Independent Review Panel Report

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EXECUTIVE SUMMARY

The Lake Tahoe Basin constituency has expressed concerns over limited progress in reducing the fire hazard from excess vegetation biomass in Stream Environment Zones (SEZ) and on steep slopes (collectively referred to as sensitive areas). In response, a workshop was conducted to explore the state of knowledge and current practices used by government agencies in the planning, review, and implementation of vegetation management projects in sensitive areas of the Lake Tahoe Basin. Findings from the workshop were broadly grouped into four categories that we believe capture the basis for each major concern; *Regulatory Policy, Socio-Economic Responses, Implementation Challenges, and Opportunities for Advancement.* Information and results provided were used to identify areas of uncertainty regarding environmental risk, and develop findings and recommendations to advance the strategies and practices of vegetation management available to contractors and government agencies in the Lake Tahoe Basin. It is our hope that this document will serve as a guide for future research, regulatory, management, and implementation strategies in the Tahoe Basin. As such, it could well serve as a measure of future accomplishments and performance outcomes – or the lack thereof.

TOP PRIORITY RECOMMENDATIONS

Individual categorical findings and recommendations are itemized in Section 3.0 *"Summary of Findings and Recommendations"* of this report. The following is an integration of various findings into five overall priority recommendations we identified as in need of immediate attention in order to move forward.

Priority Recommendation: There is an immediate need to conduct a Basin-wide planning exercise to optimize the use of limited resources available for fire hazard reduction projects.

Priority Recommendation: Current efforts to improve coordination and collaboration between regulatory and action agencies should be enhanced. Streamlining of the oversight, review, and permitting process is essential and would benefit both the action and regulatory agencies by developing a clear step by step process and projected timeline. Regulatory agencies and land managers should develop a protocol for periodic review, verification, and update of processes, quantitative thresholds, and policy relevance.

Priority Recommendation: There is a critical need to develop a Basin-wide protocol for "Standard Methods of Ecological Measurement and Monitoring in the Tahoe Basin". Concurrently, a website should be constructed where real-time information from standard protocols is immediately available to all interested parties.

Priority Recommendation: Continued research that addresses critical natural resource issues and key management questions relevant to the Tahoe Basin is essential. A list of specific management questions should be identified by the agencies relative to key indicators of interest for sensitive area management. It is then important to take advantage of unique opportunities and small scale experimental field trials to quantitatively evaluate potential impacts. To ensure credibility and applicability, such research must be scientifically defensible, applicable to the Tahoe Basin and similar ecological settings elsewhere, and publishable in peer-reviewed journals.

Priority Recommendation: Develop a website and related links to make available literature relevant to fire hazard reduction operations and their ecological effects in the Tahoe Basin readily accessible to the public, private, agency, and scientific constituency.

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1.0 Introduction: Background and Charge to the Technical Review Panel

Elected officials, agency representatives and stakeholders representing many segments of the Lake Tahoe Basin community have all raised concerns over the limited progress in reducing excess vegetation biomass in Stream Environment Zones (SEZ) and on steep slopes (collectively referred to as sensitive areas) in the Lake Tahoe Basin. Limited access, the potential for substantial environmental impacts arising from treatment methods, and a restricted field season all limit options for managing the excess biomass and translate into the completion of few projects with high cost and long timelines. Although excess forest biomass is a Basin-wide problem, there is special concern over the existing situation in sensitive areas because of the potential to accelerate the spread of a wildfire and propagate the fire over a larger area (Murphy et al., 2007). Riparian forests now have some of the heaviest ladder and surface fuel loads of any Sierran forest communities because they are less moisture limited than upland areas and are highly productive (Bisson et al. 2003; Stephens et al. 2004). Following a severe crown fire, streams feeding into Lake Tahoe could receive and then transport substantial loads of sediment, nutrient, and debris flows affecting lake clarity and beach conditions (Byron and Goldman 1989; Stephens et al. 2004). High intensity fires can also render steep slopes highly susceptible to wind and water erosion (Carroll et al., 2007). In the aftermath of the Angora Fire, there is heightened interest in advancing the strategies and practices available to implement vegetation management projects in sensitive areas. However, there is recognition that we need approaches that optimize efficiency and effectiveness, while minimizing collateral environmental impacts.

The purpose of the workshop was to explore the state of knowledge and current practices used by government agencies in the planning, review, and implementation of vegetation management projects in SEZ and steep slope areas of the Lake Tahoe Basin. Information and results provided at the workshop were used to identify areas of uncertainty regarding environmental risk, and develop recommendations to advance the strategies and practices of vegetation management available to contractors and government agencies in the Lake Tahoe Basin.

1.1 Review Panel Charge:

The panel was asked to evaluate and comment on the appropriateness and adequacy of: 1) the technical information used in planning vegetation management projects in sensitive areas, and 2) the technical information and technical basis used in the regulatory review of vegetation management projects in sensitive areas. Specifically, the panel was asked to address:

- Whether or not the technical information and state of knowledge agencies rely on is appropriate and adequate for planning and regulatory review of proposed vegetation management projects in sensitive areas? If not, what additional information or knowledge is recommended?

- Whether or not our assessments of environmental risk are appropriate and well reasoned? If not, what additional factors should be considered in these assessments?

- What efforts (e.g., pilot projects, applied research, monitoring, additional analyses, review of existing literature, etc.) should agencies pursue in the near-term (next 2-4 years) to reduce areas of uncertainty related to environmental risk of treatment methodologies?

- Are there new or existing technologies or methodologies that agencies should consider applying to vegetation management projects in sensitive areas? What are the specific advantages and disadvantages of these new technologies or methodologies?

- Overall, what specific recommendations does the panel have to advance the strategies and practices of vegetation management in sensitive areas of the Lake Tahoe Basin?

2.0 Issues Identified

During the workshop, agency representatives discussed their perspectives on vegetation management in sensitive area designations of the Tahoe Basin, four case studies were presented, and both the panel and audience (~100 participants) contributed to an open discussion regarding issues, concerns, and approaches to vegetation management. From these discussions, a number of broad issues emerged that included such aspects as a complex regulatory environment, the lack of acceptable fuel reduction tools for sensitive areas, the limitations associated with knowledge gaps in management and monitoring, difficulties associated with maintaining an adequate fuel reduction workforce, the use and application of limited outreach efforts, and the high costs of operation and implementation.

The review panel's response to these issues is broadly grouped into four basic categories that we believe capture the basis for each concern.

- **Regulatory Policy**
- **Socio-Economic Responses**
- **Implementation Challenges**
- **Opportunities for Advancement**

3.0 Summary of Findings and Recommendations

Items listed within each category of this section were not prioritized because each was identified as an overall high priority issue during the workshop. Numerical notations in this section correspond to the numeric counterparts in Section 4.0 *"Foundation for Categorical Recommendations"*. Similarities between our independent findings and recommendations to those previously identified by the "Lake Tahoe Fuels and Vegetation Management Review" (USFS LTBMU, 2002) may be examined in the Supplemental Appendices (Appendix A) to this report.

3.1 Regulatory Policy

3.1.1 Finding

- Multiple but separate regulatory processes are cumbersome to navigate in a timely manner.

Recommendation

- Agencies should develop procedures and protocols that are consistent within, and between agencies.

3.1.2 Finding

- Some existing regulations are no longer relevant or are based on old information and technology.

Recommendation

- Implementing agencies and land managers should develop a protocol for periodic (7-10 years) review, verification, and update of quantitative thresholds and policy relevance.

3.1.3 Finding

- Regulatory and action agencies are improving their coordination/collaboration.

Recommendation

- Current efforts to improve coordination and collaboration between regulatory and action agencies should continue. Streamlining of the permitting process by developing a clear step by step process and projected timeline would benefit both the action and the regulatory agencies.

3.1.4 Finding

- Agencies are effectively using memorandums of understanding to facilitate interagency interactions.

Recommendation

- Use of interagency MOUs should continue and be expanded to more strongly facilitate cooperative interaction among agencies, particularly on the issue of available burn days.

3.1.5 Finding

- A zero discharge approach is an unrealistic and overly constraining concept.

Recommendation

- Implement a concurrent and comparative disturbance risk assessment strategy that simultaneously weighs the relative importance and immediacy of environmental, health and public safety strategies, and dollar costs/benefits. A zero discharge concept to regulating fuel management practices is not in keeping with the natural disturbance driven ecosystem, and an alternative approach should be developed which will tolerate a level of sediment and nutrient discharge similar to historical levels associated with fire driven terrestrial and aquatic ecosystems.

3.2 Socio-Economic Responses

3.2.1 Finding

- Residents and businesses in the Tahoe Basin share the benefits of Basin-wide fire hazard reduction with the general public.

Recommendation

- The opportunity for cost sharing among the public and private sector beneficiaries of Basin wide management strategies should be more strongly pursued.

3.2.2 Finding

- Treatment programs must be acceptable to the constituency, achievable within the constraints of available funding, and sustainable from one treatment cycle to the next.

Recommendation

- Community leaders and service providers should explore new or novel methods to ensure the long term sustainability of local fuel treatment programs.

3.2.3 Finding

- Timelines for planning, funding availability, regulatory approval, and implementation are often disconnected and out of sequence.

Recommendation

- An advanced strategic planning process should be developed to identify specific project objectives and investigative protocol necessary to answer key management questions. Such advanced planning would help to avert timeline/funding/implementation disconnects.

3.2.4 Finding

- Outreach education has generated acceptance of treatment strategies such as prescribed burning. The Nevada and California Cooperative Extension Services have effectively facilitated outreach education, not only within the community but with agencies and research institutions as well.

Recommendation

- Outreach and education efforts should continue and be expanded where appropriate.

3.3 Implementation Challenges

3.3.1 Finding

- Management strategies developed for forest ecosystems elsewhere do not always apply to Sierran systems and/or may not be functional Basin wide.

Recommendation

- Regulatory, management, and implementing agencies should take advantage of unique opportunities that allow testing of new approaches and expansion of the overall knowledge base.

3.3.2 Finding

- Several potentially useful tools and technologies exist, many of which are not new.

Recommendation

- Identify potentially useful new or existing tools and technologies, and assess their availability and applicability to Sierran systems. Consider a variety of mechanized approaches for use in the Basin, in addition to or in combination with prescribed fire, and pursue research to address pile burning management questions. Explore opportunities to ensure the long term sustainability of local fuel treatment programs and contracts.

3.3.3 Finding

- The potential for detrimental effects of many methods can be estimated in advance by extrapolation from those already tested.

Recommendation

- Experimentation should be encouraged so that implementers will be more willing to try promising new approaches on a small scale to evaluate their ecological impacts without the risk of non-compliance penalties.

3.3.4 Finding

- Comparative assessment of site-specific individual investigations or field trials is difficult to impossible due to the lack of a Basin-wide standardized protocol for measurement and monitoring.

Recommendation

- Regulatory agencies need to clearly identify specific areas of concern and articulate respective key management questions. This is an essential step in guiding the development and design of successful monitoring and/or research programs that generate data and information directly applicable to agency needs. Existing protocols should be evaluated as to their unique applicability to Sierran ecosystems. Appropriate monitoring activities should then be compiled for each key management activity and adopted as the standard protocol among agencies and contractors in the Tahoe Basin. A publication on “Standard Methods for Ecological Measurement and Monitoring in the Lake Tahoe Basin” should be developed and used.

3.3.5 Finding

- The potential effects of climate change on sensitive areas and their management are unknown but potentially significant.

Recommendation

- Sensitive area management strategies should be examined in the context of a shift in the kind and amount of hydrologic input so that future strategies can account for potential changes in hydrologic function. The effects of changing climates on the Basin's fire regimes should also be examined.

3.3.6 Finding

- Operational costs in the Basin are typically much higher than outside the Basin.

Recommendation

- Carefully evaluate Basin-specific requirements to determine necessity. Guarantee a long-term program, and coordinate/consolidate operations on small-scale units and ownerships. Look at project management and assessment in the context of a larger temporal and spatial perspective.

3.3.7 Finding

- Regulations and high costs on sensitive sites often encourage treatment of the easiest locations rather than the areas of greatest need. Much of the Basin is not readily accessible by road for mechanical treatments other than helicopter yarding.

Recommendation

- Optimize the use of limited resources by conducting a Basin-wide analysis of: a) costs and expected benefits of various treatments (e.g., mechanical, hand and/or fire) under various spatial and temporal scenarios, and the need for roads or other access; b) expected environmental costs of treatments; and c) simulated resulting behavior and costs associated with wildfire.

3.4 Opportunities for Advancement

3.4.1 Finding

- Regulations may be overly conservative as a result of uncertainty.

Recommendation

- Management agencies should work more directly with scientists during project planning to develop a scientific foundation for the assessment of project impacts in the context of cumulative and landscape scale impacts associated with sensitive area management strategies.

3.4.2 Finding

- Comparative evidence of impacts and efficacy in the Basin is lacking.

Recommendation

- In the absence of comparative evidence, the comparison and testing of promising new ideas and innovative technologies should be encouraged and facilitated. This

should be coupled with real time monitoring feedback of relevant ecosystem indicators so that management implementation can be truly adaptive.

3.4.3 Finding

- In many cases, data collected for monitoring purposes has been haphazard and does not lend itself to treatment evaluation and assessment.

Recommendation

- A list of specific management questions should be identified by agency representatives relative to key indicators of interest for sensitive area management. A pertinent list of standard methods of analysis and monitoring to be used in addressing the management questions must then be provided.

3.4.4 Finding

- Much relevant literature exists, but is not available or readily accessible from a single location.

Recommendation

- A flagship web site consisting of links containing a collective compilation of literature pertinent to Tahoe Basin issues should be developed. These links could be organized relative to current key management questions. Listing of the literature could be organized as to topic, location, and literary source.

4.0 Foundation for Categorical Recommendations

4.1 Regulatory Policy

4.1.1 Concerns were raised regarding consistency among agency policies. The permitting process and policy thresholds for a given issue need to be consistent across regulatory agencies. In many cases, implementers are required to obtain permits from two, three, or more entities before undertaking an action. It has not been uncommon for one agency to approve a proposed action, whereas another will not. Furthermore, if the action is modified to meet the requirements of one agency, the permit may have to be renegotiated with another. This situation has sometimes been confounded by staff turnovers within a regulatory agency; e.g., when a verbal agreement has been obtained to proceed from one staff member, only to find it unacceptable to replacement personnel. Management planners find this inconsistency frustrating, can lose valuable time and funding opportunities, and must often change plans to meet the changing interpretation of existing regulations.

Recommendation: *Agencies should develop procedures and protocols that are consistent within, and between agencies.*

4.1.2 In concert with the development of more uniform regulatory thresholds among agencies is the need for periodic review. With new technology comes the opportunity for innovative management strategies that could alter or refine historical threshold values. In the past, technological advancement and expansion of the knowledge

base was much slower. Today, it is not unusual that significant new advancements take place on a 5-year rather than a 25-year cycle. A case in point identified during the workshop was the 30% slope threshold for ground based skidding. The foundation for this threshold appears to reside within general guidelines for forest management and the original (at least in part) Bailey Land Capability Classification (Bailey, 1974), and may have been well justified based on our knowledge of ecosystem impact and response at that time. Presently, however, none of the agencies could provide a sound scientific basis that would either support or refute continuation of this long established threshold. The Bailey system was based on the original *"Tahoe Basin Soil Survey, California and Nevada"* (USDA, 1974) which has now been updated by the *"Soil Survey of the Tahoe Basin Area, California and Nevada"* (USDA, 2007). We suggest that this classification system and any related thresholds be re-evaluated in the context and guidance of findings presented in the new Soil Survey.

Recommendation: *Implementing agencies and land managers should develop a protocol for periodic (7-10 years) review, verification, and update of quantitative thresholds and policy relevance.*

4.1.3 Steps are already underway to improve coordination and collaboration between regulatory and action agencies, and the panel encourages the agencies to continue with this strategy. Furthermore, a reasonable goal of interagency collaboration should be streamlining of the permitting process. One approach to this would be to develop a clearer step-by-step process and projected timeline. Such a simplified procedure would be of particular benefit to new employees in both the action agencies and the regulatory agencies.

Recommendation: *Current efforts to improve coordination and collaboration between regulatory and action agencies should continue. Streamlining of the permitting process by developing a clear step by step process and projected timeline would benefit both the action and the regulatory agencies.*

4.1.4 It was noted that the memorandum of understanding (MOU) process was becoming increasingly common among agencies within the Basin, and the panel suggests that this process continue to facilitate cooperative interaction among agencies. One area of bi-state regulation that is particularly challenging in the Basin is the difference in burn day restrictions between California and Nevada. Burning is an essential practice within the Basin in order to reduce fuel loads, and to restore ecosystem health and forest diversity. The very short burning season coupled with variable burn day restrictions makes this practice difficult to implement as widely as desired for the health of the forests and the safety of the adjacent communities, particularly in California. Last year (2007) on the Nevada side of Lake Tahoe, there were approximately 14 days in the fall that met local controlled burning prescription parameters at Incline Village. Over the same period only a few burn days were available in California, which severely limited the use of prescribed fire. Several entities regulate the air shed on the California side of Lake Tahoe and it would make sense to consolidate them into one body to allow managers to work with only one group thereby increasing efficiency. The California side of the lake

needs to take actions to increase the number of days when burning is permissible. It is recognized that wind patterns will generally move smoke to the east over the lake. Fire is a critical component of many forests around Lake Tahoe and more days when burning is permissible are needed. The North Lake Tahoe Fire District should continue its successful burning program.

> ***Recommendation:*** *Use of interagency MOUs should continue and be expanded to more strongly facilitate cooperative interaction among agencies and across state boundaries, particularly on the issue of available burn days.*

4.1.5 Some of the current regulations with respect to water quality protection are narrowly focused and do not consider the wider contextual history that has resulted in the current conditions, the concept of achievable desired conditions, or the consequences of taking no action. For example, fire suppression has caused a decline in forest health that includes the emergence of dense and unhealthy mono-culture stands characterized by reduced growth, increased disease and insect infestation, and the surface accumulation of heavy organic debris and decomposing organic (O horizon) materials (Ansley and Battles, 1998; Johnson et al., 2005; Miller et al., 2006; Neary et al., 1999; Stephens and Moghaddas, 2005; Stohlgren, 1998), making these systems extremely prone to wildfire. Fuel reduction strategies not only make it easier to fight fires and protect lives and property, but it can also improve the health of the forest, making it less susceptible to severe wildfire, insect and disease attack, and more capable of producing the large widely spaced healthy trees more typical of a pre-European forest.

O horizon litter layer removed from forested site near Stateline, NV. Credit: Theresa Loupe

A healthy Sierran forest also is generally more conducive to supporting wildlife, including sensitive birds and salmonids. We thus need to evaluate the benefits and costs of treatment against the benefits and costs of wildfire, which is more likely in unmanaged stands. The latter will have major undesirable impacts on not only human life and property, but also on nutrient and sediment runoff water quality (Miller et al., 2006; Carroll et al., 2007), wildlife, and forest regeneration. In this context, mechanical fuel reduction treatments should not produce uniformly spaced trees over wide areas. Instead, spatial variation in forest structure after restoration treatments is an important characteristic (Stephens and Fule, 2005). The pre-European forests in the Tahoe Basin were the result of thousands of

Gondola Wildfire burn site near Stateline, NV. Credit: Jay Howard

years of frequent, low intensity wildfire. These low intensity wildfires would have generated small amounts of sediment which served to keep nutrients and stream beds in balance, as well as keeping forests healthy. This suggests the role of fire and the inevitability of wildfire need to be explicitly considered when planning and regulating fuel management activities (Stephens et al. 2004). Appendix B in the accompanying Supplemental Appendices describes one tool that was developed to aid watershed managers in evaluating the impacts of a fuel management activity in the context of a fire-driven ecosystem. The panel suggests that a zero-discharge concept to regulating fuel management practices is not in keeping with the natural disturbance-driven ecosystem, and that thresholds be designed to tolerate a sediment and nutrient discharge similar to historical levels associated with fire-driven terrestrial and aquatic ecosystems.

Recommendation: *Implement a concurrent and comparative disturbance risk assessment strategy that simultaneously weighs the relative importance and immediacy of environmental, health and public safety strategies, and dollar costs/benefits. A zero discharge concept to regulating fuel management practices is not in keeping with the natural disturbance driven ecosystem, and an alternative approach should be developed which will tolerate a level of sediment and nutrient discharge similar to historical levels associated with fire driven terrestrial and aquatic ecosystems.*

4.2 Socio-Economic Responses

4.2.1 The benefits of fire hazard reduction are shared by local residents and the larger public. Residents see decreased probabilities of loss of life, personal property, real property value and aesthetic values. Over the long term, avoiding large wildfires will deliver more enjoyable experiences to those visiting the Basin, and to non-visitors the knowledge that Lake Tahoe is still bluer than it would be otherwise. The costs of fuel reduction are high in the Basin for a number of reasons – including the presence of development. Given the shared benefits and the cause-effect for high costs, it seems reasonable for the costs to be shared by public land management agencies, local residents, and business owners.

Recommendation: *The opportunity for cost sharing among the public and private sector beneficiaries of Basin wide management strategies should be more strongly pursued.*

4.2.2 For a treatment program to succeed in the highly populated Basin, it must be acceptable to the residents and be achievable within the constraints of available funding. It must also be sustainable from one treatment cycle to the next. Short-term influxes of funding may allow some critical areas to be treated, but long-term assurances of resources are necessary to ensure that reasonable treatment cycles of ten to twenty years can be maintained. Sources of funding include federal and state grants as well as local support through taxes, homeowner associations, or a host of other community actions, such as fund raisers, local taxes on tourists, and cost-sharing. Presentations during the workshop indicated that some of these activities are well established in selected

communities (e.g., Incline Village). Community leaders and service providers are encouraged to actively explore the expansion of cost-sharing opportunities to other areas in the Basin. They are also encouraged to explore other new or novel methods to ensure the long term sustainability of local fuel treatment programs.

Recommendation: *Community leaders and service providers should explore new or novel methods to ensure the long term sustainability of local fuel treatment programs.*

4.2.3 During the presentations a common disconnect was noted between planning, funding availability, regulatory approval, and implementation timelines. One of the more apparent problems was related to the issue of streamlining the approval process for project implementation. Available funding is often linked to a fiscal cycle. When the approval process is offset, final regulatory approval may come when funding is no longer available. The implementation timeline creates a related problem. Due to the short work season, even with funding and approval to proceed, the ability to then complete the management activity within the approved timeline is often restricted.

Recommendation: *An advanced strategic planning process should be developed to identify specific project objectives and investigative protocols necessary to answer key management questions. Such advanced planning would help to avert timeline/funding/implementation disconnects.*

4.2.4 The importance of effective outreach and education cannot be overemphasized. The critical nature of this important component was highlighted in the prescribed burning program implemented in concert with the North Lake Tahoe Fire District. This progressive strategy not only relies upon supplemental funding via their constituency, but also necessitates community acceptance and understanding of project goals, objectives, and safety protocols. Outreach education is a continuing process and many existing programs have this as an active component. The Nevada and California Cooperative Extension Services have this as a primary function and have been effectively utilized to facilitate such interaction in the past; not only with the community constituency but with agencies and research institutions as well.

Recommendation: *Outreach and education efforts should continue and be expanded where appropriate.*

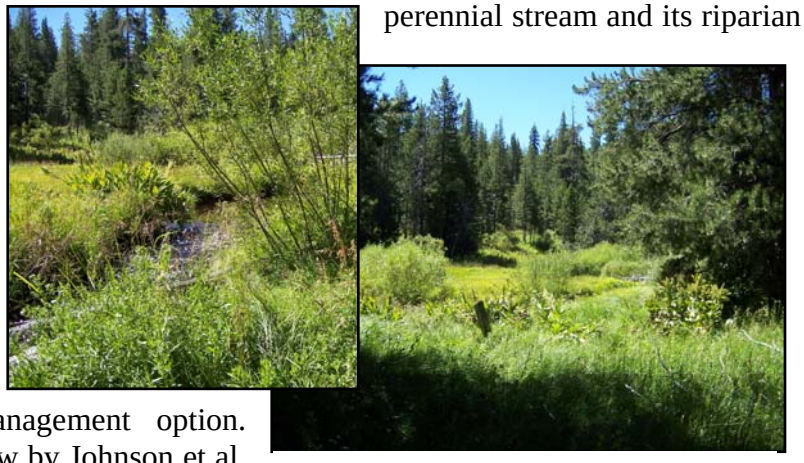
4.3 Implementation Challenges

4.3.1 The Tahoe Basin itself is unique in character. Traditional management protocols developed for forest ecosystems elsewhere do not always apply to Sierran systems because the eastern Sierra Nevada and Lake Tahoe region are characterized by spatially and temporally discoupled nutrient cycles that are created and driven by climatic conditions. For example, temporal discoupling of the N and P cycles typically occurs during snowmelt where the release of N and P from snowpack, decomposing litter, and soil does not coincide with the period of maximum vegetation uptake. Furthermore, in most snow-dominated systems, the majority of nutrient release occurs during the early

parts of snowmelt; albeit Johnson et al. (2001) have found exactly the opposite in the Little Valley area of the eastern Sierra wherein the majority of nutrient release occurs during the later stages of snowmelt. The implementation of management strategies directed towards a specific purpose and location may or may not be a good approach overall, or may not be functional Basin wide. Determining which restoration methods are most effective in controlling the runoff transport of fine sediments as well as those most associated with nutrient loading should be performed in the context of a more comprehensive framework wherein each on-the-ground management strategy could be tested against one another in similar and divergent environments. This would help to ascertain why some practices work better than others in one locale versus another. Such an approach often involves taking advantage of unique opportunities that allow expansion of the overall knowledge base. As a case in point, a top priority following the Angora wildfire (and rightly so) was stabilization and restoration of sensitive areas within the affected watershed where management strategies were designed to reduce the potential for erosion and sediment transport. This was accomplished by mulching of steep slopes and installation of sediment traps and barriers in riparian areas. However, the clarity of Lake Tahoe also is particularly sensitive to nutrient releases from the uplands, and wildfires can initiate a large release of nutrients (Johnson et al., 2007; Miller et al., 2006; Murphy et al. 2006). Therefore, it makes sense to study how post-wildfire rehabilitation measures could limit the release of these nutrients as well. Other examples include the effects of both upland and lowland restoration plantings and slash pile burning on discharge water quality, the effects of riparian wet meadows on nutrient cycling, and the long-term effects of prescribed fire and chipping on nutrient availability and runoff water quality. Therein, we believe, lay key opportunities where new and unique management strategies could be explored.

> ***Recommendation:*** *Regulatory, management, and implementing agencies should take advantage of unique opportunities that allow testing of new approaches and expansion of the overall knowledge base.*

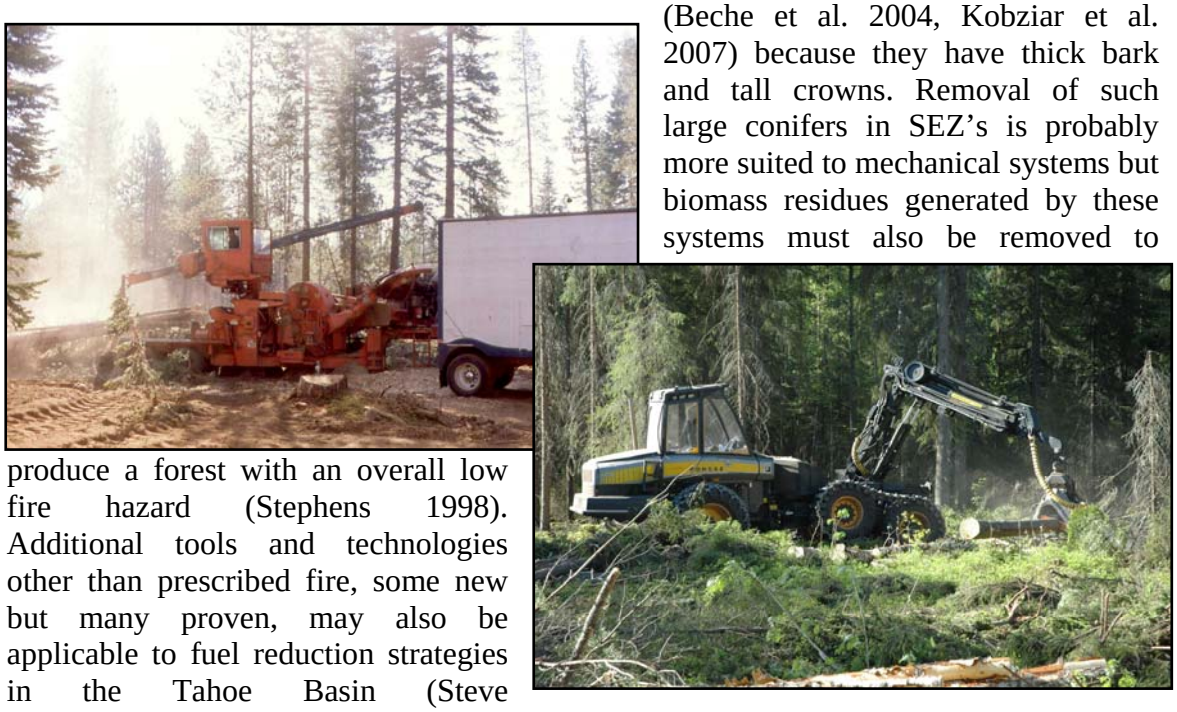
4.3.2 There is limited research on the effects of prescribed fire in SEZs but in one study on the west side of Lake Tahoe with mild slopes, nutrient releases were relatively small after burning (Stephens et al. 2004). An additional study that used a high intensity prescribed fire in a perennial stream and its riparian area in mixed conifer forests in the western Sierra Nevada also found few significant changes after fire (Beche et al. 2005). The use of fire in SEZs requires more research but the two studies cited above support the idea that it could be a feasible management option. However, a literature review by Johnson et al.



SEZ at Sagehen Creek. Credit: Nicole Gergans

(2007) shows the effects of fire on soil physical and chemical properties to be highly dependent upon the fire severity. Low-severity broadcast-burn prescribed fires typically have minimal negative impacts if the fuel loads are light and duration is short whereas high severity wild fires can result in substantial losses of soil organic matter, nitrogen, and overall soil fertility. Of particular interest to SEZ biomass management (Johnson et al., 2007) is the impact of slash pile burning, which typically causes large local variations in fire severity. Severe fire under slash piles can cause significant changes in soil chemistry and water quality, losses of soil organic matter and N and perhaps even changes in soil mineralogy (Ulery et al., 1996). We (Johnson et al., 2007) have observed severe effects of slash pile burning in some areas of the Sierra Nevada, where former slash piles are now devoid of vegetation and soils have take on a reddish hue suggestive of low organic matter and mineral alteration. Others (Korb et al., 2004) have reported that in addition to altering soil properties, the burning of slash piles nearly eliminated viable seeds and arbuscular mycorrhizae propagules thus stimulating the invasion of undesirable exotic species. They found, however, that soil amendments and reseeding with native species mitigated these effects. While slash piles occupy only a small proportion of land area, cumulative watershed effects may or may not be significant over the landscape. Key management questions in need of research that are directly pertinent to SEZ biomass treatment include: 1) Whether or not slash pile burning in SEZ should be allowed?; 2) What are the potential adverse effects either in terms of excess nutrient mobilization or sterilization?; 3) Can the adverse impacts be effectively mitigated?; and 4) if allowed, to what scale, placement, and size of burn piles should be restricted?

With 100 years of fire exclusion in the Basin (Taylor and Beaty 2005), however, many conifer trees have become established and are now relatively large (over 20 inches in diameter). The use of fire alone will not remove many trees in these larger size classes (Beche et al. 2004, Kobziar et al. 2007) because they have thick bark and tall crowns. Removal of such large conifers in SEZ's is probably more suited to mechanical systems but biomass residues generated by these systems must also be removed to produce a forest with an overall low fire hazard (Stephens 1998). Additional tools and technologies other than prescribed fire, some new but many proven, may also be applicable to fuel reduction strategies in the Tahoe Basin (Steve Rheinberger, USFS; personal



Top Left: Chipper operating at roadside. Credit: Bruce Hartsough. Bottom Right: A cut-to-length harvester. Credit: Erik Drews

communication). A discussion of many such techniques is available in the accompanying Supplemental Appendices (Appendix C). The various equipment and systems have many different names, but none of them are black boxes: the relative impacts on soil and vegetation can be approximately estimated because we understand the inner workings. How applicable is each system in the Basin? This question can be answered for many tools without the need for a unique study by extrapolating from results of previously tested equipment. For example, if a tong thrower[1] (a high-lead system) generates acceptable impacts on steep terrain soils, then any cable system that provides one-end or full suspension can be expected to do the same – if used properly. If a given forwarder does not overly compact soils in an SEZ, the same machine on larger tires or tracks, or a lighter machine on the same tires should also be acceptable under the same site conditions.

How available are the various types of equipment, how likely are owners to bring their operations from outside the Sierra to the Tahoe Basin, and what's the possibility of new investors purchasing specialized equipment just for use in the Basin? Numerous firms in the Sierra Nevada own feller-bunchers and grapple skidders. Only two companies in the State operate harvesters and forwarders; many more are in business in Oregon and Washington. A few contractors in the Sierra own cable yarders, although these machines are more prevalent on California's north coast and the Pacific Northwest. No in-State firms log with helicopters. Although adopting locally available equipment is by far the option with the best chance for timely, cost-effective implementation, external companies might be more inclined to consider work in the Tahoe Basin if there is a critical mass that warrants the very expensive move-in venture, and the guarantee of long-term work could be a great facilitator in this regard.

> ***Recommendation:*** *Identify potentially useful new or existing tools and technologies, and assess their availability and applicability to Sierran systems. Consider a variety of mechanized approaches for use in the Basin, in addition to or in combination with prescribed fire, and pursue research to address pile burning management questions. Explore opportunities to ensure the long term sustainability of local fuel treatment programs and contracts.*

4.3.3 As more operations are conducted within the Basin, confidence will grow in the ones that are successful under the local constraints. Managers and contractors outside the Basin, however, are not likely to try more expensive, Tahoe-tailored equipment and methods because of the added expense. This means that unique systems for the Basin will have to be tested here, or someone here will have to pay for tests elsewhere. Given the small scale of a treatment unit in the Basin – 10 or 20 acres seems reasonable – the total sediment yield would not be substantial if the method did not perform as well as anticipated. We do not recommend wholesale experimentation with questionable approaches, what we are suggesting is that a little risk-taking with methods that appear to

[1] This is an excellent example of an existing type of equipment proven elsewhere. It was developed and patented in the mid-1980s by Renfro Brothers in Idaho, and licensed to Jewell Manufacturing in Oregon. Approximately 40 excavators in the Pacific Northwest had been equipped with tong throwers by 1996.

be promising based on current knowledge be encouraged. For example, we know that a system employing a forwarder (CTL or whole tree) to transport material eliminates sweeping or plowing effects of dragging loads, and use of such a system elsewhere on slopes of up to 40% is not unusual. If a trial in the Basin when soils are relatively dry is successful, it would extend the applicability of this system to many acres that otherwise would have to be treated with costlier cable systems and upslope roads.

> ***Recommendation:*** *Experimentation should be encouraged so that implementers will be more willing to try promising new approaches on a small scale to evaluate their ecological impacts without the risk of non-compliance penalties.*

4.3.4 There is a critical need for regulatory agencies to clearly identify their agency specific areas of concern, and then work with scientists and implementing agencies to articulate the respective key management questions. These questions are essential to guiding the development and design of successful monitoring and/or research programs that generate data and information that are directly applicable to agency needs. However, key to the success of any such Basin-wide strategy is the development of a consistent and effective monitoring protocol for soils, hydrology, vegetation, fuels and model application that are current, process-specific, and uniform across agencies and contractors. Most professional societies have developed published methods of analysis for just such a purpose. Examples include the Environmental Protection Agency, Soil Science Society of America, ASTM Standard Methods of Analysis, and others. A "standard" testing and monitoring protocol is needed for the Tahoe Basin. In its absence, different implementers and agencies frequently employ different techniques in attempting to address the same management question. It was noted during the workshop that the effect of mechanical treatment on soil compaction was a key management concern. Three separate studies, the Heavenly Valley SEZ Demonstration Project, the Homewood Ski Area project, and the Celio Ranch Fuels Reduction project, each used a different protocol for the characterization of soil compaction. Consequently, comparative analysis of the findings is virtually impossible and creates a prime example of why interpretive assessments of a given database often vary dramatically. At least one agency (LTBMU) is currently using monitoring protocols that are already in place and that, where required, have been modified to conform to existing conditions. We recommend that these protocols be distributed Basin wide and evaluated as to their unique applicability to Sierran ecosystems, following which appropriate monitoring activities should be compiled for each key management activity and adopted as the standard protocol among agencies and contractors. A publication on "Standard Methods for Ecological Measurement and Monitoring in the Lake Tahoe Basin" should be developed that includes different levels of intensity that can be applied to different types and scale of projects.

Ideally, a system that produced acceptable impact on one site would also deliver positive results on all similar sites. In reality, it is difficult to determine if two sites are similar, and even identical equipment may generate different loads. For example, a forwarder might be loaded to its volume capacity with dead lodgepole pine or green tree fir logs; the latter vehicle might weigh a third more than the former. Inexpensive, real-time

A forwarder transporting cut-to-length logs in the Lake Tahoe Basin. The same or a similar vehicle can transport whole trees or sections of trees with limbs and tops attached. Credit: Tetsuhiko Yoshimura

monitoring of anticipated worst-case situations would allow operations to be halted as soon as signs of unacceptable impact become apparent, rather than waiting for delayed results from expensive, labor- and lab-intensive tests. We focus on soil compaction as an example. A traditional protocol might call for core samples to be taken from a random or regular grid of many points distributed across a treatment unit: expensive, labor-intensive, not focused on the anticipated worst cases, and with substantial delay between the beginning of any negative impacts and learning about them. Another approach might rely on the fact that soil cannot be compressed unless it deflects. A few laser range finders could be suspended from trees over worst-case wet spots on vehicle trails. The finder would trigger an alarm in the vehicle and/or a call to a site administrator's cell phone if the measured distance to the surface increased beyond some threshold value. Soil cannot be sheared by tires or tracks unless the tires or tracks move (slip) relative to the surface. Slip sensors are now common on agricultural tractors (to optimize tillage operations) and could be added to skidders and forwarders, again sounding the alarm if slip exceeded an agreed upon threshold. Real-time sensors of soil and other properties are being developed for precision agricultural operations and may be applicable to forestry as well. GIS tracking is another example where GIS units mounted on vehicles can document whether or not the vehicles remain on designated trails. As Tim Hagan (TRPA; personal communication) and Steve Rheinberger (USFS; personal communication) pointed out, proper use of equipment is as important as the characteristics of the machines. Because of this it is more important to prescribe results rather than equipment. Defining what the result should look like is also a better way to encourage innovation that may reduce costs. This approach, however, dictates that the agencies be able to clearly define threshold limitations before the work begins.

> ***Recommendation:*** *Regulatory agencies need to clearly identify specific areas of concern and articulate respective key management questions. This is an essential step in guiding the development and design of successful monitoring and/or research programs that generate data and information directly applicable to agency needs. Existing protocols should be evaluated as to their unique applicability to Sierran ecosystems. Appropriate monitoring activities should then be compiled for each key management activity and adopted as the standard protocol among agencies and contractors in the Tahoe Basin. A publication on "Standard Methods for Ecological Measurement and Monitoring in the Lake Tahoe Basin" should be developed and used.*

4.3.5 It would be remiss to neglect the implications associated with climate change. Predictions for the next century include a 3°C rise in global temperatures, therefore increasing global evaporation and precipitation, much of which is predicted to occur in northern latitudes (Roos, 2005). Predictions for changes in precipitation quantity and intensity are quite variable for the Sierra Nevada. One scenario is that precipitation will increase in intensity leading to large scale flooding. Another is that the Lake Tahoe area will be subject to overall warmer temperatures and more evaporation/evapotranspiration, while increased precipitation will be more common further to the north. There is general agreement, however, that with warmer temperatures snow elevation levels will be higher and accumulation likely lower which will lead to longer fire seasons (Westerling et al. 2006). Sensitive-area management strategies involving biomass reduction, drainage control, and practices to diminish sediment and nutrient transport to Lake Tahoe should be examined in the context of a shift in the kind and amount of hydrologic input. Currently, most prescriptions call for average conditions at the stand level to be replicated over the landscape, essentially producing fairly homogenous forests. Managing forests in the face of uncertainty because of changing climates will require new approaches (Millar et al. 2007). We believe that the production of resilient, spatially heterogeneous forest structure would be the best overall strategy concerning climate change. In addition, future planning should be designed to account for potential changes in hydrologic function in response to different moisture regimes to determine what the ultimate effects of climate change could be on management protocols for sensitive areas.

> ***Recommendation:*** *Sensitive area management strategies should be examined in the context of a shift in the kind and amount of hydrologic input so that future strategies can account for potential changes in hydrologic function. The effects of changing climates on the Basin's fire regimes should also be examined.*

4.3.6 The cost information presented by Steve Rheinberger (USFS; personal communication) as typical for various fuel reduction treatments were on the order of half or less of those experienced for similar recent operations in the Basin. Several factors contribute to high Basin costs. Operations require more time and effort to plan, permit and approve. Small treatment units cost more per acre because mobilization and de-mobilization costs must be spread over less area. Tahoe's unique considerations for water quality and working in people's back yards require measures beyond those used elsewhere. For example, cut-to-length (CTL) operations that have been prescribed for the Basin are more expensive than whole-tree methods commonly used elsewhere. In addition, the Basin's brand of CTL treatment is costlier than that

A stand near Tahoe City after mechanized treatment at a cost of approximately $2500 per acre. Credit: Tetsuhiko Yoshimura

conducted elsewhere because contracts have required implementers to: a) chip materials onto entry roads; b) collect, forward and pile large woody debris; c) masticate slash and small woody debris; d) re-forward and distribute the large woody debris; and e) transport logs at higher haul costs because of the lack of local mills. There clearly has been a lack of serious interest by contractors to bid on projects in the Basin. The different requirements add a degree of uncertainty, as does experience with submitting a successful bid, only to have the contract cancelled, as was the case with the recent California State Parks over-the-snow SEZ operation. Some contractors have moral issues with requirements they consider to be wastes of public funds, and others have been adversely affected by past implied promises of long-term chipping or CTL programs that did not come to fruition. They purchased equipment, only to have it sit idle.

An operating season of 120 days is not unusual for a harvesting contractor in the Sierra Nevada. If the season at Tahoe extends over three to four months, the number of working days might be in the range of 60-100, or less for SEZs during wet years. This is not unreasonable if nearby contractors can utilize the same equipment within and outside the Basin, but it doubles the hourly capital cost of any Basin-specific equipment including modifications such as larger tires or tracks to equipment used elsewhere. In addition to an adequate season, contractors need a reasonable amount of work (in acres). Let's assume approximately 6,000 acres are to be treated per year over the next decade (Holl 2007), and half of this involves mechanical treatment. Assuming a mechanical felling machine or a chainsaw crew can treat 2-6 acres per day (Holl 2007; productivity varies widely with type of equipment, tons per acre removed, tree size, etc.), this work might support 10-20 felling machines or crews throughout the Tahoe season. By TRPA's latest estimates, SEZs represent about 18,000 acres, or roughly 10% of the land area in the Basin (Tim Hagan, TRPA; personal communication). If the mechanical treatments are spread in equal proportion (they may not be) across land types, SEZ operations might support one or two felling machines per year. If unique equipment is required for work in the SEZs, interest from contractors will be limited.

As Tamara Sasaki (California State Parks; personal communication) described at the Workshop, few hand crews are available to carry out operations in the Basin, and those involved with prescribed burning are all in demand at the same time due to the narrow burn windows. In addition, hand crews can be pulled off to fight wildfires, thus exacerbating the problem of availability for project work. Agencies should consider contracting out dedicated hand crews that are not also required to fight wildfires. Whether a contractor is involved with mechanical or hand operations, he or she will be more likely to participate if relatively certain about the amount of work available, what equipment is required and the effect of operational

Material cut and piled by hand in Blackwood Canyon. Credit: Tetsuhiko Yoshimura

constraints. Long-term contracts would be excellent incentives. Prices should come down as people gain experience operating with in the Basin. The Forest Service has critical mass and can provide substantial work, but no other land management group in the Basin can do so on its own. It would be beneficial therefore to coordinate fuel reduction projects because economies of scale do exist. If, however, administration of such a program is as costly as one scenario ($3 million per year for 1200 CWPP acres per year = $2500 per acre; Holl 2007) it is unlikely to be pursued.

> ***Recommendation:*** *Carefully evaluate Basin-specific requirements to determine necessity. Guarantee a long-term program, and coordinate/consolidate operations on small-scale units and ownerships. Look at project management and assessment in the context of a larger temporal and spatial perspective.*

4.3.7 An appropriate access network is critical. Roads are expensive to build, more expensive to remove, and generally create more environmental impact than all the harvesting carried out from the road, assuming the harvesting is planned and conducted carefully. It is therefore important to utilize the existing road and trail network as much as possible. For example, use of an existing road in the drier portion of a SEZ would almost certainly be preferable to locating a new road just outside the SEZ. Most of damage associated with a properly maintained existing road has already taken place. However, Dave Fournier's (USFS LTMBU; personal communication) analysis indicates that only a small percentage of National Forest land in the Basin is currently accessible by road.

Top Left: skyline yarder on an excavator base. Credit: Jewell Manufacturing
Bottom Right: Skyline yarding whole trees. Credit: Raffaele Spinelli

Cable systems are the most likely candidates for mechanical removal on steeper terrain, and, in thinning create the least damage to residual vegetation when loads are pulled uphill, implying that roads should be at the tops of steep treated units. Clever planning and operation may allow for full suspension during downhill yarding to valley-bottom roads, or use of low-standard trails rather than roads to access the upper edges of steep areas. Residue biomass fuels generated by cable thinning operations (slash) must be treated to produce an overall low fire hazard condition (Stephens 1998).

Managers must carefully consider if and where to construct new roads, considering the full costs and benefits, economic and environmental. We fully endorse Steve Rheinberger's (USFS; personal communication) suggestion to engage an

experienced forest engineer/harvesting specialist to participate in a Basin-wide planning exercise: e.g., a logging feasibility study. The existing community wildfire protection plan (CWPP) for the Tahoe Basin does a reasonable job of describing where treatments should occur and in what priority. However, the CWPP does not provide any information on how such treatments should occur. Where road access is unavailable, burning on steeper slopes should be considered with local evaluation of fuels and associated risks taken into account. If these areas are not burned to reduce hazards they may otherwise remain untreated. A logging feasibility study should identify where to employ the limited resources available for prescribed burning only, mechanical treatment with or without burning, the opportunities to use existing roads, and the need for new roads. This would involve modeling the impacts of treatments on potential wildfires as well as the costs of access and the fuel reduction operations themselves.

> ***Recommendation:*** *Optimize the use of limited resources by conducting a Basin-wide analysis of: a) costs and expected benefits of various treatments (e.g., mechanical, hand and/or fire) under various spatial and temporal scenarios, and the need for roads or other access; b) expected environmental costs of treatments; and c) simulated resulting behavior and costs associated with wildfire.*

4.4 Opportunities for Advancement

One of the objectives of this workshop was to explore current practices and to identify ways to advance new strategies and practices for vegetation management in sensitive areas of the Lake Tahoe Basin. The intent of this section is to suggest a science based framework for the ramping up of efforts to obtain new information, and developing ways to convert that information into applicable knowledge that will assist in the planning, review, and implementation of future projects. Shifting the "evaluation paradigm" of vegetation management projects from one focused on project development impacts towards their evaluation as habitat restoration projects could be the most direct way to deal with the issue of permanent vs. temporary impacts, and could provide the basis for new mitigation opportunities.

4.4.1 Manipulative research projects that include random assignment of treatments and replication are very challenging to perform in the Basin because of regulations and a limited land base. And yet a key research need is to identify and quantify environmental thresholds and standards in a variety of ecological settings, and under various manipulations. In such cases where robust experiments are appropriate we recommend that the potential for research projects near the Basin in similar physical and ecological settings be considered. For example, restoration methods that are most effective in controlling runoff transport of fine particles as well as those most effective in the reduction of nutrient discharge loading should be assessed. This would allow a more complete understanding of the environmental factors (i.e. temperature, moisture, vegetation, litter) that determine the formation, persistence, and dissipation of seasonal and long-term effects on runoff water quality and erosion. In this context, similar slope stabilization, infiltration, revegetation, or sedimentation techniques could be tested against each other in similar and divergent environments as a means of ascertaining why

some work better than others in one locale vs another. Research forests such as at Little Valley, NV or Sagehen Creek, CA could serve as sites for this kind of research that would yield information directly applicable to the Basin; other such areas are probably available. Finally, our collective ability to learn from many of the vegetation management projects could be greatly enhanced if the management agencies would work more directly with scientists during project planning. Many such projects are essentially small-scale limited experimentation, and the costs of planned manipulations could be leveraged to reduce the total cost of obtaining new information by "institutionalizing" the demonstration project approach to address larger spatial or ecological issues (e.g., landscape level reductions in fire risk, or affects of treatments on wildlife/forest health). It is critical in this regard, that the projects be scientifically strong and results publishable in peer-reviewed journals. The current research program at Lake Tahoe administered by the USFS Pacific Southwest Research Station is a tremendous resource for the Basin. The program has used rigorous peer review of proposals and the panel strongly recommends that this continue. It is advantageous that local land management agencies have input as to what proposals best meet land management and planning needs, but the scientific merit of the studies should be evaluated via the science based peer review process.

There is now opportunity for a paradigm shift away from the subjective assessment of unknown issues, towards one that is more action oriented. Because regulatory exception or non-exception in the Basin must often be based on subjective judgment of the "risk potential" rather than on a sound quantitative support system, the application of predictive models can provide important tools to understanding and estimating the potential outcome of management strategies and programs. Pertinent examples would include the application of proven soil erosion (see Appendix B of the Supplemental Appendices), nutrient cycling, and hydrologic models at the landscape scale, where such techniques can help make alternatives analyses more objective. Successful model application, however, dictates the need for site specific parameterization and model calibration. A prioritization of which ecosystem parameters are important, what should be measured, and what information is needed to parameterize and calibrate the models should be established. Individual project monitoring and assessment should be structured to provide relevant information for model improvement, development, and validation for the Lake Tahoe Basin. In the event that the current models are not adequate predictors, appropriate modifications or adjustments are needed in order to make the existing models more functional. If this is not an option, starting from scratch and developing a new model that is simple, accurate, and appropriate for the Basin may be necessary. Model use and predictive application should then become consistent among agencies Basin wide. Furthermore, it is our sense that natural systems are typically resilient overall, and impacts on a site specific basis may not be as severe (perhaps even negligible) when considered from a landscape perspective. Not all anthropogenic activities in sensitive areas cause significant cumulative or irreparable large scale damage, and although the subjective approach remains important for environmental awareness in the Tahoe Basin, we recommend that the acquisition of a more robust quantitative database provide the foundation for the policies of future management strategies.

Recommendation: *Management agencies should work more directly with scientists during project planning to develop a scientific foundation for the assessment of project impacts in the context of cumulative and landscape scale impacts associated with sensitive area management strategies.*

4.4.2 In concert with the above paradigm shift, is the need for innovative experimentation and real time monitoring feedback. The significance of an impact must be assessed from both a statistical and ecological perspective. Although statistical evaluation is fairly routine today, sound ecological assessment remains elusive. A key component of ecological assessment is identification of known indicators of ecosystem status, response, and recovery. The search for and measurement of ecosystem indicators is a dynamic process because relevancy is not necessarily static. This dictates the need for real time monitoring feedback so that the implementation of management strategies can be truly adaptive. For example, prior to the Angora wildfire, overstocking and high surface fuel loads of adjacent steep slopes was considered a key ecosystem indicator relevant to both forest health and the spread of fire within the Basin. That relevancy did not change during the wildfire. What did change, however, was realization by some that overstocking and high surface fuel loads of flat to moderately sloping streamside zones was highly relevant to anthropogenic health and safety at the urban interface. We suggest that in the absence of comparative evidence, on-site comparison and testing of new ideas and innovative technologies be allowed when there are effective monitoring protocols in place to evaluate impacts.

An untreated stand near Tahoe City. Credit: Tetsuhiko Yoshimura

Recommendation: *In the absence of comparative evidence, the comparison and testing of promising new ideas and innovative technologies should be encouraged and facilitated. This should be coupled with real time monitoring feedback with relevant ecosystem indicators so that management implementation can be truly adaptive.*

4.4.3 The application of new technology and/or innovative approaches appears to require outside-Basin evidence of success prior to approval by regulators for implementation. However, due to its unique status as a comparatively pristine sub-alpine setting, comparative evidence relative to a specific condition or management question in the Tahoe Basin may not be available. Although a risk-based approach or model is a long-term goal for the management of sensitive areas, better information on the presence or absence of short-term impacts is needed. To obtain good information on either long- or short-term effects, the specific management question and effect on the relevant indicator must be clearly identified. For example, if the best ecosystem indicator of adverse soil

disturbance in an SEZ is in fact soil compaction (albeit may not be), then the accurate measurement and aerial characterization of that parameter and its response is paramount regardless of the management technique being implemented. Once agency representatives clarify what we need to know, we can then design a monitoring protocol to address that specific issue using standardized methodologies yielding results that can be compared across implementation activities. We recommend that a list of specific management questions be identified relative to key indicators of interest and concern for sensitive areas, for which pertinent standard methods of measurement and monitoring for assessment are then specified. It will then be possible to address: a) whether or not the proposed monitoring program was of sound design; b) whether or not the program was properly implemented; c) whether or not standard methods of analysis were applied; and d) whether or not the comparative impacts are statistically and ecologically valid.

Recommendation: *A list of specific management questions should be identified by agency representatives relative to key indicators of interest for sensitive area management. A pertinent list of standard methods of analysis and monitoring to be used in addressing the management questions must then be provided.*

4.4.4 A common theme has centered on the need to more rapidly move forward. Regulatory constraints, actual or imagined, are perceived as impediments to implementation that prevent projects from achieving fruition. The need to implement the activity, make the necessary measurements, use real time monitoring for control of project impacts, and generate the interpretive assessment clearly exists. Even so, prudence dictates a controlled approach. Effective use of the available literature could assist greatly in this regard. Experience suggests that if something is not published in the open literature, it is not accepted at the policy level. Publishing may not always be beneficial, but the requisite peer review process provides a means of quality control. The use of data from informal studies could be of collective benefit if it has conformed to an acceptable standard protocol. One source of interpretive disagreement stems from the lack of quality control. A collective compilation of the literature would be highly advantageous, particularly if grouped by topic, study location, and literature source (Journal, Technical Report, Popular Press, Individual Study). Several efforts in this regard are currently in progress and should be continued. In order to avoid duplication of effort, a list of web link connections on a central server should be developed. This would allow for the development of a centralized indexing system for pertinent science and project-based literature, a centralized system for the collection of real time monitoring data, and a forum for sharing the interpretive analysis of collective findings.

Recommendation: *A flagship web site consisting of links containing a collective compilation of literature pertinent to Tahoe Basin issues should be developed. These links could be organized relative to current key management questions. Listing of the literature could be organized as to topic, location, and literary source.*

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