. Right photo of the bat colony at Newhall House.

Figure 26: Left photo of the Tahoe Treasure II mine adit. Right photo of the Tahoe Treasure I mine adit before it was gated.

- *What is the status and trend of northern goshawk populations in the Basin?*

Northern goshawk surveys in the basin were conducted for project-level surveys, and for population monitoring purposes. Project-level surveys on the LTBMU were conducted within suitable habitat of a project footprint or within 400 meters of project footprints (depending on the project activities), following the "Northern Goshawk Inventory and Monitoring Technical Guide" (USDA, 2006). Surveys were conducted to determine goshawk presence, occupancy, reproductive status and number of fledged juveniles within an area. Goshawk presence is defined as one or more goshawks seen or heard in the survey area or presence of goshawk feathers in the survey area. Occupancy was defined as a territorial adult within a nesting area, regardless of reproductive activity. Reproductive status was determined by evidence of egg-laying.

A monitoring plan (NOGO MP) was developed by researchers from the Forest Service Pacific Southwest Research Station, Redwood Sciences Lab in Arcata, California. The NOGO MP was designed as an early-warning system to detect biologically significant changes in the northern goshawk population with statistical rigor. Due to a lack of statistically viable data, the current trend in the northern goshawk population is unknown. To date no conclusions can be drawn from the NOGO MP because only one round of surveys was implemented. Table 10 shows the number of occupied territories and reproductively active territories each year versus the number of territories surveyed and the mean percent occupied and reproductively active over the five year period.

The acres of northern goshawk habitat and number and identity of territories surveyed fluctuated annually depending on the number of projects requiring surveys, number of PACs selected for surveys, whether it was a NOGO MP survey year or not and amount of available funding. Between 14,465 and 54,045 acres of northern goshawk habitat were surveyed each year over the five year summary period. The number of areas with goshawk presence ranged from 10-16 per season (mean = 14, SD = 3). There were 2-11 reproductive territories per season (mean = 8, SD = 4) with 2-19 young fledged (mean = 10, SD = 7). The number of young fledged should be interpreted with caution as reproductive success is strongly influenced by factors that were not monitored (e.g., weather, prey availability).

An increase in survey effort (in terms of acres of habitat surveyed) did not appear to correlate with increased detection probability. However, these data are based strictly on acres surveyed and not on

territory identity and some territories may be more active than others. Acres surveyed were the highest in 2009 (surveys were being conducted for several large fuels reduction projects that year) and lowest in 2008. Additionally, 2009 was the initial year of the NOGO MP. Individuals detected, occupied territories, reproductively active territories and juveniles fledged were all higher in 2009 than in 2008. Although this increase in goshawk activity could be correlated with increased survey effort, goshawk presence was higher in 2010 and 2012 when approximately 20,000-25,000 fewer acres were surveyed. Goshawk numbers decreased from the previous season in 2011. The 2012 season had especially high detection and reproduction numbers. In fact, the number of juveniles fledged was the highest ever recorded in one season in the LTBMU during 2012. The reason for these patterns is not clear. It may be that the mild winter of 2011-2012 contributed to more nesting opportunities and prey, but we do not have data to evaluate this possibility. Likewise, the long and heavy winter of 2010-2011 may have contributed to a decline in goshawk and reproductive activity during the 2011 season. Five territories surveyed in both 2010 and 2011 were reproductively active in 2010 but not in 2011. It may be that the long winter (extending into June) and heavy snowpack influenced nesting opportunities, energetic costs, prey availability, and other reproductive requirements, or nests may have failed due to inclement weather events. In addition to weather, the data may have been influenced by other factors such as prey availability, surveyor ability, territory identity (more active versus inactive territories), and propensity of goshawk to respond to broadcast calling.

Surveys are anticipated to continue although it may be that fewer acres and territories would be surveyed annually because of a declining trend in the number of projects requiring surveys and funding resources. Surveys and their results are essential to informing management activities and decisions. Originally, we had hoped that the NOGO MP would provide us with a protocol to select and evaluate goshawk territories in a way that would provide information on population trends. The intent of the NOGO MP is to be an early-warning system to detect biologically significant changes in the goshawk population with statistical rigor. The metrics evaluated as part of the NOGO MP (territory occupancy, reproduction, and nest productivity) are considered effective tools for determining population trends and evaluating the stressors influencing the population. However, the NOGO MP is very costly and not likely to be implemented in the future unless we are able to identify cost-saving changes in the monitoring plan that do not jeopardize the statistical rigor and intent of the program. An evaluation of possible alternative solutions is needed and efforts should be made to adapt the monitoring plan to make it more affordable while retaining its ability to detect biologically significant changes in the population. Until the NOGO MP can be resolved, we recommend continuing LRMP surveys at territories that have been reproductively active. Each year, territories that were reproductively active in the previous three years should be surveyed. Additionally, any PAC that has not been surveyed in the previous two years should be surveyed. By selecting these PACs, we avoid becoming hyper-focused on those consistently reproductive territories and would be able to gather additional data on territories with less consistent reproductive activity. These surveys would help to inform management decisions such as National Environmental Policy Act (NEPA) biological evaluations and would allow us to track the reproductive success of the frequently active territories in the LTBMU.

Future work would benefit from identifying a cost-effective way to collect data on some potential influencing factors such as weather, prey, and stand characteristics. Under existing protocols, nest stand vegetation data is collected at the end of the first nesting season that it is found. This could be repeated at intervals to try to evaluate potential changes over time and correlate changes in stand characteristics with changes in reproduction. In the LTB it goshawks use stovepipe nest trees. If stovepipe nests continue to be found, particular attention should be paid to the nest stand vegetation data in order to attempt to determine what if anything is setting these sites apart from traditional nest

stands. Small mammal data could provide insight into prey as an influencing factor. The LTBMU staff would be interested in partnering to collect data these data.

Table 10. The number of occupied territories and reproductively active territories during 2008 to 2012 compared to the number of territories surveyed and the mean percent occupied and reproductively active over the five year period.

	Territories Surveyed	**Occupied Territories**	**Reproductive Territories**	**% Occupied**	**% Reproductively Active**
2008	16	5	2	31	12
2009	26	11	10	42	38
2010	16	13	10	81	62
2011	15	14	6	93	40
2012	18	15	11	83	61
			MEAN	**66%**	**43%**

- *What is the status and trend of Peregrine Falcon populations in the Basin?*

Annual peregrine falcon surveys were initiated in the LTBMU in 2008 in response to several incidental detections in 2006 and 2007 on USFS land. Since 2008 all known or suspected nesting cliffs on USFS lands in the LTBMU were monitored annually using the "Protocol for Observing Known and Potential Peregrine Falcon Eyries in the Pacific Northwest" (Pagel 1992). The protocol was amended to accommodate a small budget and to include guidance on the species from the Santa Cruz Predatory Bird Group website (http:/www2.ucsc.edu/scpbrg/pefaprotocol.htm). Seven locations were surveyed for peregrine falcon during the summary period.

The current forest plan states that there be restricted recreational activity (e.g., rock climbing) on nesting cliffs between 1 April and 31 July (USDA 1988). Since peregrine falcon is not a sensitive species, this is the only direction the forest has to support surveys. Based on this direction the forest reduced surveys beginning in 2013 to include only those areas where peregrines have been detected and rock climbing occurs. Currently these sites include only Luther Rock and Castle Rock. The other sites previously surveyed are not rock climbing areas with the exception of Shakespeare Point. However, the cliff face of Shakespeare Point is private land.

It would appear that the peregrine falcon population in the LTBMU is either increasing, is becoming more easily detected, or is being reported more frequently. If the population is increasing, it could be the result of juvenile dispersal from the Lover's Leap territory or other nearby territories (there have been multiple urban peregrine detections in Reno, Nevada). Lover's Leap is on the El Dorado National Forest Pacific Ranger District just outside the LTBMU. This site has had a peregrine falcon pair since 2004 that has nested frequently. In addition, the peregrine falcon population is expanding nationally due to increased reproductive success resulting from the DDT (dichloro-diphenyl-trichloroethane) era recovery and reintroduction efforts (Kauffman et al. 2003). Since delisting in 1999 to the end of the first post-delisting monitoring period (2003) the population grew from 1,750 nesting pairs to 3,005 nesting pairs nation-wide (Federal Register Vol. 71, No. 198 Doc. E6-17009).

Because the peregrine falcon population in the LTBMU may be increasing and surveys are currently only conducted after incidental sightings are reported, it would be beneficial to conduct a comprehensive

LTBMU-wide assessment of peregrine falcon occupancy in suitable habitat and conduct this assessment annually in order to address trends in the population. However, given that peregrine falcons are not a Forest Service Sensitive species and budget is limited, a comprehensive assessment or even continued monitoring of known nest locations may not be feasible unless it is undertaken as a partnership effort.

Peregrine falcon surveys should also continue in locations where rock climbing or other recreational activities could disturb nests or possible nests. Coordinating with local climbers to close a portion of a cliff is preferable to closing entire nesting cliffs as long as the falcons continue to tolerate the disturbance and climbers continue to respect the peregrines. However, close attention should be paid to failed nests and the possible causes for them.

Figure 27: Juvenile Peregrine falcons at Castle Rock in 2013.

- *What is the status and trend of Spotted Owl populations in the Basin?*

California spotted owl surveys in the LTB have been conducted for project-level surveys, and for population monitoring purposes. Project-level surveys on the LTBMU were conducted within suitable habitat of a project footprint or within 400 meters of project footprints (depending on the project activities) following the Forest Service, Region 5, 'Protocol for Surveying for Spotted Owls in Proposed Management Activity Areas and Habitat Conservation Areas' (USDA, 1993). The first survey period (2011 and 2012) of a 10-year California spotted owl monitoring plan (SPOW MP) was in 2011 and 2012 (Slausen and Baldwin 2011). The SPOW MP was designed as an early-warning system to detect biologically significant changes in the spotted owl population with statistical rigor. Without a statistically viable monitoring effort it is difficult to address population trends in the basin.

The acres of spotted owl habitat and number and identity of spotted owl territories surveyed fluctuated annually depending on the number of projects requiring surveys, number of PACs selected for surveys, whether it was an SPOW MP survey year or not, and amount of available funding. Between 17,911 and

39,395 acres of spotted owl habitat were surveyed each year over the five year summary period. The number of spotted owl detections ranged from 10-18 (mean = 14, SD = 4) per survey season. The number of pairs detected ranged from 3–6 (mean = 5, SD = 1) per season and the number of reproductive territories (defined as a territory containing a pair of owls that attempt to reproduce regardless of whether they are successful or not.) ranged from 0–4 (mean = 2, SD = 1) per season The number of young fledged ranged from 0-4 (mean = 2, SD = 1) per season (Table 11).The number of young fledged should be interpreted with caution as reproductive success is strongly influenced by factors that were not monitored (e.g., weather, prey availability).

Although there was an increase in the number of individuals and pairs detected in the LTBMU over the summary period, these results should not be interpreted to mean that there is an increasing trend in the population. Trend patterns cannot be determined from current data because the surveys are not statistically viable. The SPOW MP surveys were designed to identify trends in the population but only one survey period fell within the time frame of the summary period.

Acres surveyed were significantly higher in 2009, 2010, and 2011 than in 2008 and 2012. From 2009-2011 surveys were being conducted for large fuel reduction projects and 2011 was the first year of the SPOW MP. It may be that the increase in survey effort contributed to an increase in the number of individuals and pairs detected in 2009 and 2011. However, far fewer individuals were detected in 2010 (10 in 2010 versus 16 in 2009 and 17 in 2011) despite a relatively large survey effort. Furthermore, in 2012 the survey acreage was lower than in the previous three years yet the number of owls detected was the highest of the summary period at 18 individuals and the number of pairs detected (6) was the same as in 2011 which was the highest of the summary period. The variable detections among summary period years may be due to the number of territories selected to survey each year and the identity of the territory. All territories were surveyed in 2011; 2012 had the second greatest number of territories surveyed despite fewer acres of survey. The fact that these two years surveyed the greatest number of territories could be the explanation for why these two years had the highest number of detections of individuals and pairs. Similarly, because 2011 and 2012 surveyed the most territories, surveys conducted these years had the greatest likelihood of including territories that are usually active. Conversely, the fewest number of territories were surveyed in 2009 yet a large number of individuals were detected (but not as many as in 2011 and 2012).

Additional factors besides survey effort and locations surveyed could also influence the owl detection patterns. It may be that prey availability influenced spotted owl population dynamics such that an increase in prey was tracked by an increase in owls but we do not have these data. It could also be that surveyor ability or propensity of individual owls to respond to survey calls influenced the detection numbers but as with prey. Weather fluctuated widely over the summary period and could have influenced detections of owls. The winter of 2010/2011 was especially long and wet, with a long-lasting snow pack and snow continuing to fall into June; individual owl detections and the number of pairs were higher in the 2011 season compared to the 2010 season. The winter from 2011 to 2012 was exceptionally mild with a very low snowpack and a long mild spring; owl detections increased in 2012 compared to the 2011 season. Several pairs were detected in locations where they hadn't been for several years including General Creek, Spring Creek, and Twin Crags. If wet long winters result in a low reproductive year and dry short winters result in a high reproductive year, then drying trends due to climate change may have a short-term beneficial effect on spotted owl populations. However, long term drying trends would result in lower canopy cover, smaller trees and a lower prey base. So, while changes in climate may initially have a positive effect on spotted owl populations, over the long term the population would be expected to decrease due to a decrease in habitat quality.

Surveys are anticipated to continue although surveys may consist of fewer acres and territories than during the summary period due a declining trend in the number of projects requiring surveys and funding resources. Surveys and their results are essential to informing management activities and decisions. Originally, we had hoped that the SPOW MP would provide us with a protocol to select and evaluate spotted owl territories in a way that would provide information on population trends. The intent of the SPOW MP is to be an early-warning system to detect biologically significant changes in the spotted owl population with statistical rigor. The metrics evaluated as part of the SPOW MP (territory occupancy, reproduction, and nest productivity) are considered effective tools for determining population trends and evaluating the stressors influencing the population. However, the SPOW MP is costly and not likely to be implemented in the future unless we are able to identify cost-saving changes in the SPOW MP that do not jeopardize the statistical rigor and intent of the program. An evaluation of possible alternative solutions is needed and efforts should be made to adapt the monitoring plan to make it more affordable while retaining its ability to detect biologically significant changes in the population. Until the SPOW MP can be resolved, we recommend continuing LRMP surveys at territories that have been reproductively active. Each year, territories that were reproductively active in the previous three years should be surveyed. Additionally, any PAC that has not been surveyed in the previous two years should be surveyed. By selecting these PACs, we avoid becoming hyper-focused on those consistently reproductive territories and are able to gather additional data on territories with less consistent reproductive activity. These surveys will help to inform management decisions such as National Environmental Policy Act (NEPA) biological evaluations and will allow us to track the reproductive success of the frequently active territories in the LTBMU.

In order to remedy problems experienced with monitoring nest activity with remote game cameras, future camera installments should be mounted on a pole driven into the ground in an appropriate location. This idea needs further development to account for easily raising and lowering the pole, stability and security. Using a camera to monitor nests could reduce habituation to human provided food.

Future work would benefit from identifying a cost-effective way to collect data on some potential influencing factors such as weather, prey, and stand characteristics. Under existing protocols, nest stand vegetation data is collected at the end of the first nesting season that it is found. This could be repeated at intervals to try to evaluate potential changes over time and correlate changes in stand characteristics with changes in reproduction. Small mammal data could provide insight into prey as an influencing factor. The LTBMU staff would be interested in partnering to collect data these data. Barred owls (Strix varia) are closely related to the spotted owl. Historically barred owls were limited to the eastern US and Canada. Throughout the 20th century their range expanded westward in the northern part of their range (Canada) and then south into the western US states. Being larger and more aggressive barred owl are displacing spotted owls in areas where they now overlap (Mazur and James 2000). Any future detection of barred owls needs to be closely followed up.

The USFWS (Federal Register: Vol. 71, No. 100, pages 29886-29908) recognized that short term impacts on California spotted owl could occur from fuel reduction projects for the greater, long-term benefit of protecting nesting habitat from being lost to a stand-replacing fire. More on-the-ground information would be useful in an adaptive management framework to understand how owls respond in the short- and long-term to fuel reduction treatments. There is currently a Fuel Reduction and PACs monitoring plan in preparation. This effort would monitor how owls respond in the short and long-term to fuel reduction treatments.

Table 11. The number of occupied territories and reproductively active territories during 2008 to 2012 compared to the number of territories surveyed, and the mean percent occupied and reproductively active over the five year period.

	Territories Surveyed	**Occupied Territories**	**Reproductive Territories**	**% Occupied**	**% Reproductively Active**
2008	11	7	0	64	0
2009	8	8	4	100	50
2010	10	5	1	50	10
2011	18	8	1	44	5
2012	14	10	2	71	14
			MEAN	**66%**	**16%**

Figure 28: Fledgling spotted owl at the Cookhouse Meadow territory in 2013.

- *What is the status and trend of willow flycatcher in the Basin?*

Willow flycatcher surveys in the LTBMU were conducted during all of the summary period years using the USFS Region 5 protocol "A Willow Flycatcher Survey Protocol for California" (Bombay et al. 2003). Survey effort for willow flycatcher during the summary period was not consistent; acres of habitat surveyed and occupied sites surveyed varied annually depending on partner agency priorities, the number of projects requiring surveys, and amount of available funding. Between 156 and 296 acres were surveyed each year over the summary period. The LTBMU was included in the Willow Flycatcher Demography Study (WFDS) study from 1997-2010. Surveys conducted in the LTBMU by the WFDS team from the Tahoe National Forest also searched for and monitored nests in addition to following the

Region 5 protocol. All sites found to be occupied by LTBMU staff were then surveyed by WFDS and assessed for reproductive effort and outcome. Surveys in the basin after 2010 did not include nest searching or nest monitoring.

There were 1-10 (mean = 6, SD = 4) adults detected annually over the summary period and 2-4 (mean = 3, SD = 1) reproductive territories (a territory where a pair was present and a nest was built) (2008-2010). Reproduction was not assessed in 2011 or 2012. Reproductive success and fledgling numbers are not presented in this report because all of that data was reported to us from partners and the data is sporadic and sometimes unclear.

As mentioned before the winter of 2010/2011 was particularly long and wet with a long-lasting snowpack and snow continuing to fall well into June. Where these conditions seemed to hinder California spotted owl and northern goshawk reproduction, it would have the opposite effect on willow flycatcher. A high-water year with a late spring would be beneficial to a species that requires standing water during the nesting season. Conversely, in 2012 when there was a long dry spring willow flycatcher habitat would decrease. In 2012, the number of detections dropped considerably. There were no known reproductive territories in 2011 or 2012 but this was because the WFDS surveys ended therefor there were no reproductive surveys. WFDS surveyed the occupied sites that were most reliably occupied and the sites that were reproductively active. Once that study ended those sites were added into the four year survey rotation detailed in the SNFPA ROD (2004), so the most active sites were not surveyed in 2011 and 2012.

The demography study found that the willow flycatcher population south of Lake Tahoe (this includes several sites within the LTBMU but also several sites south of the basin) has declined by 14% since 1997. There has been an increasing trend of sites being occupied by single males as opposed to reproducing pairs. In addition, the mean annual cowbird parasitism rates were 15-18%. Relative to populations of willow flycatchers in lower elevation and non-mountainous regions, flycatchers in the South Lake Tahoe and other high elevation regions are constrained by the amount of time available to nest within a season. In addition, the small size of the population susceptible to stochastic effects that might reduce the population to sizes too low for recovery. Urbanization in the area has removed suitable habitat creating holes between large meadow systems that are too great to allow for dispersal from other regions. Restoration projects already planned and/or implemented in the basin should improve habitat, although much of the habitat lost to urbanization will never be replaced. In order to facilitate dispersal future restoration projects should occur in geographically similar locations when possible.

Willow flycatcher surveys in the LTBMU have been ongoing since 1992 and should continue in order to inform management activities and decisions. However, surveys have primarily been related to project activity. A basin wide assessment of suitable habitat and occupancy has never been undertaken. It would be a good idea to plan and implement such a project. In addition, post-restoration monitoring of the restoration projects should occur in order to determine the efficacy of those efforts on increasing willow flycatcher presence.

- *What are the trends for Management Indicator Species at the bioregional (that overlaps the LTBMU) scale?*

The following is a summary from the bioregional report released in 2010 (Citation: USDA Forest Service. 2010. Sierra Nevada Forests Bioregional Management Indicator Species (MIS) Report: Life history and analysis of Management Indicator Species of the 10 Sierra Nevada National Forests: Eldorado, Inyo,

Lassen, Modoc, Plumas, Sequoia, Sierra, Stanislaus, and Tahoe National Forests and the Lake Tahoe Basin Management Unit. Pacific Southwest Region, Vallejo, CA. December 2010. 132pp.:

Habitat Status and Trend: MIS habitat status and trend is determined using vegetation monitoring data collected by the Pacific Southwest Region Remote Sensing Laboratory (RSL). The RSL vegetation monitoring program covers approximately 21 million acres of National Forest System lands within the Pacific Southwest Region, including the Sierra Nevada. For the past 15 years, a 5-year cycle consisting of five areas of approximately 4 million acres each was identified as project areas for organizing mapping and monitoring work. Each year, up to three adjacent National Forests were identified for acquiring aerial photography and imagery. Vegetation map updates are scheduled the following year for these same Forests. Activity information (wildfire, harvest and fuel treatments, and pest mortality) and change detection are used to target updates in the existing vegetation maps. Forest inventory re-measurements are ongoing at 10 percent annually across all lands. However, specific plots may need to be scheduled for re-measurement where changes have occurred from fire, harvest, or other major landscape changes since the last measurement date. Details regarding the protocols used, as well as the data collected, can be found at: http://www.fs.fed.us/r5/rsl/projects/.

For the first habitat monitoring cycle, the most current data available for each National Forest in early 2008 (vegetation classification periods 1999-2000) were analyzed by the RSL. In order to estimate a trend, the habitat data from the Sierra Nevada Ecosystem Project (SNEP) (approximately 10 years) were used for "early 1990s." Each of the two data sets were collected and classified over multiple years across the 10 national forests, as it is not logistically possible to collect and classify vegetation data across the 10 national forest simultaneously. For the second (current) habitat monitoring cycle, classification periods 1999-2000 were compared with the most current monitoring data available for each National Forest as of October 2010 (vegetation classification periods 1999-2008).

Using these data there was a slight increase in closed canopy late seral coniferous forest with a corresponding decrease in open canopy late seral coniferous forest and an increase in mid seral coniferous forest with a corresponding decrease in early seral coniferous forest. Over the last two decades, late seral closed canopy coniferous forest habitat changed from comprising 7% of the National Forest System land acres in the Sierra Nevada to 9%. Since the early 2000s, the trend has been stable at 9%.

Snag Status and Trend: The current status of the snag ecosystem component for both green and burned forests was calculated using the latest compiled vegetation inventories [sampled Forest Inventory and Analysis (FIA) plots] and vegetation strata population maps for the 10 Sierra Nevada National Forests. Snags of all tree species were tracked by size [Medium (15-29.9" dbh) and Large (>30"dbh)], decay class (1-5), and number per acre (inventory strata averages) by Forest. These numbers were then expanded by mapped strata acres. The weighted average by major forest type was then calculated for each national forest. These were then summed to produce a weighted average by major forest type across the 10 National Forests. In order to estimate a trend, data from the sampled FIA plots from the 2000s were used and total snags $\geq$15" dbh per acre by major forest type were compared with the current data. These data include snags in both green forest and burned forest; data on the status of burned forest in the Sierra Nevada was also tracked. Past data used in snag status estimate included vegetation maps (date range - 1999-2003) and sampled FIA plots (date range 2001-2004). Current data used in snag status estimate included vegetation maps (date range – 1999-2008) and panel measurements (date range – 2001-2009).

These data suggest snags per acre increased within westside mixed conifer (+0.16), white fir (+2.66), productive hardwoods (+0.35), and red fir (+1.25) and decreased within ponderosa pine (-0.170 and eastside pine (-0.14). These data include snags in both green forest and burned forest. Between 2000 and 2007, 211,000 acres underwent severe burn and 176,000 acres underwent moderate burn in the Sierra Nevada.

Pacific marten Status and Trend: The population monitoring strategy for this MIS is distribution population monitoring (USDA Forest Service 2007a). Pacific marten (formerly taxonomically classified as American marten) has been monitored throughout the Sierra Nevada as part of general surveys and studies from 1996-2002 (Zielinski et al. 2005). Since 2002, the Pacific marten has been monitored on the Sierra Nevada forests as part of the Sierra Nevada Forest Plan Amendment (SNFPA) monitoring plan (USDA Forest Service 2005, 2006, 2007b, 2009, 2010). Since 2002, population monitoring involved conducting presence/absence surveys throughout the Sierra Nevada to estimate the proportion of sites ("primary sample units") annually occupied by both fisher and marten (USDA Forest Service 2007b). Habitat monitoring also occurs using a combination of remotely-sensed vegetation data and plot data collected in conjunction with the Forest Inventory and Analysis (FIA) plots that are co-located with the primary sample units. Data used in analyses were from 2002-2005 throughout the Sierra, 2006 (location is unclear, possibly throughout Sierra), and 2007-2008 just southern Sierra sites because of the emphasis on tracking fisher.

Current data at the rangewide, California, and Sierra Nevada scales indicate that, although marten appear to be distributed throughout their historic range, their distribution has become fragmented in the southern Cascades and northern Sierra Nevada, particularly in Plumas County. The distribution appears to be continuous across high-elevation forests from Placer County south through the southern end of the Sierra Nevada, although detection rates have decreased in at least some localized areas (e.g., Sagehen basin area of Nevada County).

Aquatic (Benthic) Macroinvertebrates (BMI) Status and Trends: Habitat condition and trend were measured by collecting aquatic macroinvertebrates, and analyzing the resulting data using the River Invertebrate Prediction and Classification System (RIVPACS) (Hawkins 2003) to determine if the macroinvertebrate community has been impaired relative to reference condition. Some of the stream habitat attributes included in the R5 Stream Condition Inventory were measured (SCI, Frazier et al. 2005). In addition, to account for possible impacts from global climate change to stream dynamics and aquatic MIS, additional BMI work related to climate change began through a partnership with Dr. David Herbst of UC Santa Barbara.

Sierra Nevada MIS monitoring for BMI was conducted in 2009 and 2010 (Furnish 2010). Benthic macroinvertebrates were collected from stream sites during both the 2009 and 2010 field seasons according to the Reachwide Benthos (Multi-habitat) Procedure (Ode 2007). During both 2009 and 2010, 13 streams were sampled for macroinvertebrates and algae (Figure BMI-1a). During both years, contractors were able to visit most sites, but sampling success was very limited for a variety of reasons. For example, of the 54 stream and lakes sites visited by contractors during 2009, 20 were assessed, 19 were inaccessible due to high water, rugged terrain or excessive distance, seven were dry, four were on private property, three lakes sites were deemed reservoirs and therefore unrepresentative of natural lake conditions, and one site had been recently burned. Severe drought conditions during 2009 resulted in many problems finding appropriate perennial sites even after a thorough map reconnaissance and consultation with forest specialists to establish whether a site was actually perennial and accessible. Four of the stream sites were collected as annual sites, meaning that they were sampled both years to

examine annual variability of the benthic community. During 2009 and 2010, seven and nine lakes were sampled, respectively. Six lake sites were sampled during both 2009 and 2010 to allow an assessment of annual variability.

Current data from the Sierra Nevada indicate that status and trend in the RIVPACS scores appears to be stable; initial BMI data from 2009 and 2010 found 46% (6 of 13) of the surveyed streams indicate an impaired condition and 54% (7 of 13) indicate a non-impaired condition, similar to the IBI conditions estimated by Moyle and Randall (1996).

Black-backed woodpecker status and trend: The population monitoring strategy for this MIS is distribution population monitoring (USDA Forest Service 2007a). Surveys were conducted in 2008 and 2009 (and ongoing) by Institute for Bird Population Studies. Methods aren't well defined in this MIS report but appear to have included call playbacks. Current data at the rangewide, California, and Sierra Nevada scales indicate that the distribution of black-backed woodpecker populations in the Sierra Nevada is stable.

California spotted owl status and trend: The population monitoring strategy for this MIS is distribution population monitoring (USDA Forest Service 2007a). California spotted owl has been monitored in California and throughout the Sierra Nevada through general surveys, monitoring of nests and territorial birds, and on-going demography studies (Verner et al. 1992; Gutierrez et al. 2008, 2009, 2010; USDA Forest Service 2001, 2004; USFWS 2006; Sierra Nevada Research Center 2007, 2008, 2009, 2010; USDA Forest Service 2006). Five demographic studies of the California spotted owl have been ongoing for a number of years, four of which are in the Sierra Nevada. 2010 data at the rangewide, California, and Sierra Nevada scales indicate that, although there may be localized declines in the rate of population change, the distribution of California spotted owl populations in the Sierra Nevada is stable.

Hairy woodpecker, mountain quail, and yellow warbler status and trend: The population monitoring strategy for this MIS is distribution population monitoring (USDA Forest Service 2007). Monitoring of mountain quail (*Oreortyx pictus*), Hairy Woodpecker (*Picoides villosus*), Fox Sparrow (*Passerella iliaca*), and Yellow Warbler (*Dendroica petechia*) across the ten National Forests in the Sierra Nevada has been conducted since 2009 in partnership with Point Blue Conservation Science (formerly Point Reyes Bird Observatory Conservation Science). Data used for this analysis come from 2009 and 2010. In each year, 500 upland transects were targeted. In 2009, 50 riparian transects were targeted; in 2010, this was increased to 100. Current data at the rangewide, California, and Sierra Nevada scales indicate that the distribution of hairy woodpecker, mountain quail, and yellow warbler populations in the Sierra Nevada are stable.

Northern flying squirrel status and trend: The population monitoring strategy for this MIS is distribution population monitoring (USDA Forest Service 2007a). The northern flying squirrel has been monitored and surveyed in the Sierra Nevada at various sample locations by live-trapping, ear-tagging, radio-telemetry, camera surveys, and snap-trapping (Sierra Nevada Research Center 2007, 2008, 2009, 2010). Current data at the rangewide, California, and Sierra Nevada scales indicate that the distribution of northern flying squirrel populations in the Sierra Nevada is stable.

Pacific Treefrog (Pacific Chorus Frog) status and trend: The population monitoring strategy for this MIS is distribution population monitoring (USDA Forest Service 2007a). Since 2002, the Pacific treefrog has been monitored on the Sierra Nevada forests as part of the Sierra Nevada Forest Plan Amendment (SNFPA) monitoring plan (USDA Forest Service 2005, 2006, 2007b, 2009, 2010). The Sierra Nevada

Amphibian Monitoring Program (SNAMPH) is designed to assess the status and change in occupancy of two frog species, Yosemite toad (*Bufo canorus*) and mountain yellow-legged frog (*Rana muscosa*); the program also collects data for all amphibians and reptiles observed, including the Pacific treefrog (*Pseudacris regilla*). The SNAMPH conducts visual encounter surveys (VES), focusing on detecting tadpoles, within a subset of small watersheds (2-4 km^2) selected throughout the range of each target species (Yosemite toad and mountain yellow-legged frog); most are surveyed once over a 5-year cycle and 20% are revisited annually. The monitoring program was pilot tested in 2002 and 132 sample watersheds have been surveyed at least once through 2007. Twenty-six watersheds have been surveyed at least 4 consecutive years. Current data at the rangewide, California, and Sierra Nevada scales indicate that the distribution of Pacific treefrog populations in the Sierra Nevada is stable.

Sooty (Blue) Grouse (Dendragapus obscurus or D. fuliginosus) status and trend: The population monitoring strategy for this MIS is distribution population monitoring (USDA Forest Service 2007a). The sooty grouse has been monitored in the Sierra Nevada at various sample locations by hunter survey, modeling, point counts, and breeding bird survey protocols (Bland 1993, 1997, 2002, 2006; CDFG 2004a, CDFG 2004b; LTBMU 2007; Sauer et al. 2007). Current data at the rangewide, California, and Sierra Nevada scales indicate that the population distribution for the sooty grouse for the Sierra Nevada north of the Kern Gap is stable.

Forest Resources

Thirteen forest resource monitoring questions were investigated between 2008 and 2012 (Table 12). Eleven of these questions have been summarized in this report.

Table 12: Lake Tahoe Basin management Unit 2008-2012 Forest Resources Monitoring Accomplishments.
The type of monitoring, measures used during monitoring, monitoring question, activities completed, and potential for future monitoring are all presented. Monitoring questions that are addressed in the report are notated with an x under summary.

Category *	Emphasis/ Measure	Monitoring/ Assessment Question	2008	2009	2010	2011	2012	Future	Summary
I	Residual basal area	Are we marking mechanial thin units to project prescription?					12 Plots	x	x
I	Residual trees per acres and size classes	Is the number of residual trees per acre left in hand thinned units meeting the target of the prescriptions? If not, does the resulting TPA still meet the objectives and desired conditions?				10 units		x	x
PE	Forest Type/ Proportion of Total Acres	Are the proportions of each major forest type in the Basin within the historic range?							x
PE	Seral Stage/ Percent	Are the seral stage percentages for a major forest type within the historic reference condition?							x
PE	Parcel Condition related to forest health (hazard trees, invasive plants, insects & disease), fuels accumulation, hydrologic condition (erosion), & encroachments	What is the condition of urban forest parcels, i.e. what is the management need for the parcel?	1390 parcels	1370 parcels	1704 parcels	376 parcels	24 parcels	x	x
PE	Acres, mortality	Are we meeting prescribed fire objectives by: 1. Reintroduction of fire back into the ecosystem, 2. Reducing fuel loading, and 3.Keeping tree mortality below 20%?	853 acres	1424 acres	1840 acres	1439 acres	511 acres	x	x

Category *	Emphasis/ Measure	Monitoring/ Assessment Question	2008	2009	2010	2011	2012	Future	Summary
PE	Mortality-Actual/ Trees Per Acre	Are levels of tree mortality, by causal agent, at background levels?	x	x	x	x	x	x	x
PE	Change in species presence (e.g. black backed woodpecker, CA spotted owl) associated with snag habitat; # of snags retained or created, size of snags, spatial distribution	What progress has been made towards protecting/maintaining habitats with snags and CWD (e.g. burned forests, insect outbreaks, late seral)?				x	x		
PE	Aspen Stand Restoration Photopoints	What are the visual changes in conifer density reduction and aspen stand enhancement?			9 sites, 72 photographs	1 site, 4 photopoints	5 sites, 18 photopoints	x	
PE	Photopoints	What are the visual changes in conifer density reduction and riparian meadow grass and shrub species at Big Meadow?			established 40 photopoints at 10 units	revisited 40 photopoints at 10 units; established 20 photopoints at 7 units	revisited 20 photopoints at 7 sites; established 6 photopoints at 4 units	x	x
PE	Planted Seedling Survival Data	What percentage of seedlings has survived planting at first and third year of planting? What species are dying and why? Is there a need to replant based on desired stocking levels?	x	x	x	x	x	x	x
PE	Rust resistant sugar pines	Where are the potential rust resistant sugar pines located? What type of genetic resistance do they have? Where are the determined MGR (Major Gene Resistant) trees located and what condition are they in?	x	x	x	x	x	x	x

Category *	Emphasis/ Measure	Monitoring/ Assessment Question	2008	2009	2010	2011	2012	Future	Summary
ST	Big Tree Data	What are the largest known native tree species on the Lake Tahoe Basin Management Unit?	x	x	x			x	x

*PE=project effectiveness, ST=status and trend

- *Are we marking mechanial thin units to project prescription?*

In 2012, 12 plots for a total of 54 acres were assessed for residual basal area at MEOW CTL Contract units 145 and 150 in the South Shore project area. Similar efforts will continue throughout the duration of the South Shore and/or Carnelian Hazardous fuels reduction projects to ensure silvicultural prescriptions are met through marking, especially when new marking crews are used and/or current conditions within units appear to differ from those determined by the stand exam data. Units for monitoring will be determined on an as-needed basis.

The target residual basal area for these two units was 100 square feet per acre for trees between 10.0" and 30.0" dbh. Trees less than 10" dbh were to be designated for removal by description within the contract to retain 10 (unit 150) or 20 (unit 145) trees per acre. Basal area ranged from 60 to 260, with an average of 130 before quality control monitoring was conducted. During monitoring, four units had additional marking to reach the final average basal area of 123, with a range of 60 to 240. An increase in the overall stand average of 123 was due to the presence of trees greater than 30" which could not be marked. Plots marked with a basal area less than 100 were found in aspen pockets, built environments, and areas with a large number of dead tops. Areas with basal area greater than 100 were in areas where remaining trees were all greater than 30" and therefore could not be marked.

Due to 30" diameter limits set forth in the South Shore EIS and current Forest Plan/Sierra Nevada Framework, it is not possible to meet the target basal area in some stands. Unfortunately, this diameter limit creates situations where unhealthy trees greater than 30" dbh are retained and healthy trees less than 30" dbh have to be cut in order to meet the target basal area. If public perception could be changed on "cutting big trees" and this diameter limit could be changed in the overriding environmental documents, we could do better work on the ground and better meet the forest health/fuels reduction objectives for these projects while promoting uneven aged stands. However, even without that change, sometimes it is just difficult to meet prescriptions if the current stand conditions vary from those defined by stand exam data and/or there are other reasons to mark a stand heavier or lighter than the prescription warrants (high occurrences of insects/disease, heavy mortality, or conversely pockets of healthy, well-spaced trees with very large diameters, etc.). In such cases, the silviculturist is notified, but prescriptions are designed to allow for variability within the stand.

- *Is the number of residual trees per acre left in hand thinned units meeting the target of the prescriptions? If not, does the resulting TPA still meet the objectives and desired conditions?*

The fall of 2011, post treatment quick plot stand exams where conducted within the Roundhill and Spooner Fuels Reduction and Forest Health project areas. Ten hand thinning units were monitored with one plot placed every 10 acres. The data was entered in to common stand exam (CSE) and forest vegetation simulator (FVS) to determine post treatment residual trees per acre (TPA). Prescription spacing reflects the target residual spacing and trees per acre for meeting fuels reduction and forest health objectives (Table 13). Post treatment data suggest that densities were at levels that meet the objectives; however, some units exceeded prescribed density reductions necessary to meet those objectives. In most units, a reduction in trees per acre is not a concern. However some units require a greater number of trees left per acres due to concerns such as wildlife habitat or visual quality. In these units, fuels and forest health objectives may not be met. There are uncertainties in how well the post treatment data actually reflects current stand conditions (stand densities). The lower TPA in post treatment plots may be due to the size of the plots data were collected from. The plots are placed every 10 acres, which may have been too small to accurately capture the number of residual trees; in some

cases plots fell within open areas that may have artificially drove the TPA down. The following conclusions are based on stand exam data:

- The average spacing and size of residual trees was, as expected, highly variable.
- Diameter limits cause the spacing between residual trees to be highly variable and overall averages hard to predict.
- There were occurrences where trees were cut within current contract protocol to a spacing that resulted in almost double the prescription distance intended between residual trees.
- The prescription distances between trees was achieved when trees were right at or short of the prescribed spacing and were not cut.
- The overall average tree spacing ranged from 20 to 25 feet regardless of whether the target TPA was 75, 80 or 100. (This does not include data from areas naturally open prior to treatment.)
- Summit 35, had an average spacing that was closer to 30-35 feet between residual trees (40 - 45 TPA) because prior to treatment there was a greater number of large trees (greater than 14") and wider spacing between the large trees.

Table 13: Selected unit prescriptions and monitoring results for Roundhill and Spooner Fuels reduction projects.

Unit	Prescription Spacing (ft)	Prescription TPA	Post Treatment Spacing (ft)	Post Treatment TPA
Roundhill 8	21 x 21	100	25 x 25	68
Roundhill 14/15	23 x 23	80	22 x 22	90
Spooner 21	25 x 25	70	25 x 25	70
Spooner 22	21 x 21	100	30 x30	48
Spooner 23	21 x 21	100	27 x 27	58
Spooner 24	25 x 25	70	24 x 24	78
Spooner 35	21 x 21	100	33 x 33	40

A difference of 75 TPA compared to 100 TPA is significant in terms of objectives for fire behavior and forest health. However, during implementation a difference of 21 foot spacing for 100 TPA versus 25 foot spacing for 75 TPA only leaves a few feet difference between the two prescriptions which is not enough on average for distinguishing the prescriptions on the ground. This is due to the natural variability in the spatial distribution of the trees, how the implementation occurs when meeting the contract specifications, and how the contract specifications are written. The diameter limit cut-off of 14" causes a large difference in residual TPA, depending on the number of larger trees and the average spacing of the larger trees prior to thinning. It also depends on whether the trees are distributed continuously throughout the unit or in large patches.

These findings helped to determine how diameter limits affect the predicted residual TPA allowing the LTBMU to modify hand thinning prescriptions for maintaining the variability and meeting desired stand densities overall. Prescription changes were considered including diameter limit instead of spacing. A diameter limit only prescription (e.g. cut all trees up to 14") however, would result in a lack of desired structure for an uneven aged stand with a healthy understory of a few scattered smaller sized trees. A simplified hand thinning prescription is now used for most hand thinning units excluding wildlife and other special areas. The default prescription for all hand thinning units is to thin to 75 TPA (25 foot spacing) with a 14" diameter limit. In situations where a large proportion of the trees in the stand are greater than 14" the desired residual TPA would be reduced to about 40 to 50 and the diameter limit would be increased up to 20" instead of 14".

Contract specifications for spacing requirements have been modified for upcoming hand thinning contracts to better meet desired target stand densities. The units will have post treatment stand exams to determine post treatment densities. Depending on results, prescriptions or contract specifications may be further modified. For special areas of concern such as wildlife areas, marking of trees may be used for identifying cut trees instead of the spacing description currently used in contracts.

- *Are the proportions of each major forest type in the Basin within the historic range?*

Proportions of major forest types across the landscape are off by as much as 50 percent. There is a large over-abundance of the white fir/mixed conifer type and under-representation of Jeffrey pine (Table 14). Fuel treatment projects are designed to bring the proportions of forest types closer to the natural range of variability.

- *Are the seral stage percentages for a major forest type within the historic reference condition?*

Only the white fir-mixed conifer type is within the reference condition for mid-seral/open and late-seral/open, late-seral/closed (Table 14). The late seral stages represented are on the border of the reference condition. Therefore, none of the major forest types are completely within the reference conditions across the seral stages. Fuel treatment projects are designed to bring the seral stage percentages of forest types closer to the natural range of variability.

- *What is the condition of urban forest parcels, i.e. what is the management need for the parcel?*

From 1982 to present, over 3,500 parcels (or Urban Lots) totaling 13,000 acres valued at $105 million have been acquired under the authority of the Santini-Burton Act. From 2001 to 2005 parcel condition monitoring (PCM) data was collected to establish a baseline to determine the general condition of each lot. The LTBMU has approximately 3,500 parcels. Parcels are monitored for varying reasons and sometimes the same parcel is monitored for several years in a row. During the summary period 4,864 urban parcels were monitored (Table 15). Monitoring of Urban Parcels will continue to occur over the next five years based on funding and staff availability. Each parcel was previously on a 1, 3, or 5 year rotation based on the location in the urban interface and/or management needs found on the lot. For future monitoring the urban parcels will be on a 5 year rotation schedule with approximately 650-700 parcels to be monitored yearly. The parcels are grouped by geographic location working in the south shore area during 2013 and 2014, east shore in 2015, north shore and west shore in 2016, and west shore and remaining south shore areas in 2017. At each parcel data was collected on:

- Vegetation Type and Management Conditions
- Fuels Conditions/Concerns
- Watershed Conditions/Concerns
- Property Management
- Management Needs
- Photo Documentation of the general condition of the parcel and any other special concerns.
- Data is entered into a local database to be summarized as needed.

Data collected for each lot has displayed trends in the general condition of the lot and sometimes indicated trends for geographic locations around the lake (Table 16). Current management needs are greatest in El Dorado and Washoe Counties, due to the number of parcels the LTBMU manages in these counties (Table 16). A change in condition, often a decline, has established areas of concern and

influenced management activities based on location and type of concern such as fuels reduction, restoration, invasive species, or hazard tree abatement, etc. Fuels, watershed, and property management conditions vary from site-to-site and proximity to homes. Management needs remain constant on a yearly basis. Areas impacted after a devastating wildfire such as the Angora Fire showed a significant increase in tree mortality, invasive species, watershed concerns, and property management. Areas that have received management activities are showing improvement of the condition/concern; for example a reduction in invasive species, fuels, insects and diseases, or stabilized/repairing watershed conditions.

Table 14: Modeled Pre-Comstock Historical Reference and Current Conditions

Vegetation Description	Approx. Percent of Area 1935	Approx. Percent of Area 2003		Condition	Average Percent of Vegetation Type				
					Early-Seral	Mid-Seral, Closed Canopy	Mid-Seral, Open Canopy	Late-Seral, Open Canopy	Late-Seral, Closed Canopy
Jeffrey pine	37	19		Reference (modeled)	5-15	5-10	25-30	45-50	5-10
				Current	4	42	49	4	1
White fir mixed conifer	10	21		Reference (modeled)	10-20	5-15	10-15	30-40	20-30
				Current	3	16	11	40	30
Red fir	15	18	Red fir-white fir phase	Reference (modeled)	10-20	20-30	5-15	15-25	25-35
				Current	1	13	49	30	8
			Red fir-western white pine phase	Reference (modeled)	5-15	10-20	20-25	35-40	10-15
				Current	1	5	48	41	5

Notes:

- Historic Reference Condition modeling for major LTB forest types, developed from non-linear forest stand dynamics (state and transition) modeling, using disturbance regimes from pre-Euro-American settlement period. Climate inputs from 20th century. Values cannot be reliably applied to landscape units less than about 10,000 acres in area (Safford and Schmidt 2007).
- 1935 percent of area from Forest Service 1935 Vegetation Type Map (Wieslander);
- 2003 percent of area from Lake Tahoe Basin Existing Vegetation Map, Version 4.1, updated for the 2007 Angora Fire.
- Early, mid, and late seral stages represent stand quadratic mean diameters of 0-5”, 5-25”, and >25” dbh respectively.
- For white fir, and the red fir types, an “open” canopy has less than 50 percent closure while a closed canopy has closure greater than 50 percent; for Jeffrey pine, the open-closed cutoff is 40%. For detailed seral stage definitions, see the glossary and Historic Reference Condition Mapping, Safford and Schmidt 2007.
- Vegetation data to be updated as new information becomes available.

Table 15: Summary of Parcel Condition Monitoring (PCMs) conducted between Fiscal Year 2008-2012.

	California		Nevada		
Number of Urban Lots Inspected	**El Dorado CO.**	**Placer CO.**	**Douglas CO.**	**Washoe CO.**	**Total**
FY08 (10-01-2007 to 09-30-2008)	241	74	426	649	1390
FY09 (10-01-2008 to 09-30-2009)	1258	14	44	64	1370
FY10 (10-01-2009 to 09-30-2010)	1000	350	129	225	1704
FY11 (10-01-2010 to 09-30-2011)	2	13	4	357	376
FY12 (10-01-2011 to 09-30-2012)	0	0	0	24	24

Figure 29: Urban Lot employee conducting a parcel condition monitoring on an urban parcel.

Table 16: Summary of Management Needs Identified and Resolved between Fiscal Year 2008-2012.

	El Dorado County		Placer County		Douglas County		Washoe County	
Management Need	**# Lots Identified**	**# Lots Resolved**	**# Lots Identified**	**# Lots Resolved**	**# Lots Identified**	**# Lots Resolved**	**# Lots Identified**	**# Lots Resolved**
Barricade	137	61	16	12	18	13	45	21
Boundary Marked/ Posted	940	331	161	25	246	46	544	149
Encroachment	291	153	40	23	53	18	128	5
Hazard Trees	72	46	13	12	9	4	41	30
Noxious Weeds*	175	4	175	1	175	0	175	4
Restoration	71	43	26	25	24	12	50	41
Survey	697	133	39	22	108	26	246	29
Unresolved Management Needs	1612		350		514		950	

*Noxious Weeds are not resolved until the Lot remains weed free for 3 years

- *Are we meeting prescribed fire objectives by: 1. Reintroduction of fire back into the ecosystem, 2. Reducing fuel loading, and 3.Keeping tree mortality below 20%?*

Post Burn Monitoring requires that estimation of attainment of burn objectives (see monitoring questions) are estimated immediately post burn. These are primarily subjective answers based on ocular estimates. Although the questions are very subjective, the vast majority of burns are successful at meeting objectives. Occasionally piles do not consume to the degree set by objectives. Ignitions are ceased once burning conditions drop below the point where objectives are being met. It should be noted that a relatively narrow set of conditions are required in which prescribed fire objectives are expected to be met. Prescribed burning outside these conditions is usually not conducted. In some cases, we will return when burning conditions improve and reignite the piles and burn them down to meet objectives.

Fire was introduced to 6,067 acres during the summary period (Table 12). Pile burns are a highly valuable tool since because fire is introduced into the system. Many times creep between piles is allowed and piles are a necessary first step to being able to conduct maintenance and ecosystem burns. Pile burning should be recognized as contributing to meeting ecological as well as operational goals.

- *Are levels of tree mortality, by causal agent, at background levels?*

The USDA Forest Service, Forest Health Monitoring is a national program designed to determine the status, changes, and trends in indicators of forest condition on an annual basis. (http://www.fs.usda.gov/detail/r5/forest-grasslandhealth/?cid=fsbdev3_046696). As part of the Forest Health Monitoring, current year conifer and hardwood mortality, defoliation, and other damage are detected by annual aerial surveys over forested lands including the LTBMU. The monitoring determines the locations in relation to ongoing fuels reduction and forest health projects.

Number of trees and acres with mortality or damage are calculated for areas surveyed and reported annually (Table 17). Only current year mortality is estimated with ground-truthing done to confirm causal agent. Although specific areas may have higher levels, on average for the LTBMU, the incidence is at a background level. Background levels have not warranted any concerns for treatment needs outside of ongoing fuels reduction and forest health projects. Information is used to modify prescriptions in those areas of planned treatment or to consider future treatment needs.

Table 17: Acres of mortality and casual agents 2008 through 2012.

Acres with mortality and damage by causal agent and year						
Causal Agent	**2008**	**2009**	**2010**	**2011**	**2012**	**Totals**
Unspecified or mixed bark beetles*	78	3,373	116	214	113	3,894
Jeffrey pine beetle	159	212	180	142	161	854
Mountain pine beetle	1,985	961	694	776	492	4,908
Red turpentine beetle	0	40	0	0	0	40
Ips engraver beetles	1	0	4	0	0	5
Fir engraver	163	1,416	5,607	2,517	44	9,747
Unknown**	24	73	39	39	113	288
Totals	2,410	6,075	6,640	3,688	923	19,736
Number of estimated dead trees by causal agent and year						
Causal Agent	**2008**	**2009**	**2010**	**2011**	**2012**	**Totals**

Unspecified or mixed bark beetles*	103	13,717	110	506	227	14,663
Jeffrey pine beetle	413	247	353	150	194	1,357
Mountain pine beetle	7,848	2,931	2,510	868	726	14,883
Red turpentine beetle	0	1,750	0	0	0	1,750
Ips engraver beetles	19	0	20	0	0	39
Fir engraver	125	3,852	12,098	3,864	76	20,015
Unknown**	10	0	0	230	0	240
Totals	8,518	22,497	15,091	5,618	1,223	52,947

Unspecified or mixed bark beetles typically denotes mortality affecting true fir and one or more species of pine.
**Unknown agents in the Tahoe Basin were attributed as aspen decline, aspen mortality or aspen defoliation.

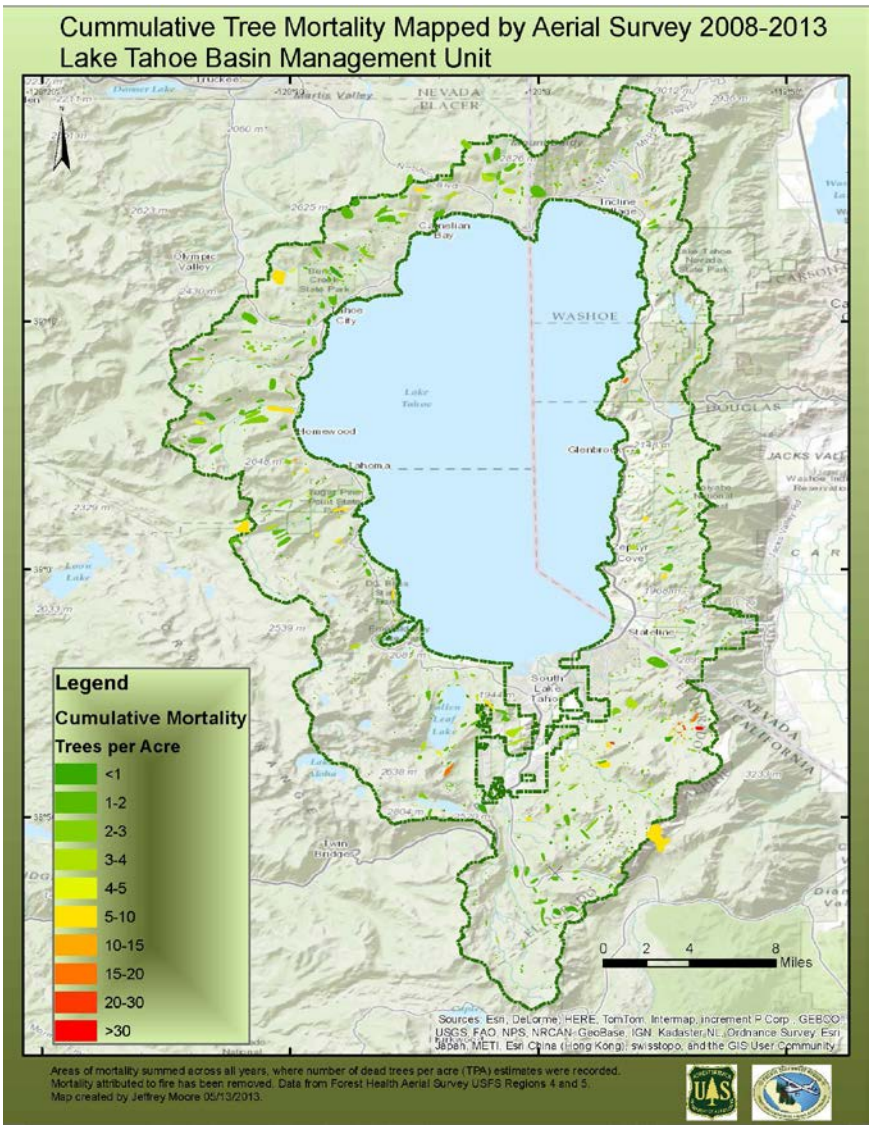

Figure 30: Cumulative mortality 2008 through 2013.

- *What are the visual changes in conifer density reduction and riparian meadow grass and shrub species at Big Meadow?*

Forty photopoint stations were established in 2010 in 122 acres (10 units) of habitat to be treated. Habitat in this project consists of upland, meadow, riparian, and aspen stands. Photographs at each station were taken in the four cardinal directions around the point and a hemispherical photo was taken of the canopy at each point. In 2011, 35 of the photopoint stations were relocated (five could not be found) and photos were repeated. An analysis of the percent canopy that was open to sunlight (percent canopy openness) was conducted for the hemispherical photos taken in 2010 and then repeated in 2011 (N=35, GAP Light Analyzer Program). Percent canopy openness at 35 stations had an average increase of 12% (range -7.39 – 25.43). (Note that two of the 35 stations appeared to have less canopy openness in 2011 than in 2010. These data will be further evaluated.) Representative photos were compiled that show the qualitative (visual) change in conifer density at some of these photopoint stations.

In 2011, 20 photopoint stations were established in 55 acres (7 units) to be treated. Sixteen of these stations were relocated in 2012 and photographs were repeated. An analysis of the change in percent canopy openness concluded that mean canopy openness for the 16 stations increased by 10.4% (range -1.7 – 35.07). (Note there was one station that appeared to have less canopy openness in 2012 than in 2011. The data for this station will be further evaluated.) Representative photos were compiled that show the qualitative (visual) change in conifer density at some of these photopoint stations (Figures 31 to 42).

In 2012, six photopoint stations were established in four units within or adjacent to meadows (21 acres) that were treated during 2012. These stations will be revisited at the same time of year in 2013 and change in canopy openness will be calculated. Representative photos will be compiled that show the qualitative (visual) change in conifer density at these photopoint stations.

Hand thinning of conifers in upland, riparian, aspen, and meadow units in the Big Meadow project area has increased the openness of the canopy in densely stocked stands (or encroached-upon meadows) and reduced conifer density. No management actions have been influenced by these findings at this time.

Figure 31: Big Meadow 04-View 3, Left: 2010 prior to treatment, Right: 2011 post-treatment

Figure 32: Big Meadow 12-View 2, Left: 2010 prior to treatment, Right: 2011 post-treatment

Figure 33: Big Meadow 11-View 4, Left: 2010 prior to treatment, Right: 2011 post-treatment

Figure 34: Big Meadow 14-View 4, Left: 2010 prior to treatment, Right: 2011 post-treatment

Figure 35: Big Meadow 15-View 1, Left: 2010 prior to treatment, Right: 2011 post-treatment

Figure 36: Big Meadow 15-View 2, Left: 2010 prior to treatment, Right: 2011 post-treatment

Figure 37: Big Meadow 15-View 4, Left: 2010 prior to treatment, Right: 2011 post-treatment

Figure 38: Big Meadow 22-View 1, Left: 2010 prior to treatment, Right: 2011 post-treatment

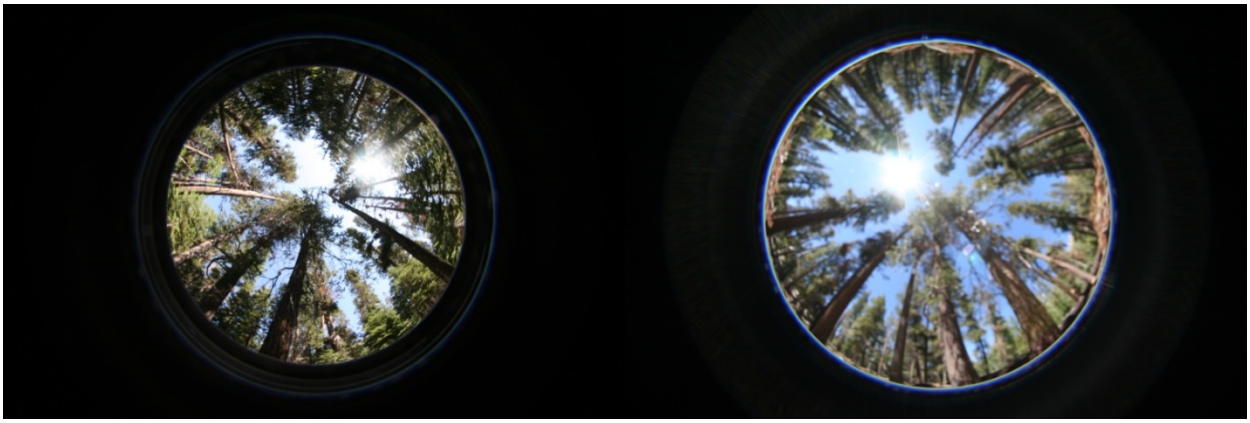

Figure 39: Big Meadow 46 canopy photo, Left: 2011 prior to treatment, Right: 2012 post-treatment. Analysis results: 23.39% increased canopy openness.

Figure 40: Big Meadow 54 canopy photo, Left: 2011 prior to treatment, Right: 2012 post-treatment. Analysis results: 35.07% increased canopy openness.

Figure 41: Big Meadow 56-View 2, Left: 2011 prior to treatment, Right: 2012 post-treatment.

Figure 42: Big Meadow 57-View 1, Left: 2011 prior to treatment, Right: 2012 post-treatment.

- *What percentage of seedlings has survived planting at first and third year of planting? What species are dying and why? Is there a need to replant based on desired stocking levels?*

Since 2008, reforestation and monitoring has occurred in the Pioneer, Gondola, Washoe and Angora Fire areas. First and third year survival exams and monitoring of permanent staked rows or plot surveys were conducted annually to determine percent survival and mortality of planted trees and overall stocking levels based on both planted and natural regeneration.

The Pioneer Burn area was initially planted in 2005, but suffered high mortality from pocket gophers. In 2006 after a second planting, there was only a 15% survival. The area was planted a total of four times within different areas of the burn (not all 15 acres were planted each time). Jeffrey pine was the primary tree planted, however a few rust resistant sugar pine (RRSP) were also planted. In 2010, there were approximately 125 trees per acre, primarily planted Jeffrey pine and naturally recruited lodgepole pine. No further planting will occur.

The Gondola Fire area was initially planted in 2003 and was replanted in 2006. The 2006 planting consisted mainly of Jeffrey Pine with a few RRSP and had a 30% survival. The area was replanted again in 2008 with 250 trees per acre and included ponderosa pine. The second planting was a success with 100% survival in both first and third year surveys.

The Washoe Fire area was planted in 2009 with Jeffrey pine, sugar pine, incense cedar, and red fir. First year survival showed 100% survival with a decline to 77% survival in 2011 during third year surveys.

The Angora Fire area was planted in sections over the course of five years starting in 2009. A mix of Jeffrey pine, RRSP, incense cedar, and red fir has been planted. The primary species planted was Jeffrey pine. The number of trees per acre and survival varied. Average survival has been 50%; however some areas had less than 30% survival. High survival was mainly due to the high amount of spring precipitation (rain) received following planting while mortality was due to brush competition. Whitethorn (*Ceanothus cordulatus*) was present during a majority of the planting and the only brush release that occurred was at the time of planting. Because planting occurred in many areas prior to snag removal operations, both with hand crews and mechanical equipment, survival was also low from the operations or burning of piles that occurred after planting.

The survival exam information that exists has not been adequately compiled and summarized and there is also survey information that needs to be collected. The LTBMU is hoping to organize the data, collect more data, and have a better picture of the existing conditions to better assess areas that may need replanting in the future. The expectation for now is that only a small amount of replanting will occur based on little need and limited funding. Prioritization, therefore, is important based on the synthesized data.

Figure 43: Angora Fire area three year old Jeffrey pine seedling competing with whitethorn for survival.

- *Where are the potential rust resistant sugar pines located? What type of genetic resistance do they have? Where are the determined MGR (Major Gene Resistant) trees located and what condition are they in?*

The LTBMU works in cooperation with the Sugar Pine Foundation (SPF) and Placerville Nursery to locate Major Gene Resistant (MGR) pine trees. MGR trees are resistant to White Pine Blister Rust which is an exotic pathogen that infects and causes mortality to five-needle pines (including western white pine and sugar pine).

There is a large candidate pool of sugar pine that are resistant to white pine blister rust found around Lake Tahoe on state and private land as well as Forest Service land. The LTBMU works with the SPF to collect cones and with the Placerville Nursery – Genetics Department to screen the seeds for rust resistance. An annual report of Rust Resistant Sugar Pine (RRSP) trees is sent to the Basin for record keeping and insuring appropriate management according to the LTBMU Sugar Pine Action Plan (USDA 2012). Seeds collected from these RRSP are sent annually to the nursery for sowing and future reforestation.

As of April 2013, the LTBMU has 35 confirmed RRSP which is up from 33 trees in 2011. Most of the RRSP trees are located on the South and East shores of the LTBMU with a few scattered on the West and North shores. The trees are currently still all alive and healthy. There is only one seed zone where RRSP trees have not yet been found which is in the area of Freel Peak, however location and access makes cone collection in this area difficult.

The LTBMU will continue to monitor the efforts of the SPF and Placerville Nursery, tracking locations and condition of the RRSP trees. The LTBMU will continue supporting activities such as reforestation of RRSP and protection of the trees according to the LTBMU Sugar Pine Action Plan (2012).

- *What are the largest known native tree species on the Lake Tahoe Basin Management Unit?*

The big tree booklet for the Lake Tahoe Basin Management Unit was last updated and posted on the LTBMU website in 2011 (USDA 2011). As new trees are found, the big tree booklet is updated with the largest tree information. Sixteen trees were identified in the big tree registry for the LTBMU between 1993 and 2010 (Table 18). Thirty-three percent of these trees were identified in 2004. Two of the trees identified died, Jeffrey Pine (*Pinus jeffreyi*) (2006) and Sugar Pine (*Pinus lambertiana*) (2007). *The Pinus jeffreyi* has been replaced and although updated in Table 18, the booklet on the website has not been updated with the new tree information. New occurrence information for the largest *Pinus lambertiana* is still needed. In addition, a big tree record is needed for Whitebark pine (*Pinus albicaulis*). Two of the species identified are known to exist in only the one location pinyon pine (*Pinus monophylla*) and Black Oak (*Quercus kelloggii*). Douglas fir (*Pseudotsuga menziesii*) has been found only in a few locations with the LTBMU. The LTBMU may want to consider including big trees that occur on non-FS land as well as FS land. For instance on CA State Park common stand exam data has a *Pinus jeffreyi* at 175 feet, which could compete with the LTBMU *Pinus jeffreyi* record. The LTBMU may also want to consider storing information collected for potential largest tree qualification to maintain up to date candidates for largest tree replacements.

Fire (planned and unplanned)

Eight forest resource monitoring questions were investigated between 2008 and 2012 (Table 19). Two of these questions have been summarized in this report.

Table 18: Size and location information for the biggest trees found on the Lake Tahoe Basin Management Unit, last updated in 2011.

Species	**Common Name**	**DBH (inches)**	**Height (feet)**	**Crown (feet)**	**County**	**State**	**Year ID**	**Recent Visit**	**Died**
Abies magnifica	Red Fir	82.8	176	38	El Dorado	CA	2004	2004	NA
Abies concolor	White Fir	75.3	168	34	El Dorado	CA	2004	2004	NA
Calocedrus decurrens	Incense Cedar	107.3	132	63	El Dorado	CA	2009	2009	NA
Juniperus occidentalis	Western Juniper	85.5	82	38	El Dorado	CA	2010	2010	NA
Pinus contorta var. *murrayana*	Sierra Nevada Lodgepole Pine	71.1	110	66	El Dorado	CA	2004	2004	NA
Pinus jeffreyi	Jeffrey Pine	81.7	156	66	El Dorado	CA	1998	2004	N/A
Pinus lambertiana	Sugar Pine	Measurements have not yet been taken			El Dorado	CA			2007
Pinus monophylla	Pinyon Pine	5.25	24	16	El Dorado	CA	2006	2006	NA
Pinus monticola	Western White Pine	100.9	152	81	Douglas	NV	1993	2003	NA
Pinus ponderosa	Ponderosa Pine	88.2	168	62	El Dorado	CA	1995	1995	NA
Populus tremuloides	Quaking Aspen	39.7	97	31	Placer	CA	2004	2004	NA
Populus trichocarpa	Black Cottonwood	56.7	89	22	Placer	CA	2004	2004	NA
Pseudotsuga menziesii var. *menziesii*	Douglas Fir	54.1	147	44	Douglas	NV	1993	2002	NA
Quercus kelloggii	California Black Oak	10.3	12	23	Placer	CA	2002	2002	NA
Salix scouleriana	Scouler Willow	14.3	78	13	Washoe	NV	2003	2003	NA
Tsuga mertensiana	Mountain Hemlock	69.9	104	45	Placer	CA	2004	2004	NA

Table 19: Lake Tahoe Basin management Unit 2008-2012 Fire (planned and unplanned) Monitoring Accomplishments.
The type of monitoring, measures used during monitoring, monitoring question, activities completed, and potential for future monitoring are all presented. Monitoring questions that are addressed in the report are notated with an x under summary.

Category *	Emphasis/ Measure	Monitoring/ Assessment Question	2008	2009	2010	2011	2012	Future	Summary
A	vegetation condition and regeneration, fuels, tree mortality, snag retention, understory diversity and cover	What were the effects of the Showers and Gondola wildfires on tree mortality, vegetation composition, and fuel loads, how do these change over time?	43 plots Gondola	17 plots Showers			42 plots Gondola; 17 plots Showers	x	
A	Soil Hydrophobicity, evaluation of erosion through visual surveys and aerial photography	What was the effect of the Angora wildfire on soil stability and hydrophobicity and when will soil hydrophobicity recover to background levels?	x	x	x				
A	channel morphology, riparian cover, and aquatic biological community (fish and macroinvertebrates)	What was the effect of the Angora wildfire on the condition of the Angora Creek channel and how will the channel recover over time?		x					
A	Water Quality - sediment and nutrient concentrations	What was the effect of the Angora wildfire on the water quality of Angora Creek, and how will water quality recover over time?	x	x	x	x			
I	Treatments implemented (acres, miles, logs, trees, fences)	Were the Angora burned area emergency response (BAER) treatments implemented as planned?	x						x

Category *	Emphasis/ Measure	Monitoring/ Assessment Question	2008	2009	2010	2011	2012	Future	Summary
PE	fuel treatment effects, vegetation condition and regeneration, fuels, tree mortality, snag retention, understory diversity and cover,	What were the effects of the Angora wildfire and prefire forest treatments on tree mortality, vegetation composition, and fuel loads, how do these change over time, and how do they vary in managed versus unmanaged stands? How are long-term forest carbon stocks in managed and unmanaged stands sensitive to variable rates of mortality and regeneration? What are the long term patterns of forest recovery, and vegetation response to pre-fire, and post-fire forest treatments?	Established 86 CSE, and 218 forest regeneration plots; resampled 11 fire severity transects	Revisited all plots and transects	Revisited all plots and transects	Revisited regeneration plots and severity transects	Revisited all plots and transects	x	x
PE	Prescribed fire acres	Are planned and unplanned ignitions being used to meet or trend towards resource goals? Are we meeting prescribed fire objectives?	x	x	x	x	x	x	
PE	burn pile inventory, overstory mortality, seedling density, fuels loading, understory vegetation structure, invasive plant species	Are management objectives met with current burn pile practices? What effect does pile burning have on surface fuel loading post burn? How do slope, density, size of burn piles, fuel characteristics, and unit location (SEZ or Upland) influence vegetation response?					Established: 4 Aspen units - 13 plots and 1 Fen unit - 4 plots	x	

**A=assessment, I=inventory, PE=project effectiveness*

- *Were the Angora burned are emergency response (BAER) treatments implemented as planned?*

Implementation monitoring was conducted for the 2007 Angora Fire as part of the burned area emergency response (BAER). Implementation monitoring is done to verify that the treatment was implemented as planned and to document the actual cost of the measure.

Implementation monitoring occurred while treatments were being installed during the Angora BAER during August through October of 2007. Project inspectors evaluated land, road, and protection and safety treatments during implementation to assure prescription specifications were met. Types of treatment included: aerial mulching, ground mulching, installation of check dams, filter fencing and water bars, fencing for Off-Highway Vehicles (OHV) intrusions, seeding, noxious weed detection surveys, storm proofing of roads, hazard signs, and hazard tree removal. All treatments were implemented and completed within funding allowances (i.e. noxious weed detection surveys were only funded for one visit) (Table 20).

All cost and treatment prescription can be found in the Final 2500-8. Cost from the BAER Catalog in 2007 under predicted the actual cost due to rise in gas and jet fuel. Acres for treatments in the assessment phase were developed through a GIS application. Actual (project and contract) acres for each prescription were determined by the implementation team (Table 20).

Initially the Assessment Team proposed to ground hydromulch 35 acres off the following neighborhoods: Boulder Mountain Drive, Mule Deer Circle, and Angora Creek. This treatment was incorporated into a hand application of wood mulch due to the inaccessibility of vehicular access. Additionally the Assessment Team identified ~100 acres of hand straw mulching as a land treatments for BAER Implementation. Due to the complex nature of ownership in the Urban Interface environment hand mulching was the best alternative. This mixed pattern of ownership did not allow for an aerial application. This was a very involved and labor intensive process. Several sites were identified for log check dams, filter fencing, and log fencing. The expansion of existing populations and the detection of new populations were identified for noxious weeds surveys in the fall and second visits were planned for early spring.

The BAER assessment of road conditions was performed through on-the-ground and map reconnaissance of the contains 4.2 miles of Forest Service system (FSS) roads and 4.6 miles of FSS trails roads in the burned area. The roads in the fire area were generally characterized as native surface with low slope alignment, constructed with outslope; rolling dips and runout ditches; small cut and fill slopes; and limited drainage structures with the exception of Angora Ridge Road (Forest Service System (FSS) road 1214) and Boulder Mountain Drive, which are paved.

The Assessment Team identified trees that posed an eminent threat to crews and public safety. To prevent injury the hazardous trees needed to be felled. This activity occurred during the implementation phase of BAER. Continued treatment for Urban Interface and General Forest hazard tree reduction became the responsibility of the LTBMU. Trees that were dead and dying (not imminent hazards) were identified for removal through the Angora Hazard Trees Removal Project and Contract.

Table 20: Angora Burned Area Emergency Response Treatment Accomplishments.

	Treatment units	Total treatment	Completed	% Completed	Treatment start date	Expected Completion date	Status
Aerial Hydromulching - Unit #1	acres	42	**56**	133	9/11/2007	9/26/2007	**Completed**
Aerial Hydromulching - Unit #2	acres	394	**394**	100	9/11/2007	9/26/2007	**Completed**
Aerial Hydromulching - Unit #3	acres	169	**177**	105	9/11/2007	9/26/2007	**Completed**
Aerial Hydromulching - Unit #4	acres	31	**40**	129	9/11/2007	9/26/2007	**Completed**
Total Aerial Hydromulching - All Units	**acres**	**636**	**667**	105	9/11/2007	9/26/2007	**Completed**
Noxious Weed Detection Surveys - Urban Lots	acres	14.64	**14.64**	100	8/13/2007	8/27/2007	1st Visit Completed
Noxious Weed Abatement - Urban Lots (5562 plants hand pulled)	acres	13.13	**13.13**	100	8/13/2007	8/27/2007	1st Visit Completed
Noxious Weed detection surveys - Gen. Forest	miles	24	**24**	100	8/7/2007	8/20/2007	1st Visit Completed
Seeding for Noxious Weeds on Urban Lots	acres	10.9	**10.9**	100	8/13/2007	8/25/2007	Completed
Seeding for High Burn Severity on Urban Lots	acres	0.71	**0.71**	100	8/13/2007	8/25/2007	Completed
Seeding for High Burn Severity on General Forest Units	acres	6.75	**6.75**	100	8/13/2007	8/25/2007	Completed
Total Seeding	**acres**	**18.36**	**18.36**	100	8/13/2007	8/25/2007	Completed
Hand Mulch Hillslopes (Woodstraw)	**acres**	**15**	**15**	100	8/13/2007	8/24/2007	Completed
Hand Mulch Hillslopes (Rice straw)	**acres**	**110.2**	**110.2**	100	7/30/2007	8/29/2007	Completed
Install check dams and waterbars	**logs**	**6**	**6**	100	8/13/2007	8/21/2007	Completed
Acres of Units Treated with Check Dams	**acres**	**0.845**					
Install filter fence on urban lots	**feet**	**200**	**200**	100	8/13/2007	8/21/2007	Completed
Acres of Units Treated with Filter Fencing	**acres**	**0.479**					
Install log/worm fence on urban lots	**fences**	**13**	**9**	69	7/31/2007	10/15/2007	Completed

- *What were the effects of the Angora wildfire and prefire forest treatments on tree mortality, vegetation composition, and fuel loads, how do these change over time, and how do they vary in managed versus unmanaged stands? How are long-term forest carbon stocks in managed and unmanaged stands sensitive to variable rates of mortality and regeneration? What are the long term patterns of forest recovery, and vegetation response to pre-fire, and post-fire forest treatments?*

Monitoring began in the fall of 2007, and continued each year through the fall of 2012. Three protocols were carried out each year (CSE plots were not sampled in 2011). Eleven fuels treatment effectiveness/fire severity transects were visited each year. Transect data were for an assessment of fire effects to trees and ground cover (Safford et al. 2009 and 2012). Eighty-six common stand exams (CSE) were installed and sampled every year except for in 2011. These are 1/5 acre (809 sq m) circular inventory plots, installed at the vertices of a 400 m grid across the fire area and including control plots outside of the fire. Data collected include: plot location and environment, ground cover, species cover and richness, fuels, coarse woody debris, trees (live and dead) (Carlson et al. 2008, 2009, 2010, 2011 and 2012). Two hundred eighteen postfire regeneration plots were installed and sampled every year. These were 1/70 acre (60 sq m) circular plots, installed at the vertices of a 200 m grid across the fire area and including control plots outside of the fire. Data collected include: plot location and environment, ground cover, seedlings and saplings, trees (live and dead) (Carlson et al. 2008, 2009, 2010, 2011 and 2012). Fire severity transects are scheduled for on more visit in the summer of 2013. The goal is to then resample the common stand exam grid every five years (next would be 2017), which will depend on funding. Specific questions investigated included:

- Fire severity: Did prefire fuels treatments in the Angora Fire perimeter contribute to reduced fire severity? What other effects did fuel treatments have?
- Vegetation succession: What successional pathways do different parts of a postfire landscape follow in the Lake Tahoe Basin? Absent treatment, what will vegetation in the Angora Fire area look like in 5 or 10 years or further into the future? How are successional pathways related to fire severity and landscape variables like slope, aspect, soil type, and elevation?
- Plant diversity: What were the effects of fire severity, forest treatment, and other variables on the diversity of plant species across the fire area?
- Fuels accumulation: At what rates will live and dead woody fuels accumulate in the Angora postfire landscape?
- Conifer regeneration: What is the rate of conifer seedling recruitment and survival within the Angora Fire perimeter? Are there differences between species? What landscape factors (slope, aspect, elevation, etc.) affect conifer regeneration?
- Snag fall and retention: At what rates do trees killed by fire fall to the ground? How do these rates differ among species and by tree size?
- Conifer mortality rates: What are the short- and long-term survival rates among conifer trees burned by fire? What factors (species, fire severity rating, tree size, landscape position, etc.) best predict long-term survival?
- Carbon: What were the outcomes of fire and prefire forest treatments for aboveground carbon stored in trees?

Our fire severity measurements showed that fuel treatments in the Angora Fire generally performed as designed and substantially changed fire behavior and subsequent fire effects to forest vegetation. Exceptions include two treatment units where slope steepness led to lower levels of fuels removal due to local standards for erosion prevention. Hand-piled fuels in one of these two units had also not yet been burned. Excepting these units, bole char height and fire effects to the forest canopy (measured by

crown scorching and torching) were significantly lower, and tree survival significantly higher, within sampled treatments than outside them. In most cases, crown fire behavior changed to surface fire within 50 m of encountering a fuel treatment.

Our results, together with the subsequent expansion of the monitoring effort to 11 other fires in California, have been used extensively to support ongoing and planned forest treatment projects throughout the Region. We also found that steeper slopes in the Angora Fire burned at higher severity than adjacent flatter ground, and this resulted in some debate within the LTB regarding limitations on mechanical thinning on steeper slopes.

We found that fuel reduction treatments were successful at ameliorating fire severity at our study site by removing an estimated 36% of aboveground biomass. Treated and untreated stands stored similar amounts of carbon three years after wildfire, but differences in fire severity were such that untreated stands maintained only 7% of aboveground carbon as live trees, versus 51% in treated stands. Over the long-term, our simulations suggest that treated stands in our study area will recover baseline carbon storage 10–35 years more quickly than untreated stands. Our sensitivity analysis found that rates of fire-related tree mortality strongly influence estimates of post-fire carbon recovery. Rates of regeneration were less influential on recovery timing, except when fire severity was high.

Safford carried out a separate study with Tyler Myers and Emily Barnett from South Lake Tahoe High School that investigated effects of canopy cover, litter depth and stem density on understory plant diversity. An informal study with the SLT High School students suggested that understory species richness was driven by levels of canopy cover, tree density, and litter depth, and forest thinning as practiced by the LTBMU had a positive impact on species richness. This study won third prize in an international junior forestry congress in Moscow, Russia. We are currently completing a more rigorous analysis of these patterns.

We also are working with our University of Montana partners to analyze other results of our monitoring efforts, including fuels accumulation rates, coarse woody debris, and snag fall rates. We expect to have these analyses completed in the summer of 2013.

Figure 44: Left - Investigating causes of tree mortality within the Angora Fire perimeter with zone pathology-entomology team, August 2008. Right - Collaboration with the Tahoe-Baikal Institute: sampling fire severity transects with visiting Russian scholars, September 2008.

Figure 45: Left - Collaboration with USFS International Programs: training environmental scientists from the Lebanon Reforestation Initiative in fuels sampling, control plot for the Angora Fire project, 2011. Right - South Lake Tahoe High School Generation Green students helping with common stand exam sampling, June 2012

Social Monitoring

Ten social monitoring questions were investigated between 2008 and 2012 (Table 21). Eight of these questions have been summarized in this report.

Table 21: Lake Tahoe Basin management Unit 2008-2012 Social Monitoring Accomplishments.
The type of monitoring, measures used during monitoring, monitoring question, activities completed, and potential for future monitoring are all presented. Monitoring questions that are addressed in the report are notated with an x under summary.

Category *	Emphasis/ Measure	Monitoring/ Assessment Question	2008	2009	2010	2011	2012	Future	Summary
A	Water Uses Survey	Are water uses consistent with existing rights and are instream beneficial uses being protected within existing appropriations?	x	x	x	x	x	x	
C	Compliance Monitoring/ Annual Operating Plans	How is the LTBMU monitoring permittee compliance with terms and conditions of the special use permit? Is the current monitoring scheme an effective means of tracking not only overall compliance, but correction of specific compliance issues? How can special uses compile compliance status and instances of noncompliance into useful data that can allow for trend analysis and possibly lay the groundwork for more effective management strategies that will foster better initial compliance and also facilitate easier tracking and verification that noncompliance has been corrected?	x	x	x	x	x	x	x
PE	Limits of Acceptable Change – Desolation	How has the concept of Limits of Acceptable Change been used to manage the LTBMU wilderness program?	x	x	x	x	x	x	
PE	Chiefs Challenges For Wilderness – 10 elements monitored	How has the LTBMU attained the Chief's Wilderness Stewardship goals for the Desolation Wilderness?	x	x	x	x	x	x	x
PE	INFRA and SUDS (square ft. of parking, infrastructure, permitted acres), GIS, deferred maintenance costs, special use permits administered to standard, expired special use permits.	How are recreation facilities contributing to the plan's desired condition(s) and objective(s) socio-economic sustainability?			x				x
PE	National Visitor Use Monitoring (NVUM)	What is the trend of visitor use, visitor satisfaction, and progress toward meeting recreation objectives in the plan?	x	x	x	x	x	x	x
PE	Visitor satisfaction surveys, campsite condition inventories)	What level of solitude are visitors experiencing?	x	x	x	x	x	x	x

Category *	Emphasis/ Measure	Monitoring/ Assessment Question	2008	2009	2010	2011	2012	Future	Summary
PE	facility condition index; road and trail deferred maintenance	Are maintenance levels sufficient to support existing infrastructure (e.g. roads, trails, facilities)?	20%	20%	20%	20%	20%	x	x
PE	NVUM indicators of satisfaction; ATM project analysis	Does the managed route system meet public access and resource management needs?			x			x	x
PE	OHV Study -Greensticker qualitative conditions assessment protocol.	What is the current condition of OHV routes as it relates to the potential for soil loss, and what are the current maintenance needs?	x						

- *How is the LTBMU monitoring permittee compliance with terms and conditions of the special use permit? Is the current monitoring scheme an effective means of tracking not only overall compliance, but correction of specific compliance issues? How can special uses compile compliance status and instances of noncompliance into useful data that can allow for trend analysis and possibly lay the groundwork for more effective management strategies that will foster better initial compliance and also facilitate easier tracking and verification that noncompliance has been corrected?*

From 2008 to 2012 the LTBMU increased the level of permit compliance monitoring as well as the reporting of our permit compliance monitoring. Compliance monitoring is achieved through the completion of an annual inspection. An inspection is the evaluation of the overall on-site operations of a special use permit as well as an internal evaluation of a permittee's adherence to administrative requirements such as the payment of bills, and submittal of documentation such as insurance, annual operation and maintenance plans, etc. The Special Uses Data System (SUDS) database is where permit administrators record the following information regarding compliance inspections: type of inspection, planned inspection date, actual inspection date, compliance status, whether the FS took action after finding noncompliance, and any additional remarks.

From 2008-2012, inspections were preformed according to FSM 2716.5. For each use code, there was a specific interval that inspections were to be completed by each forest. Each fiscal year, the LTBMU is required to meet a target number of roughly 250 inspections (target number is determined by the region). Since 2008, the LTBMU has met the annual target. The majority of inspections performed are recreation residence permits. This is reasonable due to the fact that the LTBMU has roughly 600 recreation residence permits, which is a vast percentage of total permits issued by the Basin (roughly 640 total special use permits).

In early 2013, following an OIG Audit of the *Forest Service Administration of Special Use Programs,* the Regional Office (R5) directed all forests to perform inspections according to a specific inspection schedule (FSM 2716.52), or where a specific schedule is not provided inspections will be performed at least every 5 years, based on the characteristics of that use and the conditions found during the last inspection. FSM 2716.51 directs the authorized officer to focus resources on situations where, if noncompliance occurs, it is more likely to have an adverse impact and inspect for the following compliance elements: 1) Construction, 2) Health and Safety, 3) Nondiscrimination, 4) Structural Safety, 5) Supervision of Children Under the Age of 18, 6) Environmental or Property Damage, 7) Land Use Fees, 8) Noncompliance, and 9) Continuance of Use Determinations.

Inspections for 2013 through 2017 fiscal years have been identified and will be prioritized each year prior to the field season. As a result, all authorizations will be inspected at least once every five years, as required by the directive. Currently, there are roughly 640 issued recreation special use permits, 600 of which are recreation residences where a separate administered to standard target is in place. Therefore, a minimum of 10 recreation permits (non-recreation residence) will be inspected during each of these subsequent years in order to meet the requirement. The following criteria were used to prioritize these inspections: a. high use level authorizations, b. authorizations that include adjacent water activity, c. recreation residence inspections in order to meet administered to standard target values (250+ inspections).

In addition to general compliance inspections, special uses has begun requiring permittees with adjacent water activity to conduct aquatic invasive species (AIS) inspections for all non-motorized watercraft that

enter the basin. Each permittee has a series of questions to ask visitors who are attempting to bring a private non-motorized watercraft into the permit site. The goal of the questionnaire is to determine which water body the visitor has recreated at most recently and when, and whether or not this water body contains aquatic invasive species. Based on the visitors' answers to the questions, the watercraft in question is either determined to be clean and or dry and is given permission to enter, or the watercraft is determined to be a threat to the aquatic ecosystem and is required to be inspected and/or decontaminated prior to entry. All forms are collected by the special use permit administrator on a biweekly basis. Each line item is entered into a data base at the end of the summer season for analysis purposes.

We have learned that the LTBMU has been able to consistently meet and/or exceed the regionally determined administered to standard target. With respect to compliance monitoring and inspections, the SUDS database is a tool used for simply reporting whether inspections were completed, when they were completed, and whether or not the permit was in compliance with the terms and conditions of the special use permit. Specific record-keeping documenting the inspection and the nature of noncompliant issues (when present) is generally maintained in the individual special use permit files, where the inspection can be referenced along with any correspondence initiated between the Forest Service and the permittee in efforts to rectify the noncompliant situation.

Although SUDS does have a "Remarks" section where administrators can expand on the noncompliant issues (when present), this section is not often used because there are no SUDS reports that can be generated to compile this type of open ended data from which to view trends or draw conclusions. Methods to view trends and work toward more effective management strategies could be improved by creating an annual spreadsheet with all planned inspections listed by permit number, use code, date of inspection, and compliance status. Additionally, where noncompliance is found, the spreadsheet can include columns describing the nature of noncompliance (if any), and what type of action was taken by the Forest Service to facilitate corrections by the permittee. This way, we can generate multiple reports depicting trends in permittee compliance. It would be possible that a spreadsheet like this could tell us certain things that a SUDS report could not, for instance:

- How many of the inspected permits were compliant (what percentage of inspected permits was compliant?)?
- Of those that were non-compliant in a certain year, how many brought the permit into compliance after FS action?
- What type of FS action is most often used to initiate contact with a noncompliant permittee?
- Of the various types of FS action following a noncompliant inspection (phone call, letter, notice of noncompliance, field meeting with the permittee), which action facilitated the most improvement?
- Is there a correlation between certain types of noncompliant issues and the type of FS action taken to rectify the situation?
- Trends of compliance over time sorted by use code, past compliance, etc.

These types of questions would help the program to formulate conclusions about its compliance monitoring as a whole, areas where program administration could be improved, and to possibly find ways to apply a consistent and broader management strategy toward dealing with permittee noncompliance. This could result in overall improved initial compliance and improved response by permittees once FS action is taken to facilitate the correction post-inspection.

- *How has the LTBMU attained the Chief's Wilderness Stewardship goals for the Desolation Wilderness?*

An annual needs assessment is conducted to evaluate if the Desolation is being managed to meet wilderness stewardship goals; and the wilderness workforce is meeting the assigned workforce target for the year. The LTBMU has been the lead reporting forest for the Desolation Wilderness (co-managed with the Eldorado National Forest) wilderness stewardship accomplishments. Ten elements are reported: 1) wilderness fire suppression responses/preparation, 2) presence/monitoring of non-native invasive plants inside the wilderness, 3) atmospheric monitoring, 4) completion of a wilderness education plan, 5) wilderness management guidelines are up to date and address critical values and needs for solitude or a primitive and unconfined type of recreation, 6) campsite inventory monitoring, 7) non-compliance issues with outfitter guides, 8) wilderness plans address issues of noncompliance with social or resource guidelines, 9) monitoring is conducted to ensure Forest Land Management Plans are being achieved and 10) minimum workforce targets are achieved.

The Chief's 10-Year Stewardship Challenge will end in 2014. It is expected to be replaced with a similar wilderness monitoring program, because only about three fourths of the nation's wilderness areas are meeting minimum Stewardship standards.

The Desolation Wilderness has reported the highest score of attainment in the National Forest System in each of the last six years. In 2006 the Desolation Wilderness was awarded the Chief's National Wilderness Stewardship Award. Management of the Desolation Wilderness has been substantially supported and strengthened by the funding obtained through the Recreation Enhancement Act (REA, formerly known as the "Fee Demo" program). With this funding, and with the contributed cooperation of resource specialists, the Desolation has consistently performed well in meeting Stewardship goals for maintaining effective fire management plans, monitoring programs for invasive plants, and supporting air quality monitoring conducted by other agencies. Additional effort is needed to promote the Wilderness Education Plan, and effectively conduct field monitoring with follow-up actions to any non-compliant resource and social conditions identified. Overall, the review of the accomplishment reports reflects the efforts of the Eldorado and LTBMU wilderness staff to protect and maintain the wilderness character of the Desolation Wilderness. Ongoing efforts to maintain a seasonal field staff and volunteer program are also critical to the future of the Desolation Wilderness. The continuing popularity and relatively easy accessibility of the Desolation have added to the challenge.

- *How are recreation facilities contributing to the plan's desired condition(s) and objective(s) socio-economic sustainability?*

Sustainable recreation management incorporates three themes that require monitoring: socio-economic sustainability, built environment sustainability, and natural setting sustainability. All three components need to be successfully integrated into the landscape in order to achieve sustainable recreation. In order to address these themes some goal include: 1) recreation opportunities would provide a spectrum of high quality recreation opportunities; 2) public access would be encouraged where lawful and feasible to high-quality natural areas and shore-zone consistent with desired resource conditions that is consistent with user expectations and sustainability objectives; and 3) recreation programs and facilities are economically sustainable and are managed to achieve a desired range of social expectations while maintaining the quality of the setting and natural resources.

The social components of the identified monitoring elements along with the visitor's perceptions of the condition of the environment have been monitored through the National Visitor Use Monitoring or NVUM system, beginning in 2005 on the LTBMU (English et al 2002). Facility evaluations are routinely conducted under the Forest Service infrastructure (INFRA) database program.

National Forest recreation visits have contributed to the local economy. In 2010 there were 5,700,000 reported visits to the LTBMU with an average group size of 3.6 persons, and each party spending just under $1,000 per trip for lodging and other expenses. During the same 5 year period 90% of the surveyed visitors responded that their satisfaction rating for the perceived condition of the environment was "somewhat" to "very satisfied." Future opportunities identified by recreation staff have been to expand recreation opportunities on the LTBMU, including such actions as reconstructing a 40 foot long picnic shelter at one of the beaches, expanding available services to include kayak rentals, snack vendors, RV rentals, improving campsite and facility accessibility, and to focus on public health & safety at developed facilities. On a facility (built environment) perspective, there has been a strong effort on the LTBMU to variously upgrade water systems, and ensure that structure maintenance and designs are consistent with National Forest desired conditions for the landscape. Management actions have become more adaptive to ensure recreation is sustainable on the LTBMU while meeting the public's expectations.

Figure 46: Nevada Beach. Left: Accessible walkways, Right: new assessable covered picnic shelter.

- *What is the trend of visitor use, visitor satisfaction, and progress toward meeting recreation objectives in the plan?*

One of the key mandates of recreation management in the National Forest System is to promote sustainable recreation. In the late 1990's, a team of research scientists and forest staff developed a recreation sampling system (National Visitor Use Monitoring or NVUM), that provides statistical recreation use information at the forest, regional and national level (English et al 2002). Recreation, wilderness, ecosystem management and research specialists were involved with developing this sampling program. Every 5-years, each National Forest and Grassland undergoes a year-long visitor sampling program. Information is gathered on visitor characteristics (age, race, zip code, activity participation, income, visitor preferences, and satisfaction information). The visitation estimates are useful in evaluating visitor capacity issues. The Lake Tahoe Basin Management Unit was first monitored in the NVUM program during FY 2005. Information was updated in 2009, and a second full-year NVUM visitor survey conducted in FY 2010, with a minor update completed in 2011.

A formal summarized National Visitor Use Monitoring Results was completed in February 2009 (using updated data initially collected in FY 2005). A Visitor Use Report was completed for LTBMU data collected in the NVUM program in FY 2010 (updated August 2011). It is available on the NVUM website.

Review of data collected under the NVUM program suggests the LTBMU recreation management program has been effective in promoting sustainable recreation and in meeting the visitor's expectations and preferences. Five year trends reflect that total visitation and visits to the LTBMU by multiple ethnic groups have been increasing. The majority of visitors that visit the LTBMU typically drive over 100 miles to get here (no change significant changes over past 5-years). In 2005 the top three activities were viewing scenery, hiking or walking, and viewing wildlife. Compared to 2010 where the top three activities were relaxing, downhill skiing, and viewing natural features. There has been more discussion on the potential need for expanding our current site capacities to accommodate growing demand, and there has been growing pressure on the impacts of lower winter recreation use (i.e. impacts from climate change) and pressures to offset by expanding summer use of these winter sites. Visitor satisfaction is an element that reflects customer satisfaction with the recreation setting, facilities and services provided. The 5-year trend has shown a stable satisfaction rating for the LTBMU, with 98 percent of visits given a rating of very satisfied or somewhat satisfied for their overall experience.

Figure 47: Camping and attending interpretive talks are activities that have been popular on the LTBMU over many years.

- *What level of solitude are visitors experiencing?*

In the late 1990's, a team of research scientists and forest staff developed a recreation sampling system (National Visitor Use Monitoring or NVUM), that provides statistical recreation use information at the forest, regional and national level (English et al 2002). Recreation, wilderness, ecosystem management and research specialists were involved with developing this sampling program. Every 5-years, each National Forest and Grassland undergoes a year-long visitor sampling program. Information is gathered on visitor characteristics (age, race, zip code, activity participation, income, visitor preferences, and satisfaction information). The visitation estimates are useful in evaluating visitor capacity issues. The Lake Tahoe Basin Management Unit was first monitored in the NVUM program during FY 2005. Information was updated in 2009, and a second full-year NVUM visitor survey conducted in FY 2010, with a minor update completed in 2011.

In 2005 approximately 75% of wilderness visitors, and 69.5% of day use developed sites visitors reported feeling only a modest degree of crowding. Zero percent of wilderness visitors reported feeling the Desolation Wilderness was “overcrowded” and 1.3% of day use developed site visitors reported feeling there was overcrowding. On the other hand, 12.7% of the campers (in developed sites) reported feeling there was overcrowding and 69.5% of day users reported feeling only a modest degree of crowding during their visits). Compared to in 2010, 48.3% of wilderness visitors and 57% of day use developed sites visitors reported only a modest degree of crowding. Continuing this trend, 2% of wilderness visitors reported feeling the Desolation was “overcrowded” during their visit and 0.6% of the day users. On the other hand, campers in developed sites indicated the crowding situation had improved with 0% reporting overcrowding. Managers have improved the overcrowded feeling by maintaining camping capacity limits. The increase of visitors feeling like the Desolation is overcrowded, highlights the need to continue to maintain the quota limit of 12-persons/group in the Desolation Wilderness.

Figure 48: Desolation visitor experiencing a moment of solitude.

- *Are maintenance levels sufficient to support existing infrastructure (e.g. roads, trails, facilities)?*

Every year a condition survey is performed on 20% of the existing facilities. Information from the facility surveys is entered into a database and a summary report can be generated at any time. The facility database also includes a numerical rating called a facility condition index for each facility and a dollar amount of deferred maintenance, although costs are based upon national averages. A condition survey on 20% of the roads was done in 2011 and 2012. A condition survey on 20% of the trails was done every year between 2008 and 2012.

Maintenance levels are not sufficient to support existing facilities. The facilities that are in good condition were replaced with non-maintenance funding. The amount of deferred maintenance exceeds our ability to maintain facilities.

The complexity of road and trail databases causes confusion for data gathering and data entry and ultimately degrades the quality of the data. The LTBMU is unique. Allocations by congress have enabled the LTBMU to address deferred maintenance issues in order to provide for public access, land management, and resource protection.

- *Does the managed route system meet public access and resource management needs?*

The Nation Visitor Use Monitoring (NVUM) program is done every five years and was last done in Lake Tahoe in 2010. The NVUM program conducts visitor surveys at various locations around Lake Tahoe. Access and Travel Management (ATM) plans are part of the NEPA process. The plans describe how managed route access and travel will be handled. The plans can be stand alone or part of a larger project. Although ATMs have included monitoring, no monitoring was done between 2008 and 2012.

The results of the visitor surveys collected in 2010 were compiled in the Visitor Use Report 2010. The Visitor Use Report provides information about total visitor use, site types visited, visitor demographics, satisfaction with facilities and services, and money spent by visitors. Visitor satisfaction with the managed route system is generally good and meeting public access needs. Satisfaction with Forest-wide road conditions and signage adequacy is high. Managers will continue with programs and projects already in place.

V. CONCLUSIONS/FUTURE MONITORING

Seventy-six monitoring questions were investigated between 2008 and 2012; fifty-six of these have been summarized in this report. The way a question is asked combined with how it was grouped in this report influence the spread and type of questions asked. However, some insight can still be provided on the dominant types of monitoring that occur in the LTB. The majority of the questions investigated were focused on terrestrial resources and project effectiveness monitoring. Twelve percent were physical science monitoring questions, 4% were stream ecosystem management, 13% were aquatic resource, 8% were meadow, 23% were terrestrial resources, 17% were forest resources, 10% were fire, and 13% were social resources. Nine percent of the questions were assessment questions, 1% were compliance, 4% were inventory, 52% were project effectiveness, and 32% were status and trend questions.

Table 22. Summary of monitoring presented in report by topic area and type of monitoring.

Topic Area	Assessment	Compliance	Inventory	Project Effectiveness	Status/ Trend	Total	Summary
Physical Science Monitoring	1	0	0	6	2	9	9
Stream Ecosystem Management	0	0	0	3	0	3	3
Aquatic Resources	1	0	0	3	5	9	7
Meadow	0	0	0	3	3	6	4
Terrestrial Resources	0	0	0	4	14	18	13
Forest Resources	0	0	2	10	1	13	11
Fire (planned and unplanned)	4	0	1	3	0	8	2
Social	1	1	0	8	0	10	7

Topic Area	Assessment	Compliance	Inventory	Project Effectiveness	Status/ Trend	Total	Summary
Total	7	1	3	40	25	76	56

Physical Sciences (Soil, Water, Air)

Summaries were provided on all of the nine watershed monitoring questions: one assessment, six project effectiveness, and two status and trend questions (Tables 1, 21). The first watershed condition assessment conducted in 2011 identified three out of ten Lake Tahoe HUC5 watersheds as functioning properly. The remaining seven HUC5 watersheds that comprise the Tahoe Basin watershed were rated as Functioning at Risk. No watersheds were rated as impaired. Two of the "at risk" watersheds were selected by the Lake Tahoe basin Management Unit, as a priority for restoration efforts, because they are the largest contributors of pollutant loading which affects Lake Tahoe Clarity and are experiencing impairment of aquatic habitat and forest health.

The primary driver in the Lake Tahoe Basin as it relates to soil and water quality, are the Lake Tahoe Total Maximum Daily Load reduction targets (Tahoe TMDL) , established by the EPA in 2011. The Tahoe TMDL established that 9% of the loading of fine sediments, phosphorus, and nitrogen to Lake Tahoe could be attributed to Upland sources. The Tahoe TMDL established a load reduction target of 12% of this 9% annual load attributed to Upland sources. The USFS manages the majority of lands classified as Uplands in the Tahoe Basin and therefore has the bulk of the responsibility in implementing management actions to achieve this target. Overall monitoring shows that USFS management has been moving in the right direction, towards achieving the load reduction targets identified in the Tahoe TMDL. Monitoring has also been effective in identifying areas that still need improvement to inform an adaptive management response.

There is no practical way of monitoring load reductions from upland sources specifically to determine quantitatively if progress is being made to achieve targets. However through project effectiveness monitoring, we can determine whether USFS management has been successful in preventing adverse impacts to soil and water through best management practices and if direct restoration efforts have been successful at reducing inputs from chronic sources of erosion in degraded areas. For the past two decades, the design and monitoring of USFS soil and water protection BMPs have been directed at the Regional scale. However, in 2014 new directives for both design and monitoring were completed at the National Scale. This continued focus at the USFS local, regional, and national scale, will continue to ensure that soil and water protection BMPs are carried out effectively on National Forest lands in the Lake Tahoe Basin.

In general, the LTBMU has been effective at implementing soil and water protection BMPs according to design and these BMPs are effective at preventing adverse impacts to soil and water quality. Restoration through roads and trails decommissioning and retrofits has been implemented on the LTBMU at an aggressive pace and scale. Monitoring results presented in this report have demonstrated that this work has substantially reduced sediment loading, particularly from roads. Monitoring has also demonstrated that unpaved trails are not a significant source of potential sediment loading when compared to unpaved roads.

"Light on the land" equipment and treatment techniques used for mechanical vegetation treatments have not resulted in ecologically significant adverse effects on the Tahoe Basin soils evaluated, because of a combination of robust soil cover, small decreases in soil porosity, and relatively high post-project soil permeability (e.g. saturated hydraulic conductivity). Runoff and Erosion modeling conducted with

soil quality monitoring results, has shown that techniques used have successfully prevented potential increases in overland flow that can result in accelerated erosion.

A large scale effort to monitor the effectiveness of ski area management in preventing and reducing adverse soil and water impacts form the Heavenly Mountain Resort have shown those efforts to also have been largely successful. Some improvement is still shown to be needed in regards to managing parking area runoff at the base lodges and technical improvements to water quality treatment systems are being explored.

Stream Ecosystem Management

Summaries were provided on all three of the stream ecosystem management project effectiveness monitoring questions (Tables 2, 21). Effectiveness monitoring has shown that stream channel floodplain restoration efforts implemented over the past decade have been largely successful in moving towards multiple restoration goals including: increasing channel stability, restoring hydrologic connectivity to floodplains, reducing sediment loading, and improving aquatic and riparian habitat. While lessons can be learned from past projects, watershed assessment analysis as well as monitoring, continue to confirm that each restoration project needs to thoroughly consider the unique watershed conditions, constraints, and stressors affecting the stream channel reaches in which channel degradation has been documented. There will never be a one size fits all stream channel/floodplain restoration approach. Developing an appropriate restoration approach will continue to require a robust understanding of geomorphic process and thorough watershed analysis, utilizing a multi-disciplinary team of engineers, geomorphologists/hydrologists, biologists, botanists, and ecologists. Long term monitoring (for 10 to 15 years post construction) will be critical for understanding and the quantifying the long term effectiveness and benefits of these restoration efforts.

Aquatic Resources

Summaries were provided on seven of the ten watershed monitoring questions: one assessment, two project effectiveness, two status and trend, and two project effectiveness/status and trend questions (Tables 4, 21). Monitoring and assessment activities have provided critical information to develop projects. To date projects to remove non-desirable species have been effective.

Active gillnetting in Desolation Wilderness lakes has caused significant decline or eradication of fish populations within five years. This is important because monitoring efforts have informed the LTBMU that relatively few native species of amphibians and aquatic reptiles are present and of those species only the Sierran tree frog has a high occupancy rate. The eradication of fish in these alpine lakes will provide an opportunity to increase amphibian populations targeted at Sierra Nevada Yellow Legged Frog.

Monitoring efforts from the Native Non-game Fish Assessment has provided insight on the current distribution and relative abundance of both native and non-native fish. Most streams in the LTB have low diversity; some of streams only have one species, which is often a non-native trout species. From 2008 through 2012, 13,661 non-native fish have been removed from approximately 17 miles of stream. Despite the challenges in removing non-native fish through electroshocking (e.g. lack barriers, terrain), results have been positive. In reaches where non-native species have been removed, LCT numbers are increasing. An action plan is needed to address aquatic organism passage (AOP) in an efficient and effective manner that will provide migration but not spread non-desirable species into uninfected areas. Of the AOP crossings assessed during this summary period 82% were identified as barriers to migration, closing off large areas to spawning and rearing for native and non-native species. However, in some

cases, these barriers are beneficial (i.e. where recovery is under consideration or for preventing the spread of warm-water invasive species).

To date projects to remove non-desirable species have been effective. Invasive plants continue to be introduced and spread on LTBMU. Despite an active detection and prevention program, new infestations and occasionally new species are discovered each year. Due to continued propagule pressure or adjacent infested areas, most species that are already established on LTBMU are not likely to be eradicated. However, active treatment of newly introduced species and small infestations of known species has been effective at containing or reducing the spread of these species. This reinforces the importance of Early Detection Rapid Response (EDRR) as a primary management technique for prioritizing invasive plant species of management concern.

Meadows

Summaries were provided on four of the six watershed monitoring questions: two project effectiveness and two status and trend questions (Tables 6, 21). As of 2009, the majority of meadows in the LTB were considered to be moist to wet meadows. Total number of fens is greatest in the South Basin region. These fens were in general more highly rated for conservation significance compared to other regions in the Basin (East Basin, Incline Village, Meiss Country, and West Basin). While the majority of meadows are consider moderate to high functioning in the LTB as of 2009, there was a significant increase in the presence and frequency of lodgepole pine (*Pinus contorta*) from 2004 to 2009. An increase in lodgepole pine was also noticed in areas that experienced soil compaction at the Cookhouse Meadow restoration project. Future management might want to focus on methods to reduce the potential for lodgepole encroachment in project areas as well as in meadows in general. Potential considerations during projects could include better sub-soiling of compacted soils to reduce conifer encroachment. Although prescribed fire alone may be insufficient to reverse lodgepole invasion, periodic burning of meadows may kill trees before they grow large enough to escape mortality and/or before there is a loss of herbaceous fuels that may limit future fire effectiveness. Future meadow projects may also want to increase the spread of sod or native seed within the project area to reduce *Poa pratensis* and/or other non-native species.

Terrestrial Resources

Summaries were provided on 13 of the 18 watershed monitoring questions: two project effectiveness questions and eleven status and trend questions (Tables 7, 21).

Current invasive plant prevention and treatment measures appear to be moderately effective at reducing spread from existing infestations and preventing new introductions. The majority of projects that were uninfested prior to project-implementation remained uninfested after implementation, suggesting that for most projects either the invasive plant risk was low or that prescribed measures were effective. However, project implementation still poses some risk for the introduction of invasive plants; new infestations were detected at 17% of projects and exponential spread was documented at several infestations. With the exception of bull thistle, the new detections are species that are uncommon in the Lake Tahoe Basin; as such, the introduction of even a single infestation represents a substantial risk for further spread.

The majority of Forest Service sensitive plant species are either stable or increasing. Species that are more closely monitored show interannual variability, often linked to water and/or other vegetative cover. The long-term monitoring plots established for Tahoe draba and long-petaled lewisia suggest that

there may be specific biotic conditions that compose each species suitable habitat (i.e. low vegetation cover). With the current monitoring data for each species it is still difficult to discern a trend for the viability of either species on LTBMU. Nonetheless, these plots will provide an excellent baseline for future monitoring and habitat assessment. For Tahoe yellow cress, the 34-year survey record of all known sites where the species occurs globally has been crucial in the identification of the cyclic nature of its distribution and abundance, how strongly occupancy is related to lake level, and its metapopulation dynamics . In general, there have been more occupied TYC sites when the lake is low and fewer when it is high. Total stem counts have not been as closely tied to lake level as site occupancy, but still tend to follow lake level, with high stem counts observed in years with lower lake levels. Certain sites are almost always occupied, while many sites—usually smaller ones—exhibit sporadic occupancy. This knowledge of the basic biology of the species forms the very foundation of the Conservation Strategy which will be revised and is scheduled for administrative review in late 2014.

Of the forest service sensitive terrestrial wildlife species, one is increasing, one is decreasing, and three are unknown. The peregrine falcon population in the LTBMU appears to be on the rise. The willow flycatcher population in the LTBMU is declining. The status of the northern goshawk, California spotted owl and Townsend's big-eared bat population in the LTBMU is unknown. As of 2010, nine of the ten management indicator species seem to be stable at the rangewide, California, and Sierra Nevada Scales (Black-backed woodpecker , California spotted owl, Hairy woodpecker, mountain quail, and yellow warbler, Mule deer , Northern flying squirrel, Pacific Treefrog , Sooty (Blue) Grouse). Although the Pacific marten appears to be distributed throughout their historic range, their distribution has become fragmented in the southern Cascades and northern Sierra Nevada. Based on population information for willow flycatcher and the fact that relatively little is known about the status and habitat associations of Pacific marten and Townsend's big-eared bat in the Lake Taboe Basin, these species should be monitored closely. It may be beneficial to design restoration project to support habitat for each of these species.

Forest Resources

Summaries were provided on 11 of the 13 watershed monitoring questions: two inventory, eight project effectiveness, and one status and trend question (Tables 12, 21). There is a large over-abundance of the white fir/mixed conifer type and under-representation of Jeffrey pine forests. Only the white fir-mixed conifer type is within the reference condition for mid-seral/open and late-seral/open, late-seral/closed. Mortality levels of trees within the LTB have not warranted any concerns for treatment needs outside of ongoing fuels reduction and forest health projects.

Project effectiveness monitoring has improved prescription efficiency and has identified areas where desired conditions are not feasible. Prescriptions for hand thin units have been simplified in areas without resource concerns. Thinning of conifers in upland, riparian, aspen, and meadow units have increased the openness of the canopy in densely stocked stands (or encroached-upon meadows) and reduced conifer density. Diameter limits for tree removal cause situations where unhealthy trees greater than the target dbh are retained and healthy trees less than the target dbh have to be cut in order to meet the target basal area. These diameter limits also can cause a large difference in residual trees per acre, depending on the stand conditions. If diameter limits were not included in projects then desired conditions would be easier to meet while promoting uneven aged stands. Pile burns are a highly valuable management tool because they introduce fire to the landscape and are a necessary first step to being able to conduct maintenance and ecosystem burns. Piles should be recognized as contributing to meeting ecological as well as operational goals.

Post fire revegetation data needs to be further compiled and summarized. The LTBMU is hoping to organize the data, collect more data, and have a better picture of the existing conditions to better assess areas that may need replanting in the future. The expectation for now is that only a small amount of replanting will occur based on little need and limited funding. Prioritization, therefore is important based on the synthesized data.

Fire (planned and unplanned)

Summaries were provided on two of the eight watershed monitoring questions: one inventory and one project effectiveness question (Tables 18, 21). Fuel treatments in the Angora Fire generally performed as designed and substantially changed fire behavior and subsequent fire effects to forest vegetation. In most cases, crown fire behavior changed to surface fire within 50 m of encountering a fuel treatment. Exceptions include two treatment units where slope steepness led to lower levels of fuels removal due to local standards for erosion prevention. Steeper slopes in the Angora Fire burned at higher severity than adjacent flatter ground, and this resulted in discussions on the limitations on mechanical thinning on steeper slopes. Over the long-term, simulations suggest that treated stands in our study area will recover baseline carbon storage 10–35 years more quickly than untreated stands. In addition, preliminary data suggests that forest thinning as practiced by the LTBMU had a positive impact on species richness.

Social Monitoring

Summaries were provided on seven of the ten watershed monitoring questions: one compliance and six project effectiveness questions (Tables 20, 21). The LTBMU has been able to consistently meet and/or exceed the regionally determined standard target with respect to compliance monitoring and inspections of special use permits. While the corporate standard reporting system is useful for reporting inspection completion, the LTBMU has identified a need to develop a local spreadsheet to track inspections by permit number, use code, date of inspection, and compliance status to help the program formulate conclusions about its compliance monitoring as a whole, areas where program administration could be improved, and to possibly find ways to apply a consistent and broader management strategy toward dealing with permittee noncompliance.

The LTBMU recreation management program has been effective in promoting sustainable recreation and in meeting the visitor's expectations and preferences. The Desolation Wilderness has reported the highest score of attainment in the National Forest System in each of the last six years. Ninety-eight percent of visitors have given a rating of very satisfied or somewhat satisfied for their overall experience. Managers have improved the overcrowded feeling by maintaining camping capacity limits. The increase of visitors feeling like the Desolation is overcrowded, highlights the need to continue to maintain the quota limit of 12-persons/group in the Desolation Wilderness. However, maintenance levels are not sufficient to support existing facility needs; the amount of deferred maintenance exceeds our ability to maintain facilities.

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