POLICY REPORT

Independent Science Panel Report

Herger-Feinstein Quincy Library Group Forest Recovery Act

July 2013

PINCHOT INSTITUTE FOR CONSERVATION

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"Herger-Feinstein Quincy Library Group Forest Recovery Act" (PL 105-277, div. A, Section 101(e) [title IV, section 401], 21 October 1998), 112 United States Statutes at Large, pp. 2681-231- 2681-305.

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A. Results in Brief

An independent science panel was established by Congress pursuant to the Herger-Feinstein Quincy Library Group Forest Recovery Act (HFQLG Act) to review the effectiveness of new forest management approaches on the Lassen and Plumas National Forests, and portions of the Tahoe National Forest in northern California. These approaches were designed to meet goals established in the "Community Stability Proposal" (1992) which was first proposed by the Quincy Library Group, a diverse group of collaborators including local citizens, the forest products industry, and environmental groups.

The Community Stability Proposal recommended a suite of forest restoration treatments be undertaken across 1.53 million acres of land within the national forests to simultaneously improve economic stability of the local communities, reduce the size and severity of wildfires, protect the California spotted owl population, and improve the condition of water resources. The Community Stability Proposal was incorporated by reference into the HFQLG Act, which added additional requirements and guidance on how the suite of forest restoration treatments would be implemented and evaluated. The proposed measures were assessed by the USDA Forest Service and adopted as management plan revisions for the three forests (USDA 2001, 2004). The HFQLG pilot project was supported through Congressional appropriations and twice extended beyond its original demonstration period of five years. The HFQLG pilot project was completed on September 30, 2012.

The independent science panel was tasked with reviewing and evaluating "whether, and to what extent, implementation of the pilot project under this section achieved the goals stated in the Community Stability Proposal, including improved ecological health and community stability" (HFQLG Act 1998). The independent science panel was comprised of a ten member team drawn from around the country, representing expertise in economics, fire science, forestry, hydrology, sociology, soil science, and wildlife ecology. The review included a 2008 report to the HFQLG implementation team recommending adjustments in monitoring activities to support the scientific evaluation (Pinchot Institute 2008). The final review of the HFQLG pilot project generated nine "Key Findings," listed below and described in this report:

(1) The pace and scale of HFQLG pilot project treatment implementation did not meet expectations for the supply of wood fiber or the number of acres treated.

(2) The HFQLG pilot project was unable to provide local economic stability through an adequate and continuous supply of timber to local mills.

(3) The HFQLG pilot project produced positive social and organizational changes.

(4) Implementation of the HFQLG pilot project fire and fuel management treatments typically reduced localized fire severity and had benefits for fire suppression activities.

(5) Fuel reduction and silvicultural treatments, where implemented, helped develop all age, multistory, and fire resilient stands, but it is uncertain how these treatments affected ecological integrity at the landscape level.

(6) California spotted owl nest and roost sites were protected during the HFQLG pilot project implementation, but the HFQLG pilot project failed to assess if there were adverse environmental impacts to the owl population resulting from treatments.

(7) The HFQLG pilot project successfully implemented measures designed to protect water bodies, but scientific studies did not adequately determine how treatments affected water resources, and the pilot project treatments did not protect streams and riparian areas from the impacts of catastrophic wildfire.

(8) Protection measures, management strategies, and monitoring activities helped reduce some adverse environmental impacts. Other impacts, including to some species of concern, were uncertain because scientific evaluations were uneven, ineffective, or not completed.

(9) The HFQLG pilot project expanded and supported existing wetland and riparian restoration activities, but did not implement a new program of water resource protection and management referenced by the HFQLG Act.

Box 1. Key Findings

Many factors influenced the implementation of the HFQLG pilot project, the effects implementation had on proposed outcomes, and the extent to which scientific analysis could explain the outcomes. To a great degree the HFQLG pilot project was conceived to test potential solutions for difficult natural resource management challenges, including the competing perspectives of many stakeholders. Over the course of thirteen years there were important persistent challenges that impeded testing of these potential solutions as follows:

- The HFQLG pilot project comprised portions of three national forests, each of which had different capacities, organizational cultures, and success engaging external stakeholders. Such differences influenced the pace and scale of implementation.
- Frequent changes in leadership at the forest level affected whether and to what extent the HFQLG pilot project was implemented, and therefore, what could be learned.
- The timeliness and comprehensiveness of scientific monitoring information relied on partnerships with scientists from Forest Service research stations and outside organizations. In some instances these partnerships were crucial for adding breadth and depth to the monitoring program. In other instances, scientific findings were not completed, useful, or employed to inform activities in a timely manner.
- Monitoring the HFQLG pilot project required collating and analyzing information developed through disparate processes occurring within different administrative units of the Forest Service and other agencies. A benefit of the HFQLG pilot project was that it consolidated interrelated information, which was crucial to management.
- Appeals and litigation of Forest Service environmental decisions directly and indirectly affected implementation. Projects delayed because of legal challenges also impacted monitoring activities because they had to be revised, delayed, or abandoned. Additionally, prior appeals and litigation or the threat of future litigation forced the Forest Service to conduct more thorough analyses of the environmental impacts of forest treatment activities.

Feedback from stakeholders and the Forest Service suggested that there was greater support for the HFQLG pilot project in the later years of implementation. This was partially a result of new science published in agency publications (North et al. 2009, North 2012). This outcome of support and acceptance demonstrates the value of science-based dialogue that served as the original impetus for the Community Stability Proposal.

The collaboration that led to the Quincy Library Group's Community Stability Proposal has been celebrated as a potentially transformative approach for federal lands management. Whereas the HFQLG pilot project originated through an unprecedented type of collaboration, it also represented an unprecedented type and level of federal investment. Despite these precedents, full implementation was not accomplished in the thirteen years of the HFQLG Act. The degree to which local economic stability has been accomplished or how the California spotted owl and other species of conservation concern will fare over the long term has not been answered. Where implemented, the HFQLG pilot project treatments helped reduce the damaging effects of wildfire. The treatments also produced some much needed local economic stimulus. Thus, the HFQLG pilot project has demonstrated some potential of collaborative engagement. Yet, after more than a decade it cannot yet be considered a model for how institutions and collaborative partnerships achieve the complex outcomes of promoting forest health and economic stability while maintaining environmental values. Thus, the full effects and potential impacts of the HFQLG pilot project remain uncertain.

B. Background & Methods

The HFQLG Act was enacted on October 21, 1998 establishing the HFQLG pilot project to test approaches that grew from the efforts of the Quincy Library Group and their interaction with the Lassen, Plumas, and Tahoe National Forests in northern California. The Quincy Library Group developed the Community Stability Proposal in 1992 with the intention to reduce conflict over forest management approaches, sustain communities in the region, improve the health of forests and watersheds, and maintain the ecological integrity of managed forests. A subsequent HFQLG Final Environmental Impact Statement (FEIS) analyzed an array of alternatives to demonstrate and test the approaches proposed in the Community Stability Proposal.

In the Record of Decision (ROD) the Forest Service proposed to establish and implement a pilot project not to exceed five years by amending, as needed, management direction in the Land and Resource Management Plans for the Lassen, Plumas, and Sierraville District of the Tahoe National Forest (USDA 1999). The purpose of the HFQLG pilot project was to test and demonstrate the effectiveness of resource management activities designed to meet ecological, economic, and hazardous fuel reduction objectives. The HFQLG Act provided support through Congressional appropriations of $293 million over what became a thirteen year period. With this monetary support and in consultation with the Quincy Library Group, the Forest Service implemented activities that included shaded fuel break construction consisting of a strategic system of defensible fuel profile zones (DFPZ), group selection and individual tree selection harvest, and a program of riparian management and riparian restoration projects.

A program of scientific assessment was also established in the ROD to meet three objectives. The first was to accomplish the reporting and monitoring requirements as set forth in the Act. The second was to gather information to aid the work of an Independent Science Panel. The third was to assess the degree of implementation and effectiveness of the selected management practice in meeting objectives outlined in FEIS.

In 2007 the independent science panel initiated a review of the HFQLG pilot project. The Pinchot Institute for Conservation was selected to convene the panel to evaluate associated implementation and lessons it may offer, through a multi-year interdisciplinary review. The scope of this review is described in the HFQLG Act:

> "(1) The Secretary (of Agriculture) shall establish an independent scientific panel to review and report on whether, and to what extent, implementation of the pilot project under this section achieved the goals stated in the Quincy Library Group-

Community Stability Proposal, including improved ecological health and community stability. The membership of the panel shall reflect expertise in diverse disciplines in order to adequately address all of those goals.

(2) Preparation.--The panel shall initiate such review no sooner than 18 months after the first day of the term of the pilot project under subsection (g). The panel shall prepare the report in consultation with interested members of the public, including the Quincy Library Group. The report shall include, but not be limited to, the following:

(A) A description of any adverse environmental impacts resulting from implementation of the pilot project.

(B) An assessment of watershed monitoring data on lands treated pursuant to this section. Such assessment shall address the following issues on a priority basis: timing of water releases; water quality changes; and water yield changes over the short- and long-term in the pilot project area.

(3) Submission to the congress.--The panel shall submit the final report to the Congress as soon as practicable, but in no case later than 18 months after completion of the pilot project."

The multi-year interdisciplinary review took place in two phases, with visitations to the HFQLG pilot project area in 2007, 2008, 2012, and 2013. In 2008, we completed Phase One, which consisted of a comprehensive review of available data and monitoring approaches employed up to that time. The purpose of the interim review was to make recommendations to the HFQLG implementation team about necessary changes to the monitoring program that would provide data upon which this final evaluation would be based. Time was spent on each forest consulting with key stakeholders and agency leads during this process.

The HFQLG pilot project was extended in December 2007, and the Forest Service was directed to initiate a collaborative process with environmental group plaintiffs and the Quincy Library Group to consider treatment modifications. The collaborative process began in 2008 and concluded on September 30, 2012. We resumed our evaluation on October 16, 2012 to provide to Congress a report on the effectiveness of the HFQLG pilot project activities.

Independent Science Panel Review Methods

We adopted a Goals, Objectives, and Indicators approach to facilitate review of the HFQLG pilot project. This hierarchical approach uses the higher-level intent from the Community Stability Proposal as the "Goals" that we evaluated. The Community Stability Proposal strategies were employed as "Objectives" to evaluate the means by which the goals were achieved. Objectives were derived from the HFQLG Act and the initial Request for Proposals for this review. The Implementation Monitoring Questions developed from the FEIS were used as "Indicators" to provide us with quantitative and qualitative variables that could be measured or described. In some cases, the HFQLG Act itself provides more specific implementation guidance and when appropriate, we adopted these as Indicators. Evidence from each of the Indicators was accumulated by our panel to describe trends under each Objective, which we then characterized as the "Key Findings." We present additional supporting findings in Appendix I to provide justify our conclusions.

"justification for" or strike "provide"

We identified Key Findings addressing the central question posed by the HFQLG Act—i.e. ". . . whether, and to what extent, implementation of the pilot project under this section achieved the goals stated in the Quincy Library Group-Community Stability Proposal, including improved ecological health and community stability." While the Key Findings and the HFQLG Act address a number of resource management issues affected by the HFQLG pilot project, three major issues were of particular concern: (1) the economic stability of local communities (Key Findings 1, 2, and 3), (2) fire effects (Key Findings 4 and 5), and (3) the California spotted owl (Key Finding 6). Other Key Findings address water resources and watershed condition (Key Findings 7 & 9), and adverse impacts on other resources especially species of concern (Key Finding 8). The history of California spotted owl policy and forest management is included in Appendix II to illustrate how relevant events shaped management decisions leading up to the HFQLG Act and subsequent amendments (USDA 2001, 2004).

C. Key Findings

Key Finding 1. The pace and scale of HFQLG pilot project treatment implementation did not meet expectations for the supply of wood fiber or the number of acres treated.

Acres Treated and Volume Removed

met only once in 15 years

The annual goals for treatment acres as set forth in the HFQLG Act were not consistently met. The HFQLG Act authorized funding to support not less than 40,000 acres annually of strategic defensible fuel profile zones, individual tree selection, group selection, and other vegetation management from which merchantable timber and biomass would be generated. Figure 1a depicts a comparison of “accomplished” annual acres to the minimum threshold of 40,000 acres. The Forest Service defined accomplished treatments as projects offered and sold in the fiscal year presented, which were reported annually to Congress. HFQLG pilot project implementation exceeded or came close to the 40,000 acre threshold in FY 2001 and FY 2004, but did not exceed 63% of the threshold for the remaining years.

The HFQLG Act and subsequent reports to Congress described resource management activities strictly in terms of acres treated. However, the individual forest plans and the underlying FEIS analysis of alternatives expressed commodity outputs in million board feet (MMBF), hundred cubic feet (CCF), and tons harvested. Annual sawlog output was estimated to be approximately 286.3 MMBF (237,629 CCF), and annual biomass production was 227,000 dry tons (189,167 CCF) for Alternative 2, the selected FEIS alternative. By comparison, the actual harvest from National Forest lands within the HFQLG pilot project region was approximately 273 MMBF (227,500 CCF) in 1990, which declined to 39 MMBF (32,500 CCF) by 1998 (derived from Table 3.57, 1999 FEIS). From 1999-2011, average annual harvest was approximately 79 MMBF (65,862 CCF) in sawlogs and 83,762 dry tons (69,802 CCF) in biomass.

Figure 1b depicts reported acres accomplished versus acres ultimately treated. The solid line represents the aggregate balance of untreated acres that were offered and sold but not implemented.

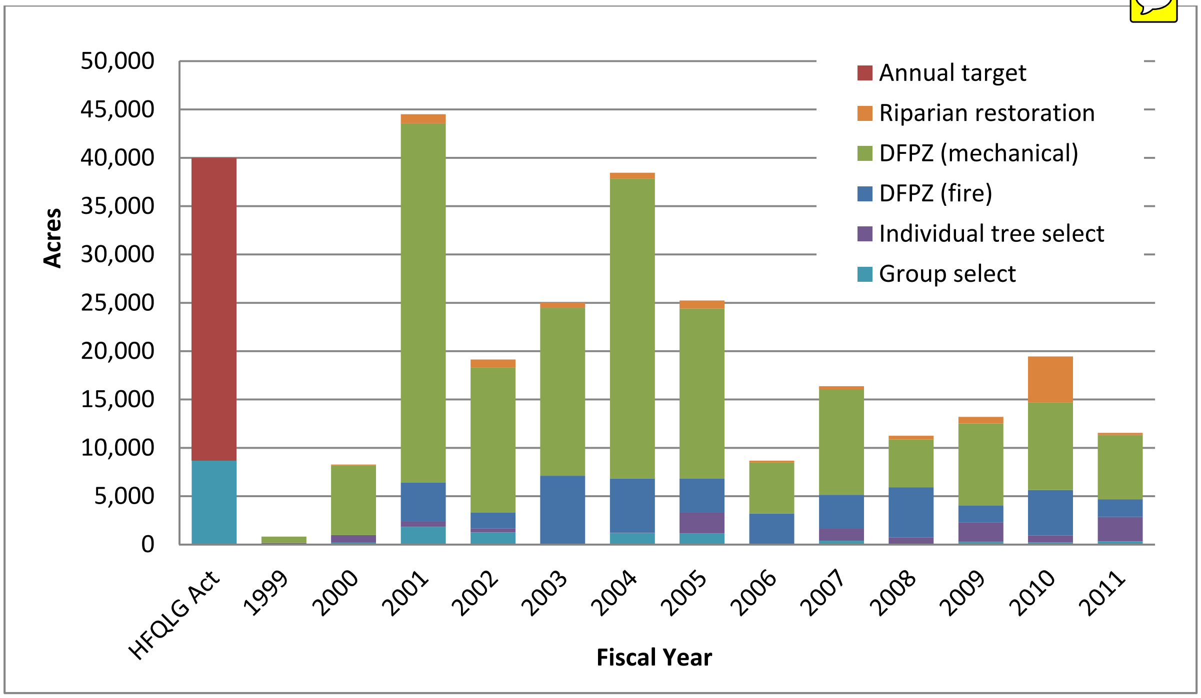

Figure 1a. Total annual acres of project accomplishments for the HFQLG pilot project, FY 1999-2011.

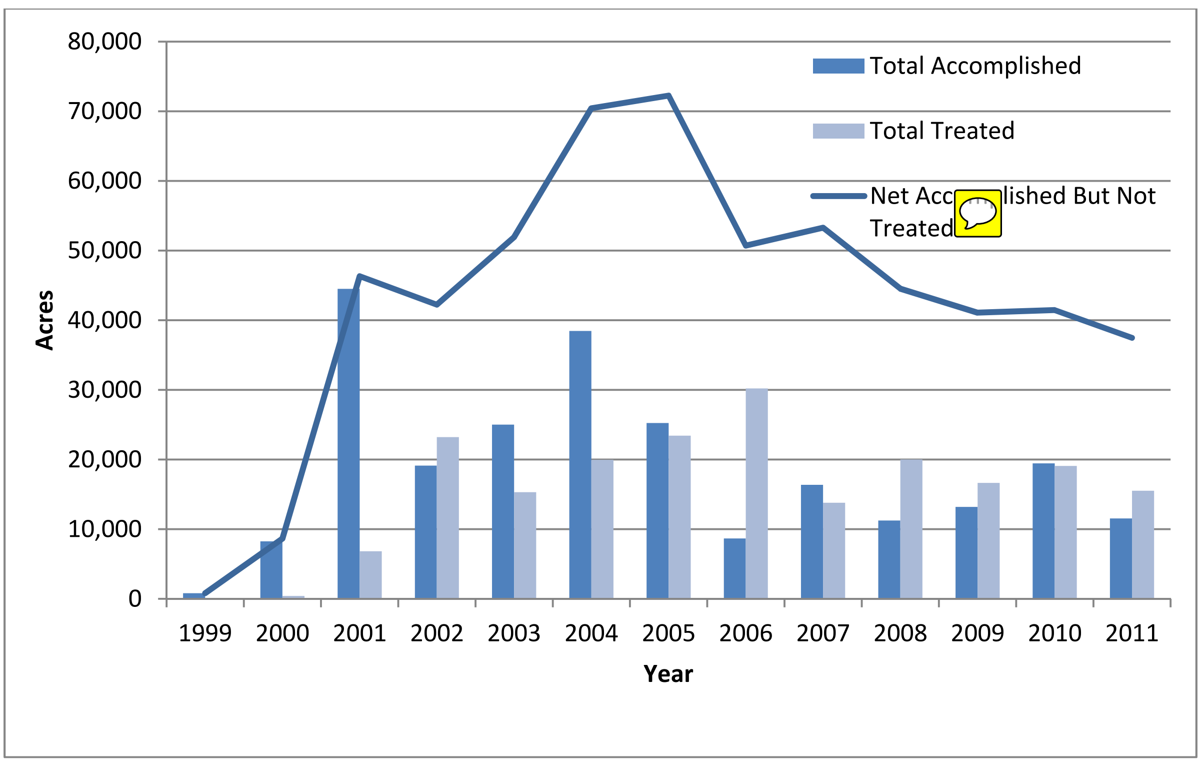

Figure 1b. Total annual acres of project accomplishments (offered and sold) compared to total annual treated for the HFQLG pilot project, FY 1999-2011.

Figure 2 depicts sawlog and biomass volume accomplishments from 1999-2011. The ratio of sawlogs to biomass was skewed towards biomass as a result of the types and location of treatments accomplished. Group selection, which was emphasized in the HFQLG Act as the primary source of sawlog production, was implemented on only 4,452 acres across all years. The minimum accomplishment target set for group selection treatments was 8,713 acres per year and more than 113,000 acres across all years (USDA 2012a).

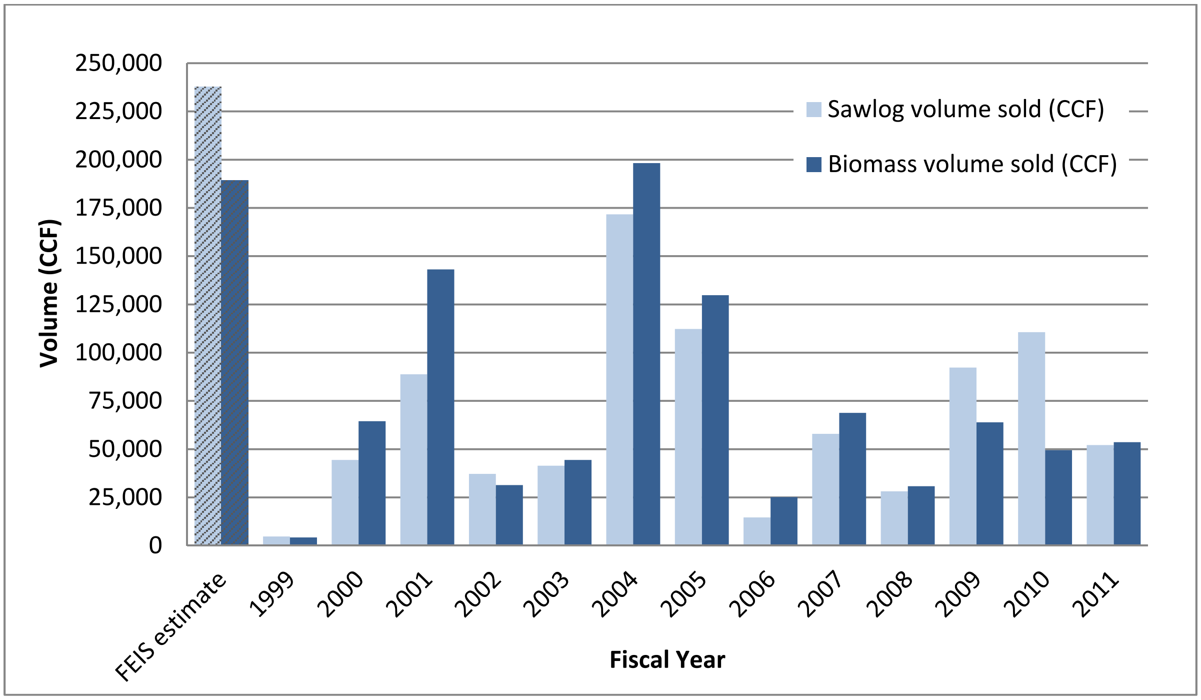

Figure 2. Total annual sawlog and biomass volume accomplishments for the HFQLG pilot project, FY 1999-2001.

Barriers to Implementation

Four factors were cited by Forest Service personnel and interested and affected parties as affecting the agency's ability to implement planned treatments: (1) market conditions, (2) policy and operational considerations, (3) post-fire salvage; and (4) appeals and litigation:

> Market conditions: The 2007-2009 economic recession was driven in large part by sharp declines in housing demand beginning in 2006, which directly affected the forest products industry. Through 2011, the forest products industry had not recovered to pre-recession production (Woodall et al. 2011). Within the HFQLG pilot project area, the decreases in post-recession sawmill capacity and lower market value of harvested material led to an increase in "no bid" sales. Lower interest in sales was generally related to expected costs for harvest operations versus anticipated revenue from available timber volume, which was affected by timber market prices (USDA 2012a).

Policy and operational considerations: Evolving policies and site-specific operational considerations caused a reduction from expected pace and scale of annual treatments. Foremost, the 2001 and 2004 Sierra Nevada Forest Plan Amendments, and subsequent appeals and litigation, contributed to an uncertain environment in the early years of implementation as discussed below. Forest Service line officers, interdisciplinary teams, and the public evaluated site-specific issues within proposed project areas such as size class distribution, topography, economics, and wildlife habitat. Such site-specific analyses varied greatly across administrative units and often constrained the number of acres upon which treatments could be implemented. Acreage and wood fiber volume produced from group selection treatments in particular consistently fell below expectations.

Post-fire salvage: Several wildland forest fires burned within the HFQLG pilot Project area over the thirteen years of implementation, including the Moonlight and Antelope-Wheeler Complex Fires in 2007, which burned approximately 88,000 acres on the Plumas National Forest (Federal Register 2008). According to Forest Service personnel, human and financial resources were diverted to conducting post-fire salvage planning and operations, which took staff time away from planning, designing, and administering ongoing HFQLG pilot project treatments.

Appeals and Litigation: Appeals and litigation were widely cited by agency, industry, and community partners as a primary reason for reduced project implementation. Agency planners acknowledged that they often delayed or altered projects to reduce the geographic scope of a project or to avoid removing large diameter trees associated with group selection techniques out of fear that projects would be contested. Interviews with Forest Service personnel and external stakeholders suggested that, in response to appeals and litigation or the threat of litigation, proposed actions were designed to be smaller in geographic scale and lesser volume removed to avoid large-scale projects that would require a full EIS. A total of 417 projects (241,945 acres) were implemented over the thirteen-year period of the HFQLG pilot project. Forest Service records indicated that at least 20 projects were appealed, which represented less than 5% of the total projects implemented. Six of those appealed projects proceeded to litigation. The North 49 Project on the Lassen National Forest, the Empire Project on the Plumas National Forest, and the Phoenix Project on the Tahoe National Forest were specifically identified as large-scale EIS efforts that affected the scope of subsequent HFQLG pilot project planning and implementation.

The trajectory of project accomplishments corresponded with policy changes and key lawsuits. The low level of wood volume production in 2002 and 2003 was consistent with the 2001 Sierra Nevada Forest Plan and its diameter limit restrictions on trees harvested. Total acres treated were more than 44,000 acres in FY 2001 before declining in FY 2002-

2003. Implementation was focused primarily on Eastside forests with lower-wood volume and value during this time. Sawlog and biomass volume removal increased as a result of the 2004 Sierra Nevada Forest Plan Amendment ROD, which permitted removal of trees with larger diameters than allowed under the 2001 ROD. However, lawsuits in FY 2006 stopped five timber sales in the Lassen National Forest. Six timber sales ceased in the Plumas National Forest after three EIS documents were successfully appealed for need of additional analysis, and no timber was sold in the Sierraville Ranger District also due to the need for additional analysis. The timber sales that were sold and not appealed generally had smaller amounts of sawlogs and more biomass, which affected the value of sales. Forest Service staff estimated that 90 percent of all timber sales and service contracts were delayed due to appeals in FY 2008, when the volume of sawlogs sold declined more than 50 percent to its lowest level since 2003 (Faucet et al. 2011).

FY 2009 marked a change in agency strategy, which involved the Forest Service working more directly with concerned stakeholders, as directed by legislative language in the December 2007 HFQLG Act extension. More timber sales were successfully sold without appeal, although acres treated and wood volume produced were still below minimum threshold expectation. As an example of the effect of greater coordination with stakeholders, the Forest Service worked with plaintiffs to develop a mutually agreeable version of the North 49 Project on the Lassen National Forest. The North 49 Project represented the largest project in volume that year (Faucet et al. 2011). Similar approaches were used for the Keddie and Buck projects on the Plumas National Forest. Agency personnel and stakeholders frequently cited the publication of *An ecosystem management strategy for Sierra Mixed-Conifer Forests* (PSW-GTR-220: North et al. 2009), and the companion volume, *Managing Sierra Nevada Forests* (PSW-GTR-237: North 2012), as critical turning points to reduce appeals and litigation. In FY 2010, the federal District Court and Ninth Circuit Court of Appeals issued rulings allowing some previously-enjoined projects, or portions of projects, to proceed (Faucet et al. 2011). Subsequent declines in timber sales from FY 2010 to 2011 were a result of "no bid" sales previously discussed, and not appeals.

Pilot Appropriations and Unit Costs

Throughout the HFQLG pilot project, annual appropriations remained relatively stable with total appropriations of $324.7 million (FY 1999 – 2011). Annual expenditures averaged $22.6 million per fiscal year and $25.8 million between FY 2001 and FY 2011 (FY11 Annual Report) (Table 1). A total of $293.2 million was ultimately spent on HFQLG pilot project implementation. By comparison, expenditures for FY 1992 through FY 1997 for the same region averaged $21.1 million (constant dollars).

Approximately 12% of total expenditures ($34.5 million) were used for administrative purposes, including staff and resources for appeals and litigation and post-fire recovery planning (USDA 2012a). A breakdown of costs incurred for administration and overhead, planning, monitoring, and litigation relative to on-the-ground implementation was not possible because the Forest Service combined budget line items, which prevented a thorough analysis of expenditures. Interviews with agency personnel indicated that increased planning and more detailed analysis precipitated by appeals and litigation, or the threat of such, contributed to escalating unit costs ($/acre treated, $/CCF removed) illustrated in Table 1 (USDA 2012a). This in turn reduced the total number of acres that could be effectively planned and treated with fixed levels of appropriated funding. However, we could not quantify the extent to which external appeals and litigation affected unit costs because of the combined budget line items in Forest Service records.

Table 1. Annual Forest Service budget, expenditures, and per unit costs. [1]*Unit cost is the total direct cost to government minus revenue generated from sawlogs and biomass receipts.*

Fiscal year	Total expended (million $)	Revenue generated (million $)	Acres treated	Unit cost per acre[1]	Sawlog volume sold (CCF)	Biomass volume sold (CCF)	Total volume sold (CCF)	Unit cost/CCF[1]
1999	$2.0	$0.00	812	$2,463	4,785	4,278	9,063	$221
2000	$7.2	$0.02	8,268	$ 868	44,422	64,517	108,939	$66
2001	$28.3	$0.14	44,506	$ 633	88,802	143,117	231,919	$121
2002	$21.5	$0.99	19,142	$1,072	37,168	31,354	68,522	$299
2003	$23.1	$0.96	25,023	$ 885	41,418	44,402	85,820	$258
2004	$30.1	$1.96	38,457	$ 732	171,692	198,204	369,896	$76
2005	$29.2	$2.91	25,250	$1,041	112,270	129,814	242,084	$109
2006	$25.8	$4.61	8,668	$2,444	14,625	25,132	39,757	$533
2007	$25.8	$2.05	16,373	$1,451	57,904	68,818	126,722	$187
2008	$24.2	$0.86	11,251	$2,075	28,143	30,850	58,993	$396
2009	$25.8	$2.61	13,197	$1,757	92,299	63,901	156,200	$148
2010	$26.1	$5.00	19,446	$1,085	110,579	49,439	160,018	$132
2011	$24.1	$1.70	11,552	$1,939	52,103	53,600	105,703	$212
Total	**$293.2**	**$23.81**	**241,945**	**$1,113**	**856,210**	**907,426**	**1,763,636**	**$153**

Key Finding 2. The HFQLG pilot project was unable to provide local economic stability through an adequate and continuous supply of timber to local mills.

Data from the socio-economic monitoring studies conducted by Jack Faucett Associates (2011) indicated that the HFQLG pilot project was unable to alter trajectories in employment declines, county payments, and community demographics changes. In our opinion, the socio-economic monitoring helped characterize the broad changes in the HFQLG pilot project area, but exhibited shortcomings similar to those identified in the critique by Kusel and Saah (2012), which address the economic analysis conducted pursuant to the critical habitat designation for the northern spotted owl. Loss of local jobs in the local forest products industry can have a profound impact on communities both in the short and long term. Measures of change in jobs and income are critical, but need to be interpreted by considering the dynamics associated with income and job loss. For example, ensuing economic and social turmoil can lead to short term difficulties for families and communities that result in long term reduction in community capacity (Kusel 2003). The ability to capture change in community capacity and subsequent drivers is fundamental to the current scientific understanding of community stability.

As previously indicated, the annual supply of wood fiber was often well below expected levels, was inconsistent in acres treated, and the ratio of sawlog-to-biomass volume removed was skewed towards lower-valued products, which compounded community impacts. The 2007 economic recession also had a significant effect on community stability irrespective of HFQLG pilot project activities.

Employment Impacts

Total private sector employment decreased 16% from 1999 (10,628 jobs) to 2009 (8,930 jobs), while forest products employment declined 60% from 1,741 to 701 jobs (Figure 3). Employment estimates for 2010–2011 were not available at the community scale. Sawmill-based forest products job losses were concentrated in the communities of Susanville (247 jobs; 92% decline), Bieber (220 jobs; 88% decline), Quincy (207 jobs; 56% decline), and Loyalton (170 jobs; 92% decline). Another five sawmills or biomass co-generation facilities closed or temporarily ceased production since 1999, and others have reduced capacity. The Big Valley sawmill in Bieber and the Sierra Pacific Industries sawmill in Loyalton closed in 2001, the Sierra Pacific Industries sawmill closed in Susanville in 2004, the Sierra Pacific Industries small-log sawmill operation temporary closed in Quincy in 2009 and the Sierra Pacific Industries co-generation plant in Loyalton closed in 2010 (USDA 2012a). These mill closures were in addition to four sawmills that had closed between 1991 and 1999 prior to implementation of the HFQLG Act (FEIS; USDA 1999a).

There was an expectation expressed by local stakeholders and the forest products industry that the HFQLG Act would increase the pace and scale of timber harvesting to arrest the declines in mill closures and job losses. While this did not occur, community and industry partners frequently cited the HFQLG pilot project as the “only game in town” and critical to maintaining the region’s forest products industry and industry-related employment. More than 240,000 acres were ultimately treated on the three national forests, which would likely not have been accomplished without the HFQLG pilot project.

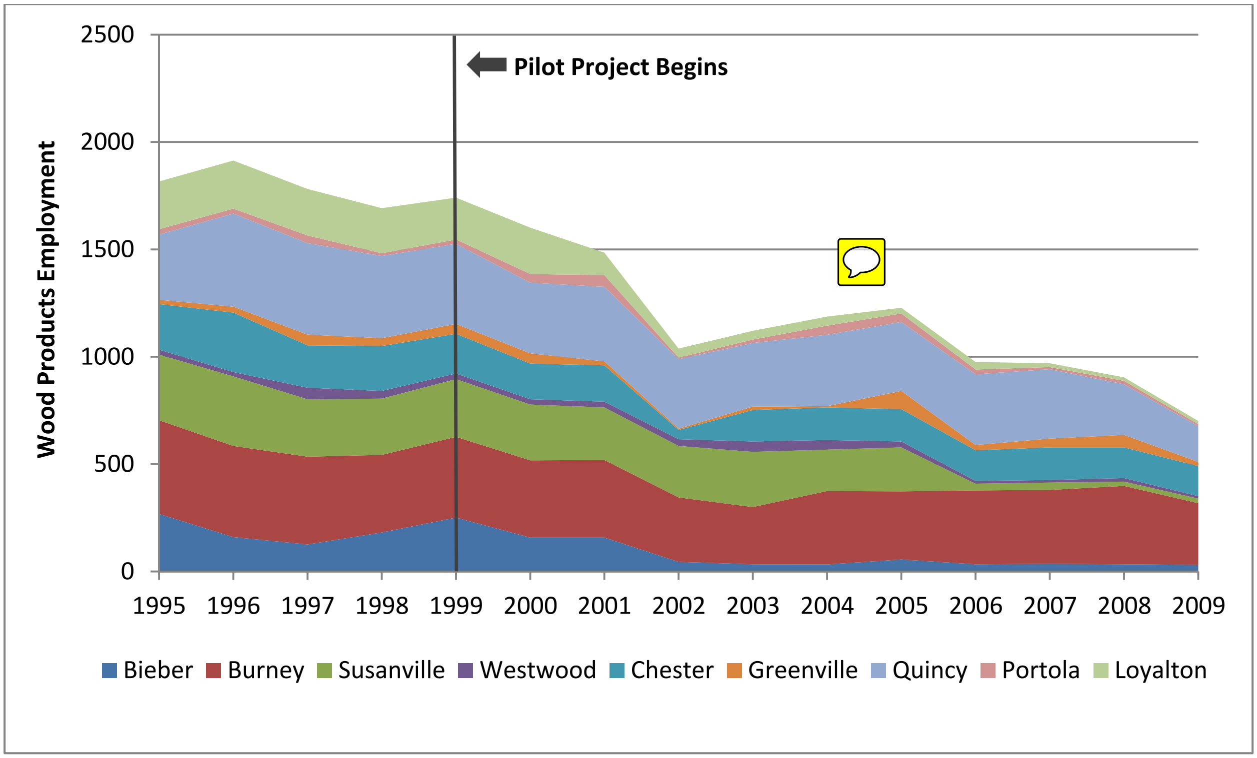

Figure 3. Estimated total forest products industry employment. From Faucett et al. 2011.

The forest products industry also has non-employer businesses – small single-proprietor businesses and private contractors that have no paid employees. Non-employer forest product firms conduct timber felling, vegetation management, and log hauling operations, and are typically family-owned or owner-operator establishments. Within the HFQLG pilot project area, there was an average of 299 non-employer forest products firms prior to implementation. After a slight decline in 2000 and 2001, the number of non-employer forest product firms increased to an average of 333 firms from 2002-2009. No data are available for 2010-2012 (Faucett et al. 2011).

One of the goals of the Community Stability Proposal was to sustain the local economy and support community stability by placing an emphasis on awarding service contracts to local bidders. Service contracts were awarded to firms to do planning (including environmental studies and surveys) and implementation work (including prescribed burns, removal of underbrush, hauling, and watershed restoration). The Forest Service defines "local" as those firms in the HFQLG pilot project area and the remainder of the Sierra Cascade Province Contracting Area. More than 65 percent of contract dollars were awarded to local contractors with a total value of $39.3 million. Nearly $15 million was awarded to firms located immediately within the boundaries of the HFQLG pilot project (24.8% of total contract dollars) (Faucett et al. 2011).

Tourism industry jobs were generally static from prior to implementation through 2012. The exceptions were increases in Susanville and Portola. In 2000 there were approximately 600 tourism jobs in Susanville, the largest community in the area. By 2007, tourism jobs in Susanville had increased 50% to approximately 900 jobs, before contracting to slightly over 700 jobs between 2008 and 2009 (no data were available for 2010-2012). Similar increases in tourism industry jobs were experienced in Portola.

Prior to 1999, the ratio of jobs between the service sector and forest products industry was approximately one-to-one. Despite the decline in post-recession tourism jobs, there were still at least 2.5 jobs in tourism for every one job in the forest products sector. This indicates an increased diversification in the local economy since implementation of the HFQLG pilot project, although tourism jobs were often seasonal with lower wages than in the forest products industry ($21,970 compared to $35,360) (Faucett et al. 2011).

County Payments

Counties encompassing National Forest System lands receive receipts from commercial timber harvest on public land to fund public services like education, road construction and maintenance, law enforcement, waste removal, and fire protection. Commercial timber harvesting has historically provided the five counties (Lassen, Plumas, Shasta, Sierra, and Tehama) in the pilot project area with important sources of revenue. Prior to the HFQLG pilot project, during the period of 1986-1999 National Forest System payments to the five counties declined starting in 1992 (Figure 4). Plumas County in particular saw payments drop from a high of nearly $8.9 million in 1992 to $602,000 in 1999 because of restrictions placed on timber harvest to protect wildlife and old-growth forests. Additional receipts were also paid to these counties from National Forest System lands outside of the HFQLG pilot project region but were included in Figure 4 because the data were aggregated at the county level.

The Secure Rural Schools and Community Self-Determination Act was passed in 2000 to stabilize federal payments and provide predictable funding to counties. Under the legislation, eligible counties received payments from 2001 to 2006, beginning with an amount equal to the average of the three highest payments and then adjusted annually corresponding to changes in the consumer price index. One measure of the impact of the pilot project on community stability was an estimate of county payments in the absence of the Secure Rural Schools Act payments. Using Forest Service data, Figure 5 demonstrates that for Lassen, Sierra, and Tehama counties, payments would have remained flat or declined from FY 2002 to 2009; payments to Sierra and Tehama counties would have been 40-50% of the highest payments received in the late-1980's, and payments to Lassen county would have been 17-28% of late-1980's levels. Estimated payments to Plumas and Shasta counties would have increased annually between FY 2002 and FY 2006, but then would have declined through FY 2009; the FY 2006 estimated payment was about 39% of the 1992 high mark. Estimated payments across the five counties increased in FY 2010 and 2011.

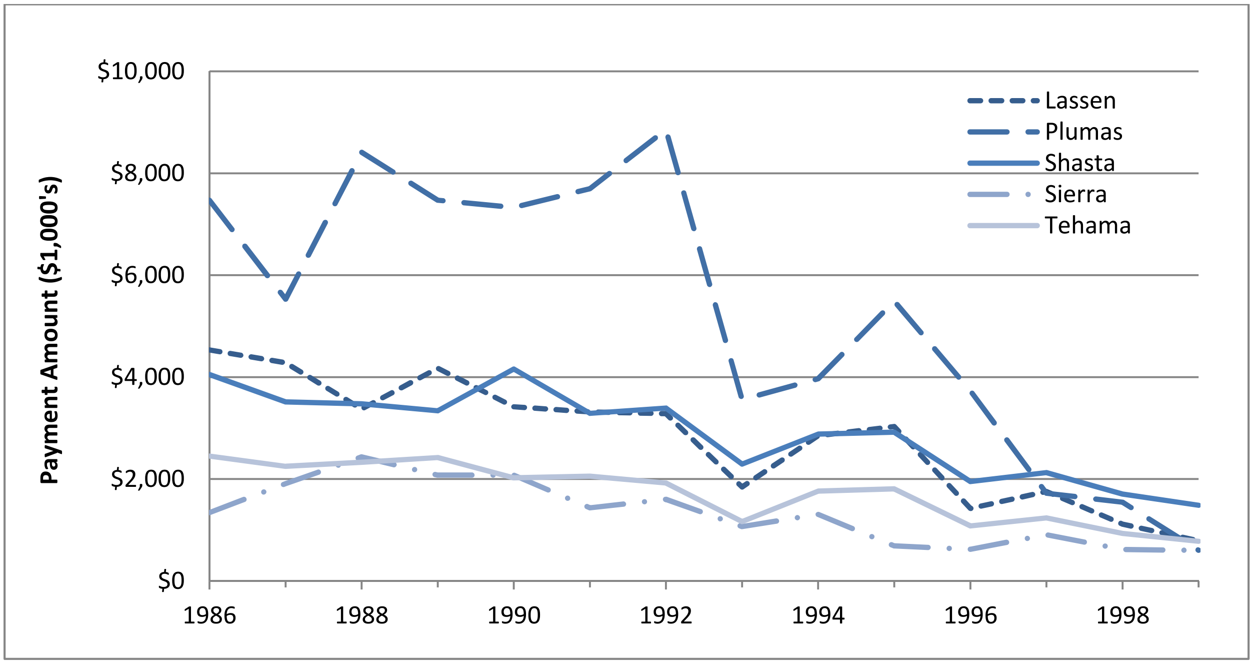

Figure 4. National Forest timber receipts paid to Lassen, Plumas, Shasta, Sierra, and Tehama counties, FY 1986-1999.

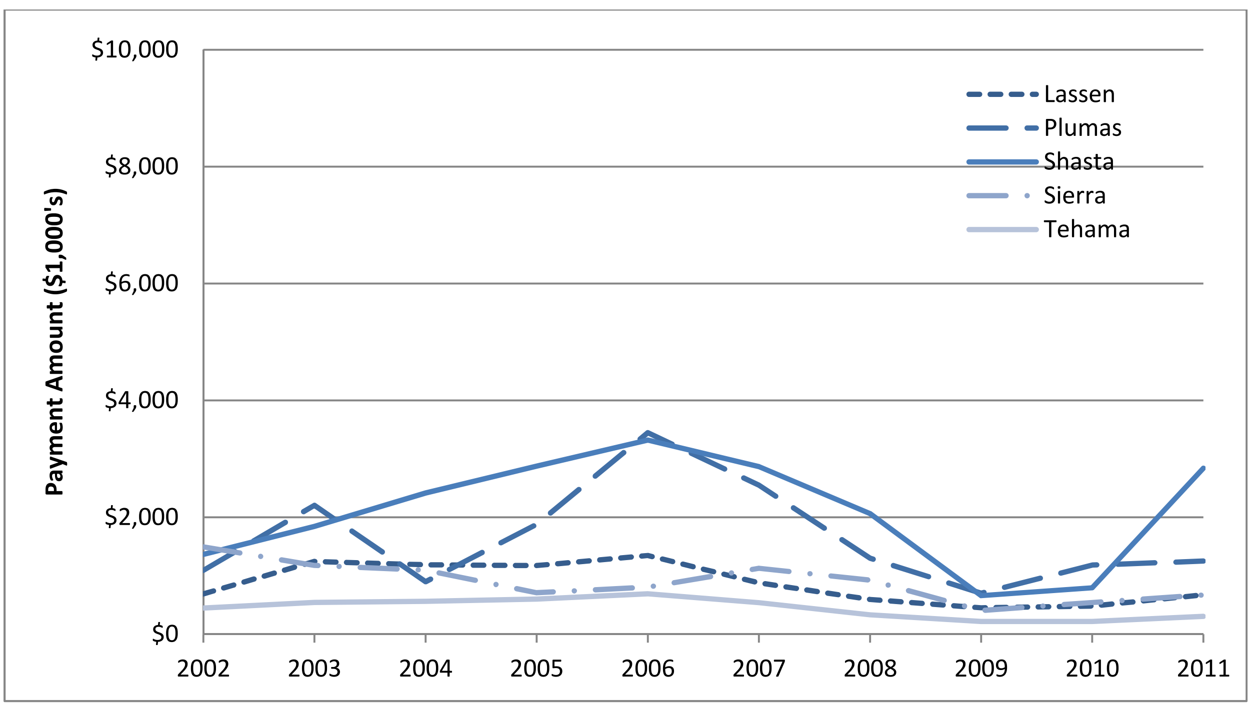

Figure 5. Projected National Forest timber receipts paid to Lassen, Plumas, Shasta, Sierra, and Tehama counties in the absence of Secure Rural Schools payments, FY 2002-2011.

Community Demographic Impacts

Prior to the HFQLG pilot project, the population in the region increased on average 1.0 percent annually from 1990 to 1998 (USDA 1999). During implementation of the HFQLG pilot project (2000 - 2010), the population in the region decreased by approximately 17,500 people, or 43.3 percent. Population decrease and school enrollment decline were more pronounced in communities like Quincy and Bieber – communities that were impacted by sawmill closures during the pilot project timeframe. For example, Plumas County school enrollment declined by about 37%, from a high of 3,060 students in 2002 to 1,936 students in 2012. Region-wide free and reduced lunch program participation increased from 35% to 45% since the beginning of the HFQLG pilot project, and reached its high mark at more than 47% during the 2009/2010 school year. While community demographic and school enrollment declines were products of multiple socio-economic factors, the decline in forest products employment resulting from sawmill closures was likely a direct contributor in the communities of Bieber, Loyalton, and Quincy.

Key Finding 3. The HFQLG pilot project produced positive social and organizational changes.

Data provided by the HFQLG pilot project monitoring program, and information provided by Forest Service personnel and stakeholders indicated social outcomes beyond the goals and objectives explicitly identified in the HFQLG Act and Community Stability Proposal. These included: new resources for riparian and watershed restoration; greater attention to monitoring HFQLG pilot project activities both within the agency and by outside organizations; and increased recognition of linking ecological and socio-economic consequences of agency management practices.

- The HFQLG Act authorized a program of work and dedicated funds for riparian restoration. Over 10,300 acres of riparian restoration projects were completed under the auspices of the pilot project. Approximately 137 miles of road were eliminated; 76 stream crossings were eliminated and another 103 were restored. These accomplishments would not have been possible without the financial support and assistance from external project partners leveraged with HFQLG-related funding. In just one example in 2012, the Plumas National Forest leveraged $97,000 in federal watershed restoration funds with more than $261,000 in non-Forest Service funds from six different partner organizations. Given the importance of the HFQLG pilot project area as source headwaters for several critical river systems and domestic and agricultural water supplies, related funds helped raise the visibility of riparian restoration and watershed work, and broadened the coalition of stakeholders. (*see* Key Finding 7).

- The HFQLG pilot project authorized a program of work and dedicated funds for a wide-ranging, multi-year monitoring program, which is highly unusual for the agency. Forest Service personnel and stakeholders noted this as an important, albeit modest, change in agency organizational practice that improved management decisions and fostered public trust.

By requiring a monitoring program to assess the ecological and socio-economic effects of the HFQLG pilot project, agency personnel and stakeholders could potentially better see and understand linkages between on-the-ground actions and ecological and socio-economic effects. Recognizing such linkages were cited as key building blocks for greater collaboration between the Forest Service and stakeholders as implementation progressed. However, socio-economic monitoring efforts were also viewed by external stakeholders as insufficient for assessing community stability impacts beyond those related to traditional demographic and employment indicators. The socio-economic monitoring program was also viewed as insufficient for establishing a foundation for long-term analysis and collaboration that could be used in future planning efforts.

Key Finding 4. Implementation of HFQLG pilot project fire and fuel management treatments typically reduced localized fire severity and had benefits for fire suppression activities.

The construction of a strategic system of shaded fuel breaks, known as Defensible Fuel Profile Zones (DFPZ), was a core component of the HFQLG pilot project. Appendix J of the HFQLG FEIS (1999) described a DFPZ as follows:

> "Stands would be fairly open and dominated mostly by larger, fire tolerant trees. The openness of crown fuels creates a network of intermingled openings between the clumps of large trees, the absence of most small diameter trees and the low amount of surface fuel would produce a very low probability of sustained crown fire. DFPZs would be designed to blend into the adjacent forest, leaving lower canopy, down logs and snag levels adjacent to the primary control point (usually a road). While limited empirical information exists to evaluate what the threshold to limit crown fire spread might be, Weatherspoon and Skinner (1996) report canopy cover should not usually be more than 40%, although adjustments in stand density based on local conditions is appropriate. The density of tree crowns, measured by crown bulk density is one method that has been used to establish what the crown cover threshold might be, and this statistic could be calculated from typical stand exam data. Agee (1996) describes the relationship of crown bulk density and crown fire spread, along with limitations of these method [sic] of measurement."

Forty to sixty thousand acres would be treated each year in strips approximately 0.25 mile wide, located where possible along existing roads to provide an efficient base for suppression activities to occur more safely and efficiently (USDA 1999). When completed, the system of shaded fuel breaks would cover 12% of the public lands within the pilot project area (USDA 1999).

Scale of DFPZ Implementation

The total acres accomplished and treated for the three HFQLG pilot project silvicultural treatments (DFPZ, individual tree selection, and group selection) were well below the anticipated amount, or minimum “threshold” (Figure 1b). The acres “accomplished” reflected treatments that were under contract for completion compared to treated acres, which reflected actual treatments completed (USDA 2004). The pace of treated acres was typically slower than the pace of contracts awarded because there was a time lag between issuing contracts and treatments actually occurring. However, the values for both acres accomplished and acres treated show a similar trend. With the exception of 2001, the acres accomplished were below the anticipated 40,000 acres treated per year. This discrepancy deficiency? was even more pronounced with respect to acres treated per year because the annual threshold was never met during the implementation period. The reasons stated for the difference between the HFQLG treatment goal and actual implementation included litigation of individual projects and other policies guiding projects, such as the 2004 Sierra Nevada Forest Plan Amendment. These reasons were repeatedly noted by HFQLG reports to congress in FY 2007 and FY 2011 (USDA 2008, USDA 2012a). While some HFQLG projects were allowed to proceed after being delayed initially by litigation, other project were never implemented due to appeals and litigation (USDA 2012a). Market conditions affecting sawlog and biomass values were also cited as a factor contributing to reduced accomplishments (USDA 2008).

Effectiveness of DFPZ’s for Modifying Fire Behavior and Effects

During the HFQLG pilot project implementation period, 20 different wildfires came into contact with DFPZ treatments. Fire behavior was often documented for individual events and DFPZs consistently resulted in reduced fire severity (Murphy et al. 2010). Wildfires contacting DFPZs repeatedly showed decreases in active fire behavior and effects, including reductions in flame length and fire severity. These findings were corroborated by scientific literature through both field studies and modeling (Safford et al. 2012; Stephens et al. 2009). The influence of DFPZs and fire size was most notable for several fires that started within or adjacent to DFPZs and were readily contained at less than 10 acres.

Fuel treatments also enhanced suppression effort and effectiveness in several cases. These included the utilization of DFPZs as anchor points for fire line construction, and for burnout activities and the facilitation of the safe movement of firefighting personnel to and from wildfire areas during fire events (Dailey et al. 2008, Murphy et al. 2010). While the use of DFPZs as anchor points for a range of suppression activities, and safety zones for the movement of firefighting personnel, was well-documented in reports provided by the Forest Service there is less evidence in the scientific literature.

Within the HFQLG pilot project area, there was a "significant linear increasing trend" in mean wildfire size between 1900 and 2007 (USDA 2010a). During this same time period, there was no significant increase in the number of acres burned or number of fires per year (USDA 2010a). As noted in the FY09 HFQLG Status Report to Congress (USDA 2010a), "Because the HFQLG pilot project has not yet been implemented in its entirety, it is difficult to determine the potential effect of HFQLG treatments on large fire frequency at this time." The increase in the trend in fire size and severity in the Sierra Nevada and Southern Cascades has been documented in the literature (Miller et al. 2009) as resulting from a combination of factors, including fuel accumulation, exclusion of fire by active suppression, and current climate trends (Miller et al. 2009).

A report by Merriam (2013) extended the historical wildfire trend analysis within the HFQLG pilot project area to examine the trends in average fire size as well as the trends in large fire frequency up to the year 2011. The analysis assessed the trend in large fires within two time periods, pre-HFQLG pilot project (1900-1998) and during-HFQLG pilot project (1999-2011), using statistical analysis comparing the five year moving average of mean fire size during these time periods. With respect to average fire size, the results of the analysis showed that average fire size was larger during the HFQLG project period than in the period before it. However, there was no evidence suggesting that HFQLG pilot project implementation contributed to the increase in fire size. In addition, while the analysis showed more fires during the HFQLG pilot project implementation period, the increase did not signify a steady upward trend (Merriam 2013). Moreover, it was not possible to determine from available monitoring data if the increase in the total number of fires was caused by lightning, humans, or management activities directly related to HFQLG.

Overall, the influence DFPZs had on modifying local fire effects, including fire severity, was well documented for multiple wildfires occurring within the project area during the implementation period. While there was an increase in the general trend of area burned with high fire severity during this time, there was no evidence that implementation activities contributed to the trend. Establishing which factors may have increased the extent of high severity fires, including how this may relate to lack of complete implementation of HFQLG pilot project treatments, could not be answered conclusively.

Key Finding 5. Fuel reduction and silvicultural treatments, where implemented, helped develop all age, multistory, and fire resilient stands, but it is uncertain how these treatments affected ecological integrity at the landscape level.

Age class distribution of forest stands and forest structural features such as dead standing trees and dead and down woody material are two key elements to manage when trying to achieve a desired future condition of a forest. Silvicultural prescriptions (in addition to

DFPZ fuel reduction treatments) were stipulated by the HFQLG Act (following recommendations in the Community Stability Proposal) for uneven-aged management silvicultural systems that would move the forests within the HFQLG pilot project area to a desired future condition consisting of an all-age, multistory, fire-resistant forest approximating pre- settlement conditions. The Community Stability Proposal specified the use of individual tree selection (such as the system used by Collins Pine Company) and group selection as the silvicultural systems necessary to reach the desired future condition. The group selection/individual tree selection treatments were to be conducted on an average of 0.57% of the pilot project area land each year of the pilot project period to emulate a 175-200 year rotation with harvest entries occurring within a planning area every 15 years (i.e., creating new age cohorts every 15 years).

The intended design was implemented differently from an operational perspective. Specifically, the available harvestable land base was calculated and the 0.57% target for group selection/individual tree selection treatments was applied to each *treatment planning area*, rather than to the entire HFQLG pilot project area. The resulting acreage of group selection/individual tree selection was often reduced further during harvest layout on the ground when access, lack of merchantable volume, or other resource protection issues arose. These deviations from target goals were encountered because the initial planning process typically involved the use of GIS and remotely-sensed data, while the final implementation occurred on the ground where constraints were more readily identified. While the implementation of small group selection and individual tree selection harvests created logistical challenges and higher costs compared to even-aged systems, Forest Service personnel noted that the increased flexibility provided by these systems created better opportunities to restore historical species composition and forest structure.

The identification of forest structural targets served as benchmarks for the creation of pre-settlement conditions and had the potential to provide some measure of ecological integrity. Implementation of DFPZs, group selection, and individual tree selection treatments was guided by the 2004 Sierra Nevada Forest Plan Amendment in terms of canopy cover, dead tree (snag), and large log retention targets. The legacy of past management, including past harvesting practices and exclusion of fire, created a forest landscape where many stands exceeded the desired canopy cover associated with a pre-settlement forest condition. This management legacy also left much of the current forest structure depleted of large living and dead standing trees (Collins et al. 2011) and large logs on the ground (based on pre-treatment data from Bigelow et al. 2012a).

The pre-treatment condition played a role in the ability of managers to achieve the target conditions that were indicative of pre-settlement forest structure. However, the harvest treatments were generally successful in protecting the large diameter trees (> 30 inches diameter at breast height) from harvest or damage during the logging operation. Overall there was relatively minimal stand canopy cover reduction as a result of silvicultural treatments (a 15% reduction on average). Treatments initially reduced densities of large dead standing trees, particularly within DFPZs and near roads where hazards to firefighters were a concern. However, within four years, subsequent tree mortality contributed to recovery to pre-treatment levels, which did not diminish the success of protecting large live trees. Because the management strategy was to retain large diameter trees, it is likely that future dead standing tree densities will increase as large diameter trees mature and die. This forest structural change will take many decades to occur and cannot be evaluated in the timespan of the HFQLG pilot project. Dead and down log volumes were generally below target levels both before and after treatments. Treatments generally reduced existing dead and down log volumes below pre-treatment levels. This was often the result of mechanical destruction or combustion during subsequent prescribed fire. Prescribed fire treatments resulted in additional scorch-related mortality of residual trees, which will provide future recruitment of large woody debris-similar effects have been previously documented in the literature (Stephens and Moghaddas 2005). As with the standing dead trees, the retention of living large diameter trees will contribute to future dead and down log volumes. Development of target levels of dead and down log volumes could also take many decades.

Fire modeling yielded predictions of a decrease in mean conditional burn probability (modeled probability a portion of the landscape will burn with a fixed number of random ignitions), and the potential for active and passive crown fires during moderate and extreme weather conditions for up to five years after treatment based on the observed forest structure (Bigelow et al. 2012a). The models also showed that treatments did not decrease predicted surface fire behavior. However, some monitoring data were collected prior to the prescribed fire that followed treatments. These data could have influenced the model parameters pertaining to surface fire behavior. Based on empirical evidence from multiple wildfires that occurred within the project area, where established, DFPZs were consistently helped reduce localized fire severity measured by total live tree basal area killed. However, there was an increase in the general trend of area burned with high fire severity during the implementation period, but there was no evidence that activities performed under the HFQLG Act contributed to that increase (*see* Key Finding 4 and references therein).

Group selection treatments are not specifically designed to meet fire objectives, and as such they result in very low crowns close to the ground that are prone to torching. Stands treated using group selection were expected to be susceptible to scorch-related mortality for 20 years, although this may be mitigated to some degree by future treatments, including shrub control, stand density reduction, and pruning. In east-side forests, however, fragmentation created by group selection treatments may make the landscape less susceptible to crown fire (Bigelow and Parks 2010).

The HFQLG pilot project treatments were most effective at the stand level, and protected important forest structural elements critical to ecological integrity while, over time, shifting the forest to the desired future condition identified in the HFQLG Act. However, management legacies created challenges for achieving landscape scale objectives during the relatively short period of the HFQLG pilot project. The legacy of past management has significantly influenced forest structure and will not be reversed quickly. Shifting forest structure to an uneven-aged landscape will take many decades of applying the silvicultural approaches specified in the HFQLG pilot project—a goal further challenged by lack of full implementation. There also remains a considerable amount of scientific uncertainty regarding the pre-settlement conditions of forests in the region. This uncertainty further complicates the question of whether the management strategies as implemented will lead to the desired future condition, and in what timeframe. Further research and adaptive management strategies are warranted until these uncertainties are resolved.

Key Finding 6. California spotted owl nest and roost sites were protected during the HFQLG pilot project implementation, but the HFQLG pilot project failed to assess if there were adverse environmental impacts to the owl population resulting from treatments.

At the time of the passage of the HFQLG Act the effects of shaded fuel break treatments (DFPZs) and group selection silvicultural treatments on California spotted owls were unknown. Therefore, an important part of the monitoring program was to evaluate the effects of HFQLG pilot project treatments on spotted owl viability. Protection provisions in the Sierra Framework were a major reason the U.S. Fish and Wildlife Service did not list the California spotted owl under the Endangered Species Act. That group selection treatments introduced by the HFQLG pilot project were a departure from silvicultural prescriptions included in the Sierra Framework, should have elevated the priority of assessing adverse impacts to California spotted owls. Evaluating adverse impacts to California spotted owls had implications not only for the efficacy of the HFQLG pilot project as a resource management framework, but also much broader implications with respect to listing of the California spotted owl. These connections, coupled with a species that probably has the strongest base of biological information for any species of conservation concern in the United States (Gutiérrez 2008), made such environmental impact assessments imminently possible. Unlike most other monitoring objectives for assessing adverse environmental impacts under the HFQLG Monitoring Plan, there was a substantial body of information to support an assessment of HFQLG treatment effects on California spotted owls. The demographic information necessary to support an assessment was available because a long-term California spotted owl study had been occurring within much of the project area from 1990 to the present, so both pre-treatment and post-treatment information were available. This demographic study was based on marking and recapturing of California spotted owls (Plumas-Lassen Administrative Study). Thus, there were extensive data on survival and reproductive output of individual owls, occupancy of sites, density of owls, and distribution of owls on landscapes.

The locations of all spotted owls on the HFQLG project area have been recorded routinely as part of existing Forest Service management. When territorial owls are located, an area of approximately three hundred acres of the best habitat is delineated around the roost or nest sites of the owls. These areas are called protected activity centers (PACs); PACs were given explicit protection under the HFQLG Act. Land planning ensured that HFQLG treatments avoided PACs within the project boundary. Thus, the HFQLG pilot project was successful in protecting California spotted owl PACs as required by the HFQLG Act.

Following the Phase One review we conducted in 2008, the basic demographic rates of reproduction, survival, and rate of population change were estimated using "state-of-the-art" analytical techniques (Keane et al. 2011, Conner et al. In Press). While these baseline data was available to the HFQLG owl monitoring team, it was not used to make critical assessments of adverse environmental impacts on California spotted owls. Moreover, this was not accomplished despite the Phase One report (Pinchot Institute 2008) providing both guidance and noting the urgency of accomplishing this key element for monitoring adverse environmental impacts under the HFQLG Act, particularly because the Lassen-Plumas owl population appeared to be declining. The Lassen-Plumas owl population began to decline in the mid-1990s, but there was statistical uncertainty about this decline between 1992-2005 (Franklin et al. 2004, Blakesley et al. 2010). This uncertainty was much reduced because of recent analysis by the HFQLG owl monitoring team that indicated the population was declining (Keane et al. 2011, Conner et al. In Press). Keane et al. (2011) found that the Lassen-Plumas population of California owls was approximately 78% of its size in 2010 compared to 1992. Whether the Lassen-Plumas owl decline was related to HFQLG implementation activities, other factors, or was an interaction among factors was unknown, but it raised the urgency with which the question about treatment effects should have been addressed by the HFQLG pilot project.

The original HFQLG pilot project's California spotted owl monitoring questions were revised in 2007 to include a more comprehensive set of monitoring questions developed under the auspices of the Plumas Lassen Administrative Study (Keane and Blakesley 2007). The HFQLG owl monitoring team cited two primary reasons why the evaluation of adverse environmental impact was not completed:

1. The size and precise location of HFQLG treatments were not known, which prevented analysis of treatment effects.

2. The existing Forest Service vegetation maps for the HFQLG project area were inaccurate, and new maps were not created in time to conduct analyses of treatment effects.

Keane et al. (2011: 90) stated "First, the lack of available, and delays in obtaining, updated vegetation maps of accurate pre- and post-treatment vegetation information and accurate spatial locations of treatments remains a significant roadblock. Usable vegetation maps have not been completed nor been available for our efforts to address vegetation and treatment mapping information needs for habitat modeling."

The first problem resulted from improper monitoring design (i.e., treatment sites should have been delineated immediately following project completion using Global Positioning System and Geographic Information System technologies; see Appendix I for specific details). The second problem was more complex and may relate to broader institutional failures.

Key Finding 7. The HFQLG pilot project successfully implemented measures designed to protect water bodies, but scientific studies could not adequately determine how treatments affected water resources, and the pilot project treatments did not protect streams and riparian areas from the impacts of high severity wildfire.

Protection and restoration of watershed resources are a purpose of the HFQLG pilot project, longstanding priorities of the Forest Service, and prevalent in the management direction of Forest Service policies and plans. These activities and provisions specified in the HFQLG Act and the Community Stability Proposal therefore align well with prior activities. They are brought further into alignment by the Forest Service's management decision in response to the HFQLG Act, and monitoring plans developed in the associated FEIS. As a result, the HFQLG Act imposed requirements that both reinforced and expanded existing activities related to water resource protection, management, and monitoring. Success in meeting the additional requirements of the HFQLG Act was mixed—particularly in regard to understanding the effects of fire where it occurred--resulting in some uncertainties on whether and to what extent the HFQLG pilot project impacted water resources.

Implementation of Protection Measures

Best management practices (BMPs) to protect water and water quality within the HFQLG pilot project area were consistently applied, including the riparian buffer standards similar to those used throughout much of the US Forest Service lands in the California Sierra Nevada range. BMPs were found to effectively protect aquatic and watershed resources of concern (e.g., creeks, riparian areas, seeps, springs, and other small aquatic habitat areas) in over 90% of sites monitored following treatment activities. Although the monitoring methods provided only coarse level findings on effects, both implementation and effectiveness monitoring results suggest that these BMPs were correctly implemented and effective in achieving the intended results.

Treatments and Fire Effects on Watershed Condition

Evidence suggests that impacts from forest management activities were minor where streams were buffered, and any impacts were temporary (e.g., stream crossing treatments, aspen restoration, etc.). However, the watershed-related monitoring data was insufficient to explain or predict the ecological effects of resource management activities. The implication is that the HFQLG pilot project did not show whether the treatments can alter water resources and aquatic ecosystems over the long-term, and with increased implementation. Long-term monitoring (sixteen years) showed high variability in sedimentation, shading and other characteristics for different types of streams in the study area (Mayes and Roby 2013). The FEIS described the challenges high inter-annual variability posed to understanding the effects of the HFQLG pilot project. More robust scientific analysis could have enabled detection of changes (i.e., statistically significant findings of change or no change) associated with management actions or wildfires, and provided a foundation for adaptive management into the future.

The Forest Service evaluated watershed conditions using *Stream Condition Inventory (SCI)* and *Equivalent Roaded Acres* (ERA). These methods were already being used by the Forest Service to characterize water resource issues, and select Alternatives in the FEIS (USDA 1999). However, the SCI and ERA data were not well suited to addressing several of the key questions related to the HFQLG pilot project, including determining the effect of HFQLG activities on watershed condition and stream and riparian attributes over time (questions 17-19 in USDA 2007). The protocols used are sound for assessing general conditions, but less useful for extrapolating site-specific observed responses to management actions to the watershed or broader landscape scale. This limitation is due primarily to the small number of sites surveyed using the SCI within areas subject to the same management type and within similar landscape conditions (e.g. vegetation type, climate, topographic position and reach types per Montgomery and Buffington 1997). In addition, limiting study designs to pre- and post-sampling was complicated by difficulties in predicting which sites would be treated and when. This led to considerably more pre-treatment sampling than was needed, and too little sampling when pre-treatment data would be most informative. One of the most significant scientific omissions is the lack of information about the effectiveness of management in reducing impacts to water resources from high-severity fire, a question central to the purpose of the HFQLG pilot project.

Vegetation Treatments

Much of the scientific information collected (Stream Condition Inventory metrics) revealed high inter-annual variability under background conditions, making significant effects associated with management actions difficult to detect (i.e., the sensitivity of the sampling to detecting change was small). In spite of this limitation, some site-specific statistically significant differences before and after vegetation treatments were reported, indicating that vegetation treatments did in some cases change stream conditions (i.e. sediments, channel morphology, and shading), although the ecological implications of these changes are less clear. Reported impacts occurred only some of the time (3 of 16 sites), and were small and/or short-lived (less than 2 years). Similarly, vegetation treatment had infrequent and short-lived effects on aquatic invertebrate assemblages, and long-term monitoring on a small number (3) of sites revealed no consistent trends and high inter-annual variability.

The removal of conifers to restore natural riparian ecosystems, or the aspen enhancement projects, were important priorities for the restoration program and occurred near and along streams. Again, reports on stream impacts were variable: significantly increased sediment impacts in two of five sites; and increased stream temperatures in one out of a total of five sites monitored. There were no impacts to aquatic macro-invertebrates at the two sites where they were measured. The relatively limited number of sites and samples prohibit definitive conclusions that can guide design of similar restoration projects, or help predict the possible impacts of expanded activities of this kind.

Roads

The HFQLG pilot project was generally effective at addressing sedimentation (and presumably hydrologic effects) from roads. Renovating, re-routing, and eliminating roads was a significant focus of the pilot project, based on the FEIS determination that road-related sources of sediment were a major concern. Over the project period the Forest Service eliminated an impressive 137.75 road miles in riparian areas, restored 103 stream-road crossings, and eliminated 76 stream-road crossings. However, the effects of roads, landings, and culvert decommissioning were monitored at only four sites within the HFQLG pilot project area. Increased sedimentation was reported for three of the four sites, and initial impacts to aquatic macro-invertebrate and immediate recovery (the following year) was reported at the two sites monitored. Significant impacts on stream channel sediment following meadow restoration were reported for one out of four sites within the HFQLG pilot project area and macro-invertebrate assemblage indicators declined in one of the two sites where measured.

Fire Effects on Watershed Functions

The HFQLG pilot project provided a chance to evaluate how managing fire severity within stream corridors and throughout watersheds can affect water resources and aquatic ecosystems. Anecdotal observations in burned areas within the HFQLG pilot project area suggest that fires substantially change aquatic and riparian habitat, sediment supply, water quality and hydrology. However, there is insufficient information to evaluate the overall effectiveness of management with respect to fire effects on watershed functions.

The Forest Service monitored stream conditions at two sites within the HFQLG pilot project area that experienced large fires—the Cub Fire (2008) and the Moonlight Fire (2007). The Moonlight fire burned ‘99%’ of the watershed area above the studied stream reach (over 50% at high severity), and was followed by salvage logging in some burned areas. The Cub Fire burned ~80% of the watershed, one-quarter at high severity, with no subsequent salvage logging. Four years of pre-fire monitoring and four years of post-fire monitoring was conducted for each fire, on Cub and Moonlight Creeks (Mayes and Roby 2013). Large and statistically significant increases in pool tail fines (a measurement of sedimentation) for both fires were short-lived (one year for the Moonlight Fire and two years for the Cub Fire).

To the degree that HFQLG fuel treatment and other management activities might have reduced the likelihood, severity, and extent of wildfire, wildfire impacts to aquatic resources might also have been reduced. However, the linkage between these three elements - HFQLG fuel treatments, riparian burn extent and intensity - and impacts to the aquatic habitat and sediment supply, were not well documented even in the two instances where pre and post burn monitoring occurred. For example, monitoring to establish such linkages should be designed to measure how HFQLG management activities affect burn severity in the riparian area, and how such potential differences in burn severity affect aquatic resources.

Water Yield

The direct effects of HFQLG pilot project treatments and road management activities on water yield and soil moisture were likely minimal. However, the present and future risks of fire to water yield, water quality, and soil conditions are still unknown. Water yield management in source watersheds is a matter of significant interest to various members of QLG, as well as others within the State of California, as a potential water supply resource and revenue for the northern California Sierra Nevada region's economy. Efforts to develop a better understanding of the hydrologic response to HFQLG pilot project activities could have had important policy implications and should have been more proactive. Moreover, important information could have been generated to support other water modeling efforts in the region. Hydrologic models used in the region typically use data from other west-coast experimental watersheds that are not representative of conditions in the HFQLG area. Thus, the opportunity was lost to use the HFQLG pilot project to better address this issue, perhaps using methodologies other than the traditional paired hydrologic basin approach (e.g., using Doppler-adjusted radar rainfall models for higher resolution estimates of actual rainfall in a manner that would reduce the time required of paired basin studies).

The Forest Service generated a detailed technical report (Troendle et al 2007) in which the authors argued that expected changes in modeled water yield from forest thinning activities are small (<1%) and of moderate duration (~15 years following treatments). The total volume of additional water generated from the full treatment scenario was modeled at 17,000 to 26,000 acre-feet annually, not a trivial amount of additional water. However, Troendle et al. (2007) outline the rationale for why measuring such differences at the HFQLG pilot project scale would be difficult using traditional paired watershed studies, and this justification was used by the Forest Service HFQLG team to end further efforts at informing this issue.

Key Finding 8. Protection measures, management strategies, and monitoring activities helped reduce some adverse environmental impacts. Other impacts, including to some species of concern, were uncertain because scientific evaluations were uneven, ineffective, or not completed.

When the HFQLG Act was passed, there was little known about the environmental impacts of shaded fuel breaks (DFPZs) and group selection harvests on species of concern (primarily species classified as rare, threatened, endangered, or sensitive) and on soil, air, and water resources. The HFQLG Act stated that implementation of the Act must "minimize the adverse environmental impacts from resource management activities." The HFQLG Act also included instructions to provide a "description of any adverse environmental impacts resulting from implementation of the pilot project." Below we report on those specific environmental impacts for which the Forest Service collected monitoring data. Additional specific impacts are described in Appendix I.

HFQLG pilot project treatments changed the structure of the forest at the stand and landscape scales. Consequently, monitoring for adverse environmental impacts was needed at both spatial scales. The monitoring strategy developed for the HFQLG pilot project was derived from the HFQLG FEIS, Chapter 6 and the ROD (USDA 1999). During the Phase One review, we conducted a comprehensive evaluation of available data and monitoring approaches that had been employed by the HFQLG pilot project monitoring teams through 2008. The Phase One report contained recommendations for modification of the monitoring program to facilitate the final review of the HFQLG pilot project. At that time we also acknowledged the many challenges associated with monitoring or assessing impacts to rare and elusive species. These monitoring challenges continued and in many cases insufficient scientific and statistical rigor made it impossible to determine if there were adverse impacts caused by the HFQLG pilot project treatments (e.g., to marten and amphibians). However, there were many examples where focal species and threatened, endangered, and sensitive (TES) species or their habitats were protected adequately (e.g., plants, land birds) during treatment activities. For many important environmental values we could not evaluate the overall extent to which implementation of the HFQLG pilot project had an adverse impact on the environment.

Selected Vertebrate Species (American marten, land birds, and amphibians)

HFQLG pilot project treatment impacts on American marten (*Martes americana*) were uncertain because the analysis was either not completed or only partially completed. The best reproductive habitats for marten populations in the northern Sierra Nevada have been linked to sites with the largest amount of dense, old forest (Zielinski 2013). Given this association with old forest, evaluating impacts of treatments on this habitat type was necessary to evaluate impacts to marten. The ROD (USDA 1999) required no more than a 10% reduction in suitable habitat (compared to the 1999 baseline) for old forest-dependent species. The implementation of HFQLG treatments resulted in a 2.2% loss of old forest relative to the 1999 baseline (Dillingham 2013). Wildfire caused the loss of 15.5% of old forest relative to the 1999 baseline during the pilot project period (Dillingham 2013). The small percentage of old forest lost as a result of treatments suggested that there was a low risk of impact on marten abundance and distribution because of implementation of treatments. However, evaluation of the overall impacts to marten depended on an assessment of the habitat loss due to full implementation, not only in terms of total old forest loss, but also in terms of the spatial configuration of habitat that was lost (e.g., to evaluate effects on habitat connectivity). To conduct such an evaluation the monitoring team began developing predictive habitat models but the model results were not completed by the conclusion of the pilot project. As a result, we were unable to determine whether the HFQLG pilot project treatments had (or will have) an adverse effect on the American marten.

HFQLG pilot project treatments typically minimized adverse impacts on focal land bird species and habitat guilds (i.e., groups of species associated with particular habitats). There was little change in species richness (i.e., the number of bird species present at a given site) at project sites in the first five years following treatment, which suggested minimal, if any, impact on land birds as a result of HFQLG pilot project treatments (Burnett et al. 2012b). There were general decreases in the abundance of mature-forest, closed-canopy species and increases in the abundance of species associated with edge and open forest conditions. This result was expected based on the observed changes in forest structure. However, the magnitude of individual species responses to treatment was small. When species were combined into habitat guilds, the abundance within guilds showed little change as a result of implementation of shaded fuel breaks. For group selection treatments there was weak evidence of a decrease in abundance of canopy species, an increase in abundance of understory species, and no change in abundance of edge species as a result of the treatments. Abundance of canopy and understory species showed slight decreases following pre-commercial thinning treatments; there was no observed change of edge species following pre-commercial thinning. Although generally there were no adverse impacts on forest bird populations detected, the treatment locations and schedule resulted in a lower sample size of group selection treatments, which reduced the strength of inference for this finding. Riparian restoration in aspen and meadow habitats had beneficial impacts on landbirds by creating habitat for riparian-associated species (Campos and Burnett 2012). The collaboration between Point Reyes Bird Observatory (PRBO) and Forest Service personnel was an example of effective collaboration to acquire critical information for adaptive management. Both PRBO and Forest Service personnel were responsive to the analytical needs of the HFQLG pilot project and the recommendations made in the 2008 Phase One report (Pinchot Institute 2008).

The HFQLG pilot project was unable to assess the effects of treatments on sensitive amphibian species. There were several reasons for this, including: the lack of an adequate study design during the initial eight years of the monitoring program; the inability to locate sensitive amphibian species within HFQLG project areas; and the delay or abandonment of proposed management activities at locations where sensitive amphibian species occurred.

Threatened, Endangered, and Sensitive (TES) Plant Species

HFQLG pilot project treatments did not appear to have adverse impacts on threatened, endangered, and sensitive plant species, though protection was inconsistent early in the pilot project implementation period. Forest Service personnel (or contractors) surveyed each project area for occurrence of threatened, endangered, and sensitive plant species prior to project implementation. Agency botanists established protection zones (termed "control areas") around threatened, endangered, and sensitive plants. The number and size of control areas was a function of the rarity of the species; the distribution and abundance within, and outside of, the project area; and the tolerance of the species to disturbance. The goal was to protect 90% of the planned control areas. The goal was not met during the first four years (2002-2005) of monitoring. However, agency personnel made some adjustments to project implementation, and the goal was met during five of the last six years (2006-2011). Those adjustments included (a) establishing better communication among botanists and contracting officers; (b) ensuring control areas were properly flagged prior to any management activities; and (c) ensuring control areas were accurately depicted on a map that was distributed to all project personnel. Although several control areas were inadvertently impacted during project implementation, subsequent monitoring revealed that most of the threatened, endangered, and sensitive plant populations within those control areas were not adversely affected.

Noxious Weeds

The Forest Service applied aggressive actions before and after treatments either to control or eradicate noxious weeds. Although new infestations of noxious weeds were detected at 24% of the treatment sites, most new infestations were comprised of widespread species that are very difficult (arguably impossible) to control or eradicate (C. Dillingham, Forest Service, personal communication). Forest Service staff adequately implemented the standards and guidelines established in the FEIS. At most treatment sites, pre- and post-project inventories for noxious weeds were completed; noxious weed control measures were implemented; and equipment was cleaned prior to entering the project sites. In general, aggressive actions prior to and throughout project implementation were successful in eradicating small populations of noxious weeds, but they were less successful in eradicating large populations and species that are highly invasive and difficult to treat. Overall, the

HFQLG pilot project was successful in preventing and suppressing most noxious weed infestations.

Soil Resources

Negative impacts to soil and soil productivity associated with HFQLG pilot project resource management activities and included cumulative soil compaction and reduction in large woody material, as well as lesser impacts on soil cover (Young et al. 2011). HFQLG pilot project pre- and post-treatment monitoring revealed that nearly two-thirds of the sites had compacted soils prior to HFQLG pilot project treatments and these activities resulted in a 10% increase in detrimental compaction. Thus, while monitoring revealed that cumulative historical effects on compaction are widespread and expected to increase with on-going treatment, the effects directly associated with HFQLG pilot project treatments were modest. Overall, 12% of the post-treatment sites monitored showed ecologically important levels of humus-enriched topsoil displacement, which reduces overall site productivity (Young et al. 2011). Similarly, reduction in ground cover by duff and woody material, which protects the soil from surface erosion, was less than 10%. For both topsoil displacement and reduction in protective soil ground cover, more impacts were associated with group selection than thinning. Finally, the largest effect on soil characteristics associated with resource management was reduced retention of large down woody material, particularly in group selection treatment areas. Prior to treatment, natural variability and legacy effects left a little over two-thirds of the monitored units with sufficient large woody material. Overall, HFQLG pilot project treatments resulted in an additional 40% reduction in the number of treated sites meeting targets for large woody material left of site. Forest Service silviculturists and soil scientists suggest these decreases in post-treatment large woody material were associated with desires of practitioners to leave a 'clean site' after treatment.

Smoke Management (from prescribed fires)

Management of smoke pollution was successful. Smoke management planning and coordinating procedures implemented after 2006 were extremely effective in reducing and, even eliminating in some cases, smoke complaints, even though several thousand acres were burned each year throughout the HFQLG pilot project area. With the exception of four violations of air quality standards, the provisions of the smoke management plans implemented under HFQLG prescribed fire projects were met over the nearly 79,000 acres that were burned between 2001 and 2010. The absence of air quality violations after 2006 was likely attributable to improved coordination between fire management and air quality specialists within the Northeast Air Alliance.

Conclusions

The HFQLG pilot project was primarily successful in reducing impacts when the management approach relied on direct protection (e.g., control areas for threatened, endangered, and sensitive plants) or when monitoring (e.g., land birds) or management (e.g., noxious weeds, smoke) protocols were well established. It was either unsuccessful or less successful for rare and elusive species, and for species (or issues) that did not have well established monitoring protocols. These differences in success demonstrate that the HFQLG pilot project lacked sufficient input or guidance from either senior scientists or administrators at critical times in the planning, development, and initiation phases of monitoring for adverse environmental impacts.

Key Finding 9. The HFQLG pilot project expanded and supported existing wetland and riparian restoration activities, but did not implement a new program of water resource protection and management referenced by the HFQLG Act.

Restoration of wetlands and riparian areas was a significant resource management activity for the three forests encompassing the HFQLG pilot project area, and it required substantial investment of resources. Functional restoration activities include geo-engineering and plantings to restore wetland function, eliminating roads, improving road crossings, and stabilizing stream banks. Activities of this kind pre-dated enactment of the HFQLG pilot project, and they often involve partnerships with outside organizations. The HFQLG Act added impetus and support for this work, and generated opportunities for additional partnerships, effort, and funding.

Interviews and available planning documents suggest that implementation of restoration activities was prioritized at the Forest or District levels based on need and opportunity. District personnel seized opportunities to provide technical or financial support for active resource management or restoration activities, often at the behest of local and regional partners. However, in light of the objectives of the HFQLG pilot project and its geography, a more systematic planning effort was merited (and was specifically identified by the HFQLG Act), and likely would have improved the priorities and outcomes of the scientific, management and restoration activities related to water resources.

Riparian & Meadow Restoration

The HFQLG pilot project was successful in restoring over 10,000 acres of riparian and meadow habitat throughout the HFQLG pilot project area. Riparian restoration accomplishments varied across the Plumas, Lassen, and Tahoe National Forests (2,585 acres, 7,198 acres, and 1,300 acres respectively) -- prioritized by Ranger District based on other plans and priorities, including the Forest Plans, HUC-07 level NEPA planning, and beginning in 2005, the Upper Feather River Integrated Watershed Management Plan (2005). To this end, the support and direction provided by the HFQLG pilot project helped the Forest Service accomplish established priorities.

Road Elimination & Renovation

The HFQLG pilot project provided funding for much-needed road improvements. At the outset the Forest Service identified roads as "...the largest single human-caused source of sedimentation and habitat degradation in the planning area" (USDA 1999). The area contains 13,200 miles of roads, 230 of which were targeted for elimination during the initial five-year pilot period, 300 miles when considering pre-existing plans (USDA 1999). Road-related impacts to riparian areas were addressed throughout the HFQLG pilot project area by eliminating over 130 miles of road miles in riparian areas, restoring over 100 stream channel road crossings, and eliminating an additional 75 crossings. These activities were supported by several hundred thousand dollars of annual expenditures for the HFQLG pilot project area.

In addition, range conservationists in the HFQLG pilot project area continued improving range management and condition throughout the project period as part of normal Forest Service operations, but did not undertake special efforts to alter range management in the HFQLG pilot project area as referenced in the HFQLG Act. Similarly, the Forest Service worked regularly with the Federal Energy Regulatory Commission as an active participant in all of the relicensing processes that affect resources on National Forest lands as part of the agency's existing on-going operations, so no change in these actions was necessary to fulfill this objective.

D. Conclusions

The HFQLG pilot project was intended to be a national demonstration of landscape-scale forest treatments that could simultaneously improve community economic stability, reduce the size and severity of wildfire, protect the California spotted owl population, and improve the condition of water resources. During the period of implementation (1999 to 2012), the HFQLG Forest Recovery Act became one of several major management policies intended to reshape forests in the California Sierra Nevada region; others were the Sierra Nevada Forest Plan Amendments in 2001 and 2004 (USDA 2001, USDA 2004).

Results of the HFQLG Pilot Project

The HFQLG pilot project brought considerable public attention and directed consistent federal appropriations to conduct forest resource management activities (treatments). This resulted in important economic and social benefits to the region and accomplished high-priority forest treatments. However, the pace and scale of treatments did not meet the expectations of the HFQLG Act, nor were the goals of the Community Stability Proposal fully achieved. Annual acres harvested and volume of wood fiber sold was consistently below levels projected for the alternative selected in the 1999 FEIS (USDA 1999). Project-level treatments were inconsistent in size and volume offered, and the ratio of sawlog-to-biomass volume removed was consistently skewed towards lower-valued material. Communities dependent upon the forest products industry were subsequently affected; wood products employment, population, and school enrollment all declined during the thirteen years of the pilot project. Retail business activity initially increased in some communities but retracted to pre-pilot project levels during the recession. Service-based employment, including employment associated with seasonal lodging and tourism, increased but not sufficiently to offset a 60% decline in forest industry employment. Total private sector employment declined 16%, and total population within the pilot project area declined by 43% from 2000 to 2010. However, these declines may have been greater in the absence of the HFQLG pilot project. The occurrence of a major economic recession certainly affected timber demand and prices, which confounded the ability to attribute economic changes either to shortcomings of the HFQLG pilot project or to impacts of the recession.

Among the positive aspects of the HFQLG pilot project included the impetus to mobilize and enhance new and existing scientific activities on the three national forests. Dedicated funding for monitoring was a positive element that should be expanded in any potential future applications. Although monitoring activities varied in their success, when conducted effectively they were valuable for informing project planning and management decisions. The monitoring also strengthened efforts to better understand the ecology and distribution of lesser known species, and advance the science on ecosystems processes that are less understood. These outcomes are important to long-term policy and management strategies for forests in the region.

The implementation of DFPZs as a fuel reduction strategy clearly achieved many of the intended benefits including reduced fire severity. Wildfires impacting DFPZs repeatedly showed decreases in active fire behavior, flame length, and fire severity. The DFPZ treatments also enhanced suppression efforts and effectiveness by serving as anchor points for fire line construction and for burnout activities; they were also used to facilitate safe movement of firefighting personnel and equipment to and from wildfire areas. These benefits were tangible and were documented by monitoring data and analyses.

Science and monitoring showed that group selection silvicultural treatments have the capability of shifting forests in the Sierra Nevada towards a desired future condition that supports the development of ecological integrity in a forest highly-influenced by past management activities. However, the legacy of historical management practices will take many decades to reverse and it is not clear that the rotation age being implemented will result in old growth forest (pre-settlement conditions) communities. Whereas, there is scientific uncertainty regarding the definition of forest structure and landscape composition of pre-settlement forests, the HFQLG pilot project treatments typically maintained important forest structural elements while protecting the large diameter live trees and old forest habitats that form the basis for the desired future condition. Further research to define the range of desired forest structural elements, the landscape distribution indicative of the pre-settlement forest, and the appropriate rotation age to achieve this is needed before full implementation of the group selection strategy proceeds.

The HFQLG pilot project was successful in reducing environmental impacts associated with forest treatments where the management approach relied on direct protection (e.g., Best Management Practices, control areas for TES plants) or when monitoring (e.g., landbirds) or management (e.g., noxious weeds, smoke) protocols were well established. It was either unsuccessful or less successful if the species and their protocols were either less known or not well established. The HFQLG pilot project was less successful in understanding impacts of forest treatments on the California spotted owl, which involved complex ecological relationships that were influenced by factors both within and outside of the HFQLG pilot project area. Evaluating the effect of DFPZ treatments on California spotted owl viability was essential to evaluating the success or failure of the HFQLG pilot project, but this was not accomplished. Moreover, the fact that group selection treatments were a departure from silvicultural prescriptions allowed under the 2001 Sierra Nevada Forest Plan created the need to understand the cumulative impacts of the deployment of these treatments. Spotted owl Protected Activity Centers (PACs) were given explicit protection under the HFQLG Act and effective land planning ensured that HFQLG treatments avoided PACs within the project boundary. However, the spotted owl population within the pilot project area declined during the implementation period and the evaluation of whether the pilot project treatments contributed to this decline was not completed.

Similar scientific shortcomings were apparent in the evaluation of treatment impacts on sensitive species such as the American marten and Sierra Nevada yellow-legged frog. While the studies were hindered by working with species that were either difficult to detect or rare and elusive, the research was either incomplete or not designed in such a way to effectively evaluate HFQLG treatment impacts.

Among the unknown risks (or benefits) from implementation were those related to water resources. The impacts from forest management activities likely were minor where buffers were established to protect streams, and where impacts were detected they were temporary. But the watershed monitoring data were insufficient to evaluate the ecological benefits and/or impacts of treatments, particularly at full implementation levels.

Factors Affecting HFQLG Pilot Project Implementation

Agency Culture. Throughout our review, we discovered that multiple factors affected implementation of forest treatments ranging from those outside of agency control to systemic agency issues that will compromise future applications. An important context for implementation was that the HFQLG pilot project comprised portions of three national forests, each of which had different resources, capacities, and organizational cultures. Stakeholders within and outside the Forest Service noted that success varied among the forests and even districts depending on the ability and willingness of personnel to implement legislative directives and to engage stakeholders. Variation of this kind influenced the pace, scale, and overall success of the HFQLG pilot project.

Forest Leadership. We observed that institutional differences among the three forests influenced how the HFQLG pilot project was prioritized relative to other demands, and the willingness of administrators and senior staff to adjust workflow to align with the goals of the HFQLG Act. Interviews with agency personnel and stakeholders suggested that the direction and support of leadership, or lack thereof, was an important factor in achieving success. Frequent changes in leadership at the forest level affected whether and to what extent the HFQLG pilot project was implemented; nine Forest Supervisors directed work on the three forests during the thirteen years of implementation. The level of support and direction provided to staff for pilot project activities—whether for monitoring or implementation—significantly influenced the pace and scale of implementation, the relationships with key external stakeholders, and the quality of science conducted to understand the extent of environmental impacts.

Pilot Extension. The extension of the HFQLG pilot project was also a factor in implementation that provided an opportunity for greater implementation and more science activities for an additional five years. More than 240,000 acres were ultimately treated over the thirteen years allowing more time to test the effectiveness of treatments. However, monitoring plans were based on a five-year implementation window stipulated in the initial ROD and FEIS (USDA 1999), and perhaps science activities would have been designed differently for the thirteen-year period. The Independent Science Panel provided formal advice and guidance on the monitoring program to improve evaluation of the HFQLG pilot project (Pinchot Institute 2008). Some recommendations were incorporated, including significant improvements in science activities related to terrestrial birds, soils, and aspects of watershed condition. However, others were incomplete or not adopted such as additional socioeconomic monitoring that would have provided information about project-level expenditures by activity code and non-economic factors affecting community stability.

Appeals and Litigation. Appeals and litigation were an important factor in implementation. External stakeholders contested the scientific basis of management and potential environmental effects of treatments, especially group selection, which was likely compounded by heightened attention generated by the HFQLG Act. For example, certain large projects were “shelved” indefinitely as an outcome of litigation. Other projects were significantly modified and ultimately improved. Projects “held up” because of legal challenges also impacted monitoring activities. Science activities requiring pre- and post-treatment information had to be revised or abandoned. Additionally, agency staff typically needed to repeatedly re-mark exclusion areas or boundaries of proposed treatments based on newly configured treatment objectives or areas. Based on Forest Service records, 20 of the 417 HFQLG treatments were appealed over the 13 years of implementation. Only six projects were litigated but had an impact on agency planning and ultimately the configuration and timing of future projects.

Monitoring Effectiveness and Adaptive Management. The timeliness and comprehensiveness of scientific information necessary to evaluate the pilot project was both helped and hindered by the reliance on partnerships with Forest Service station scientists and outside organizations. In some instances, as with the work of PRBO Conservation Science and universities, these activities were crucial for adding breadth and depth to monitoring results. In other instances, scientific findings were not available, useful, or fully employed to inform HFQLG pilot project activities on a timeline consistent with programmatic needs. While the timeliness of scientific information as a general issue in natural resource management is not uncommon, this problem signaled that systemic issues were particularly challenging for the HFQLG pilot project, and it had broader implications for the role of science in both collaboration and adaptive management.

Several examples bring into question how science was used and the adequacy of mechanisms for translating new knowledge into changes in management. HFQLG pilot project monitoring required collating and analyzing information developed through disparate processes that resided in different places. One benefit of the HFQLG pilot project was that interrelated information crucial to management was brought together in one place. This also suggests that science findings related to the HFQLG pilot project were not typically kept and maintained in a manner that facilitates project-level decisions.

Forest Service staff made adjustments when monitoring information indicated that protection measures for wildlife and resources were not being fully implemented. For example, when monitoring revealed that occurrences of sensitive plant species were not always protected (65% of the time), the problem was quickly addressed and improved to 86% compliance. In most cases, mid-course adjustments were related to direct protection (e.g., Best Management Practices and control areas for threatened, endangered, and sensitive plants). However, adjustments requiring scientific analysis and interpretation were not typically attempted. As a result, HFQLG pilot project treatment designs were sometimes considered prescriptive and inviolable. The Forest Service also missed important opportunities to adjust activities based on the monitoring information. In one example, agency staff failed to recognize the urgency of determining whether forest treatments were partially responsible for the decline of the California spotted owl in the pilot project area, despite its high profile and central role in the HFQLG Act. These observed shortcomings in scientific information illustrate how monitoring and subsequent incorporation into management activities lacked sufficient input, guidance, and ongoing support from senior scientists or administrators that must be addressed in future applications. This is particularly important because adaptive management is predicated on such responses and feedback mechanisms.

Collaboration. Feedback from stakeholders and agency staff suggested that there was greater support and general acceptance for the HFQLG pilot project in the later years than in the earlier years. Interviews with agency staff and external stakeholders suggest this was at least partially accomplished through new scientific information generated by Forest Service publications GTR-220 and GTR-237 (North et al. 2009, North 2012). Collaboration between the Forest Service and Sierra Forest Legacy, a leading appellant, in using this new information played an important role in reducing appeals and litigation. In some projects, larger-diameter trees were considered for removal but only when evidence was consistent with ecological risks and external stakeholders were first consulted. Such examples of the outcomes demonstrated the value of collaboration that served as an original impetus for the Community Stability Proposal.

The concept brought forth by the Quincy Library Group has been celebrated as a transformative approach for federal lands management. Multiple stakeholders came to the table to translate new science to serve the needs of communities, while preserving the natural legacy of California Sierra Nevada forests. Over time some parties disengaged from local collaborative efforts to challenge forest treatments and the underlying science. This had the effect of undermining trust among stakeholders, which ultimately affected the pace and scale of implementation.

While the HFQLG pilot project originated through an unprecedented type of collaboration, it also included significant federal investment, approximating $293 million, the economic impacts of which cannot be separated from the impacts of the management approaches introduced. Implementation was incomplete, and, therefore, the full effects were uncertain. How the California spotted owl and other species of conservation concern will fare over the long term also has not been answered. However, where the HFQLG pilot project was implemented it helped reduce the damaging effects of wildfire, and in the process produced needed economic stimulus, albeit not at the level anticipated. That the full effects and potential impact of the HFQLG pilot project remain uncertain well beyond the five year duration first proposed demands caution. The HFQLG pilot project has demonstrated the potential of collaborative engagement, but as yet, not a model for how institutions and collaborative partnerships must adapt to achieve the complex outcomes of promoting forest health, economic stability, and maintaining environmental values.

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F. Appendices

Appendix I.

Supplement Information Related to Key Indicator Findings

Abbreviations:

"Act"	HFQLG Healthy Forest Restoration Act (numbers refer to sections of the Act)
"CSP"	Community Stability Proposal (numbers refer to sections of the proposal)
"RFP Goals"	Instructions given in the Independent Science Panel Request for Proposals (issued by the Forest Service PSW, 2007)

Key Finding 1: The pace and scale of HFQLG pilot project treatment implementation did not meet expectations for the supply of wood fiber or the number of acres treated.

Key Finding 2: The HFQLG pilot project was unable to provide local economic stability through an adequate and continuous supply of timber to local mills.

Key Finding 3: The HFQLG pilot project produced unanticipated positive social and organizational changes.

Related Goal: Provide community[1] economic stability [CSP 2.i and 4]

Objective: "in order to provide an adequate timber supply for community stability and to maintain a relatively continuous forest cover, a management system using group selection (similar to that proposed by the Friends of Plumas Wilderness in the Plumas NF Land Management Plan or that used at UC's Blodgett Forest) and/or individual tree selection (similar to that employed by Collins Pine) must be implemented immediately." [CSP 2i] Notes: in the RFP Goals, "adequate" is replaced with "continuous"; and modified with "and economic benefits from employment in resource management activities".

Objective: "In order to adequately assure community stability, protective mechanisms such as SBA/SSTS set-asides should be continued, stewardship contracts should be expanded, and a "sustained yield unit" as authorized by Congress must be established." [CSP4]

[1] "Communities within Lassen, Plumas and Sierra Counties rely upon the forest products industry for education, roads and basic infrastructure. Specifically, the communities of Susanville, Chester, Quincy, Loyalton, Bieber, and Greenville."[CSP 1]

The findings related to socioeconomic elements of the HFQLG pilot project are presented in their entirety in the narrative for Key Findings 1-3.

Key Finding 4: Implementation of HFQLG pilot project fire and fuel management treatments and riparian restoration did not meet annual targets but where they were established they typically reduced localized fire severity, which benefited fire suppression activities.

Related Goal: "implement fire and fuel management recommendations from CASPO over the entire land base." [CSP 2.ii]

Objective: Fuel treatments would be implemented across the landscape such that they would contribute to fire resiliency and reduction of potential effects to all resources (long term strategy) (adapted from RFP Goals)

Indicator: "Fuelbreak construction.--Construction of a strategic system of defensible fuel profile zones, including shaded fuelbreaks, utilizing thinning, individual tree selection, and other methods of vegetation management consistent with the Quincy Library Group-Community Stability Proposal, on not less than 40,000, but not more than 60,000, acres per year." [Act d1, d2].

Indicator: "The total acreage on which resource management activities are implemented under this subsection (Fuelbreaks& Group/Individual Tree Selection) shall not exceed 70,000 acres per year." [Act d3]

Tables 5 and 7 in HFQLG FY 2011 Status Report to Congress (USDA 2012a) provided the total acres treated during the project period for the three silvicultural treatments (DFPZ, individual tree selection, and group selection) and restoration of riparian areas. The "acres accomplished" reflected treatments that were under contract whereas the "acres treated" (see Figure 1a in Key Findings section above) reflected the realized treatments (i.e., those that actually occurred; USDA 2004). The pace of implementation was typically slower than the pace of contracts awarded, although these two metrics showed a similar trend. With the exception of 2001, the total acres accomplished were below the minimum acreage of 40,000 allowable for treatment each year. This trend was more pronounced with respect to actual acres treated per year, where the minimum allowable acres treated was never achieved during the implementation period.

The reasons listed in the Forest Service's Fiscal Year 2007 and 2011 Status Report to Congress to explain the disparity between the HFQLG acreage treatment goals and actual implementation included litigation of individual projects and policy changes within the agency that guided projects, such as the 2004 Sierra Nevada Forest Plan Amendment

(USDA 2008, USDA 2012a). While some HFQLG projects were allowed to proceed after being upheld in court, appeals and litigation still caused delays or additional restrictions on some projects during implementation (USDA 2012a). In addition market conditions affecting sawlog and biomass values were also cited as factors contributing to reduced accomplishments (USDA 2008).

Objective: Provide for rapid access and retreat to ensure a safe efficient base for fire suppression activities. Gain immediate leverage by breaking the continuity of fuelbeds and fire ladders. (RFP Goals)

Indicator: (Monitoring Question 25) "What is the effect of treatments on fire behavior and suppression?"

During the implementation period, 20 different wildfires came into contact with DFPZ treatments. Fire behavior during these occurrences was often documented for individual incidents, which were then summarized in a comprehensive report (Murphy et al. 2010). With respect to fire behavior, wildfires impacting DFPZs repeatedly showed decreases in active fire behavior, including reductions in flame length and fire effects, specifically reductions in fire severity. These findings were corroborated independently by scientific literature through both field studies and modeling (Stephens et al. 2009, Safford et al. 2012). Fuel treatments consistently reduced fire severity during multiple wildfires that occurred during the implementation period (Murphy et al. 2010). In addition, fuel treatments enhanced suppression effort and effectiveness in several cases. These enhancements included the utilization of DFPZs as anchor points for fire line construction and for burnout activities (Murphy et al. 2010). In addition, DFPZs were used to facilitate safe movement of firefighting personnel and equipment to and from wildfire areas (Murphy et al. 2010), including one instance where they were used for emergency exit in an area experiencing an increase in fire behavior (Dailey et al. 2008).

The influence of DFPZs on fire size was most notable for several fires which started within or adjacent to DFPZs; these fires were readily contained within 10 acres. This finding was documented in USDA (2011: page 26) for the years 2008 and 2009 as follows:

> "…of 32 fire starts that occurred within Defensible Fuel Profile Zone (DFPZ) boundaries in 2008 and 2009, all fires were contained at less than 10 acres. On the other hand, of 346 starts recorded outside of DFPZs in 2008 and 2009, 11 percent (39 starts) grew into fires greater than 10 acres. Fire starts that were closer to DFPZ boundaries were significantly less likely to escape initial attack and develop into fires greater than 10 acres. Over 60 percent of starts that were contained by initial attack were less than two kilometers from a DFPZ (figure 5). By contrast, only 30 percent of starts that escaped initial attack were less than 2 kilometers (1.24 miles) from a DFPZ." (USDA 2011)

In addition, Merriam (2013: page 4) reported:

> "….1) As the amount of watershed treated by DFPZ increased, the amount of the watershed burned by wildfire decreased; 2) Fire size increased as start distance from the DFPZ increased…"

Finally, the results of two fire modeling studies showed that DFPZs had the potential to reduce potential fire size for both hypothetical (Moghaddas et al. 2010) and real wildfires (Saah 2011), although the potential to reduce fire size was limited by the total area treated prior to the wildfire.

Objective: Improve protection of forests and property from large-scale high intensity wildfire (adapted from RFP Goals)

Indicator: (Monitoring Question 23) "What is the trend in large fire frequency?"

From 1900 and 2007, there was "significant linear increasing trend" in mean wildfire size within the pilot project area (USDA 2010). However, during this same time period, there was no significant increase in the number of acres burned or in the total number of fires per year (USDA 2010). As noted in USDA (2010), "Because the HFQLG pilot project has not yet been implemented in its entirety, it is difficult to determine the potential effect of HFQLG treatments on large fire frequency at this time."

A recent report (Merriam 2013) continued the initial USDA (2010) analysis to examine the average fire size as well as the trend in large fire frequency through the year 2011. This analysis was an assessment of the trend in large fires within two time periods, pre-HFQLG pilot project (1900-1998) and during-HFQLG pilot project (1999-2011), statistically comparing the fire-year moving average of mean fire size during these time periods. With respect to average fire size, average fire size was larger during the HFQLG period relative to the period prior to implementation, as excerpted below:

> "Fires recorded within the HFQLG project area since 1900 averaged approximately 1,500 acres in size, but have varied from between zero, when no fires were recorded, to an average fire size of over 28,000 acres in 2000 (Fig. 3). During 1994 and 2000 the mean number of acres per fire was over four orders of magnitude larger than during any other year since 1900. Mean fire size has increased significantly (one way ANOVA, df=1,110, F= 6.59, p=0.01) since HFQLG implementation, averaging 1,159 acres (+ 268 acres) pre-HFQLG (1900- 1998) and 3,873 acres (+ 2,140 acres) post [during]-HFQLG (1999-2011)." (Merriam 2013:Pg. 1)

In addition, this analysis revealed that while the total number of fires increased during the implementation period in the period before the HFQLG pilot project there was no upward trend during the implementation period (Merriam 2013), as excerpted below:

> "The annual number of fires occurring within the HFQLG project area has ranged from zero, recorded during nineteen separate years since 1900, to 38 fires recorded in 1917 (Fig. 2). Fire number has increased significantly (one way ANOVA, df=1,110, F= 4.48, p=0.04) since HFQLG implementation, averaging six fires per year (+ 0.7 fires) between 1900 and 1998 and 10.3 fires (+ 2.3 fires) per year between 1999 and 2011." (Merriam 2013); and,
>
> "Finally, mean fire size was significantly increasing prior to HFQLG implementation, but has not exhibited any trend after implementation" (Merriam 2013)

From the data reported, it was not possible to determine if the increase in fire starts was caused by lightning, humans, or management activities directly related to HFQLG implementation. However, there was no evidence to suggest treatments contributed to the increase in mean fire size.

There has been an increase in fire size in the Sierra Nevada and Southern Cascades (Miller et al. 2009), which has been the result of many factors, including fuel buildup, exclusion of fire over time because of active suppression, and current climate trends (Miller et al. 2009). Beyond documentation of regional trends that influence large fire frequency, there were other factors, including lack of complete implementation of the HFQLG Act that made full analysis and interpretation of this and other fire related questions difficult to answer conclusively (Merriam 2013).

Indicator: (Monitoring Question 24) "What is trend in severity of large fires on acres burned?"

Across the Sierra Nevada, there has been an increasing trend in the area of burned with fires of high severity (Miller et al. 2008, 2009). Between 1984 and 2007, there was "…a significant linear increase in the percentage of area burning at high severity across the HFQLG pilot project area" (USDA 2010). USDA (2010) reported the following: "Because the HFQLG pilot project has not yet been implemented in its entirety, it is difficult to determine the potential effect of HFQLG treatments on large fire frequency at this time." A recent report (Merriam 2013) extended the USDA (2010) analysis by examining trends in the total acres burned with high severity fire before and after the HFQLG pilot project. Merriam (2013) found an increase in the percentage of total area burned that was classified as high severity during the HFQLG implementation period, when compared to the period prior to implementation back to the year 1984, the year when fire severity data was first available. With respect to the trend in the severity of large fires, Merriam stated: "We found that prior to 1999 there was no significant trend in fire severity, while after HFQLG implementation in fire severity showed a significant linear increase" (Merriam 2013).

The direct effects that DFPZs had on modifying local fire effects, including fire severity, was well documented for multiple wildfires occurring within the pilot project area during the implementation period. The finding that projects, when completed as designed, reduced potential fire severity was corroborated by several published studies. Although there was an increase in the general trend of area burned with high fire severity during the implementation period, there was no evidence that implementation activities contributed to the increase in that trend. As described above, the increase in fire severity in the Sierra Nevada and Southern Cascades has been documented in the literature (Miller et al. 2008, 2009) because of several factors such as fuel accumulation, exclusion of wildfire by active suppression, and current climate trends (Miller et al. 2009). Beyond the documented regional trends influencing large fire frequency, there were other factors, including lack of complete implementation of the HFQLG Act, that made full analysis and interpretation of this and the other fire related questions difficult to answer conclusively.

Key Finding 5: Fuel reduction and silvicultural treatments when implemented helped develop an all age, multistory, fire resilient forest but it is uncertain how these treatments affected ecological integrity at either the stand or landscape levels.

Related Goal: "promote forest health, [and] ecological integrity". [CSP Introduction, CSP 2]

Objective: "All silvicultural prescriptions will be uneven-aged management. The Desired Future Condition is an all-age, multi-story, fire-resistant forest approximating pre-settlement conditions. This will be achieved by utilizing individual tree selection such as the system used by Collins Pine and/or group selection (area control to reach regulation)." [CSP b]

Indicator: "Group selection.- Group selection on an average acreage of .57 percent of the pilot project area land each year of the pilot project." [Act d2A]

Group selection and individual tree selection timber harvesting activities fell well below the annual target of 0.57% of the HFQLG pilot project area if the entire 1.53 million acre area was considered as the basis for the area control target. Over the 13 year implementation period, 18,252 acres (1,404 per year) were accomplished and 7,859 acres (605 per year) were treated using group selection and individual tree selection systems. Depending upon the acreage of fuel reduction treatments implemented, the HFQLG Act allowed up to 30,000 acres per year to be treated using group selection and individual tree selection systems. The combined acreage of accomplished group selection and individual tree selection treatments represented 1.19% of the total pilot project area land over the 13 year period (0.51% when only considering treated acres). The group selection and individual tree selection treatments were to be conducted on an average acreage of 0.57% of the pilot project area land each year of the HFQLG pilot project to achieve a 175-200 year rotation with harvest entries occurring within a planning area every 15 years (i.e., creating new age cohorts every 15 years). The HFQLG Act stipulated that 0.57% of the pilot project area be treated with group selection and individual tree selection annually, however, the target was implemented differently from an operational perspective. For every planning area, the available harvestable land base was calculated and then the 0.57% target for group selection and individual tree selection treatments was applied. Then when actual harvests were laid out, the resulting acreage of group selection and individual tree selection was often below 0.57% because of issues related to access, lack of merchantable volume, or resource protection. This challenge was encountered because the typical planning process initially involved the use of GIS and remotely-sensed data; subsequently project planning during field visits prior to implementation resulted in discovery of site specific constraints as noted above. While the implementation of small group selection and individual tree selection harvest units created logistical challenges and higher costs compared to even-aged systems, agency personnel noted that group selection and individual tree selection created more opportunities to restore historical species composition and forest structure.

Indicator: (Monitoring Question 2) Are the desired abundance and distribution of snags and logs achieved in DFPZs and group selections?

Indicator: (Monitoring Question 3): "Does the implementation of silvicultural prescriptions produce or retain desired stand elements such as logs, canopy cover, large trees, and early seral stage?"

The identification of forest structural targets served as benchmarks for creation of pre-settlement conditions and provided some measure of ecological integrity. Implementation of DFPZ, group selection, and individual tree selection treatments was guided by the 2004 Sierra Nevada Forest Plan Amendment in terms of targets for canopy cover, dead tree (snag), and large log retention. Bigelow et al. (2012a) evaluated the implementation of DFPZ, group selection, and individual tree selection treatments on 64 planning units within the HFQLG pilot project area. The monitoring design did not allow for an analysis that distinguished between treatment types, so the results reflected the impact of all silvicultural prescriptions. Mean canopy cover decreased from 48% to 33% after treatment and remained unchanged for the following four years (Bigelow et al. 2012a). The targets for post-harvest canopy cover were based on a 40% target with some flexibility given to managers to modify this target percentage for specific stand conditions and location (e.g., east side vs. west side). Prior to treatment, canopy cover was within the target range in

21% of stands with specified canopy targets. One year after treatment, 36% of stands met canopy objectives (Bigelow et al. 2012a). Treatments successfully moved some dense stands into the target range, while other stands may have had lower densities of large diameter trees that were excluded from harvest but did not provide enough canopy closure to meet the targets. Bigelow et al. (2012a) also reported that the harvest treatments were generally successful in protecting the large diameter trees (> 30" diameter at breast height) from harvest or damage during the logging operation.

Large dead standing tree (snags) retention targets were also established by the Sierra Nevada Forest Plan and were evaluated by Bigelow et al. (2012a). Pre-treatment densities of snags were generally low relative to the target densities of 3-8 trees per acre. So, it was not surprising that post-treatment densities were generally below the target range (only 14% of the sites met the target post-treatment vs. 28% pre-treatment) (Bigelow et al. 2012a). However, within four years, dead standing densities were again similar to pre-treatment levels. Bigelow et al. (2012a) noted that the paucity of large dead standing trees was more a reflection of the management history of the forest than to treatment impacts given that the implementation of treatments generally maintained pre-treatment levels. Because the management strategy was established to retain the large diameter trees, the dead standing tree densities in the future will likely increase as the large diameter trees senesce and die. Such a structural change in forests will take many decades to develop and could not be evaluated in the timespan of the HFQLG pilot project implementation period. Likewise, Bigelow et al. (2012a) documented a similar pattern for dead and down logs in the pre- and post-treatment data. Dead and down log volumes were generally below target levels both before and after treatments. Treatments generally reduced dead and down log volumes from pre-treatment levels. This was often a result of mechanical destruction or combustion during subsequent prescribed burn treatments. As with the standing dead trees, the retention of living large diameter trees will likely contribute to future dead and down log volumes that achieve the desired volume. Development of target levels will also take many decades to develop.

Also relevant to the movement of forests to a desired future condition that presumably reflects a pre-settlement environment was the requirement stipulated by the ROD (FEIS 1999) that suitable habitat for both old forest-dependent and aquatic/riparian-dependent species not be reduced by more than 10 percent of levels originally measured in 1999 within three specific old forest vegetation types (California Wildlife Habitat Relationship CWHR labels 5M, 5D, and 6). These forest types historically have been used to represent habitat required by old forest-dependent species within the pilot project area. The HFQLG pilot project achieved this objective by limiting reductions in old forest vegetation types to 2.2% (including projects listed at accomplished but not yet implemented) during the implementation period (Dillingham 2013). However, additional reductions occurred because wildfires removed 15.2% of the baseline acreage of old forest vegetation types (Dillingham

2013). These same wildfires also created a relatively large cohort of early seral habitat on the landscape, in addition to those created mechanically by group selection treatments.

Fire modeling conducted by Bigelow et al. (2012a) yielded predictions of decreases in conditional and active crown fire behaviors under moderate and extreme weather conditions up to five years after treatments based on the observed forest structure. Bigelow et al. (2012a) also found that treatments did not decrease predicted surface fire behavior and noted that this was "possibly because any decreases in surface fuels (as estimated visually in photo-series, and reflected in choice of fuel models) may have been counterbalanced by increases in predicted understory wind velocity." In some sites evaluated by Bigelow et al. (2012a), prescribed fire was not applied as a follow up treatment because post-harvest fuel loads and corresponding fire behavior were already below desired conditions. This occurred when pre-treatment fuel loading was relatively low and whole tree harvesting was implemented as the primary mechanical treatment. In other cases, monitoring data were collected prior to follow up treatment implementation, which could have influenced the model parameters with respect to surface fire behavior. In a study conducted on the Meadow Valley DFPZ project, Moghaddas et al. (2010) found that the very low crowns of trees in group selection units were prone to torching because they were close to the ground. These treated stands were expected to remain susceptible for 20 years (Stephens and Moghaddas 2005) although this may be mitigated to some degree by future treatments, including shrub control, stand density reduction, and pruning (Keyes and O'Hara 2001).

Key Finding 6: California spotted owl nest and roost sites were protected during the HFQLG pilot project implementation, but the HFQLG pilot project failed to assess if there were adverse environmental impacts to the owl population resulting from HFQLG treatments.

Related Goal: "Minimize the adverse environmental impacts from resource management activities" [RFP Goals]

Indicator: (Monitoring Question 11) "Were there any PACs impacted as a result of HFQLG pilot project Activities?"

Management of California spotted owls in the Sierra Nevada has been centered on protecting activity centers (PACs). The California Spotted Owl Technical Assessment Team (CASPO) hypothesized that PACs would provide essential, but minimal, protection for core areas used by California spotted owls. Research has shown that PACs are used by California spotted owls over very long time periods; thus, use of PACs by owls support the hypothesis by CASPO that PACs would be effective for protecting nesting and roosting areas of California spotted owls (Berigan et al. 2012). Other protections afforded California spotted owls by CASPO and the Forest Service included seasonal operating restrictions within home range core areas and protection of large trees throughout the landscape (Verner et al. 1992, Gutiérrez et al. 1995, Blakesley et al. 2005). Therefore, protection of PACs was distinguished as a specific element of the HFQLG Act because of their essential role in conservation of California spotted owls.

Indicator Finding: No Spotted Owl PAC was impacted as a result of treatments during the HFQLG pilot project.

Note: The following questions are the revised monitoring questions proposed by the Plumas Lassen Administrative Study (Keane and Blakesley 2007). These questions replaced the original monitoring questions 12-14 in the HFQLG monitoring plan. One original question (#11, see above) was taken from the language in the HFQLG Act (Section 401, C, 1 provides explicit protection for PACs). We present the findings derived from the California spotted owl monitoring activities by HFQLG as they relate to the revised monitoring questions. We quote these monitoring questions verbatim from Keane and Blakesley (2007), but we also note to which of the original HFQLG monitoring question they are relevant.

Indicator: (This new monitoring question was modified from original monitoring questions 12&14) – "What are the associations among landscape fuels treatments and CSO density, distribution, population trends and habitat suitability at the landscape-scale?"

This new question was appropriate because it was an attempt to identify population-level responses by California spotted owls to treatments while accounting for background changes in habitat conditions on the landscape. That is, owls could have responded either to treatments or to other changes in habitat (e.g., fire or natural growth of vegetation). Thus, it was necessary to differentiate effects related to treatments from those related to natural changes.

The monitoring team estimated both density and distribution of California spotted owls (Keane et al. 2011). Population density was estimated for different watershed sampling units across the QLG pilot area (Keane et al. 2011), but density estimates "were not directly comparable" because the size of the sampling units varied through time (Keane personal communication, 10 May 2013). The distribution of owls was plotted and presented graphically, but it was not analyzed in terms of spatial dynamics over time. California spotted owl responses (movements and distribution) were verbally described for owls residing within Meadow Valley (Keane et al. 2011) as a case study because it was the only landscape-scale treatment within their sampling units (J. Keane, personal communication, 10 May 2013). In general, we considered all treatments to be landscape scale within the context of HFQLG, but in this particular case, the actual deployment of all treatments occurred as a single unit within a single owl sampling area. This case study begin in 2003, but treatments began as early as 2000 so it was not possible to determine from the monitoring reports if there were any responses by the owl as result of these earlier treatments. Regardless, based on the graphical portrayal of owls on the landscape over time there appeared to be changes in owl locations over time but this was not analyzed explicitly.

Population trends for California spotted owls over the entire 20 year owl monitoring study within the pilot project area also were estimated by Keane et al. (2011) and Conner et al. (In Press). These analyses indicated that the owl population was declining in the pilot project area. However, there was no analysis that attempted to associate the population trend, density, or distribution of owls with treatments or to evaluate them with respect to habitat suitability as required by this monitoring question (see also beyond). The reasons given for not analyzing treatment effects were that such an analysis required both an accurate spatially-explicit map of the treatments and an accurate spatially-explicit map of annual habitat (vegetation) conditions for the entire pilot project area over the entire project period. Such information could have been linked to existing demographic information about the owl. There was a map of treatment locations. We heard two accounts related to the accuracy of this treatment map: 1) it was not accurate with respect to the exact size, boundary, and location of treatments because in most cases no one immediately returned to treatment sites upon treatment completion to delineate the true boundary of the treatments following their completion (John Keane and Claire Gallagher, personal communication 19 March 2013), and 2) that while the map was not perfect, the map was adequate to conduct an analysis of treatment effects (Colin Dillingham personal communication July 2013, Ryan Burnett personal communication 12 July 2013). It is true that when a project was delineated on the ground and entered into a database (see also above); it was also true (in general) that projects sites were not revisited to determine if the actual size, shape and location of the treatment might have deviated from the original project delineation (e.g., modifications are often made in the field when slopes are found to be too steep to log or some other factor precludes rigid adherence to the original boundary). Field verification of the final treatment area would have allowed an accurate depiction of location, size, and shape of treatments. Regardless, if treatment variation was small (i.e., there were relative small deviations between the predicted project areas and the realized project areas) and the analysis was not conducted then the burden of failure to meet this fundamental goal of assessing treatment effects on owls would lie with the owl monitoring team. If the variation between pre and post treatment was great then the burden of failure would lie largely with the general QLG monitoring team. We could not determine which of these scenarios were true. Forest Service personnel attempted to determine the actual boundaries of the treatments after realizing that there were differences between predicted treatments and realized treatments by using field inspections and remote sensing tools (Colin Dillingham, Claire Gallagher personal communication 19 March 2013).

Unfortunately, vegetation regrowth and the long time elapsed since some of the treatments occurred prevented an accurate delineation of treatment size and location retrospectively.

In any assessment of forest fuel treatment effects on wildlife, it is important to account for background changes in vegetation because vegetation can change for reasons other than the treatments. Thus, background changes in vegetation can confound an analysis of treatment effects. That is, an owl could respond to changing vegetation rather than to treatments, but one cannot separate which is responsible if only one is known. Knowing the vegetation composition and changes within an owl territory has been the precursor to understanding spatial variability (i.e., vegetation and habitat variability) of habitat within those territories. This has been a fundamental principle of all spotted owl habitat studies conducted at the landscape scale (e.g., Franklin et al. 2000, Seamans and Gutiérrez 2007). Linking vegetation change (i.e., habitat change) to owl demography, hence assessing potential impacts of treatments, requires a reasonably accurate (≥75% accurate) map of the land cover types within the home range core areas of all owls as well as areas available to the owls.

To that end, following our early recommendations (Pinchot Institute 2008), Forest Service personnel (John Keane, personal communication, 19 May 2013) requested the agency's Remote Sensing Lab (RSL) to create spatially-explicit vegetation maps for the pilot project area because existing agency vegetation (cover-type) maps were not sufficiently accurate to conduct an analysis the effect of vegetation change on California spotted owls. These RSL maps would have served as the basis of assessing vegetation changes at the "landscape-scale." These maps were not created. It was unknown to us whether the RSL simply did attempt to create these maps or attempted to create them but failed. It was evident that several attempts were made by forest supervisors and regional personnel to get the RSL to produce the maps, but there was no adequate response as judged by the fact that there was no map produced (Dillingham 2013a). That the maps were not created was a fact, but the reasons why the RSL did not respond to leadership requests even though RSL knew it was a top priority or why leadership did not attempt to alleviate this situation in some other way was beyond the scope of this report.

The review panel received a summary of potential treatment areas (i.e., the gross area projected for treatment, rather than the actual treatment area [see above]; Ross Gerrard, May 10 2013) within California spotted owl home range core areas. This summary showed that approximately 2.2% of owl territory area received treatment, but these treatments were distributed unevenly among territories. For example, 50 of 200 owl territories received treatments, and of these, 25 territories had less than 5% of their area in treatment, 8 territories had 5–10 % of their area in treatment, and 17 territories had > 10% of their area in treatment (Ross Gerrard in Dillingham 2013a). Such variation among territories with respect to treatments suggested there was opportunity to evaluate the effects of treatments on owls.

Indicator finding: This monitoring question was not answered or addressed even though it was fundamentally important to answer this, and other, essential questions, because accurate maps of treatments and land cover were not created. However, the population dynamics information necessary to conduct such an analysis was collected.

Indicator: (New question derived from original monitoring questions 12 and 13) "What are the associations among landscape fuels treatments and CSO reproduction, survival, and habitat fitness potential at the core area/home range scales?"

Habitat fitness potential is a theoretical construct developed by Franklin et al. (2000) that attempts to depict the relative quality of an owl territory by assigning reproductive output and survival values from all owls occupying that territory over time to that territory. Forest Service personnel collected excellent data on California spotted owl reproduction and survival from 1990-2012, which encompass the pilot project period.

Neither the vital rates (reproduction and survival) nor habitat fitness potential were used to examine "associations among landscape fuels treatments" by Forest Service personnel. Habitat fitness potential was not calculated as required by this monitoring question. The lack of knowledge of treatment size and exact location and the lack of accurate cover type maps (see above) were two of the proximate reasons the associations with California spotted owl reproduction, survival, and habitat fitness potential. As discussed above, the ultimate cause of this failure was unknown and beyond the scope of this review.

Indicator Finding: This objective was not completed because habitat fitness potential was not estimated and accurate maps of treatments and land cover types were not created.

Indicator: (New monitoring question derived from original monitoring question 12)–"What are the associations among landscape fuels treatments and CSO habitat use and home range configuration at the core area/home range scale?"

Forest Service personnel conducted a radio telemetry of study of California spotted owls whose territories had been impacted by treatments, but it was difficult, if not impossible, to draw conclusions about the effects of treatments on "owl habitat use and home range configuration" because the study design was not adequate (this study was neither a case-control experiment, nor a BACI [before, after, control, impact] design; Gallagher 2010). The radio telemetry study had general value because information was learned about California spotted owls foraging in and near areas that had been treated, but a direct link between the treatments and an owl response could not be made.

Indicator Finding: This objective was not accomplished because of an inadequate sampling design.

Indicator: (Modified monitoring question derived from original monitoring question 13) "What is the population trend of CSO in the northern Sierra Nevada and which habitat covariates (including competitors and disease) account for variation in population trend?"

The California spotted owl population trend on the pilot project area was estimated (Keane et al. 2011 and Conner et al. In Press). Both of these reports showed the owl population was declining within the pilot project area. The strongest evidence was provided by Conner et al. (In Press) because they also estimated the probability that this owl population was declining vs. not declining was high. This decline should have motivated a strong desire to understand any links between the decline and the treatments because these declining trends were indications that all was not well with the owl population. However, these trends were not linked to changes in vegetation or to treatments. The reasons for failure to assess environmental impacts were the same as explained above.

Indicator Finding: California spotted owl population trends were estimated, but not linked to vegetation because an accurate map of vegetation was not created.

Indicator: (New monitoring question)–"Are barred owls increasing in the northern Sierra Nevada, what factors are associated with their distribution and abundance, and are they associated with reduced CSO territory occupancy?"

Barred owls are believed to have negative effects on spotted owls (Forsman et al. 2011, Yackulic et al. 2012). Therefore, although this monitoring question does not bear directly on the question of HFQLG project treatments, it would be an important question to evaluate because if a negative association was to be found between treatments and California spotted owls, but barred owls, *Strix varia*, had also invaded the California spotted owl sites, then the effect of the invasions could not be separated from the treatment effect.

Forest Service personnel recorded the presence and location of barred owls and depicted these graphically. There was no attempt to associate the presence of barred owls with California spotted owl territory occupancy.

Indicator Finding: Barred owls were increasing on the HFQLG area, but the factors associated with their distribution, abundance, and relationship to California spotted owls were not analyzed.

Indicator: (New monitoring question)–"Does West Nile Virus affect the survival, distribution and abundance of California spotted owls in the study area?"

Like the invasion of barred owls, West Nile Virus (WNV) had the potential to be a confounding effect when assessing effects of treatments if not accounted for in analyses. West Nile Virus surveillance monitoring was conducted by Forest Service personnel with no WNV antibodies detected in the 209 California spotted owls sampled (Hull et al. 2012). This result did not mean that WNV did not affect California spotted owls, rather it meant that either the sampling could not detect the level of infection that was present or that mortality of owls as a result of WNV infection was so high they all died and, hence, were unavailable for sampling. There was no evidence for the latter situation reported by Hull et al. (2012).

Indicator Finding: The occurrence of West Nile Virus was monitored during the HFQLG project area, but it was not detected.

In summary, the ISP believes that there was potential for evaluating HFQLG pilot project treatment impacts under the proposed questions in monitoring plan, but this was not done. We feel the owl data were adequate to assess these questions because the long-term nature of the Lassen California spotted owl studies should have allowed separation of natural variation from variation due to treatments (Franklin et al. 2004). The basic data were in place to conduct an assessment of treatment effects on owls, but the decision not to use existing treatment maps may have been a fundamental flaw although there is disagreement among Forest Service personnel on this issue. Moreover, the failure to create an updated land cover map was an egregious flaw because it became the major failure in the owl monitoring program. Whose responsibility it was to ensure the map was developed likely was shared among monitoring groups and leadership but it was beyond the scope of our review to determine this responsibility.

Key Finding 7: The HFQLG pilot project successfully implemented measures designed to protect water bodies, but scientific studies could not adequately determine how treatments affect water resources, and the HFQLG pilot project did not protect streams and riparian areas from the impacts of high severity wildfire.

Related Goal: "Minimize the adverse environmental impacts from resource management activities" [RFP Goals]

Indicator: "Riparian systems protection during resource management activities was provided by implementation of the Scientific Analysis Team's (SAT) guidelines." [CSP 4c]

Indicator: (Monitoring Question 5): "Are BMPs implemented during project activities?"

Application and effectiveness of best management practices (BMPs) that target water quality protection are summarized in the BMP summary report for HFQLG 2011. These BMPs include stream course protection (T01), erosion control on active skid trails (T02), landings (T04), logging roads (E08), stream crossing (E09), road decommissioning (E10), use of prescribed fire (F25), and harvesting. BMPs were monitored annually from 2006 through 2011 within the Pilot Project Area (Mitchell-Bruker 2011). These monitoring areas all occur within 300 and 150 feet of perennial and intermittent/ephemeral streams, respectively and include over 70 randomly selected sites per year.

Over six years of monitoring, BMPs were implemented between 90 and 95% of the time from 2006 through 2009, and 100% of the time from 2010 through 2011. Improvements in BMP implementation rates were reported for all practices during the monitoring period. Effectiveness for each BMP was determined based on visual evaluations of surface erosion and sediment deposition in the riparian zone. These assessments identified some lapses in effectiveness, with a trend towards improvement that reached greater than 90% effectiveness for all sites evaluated in 2010 and 2011.

Indicator: (Monitoring. Question 10): "Are springs, seeps, and other small aquatic habitats protected during project activities?"

From 2002 through 2007, 158 treatment units were monitored to determine whether or not special aquatic features, including springs, seeps, and other small aquatic habitats were identified during NEPA review and protected during implementation of treatments. Overall, the Special Aquatic Habitats Monitoring report for 2007 indicated 100% identification and protection of these habitat types (Dillingham et al. 2007).

Indicator (Monitoring Question 6): "Do activities meet soil quality standards?"

Soil monitoring methods and standards for comparison used Forest Service published methodologies, including soil cover, large woody debris, detrimental compaction, and detrimental displacement of topsoil. Treatments resulted in some reduction in soil quality, based on the Forest Service soil quality standards, particularly in the loss of large woody debris from treated sites.

Soil ground cover (from USDA 2012a)

Soil ground cover changes associated with treatments were minor. There was a 4% net decrease in the number of areas meeting soil ground cover standard once treated. The change post treatment was greatest with group selection, which involves more focused on-the-ground activity than other treatments (20% vs. <2% for other treatments).

Retention of large down woody material (from USDA 2012a)

The largest effect on soil characteristics associated with resources management was reduced down woody material, data showing a 40% decrease in the number of treated sites meeting the large woody debris standards post-treatment. Group selection had a much greater effect on large woody material than thinning. After thinning treatments 59% of the units met large woody debris standards, whereas after group selection 13.6% of the units meet the standards. Moreover, in areas treated with group selection there was an increase from 39% to 55% of the sites having no large woody debris.

Important information on natural variability of large woody debris was produced through monitoring efforts. For example, only 71% of the monitored units met the standards prior to treatment. Natural variability and legacy effects accounted for lower amounts of large woody debris in 29% of the sites. Sources of variability, including upland vegetation type (east vs. west side conifer) could be incorporated into future monitoring plans, data analysis, and thresholds of concern. Retaining large woody debris onsite post-harvest is also a matter of working with operators that tend to leave a "clean site."

Soil compaction (from USDA 2012a)

Treatment monitoring revealed that nearly 2/3 (64%) of the sites had compacted soils prior to treatments. Treatments resulted in a 10% increase in detrimental compaction, with a slightly greater increase for group selection (13.6%) than for thinning (9.6%) treatment areas. Thus, the cumulative historical effects of management activities on compaction were widespread and expected to increase with on-going treatment. Project-related soil compaction was partially ameliorated by sub-soiling (tilling or breaking up top soil) in a subset of the compacted sites. More group selection than thinning sites were subsoiled, reducing the overall compaction effects of that treatment type.

Topsoil displacement (from USDA 2012a)

Litter, woody debris, and rocks overlying the soil protect the soil from surface erosion and soil loss. Overall, 12% of the post-treatment sites monitored showed soil displacement in over 15% of the area, which is a benchmark informally set in the Forest Service Status Reports to Congress (U.S. Forest Service 2012). A higher percentage of thinning versus group selection sites met this standard following treatment (96% versus 77%).

Indicator: (Monitoring Question 17) "What is the effect of activities on indicators of watershed condition?"

The HFQLG pilot project did not generate enough scientific information to address effect of activities on watershed condition. The monitoring program relied on indirect measures that have generally been shown to be poorly correlated to real effects (Beschta et al. 2000 Scherer 2001). Information used to measure treatment effects on watershed condition included road density, near stream road density, Equivalent Roaded Acres (ERA), near-stream ERA, and number of road /stream crossings. These were chosen based on the assumption that they are correlated with hillslope erosion and sediment loading to the channel (USDA 2007).

These metrics, including ERA and road density, are poor indicators of important impacts (Beschta et al. 2000 Scherer 2001) because the linkage between ERA, roaded area, and sediment impacts is highly dependent on more specific attributes that are often not documented or included in the calculation of ERA. Moreover, these indicators are indirect measures of key factors that affect watershed health (e.g. mapped roads could be a cause for sediment impacts, but not the impact itself), are redundant (e.g. ERA and road density), and do not reflect variable levels of sensitivity among watersheds to road and ERA-related impacts (e.g. granitic vs. volcanic areas respond differently to soil disturbing activities yet roaded area would be reported the same under both geologic types). Predicted change in ERA resulting from planned road treatments was 5.1 to 6.3%, assuming full project implementation. This represents a 1.2% change, which is well below the 13% ERA threshold of concern (Hoffman 2011). Near-stream ERA was predicted to increase from 4.4% pre-treatment to 4.7% post-treatment, assuming full implementation of treatments, which was also below the threshold of concern (Hoffman 2011).

Forest Service personnel presented stream condition inventory (SCI) monitoring results as empirical corroboration of the linkage between the ERA findings and actual effects (Hoffman 2011). However the SCI analysis would need to be stratified by key landscape characteristics that affect erosion and sediment delivery (e.g. parent material, topography, vegetation cover) and include a much larger number of samples per stratum, to determine 'significant' management effects and provide corroboration.

The Forest Service Watershed Effects report (Hoffman 2011) presents Equivalent Roaded Area (ERA) and road density data as indicators of watershed effects associated with resource management activities. They also suggest that SCI results provide additional evidence that these effects had minimal effect on watersheds. SCI monitoring results from treated sites in the HFQLG pilot project area indicated limited impacts on streams (Mayes and Roby 2013). Similarly, predicted ERA values are below threshold of concern (Hoffman 2011). However there was no correlative relationship established for these two data sets. The fact that the ERA includes a large percentage of planned but not implemented actions and the paucity of field data within landscape strata invalidates attempts to broadly apply SCI findings to the greater areas covered by the ERA analyses. Moreover, the ERA estimated sediment impacts depend upon specific attributes that are often not included in the ERA database (Beschta et al. 2000, Scherer 2001). These indicators are indirect measures of watershed health (e.g. mapped roads could cause sediment impacts, but are not the impact itself), are redundant (e.g. ERA and road density), and do not reflect variable levels of sensitivity among watersheds to road and ERA-related impacts (e.g. granitic vs. volcanic areas respond differently to soil disturbing activities, yet roaded area would be reported the same under both geologic types).Thus, while the SCI data provide real information on site-specific channel effects, the efficacy of using ERA and road density data to monitor resource treatment effects at the watershed scale remains unsubstantiated by actual effects data.

Indicator: (Monitoring Question 18) "How do stream attributes (channel, riparian, macro-invertebrates) change over time?"

Indicator: (Monitoring Question 19): "What is the trend in channel and riparian attributes and macroinvertebrates in sub watersheds with the highest concentration of HFQLG activities?"

The relatively small number of samples, relative to the natural range of variability, limits the usefulness of SCI monitoring results to interpret treatment effects on streams. Treatments were allocated to four treatment types, as well as wildfire (Mayes and Roby 2013). Effects of these activities on three types of channel and riparian attributes were monitored and reported upon for the Pilot Project area in a total of 31 sites (Table Ia). The largest treatment group had 16 sites, while most had five or fewer, as summarized in Table Ia (Mayes and Roby 2013).

Table Ia. Values shown in each cell reflect the number of sites monitored (the number of sites for which negative impacts were reported). (Mayes and Roby 2013)

Types of effects (columns) Treatments (rows)	Sedimentation	Macro-invertebrates	Shade	Stream Temperature
DFPZ Fuel thinning (various methods)	16 (5)	10 (1)	16 (2)	2 (0)
Aspen Enhancement	5 (2)	2 (0)	4 (1)	2 (1)
Road, landing, culvert decommissioning	4 (3)	2 (2)	0 (0)	1 (0)
Stream/ Meadow Improvement	4 (2)	2 (1)	4 (1)	0 (0)
Wildfire	2 (2)	2 (1)	2 (2)	2 (1)
Reference streams: Response reaches	5	5	5	2
Reference streams: Transport reaches	10	10	10	2

Under the HFQLG pilot project, stream condition monitoring before and after treatments occurred at sixteen sites and indicated that treatments could negatively impact channel sediment and morphology (Mayes and Roby 2013). These impacts included increased pool fines, decreased pool depth, and/or decreased channel shade. However, these effects occurred only part (<50%) of the time, and were small and/or short-lived (<2y) (Mayes and Roby 2013).

The effect of treatment on aquatic invertebrate assemblages was apparently relatively modest and infrequent. This finding was based on SCI assessments, which showed significant effects for only one out of two measures at one of the ten sites (Mayes and Roby 2013). Longer-term aquatic invertebrate monitoring data were reported for three sites and including one year pre- treatment and 4- 5 years post-treatment, and revealed no consistent trends and had high coefficients of variability (Mayes and Roby 2013).

Shade associated with adjacent upland and streamside vegetation remained unaffected or only briefly affected by vegetation management. There were significant and short-lived decreases in shade reported for two of sixteen sites monitored sites following treatments (Mayes and Roby 2013). Stream temperatures were only monitored at two sites, neither of which showed significant effects associated with treatments, even though one of the two had a significant reduction in riparian shade (Mayes and Roby 2013). Long-term monitoring on reference reaches demonstrated that ground water inputs can be more important than shade along some transport reaches (Mayes and Roby 2013).

SCI monitoring suggested that some impacts could occur in channels associated with aspen restoration projects. Aspen restoration, which involved near stream conifer removal, was associated with increased in-channel fine sediment (<2mm) following treatment in two of five sites monitored (Mayes and Roby 2013). Stream temperatures were affected in one of four aspen restoration sites monitored. Aquatic macro-invertebrates were only measured at two of these sites, with no pre- and post-treatment differences. One of these sites was monitored over six years, but no trends were apparent (Mayes and Roby 2013).

Road, landing, and culvert decommissioning resulted in increased fine sediment inputs at three of five sites monitored, and initial impacts on macro-invertebrates were reported for the two sites monitored (Mayes and Roby 2013). There was an observed recovery from these impacts the following year. Meadow restoration activities affected channel sediment in two of the four sites and aquatic macro-invertebrates in one of the two sites where measured (Mayes and Roby 2013).

Four years of pre- and post-fire SCI monitoring of Moonlight and the Cub Creek fires revealed large and significant increases in pool tail fines for either one or two years following the fires (two for Cub, one for Moonlight; Mayes and Roby 2013). In addition, residual pool depths decreased the first year following the Moonlight fire (Mayes and Roby 2013).

Data and field observations made during SCI monitoring suggested possible explanations for apparently opposite responses in the riparian areas within the Cub Creek and Moonlight Creek fires. Macro-invertebrates indices declined the second year following the Cub Creek fire, which suggested the changes could be associated with the increased fines reported for that year (Mayes and Roby 2013). Mayes and Roby (2013) cited the high percentage of species preferring these substrates in the year two post fire sample. Macro-invertebrate indices of diversity and reach condition increased following the Moonlight Fire, which the authors suggested could be associated with the observed increase in food resources provided by the flush of deciduous hardwoods (willow) cover in the riparian zone following the fire (Mayes and Roby 2013). Again, pre-fire variability was high, and that opposite responses could also be explained underscores the complexity of system responses to fire and the need long term data to better understand management effects.

Long-term monitoring of stream condition at reference sites was also reported by Mayes and Roby (2013). (Table Ia). This study was divided into five response reaches and ten transport reaches based primarily on differences in channel gradient (Mayes and Roby 2013). Monitoring spanned sixteen years and included 2 to 9 repeat samplings of the most SCI indicators (see Table 1a), with 3 to 5 repeat sample years being the most common. SCI scores for each reference reach showed large inter-annual variability for some of the metrics as well as differences between transport vs. depositional reaches (Mayes and Roby 2013). In particular, high inter-annual variability was typical of the BI macro-invertebrate index, whereas shade was less variable among years. Direct linkages between findings on the reference vs. management reaches were not explicitly included (Mayes and Roby 2013). For example, based on these reference site SCI data, natural variability of many of these attributes were very high, and monitoring could have been restructured (e.g., stratify, include covariate measurements, and/or increase number of samples) in order to ensure that the monitoring results were sufficiently sensitive to minimum detectable changes in condition (Elzinga et al. 1998).

Key Finding 8: Protection measures, management strategies, and monitoring activities helped reduce some adverse environmental impacts. Other impacts, including to some species of concern, were uncertain because scientific evaluations were uneven, ineffective, or not completed.

Related Goal: "Minimize the adverse environmental impacts from resource management activities." (RFP Goals)

HFQLG Act Scientific Panel Guidance Act Panel Guidance states [Act k2]: "The report shall include, but not be limited to, the following: (A) A description of any adverse environmental impacts resulting from implementation of the pilot project."

Vertebrates

Indicator: (Monitoring Question 15): "Is there a change in forest carnivore habitat or forest carnivore abundance and distribution?"

One original objective of the 1999 FEIS Monitoring Strategy was to document changes in the amount and distribution of suitable marten and fisher habitat (USDA 1999). This objective was modified in the current Implementation Monitoring Plan as follows: "Develop a consistent definition of suitable habitat for martens in the HFQLG analysis area to be used to track changes in habitat suitability and monitoring changes in population distribution and abundance."

The American marten (*Martes americana*) was chosen as the forest carnivore of interest for this monitoring question because it was a management indicator species. In the Phase One Report (Pinchot Institute 2008), we recommended that Forest Service personnel revise the monitoring and research direction to explicitly address questions relevant to the HFQLG Act. For example, the marten is a species that is dependent on mature conifer forest so treatments have the potential to reduce the canopy cover, which, if this occurred, might expose martens to predators or result in a reduction of prey habitat (Zielinski 2013). We recommended the monitoring team ask questions such as "Does DFPZ implementation negatively affect the stand structure and arrangement required for marten habitat connectivity corridors or reproductive habitat?"

Zielinski et al. (2011) found differences in habitat use during summer and winter by martens. This finding required modification of habitat models that were developed based on winter data. Documenting the amount and distribution of marten habitat can be facilitated using validated predictive habitat models. To this end, the HFQLG monitoring team contracted with Forest Service PSW (W. Zielinski) to sponsor a graduate student at Oregon State University (K. Moriarty) to evaluate the effectiveness of existing habitat models that predict marten occurrence (USDA 2011). Additional objectives of this research included: estimating the types of openings in managed forests through which martens will move; determining the barriers to marten movement; evaluating micro-site features; and assessing potential interspecific interactions that influence marten movement (USDA 2011).

Marten populations in the northern Sierra Nevada have been linked to sites having the largest amount of dense, old forest which is considered to be the best reproductive habitat (Zielinski 2013). Given this association with old forest, evaluating impacts of treatments on this habitat type was necessary to evaluate risk to marten. The HFQLG ROD (USDA 1999) required no more than a 10% (compared to 1999 baseline) reduction in suitable habitat for old forest-dependent species. The loss of old forest as a result of HFQLG treatments was limited to 2.2% during the implementation period relative to the 1999 baseline (Dillingham 2013). Wildfire removed 15.5% of old forest relative to the 1999 baseline (Dillingham 2013). The small percentage of old forest lost as a result of treatments suggested that there was a low risk of impact on marten abundance and distribution at the level that implementation occurred. However, the evaluation of the ultimate impacts will depend on an assessment of the habitat loss when all planned implementation has occurred, not only in terms of total old forest loss but also the pattern (e.g., effects on habitat connectivity). Such an evaluation on long-term impacts will be most efficiently accomplished using predictive habitat models. The research and model development were ongoing at the time of our review and, thus, were incomplete at the conclusion of the HFQLG pilot project. Consequently, we were unable to determine if adverse impacts resulted from HFQLG pilot project treatments on the American marten, an old-forest associated species of concern.

Indicator: (Monitoring Question 16) "How do selected vertebrate species respond to resource management activities?"

Landbirds were chosen by Forest Service personnel to monitor vertebrate response to treatments. The landbird monitoring effort within the HFQLG pilot project area was conducted under the auspices of the Plumas Lassen Administrative Study (PLAS) by PRBO Conservation Science (Sierra Nevada Group) (now known as "Point Blue"). PRBO had been conducting landbird monitoring in the Almanor Ranger District for several years prior to the initiation of HFQLG pilot project and was well-qualified to conduct this research. PRBO compared bird species richness and abundance following treatment (from 2-6 years) to pre-treatment and untreated reference sites. Treatments included the three primary silvicultural prescriptions under the HFQLG pilot project: 1) group selection; 2) shaded fuel breaks (i.e., DFPZ); and 3) pre-commercial thinning.

Analysis of forest bird response to prescriptions showed little effect of treatment on the number of different species (species richness) in the first five years following treatment as compared to untreated sites (Burnett et al. 2012a). There were general decreases in the abundance of mature-forest closed-canopy species and increases in the abundance of species associated with edge and open forest conditions. This result would be expected based on the observed changes in forest structure although the overall magnitude of individual species responses to treatment was small. When species were combined into habitat guilds, the abundance within each guild showed little change as a result of shaded fuel breaks. For group selections there was weak evidence of a decrease in abundance for canopy species, an increase in abundance for understory species, and no change in abundance for edge species as a result of treatments. Abundance of canopy and understory species showed slight decreases following pre-commercial thinning treatments; there was no observed change for edge species following pre-commercial thinning. The PRBO study results were consistent with a recent meta-analysis of the effects of fuel reduction treatments on birds in fire-prone forests. This analysis showed that 88% of impacts on bird and small-mammal species were either neutral or positive (Fontaine and Kennedy 2012).

The riparian restoration component of the HFQLG pilot project included restoration of quaking aspen (*Populus tremuloides*) and meadow habitats. From 2004-2011 PRBO conducted a study of the responses of landbirds to restoration projects implemented under the HFQLG pilot project within these two habitats (Campos and Burnett 2012). Campos and Burnett (2012) found that the focal species within the avian community generally responded positively or neutrally following restoration (based on 10 years of post-treatment data). None of the 11 focal species responded negatively over the long-term. Meadow restoration at one site using the plug and pond technique resulted in significant increases in focal meadow bird abundance and species richness 2- 6 years post restoration compared to adjacent untreated control sites.

The collaboration between PRBO and Forest Service personnel was an example of effective collaboration to acquire critical information for adaptive management. Both PRBO and Forest Service personnel were responsive to the analytical needs of the HFQLG pilot project and the recommendations made in the 2008 Phase One report (Pinchot Institute 2008).

Indicator: (Monitoring Question 22) "Do amphibians persist at currently occupied sites?"

Forest Service personnel collected data from 2000-2008 to answer the amphibian monitoring question that was posed in the FEIS (USDA 1999). That question was "Do amphibians persist at currently occupied breeding locations?" As we identified in our Phase One report, the monitoring question and the subsequent sampling methods were not appropriate because they did not provide the Forest Service with the data necessary to evaluate project-level effects within the timeframe of the study (Pinchot Institute 2008). Indeed, the Final Amphibian Monitoring Report states: "Initially, monitoring efforts to answer this question began in the year 2000 and were carried forward every two years through 2008 utilizing a survey method that was based on presence or absence of Forest Sensitive frog species as defined by the Regional Forester in the Region 5 Sensitive Species List. These surveys were located at current and/or historical locations where Cascades frogs (*Rana cascadae*), foothill yellow-legged frogs (*R. boylii*), and Sierra Nevada yellow-legged frogs (*R. sierrae*) occurred, although these surveys [sic] locations were not necessarily located within HFQLG projects areas and in most cases did not assess impacts of HFQLG activities" (Foote et al. 2013).

In 2009 the monitoring team abandoned its original monitoring strategy and began implementing a new strategy that included monitoring the abundance of Sierra Nevada yellow-legged frog populations that occupied habitat within or directly adjacent to treatments proposed for implementation between 2009 and 2011 (Foote et al. 2013). Four sites met this criterion (Foote et al. 2013). However, none of the treatments were completed between 2009 and 2011 (Foote et al. 2013). As a result, Forest Service personnel were unable to assess the effects of the treatments on resident frog populations.

All Sierra Nevada yellow-legged frogs detected during pre-treatment monitoring were located in, or immediately adjacent to (≤ 0.5 m), aquatic habitat (Foote et al. 2013). These observations were consistent with other studies (Mullally and Cunningham 1956). Because HFQLG treatments rarely occurred in or immediately adjacent to aquatic habitats (i.e., where frogs were detected), we believed the potential for direct impacts to Sierra Nevada yellow-legged frogs (e.g., through crushing) was minimal. However, Sierra Nevada yellow-legged frog populations may have been indirectly affected by increased sedimentation, reduced canopy cover, and other changes in habitat due to treatments (Foote et al. 2013). Little is known about the ecology of the Sierra Nevada yellow-legged frog in the northern part of its range (which includes the pilot project area; Foote et al. 2013). This lack of knowledge includes the relationships between habitat variables (e.g., water temperature) and population parameters (e.g., survivorship) (Foote et al. 2013). Until these relationships are better understood, one can only speculate how management actions, or lack thereof, affect the Sierra Nevada yellow-legged frog.

The Sierra Nevada yellow-legged frog population has declined precipitously and it has been extirpated from approximately 93% of the sites where it once occurred (Vredenburg et al. 2007). The species attained a “warranted but precluded” finding under the Endangered Species Act; it is a candidate for listing as threatened under the California Endangered Species Act. There was a lack of scientific data about the Sierra Nevada yellow-legged frog (and other sensitive amphibian species) on the Plumas, Lassen, and Tahoe National Forests. Thus, although the Forest Service was unable to examine the effects of HFQLG pilot project treatments on sensitive amphibian species, it collected valuable ecological data about Sierra Nevada yellow-legged frogs and their habitat. These data (albeit limited in some instances) included:

1. Presence or absence of Sierra Nevada yellow-legged frog and other amphibian species in many locations.
2. The survival rates and relative abundance of frogs at sites where they were detected.
3. Observations of habitat use.
4. Site fidelity and movement data.
5. The presence and relative abundance of the fungal pathogen *Batrachochytrium dendrobatidis* within Sierra Nevada yellow-legged frog populations at study sites.

This information enhances scientific knowledge of the species; serves as a baseline for future monitoring studies; and informs future resource management decisions. For example, chytridiomycosis is an infectious disease caused by the fungal pathogen *Batrachochytrium dendrobatidis* (Bd). Chytridiomycosis is directly linked to the recent extinction or serious decline of hundreds of amphibian species, including the Sierra Nevada yellow-legged frog (Vredenburg et al. 2010). Information on the prevalence of Bd among Sierra Nevada yellow-legged frogs in the study areas provides insight into Bd dynamics and potential conservation strategies.

The predaceous and competitive habits of the invasive American bullfrog (*Lithobates catesbeianus*) are well-documented. The extent to which bullfrogs have affected native species remains unknown, but bullfrogs are probably at least partially responsible for the decline of several native species of frogs, turtles, snakes, and waterfowl (Hecnar and M'Closkey 1997, Fuller et al. 2011).

The HFQLG pilot project involved "pond and plug" treatments, which were designed to reconnect a stream channel with a functioning floodplain and to restore a degraded meadow's water table to its historic level. Forest Service personnel conducted a study that determined bullfrogs were 16% more likely to be present at sites with pond and plug treatments than at untreated sites (Dillingham 2011). However, the study had several limitations that may have affected the reliability of the results. These limitations included a small sampling size, low sampling intensity, a sampling design that was not balanced with respect to treatment-control samples, and several potential sources of sampling bias. Nevertheless, the study suggested the benefits of the pond and plug restoration treatments should be weighed against the adverse effects associated with enhancement of habitat that is favorable to bullfrogs because it appeared this particular restoration activity inadvertently increased habitat suitability for invasive bullfrogs.

Botanical Resources

Botanical monitoring for the HFQLG pilot project focused on two issues: (a) Threatened, Endangered, or Sensitive Plants (TES); and (b) noxious weeds. For each of these two issues, Forest Service personnel conducted "implementation" and "effectiveness" monitoring. Implementation monitoring was conducted to determine if mitigation measures associated with HFQLG treatments were accomplished. Effectiveness monitoring was conducted to determine how treatments affected TES plant species and noxious weeds.

Threatened, Endangered, and Sensitive Plant Species

Indicator: (Monitoring Question 7) "Were Threatened, Endangered and Sensitive (TES) plants surveyed and protected?"

Implementation monitoring was conducted to evaluate whether the HFQLG pilot project met land management objectives. The land management objectives for TES plant species were to manage habitats and activities to achieve recovery for threatened or endangered plant species and to manage sensitive plant species so they do not need to be listed as threatened or endangered under the Endangered Species Act (USDA 1999).

The Final Environmental Impact Statement (FEIS) for the HFQLG pilot project established standard management practices to promote these objectives (USDA 1999). The FEIS identified the management practices as: "Rare plant surveys are conducted prior to site-specific project-level planning. Protection measures are implemented for individual occurrences, as needed. Other recommendations and mitigation measures in the Biologic Assessment/Biologic Evaluation (BA/BE) and botany reports are followed." (USDA 1999). The HFQLG pilot project met the management standards established in the FEIS. Surveys for TES plant species were conducted for each project (M. Coppoletta, K. Bovee, J. Belsher-Howe and S. Urie, Forest Service, personal communication). Qualified botanists conducted the surveys according to professional standards for TES plant surveys. Surveys on the Plumas National Forest were conducted according to the Plumas National Forest Rare Plant Handbook. Surveys on the Lassen and Tahoe National Forests were conducted according to survey guidelines established by the California Native Plant Society (CNPS 2001). When TES plant species existed within project boundaries, Forest Service personnel developed a "Plant Protection Plan" that outlined measures to mitigate potential adverse effects to TES species. Mitigation measures for treatments included complete avoidance of all TES plants, avoidance of "core" populations only, or no protection measures, depending on professional opinion about the measures needed to conserve each particular TES species. Areas designated for avoidance (i.e., no disturbance) were referred to as "control areas."

Although Forest Service personnel attempted to protect all TES control areas, they concluded an acceptable threshold for success would be 90% of the control areas protected. Protection of TES control areas was determined through: (1) a review of project records to determine if project maps correctly identified the control areas; and (2) a post-project field review to determine if measures outlined in the plant protection plans were actually implemented. The HFQLG pilot project met its goal of protecting at least 90% of the TES control areas during 5 out of 10 years of the pilot project (Table Ib). Overall, 86% of the control areas were protected as planned. Control areas that were not protected as planned were due to:

1. Turnover of personnel (2002, 2003).
2. Inadequate mapping (2002, 2003, 2004).
3. Completion of the project Biologic Evaluation before TES plant surveys were completed (2002, 2003).
4. Missing or inadequate Plant Protection Plan (2002, 2003, 2004).

5. Insufficient communication among botanists, project administrators, and contractors (2002, 2003, 2004, 2007, 2009).
6. Control areas never explicitly designated or identified on the contract map (2010, 2011).
7. Control areas insufficiently flagged at time of treatment (2002, 2003, 2004, 2005, 2007).
8. Insufficient buffer around control area (2010).
9. Contractor error (2003, 2004, 2005, 2008) (USDA 2002 through 2011).

Instances when control areas were not protected as planned often resulted in direct impacts to the TES plants within the control areas. The impacts ranged from severe (e.g., plant occurrence eliminated) to beneficial (e.g., plant abundance increased). However, even though there were a few instances of severe impacts to plants within a control area, none of those instances jeopardized the overall viability of that TES plant species on the three national forests (M. Coppoletta, S. Urie, and C. Dillingham, Forest Service, personal communication).

Table Ib. Success rate in protecting control areas for TES plant species (Forest Service 2012: Table 2).

Year	Number Control Areas monitored	Percent of Control Areas successfully protected
2002	9	89%
2003	29	59%
2004	26	88%
2005	31	77%
2006	28	100%
2007	30	93%
2008	16	81%
2009	15	93%
2010	15	93%
2011	25	92%
Total	**224**	**86%**

Indicator: (Monitoring Question 28a) "How do TES plant species respond to resource management activities?"

The objective of the effectiveness monitoring for TES plant species was to: "Assess impacts of resource management activities on threatened, endangered, and sensitive plant species" (USDA 1999). During the first several years of the monitoring program Forest Service personnel relied on qualitative and anecdotal information to assess the effects of treatment activities on TES plant species. Because the assessments were not designed to determine causal relationships, Forest Service personnel were unable to generate reliable conclusions about the effects of treatments on TES plant species.

In 2006, Forest Service personnel began preparing study plans for several TES plant species known to occur in proposed treatment areas. Since then, the Monitoring Team has conducted quantitative studies on nine TES species:

1. Lens-pod milk-vetch (*Astragalus lentiformis*) (Crawford et al. 2010)
2. Webber's milk-vetch (*A. webberi*) (Merriam et al. 2012)
3. Constance's rock cress (*Boechera constancei*) (Coppoletta 2010a)
4. Butte County fritillary (*Fritillaria eastwoodiae*) (Janeway and Christofferson 2010)
5. Quincy lupine (*Lupinus dalesiae*) (Coppoletta 2012)
6. Follett's monardella (*Monardella follettii*) (Coppoletta 2010b)
7. Layne's ragwort/butterweed (*Packera layneae*) (Merriam 2012)
8. Closed-throated beardtongue (*Penstemon personatus*) (Coppoletta et al. 2012)
9. Long-stiped campion (*Silene occidentalis* ssp. *longistipitata*) (Dillingham and Bovee 2012)

Each of these species was listed as "Sensitive" by Region 5 of the Forest Service, except Layne's ragwort, which was listed as "Threatened" by the federal government and "Rare" by the State of California.

We concur with the conclusion of Forest Service personnel that most of the species studied exhibited either a neutral or positive response to treatments. Indeed, the only species that exhibited a negative response to treatments was Layne's ragwort. Specifically, during the two years following treatment (a prescribed burn) there was a significant increase in the number of flowering Layne's ragwort plants in the control plots, but not in the treatment plots (Merriam 2012). This suggests treatments may have affected the reproductive potential these species.

The studies conducted on the nine TES species incorporated statistical analyses to evaluate the response of each species to treatments. However, each study had one or more statistical limitations that may have affected the reliability of the results. These limitations included: 1) small sample size; 2) insufficient number of control sites; 3) non-random sampling design; 4) low statistical power; 5) inability to partition potential treatment effects from natural variability; and 6) potentially inappropriate sampling methods. Some of these limitations were likely due to the failure to develop and implement rigorous study plans during the first several years of the pilot project. Nevertheless, the studies provided some valuable empirical data pertaining to each species' ecology and response to treatments.

Indicator: (Monitoring Question 28b) "Did new occurrences of TES plant species occur during or following project implementation?"

Forest Service personnel did not detect any new occurrences of TES plant species following treatments implemented under the HFQLG pilot project. However, they detected a significant increase in the density or abundance of several pre-existing TES plant species populations that were in treatment areas. These increases were expected because these particular species are typically associated with open or disturbed sites (USDA 2012).

Indicator: (Monitoring Question 8) "Were noxious weed introductions prevented and existing infestations suppressed?"

Indicator: (Monitoring Question 29) "Were existing infestations of noxious weeds eliminated or contained?"

The objectives for noxious weeds management were to prevent new infestations of noxious weeds and to contain or suppress any existing infestations (USDA 1999). The FEIS for the pilot project established standard management practices that should be implemented to promote these objectives (USDA 1999). The management practices were to: 1) complete site-specific noxious weed inventories for each proposed project; 2) treat existing weed infestations within or adjacent to project areas; 3) implement equipment cleaning measures for all projects; 4) ensure all imported materials were from weed-free sources; and 5) use staging areas that were weed-free (USDA 1999).

We concluded that Forest Service personnel implemented the management practices established in the FEIS. At most project sites, pre- and post-project inventories for noxious weeds were completed; noxious weed mitigation measures were implemented; and equipment was cleaned prior to entering the project sites (USDA 2012 and Table 3 therein).

Indicator: (Monitoring Question 30) "Were all new infestations of noxious weeds eliminated or did some become established?"

Indicator: (Monitoring Question 31) "Did new infestations of noxious weeds occur during or following project implementation?"

Treatments resulted in new infestations of noxious weeds, and once established, the relative cover of several weed species generally increased over time (USDA 2012, C. Dillingham, Forest Service, personal communication). This was predictable because ground disturbance will create suitable conditions for the colonization or spread of invasive weed species (USDA 2012).

There were several reasons that precluded us from being able to quantify the extent to which treatments increased the presence, abundance, and distribution of weed species. First, post-treatment weed monitoring was limited to treatment units that had specific mitigation measures for weeds (e.g., excluding equipment from established weed populations to limit the spread of weeds) (USDA 2012). In some instances, weed monitoring was limited to treatment units that contained TES plant species (USDA 2004). As a result, Forest Service personnel did not examine many of the sites to determine whether weeds had become established after treatments. Second, analysis was limited to sites that had prescribed eradication or control measures; it excluded sites with large weed populations that could not be treated feasibly or that contained species that are not actively managed by the Forest Service (USDA 2012, C. Dillingham and K. Bovee, Forest Service, personal communication). Third, the noxious weed monitoring that was conducted for the pilot project did not include control plots. This made it impossible for us to determine the extent to which new infestations were due to treatments versus other causes (e.g., grazing).

Forest Service monitoring data suggested approximately 24% of the HFQLG treatment units had new infestations of noxious weeds following treatment (USDA 2012). Although Forest Service personnel were confident treatments resulted in new infestations of noxious weeds and that weed cover generally increased over time, inconsistent sampling methods may have inflated these results (C. Dillingham, Forest Service, personal communication).

Most of the new infestations were comprised of widespread species that are very difficult (arguably impossible) to eradicate (C. Dillingham, Forest Service, personal communication). For example, cheatgrass (*Bromus tectorum*) accounted for approximately 75% of new infestations (USDA 2012). Cheatgrass is a species that is not actively managed by the Forest Service. Other invasive species documented within treatment units included Klamath weed (*Hypericum perforatum*), bull thistle (*Cirsium vulgare*), yellow star thistle (*Centaurea solstitialis*), medusahead (*Taeniatherum caput-medusae*), and Scotch broom (*Cytisus scoparius*)(USDA 2012).

In summary, we concur with Forest Service personnel that, in general, aggressive actions prior to and throughout project implementation were successful in eradicating small populations of noxious weeds, but these actions were less successful in eradicating large populations and species that were highly invasive and difficult to treat (USDA 2012).

Smoke Management

Indicator: (Monitoring Question 9) "Were the provisions of the smoke management plan implemented?"

With the exception of the three violations of smoke management plans noted in USDA 2012 (USDA 2012, Table 18, pg. 30), the provisions of the smoke management plans implemented under the HFQLG pilot project were met for nearly 79,000 acres that were burned during the pilot project between 2001-2010. However, between 2002 and 2003, only the Plumas National Forest reported acres burned (i.e., there were no data reported for Lassen and Tahoe). We noted that after violations of the smoke management plan, the Northeast Air Alliance (NEAA) developed a "Pre-Burn Communication Operating Plan.," This operating plan improved communication and coordination between Forest Service personnel and Air Quality Control specialists in the region (USDA 2007). This coordination effort was successful as noted in the 2011 HFQLG Report to Congress:

> "The absence of violations or complaints in the past 5 years can be explained by implementation of an adaptive management strategy outlined in the 2006 report to Congress. Extensive coordination and communication of prescribed burn activities between ranger districts, air districts, and the public was initiated to address the large increase in smoke issues culminating in 2005. This included public contact, which consisted of phone calls, press releases, door-to-door visits, and public information booths set up near burn project sites to directly answer questions and address concerns from the public. This strategy has been shown to be very effective in addressing smoke management issues in the pilot project area." (USDA 2012)

Indicator: Monitoring Question 26) Do prescribed fire activities meet air quality standards?

With the exception of four violations of air quality standards, the provisions of the smoke management plans implemented under HFQLG projects were met over the nearly 79,000 acres that were burned between 2001 and 2010. The absence of air quality violations after 2006 was likely attributable to improved coordination between fire management and air quality specialists within the Northeast Air Alliance.

Indicator: (Monitoring Question 27) Do prescribed fires create a nuisance in terms of air quality?

Between 2001 and 2010, there were 28 (21 of which occurred form 2001-2005) reported complaints related to smoke from pile and underburning treatments. It is important to note, that more than half of these complaints occurred in relation to just two burns (The Mabie Pile Burn and the Greenflat Underburn Projects) (USDA 2007). After implementation of pre-burn communication operation plan, which facilitated coordination efforts between fire management personnel and air quality specialists, complaints dropped to seven in 2006 and none between 2007 and 2010.

Key Finding 9: The HFQLG pilot project expanded and supported existing wetland and riparian restoration activities, but did not implement a new program of water resource protection and management as referenced by the HFQLG Act.

Indicator: Number of riparian/meadow acres restored on Forest Service lands

Over the HFQLG pilot project period, approximately 10,327 acres of riparian areas were restored, 115 miles of road within the riparian zone and 62 road-channel crossings were eliminated, and 87 road crossings were restored throughout the HFQLG pilot project area (Table Ic). The restored acres included meadow restoration and enhancement, stream channel improvement, road relocation and road closure where roads were within the riparian zone, slope stabilization, and aspen enhancement. During 2010, 4,741 acres were restored; this number was over four times greater than that reported for other years because it included post-fire plantings in the burned riparian zones of the Moonlight fire area (Colin Dillingham, pers. comm. with Amy Merrill 5/9/2013).

Hoffman (2011) indicated that funding for road obliteration derived from the HFQLG pilot project budget (including sale activities) limited the number of planned road obliterations that were actually implemented.

Table Ic. Riparian restoration projects per year of the HFQLG pilot project through 2011, including acres reported restored in the HFQLG pilot project area, miles of road eliminated, and stream crossings eliminated and restored. *Information is based on values in Table 5, USDA 2011 – Status report to congress, and FY 2010 to 2003 Status reports to congress. Reports for FY 2000-2002 were not available. Total for FY 2010 acres restored includes projects funded through the American Recovery and Reinvestment Act, which includes post-fire riparian plantings, especially in the Moonlight fire area.*

FY	Projects (#)	Acres restored	Road Miles eliminated	Road crossings eliminated	Road crossings restored
2011	9	226	6	2	3
2010	18	4,741	4	6	28
2009	5	680	1	2	3
2008	14	375	22	3	3
2007	9	306	14	10	10
2006	15	159	33	10	15
2005	11	836	1`	2	5
2004	15	603	7	24	8
2003	11	537	27	3	12
2002		838			
2001	19	945			
2000		81			
Total	**126**	**10,327**	**115**	**62**	**87**

Indicator: Number of restoration projects outside of Forest Service using HFQLG pilot project leveraged funds

As an example of externally leveraged funding, $261,700 of HFQLG pilot project funding was leveraged for FY 2012 (data for other years were not available) to acquire $774,400 of external partner funds in support of riparian restoration within the HFQLG pilot project area (spreadsheet 'FY 2012 Capability for NFVW-WC.xls', sent to A. Merrill by J. Hoffman). In a second example, nearly $2 million dollars was leveraged from the state Integrated Regional Watershed Management Program (IRWMP) to support riparian restoration and planning in Plumas National Forest through 2009 (Plumas National Forest- Exhibit 1 Prop50 Agreement June 2009).

From 2003- 2005, the Forest Service spent between one and two million dollars of HFQLG funding annually to support riparian restoration projects. Assuming these values were representative of the range of annual spending on riparian restoration, the amount of external leveraged funds reported for 2012 ($0.75 million) represented from one-third to three-quarters of the HFQLG pilot project money spent annually.

A continuation of a pre-HFQLG pilot project *Challenge Cost/Share agreement* with PRBO Conservation Science to monitor birds on Almanor Ranger District of Lassen National Forest of the HFQLG Project Area, including riparian areas and meadows, was reported for FYs 2003- 2005 (USDA 2004a, 2005, 2006) and represented additional leveraged funds applied for ecological monitoring.

Indicator: Evidence of Programmatic planning for riparian restoration.

Although riparian restoration projects were distributed throughout the HFQLG pilot project area, as summarized in Table Id, the distribution was not even. The Plumas National Forest recorded over twice the total acreage restored and road miles restored or eliminated than the Lassen National Forest and the Sierraville Ranger District of the Tahoe National Forest. At the Ranger District Level, the Mt. Hough Ranger District (MHRD) exceeded others by over two-times the acres restored, while Hat Creek Ranger District (HCRD) and Feather River Ranger District (FRRD) accomplished the least amount of restoration and road treatments during the HFQLG pilot project period. Forest Service personnel reported that the level of accomplishment depended upon capacity and direction at the unit level. No over-arching program for restoration in the HFQLG pilot project area existed to prioritize or distribute time and resources.

Table Id. Summary of riparian restoration projects accomplished through the HFQLG pilot project between 2000 and 2012.

Forests/Districts	Count of Projects	Acres Restored	Road Miles Eliminated	Crossings Restored	Crossings Eliminated
ALRD	27	1142	17	21	20
ELRD	19	1183			
HCRD	3	260			
LASSEN NF	49	2585	17	21	20
BRD	68	2826	79	15	32
FRRD	25	239	29	4	3
MHRD	8	4133	3	23	5
PLUMAS NF	101	7198	111	42	40
SVRD	21	1300	9.75	40	16
TAHOE NF	21	1300	9.75	40	16
Grand Total	171	11083	137.75	103	76

Expenditures on riparian restoration and costs per acre of restoration also varied per project and per project-acre among the three National Forests and among Ranger Districts, with Lassen National Forest spending nearly twice as much as Plumas or Tahoe National Forests during three years for which these data are available (Table Ie).

Table Ie. Summary of riparian restoration costs for implementation for fiscal years 2003, 2004, and 2005, includes all restoration such as meadow restoration, decommissioning of roads in riparian areas, culvert replacement.

	2003		2004		2005		Total	
Row Labels	Projects	Cost	Projects	Cost	Projects	Cost	Projects	Cost
LASSEN NF	12	$528,300	14	$1,317,515	30	$90,385	56	$1,936,200
ALRD	5	$115,000	5	$322,856	8	$90,385	18	$528,241
ELRD	3	$34,600	3	$283,073	22		28	$317,673
HCRD	4	$378,700	6	$711,586			10	$1,090,286
PLUMAS NF	13	$340,400	13	$324,639	31	$510,773	57	$1,175,812
BRD	9	$275,300	10	$314,189	26	$510,773	45	$1,100,262
FRRD	2	$37,100	2	$10,450	2		6	$47,550
HCRD					2		2	
MHRD	2	$28,000	1		1		4	$28,000
TAHOE NF	5	$207,000	6	$543,508	11	$263,534	22	$1,014,042
SVRD	5	$207,000	6	$543,508	11	$263,534	22	$1,014,042
Grand Total	30	$1,075,700	33	$2,185,662	72	$864,692	135	$4,126,054

The HFQLG pilot project did not appear to expand upon the existing degree or extent of watershed HUC 06 or higher level planning. Personnel at all three National Forests reported informal "programmatic planning" at the Ranger District scale. Based on this planning, watersheds believed to be in relatively poor shape were prioritized for restoration when funding was available. Within these HUC 06 to HUC 07 watersheds, watershed assessments required under NEPA as part of the Environmental Assessment were performed prior to implementing any kind of restoration action (e.g. Watershed Reports were made available to the Independent Science Panel for Davies-Merrill, Carman Creek, and Perazzo Meadows in the Tahoe National Forest by the Watershed Program Manager for the Sierraville Ranger District). Alternatives and optimal strategies for restoring watershed function were identified through the HUC -07 level watershed assessment. These planning and prioritization activities were relatively informal, varied in degree and frequency by Ranger District, but were required by existing law (NEPA).

Elsewhere in Region 5 and in the Forest Service as a whole, equal or greater progress was made in watershed-level planning and strategic restoration during the HFQLG pilot project period. In 2011, the Forest Service published a watershed condition framework, featuring a condition rating system and web-accessible product at the HUC 06 level for all National Forests (http://www.fs.fed.us/publications/watershed/), in which each HUC-06 is assigned a good/fair/poor condition ranking for riparian/wetland conditions among other things. Within some of the R5 National Forests, this watershed condition framework has been applied to identify priority watersheds and to develop watershed action plans (see chapter 6 of the Region 5 Ecological Restoration Plan, available on the web at: http://www.fs.usda.gov/detail/r5/landmanagement/?cid=stelprdb5409054). Similarly, strategies to match federal funds with private funding have been incorporated in the Region 5 strategic plan. There are many examples of leveraged funding occurring outside of the HFQLG pilot project area. That HUC 06 and higher level planning and leveraged investment occurred outside of the HFQLG pilot project area from 1999 through 2012, suggests that the HFQLG pilot project did not especially increase the scale or pace of programmatic planning for restoration.

During a period largely overlapping with the HFQLG pilot project, the Feather River Coordinated Management Corporation (Feather CRM) piloted a new restoration technique with technical support and partial funding from the HFQLG pilot project (see Feather CRM website: www.Feather-rirver-crm.org). In the past 5-8 years, this technique has been taught and adopted by other National Forests and Parks within Region 5 (e.g. Indian Meadow in Eldorado NF and Big Meadow in Sequoia NF). Thus, the HFQLG pilot project has indirectly supported development and application of this new technology for meadow restoration.

Indicator: "in order to protect fisheries and watershed health a network of riparian habitats and a watershed restoration program must be established throughout those areas managed for uneven-age structure. The initial emphasis should include increases in Forest Service *appropriations for improvements in range management and road maintenance to restore and protect riparian areas." [CSP 2iii]*

Funding expended through the HFQLG project to eliminate roads in riparian areas and to protect riparian areas at road-channel crossings during 2003- 2005 totaled at least $457,930. Because this amount was based on expenditures reported for all riparian projects, and road related project expenditures were singled out based on project names, this likely an underestimate of total expenditures.

Road-related impacts to riparian areas were addressed throughout the HFQLG pilot project area by eliminating roads and channel road crossings and by restoring channel road crossings. Overall, road maintenance projects to restore riparian areas under the HFQLG pilot project from 2000- 2012 eliminated 137.75 road miles in riparian areas, restored 103 stream-road crossings, and eliminated 76 stream-road crossings.

Indicator: "Grazing allotment renewal plans will include financing and provisions for restoration and protection of these riparian networks. In addition, the Forest Service shall seek every opportunity to work with the Federal Energy Regulatory Commission (FERC) to restore adequate flows for fisheries and recreation." [CSP 4c]

Range conservationists interviewed by phone from two of the three national forests indicated that the range management objectives of the HFQLG pilot project were 'not on our radar' (Scott Lusk, Range Conservationist for Plumas National Forest, pers. comm. with Amy Merrill April 2013). Therefore, range management and condition improvements continued unaffected, or accelerated, throughout the HFQLG pilot project period as part of normal Forest Service operations.

The Forest Service works regularly with FERC as an active participant in all of the relicensing processes that affect water resources on National Forest lands as part of the agency's existing on-going operations, so no change in these actions was necessary to fulfill this part of the HFQLG pilot project.

HFQLG pilot project funds directed towards protecting and restoring riparian areas through riparian restoration, elimination of roads in riparian areas, and restoration and elimination of road-channel crossings for three years of the HFQLG pilot project (2003, 2004, and 2005) total $4.12 million, and paid for 135 projects (Table If).

Table If. Total expenditures on riparian restoration, road restoration, elimination and road crossing restoration and elimination during three years of the HFQLG pilot project period.

Forests/Districts	2003	2004	2005	Total Costs	No. of Projects
ALRD	$115,000	$322,856	$90,385	$528,241	18
ELRD	$34,600	$283,073		$317,673	28
HCRD	$378,700	$711,586		$1,090,286	10
LASSEN NF	$528,300	$1,317,515	$90,385	$1,936,200	56
BRD	$275,300	$314,189	$510,773	$1,100,262	45
FRRD	$37,100	$10,450		$47,550	6
HCRD					2
MHRD	$28,000			$28,000	4
PLUMAS NF	$340,400	$324,639	$510,773	$1,175,812	57
SVRD	$207,000	$543,508	$263,534	$1,014,042	22
TAHOE NF	$207,000	$543,508	$263,534	$1,014,042	22
Grand Total	**$1,075,700**	**$2,185,662**	**$864,692**	**$4,126,054**	**135**

Appendix II.
California spotted owl and the HFQLG Act

The spotted owl, *Strix occidentalis*, is associated with mature and forests; the conservation of the owl and these forests has been the center of conflict for nearly three decades (Gutiérrez et al. 1995). Two of its three subspecies, *S. o. caurina* and *S. o. lucida* (northern and Mexican spotted owls, respectively), are listed as threatened species under the Endangered Species Act (ESA) because of habitat loss, population declines, and the failure of existing regulatory mechanisms by land management agencies to protect the owl. These issues are also at the root of the conflict about conservation of California spotted owls, *Strix occidentalis occidentalis*.

It was under this broad-ranging conflict that the first California spotted owl management plan was created in 1992, "The California spotted owl: a technical assessment of its current status" (CASPO; Verner et al. 1992). CASPO was designed specifically to stave off listing of the owl and to provide options for forest management while conserving the owl (Verner et al. 1992). It was considered an interim plan to guide Forest Service management until future research answered key questions about the owl that would lead to a scientifically defensible management plan (see also detailed discussion below).

The Quincy Library Group conflict was just one of many conflicts over the conservation of the spotted owl in the western United States. Thus, the HFQL Act featured the California spotted owl prominently by explicitly providing protections for the owl through its provision to protect existing owl Protected Activity Centers (PAC). PACs were designed to provide 300 acre areas of suitable owl habitat contiguous to and surrounding either a known nest or roost site of a pair or single territorial owl (Verner et al. 1992). The spotted owl was the only species for which such explicit protection was afforded in the Act (section 401, f). Historically, the spotted owl also featured prominently in the Quincy Library Group (hereafter QLG) conflict because not only was the status of the owl population in the Sierra Nevada unclear but the effects of logging on it were unknown. Subsequent to the passage of the HFQLG Act, the California spotted owl was petitioned for listing twice under the Endangered Species Act (ESA; USFWS 2003, 2005, 2006). These three facts (the prominence of the owl in the HFQLG Act, the QLG discussions about the owl, and the listing petitions) all indicated that the conflict over appropriate conservation of the owl and its habitat not only played a central role in the conflict but also did not dissipate over the course of the HFQLG pilot project. Thus, the impact of the HFQLG pilot project on spotted owls was a high priority for assessment of any adverse environmental impacts that might have resulted from HFQLG projects.

The U.S. Fish and Wildlife Service (USFWS) denial of listing was predicated on three primary issues (USFWS 2006): 1) there was uncertainty about population trends of the owl in the Sierra Nevada, 2) the creation of the Sierra Framework (USDA 2004) was assumed to provide sufficient protection for key habitat features associated with the owl (e.g., large trees and high canopy cover; these management provisions address the ESA listing criterion "habitat loss"), and 3) the Sierra Framework would provide a management framework that would allow an adaptive response if forest management was deleterious to owls (i.e., this final reason directly related to the ESA listing criterion "inadequacy of existing regulatory mechanisms" for the other owl subspecies). The HFQLG pilot project superseded the Sierra Framework with respect to management of forests within which the owl lived (except that PACs were maintained under both management frameworks). Despite the denial of listing petitions, the petitions underscored the broad concern by the public for the conservation of the California spotted owl, including many stakeholders in the Sierra Nevada. This conservation concern has been long-standing and this concern was first acknowledged by the Forest Service by the formation of The California spotted owl technical assessment team in 1991 (Verner et al. 1992). The charge of CASPO was to create a scientifically defensible conservation plan that would reduce the likelihood of the owl being listing under the ESA and to provide forest management recommendations to the U.S. Forest that would not threaten the owl (Verner et al. 1992). CASPO created their interim management plan was based on existing biological knowledge about the owl. The CASPO plan was considered interim because it was uncertain if it would, indeed, be compatible with maintaining the viability of California spotted owl populations. This landmark plan has been featured prominently by most subsequent Sierra-based management efforts including the HFQLG Act, the Forest Service FEISs and subsequent strategies (1993, 1996, 2001, 2004), and the HFQLG monitoring plan (Effectiveness Monitoring Questions 11-14). The superseding of the Sierra Framework by the HFQLG pilot project demanded a thorough evaluation of the HFQLG pilot project effects on owls because it was not only a local issue of concern, but also one with direct implications to listing the owl under the ESA. Therefore, the conservation of the owl was of central concern in the HFQLG Act, for the Forest Service, and stakeholders (both environmentalists and the forestry industry, even if for opposite reasons). Viewed in this historical context, it was the viability of the owl that precipitated much of the legacy of the QLG and HFQLG Act. Thus, it was implicit that the effects of HFQLG treatments and activities would be closely monitored for their effect(s) on owls. This monitoring of effects of treatments, theoretically, would provide the information necessary for an adaptive response envisioned by both CASPO and the Sierra Framework (USDA 2004).

Because CASPO was the legacy at the time the HFQLG Act was passed by congress, the HFQLG and the Sierra Framework (USDA 2004) referenced CASPO prominently. Implicitly, the HFQLG Act and the Sierra Framework were tests of an alternative management, which could provide way forward for land managers beyond CASPO because all other management directions subsequent to CASPO had failed (Federal Advisory Committee 1997). Such a pivotal role in the resolution of the long-standing conflict over the status of the owls and the potential threats to owls as a result of forest management meant that monitoring the HFQLG treatments to assess effects on spotted owls was a critical element of the HFQLG Act. Further, we found no evidence that either this long-standing concern over conservation of spotted owls or the need to monitor the effects of HFQLG treatments on spotted owls had dissipated over the life of the HFQLG pilot project. If anything, the concern among some stakeholders seems to have increased as evidenced by the two recent petitions, during the HFQLG project period, to list the owl under the ESA as an endangered species. Therefore, the apparent lack of urgency or recognition of this historical conflict, and more importantly its larger implications, by the HFQLG monitoring team obvious need was surprising to this review panel.

Appendix III.

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Appendix IV.

Acknowledgements

The Herger-Feinstein Quincy Library Group Forest Recovery Act introduced an experiment in collaboration and land management to the Sierra Nevada range of northern California. The experiment was intended to influence the ecology, economy, and social character of the landscape. Conducting the review required understanding not only the scope and impact of the HFQLG pilot project, but also the factors that sparked this experiment and shaped how it progressed for more than a decade.

Many individuals provided information and insight that facilitated our review. We would like to thank those individuals for their time, interest, expertise, and passion. Their contributions improved our ability to convey what can be learned from the HFQLG pilot project.

The review would not have been possible without the support of Forest Service personnel on the Lassen, Plumas, and Tahoe National Forest, and their willingness to meet many times to provide data, information, and insights. We appreciate the contributions and advice of members of the Quincy Library Group, especially Mike De Lasaux, Michael Jackson, John Sheehan, Bill Wickman, and Frank Stewart. We also appreciate the insights shared by Craig Thomas of Sierra Forest Legacy. And finally, we wish to thank the HFQLG Implementation Team, including Dave Wood, Linda Kanski, and Elise Reierson—with special thanks to Colin Dillingham, who provided invaluable assistance for planning and conducting all phases of the review. In all cases these organizations and individuals facilitated our review of the HFQLG pilot project.