Assessment of the Efficacy of the California Bureau of Land Management Community Assistance and Hazardous Fuels Programs

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1.0 EXECUTIVE SUMMARY

In this study, TSS Consultants provides a framework for assessing the social and environmental benefits and public education outcomes associated with BLM's Community Assistance and Hazardous Fuel Programs in California. Evaluations of fire hazard mitigation programs tend to focus primarily on the number of acres treated and treatment costs associated with mitigation without adequately assessing the benefits of these treatments. While some evaluations account for the value of protected structures or the avoided costs of suppression, few account for the ecosystem service value of protected natural capital. Ecosystem services are functions performed by nature that are valuable to humans, which may be irreplaceable or may be costly to replace. Examples include the water purification and flood abatement functions of wetlands, the hydrologic regulation functions of forests, and the recreational value of various natural landscapes. The total economic value approach to environmental assessment used in this study provides a method for quantifying these assets so that they can be counted as benefits. This approach is consistent with regulatory trends now forthcoming through the United States federal government and international community with the advent of projects like the Millennium Ecosystem Assessment and the EPA Science Advisory Board's Advisory Committee on Valuing the Protection of Ecological Systems and Services.

The current analysis is focused on San Bernardino, Napa and Humboldt counties, which represent a cross section of the broad diversity of Californian landscapes and socio-economic characteristics. For selected study area zip codes within each of these counties, a baseline estimate of environmental assets was generated using a spatially explicit value transfer method. Furthermore the value of built structures was quantified using spatially referenced assessor's data. The process developed for these three counties can easily be applied to other areas with similar land cover characteristics. Because we chose a sample of counties with such a wide variety of land cover we feel that these methods could be generalized to almost any part of California.

The assessment is novel in its consideration of *both* the market-based and non-market values that are at risk from wildfire, particularly ecosystem goods and services. Using a decision support methodology developed by Spatial Informatics Group LLC, the NaturalAssets™ Information System, the study presents data that will allow the BLM to more effectively quantify and account for, the social and environmental benefits derived from fire mitigation treatments. While this study necessarily was limited in its scope, suggestions are provided for how this approach could effectively be scaled up and used at a national, regional or state-wide level to analyze the efficacy of all BLM programs. Although this approach is currently compatible with BLM current reporting system, the report provides recommendations on how to augment the evaluation system so that future program elements or "system" elements that enable (or prevent) communities to take part in raising awareness and taking action for themselves are evaluated at the broader BLM program level. This evaluation would include the policies, laws, macro-economic intentions (and their implementation) which effect BLM's Community Assistance and Hazardous Fuel Programs in California.

Results

The baseline ecosystem service values generated for this study provide important information about the valuable resources protected by BLM fire mitigation programs. This information can be used on its own, or in the framework of traditional cost benefit or cost effectiveness analysis. As discussed in the study, national policy and regulatory trends are clearly moving in the direction that necessitates more effective accounting for the economic benefits provided by ecological goods and services.

The study shows for example that an overwhelming proportion of economic values related to the environment in Humboldt County come from its forests. Humboldt's relatively large area of forested cover accounted for nearly 80% of total ecosystem service value delivery by naturally functioning ecological systems in the study area. While on a per-unit basis, some forest types provide a lower stream of benefits than many non-forested types, the size of forested area in Humboldt County means that ESV benefits from forests dominate. In particular, riparian forests, old growth forests and forests with spotted owl habitat provide for a high proportion of ecosystem service values relative to area. In contrast, we find that in Napa County, forested systems only accounted for 30% of ecosystem service values delivered by functioning ecological systems. Napa's open freshwater, in the form of streams, lakes and rivers, provided 31% of measured economic benefits to society. Similar to Napa County, forested systems delivered approximately 31% of the total value delivered by ecological systems in San Bernardino County. From an ecosystem services perspective, freshwater wetlands accounted for the majority (55%) of ecosystem service benefits delivered to society. Clearly, the vast deserts and arid piedmont of San Bernardino County provide extensive benefits, but lacking studies of these benefits, we are unable to quantify them currently.

The study also presents results from a phone survey conducted to document the behavioral changes associated with the BLM's outreach efforts. One relevant finding is that Californians value their environment just as much as they value their structures. This further demonstrates the need for the BLM to account for ecosystem goods and services in their management decisions. This baseline ecosystem service layer, used in series of next steps presented in this report, will allow the BLM to demonstrate how their fuel hazard programs are protecting both structures and valuable environmental resources.

For example, the ecosystem service baseline could be integrated with spatially explicit fire behavior models like FARSITE and FLAMAP to weigh potential benefits from a treatment against cost. Specifically, the fire models would produce a baseline wildfire damage probability under a no-treatment scenario. The amount and probability of damages to both structures and environmental assets could then be compared to the predicted amount and probability of damages under alternative treatment scenarios, net of treatment cost. Treatment scenarios evaluated could range from shaded fuel breaks, strategically placed land area treatments (SPLATS), or the break up of fuel continuity around individual communities and homes. Well designed treatments should result in lower burn probabilities as well as fewer burned acres when a simulated fire does occur. Because these models are spatially explicit, the predicted fire perimeters can be overlain

on our baseline ESV and structure maps to estimate what the extent of damage would be under each scenario. For each scenario, including the baseline, then, the cost of treatment (zero in the case of the baseline) can be compared to the probability of fire multiplied by the estimated damage from each fire. This can be a valuable tool for communities in the Urban/Wildland Interface, as they engage in wildfire protection planning. On a state-wide level, grant applications can be evaluated based upon their net benefits to society.

While such integrated modeling was beyond the scope of this study, we did provide two case studies, the town of Petrolia in Humboldt County and Morongo Valley in San Bernardino County, where we compared the costs of treatment to the estimated benefits from those treatments, including both protected structures and ESVs. Lacking time to model the probability of fire, or the expected fire perimeter (under no treatment and the designed treatment), we assumed a "protection area" of 1.5 miles around the treatment footprint, and estimated the value of all the structural and environmental assets that would be protected within. Morongo Valley is a highly developed part of San Bernardino County while Petrolia is in a rural part of Humboldt County. Both of these communities are located in the Wildland Urban Interface with Petrolia listed as a Community at Risk and Morongo Valley listed as a Community of Interest.

If we assume that a fire is certain to happen, and that the treatments reduce the probability of fire, we then find both treatments considered are cost-effective. When both the non-market and market-based values of protected structures, goods and services are taken into consideration, there appears to be a net economic benefit for each community. For instance, in the case of Petrolia, the data show that treatment project costs were $332 per acre, yet the total economic value of market and non-market goods and services within the protected buffer zone yield approximately $634 per acre, resulting in a net benefit of $302 per acre. In the case of Morongo Valley, while the costs of treatment are somewhat higher at $937 per acre, the total economic value of the protected area is also considerably higher resulting in a net benefit of $5,058 per acre.

Had ESVs been excluded from our analysis of total value in the case studies, the end results would have been quite different: the total economic value in Petrolia would have been only $197 per acre, resulting in a net social cost of $135 per acre for treatment. On the other hand, in Morongo Valley, the market-based value of homes and structures appear to far outweigh the non-market goods and services associated with the protected buffer zone, so that the net cost effectiveness of treatment would remain the same regardless of the non-market benefits.

Recommendations

The ecosystem service baseline layer used in this study is a lower-bound estimate as it is limited primarily to scientific, peer-reviewed empirical studies that are standardized to one static point in time. Moreover, many important land cover types, such as desert and grassland, are absent from the valuation literature, yielding a zero value for these types, which is clearly unrealistic. We recommend that the data be expanded to include technical reports and high-quality grey literature (e.g. doctoral theses) if funding permits.

Increasing coverage would broaden the scope of the ecosystem service estimates and improve the specificity of the results by bringing California-based studies to the foreground. Future updates of this analysis could also be developed to assess changes over time in response BLM's policies. Such time-sensitive research would assist BLM's efforts to demonstrate how their management (or in the case of this report, protection from wildfire) has led to increase societal benefits.

We further suggest that the BLM develop a long-term monitoring program to track the cost-effectiveness of their policies over time. In order for the BLM to use this tool effectively, this ecosystem service baseline analysis conducted in this study needs to be repeated consistently over time in a manner that is consistent with other monitoring programs (i.e. census data, land cover land use data,). Combined with secondary data sources, the non-market valuation information will assist in detecting changes in BLM's jurisdiction that directly affect quality of life.

The same monitoring program could be designed to detect the effects of new policies and land use changes on the delivery of ecosystem goods and services. The frequency and scale of monitoring will depend on which of BLM's management objectives we are using to detect changes. For fire, it may be more effective to do this monitoring out of each BLM field office and at a much more frequent basis.

Another opportunity for the BLM to use the total economic value approach effectively is to compare and contrast individual fuel mitigation treatments and their actual efficacy on the landscape. In order to do so, we have suggested linkages with fire risk models. For resource managers and fire management officers to use this decision management system, the BLM needs to change its grant tracking to require three new data inputs. The first is the treatment footprint, the second is the sphere of influence (or protection footprint), and third is the probability of fire under the treatment scenario. The last two inputs would have to be generated by a wildfire simulation model. This will allow the field offices and the grant managers to track, compare and contrast the different fuel treatment options at a local and regional level and better quantify the benefits from them.

Lastly, the Community Assistance projects also have spatial relevance which could be further defined for the BLM to perform an impact evaluation. In order to do so, the grant recipient(s) should ascertain the treatment footprint (outreach target population) and potential sphere of influence (households, community, watershed, zip code, a county wide or state-wide outreach effort) so that a comparison can be made before and after the outreach program. Given that metrics do not exist to measure a community's capacity and cohesiveness, a programmatic level impact analysis is suggested to measure any increases in their knowledge and awareness levels or changes in attitudes or behaviors. With these two spatial footprints, these behavioral changes could be linked in space and time to the ecosystem goods and services affiliated with that particular landscape. This linkage and impact analysis will allow the BLM to determine the short-term effects of the Community Assistance program on the target audience and how behavioral changes express themselves in ecosystem values (i.e. their willingness to pay) at local and regional levels.

2.0 INTRODUCTION

Recent large-scale fires throughout the western United States have demonstrated the high social, economic and ecological costs of uncontrolled fires. Even with large expenditures and substantial infrastructure dedicated to fire suppression in the United States, the annual area burned by wildfire has increased in the last decade (USDA–USDI 2000; WGA 2000; NWCG 2001). As the scale of uncontrolled forest fires has increased, conventional suppression measures have increasingly come under question. Thus, many agencies have started to explore more proactive approaches in combating fires, including more effective prevention activities. The search for improved approaches has led to calls for revisiting forest fire management regimes that emphasize pre-fire management, prescribed burning, hazardous fuels treatment and prevention. Many of these systems and approaches are seen to be more effective in tempering uncontrolled burns, more beneficial to local ecosystems and more cost efficient in the long term.

As a result of severe wildfire damage in 2000, the National Fire Plan (NFP) was developed. The intent of the NFP is to actively respond to severe wildland fires and their impacts to communities while ensuring sufficient firefighting resources and capacity for the long term. In support of the NFP the California Bureau of Land Management (BLM) has established the Community Assistance (CAP) and Hazardous Fuels (HFP) Programs to provide safe, effective, and efficient hazard reduction programs to mitigate wildland fire risks to communities and natural resources. During 2002 to 2004, BLM has funded $5 – $6 million dollars annually for the Community Assistance and Hazardous Fuels programs. This document evaluates the efficiency and effectiveness of hazardous fuels treatments, as well as, assesses successful behavioral changes associated with education and outreach services in three California counties. The results of this assessment should assist the BLM in the future prioritization of strategic, collaborative projects for effective fuels treatments and educational outreach efforts.

2.1 Objectives

This study's objectives are to conduct a comparative evaluation of the efficiency and effectiveness of hazardous fuels treatment and to assess successful behavioral changes associated with education and outreach activities.

This study provides the basis for a quantified assessment of the benefits, cost effectiveness and public education/outreach outcomes as related to NFP funded projects administered by the California BLM. The projects evaluated cover those implemented during the 2002 – 2004 study period. Primary outcomes of this study have included:

- Quantification of the economic values associated with the Community Assistance and Hazardous Fuels Programs in three counties that are representative of California's heterogeneous landscapes.
- Identifying and assessing the behavioral changes associated with the implementation of the Community Assistance program's education/outreach activities that can be quantified at the community level.
- Providing a framework and analysis of which BLM fuel reduction projects offers the highest return on the investment when considering the ecosystem goods and services included as part of the HFP.

The assessment differs from previous ones in that it takes into consideration *both* the market-based and non-market values likely to be impacted by a catastrophic fire. Specifically, it provides a first-order baseline estimate of the ecosystem goods and services provide by California's natural landscapes that might be threatened by catastrophic fire. Using a decision support methodology developed by Spatial Informatics Group LLC, the NaturalAssets™ Information System, the study presents data that will allow the BLM to more effectively quantify and account for, the social and environmental benefits derived from fire mitigation treatments. This assessment also presents statistically significant results from a stratified public opinion survey in three geographical areas that are targeted by BLM's CAP.

2.2 Effectiveness of Treatments

Quantifying effectiveness of Urban/Wildland Interface fire mitigation treatments is a challenge as there is no accepted system of measurement. If one adds the complexity of working in very different ecological and socio-economic contexts, the metrics become even more convoluted. In January 2004, the National Academy of Public Administration (NAPA) published a report that recommended three landscape scale actions to diminish wildfire hazards through reducing community vulnerability and fuel buildup. While NAPA does not quantify the effectiveness of these strategies they endorse them as key hazard reducing actions.

> "Two years ago, when Congress asked the Forest Service and the Department of the Interior to fund a study by the Academy aimed at containing wildfire suppression costs, we prepared detailed cost reviews of six of the largest wildfires in 2001, and we reported to Congress and the land management agencies on several ways to contain the growth of suppression costs. We found that some money can be saved when fighting wildfires by making better used of local firefighting forces, being more efficient in purchasing equipment and services to fight fires, adopting more cost-effective suppression strategies, and taking other administrative steps. But clearly, the opportunities for big savings are in reducing wildfire hazards on a broad scale before a fire begins. Most incident commanders

and others we talked to reported that their discretion to adopt more cost-effective suppression strategies was severely limited by political, citizen, and media pressures.

Existing federal policy calls for acting at what it calls the "landscape scale". In that context, the landscape encompasses a whole ecological system regardless of the ownership lines and jurisdictional boundaries that divide it. The Panel endorses this landscape-scale approach. What really stood out in our 2002 fieldwork was that forces already at work predetermine most of the suppression costs. These forces – in simplest terms – are drought, weather and ignitions, which are mostly beyond our control, plus community vulnerability and fuels buildup in wildlands, which can be controlled. Three hazard-reducing actions can help control these latter risks and help contain future suppression costs. We have concentrated on these three opportunities for hazard reduction and cost containment:

1. **Create fire-resistant communities** and defensible spaces (places that are less prone to burn because of precautions taken ahead of time);

2. **Create strategic fuel break systems** that can be used to compartmentalize and dampen fire progression patterns across large expanses of wildland, transforming them into more manageable fire control areas;

3. **Reduce heavy vegetative fuel loads and restore forest** to healthy levels that permit successful initial attack, do not contribute to large uncontrollable fires, and help to avoid damage to communities, municipal watershed, the environment, and other values at risk.

Each of these hazard reduction strategies is complex to implement. Their success requires science-based assessments, collaborative planning, and coordinated actions by many different parties. Last year, we recommended a more collaborative approach, and this year we have explored in greater detail what that approach would look like organizationally and operationally. In this report, we address interagency and intergovernmental collaboration, as well as public private linkages, and how they can bring together all of the stakeholders who are essential to success in a way that will best enable them to build the capacity they need to succeed." (NAPA 2004, p. 30-31; italics added)

The CA BLM's Community Assistance and Hazardous Fuels Programs (CAHFPs) have long embraced this three-prong approach to reducing wildfire hazards and working collaboratively with its local partners. The CAHFPs have the benefit of working in a state that already has a functional structure for bringing together all of the relevant stakeholders. Since 1993, community members, exasperated by lack of attention or misguided approaches to fire management by state and federal government agencies, initiated fire management planning efforts, and invited state and federal agencies to join them. While these government agencies recognize the value of participating in

consultative local “Fire Safe Councils”, the visions of many of these local initiatives go far beyond the degree of collaboration foreseen by the agencies. As these councils began to grow throughout the State of California, the expenses for these community-based initiatives have been covered by state and federal government funds requested by the consortium of local government and non-governmental parties, under the umbrella of the Fire Safe Councils. The BLM’s CAHFPs are but two of many federal opportunities for these Fire Safe Councils to facilitate a community-based process and implement hazard reduction treatments.

The objective of fuel treatments for hazard reduction is to reduce fuel loads (i.e., the quantity of fuel) and/or change the fuel profile (i.e., the spatial arrangement of fuels), thereby minimizing the risk of severe, high-intensity wildland fires. This objective is based on the premise that altering the fuel load will protect and sustain natural resources, particularly vegetation, wildlife habitat, and watershed integrity, increase the safety of wildland firefighters and people living in the wildland-urban interface areas, and reduce the suppression costs associated with high-intensity wildland fires. The optimal level of fuel treatment requires an analysis of the tradeoff between the costs and benefits of treatment. Typically, this type of analysis has not effectively quantified and accounted for the social and environmental benefits derived from fire mitigation treatments.

Historically, economic considerations have had only minimal influence on fire management and federal fire policy. For nearly a century, the US Forest Service (USFS) and other federal agencies enforced a strict policy of aggressive suppression on all wildland fires regardless of cost. The USFS has engaged in deficit spending during forest fire emergencies followed by supplemental appropriations to cover all excess expenditures since 1980. This fiscal strategy reinforces the notion that economic considerations are secondary to fire suppression goals and objectives. Unrestricted spending for emergency suppression eliminates incentives to develop cost-effective, efficient fire management strategies, and encourages the misallocation of resources from planning and fuels treatment to emergency suppression.

There were, however, attempts at the beginning of the 20th century to improve the efficiency and cost-effectiveness of fire management. In 1914 the USFS Chief, Henry Graves, proposed that the amount spent on fire suppression should be proportional to the value of the resources being protected and the cost to protect them (Pyne 1982). The proposal put forth by Graves is consistent with the definition of efficiency, as applied to fire management, which states that net benefits to society are maximized where the marginal cost of fire suppression is equal to the marginal benefits of suppression. In 1916, Roy Headly proposed the "least cost plus" theory, which stated that the sum of damages and suppression costs should be kept at a minimum (Pyne 1982). Unlike Graves, Headly’s proposal does not use the efficiency criterion, but it does introduce the notion of cost minimization. The weakness inherent in both of these economic theories -- one that continues to challenge environmental economists -- is the difficulty associated with calculating the value of a continuous stream of both market and nonmarket benefits from environmental amenities. The value of recreation, wildlife habitat, watershed services, and aesthetic services, all unpriced nonmarket environmental amenities, are difficult to quantify. Because the value society derives from these amenities is influenced

by wildland fire, determining the optimal level of fire suppression and risk reduction is problematic. Stephen Pyne (1996) describes the division of power between economic and political forces over the development of federal fire policy:

> "For most of its evolution, fire management has been dominated by historical circumstances, political mandates, and non-economic criteria. Economic analysis could rationalize this process, but it could neither direct it nor substitute for it. Economic theory could occasionally advise, but it could not command."
>
> (Pyne 1996, p.326; italics added)

More recently, the economics of fire policy and management has begun to emerge as an applied field of study. An example of this surge of interest is reflected by the 1999 Symposium on Fire Economics, Planning and Policy: Bottom Lines held in San Diego, California. The ecological repercussions of past management have resulted in diminishing marginal returns to suppression: it takes more and more dollars to prevent less and less damage. Diminishing returns to suppression have increased the importance of marginal analysis as applied to fire management. The majority of economic research has, however, focused on suppression and only limited attention has been given to hazardous fuel treatment. This is primarily because up until 1995 fuel treatments were, for the most part, limited to slash burns following commercial timber extraction. Subsequent to the Federal Wildland Fire Policy of 1995, and its emphasis on hazardous fuels reduction and strategic fire management planning, the use of and interest in fuel treatments and prescribed burning has increased significantly.

Overview of the BLM Programs and Treatments

From 2002-2004, the BLM program funded 162 projects with a wide range of program objectives and evaluation criteria. During this time period, very few of these projects used the federal funds to fund their administrative costs (admin). Only 26 of these projects were strictly for admin purposes but most included a combination of program objectives. These projects included support for the state-wide Fire Safe Council and other large scale community organizations like the Diablo Fire Safe Council (which covers two counties and a population of 2.4 million people). An additional 15 projects received funding for both admin and outreach efforts while 5 projects had the objectives of admin and fuel hazard reduction. The remaining 116 projects were strictly fuel treatments and outreach efforts or some combination of the two. Fuel treatments included a wide range of activities from prescribed burning, pile burning, strategically placed fuel treatments with chipping, mastication and goats as well as the more traditional fire break creation, expansion and maintenance. Outreach was similarly diverse from the setting up of demonstration Fire Safe gardens to fire weather hotlines, to evacuation plans and brochures. These 116 can be further split into 44 fuel treatments, 26 combinations of fuel treatments/outreach, 22 outreach/educational projects and the remaining 24 for other planning activities. These planning activities sometimes included the formation of a Fire Safe Council, the development of a geographic information system (GIS), hazard and risk

mapping, evacuation planning as well as the development of work plans and interagency facilitation/ liaison functions.

The CA BLM's 2002 program (combining admin, outreach and hazardous fuels treatment projects) funded 59 projects for $3,757,968 while the Rural Fire Assistance program provided an additional $328,000 in funding to 14 Fire Districts/Departments. Excluding the support to the state-wide Fire Safe Council, these 59 BLM projects were in areas with a population of approximately 3.8 billion (3,758,589) and 104,443 homes. The 2002 expenditure of BLM grants amounts to about $1/person or $36 per home. The CA BLM's 2003 program (combining admin, outreach and hazardous fuels treatment projects) funded 75 projects for $3,477,638 while the Rural Fire Assistance program provided an additional $369,000 in funding to 18 Fire Districts/Departments. Excluding the support to the state-wide Fire Safe Council, these 75 BLM projects covered approximately 14,260 acres but most grant recipients did not report the population or number of homes impacted by these acres treated. Using this reporting system, the 2003 expenditure of BLM grants amounts to about $244/acre treated. The CA BLM's 2004 program (combining admin, outreach and hazardous fuels treatment projects) funded 28 projects for $ 2,218,944 while the Rural Fire Assistance program provided an additional $343,371 in funding to 19 Fire Districts/Departments. Excluding the support to the state-wide Fire Safe Council, these 28 BLM projects covered approximately 6,687 treated acres but most grant recipients did not report the population or number of homes impacted by these acres treated. Using this reporting system, the 2004 expenditure of BLM grants amounts to about $331/acre treated. The different metrics of these reporting systems and their ramifications for the BLM program will be discussed in Section 5.4 (Reporting System Recommendations) of this report.

From reviewing the quarterly and annual reports, it is clearly difficult for the CAHFPs grant recipients to be objective in evaluating their own programs. Most have poor evaluation criteria and there is a need to institutionalize and standardize how the BLM coordinates the evaluations and reports (to be addressed in the Reporting System Recommendations). In California, the use of the Fire Safe Council clearing house should improve BLM's ability to standardize the reporting. The best evaluations were those that reported on the creation of Fire Plans, the number of acres/miles/tons of fuel reduction, the number of inspections performed, and at least four referenced doing opinion surveys of its constituents. Many of the grant reports reiterate their work plans and make little effort to evaluate the efficacy of their projects. Those that have evaluated their projects are compiled per BLM fiscal year in Appendix B.

Due to the lack of credible metrics for evaluating the effectiveness of the BLM CAHFPs, we have made a series of assumptions for this assessment:

- Hazardous fuel treatments, irrespective of size, will have an impact on reducing the fire hazard on a landscape scale. Although the focus of this assessment is not to model (spatially or temporally) how much of an impact these treatments might have on fire behavior, there is credible research to indicate that strategically placed treatments can change fire behavior (Knapp et al. 2004, Finney 2001). We assume that all BLM funded HFP projects have a beneficial impact on protecting

market and non-market assets regardless of the probability of burning or the level of changes to fire behavior.

- Communities value their structures more than any other market asset. The research to date on community perceptions of fire support this assumption (Everett 2002; Winter and Fried 2000; Hodgson 1994). As far as generating monetary values for marketable assets, this assessment focuses on parcels and the improvement values (generated from the Grand list) and not other market assets. While the market value of standing timber is clearly high in Humboldt County, we chose not to attempt to quantify it due to the lack of data on forest accessibility, size and age structure. We address the possibility of adding these other market assets in Section 5.5 (Next Steps).
- Environmental aesthetics and recreational opportunities are important services provided by forests in the Urban/Wildland Interface. The natural landscape in and around communities has amenity and recreational values that tend to be quite high in California. In California's Sierran foothills, for example, Hodgson (1994) did a survey of residences and found that one in five respondents considered protection of the landscape more important than the protection of structures. Californians value their natural landscape and are willing to pay for the costs associated with living in a fire-prone area for the other natural amenities that these surroundings provide.
- There are additional ecosystem goods and services from which local California residents benefit even though they may not be as aware of them. Ecosystem goods and services such as flood avoidance, wildlife habitat refugia and clean water provision provide real benefits to society. This assessment includes value estimates for those ecosystem goods and services that have been quantified in the peer-reviewed literature.
- If hazardous fuel treatments are going to be effective in California, they need to be coordinated with an outreach effort to raise awareness of why landscape scale treatments are needed. This is especially important in California where the environmental assessments (performed under the National Environmental Protection Act and/or the California Environmental Quality Act) require public input and often turn into legal battles over whether fuel treatments are appropriate in certain ecological and socio-political systems. Although it is not within this assessment's scope to address or resolve these conflicts, we should be aware that they exist in the State and contribute to the costs of implementing a hazardous fuel treatment program.

Building on these assumptions, we recognize that the protection of forests from fire damage can generate real benefits to society; benefits that go beyond the protection of market goods and structural assets. Things like scenic views, recreational opportunities, flood control, wildlife habitat protection, sediment retention and water supply all contribute to the well being of people and the communities they live in. The challenge is that currently many of the economic values associated with fire mitigation efforts remain unaccounted for because they are not easily quantified in conventional policy

assessments or cost-benefit analyses. In this report, we turn to the science of ecological economics and ecosystem service valuation to provide a standardized, baseline ecological economic assessment of critical ecosystem goods and services provided by forests in the Urban/Wildland Interface.

2.3 Ecological Economics and Ecosystem Service Valuation

Ecological economics is a field of study that explicitly addresses the complex relationships between natural ecosystems and economic systems (Costanza & Daly 1987). While it builds on both conventional economics and conventional ecology, ecological economics differs in that it views the human economy as part of a much larger ecological whole and focuses on finding practical solutions to complex system problems through the iterative process of analysis, synthesis and application. Accounting for the natural environment as a form of natural capital and the valuation of ecosystem goods and services delivered by ecological systems is one of the core areas of research in the field (El Serafy 1991).

The goods and services provided by landscapes and the ecosystems that produce them contribute significantly to the well being of people, both directly and indirectly, and therefore represent significant economic value to society (Daily 1997; Wilson & Carpenter 1999). The ability to estimate the value of the ecosystem goods and services is increasingly recognized as an important element of integrated environmental decision-making and land use planning worldwide (Millennium Ecosystem Assessment 2003; National Research Council 2004; Wilson et al 2004).

It is widely recognized that not all fire is harmful and that is important to differentiate between those fires which are harmful and those that are beneficial (Ganz & Moore 2002). Federal fire policy has been significantly modified since 1995 to recognize and embrace the role of fire as an essential ecological process (USDA 1995; USDI – USDA 1995; NWCG 2001). The value of ecosystem goods and services should be recognized when considering the positive and negative effects of fire on a landscape. Traditionally, economic assessment methodologies like Cost-Benefit Analysis have not accounted for the value of many ecosystem services because the tools and techniques to evaluate ecological goods and services in a cost-effective manner were not widely available (Environmental Protection Agency 2000; National Research Council 2004). When tradeoffs are made between alternative land use and fire management decisions, the best available information is needed to avoid systematic biases in the resulting decision.

If hidden costs or benefits are not fully accounted for, people will tend to make uninformed choices leading to inefficient outcomes. For example, as witnessed recently in the Katrina hurricane, the valuation literature has long shown that offshore barrier islands and near shore saltwater wetlands in the Gulf Coast region do tend to provide significant benefits to coastal communities in the form of alleviating flooding and hurricane storm surge (Farber 1987). Yet, when these ecological benefits are not

adequately quantified and incorporated into short term land use development decisions, critical information is left outside of the market calculus and inefficiencies arise with sometimes disastrous results. The same quantification needs to be applied when evaluating the significant benefits to communities living in a fire adapted ecosystem. While this assessment focuses on the avoided costs of losing these benefits to an unwanted fire, we recognize that some ecological goods and services may benefit from periodic low intensity fires.

From an Ecological Economics perspective, the identification and valuation of economic benefits associated with ecosystem goods and services is not only possible, it has proven to be increasingly useful for informing the allocation of resources among competing demands on the environment (National Research Council 2004; Wilson & Troy 2005). For example, the population and development pressures that California is now experiencing raises significant challenges for planners and decision makers. Communities must often choose between competing uses of urbanization and the myriad goods and services provided by healthy, functioning ecosystems.

- Should this forest be cleared to provide new land for development, or should it be maintained in its current state to serve as wildlife habitat?
- Should that wetland be drained and converted to commercial uses or should more wetland area be created to provide freshwater filtration services?
- Should forests in fire-prone urban fringe ecosystems that are susceptible to post-fire erosion be closed to recreation visitors and submitted to prescribed burning treatments or should other alternatives be sought?

To choose from among these and other competing options, it is important to know not only what ecosystem goods and services will be affected but also what they are actually worth to different members of society. To assist the California BLM gather such knowledge, we have developed a conservative, baseline ecological-economic assessment of the ecosystem goods and services for three selected counties in the State of California. Counties were selected based upon the frequency of BLM projects, the availability of land cover data, and the landscape heterogeneity and transferability. Our goal has been to use the best available methods, data sources, and spatial analysis techniques to generate defensible value estimates that can then be integrated into better land use planning and environmental decision-making throughout the region.

The BLM CAHFPs' efforts in California are likely to affect land cover and hence the provision of a range of ecosystem goods and services. For example, impervious surfaces (roads, buildings, etc.) do not deliver the same ecological services as open shrub land or forest. Also, a well-thinned stand of trees would deliver a number of ecosystem services that a densely stocked stand may not, such as hazard abatement certain habitat values, and potentially aesthetic or amenity values. In order to estimate environmental benefits and costs associated with mitigation programs, we have used the value transfer methods to derive a baseline estimates of ecosystem goods and services in associated with BLM project in three counties of the State of California: San Bernardino, Napa and Humboldt.

The NaturalAssets™ Database, first developed by Spatial Informatics Group LLC in 2003, has provided BLM with an unprecedented ability to account for and track environmental benefits and costs in a fully customized format. The next step would be to improve on these values with more peer reviewed valuation studies and to estimate the changes in values from pre-fire management, prescribed burning, hazardous fuels treatment and prevention activities. At this time, by estimating the economic value of ecosystem goods and services in these three counties, we have provided BLM with the opportunity costs associated with losing vital natural assets to disturbances such as forest fire.

2.4 Regulatory Justification for Ecological Benefit Estimation

Is the cost of community assistance and hazardous fuel mitigation really worth it? When NFP projects are undertaken, it is quite appropriate to ask whether they will achieve their stated goals in a cost-effective and efficient manner and whether the capital investments associated with fire mitigation are commensurate with the social benefits received. This basic test of 'cost effectiveness' has over time, become codified in both the regulatory language and standard practice of U.S. Federal agencies (Environmental Protection Agency 2000; Heal et al 2005; U.S. Office of Management and Budget 1996).

The biggest problem in assessing the cost effectiveness of NFP projects is that many of the things that people actually value in the fire-prone natural areas surrounding their communities--beautiful views, woods to walk in, places for wildlife to live, and sources of clean water --are not traded in the marketplace. As a result, such goods and services are often left out of cost assessments—a trend that is redressed in this study.

Importantly, examples of efforts to better account for the economic value of social benefits like ecosystem services can be found throughout the legal and statutory language of environmental policies within the United States. For instance, Executive Order 12291[1] required a strict cost-benefit approach to evaluating all new regulations. The order stated that "regulatory action shall not be undertaken unless the potential benefits to society for the regulation outweigh the potential costs to society." This order, and a related order (Executive Order 12866)[2], were later replaced by Executive Order 13258, issued in 1996, which replaced the strict benefit-cost criterion for decision-making with a weaker version that instead simply required that the benefits of the regulation *justify* the costs (OMB, 1996). Under this more recent order, benefits analysis is taken to be a critical input into regulatory decisions. As the U.S. Office of Management and Budget (1996) states:

[1] Executive Order 12866. October 4, 1993. Federal Register 58 (190).

[2] Executive Order 12291. February 19, 1981. Federal Register 46(33).

"In accordance with the regulatory philosophy and principles provided in Sections 1(a) and (b) and Section 6(a)(3)(C) of Executive Order 12866, an Economic Analysis (EA) of proposed or existing regulations should inform decision makers of the consequences of alternative actions. In particular, the EA should provide information allowing decision makers to determine that:

- The potential benefits to society justify the potential costs, recognizing that not all benefits and costs can be described in monetary or even in quantitative terms, unless a statute requires another regulatory approach;
- The proposed action will maximize *net benefits to society* (including potential economic, *environmental*, public health and safety, and other advantages; distributional impacts; and equity), unless a statute requires another regulatory approach;
- Where a statute requires a specific regulatory approach, the proposed action will be the most cost-effective, including reliance on performance objectives to the extent feasible;
- Agency decisions are based on the best reasonably obtainable scientific, technical, economic, and other information.

While most EAs should include these elements, variations consistent with the spirit and intent of the Executive Order may be warranted for some regulatory actions."

(OMB 1996, p. 1; italics added)

The National Environmental Policy Act (NEPA) is the foundational environmental law that requires all federal agencies to evaluate the consequences of a full range of alternatives and to assess their impact on the environment. Whether programmatic or project-specific, NEPA is the purest expression of that strand of environmental law that seeks to expand the cost-benefit framework to include all effects of environmental impact on society. As one legal scholar notes, "valuation of ecosystem goods and services is exactly the kind of assessment NEPA envisions, providing a means of informing the public and decision makers about what we stand to gain or lose with alternative scenarios" (Fischman 2001). While NEPA does not actually have the regulatory power to compel agencies to make changes to their analyses, significant efforts have been made recently to incorporate the concepts of ecosystem services into the regulatory language and procedures recommended by NEPA.

The utilitarian mandate of ecosystem service valuation has more recently been expanded by the U.S. Environmental Protection Agency (EPA, 2000) in their *Guidelines for Preparing Economic Analyses*, which explicitly emphasizes the importance of environmental valuation to environmental decision making. Thus, in the present case, if monetary values for ecosystem services are not estimated, many of the major benefits of ecosystems listed above in Table 28 would be excluded. The possible outcome of such an omission may lead to less federal or state investment (in this case, protection) for natural ecosystems, and subsequently the services that people directly and indirectly enjoy would be consumed by wildfire and ultimately undersupplied.

Finally, economic values have increasingly been used in litigation involving damage to ecosystems from pollution or other human actions (Duffield 1997; National Oceanic and Atmospheric Administration 1993). For such empirical evidence to be credible, however, it must pass the so-called "Daubert test" named after the 1973 majority opinion authored by Supreme Court Justice Blackmun in Daubert vs. Merrell Dow Pharmaceuticals Inc.[3], which established the following precedent for admission of scientific knowledge into environmental damage assessment:

- the theories and techniques employed by the scientific expert have been *tested*;
- they have been subjected to *peer review* and *publication*;
- the techniques employed by the expert have a *known error rate*;
- they are subject to *standards* governing their application; and
- the theories and techniques enjoy widespread acceptance.

All of the valuation methods used in this study meet these general conditions. A key question addressed here is therefore not whether ecosystem service valuation is a valid exercise but rather, which of the available methods are applicable to the NFP program.

2.5 Community Assistance Evaluation

Evaluation is going to be essential to the management of the CAP and should be initiated at the individual project level[4]. This type of evaluation will enable the agency to determine if the implementation of the particular project was effective and met its original outreach objectives. Armed with the results of this evaluation, the BLM can make decisions about the modifications needed to improve the CAP and which projects to fund from year to year. In addition, an effective evaluation process will establish credibility for CAP within the national community and with its current and future local partners.

There are four main types of evaluation:

Formative evaluation usually takes place during the planning phase of a communications project and provides information on the strengths and weakness of materials or initiative strategies. The results help the grant recipient to refine their planning process, messages and materials before moving forward. Formative research would allow the BLM's local partners and Fire Districts to explore general knowledge, attitudes, and behaviors of their target audience(s) to establish a baseline for their efforts. Information for formative

[3] For more information on the Daubert ruling see: http://www.daubertontheweb.com/Chapter_2.html Accessed on September 19, 2005.

[4] Note: Grant tracking system should be designed to assess all elements of the project. While many aspects of evaluation may focus on the individual project's communications — a vital element of the overall evaluation — it is of the utmost importance that the BLM's evaluation system be designed to assess the entire community outreach effort and whether it has achieved its goals and objectives.

evaluation is usually obtained through focus groups and individual interviews with members of the target audience(s), gatekeepers, and other community leaders (Ganz et al 2003).

Process evaluation takes place during the implementation phase of the CAHFPs and is used to assess whether the grant recipient(s) has conducted the tasks, procedures, and activities as originally planned. This can be achieved through the BLM's quaterly reporting system.

Impact evaluation is used to determine the short-term effects of the program on the target audience(s), such as an increase in their knowledge and awareness levels or changes in attitudes or behaviors. The phone survey presented in this study is an example of a static, baseline impact evaluation. Typically, an impact evaluation involves a comparison before and after the program. Due to the length of this assessment's study period (2002-2004) and financial limitations, the phone survey was performed only once. While changed behavior is the desired outcome, the CAP's educational and outreach efforts have not always resulted in changing awareness, knowledge, and attitudes.

Outcome evaluation assesses the long-term results of the program, such as a decrease in numbers of acres burned in a particular watershed. Outcome evaluations are usually expensive and require a complex methodology. They also require a standard reporting system in place for a long enough period to track changes on the ground (and not changes in the reporting system). In addition, it is often difficult to distinguish the outcome of a particular fire management initiative from the effects of other outside variables on the issue (e.g., other federal and state fire management initiatives, community-base fire management initiatives, changes in land use, etc.).

2.6 Phone Survey

In order to assess successful behavioral changes associated with the BLM's Community Assistance projects, we have conducted a stratified public opinion survey in the same three geographical areas targeted by ecosystem services valuation assessments. Based upon the survey instrument's beta testing, we determined that we could generate significant results if we focused the study on a smaller target population. Zip codes were chosen as the study unit for both the ecosystem services valuation and this behavioral change assessment. This study examined behavioral changes in households after participation in a phone survey assessment. Home assessment visits by a trained coach, which involved a walk-through in the home with the home residents, were conducted in 36 homes In order to maintain quality control of these survey, we generated our own phone survey instrument and used in-house technicians and software for doing the surveying and statistical analyses required on the responses to the survey.

The first step in the survey was to obtain descriptions of BLM's Community Assistance Program during the study period (2002-2004). The geographic areas were identified by

selecting the appropriate zip codes where outreach efforts and hazardous fuel treatments had been implemented. We then purchased randomly select telephone numbers for the geographical areas and performed beta testing the survey questionnaire to identify any additional modifications that might be needed to the final survey instrument. We then surveyed the targeted population; computer recorded the results, and ran the statistical analysis on the resulting responses.

3.0 METHODOLOGY

3.1 Site Selection

For both the phone survey and ecosystem services valuation assessments, our study sites were chosen by first generating a query map of the concentrations of community assistance grants, and fuels projects funded by the BLM and the Rural Fire Assistance Program (RFA) from 2002-2004. A density analysis map was created by the BLM with data generated from the National Fire Plan Operations and Reporting System (NFPORS) and can be found in Appendix B. The purpose of this first level of analysis was to determine those locations in California that have been targeted for receiving the most funding through these federal programs. In discussions with the CA BLM, site selection was further refined from nine of these counties (with high concentrations of grant recipients) down to three counties for the purposes of this assessment. In the event that more resources become available, it is recommended that an assessment of this kind be performed for the entire State.

The three counties selected for performing the phone survey and the NaturalAssets™ Information System evaluation were Napa, Humboldt and San Bernardino Counties. They were selected because:

- All three have at least partial coverage from the 2001 NLCD canopy/impervious surface update. San Bernardino contains the least but its "communities at risk" and treatment locations generally appear to be within the updated area.
- These counties represent a good cross section of vegetative communities, latitude and development patterns (see Section 3.1, Transferability of Results).
- Napa has some good county-level GIS data which can be used to supplement the USGS data. Humboldt State University and the Forest Service also have some decent supplemental data for Humboldt County.
- All three have significant BLM lands within their boundaries.
- All three counties have a diverse number of land cover types and hazardous fuel treatments.
- All three counties are covered by the 1997-2001 California Land Cover Mapping and Monitoring Program.

Once these three counties had been selected, we focused our assessment on specific zip codes that have had either BLM Community Assistance Projects or Hazardous Fuel Projects. These zip codes were primarily selected using the National Fire Plan Operations and Reporting System (NFPORS) and the reporting system for the CA BLM's Community Assistance Program.

3.2 Transferability of Results

Humboldt, Napa and San Bernardino Counties contain an astonishing degree of landscape heterogeneity, ranging from coastal rainforests to arid inland deserts. While some landscape types are common to all three, such as hardwood, mixed and conifer forests, wetlands and agricultural land, other types are unique to the regions in which those counties fall, such as Napa's vineyards, Humboldt's old growth redwood forests and spotted owl habitat and San Bernardino's desert habitats.

The three counties were selected because they come as close as any combination of three counties can come to representing California's heterogeneous landscapes. Obviously, however, major differences exist between study counties and the areas for which we consider them representative. California contains many unique features that are irreplaceable.

Nevertheless, because the value transfer method used in this study uses the relationship between general land cover types and estimated economic values, the estimates presented below are transferable to many other parts of the state. In other words, these counties' land cover types are sufficiently representative of most of California's major biomes to allow for the transfer of ecosystem service values by land cover type.

From this perspective, Humboldt County's coastal forests, which include many types of redwood, could be considered representative of much of the northern coast of California, including Sonoma, Mendocino and Del Norte. Its inland conifer forests, as well as San Bernardino's, can be considered representative of much of the coast range as well as the Sierra Nevada. Its bays, estuaries and coastal wetlands can be thought of as representative of the San Francisco Bay and other coastal wetland areas. Napa's agriculture can be thought of as representative of much of the Central and Imperial Valley. Its hardwood forests and rangelands can be thought of as representative of much of the central coast region. The arid piedmont and desert of San Bernardino can be thought of as representative of much of eastern desert California, although we found no studies valuing the desert type.

In terms of the phone survey assessment, we did a thorough analysis of the socio-economic conditions of these three counties to determine the transferability of the results. Although the phone survey case study counties were surveyed separately to assess behavioral responses in various parts of the State, the results demonstrated similar trends amongst all three counties (Section 4.4 Phone Survey Results). Thus, the results have already expressed a level of transferability to other parts of the State.

3.3 Accounting for Ecosystem Goods and Services

In this report, we use the concept of ecosystem goods and services to establish a technical link between people and ecological systems. Building on recent advances in the peer-reviewed literature, we develop reliable, baseline estimates of ecosystem goods and services within the three study counties: San Bernardino, Napa and Humboldt.

> ***Ecosystem services*** *are the benefits people obtain either directly or indirectly from ecological systems. Ecosystem services include products such as food, fuel, and fiber; regulating services such as climate and water regulation and flood control; and nonmaterial assets such as recreational or aesthetic benefits*

As this definition suggests, the concept of ecosystem goods and services is inherently people-oriented: it is the presence of human beings that enables the translation of basic ecological structures and processes into value-laden entities. Through laws and rules, land use management and policy decisions, individuals and social groups make tradeoffs between competing ecosystem values. In turn, these land use decisions directly modify the structures and processes of the natural environment by engineering and construction and/or indirectly by modifying the physical, biological and chemical processes of the natural system. The goods and services used in this report are listed below in Table 1[5]:

TABLE 1. Ecosystem Goods and Services

Ecosystem Services	Examples
Gas and Climate Regulation	• Carbon dioxide sequestration • Oxygen production • Volatile organic compound (VOC) uptake
Disturbance Prevention	• Storm protection • Flood Prevention
Water Regulation	• Water Catchments • Groundwater recharge • Drainage and natural irrigation
Water Supply	• Provision of water for irrigation • Drinking water and industrial use • Medium for Transportation
Soil Retention and Formation	• Maintenance of productive soils • Prevention of damage from erosion and siltation • Maintenance of arable land

[5] Alternative lists of ecosystem goods and services have been proposed (see for example, Costanza et. al., 1997 and De Groot et. al., 2002); we developed this list for its specific applicability to landscape analysis in San Bernardino, Napa and Humboldt counties.

Nutrient Regulation	• Nutrient filter • Remineralization of organic and inorganic matter • Trapping sediments and pollutants
Waste Treatment	• Pollution control/detoxification • Filtering of dust compounds • Abatement of noise pollution
Pollination	• Pollination of marketable crops • Maintenance of wild plant species and populations
Biological Control	• Control of pests and diseases • Reduction of herbivory (crop damage)
Habitat Refugium	• Nursery, feeding and breeding ground for harvested species • Maintenance of biodiversity and genetic resources • Habitat for resident and migratory species (e.g., Spotted owl)
Aesthetic and Recreational	• Aesthetic quality—proximity of houses to amenities • Recreational hunting and fishing • Enjoyment of Scenery
Cultural and Spiritual	• Cultural and archaeological heritage sites • Working historical landscapes • Spiritual and religious meaning

As the list of ecosystem goods and services in Table 1 shows, not all ecosystem goods and services are inherently substitutable with one another. For any given landscape, there are many different services that may be provided by different land cover types, each of which offers a unique contribution to human welfare to the citizens of California. For example, a forest may provide fuel wood or food sources, it may help regulate climate through carbon sequestration, it may prevent soil erosion and provide humus for soil formation and it may also provide aesthetic beauty and recreation opportunities. Alternatively, a freshwater wetland may provide fresh water supply and regulation, waste assimilation of nutrients and toxic compounds, and critical wildlife habitat refugium. All of the goods and services associated with each land cover type—forest and wetland--contribute to the total economic value provided by the functioning ecological system (National Research Council 2004; Turner 2000b).

While acknowledging that human values for such ecological systems can extend from the spiritual to the utilitarian (Goulder & Kennedy 1997), the term value as it is employed in this report has its conceptual foundation in neoclassical economic theory (Freeman 1993). Simply put, economic value is the amount of money a person is willing to give up in order to get an ecosystem good or service (WTP), or the amount of money required to give up that good or service (WTA).

Ecosystem goods and services are commonly divided into two broad categories: (1) the provision of direct market goods or services such as food, pollution disposal, and raw materials; and (2) the provision of non-market goods or services which include things like climate regulation, habitat for plant and animal life, and the satisfaction people

derive from a nice view of a white sand beach or forested landscape. Throughout this report, we therefore distinguish between these two types of value with a primary focus on non-market values since they are the ones most often left outside of the decision making calculus.

In sum, the concept of ecosystem goods and services is used in this report for three fundamental reasons:

- First, it helps to synthesize essential ecological and economic concepts, allowing researchers and land managers associated with California BLM projects to link human and ecological systems in a viable and relevant manner.
- Second, it draws upon the latest available economic and ecosystem science.
- Third, politicians, business leaders and citizens alike can readily grasp and use the concept to evaluate inevitable tradeoffs between land use development and fire hazard mitigation alternatives.

The forests, rivers, estuaries and wetlands throughout the State of California clearly provide many different goods and services to people who live or visit the state. Viewed in light of the development pressures that the State of California is experiencing throughout the wildland-urban interface, significant challenges for planners and decision makers are inevitable. The citizens of San Bernardino, Napa and Humboldt counties will inevitably be forced to make tradeoffs between competing uses of the environment, encumbering the opportunity costs of potentially losing some of the uses and societal benefits to wildfire. Our challenge is to provide the CA BLM with the best information available so that such decisions can be better informed and more efficient.

3.4 Economic Value Transfer Methods

Here, we briefly assess available techniques for valuing natural ecosystems using economic methods. For that reason, we focus on the sources of non-market ecological value that can be captured through economic valuation despite recognizing that other kinds of value may ultimately contribute to decisions regarding ecosystem use, preservation, or restoration (Goulder & Kennedy 1997).

Economic valuation can help to ensure that ecosystem services that are not traded in markets and do not have market prices receive explicit treatment in economic assessments. Our goal is not to 'create' values for ecosystems. Rather, our purpose is to generate a conservative baseline estimate of the values that people already hold with respect to these ecosystems through an assessment of the best available literature. Such information will in turn assist in our assessments of the benefits provided by community assistance and hazardous fuels programs in California. This approach is consistent with that being taken in the international Millennium Ecosystem Assessment, which focuses

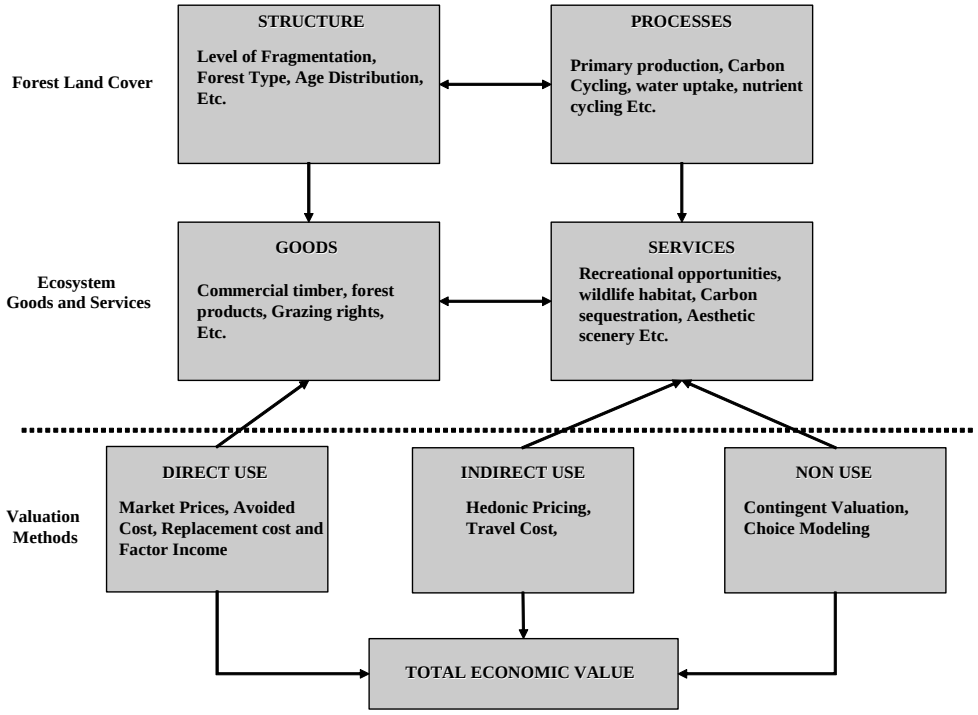
international policy makers' attention on the contributions of ecosystems to human well-being (Argady *et al* 2005; Millennium Ecosystem Assessment 2003).

Importantly, the ecological economic perspective used in this study provides a systematic way in which such values can be factored into environmental policy choices (Kopp 1993). Below, we briefly provide an overview of economic valuation and the role it can play in improving environmental decision-making. The challenge is first to identify the values that are, and those that are not, captured by the economic approach to valuation and then to discuss how a quantification of the values can contribute to better environmental decision-making.

The Total Economic Value Framework

The *total economic value* (TEV) framework is based on the presumption that individuals can hold many different kinds of values for ecosystems in the study area ranging from *market-based* values like timber to *non-market* values like aesthetics and beauty (see Figure 1). It also provides a basis for clearer understanding of how the myriad values or benefits provided by ecological systems affect people. Although any taxonomy of such values is somewhat arbitrary and may differ from one use to another, the TEV framework is necessary to ensure that all values are given recognition (Bishop et al 1987a).

Figure 1: Total Economic Value Framework for Ecosystem Goods and Services*



* Adapted from Turner (2000)

The framework shown in Figure 1 distinguishes between *use* values and *nonuse* values associated with forest ecosystems. The former refer to those values associated with current or future (potential) market-based uses of an environmental resource by an individual or group, while the latter arise from the continued existence of the resource and are unrelated to use in the market place (Duffield 1997; Freeman 1993). Typically, use values involve some human interaction with the resource whereas nonuse values do not. Importantly, within this framework an individual can hold both use and nonuse values for natural ecosystems.

A number of TEV frameworks have been proposed in recent decades (Bishop *et al* 1987a; Freeman 1993; Turner 2000a). Although varied in detail and application, the distinction between market-based use and non-market, nonuse values is a fundamental theme. As the discussion below reveals, several alternative methods have been developed to measure non-market components of TEV.

Value Transfer of Non-Market, Nonuse Estimates

One of the primary goals in this the report is to shed light on the non-market economic benefits of ecosystem goods and services associated with the landscapes in San Bernardino, Napa and Humboldt counties that are affected by fire hazard mitigation efforts.

Yet, the problem immediately arises: how does one estimate the economic value of goods and services that are not widely traded in the marketplace? While a fair amount of research has been done on the economic value of ecosystem services globally (Costanza et al 1997; Millennium Ecosystem Assessment 2003), relatively limited peer-reviewed work has been done to estimate the specific economic values of ecosystem services located in San Bernardino, Napa and Humboldt counties. Because limited empirical ecosystem service valuation research has been done at the study sites, we were required to "transfer" values from other sites.

To estimate the economic value of ecosystem services used in this report, we used a decision-support methodology developed by Spatial Informatics Group (SIG), LLC, the NaturalAssets™ Information System, that allows us to dynamically select, review and query peer-reviewed economic valuation research that has already been done in similar areas.

While measuring the use values associated with marketed goods and services simply requires monitoring market data for observable trades, non-market values of goods and services are much more difficult to measure (Bingham et al 1995). When there are no explicit markets for ecosystem goods and services, more indirect means of assessing economic values must therefore be used. A subset of economic valuation techniques

commonly used to establish values when market values do not exist are identified in Table 2 below[6].

Table 2. Conventional Non-Market Valuation Techniques
Avoided Cost (AC): services allow society to avoid costs that would have been incurred in the absence of those services; flood control (barrier islands) avoids property damages, and waste treatment by wetlands avoids incurred health costs.
Marginal Product Estimation (MP): Service demand is generated in a dynamic modeling environment using production function (i.e., Cobb-Douglas) to estimate value of output in response to corresponding material input.
Factor Income (FI): services provide for the enhancement of incomes; water quality improvements increase commercial fisheries harvest and thus, incomes of fishermen.
Travel Cost (TC): service demand may require travel, whose costs can reflect the implied value of the service; recreation areas attract distant visitors whose value placed on that area must be at least what they were willing to pay to travel to it.
Hedonic Pricing (HP): service demand may be reflected in the prices people will pay for associated goods: For example, housing prices along the shore of pristine freshwater lakes tend to exceed the prices of inland homes.
Contingent Valuation (CV): service demand may be elicited by posing hypothetical scenarios that involve some valuation of alternatives; people would be willing to pay for increased water quality in freshwater lakes and streams.

As the descriptions in Table 2 suggest, each non-market valuation methodology represented in the NaturalAssets™ information system has its own strengths and limitations, often limiting its use to a select range of ecosystem goods and services within a given landscape. For example, the economic value generated by a naturally functioning ecological system can be estimated using Avoided Cost (AC), based on the estimated cost of damages due to lost services. However, because these estimates are highly sensitive to market conditions used to estimate costs, they must be used with great caution. While rigorous and well established in the field, Travel Cost (TC) is primarily limited to estimating recreation values, while Hedonic Pricing (HP) is used for estimating property values associated with aesthetic qualities of natural ecosystems. On the other hand, Contingent Valuation (CV) surveys are often widely used to estimate the economic value of less tangible services like critical wildlife habitat or biodiversity. The challenge with CV and related methods like choice modeling is that estimated values are highly sensitive to the survey format and context of valuation (Heberlein et al 2005).

In this study, the full suite of ecosystem valuation techniques is used to account for the economic value of goods and services provided by natural landscapes in San Bernardino, Napa and Humboldt counties.

Value transfer by definition involves the adaptation of existing valuation information or data to new policy contexts with little or no data[7]. The transfer involves obtaining an

[6] This list of non-market valuation techniques is not intended to be all-inclusive. Rather, it is intended to reveal the breadth of available empirical techniques that have been and are currently being, explored in the field of ecosystem service valuation.

estimate for the economic value of non-market goods or services through the analysis of a single study, or group of studies, that have been previously carried out to value similar goods or services. The transfer itself refers to the application of estimated point values, derived utility functions, and other information from the original 'study site' to a 'policy site' (Desvousges et al 1998; Loomis 1992).

While we accept the fundamental premise that primary valuation research will always be a "first-best" strategy for gathering information about the value of ecosystem goods and services (Downing & Ozuna 1996; Kirchhoff et al 1997; Smith 1992), we also recognize that value transfer has become an increasingly practical way to inform policy decisions when primary data collection is not feasible due to budget and time constraints, or when expected payoffs are small (Environmental Protection Agency 2000; National Research Council 2004).

In other words, value transfers will always represent a policy-relevant compromise solution. When primary valuation research is not possible or plausible, then value transfer, as a "second-best" strategy, is important to consider as a source of meaningful baselines for the evaluation of management and policy impacts on ecosystem goods and services. However, the real-world alternative is to treat the economic values of ecosystem services as zero; a status quo solution that, based on the weight of the empirical evidence, will often be more error prone than value transfer itself.

3.5 Ecosystem Service Valuation (ESV) Data

The raw material for the value transfer exercise in this report comes from previously published studies that empirically measured the economic value of environmental goods and services. Generally speaking, there are three types of valuation research that exist in the field today:

- Peer-Reviewed journal articles, books and book chapters, proceedings and technical reports that use conventional environmental economic valuation techniques and is restricted to an analysis of social and economic values
- Non Peer-Reviewed publications that include PhD dissertations, non peer-reviewed technical reports and proceedings as well as raw data available on the WWW.
- Secondary analysis (e.g., meta analysis) of peer reviewed and/or non peer-reviewed studies that use both conventional and non-conventional valuation methods

[7] Following Desvouges et. al. (1998), the term 'value transfer' is used instead of the more commonly used term 'benefit transfer' to reflect the fact that the transfer method is not restricted to economic benefits, but can also be extended to include the analysis of potential economic costs, as well as welfare functions more generally.

The critical underlying assumption of the NaturalAssets™ Information System is that the ESV's for ecosystem goods or services at the selected study sites can be inferred with sufficient accuracy from the analysis of existing non-market valuation studies. Clearly, as the level of information increases within the source literature (i.e., more studies are done), the accuracy of the value transfer likewise improves. The research team developed a set of explicit decision rules for querying economic results from the raw data contained in the NaturalAssets™ system that would allow us to estimate with sufficient accuracy the economic value of ecosystem services in San Bernardino, Napa and Humboldt counties. The research team selected valuation studies that were:

- Peer reviewed and published in recognized journals
- Focused on temperate regions in either North America, Canada or Europe
- Focused primarily on non-consumptive use

Using these search criteria, we were able to obtain data from a set of viable studies (n=84) whose results were then standardized to 2004 U.S. dollar equivalents per acre to provide a consistent basis for comparison[8]. Because each study may contain more than one estimate of value, the end result is a collection of valuation data points that are coded by temporal (i.e., time of study), spatial (i.e., place where study was done) and methodological (i.e., method used) criteria thereby allowing the research team to derive a lower bound and upper bound estimate of dollar values for the study site. For this study, we were able to generate a total of (n=205) individual point estimates for reviewed land cover types (see results below). Given the aforementioned restrictions and gaps in the available literature, this approach yields conservative, baseline economic values for San Bernardino, Napa and Humboldt counties (See results section III).

In sum, the transfer method adopted in this report involves obtaining an estimate for the value of ecosystem goods or services through the analysis of peer-reviewed research that has been previously collected and stored in the NaturalAssetsTM system in a standardized format so that it can further be augmented with site-specific GIS data (i.e., land cover, socioeconomic characteristics) to ensure reliable valuation estimates at the study site.

3.6 Spatial Analysis Methods

Another principal goal in this project is to link the ESV estimates for ecosystem goods and service to available land cover/land use data in San Bernardino, Napa and Humboldt counties (see results section IV). We have developed a decision-support tool that helps decision makers assess whether the economic benefits of today's development—jobs, increased tax revenues—compensate for the economic costs to natural resources that will be borne by society now or in the future. The NaturalAssets™ Information System

[8] All dollar values are standardized to 2004 using Consumer Price Index tables published by the U.S. Department of Labor. http://www.bls.gov/cpi/home.htm.

provides us with the ability to account for and track environmental assets and potential liabilities in a fully customized, spatially explicit format that then can be used in conventional economic assessments. Combining Geographic Information Systems (GIS) and relational database technology, provided our team with the ability to generate maps and economic statistics for specific counties by linking together summaries of peer-reviewed economic valuation studies with GIS land cover layers in a flexible decision-making environment.

Thanks to the increased ease of using Geographic Information Systems (GIS) and the availability of land cover data sets derived from satellite images, ecological and geographic entities can more easily be attributed with ecosystem services and the values they provide to people(Wilson & Troy 2005; Wilson et al 2004). In simplified terms, the technique discussed here involves combining one land cover layer with another layer representing the geography to which ecosystem services are aggregated - i.e. a watershed. While the aggregation units themselves are likely to be in vector format, because vector boundaries are most precise, the land cover layer may be either raster or vector[9]. Spatial disaggregation increases the contextual specificity of ecosystem value transfer by allowing us to visualize the exact location of ecologically important landscape elements and overlay them with other relevant themes for analysis - biogeophysical or socioeconomic. A common principle in geography is that spatially aggregated measures of geographic phenomena tend to obscure local patterns of heterogeneity (Fotheringham et al 2000; Openshaw et al 1987).

Analogously, aggregate measures of non-market values, while useful, can also obscure the heterogeneous nature of the underlying resources that provide those services and thus provide misleading results. For example, an aggregate measure of ecosystem services at the global level may indicate significant amounts of a land cover type associated with nutrient cycling and waste treatment, such as estuaries (Costanza et al 1997). This measure does not tell us, however, whether the estuaries are distributed evenly throughout the world or are all clustered in one region. Obviously, those two possibilities have significantly different ramifications for resource use and landscape management. Not only does a clustered pattern of estuaries imply that some regions have more than others, but it also means that the social cost of losing one estuarine system is much higher in the areas of scarcity than in the areas of clustering.

3.6.1 Development of Land Cover Typology

Two types of values were spatially mapped for this project: ecosystem service values, and structural improvement values. The first and third required accurate, high resolution and categorically meaningful depictions of land cover. Before developing these maps, a land cover typology was created. To do this, we assessed available data coverages to determine which land cover classes at what level of categorical precision could be mapped at a usable scale and with acceptable levels of accuracy. Once an initial typology

[9] The vector data model represents spatial entities with points, lines and polygons. The raster model uses grid cells to represent quantities or qualities across space.

was created, SIG assessed the availability of peer reviewed literature placing values on those cover types. In cases where a cover type was not known to be valued, it was either given a value of zero (but still mapped, in case an applicable study should be found later) or lumped in with another similar class for which valuation studies existed. Table 3 shows the resulting typology with the code name for each cover class, its description and the counties in which it was present.

Table 3. Land Cover Typology with Applicable Counties

Code	Description	Counties
AGR	Agriculture	All
CON	Conifer	All
DSHB	Desert Scrubland	San Bernardino
DWLD	Desert Woodland	San Bernardino
EST	Estuary and tidal bay	Napa, Humboldt
FWET	Fresh wetland	All
HDW	Hardwood oak woodland	All
HEB	Herbaceous	All
MIX	Mixed hardwood, conifer	All
OWLF	Forested areas suitable for spotted owl habitat	Humboldt
RIPF	Riparian forests (50 meter buffer)	All
RW2	Redwood-second growth	Napa, Humboldt
RWOG	Redwood-old growth	Humboldt
SHB	Shrubs	All
SWET	Salt wetland	Napa, Humboldt
URB	Urban and barren	All
URBG	Urban green (forest and grass)	All
VIN	Vineyard	Napa
WAT	Open water	All

3.6.2 Spatial Data

Because of differing data availabilities, each county was mapped separately. A number of publicly available layers needed to be combined in each case to yield a map with this typology. The California Land Cover Mapping and Monitoring Program 2003 vegetation layer (referred to from here on as "Calveg") was used as the base map from which additional features from other layers were added. While this map contained many of the categories listed in the typology, it was still missing many critical categories. Also, while fairly accurate for terrestrial vegetation type, it lacked accuracy for other classes, like urban areas, agriculture and wetlands. To address this, we updated our maps using other layers that had better information for certain poorly represented or absent categories. In some cases, an ideal layer for a certain category (e.g. wetlands) only had partial coverage (e.g. NWI wetlands layer), necessitating us to obtain such a class from a variety of sources. All of the data sets used are given in table 4 below.

Table 4. Data sets utilized for land cover				
Data set	**Source**	**County used for**	**Class used for**	**Coverage**
2002 Multi-source Land Cover Data (v02_2) California Land Cover Mapping and Monitoring Program (LCMMP) Vegetation map (fveg)	CDF	San Bernardino	AGR, CON, DSHB, DWLD, HDW, HEB, SHB, URB, WAT, FWET, SWET	Complete
2003 California Land Cover Mapping and Monitoring Program (LCMMP) Vegetation map (Calveg)	CDF	All	CON, SWLD, HDW, HEB, MIX, OWLF, RIPF, SHB	Partial
1992 National Land Cover Dataset (NLCD)	USGS	Napa, Humboldt	AGR, VIN	Complete
2001 NLCD Impervious Surface Layer	USGS	Napa, San Bernardino	URB	Partial
2001 NLCD Canopy Cover Layer	USGS	All	URBG, RIPF	Partial
Coastal Redwoods Vegetation	CDF	Napa, Humboldt	RW2, RWOG	Partial
National Wetlands Inventory (NWI)	USFWS	All	FWET, SWET, EST	Partial
National Hydrography Dataset (NHD)	USGS	Napa, San Bernardino	WAT, FWET, RIPF	Complete
Northern Spotted Owl Habitat Dataset	USFS	Humboldt	OWLF	Complete
LCMMP Cause of Change Dataset	CDF	Humboldt	SHB	Complete
Urbanized area boundaries	US Census	All	URBG	Complete
1:24,000 hydrology	US Bureau of Reclamation	Humboldt, San Bernardino	RIPF	Complete

3.6.3 Spatial Overlay

To create output land cover layers with the appropriate typology, the processing steps described in detail below were used.

First, all data were clipped to their respective study area boundaries and projected to the UTM plane coordinate system (zone 10 for Napa and Humboldt, zone 11 for San Bernardino). For each county the "Covertype" field (land cover type) of the base Calveg layer was reclassed into a smaller number of categories to account for the fact that some categories from our typology included multiple categories from the Calveg typology (e.g. Urban and Barren were recombined into the Urban category). Maps of study areas for each county are given in Appendix 1, and participating mitigation program communities and sites are given in Appendix 2.

Next, vector geoprocessing was performed to combine ancillary vector (see Appendix A: Glossary of Common Terms) layers (NHD, NWI, Coastal Redwoods) with the Calveg layer, which is also a vector layer. In the case of NWI, a new layer was created from a selection of the estuaries and fresh and salt water wetland polygons in that layer. The

resulting output was then unioned with Calveg (see Appendix A: Glossary of Common Terms). The covertype of all polygons occupied by salt wetlands was set to SWET, by fresh wetlands to FWET and by estuaries to EST. In the case of Humboldt County, the open water polygons (lakes, ponds etc) were also extracted from the NWI layer to update the WAT category. For Napa and San Bernardino, water bodies were obtained from the NHD in a similar fashion: the desired class was selected and output to a new layer which was then unioned with the Calveg layer, following its union with the NWI layer. All those polygons occupied by NHD water body were set to WAT. Vector geoprocessing was also used to combine the redwood and Calveg layers. Because the Calveg layer is at a finer scale, but lacks information on redwoods, any polygon that was classed as CON by Calveg, but overlaid a 2nd growth redwood polygon from the redwood layer was classed as RW2. Similarly, any calveg polygon classed as CON and overlaying an old growth redwood polygon was classed as RWOG. Those non-conifer polygons that overlaid redwood polygons were not classified as redwood.

Fourth, the resulting layer was converted to a raster format (15 m cells for Napa, 30 for Humboldt and San Bernardino) for combination with other raster layers. In the case of Napa, a large area was left unclassified by Calveg, and so the raster calculator Conditional function was used to update areas with "unmapped" pixel values to the value of the 1992 NLCD layer for Napa and Humboldt Counties and the 2002 multi-source land cover raster data (FVEG) layer for San Bernardino County. The Conditional function operates like an if-then statement for raster data. For pixels where a specified condition or set of conditions is true, it returns either a given number value or the value of that pixel from one layer. Where it is not true, it returns the value of the corresponding pixel from a different layer. So, in this case, where the given Calveg value was "unmapped" (corresponding to a numeric code), it returned the pixel values from NLCD or Fveg (which had been reclassed to have numeric correspondence with the Calveg classes). Where pixels were designated something other than "unmapped" (that is, where they had a mapped class in the Calveg layer) it retained the Calveg values.

More raster values were updated from other layers in this way. First, because wetlands coverage was not complete in all counties, wetlands were updated from the less accurate NLCD layer where not available from NWI, also using the Conditional function. In the case of Napa, the Vineyard class was missing from the Calveg layer, so that class was added also using the Conditional function. Since both Calveg had poor mapping of urban areas and the 1992 NLCD layer had out of date mapping of such areas, the 2001 NLCD impervious surface layer was used for Napa and San Bernardino to update urbanized areas, using the conditional function. All pixels with impervious levels greater than 25% were classified as urban. In the case of Humboldt County, only the 1992 NLCD layer was used for that purpose. The LCMMP land change database was consulted to see if significant urban development had occurred since then in Humboldt, but it appeared that very little had so urban growth was not updated to a later time period. Nevertheless, that layer indicated that a great deal of clearcutting had occurred in the county so, using the conditional function, all areas that had been mapped as forest but overlaid an area designated as a major cut had their cover changed to SHB. While it is recognized that forests generally regenerate after clearcutting, this land cover change assumption rests on the contention that for several years following a major cut, early primary successional

forests do not yield most of the ecosystem services that more established forests do (e.g. their ability to regulate water flow, attenuate floods, cycle nutrient and provide habitat refugium are all greatly reduced). Because this analysis represents a snapshot in time, we assume that over time, as these cut-over areas mature, their cover class would transition back to forest. However, in the short term, we conservatively treat them as having a similar profile to shrublands.

Urban green space was mapped by rasterizing urbanized area boundaries from the census, and then identifying urban area pixels where canopy cover, determined from the 2001 NLCD canopy layer, was greater than 50%. Again this was performed using the conditional function. Riparian forests were added by creating a raster map of distance to nearest watercourse (1:24000 hydrography from the US Bureau of Reclamation for Humboldt and 1:24,000 hydrography from the National Hydrography Dataset for Napa and San Bernardino). A conditional statement was then used to identify all areas that were both within 50 meters of a mapped stream and were classed as a forest type. Finally, for Humboldt County, the US Forest Service's Northern Spotted Owl Habitat layer was rasterized and overlaid with the Calveg layer. Again using the conditional function, all forest polygons that overlaid the habitat layer were reclassed as OWLF.

The result of this spatial analysis was a land cover map for each county (see maps of land cover in Appendix C). In the case of Napa county, the land cover map produced was at a 15 meter resolution (although some data from which it was derived were based on coarser resolution), while the other two counties were at 30 meter resolution. The next task involved summarizing the land cover layers by polygon geographies, specifically zip code, watershed (for Napa and Humboldt Counties, Planning Watersheds, the smallest unit from CDF's Calwater watershed layer, are used; for San Bernardino, the more aggregated Hydrologic Units are used) and property parcel (obtained separately from each county). This was done using the Tabulate Areas raster analysis function, which creates a cross tabulation with land cover types in columns, unique polygon identifiers (for instance zip codes) in rows, and areas in the cells. While this proved adequate at the watershed and zip code level of aggregation, it was inadequate for parcels, given the fact that in some cases a single parcel was smaller than a pixel. So, to summarize land cover by parcel, the land cover map was converted from raster to vector format and unioned with the parcel layer, to be stored in an Arc GIS geodatabase.

In MS Access, a cross tabulation query was run to summarize parcel number in rows, land cover type in columns and areas in cells. The output table was then joined to the parcel layer for viewing. In addition, property assessment tables obtained from the county governments, giving improvement value by parcel, were joined to the parcel layers, allowing those values to be mapped. Finally, we created tables that summarized the acreage of each land cover class for each county. Areas and ecosystem service values for each land cover were cross-tabulated by watershed and by zip code for each county in Excel.

3.7 Spatially Explicit ESV Calculation Methods

Ecosystem service values were then determined by multiplying areas of each cover type, in acres, by the dollar per acre ecosystem service value for that cover type. The economic values used to estimate the values associated with each ecosystem good or service are drawn from the NaturalAssets™ information system as described above.

The total ESV of a given cover type for a given watershed can thus be determined by adding up the individual, non-substitutable ecosystem service values associated with that cover type. The following formula is used:

$$V(ES_k) = \sum_{i=1}^{n} A(LU_i) \times V(ES_{ki})$$

Where A(LUi) = Area of Land Use (i)
and V(ESki) = Annual value of Ecosystem Services (k) for each Land Use (i).

Resulting values were estimated for the entire study area using value transfer methods. Following that, the ESV's were aggregated by county study area, broken down for each county by land cover and cross-tabulated for each study site by: 1) land cover and watershed and; 2) land cover and zip code. Assessed structural improvements were also summarized to generate a total economic value estimate for critical human-modified land uses. These values were then compared with the BLM expenditures in each county to generate a treatment cost for each county and for each study area within each county.

3.8 Phone Survey Methods

The data is to be collected by telephone from the targeted group as specified below in sample selection. The following is the methodology used to conduct the study. The spatial extent of zip codes chosen will be used concurrently for the phone survey and GIS ecosystem services evaluation. A statistically significant number of random phone numbers will be purchased within these zip codes for the purpose of conducting the phone survey.

A draft of the questionnaire was submitted to BLM so that appropriate revisions could be made. The draft questionnaire was tested on a sampling of phone numbers as described below. Further revisions were made according to the beta test. The interviewers were trained on the purpose of the study, general telephone techniques, and the questionnaire. The questionnaire was rehearsed within the group, attempting to obtain all possible answers to each question. A pretest phone survey of 30 completed questionnaires was

performed for the purpose of final review of the instrument. Callbacks were conducted for the questions that did not obtain the appropriate information.

The phone surveys were conducted between July 1, 2005 and August 31, 2005. Surveys were conducted between 9:00 AM and 9:00 PM, seven days a week. The interviewers used a call-assisted direct entry system to enter responses directly into a computer database. The direct entry system eliminated certain interviewer errors such as not following skip patterns and missing questions. All listed residential phone numbers within the 75 total zip codes in the three counties were used as the database of survey phone numbers. 4084 of these phone numbers were selected using a random selection function in the phone number database. Survey calls were made to 3390 of these numbers.

The data was analyzed using frequency distributions and descriptive statistics. A Chi-squared test was used to analyze the three counties as independent population but there was rarely a significant distribution to merit separating the results from each county. Data analysis included a set of computer frequencies for each variable as well as cross-tabulation tables by segments of the population such as gender, age, and geographic location and use of the chi-square test. The chi-square test is used when respondents have been allocated to categories of two variables (e.g., race and neighborhood problems). The chi-square test compares the number of cases falling into each cell of the table with the frequency that would be expected if there were no association between the two variables that form the table. If the significance value is equal to or less than 0.05 (probability of committing a Type-I error), you can conclude that the chi-square test indicates that there is a statistically significant association between the two variables[10].

The protocol for the analysis is to focus on statistical relationships in which there is an observed significance level of 0.05 or less as measured by the Pearson chi-square. These are relationships in which we can be confident that there is only a 5 percent error of rejecting the null hypothesis that the relationship are just by chance. In some cases, a somewhat lower confidence level will be used (up to 0.10 if a particularly interesting result is observed or to compare results for two or more subgroups). When significant statistical relationships are observed between variables, a comment will be made as to how these variables seem to be related. These relationships will be noted in the analysis, but the reader should keep in mind several qualifications. The margin of error for the stratified random sample (e.g., the three geographic areas) is plus or minus 4.5% and dependent upon the results of the analysis of data gathered for each survey question. Furthermore, confirmation of the way in which two variables are related would require more elaborate statistical tests than are presented in this analysis.

[10] The chi-square test is only valid if three conditions are met. First, the data must be independent; no respondent can appear in more than one cell of the table. Secondly, no cell should have an expected frequency of less than one. The third requirement is that no more than 20 percent of the expected frequencies in the table can be less than five. The expected frequencies are calculated for each cell in the table by multiplying the appropriate row and column totals and dividing by N. The chi-square frequency table shows the number of cases in each cell of the table, followed by the value of chi-square (labeled Pearson), the degrees of freedom, and the probability (Foster 1998)

4.0 RESULTS

4.1 Ecosystem Service Value Transfer Results

Here we present results from the primary non-market analysis of data contained in the NaturalAssets™ information system. Using the list of ecosystem goods and services described above in table 1 and the new land cover classes generated in table 3, the research team conducted dynamic queries of the best available economic valuation data to generate conservative baseline ecosystem service values estimates for the entire study area.

Using the value-transfer search criteria outlined above in section II, the research team obtained data from a set of 84 viable empirical studies, whose results were then standardized to 2004 U.S. dollar equivalents per acre/per year to provide a consistent basis for comparison in the following tables[11]. The aggregated baseline ESV results for all land cover types represented within the study area are presented in Table 5:

Table 5: Aggregate Ecosystem Services for All Available Land Cover Types

Code	Description	Min $ acre/yr	Max $ acre/yr	Average $ acre/yr
AGR	Agriculture	$83.47	$1,689.04	**$887.06**
CON	Forest-Conifer	$32.48	$999.79	**$332.35**
DSHB	Desert Shrub	*NA*	*NA*	***NA***
DWLD	Desert Woodland	*NA*	*NA*	***NA***
EST	Estuary	$1,483.90	$5,239.01	**$2,386.75**
FWET	Fresh wetland	$1,761.07	$9,180.73	**$4,440.73**
HDW	Hardwood oak woodland	$61.68	$486.84	**$177.82**
HEB	Herbaceous	*NA*	*NA*	***NA***
MIX	Mixed hardwood, conifer	$34.32	$1,001.63	**$334.19**
OWLF	Spotted Owl Habitat	$100.53	$1,113.86	**$403.86**
RIPF	Riparian Forest	$122.17	$15,126.99	**$3,558.03**
RW2	Redwood Second Growth	$29.89	$997.20	**$329.76**
RWOG	Redwood Old Growth	$84.63	$1,051.94	**$384.50**
SHB	Shrubs	*NA*	*NA*	***NA***
SWET	Saltwater Wetland	$229.18	$8,845.04	**$2,446.06**
URB	Urban and Barren	*NA*	*NA*	***NA***
URBG	Urban Green	$602.29	$4,289.91	**$2,268.21**
VIN*	Vineyards	$83.47	$1,689.04	**$887.06**
WAT	Open Fresh Water	$227.79	$13,073.87	**$2,928.72**

*Note: Assumption that AGR and VIN ESV's are equivalent as both are intensively managed and represent human dominated systems.

[11] All economic valuation data in this report are have been standardized to represent total net present values, not discounted. This allows for the results to be incorporated into forward looking scenarios that might weight future costs and benefits differently than current costs and benefits when summing over time using specific discount rates (Heal 2004).

The ESV data in Table 5 show the minimum, the maximum and the average non market ecosystem service valuation estimates aggregated across all land cover types contained in the study[12].

Figure 2. Land Cover Types and Aggregate Ecosystem Service Values

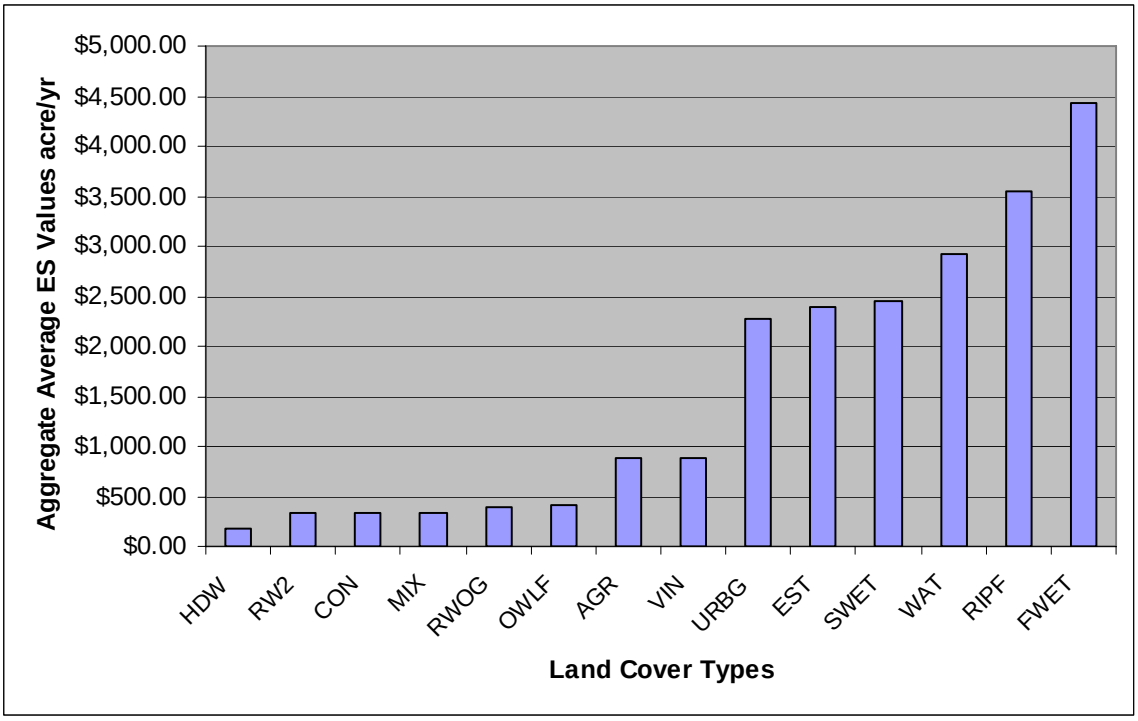


Figure 1 depicts the breadth and range of aggregate ESV's across all land cover classes used in the study. Clearly, not all land cover types represented in this report provide benefits to society equally. Rather, consistent with previously published literature (Daily 1997; Wilson & Carpenter 1999), the data reveal how land cover types in the study area that are associated with water (i.e., wetlands, estuaries and riparian forest) tend to yield the largest ecosystem service values per area unit. Also consistent with previous findings, it also appears that both agricultural systems[13] and urban greenspace tend to yield fairly large values per unit of measurement (Pretty *et al* 2000; Ricketts *et al* 2004). While non riparian forest systems tend to be less valuable per acre unit, there is still a range of variability evidenced among different forest types, with old growth and spotted owl habitat yielding the highest values per unit and oak woodland yielding the least (see Table 7).

Building on this information, the research team was next able to disaggregate results into a total of (n=205) individual point estimates for ecosystem services associated *with forested and non-forested* land cover types. Because every relevant empirical valuation study of ecosystem services may contain more than one estimate of economic value, the NaturalAssets™ system is designed to collate individual valuation data points coded by unique temporal (i.e., time of study), spatial (i.e., place where study was done) and

[12] Not all land cover types generated for the spatial analysis of San Bernardino, Napa and Humbolt counties by the SIG team could effectively be matched with equivalent ESV estimates as denoted in table 5.

[13] In this report, the same ESV's were assigned to agricultural and vineyard land cover types.

methodological (i.e., method used) criteria. Each unique ecosystem service/land cover relationship can therefore be reported in disaggregated format below.

Table 6. Ecosystem Service Estimates for Non-Forested Land Cover Types

Land Cover Type	Ecosystem Service	# Cites	Min	Max	Average
AGR	Water regulation	1	$34.50	$170.29	$102.40
	Soil formation	1	$5.83	$5.83	$5.83
	Habitat Refugium	1	$10.84	$14.81	$12.82
	Pollination	2	$2.25	$11.34	$8.24
	Cultural and Spiritual	2	$4.28	$1,461.00	$732.00
	Aesthetic & Recreational	2	$25.77	$25.77	$25.77
	Totals	**9**	**$83.47**	**$1,689.04**	**$887.06**
VIN	Water regulation	1	$34.50	$170.29	$102.40
	Soil formation	1	$5.83	$5.83	$5.83
	Habitat Refugium	1	$10.84	$14.81	$12.82
	Pollination	2	$2.25	$11.34	$8.24
	Cultural and Spiritual	2	$4.28	$1,461.00	$732.00
	Aesthetic & Recreational	2	$25.77	$25.77	$25.77
	Totals	**9**	**$83.47**	**$1,689.04**	**$887.06**
EST	Water supply	4	$5.53	$119.79	$49.80
	Cultural and Spirutual	1	$1,466.46	$1,466.46	$1,466.46
	Habitat Refugium	7	$10.82	$3,319.97	$743.54
	Aesthetic & Recreational	10	$1.09	$332.79	$126.95
	Totals	**22**	**$1,483.90**	**$5,239.01**	**$2,386.75**
FWET	Water regulation	1	$462.34	$462.34	$462.34
	Waste treatment	3	$169.64	$3,065.76	$1,701.19
	Habitat Refugium	1	$5.04	$5.04	$5.04
	Aesthetic & Recreational	7	$26.81	$3,942.00	$1,571.32
	Totals	**14**	**$1,761.07**	**$9,180.73**	**$4,440.73**
WAT	Water supply	7	$198.80	$11,088.93	$2,485.62
	Water regulation	1	$27.55	$27.55	$27.55
	Aesthetic & Recreational	17	$1.44	$1,957.39	$415.55
	Totals	**25**	**$227.79**	**$13,073.87**	**$2,928.72**
RIPF	Water supply	5	$3.98	$1,793.57	$419.11
	Waste treatment	1	$4.40	$4.40	$4.40
	Habitat Refugium	2	$54.56	$2,158.01	$890.33
	Soil retention	1	$45.49	$200.84	$123.17
	Disturbance prevention	2	$6.44	$1,918.33	$985.45
	Aesthetic & Recreational	8	$7.30	$9,051.84	$1,135.57
	Totals	**19**	**$122.17**	**$15,126.99**	**$3,558.03**
SWET	Water supply	1	$120.07	$240.14	$180.11
	Waste treatment	2	$102.86	$1,942.40	$854.35
	Habitat Refugium	4	$1.10	$734.74	$100.00
	Disturbance prevention	2	$0.58	$0.82	$0.74
	Aesthetic & Recreational	5	$4.57	$5,926.94	$1,310.86
	Totals	**16**	**$1,204.58**	**$8,579.62**	**$4,536.42**
URBG	Water regulation	1	$5.63	$5.63	$5.63
	Gas & Climate regulation	3	$25.12	$819.68	$336.37
	Aesthetic & Recreational	4	$571.54	$3,464.50	$1,926.21
	Totals	**8**	**$602.29**	**$4,289.81**	**$2,268.21**

Table 7 Ecosystem Service Estimates for Forested Land Cover Types					
Land Cover Type	**Ecosystem Service**	**# Cites**	**Min**	**Max**	**Average**
MIX	Gas & Climate regulation (CO2)	1	$32.00	$32.00	$32.00
	Habitat Refugium (Not Spotted Owl)*	4	$1.05	$426.21	$117.19
	Aesthetic & Recreational*	12	$1.27	$543.42	$185.00
		29	**$31.16**	**$1,540.62**	**$514.76**
HDW	Gas & Climate regulation (CO2)	1	$33.84	$33.84	$33.84
	Habitat Refugium (Not Spotted Owl)*	4	$1.05	$426.21	$117.19
	Aesthetic & Recreational*	1	$26.79	$26.79	$26.79
		29	**$33.75**	**$1,543.21**	**$517.35**
RWOG	Gas & Climate regulation (CO2)	1	$82.31	$82.31	$82.31
	Habitat Refugium (Not Spotted Owl)*	4	$1.05	$426.21	$117.19
	Aesthetic & Recreational*	12	$1.27	$543.42	$185.00
		37	**$117.70**	**$1,719.20**	**$608.22**
RW2	Gas & Climate regulation (CO2)	1	$27.57	$27.57	$27.57
	Habitat Refugium (Not Spotted Owl)*	4	$1.05	$426.21	$117.19
	Aesthetic & Recreational*	12	$1.27	$543.42	$185.00
		17	**$29.89**	**$997.20**	**$329.76**
CON	Gas & Climate regulation (CO2)	1	$30.16	$30.16	$30.16
	Habitat Refugium (Not Spotted Owl)*	4	$1.05	$426.21	$117.19
	Aesthetic & Recreational*	12	$1.27	$543.42	$185.00
		17	**$32.48**	**$999.79**	**$332.35**
OWLF	Gas & Climate regulation (CO2)	1	$82.31	$82.31	$82.31
	Habitat Refugium (Not Spotted Owl)*	4	$1.05	$426.21	$117.19
	Habitat Refugium (Spotted Owl)	3	$15.90	$61.92	$33.32
	Aesthetic & Recreational*	13	$1.27	$543.42	$171.04
		21	**$100.53**	**$1,113.86**	**$403.86**

* Sources are the same across Forest types except Oak Woodland and S. Owl Habitat

As table 6 shows, analogous to the observed heterogeneity between land cover classes, there is also a discernable range of variability across different ecosystem services within land cover types. For example, we find that for many non-forested land cover types, aesthetic and recreational services tend to provide the highest economic value when compared to other goods and services. This appears to be the case for URBG, SWET, RIPF, and FWET. On the other hand, for land cover types such as AGR, VIN and EST, cultural and spiritual services appear to deliver the greatest value. In the case of FWET, waste treatment services appear to deliver more annual service flow than aesthetic and recreational opportunities while habitat refugium contribute the least.

As noted in table 7, estimates for habitat refugium not associated with spotted owls and aesthetic and recreational services are replicated across the different forest types. This was done because except in very unique cases such as with Oak Woodlands or Spotted

Owl Habitat, the best available economic valuation literature generally does not yet specify between forest related recreation occurring in say, Redwood Old Growth, RWOG, or Redwood Second Growth, RW2. Nor does the economic literature tend to differentiate between wildlife habitat refugium provided by softwood conifers, CON, or mixed hardwood softwood forests, MIX. As a result, to avoid the mistake of leaving out critical forest-related goods and services, the assumption was made that if the economic valuation literature did not specify a specific forest type, then it should be applied to all forest types to ensure that all components of ecosystem service value are given recognition without running into the empirical problem of double counting (Bishop *et al* 1987b).

Table 8. CO2 Sequestration Values for PNW Forest Species

	Tons/Acre Sequestered	$ T/acre/yr
HDW	1.66	$33.84
MIX	1.57	$32.00
RW2	0.55	$27.57
RWOG	1.64	$82.31
CON	0.60	$30.16
OWLF*	1.64	$82.31
*RWOG proxy for OWLF		

For this study, the research team was able to calculate a unique ESV estimate for the Gas Regulation ecosystem service, carbon sequestration. To accomplish this, we turned to two primary literature sources (Birdsey 1992; Tol 2005). On the one hand, Birdsey (1987, table 2.17) has assembled the annual average accumulation of carbon in live trees on timberland in the Pacific Coast, by forest type and productivity class. Extrapolating this data to our 6 unique forest types, the research team was able to generate specific annual rates of CO2 sequestration in Cubic tons/acre for each forest type included in this analysis. On the other hand, Tol (2005) recently conducted an extensive meta-analysis of the best available research on the marginal damage costs of Co2 emissions. In his analysis, Tol (table 3, p. 2071) included 17 peer-reviewed studies which were analyzed for range and variability of $ per metric ton/Carbon. The result of this analysis yielded an average estimate of $50 t/C across the peer-reviewed data. Combining these results with the carbon sequestration rates provided by Birdsey (1987) yields the average $ t/C per acre per year shown in the final column of Table 8.

4.2 Gap Analysis Results

As the previous discussion alludes, not all land cover types generated for the spatial analysis in the study area could effectively be matched with all possible ecosystem services for that individual land cover type in the study area. This is because the research team's search criteria was focused primarily on peer-reviewed economic valuation results and many landscape that are of interest from a fire management perspective simply have not yet been studied for their non-market ecosystem service values. This point is clarified in the following 'gap analysis' tables.

Table 9. ESV Gap Analysis for Non-Forested Land Cover Types

	AGR	EST	FWET	SWET	WAT	RIPF	URBG
Gas and Climate Regulation							3
Disturbance prevention				2		2	
Water regulation	1		1		1		1
Water supply		4	2	1	7	5	
Soil retention & formation	1					1	
Nutrient regulation							
Waste treatment			3	2		1	
Pollination	2						
Biological Control							
Habitat Refugium	1	7	1	4		2	
Aesthetic & Recreational	2	10	7	5	17	8	4
Cultural & Spiritual	2	1					
						Total Non-Forest Estimates:	**111**

The data reported in table 9 shows that 111 individual ESV estimates were able to be obtained from the empirical valuation literature across 7 non-forested land cover types included in this study.

Table 10. ESV Gap Analysis for Forested Land Cover Types

	MIX	HDW	RWOG	RW2	CON	OWLF
Gas Regulation (CO2)	1	1	1	1	1	1
Disturbance prevention						
Water regulation						
Water supply						
Soil retention & formation						
Nutrient regulation						
Waste treatment						
Pollination						
Biological Control						
Habitat Refugium (S. Owl) *						3
Habitat Refugium *	4	4	4	4	4	4
Aesthetic & Recreational *	12	1	12	12	12	12
Cultural & Spiritual						
					Total Forest Estimates:	**94**

* Sources are the same across Forest types except Oak Woodland and S. Owl Habitat

As the gap analysis for forested land cover types in table 10 shows, 94 unique economic valuation data points were identified for use across the 6 forest cover types generated in this analysis.

Given the gaps in the available economic valuation data, the results presented in this report should therefore be treated as conservative baselines, not upper bound estimates. In short, the ESV estimates presented here are likely to underestimate, not overestimate the actual ecosystem goods and services valued by society in the study area. Due to limitations of the scope and budget associated with this project, the research team was not able to include technical reports and grey literature in this analysis. This data gap is not unique to the present analysis (EPA Science Advisory Board Environmental Economics Advisory Committee 2004), and we anticipate that in the future, it will be possible to expand the analysis to include more information so that there will be fewer landscape features listed without an ecosystem service value.

The valuation of ecosystem services is an evolving field of study and to date it has not generally been driven by ecological science or policy needs; instead it has been guided primarily by economic theory and methodological constraints (See NRC 2005). Therefore, we expect that as the field continues to mature, landscape features of interest from an ecological or land management perspective will increasingly be matched up to economic value estimates. As more first-order empirical research is gathered, we anticipate that higher, not lower, aggregate values will be forthcoming for many of the land cover types represented in this study. This is because, as discussed above, several ecosystem services that we might reasonably expect to be delivered by healthy, functioning forests, wetlands and riparian buffers simply remain unaccounted for in the present analysis. As more of these services are better accounted for, the total estimated value associated with each land cover type will likewise increase.

4.3 Spatially Explicit Ecosystem Service Valuation Results

Building on the ESV data generated with the NaturalAssets™ information system above, the research team was able to use the spatially explicit ESV calculation methods presented in section II, to generate ESV results presented here. The first set of tables presented below (see tables 11-13), summarize total ESVs by land cover class for each county located in the study area. For purposes of fire mitigation analysis, we have augmented the non-market ESV estimates with the assessed value of structures in each county because of all market values, structures are the most valuable. These assets are significantly impacted by wildfire and associated damages. No other market values were used in this analysis.

The data below reveal that significant differences exist between the three counties in the study and the ESV's each delivers to society.

Table 11. Humboldt County Study Areas Land Cover and ESV Estimates

	Study Area Zip Codes			Entire County		
class	**Acres**	**ESV/acre**	**Total ESV**	**acres**	**ESV/acre**	**Total ESV**
AGR	38,973.14	$887.06	$ 34,571,513	39,380	$887.06	$ 34,932,508
CON	271,121.33	$332.35	$ 90,107,174	282,303	$332.35	$ 93,823,306
EST	4.23	$2,386.75	$ 10,085	4	$2,386.75	$ 10,085
FWET	23,676.38	$4,440.73	$ 105,140,399	23,704	$4,440.73	$ 105,261,803
HDW	272,586.69	$177.82	$ 48,471,365	277,209	$177.82	$ 49,293,301
HEB	201,868.91	NA	$ -	205,292	NA	$ -
MIX	628,281.89	$334.19	$ 209,965,524	647,218	$334.19	$ 216,293,687
OWLF	221,522.83	$403.86	$ 89,464,211	221,580	$403.86	$ 89,487,414
RIPF	117,270.13	$3,558.03	$ 417,250,658	122,248	$3,558.03	$ 434,960,966
RW2	230,466.00	$329.76	$ 75,998,467	246,197	$329.76	$ 81,185,900
RWOG	90,604.33	$384.50	$ 34,837,363	98,005	$384.50	$ 37,682,967
SHB	53,084.54	NA	$ -	55,556	NA	$ -
SWET	1,344.15	$2,446.06	$ 3,287,882	1,356	$2,446.06	$ 3,317,256
URB	41,820.68	NA	$ -	42,944	NA	$ -
URBG	8,041.58	$2,268.21	$ 18,239,981	8,043	$2,268.21	$ 18,242,491
WAT	17,265.62	$2,928.72	$ 50,566,177	17,655	$2,928.72	$ 51,707,928
		TOTAL ESV	$ 1,177,910,801		**TOTAL ESV**	$ 1,216,199,612
		Known Market Values			**Known Market Values**	
		$ improvement value of structures	$ 4,376,522,485		$ improvement value of structures	$ 4,499,321,899
		GRAND TOTAL	$ 5,554,433,286		**GRAND TOTA**	$ 5,715,521,511

Significant economic benefits clearly accrue to society from forests in Humboldt County. As the data in Table 11 show, forest-related land cover types account for an overwhelming proportion (almost 80%) of total ESV delivered by naturally functioning ecological systems in the study area. Thus, while on a per-unit basis, forest land types may tend to provide less economic value than non-forested systems (see Figure 2 above), the large study area currently under forested cover brings the total economic value associated with forests to the foreground. After forests, it appears that freshwater wetlands, FWET, and open water, WAT, provide the next most significant ESV's in the study area.

Table 12. Napa County Study Areas Land Cover and ESV Estimates

	Study Area Zip Codes			Entire County		
class	**acres**	**ESV/acre**	**Total ESV**	**acres**	**ESV/acre**	**Total ESV**
AGR	26,265	$887	$23,298,875	27,700	$887	$24,571,316
CON	16,891	$332	$5,613,779	17,327	$332	$5,758,593
EST	1,110	$2,387	$2,648,298	1,115	$2,387	$2,661,834
FWET	4,409	$4,441	$19,577,352	4,412	$4,441	$19,592,412
HDW	141,771	$178	$25,209,687	145,867	$178	$25,938,010
HEB	64,207	$0	$0	66,148	$0	$0
MIX	11,704	$334	$3,911,425	13,619	$334	$4,551,190
RIPF	16,880	$3,558	$60,060,503	17,479	$3,558	$62,189,858
RW2	1,257	$330	$414,390	1,262	$330	$416,315
SHB	113,065	$0	$0	119,967	$0	$0
SWET	3,438	$2,446	$8,409,695	3,450	$2,446	$8,438,390
URB	18,408	$0	$0	18,462	$0	$0
URBG	1,808	$2,268	$4,099,948	1,808	$2,268	$4,099,948
VIN*	35,032	$887	$31,073,702	35,034	$887	$31,075,280
WAT	29,688	$2,929	$86,947,804	29,918	$2,929	$87,621,444
		TOTAL ESV	$271,265,459		**TOTAL ESV**	$276,914,591
		Known Market Values			**Known Market Values**	
		improvement value of structures	$ 10,957,341,955		improvement value of structures	$ 11,256,915,849
		GRAND TOTAL	$ 11,228,607,414		**GRAND TOTAL**	$ 11,533,830,440

In contrast to Humboldt County, forested systems appear to account for only approximately 30% of the total ESV delivered by functioning ecological systems in Napa County. Napa's open freshwater alone, WAT, in the form of streams, lakes and rivers appears to provide a significant economic benefit to society (31 %). And as might be expected, both agricultural land, AGR, and vineyards, VIN, also provide a substantial positive impact on the economic value associated with ecosystem services in the region (approximately 20%). For Napa county, the zip codes of high value (both structural and ESV) are within Napa and St. Helena (see Appendix F, Tables 1-4).

In Table 13 below, the data reveal that similar to Napa County, forested systems deliver approximately 31% of the total ESV delivered by ecological systems in San Bernardino County. Freshwater wetlands, FWET, account for the majority of ecosystem service

benefits delivered to society (55%), by far and away the single most important ecosystem type in the study area from an ecosystem services perspective. Given that desert shrub is the most predominant land cover type in the county and that no ESV's were estimated for desert land cover types in this study, we anticipate that fire-related ESV's would be forthcoming for these critical ecosystem types as this information is gathered and included in this type of analysis.

Table 13. San Bernadino Study Areas Land Cover and ESV Estimates

	Study Area Zip Codes			Entire County		
class	**acres**	**ESV/acre**	**Total ESV**	**acres**	**ESV/acre**	**Total ESV**
AGR	39596.26	$887	$35,124,255	71,762	$35,124,255	$63,657,272
CON	282191.6	$332	$93,786,377	333,674	$93,786,377	$110,896,564
DSHB	5260821			10,189,383		
DWLD	596696.3			606,121		
FWET	113840.5	$4,441	$505,534,805	185,251	$505,534,805	$822,650,494
HDW	37049.87	$178	$6,588,207	47,948	$6,588,207	$8,526,125
HEB	34444.69			55,833		
MIX	69668.12	$334	$23,282,391	85,968	$23,282,391	$28,729,641
RIPF	84104.76	$3,558	$299,247,244	93,540	$299,247,244	$332,816,821
SHB	384160.9			482,529		
URB	441379.6			660,011		
URBG	121.74	$2,268	$276,129	152	$276,129	$344,531
WAT	27602.46	$2,929	$80,839,872	42,117	$80,839,872	$123,347,887
		TOTAL ESV	$1,044,679,280		**TOTAL ESV**	$1,490,969,334
		Known Market Values			**Known Market Values**	
		improvement value of structures	$35,770,650,855		improvement value of structures	$68,941,985,365
		GRAND TOT	$36,815,330,135		**GRAND TOT**	$70,432,954,699

In a second set of tables (Appendix F, see tables 1-4), we present some cross tabulated ESVs by land cover (in columns) and zip codes (in rows) for each of the three study areas (counties). This also includes a column for structure values and vineyard market values in the case of Napa county. In these generally rural counties, zip codes tend to contain a number of communities, however, the name of the dominant community in each zip code is given in one of the columns. In some larger communities, such as Napa City or Arcata, there are several zip codes within a single community.

The final set of tables cross tabulates the ESV estimates available for each cover type by individual ecosystem service (Appendix F, Tables 4-6). Here, using average aggregate ESV data presented in table 5 above, we were able to generate land cover specific aggregate estimates for each ecosystem service in the three study areas. A zero in a cell signifies that a particular ecosystem service has not been valued for that particular land cover type.

Additionally, maps that we have generated for each county show the spatial distribution of ecosystem service values and structural improvement values. Appendix E gives general land cover for each county. Appendix G gives total ecosystem service value by tributary basin for Napa and Humboldt Counties and by more aggregated watershed basin units for the much larger San Bernardino County. Appendix H shows average per acre ecosystem service value by the tributary basin. Appendices I and J have total ESV values except by zip code instead of by hydrologic unit. Appendix K gives structure value by zip code. Appendix L gives structure value by tax parcel.

4.4 Phone Survey Results

432 (12.74%) of the people called completed the phone survey out of 3390 calls initiated. A survey was considered "Completed" only if the person phoned decided to participate in taking the survey. "Call Backs" were people with a ringing phone number that could never be reached (answering machine, did not answer, busy signal). "Not Interested" were people reached that did not want to participate in the survey. "Bad Number" represents phone numbers that are no longer in service. Table 14 lists the participation results of the phone survey:

Table 14. Phone Survey Participation Rates

Status	Count	Percent
Completed	432	12.74%
Call Back	1761	51.95%
Not Interested	635	18.73%
Bad Number	562	16.58%
TOTAL	**3390**	**100.00%**

Only 55% of the phone survey respondents indicated that they own or rent any property in an area where wildfire is a concern. These results are NOT significant at the .05 level (see Appendix C for statistical analysis), and there was no significance between the three counties. The lack of a significant difference between counties is somewhat surprising especially since the San Bernardino study area is located in an area that has received significant attention since the Southern California fires of 2003. Perhaps, there is a tendency in Southern California to get complacent after a large conflagration. This is consistent with earlier sociological studies in the area (Gardner et al 1987; Gardner and Cortner 1988; Cortner et al 1990) which found that the majority of homeowners surveyed did not believe the wildland fire situation to be serious at the time they purchased their home. In addition, despite having some recent fire experience in San Bernardino county, these studies found that impacted communities expressed low awareness of the fire hazard and a belief that fire would not reoccur in the area. Their findings indicated that recent wildfire survivors tend to discount future wildfire risk because they are convinced that fire won't strike twice in the same place.

In all three counties, 64% of the respondents have experienced wildfire on their properties. The majority of these experiences have been in the last year (35%) and in the last five years (52%) with the remaining experiences taking place over five years ago (13%). 36% of the respondents have taken some actions after the wildfire to better protect themselves from future wildfires; 13% did nothing and 51% said that they had already taken action prior to the event to protect their property (see Table 15 for the types of actions taken). While the majority of the actions centered around creating defensible space (73%), many respondents focused their actions on watering systems, generators for pumping water, and knowing the evacuation routes.

In all three counties, 62% of those respondents that own or rent a property where wildfire is a concern know what the term "community at risk" means. Only 18% knew what the term "Urban/Wildland Interface" means. The experiences of the respondents and their actions taken are statistically different across the three counties with each county following the same response pattern.

Table 15. Percentages of Types of Actions Taken by County

What actions did you take to make you and your property more Fire Safe	Humboldt	Napa	San Bernardino	ALL Three Counties
Discussed with family, friends or neighbors, what could be done for potential fire problems	0%	0%	1%	0.7%
Developed a formal or informal plan for dealing with future fire threats	0%	0 %	1%	0.7%
Obtained assistance from fire agencies or others on what you can do to protect you and your property from wildfires	0%	0%	0.5%	0.3%
Worked with Homeowners Association or other neighborhood group to develop a plan for improving wildfire protection	3%	0%	0.5%	0.7%
Removed vegetation from around home or other structures	44%	53%	27%	30.1%
Removed vegetation from driveway or roads accessing your property	6%	7%	26%	22.5%
Removed vegetation from other areas	13%	7%	22%	20.3%
Installed water supplies or other related equipment	28%	20%	5%	8.8%
Other	6%	13%	17%	16.0%

Although it was not designed to be a direct surrogate for risk, our phone survey instrument asked respondents to rank their perceived level of safety for their home and their community. San Bernardino ranked the highest in terms of the perceived risk to both an individual's property and to the larger community but only the property risk was significantly higher than Napa and Humboldt (at 5% and 1% error level respectively). For the perception that the community is at risk, San Bernardino scored significantly higher

than Humboldt (at 1% error level) but did not score significantly higher than Napa. This indicates that even though 45% of the respondents do not think there is a fire problem in their county, those that do believe that fire is of some concern rated their county as more at risk than the other two counties surveyed in this assessment. Napa did not score significantly higher risk than Humboldt and San Bernardino San Bernardino did not score significantly higher than Napa (see Table 16).

Again, the results for San Bernardino are surprising given the high level of completed surveys (15%) and general interest in the fire issue since the Grand Prix Fire and Old Fire of 2003. However, our findings are consistent with earlier studies (Monroe 2002; Gardner et al 1987) which found that recent wildfire survivors tend to discount future wildfire risk because they are convinced that fire won't strike twice in the same place. These studies argue that ignorance of the wildland fire risk leads many homeowners to undervalue their wildland fire risk. The tendency is that residents who believe fire is a random event are also be less likely to support protective measures or actions to reduce risk.

Table 16. Perceptions of Wildland Fire Risk Ranking by County

On a scale of 1-10, with 10 being the safest, how safe from a wildfire do you think your property is?	**Humboldt**	**Napa**	**San Bernardino**
Mean	5.91	6.53	7.38
Count	69	30	122
Standard Deviation	2.247	2.460	1.955
SE of the mean	0.271	0.449	0.177
Napa vs Humboldt (t test, α prob)	22.31%		
San Bernardino vs Napa (t test, α prob)		4.65%	
San Bernardino vs Humboldt (t test, α prob)			0.00%
On the same scale, how safe from a wildfire do you think your community is?	**Humboldt**	**Napa**	**San Bernardino**
Mean	5.188	5.700	6.027
Count	69	30	111
Standard Deviation	2.144	2.830	1.942
SE of the mean	0.258	0.517	0.184
Napa vs Humboldt (t test, α prob)	32.61%		
San Bernardino vs Napa (t test, α prob)		46.27%	
San Bernardino vs Humboldt (t test, α prob)			0.75%

Of the 55% that responded that they live in a wildfire area, 90% of these properties can be characterized as primary homes, 7% secondary homes, and 3% as undeveloped. The majority of these homes have been owned for more than ten years (50%). These demographics are statistically significant across the three counties with respondents in each county having the same pattern.

Of all of the respondents across the three counties, only 20% of these homes are adjacent to federal lands. The adjacent federal agencies are the Forest Service (55%), the BLM

(19%), and others (26%). Of the "other" land owners, these include Indian reservations, National Park lands, the University of Riverside, Nature Conservancy lands and wilderness areas. In all three counties, less than 3% of these properties with adjacent federal holdings require some level of clearing to adhere to the state's clearance requirement of 100 feet but this was not statistically significant. Of these properties, 62% of the adjacent federal property owners have cooperated in clearing their lands to protect the property under the state's clearance requirements but again there were not enough respondents to be statistically significant.

4.4.1 Outreach Efforts

63% of the phone survey respondents recall receiving information within the last three years on how to protect themselves from wildfires. This is statistically significant across the three counties with the same trend observed in each county. Of those 63%, there was a significant difference in the kinds of materials being received by county with San Bernardino received the most variety of informational sources. In this county, these included local newsletters, on-site inspections by the local Fire Department, post office leaflets, boy scout troops, and official town hall meetings (comprising some of the 22% of outreach efforts in the "other" category). A breakdown of the types of outreach materials by county is provided in Table 17. The type of outreach materials received was highly significant across the entire three counties with least one county having a significantly different pattern than the other one. Napa for example received more outreach materials from Fire Agency or officials while Humboldt and San Bernardino received more outreach materials in the mail. Humboldt and San Bernardino also attended more workshops while Napa got information from the internet. Literature from a fire agency or official and literature received in the mail were commonly higher than other outreach efforts.

Table 17. Types and Percentages of Outreach Materials by County

What types of outreach materials did you receive?	Humboldt	Napa	San Bernardino	ALL Three Counties
Literature from a Fire Agency or Official	17.4%	30.4%	15.4%	17.6%
Literature in the Mail	23.9%	21.7%	28.7%	26.8%
Literature from School	2.2%	0.0%	0.0%	0.5%
Attended Workshop	15.2%	0.0%	11.8%	11.2%
Public Service Announcement on Radio	6.5%	8.7%	2.9%	4.4%
Public Service Announcement on TV	10.9%	8.7%	5.9%	7.3%
Newspaper	15.2%	8.7%	8.1%	9.8%
Internet	0.0%	4.3%	0.0%	0.5%
Other	8.7%	17.4%	27.2%	22.0%

When asked if respondents could differentiate between the outreach materials from the various federal and state agencies, the local fire districts and Fire Safe Councils tended to be more distinct accounting for 42% of the outreach efforts (24.5% and 17.5% respectively). Granted that many of these entities receive funding from the federal agencies through grants, it is understandable that the public perceive these messages coming from the local partners. Regardless, the USDI BLM and the USDA Forest Service accounted for 5% and 11% of the outreach efforts (Table 18). Both of these agencies had higher counts in Napa County but these were not significantly different from the response pattern across the three counties.

The "other" category, which comprised 17.5% of the responses, included fire information from volunteer fire departments, Fire Districts, local Fire Departments, emergency response teams, boy scouts, homeowners association, and the gas and electric/ water companies in their billing statements. Again, some of these entities are funded through the BLM Community Outreach Program and the Rural Fire Assistance Program. Although it is unclear to what extent, some of this outreach and education can be construed as a federal effort through the expenditure of these funds at a local level.

It should also be noted that 13% of the respondents could not remember what agency had distributed the outreach materials. The distribution of these outreach efforts between these federal, state and local entities was statistically significant across the three counties with respondents in each county having the same pattern.

Table 18. Percentages of Outreach Materials by Agency and County

If the information came from a fire agency or an official, do you recall which fire agency?	Humboldt	Napa	San Bernardino	ALL Three Counties
U.S. Bureau of Land Management	4.0%	5.9%	5.0%	4.9%
U.S. Forest Service	8.0%	17.6%	10.9%	11.2%
California Department of Forestry and Fire Protection	24.0%	11.8%	2.0%	7.0%
County Fire Agency or Fire District	36.0%	35.3%	16.8%	22.4%
Fire Safe Council	12.0%	5.9%	30.7%	24.5%
Other	8.0%	23.5%	18.8%	17.5%
Don't Know or Don't Recall	8.0%	0.0%	15.8%	12.6%

56.5% of the respondents indicated that the outreach effort of these parties has contributed to them changing their behavior in some way. 7% indicated that they did not take action to protect themselves from future wildfires while another 36.5% had already taken action prior to receiving the outreach materials. Given the efforts of these various agencies and local partners, the level of success could be characterized in the amount of assets potentially saved by these behavioral changes in the study area. For instance, if the

behavioral changes of 93% of the people in study areas within these three counties can hypothetically be transferred into 93% of the structural assets protected through better defensible space then (using the accounting performed using the Grand lists), we have just made $47.5 billion more defensible from wildland fire. This is purely the structural values and does not take into consideration the value of ecosystem goods and services. Albeit this is not a transferable metric (and should be used cautiously) because those not inclined to change their behavior might be those that are not participating in the phone survey. For instance, there are still 45% of the respondents that do not think they live in an area where fire is a concern. These people are less likely to change their actions because they do not perceive a problem.

4.4.2 Demographics

Of the 432 people who completed the phone survey, 58% of the respondents were female and 42% male. The age distribution of these respondents (Table 19) depicts an older population that is more willing to participate in this phone survey. We believe that the 12.74% participation rate is correlated to the age distribution of our respondents and perhaps to the types of communities that tend to live in these three counties. It might be that these three counties tend to attract people who have retired from the urban life to move into these more rural areas due to the natural amenities that the surroundings provide. These results may also be biased to those that are willing to take the time to complete a phone survey. It is clear that the respondents in these three counties represent a highly educated cross section of society with over 66% of them attending some sort of college (from taking classes to completing 4-year or 2–year degrees) and over 11% of them having a higher degree (Masters and/or Ph.D). The demographics of the respondents are statistically different across the three counties with each county following the same response pattern.

Table 19. Age Distribution of Participants

Age Range	Count	Percent
8-21	9	2.15%
22-25	11	2.63%
26-30	12	2.86%
31-40	44	10.50%
41-50	85	20.29%
51-60	81	19.33%
61 or over	148	35.32%
Declined to answer	29	6.92%
TOTAL	**3390**	**100.00%**

Although not directly relevant to the content of this phone survey, 49% of the respondents are married, 20% are single, 7% are separated or divorced, 13% are widowed and 10% declined to answer. This high percentage of widowed also indicates that we are

sampling a predominantly older population. 75% of the respondents are white, 6% Hispanic, and 15% declined to answer. 51% of the respondents make between $10,000-75,000 and 26% declined to answer. These three questions had the most sensitivity and tended to discourage further participation in the survey. These demographics are statistically significant across the three counties with respondents in each county having the same response pattern.

5.0 ANALYSIS AND CONCLUSIONS

5.1 Analysis of Ecosystem Service Benefits

An overwhelming proportion of ecosystem service values in Humboldt County come from its forests. Humboldt's relatively large area of forested cover accounted for nearly 80% of total ESV delivery by naturally functioning ecological systems in the study area. While on a per-unit basis, some forest types provide a lower stream of benefits than many non-forested types, the size of forested area in Humboldt County means that ESV benefits from forests dominate. For instance, the Six Rivers National Forest contributes $293 million in ESV to Humboldt County with an additional $19 million in market values (i.e. structures). This contribution is primarily due to its size, and the dominance of redwood old growth and spotted owl habitat (Appendix F, Table 1).

In Napa County, forested systems only accounted for 30% of ESVs delivered by functioning ecological systems. Napa's open freshwater, in the form of streams, lakes and rivers, provided 31% of measured economic benefits to society. Both agricultural land and vineyards also provide a substantial positive impact on the economic value associated with ecosystem services in the region (approximately 20%). The communities of Napa (Zip Codes 94558 & 94559) and Saint Helena (94574) have the highest estimated quantities of ESVs and structural values within Napa County (Appendix F, Table 2).

Similar to Napa County, forested systems delivered approximately 31% of the total ESVs delivered by ecological systems in San Bernardino County. From an ecosystem services perspective, freshwater wetlands accounted for the majority (55%) of ecosystem service benefits delivered to society. For instance, the community of Twenty Nine Palms (Zip Codes 92277 and 92278) which has low assessed structural values relative to other communities in San Bernardino County, but the freshwater resources of this community yield considerable ESVs compared with the rest of the communities within this county (Appendix F, Table 3). Desert shrub is the most predominant land cover type in San Bernardino county. However there are two reasons why this land cover shows few societal benefits in this assessment. First of all, this desert-related land cover types tend not to burn and secondly, the value transfer analysis did not yield any ESV studies which estimated economic values for desert cover types.

In sum, this assessment has provided the BLM with a baseline analysis of ecosystem service benefits in three specific parts of the State. Future applications of the NaturalAssets™ information system may build upon the current assessment so that the conservative baseline for these three counties become further refined and broadened to reflect more ecosystem goods and services[14].

[14] For instance, if grey-scale literature with valuations studies were included, we might have ESV values for some of the land cover types not included in the peer-reviewed literature.

5.2 Cost Effectiveness of Fire Hazard Mitigation Efforts

In this section, we provide a cost effectiveness framework by which the BLM's fuel hazard mitigation programs can be evaluated relative to their return on investment and agency management goals.

Ultimately the ecosystem service baseline should be integrated with spatially explicit fire behavior models like FARSITE and FLAMAP to weigh potential benefits from a treatment against cost. Specifically, the fire models would produce a baseline wildfire damage probability under a no-treatment scenario. The amount and probability of damages to both structures and environmental assets could then be compared to the predicted amount and probability of damages under alternative treatment scenarios, net of treatment cost. Well designed treatments should result in lower burn probabilities as well as fewer burned acres when a simulated fire does occur. Because these models are spatially explicit, the predicted fire perimeters can be overlain on our baseline ESV and structure maps to estimate what the extent of damage would be under each scenario. For each scenario, including the baseline, then, the cost of treatment (zero in the case of the baseline) can be compared to the probability of fire multiplied by the estimated damage from each fire. This can be a valuable tool for communities in the Urban/Wildland Interface, as they engage in wildfire protection planning. On a state-wide level, grant applications can be evaluated based upon their net benefits to society.

While such integrated modeling was beyond the scope of this study, we did provide two case studies, the town of Petrolia in Humboldt County and Morongo Valley in San Bernardino County, where we compared the costs of treatment to the estimated benefits from those treatments, including both protected structures and ESVs. Lacking time to model the probability of fire, or the expected fire perimeter (under no treatment and the designed treatment), we assumed a "protection area" of 1.5 miles around the treatment footprint, and estimated the value of all the structural and environmental assets that would be protected within. Morongo Valley is a highly developed part of San Bernardino County while Petrolia is in a rural part of Humboldt County. Both of these communities are located in the Wildland Urban Interface with Petrolia listed as a Community at Risk and Morongo Valley listed as a Community of Interest. For both of these communities, if we assume that a fire is certain to happen (as it did on June 22, 2005 in Morongo Valley), and that the BLM supported fuel treatments can reduce the probability of fire, we then find both treatments considered are cost-effective.

An additional analysis we have used to look at cost effectiveness of treatments is to use the National Fire Plan Operations and Reporting System (NFPORS) to compare all of the projects within these three counties by agency and by treatment (Table 21). NFPORS is an interagency system designed to assist field personnel in managing and reporting accomplishments for work conducted under the National Fire Plan. As it is spatially explicit, NFPORS allows for the accounting of natural assets surrounding BLM projects using both man-made boundaries (like zip codes or parcels) and natural boundaries (watershed boundaries and tributaries). These maps are provided in Appendices F, G, H, and I. The NFPORS system also allows us to evaluate the contribution of the BLM

projects to the overall fire mitigation framework within these three counties and compare their efficiencies with metrics like per acre treatment costs and their ESV avoided costs.

Given the information that all of the federal agencies are compiling within the NFPORS system for these three counties, the BLM and its local partners are responsible for up to 28% of the treatment activities in Humboldt County, 8.5% of the activities in San Bernardino County and 100% in Napa County (see table 20). Typically, the federal agency most involved in fire mitigation has depended on their land bases within a county. For instance, BLM and the Bureau of Reclamation are the only federal agencies with land in Napa County[15] while the US Forest Service has a dominant presence in San Bernardino County. The BLM funding for CAHFPs is not tied its ownership so this tendency is not valid for California.

The cost effectiveness of these fuel hazard reduction treatments varies by location and by agency (Table 20). The BLM expenditures in all three counties can be evaluated by capital expenditures needed to implement each kind of treatment. For instance, in Humboldt County, of all the money spent by federal agencies on fuel hazard reduction treatments, BLM spent 5.6% of the total on fire treatments and 29% on mechanical treatments. For Humboldt County, the BLM spent $306/acre on fire treatments and $377/ acre on mechanical treatments. In Napa County where all of the treatments were performed by the BLM, 63% of the treatment costs were mechanical (at $600/acre), nearly 4% went for fire treatments and the remaining 33.5% went towards other treatments (biological and chemical). While these may seem high compared with the national averages for fire mitigation treatment, they are comparable with other parts of California[16]. This would indicate that statements made about the transferability of these three counties (Section 3.2) generally apply to these treatment costs.

Except for the National Park Service, mechanical treatments are the fuel treatment of choice, with BLM accounting for 23% of the acres treated by this method in Humboldt, 8% in San Bernardino and 34% in Napa. The most prevalent use of prescribed burning was by the National Park Service in Humboldt County. Mechanical includes subcategories like thinning, chipping, hand piling, mastication/mowing, biomass removal and lop and scatter. Fire includes subcategories like hand piling and burning, jackpot burning, broadcast burning and prescribed burning. The other category, which accounted for 55% of all treatments in Napa, includes both chemical and biological treatments for vegetation management (application of BT, pesticides, goats, etc.). Table 20 presents the number of acres of each kind of treatment for each county by agency and the percentage of the county totals. Maps of these counties and the locations of these projects can be found in Appendix D.

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[15] The Bureau of Reclamation has numerous acres in Napa around Lake Beryessa. BOR is not active with NFPORS but they do land management in the area and may have some fuels mitigation. The land status layer shows that these are the only two federal agencies in Napa County.

[16] Congressional Research Service Report for Congress on Forest Fires and Forest Health reported a national average of treatment costs at $250/acre. On the Shasta Trinity National Forest, treatment costs for slopes <30% ranged from $250-$600/acre and average $400/ acre.

Table 20. Study Area Treatments by Agency (Rx Acres, Costs, and Percent of Total)				
County	**Agency**	**Treatment**	**Acres/ $**	**% of Total**
Humboldt	BIA	Fire	45 acres	0.74%
			$50,550	2.84%
		Mechanical	584 acres	9.66%
			$571,865	32.07%
	BLM	Fire	331 acres	5.48%
			$101,246	5.68%
		Mechanical	1369 acres	22.65%
			$515,946	28.94%
	USFS	Fire	256 acres	4.24%
			$91,722	5.14%
		Mechanical	618 acres	10.23%
			$240,720	13.50%
	NPS	Fire	2729 acres	45.16%
			$193,000	10.82%
		Mechanical	111 acres	1.84%
			$18,000	1.01%
NFPORES Planned Acres			6043	
NFPORES Planned Budget			$1,783,049	
Napa	BLM	Fire	50 acres	10.80%
			$5625	3.73%
		Mechanical	158 acres	34.13%
			$94,730	62.80%
		Other	255 acres	55.08%
			$50,500	33.48%
NFPORES Planned Acres			463	
NFPORES Planned Budget			$150,855	
San Bernardino	BLM	Mechanical	576 acres	8.26%
			$243,122	2.30%
		Other	20 acres	0.29%
			$10,000	0.09%
	USFS	Fire	1100 acres	15.77%
			$830,000	7.84%
		Mechanical	5251 acres	75.26%
			$950,3000	89.74%
	NPS	Mechanical	30 acres	0.43%
			$3,000	0.03%
NFPORES Planned Acres			6977	
NFPORES Planned Budget			$10,589,122	

Source: Table generated from the NFPORS database. Data from 2004-2005

In this assessment, we are advocating the use of a cost effectiveness framework to take into consideration both the capital costs and the avoided losses to ecosystem services associated with fire mitigation. This will allow the BLM and other agencies to consider the real losses to ecosystem goods and services that might occur in the event that such

fuel treatments were not implemented. For example, in Humboldt or Napa counties, the treatment costs per acre range from $306 to $600/acre but the estimated benefits of fire mitigation are conservatively between $117 to $4,440/acre (using the lower range average ESV for hardwood oak woodland and higher range average ESV for fresh water wetland). Regardless of whether the proposed fuel treatment uses prescribed burning or mechanical treatment (in either of these two counties), the costs per acre to benefit ratio will be higher when we include the accounting of avoided losses of ESVs. This application is further explained in two case studies of Morongo Valley and Petrolia.

In an area like Humboldt County, where 6,043 acres were treated in a variety of ways (covering a study area of 31 Zip codes and 2,217,932 acres) by the four federal agencies and their local partners, ESVs are estimated at $1,177,910,801 while structural values are assessed at $4,376,522,485 for a total accounting within the Humboldt study area zip codes of $5,554,433,286. Given the modeling assumptions, the net benefit of performing these treatments and protecting market and non-market assets on the landscape level from wildfire is $2,504/acre in Humboldt County. Using the same cost effectiveness approach, we can state that the net benefit from treatments that protect market and non-market assets in San Bernardino and Napa Counties are $4,994/acre and $22,904/acre respectively. Compared with the $2,504/ acre "avoided costs" of protecting market and non-market assets in Humboldt, we can easily see that there would be a greater net loss to society resulting from a major wildfire in Napa County. Yet by reviewing the overall treatment acreages for Napa across all federal agencies (Table 20), the numbers of acres treated are substantially less than Humboldt and San Bernardino. This is probably due to the lack of federal agency land, the overall socio-political climate for accepting fuel reduction treatments, and the costs of doing business in Napa County.

There is a national tendency to focus on treatment costs and the total number of acres treated (Table 21). These metrics tend to favor fire mitigation programs in other western states where the costs of labor and materials are lower. Over the last 36 year period, the average annual price increase in California has been 8.9%. In 2004, the median home price was $523,150 compared with the national average of $219,000. These housing trends are undoubtedly contributing to the differences in costs of treatment between the three counties (Table 21). Humboldt County, with its dynamically lower housing costs and the presence of the timber industry, benefits in the presence of a cost competitive labor force for implementing fuel treatment projects.

Table 21. BLM Planned Acres, Treatment Costs, and Costs/Acre

County	Treatment	Planned Acres	Cost	$/acres
Humboldt	Fire	331	101,246	306
	Mechanical	1369	515,946	377
Napa	Fire	50	5,625	113
	Mechanical	158	94,730	600
	Other	255	50,500	198
San Bernardino	Mechanical	576	243,122	422
	Other	20	10,000	500

Source: Table generated from the NFPORS database. Data from 2004-2005

Our geographic disaggregation of ESVs by watershed and zip code allows us to depict ESV hotspots and assist the BLM in prioritizing funding to protect those areas with the highest values (Appendices G-L). From this analysis, we can compare the overall funds expended within the three counties and a per acre "avoided costs" using the total market and non-market values and the acres in the zip code study areas. This then allows for the computation of "net benefits per acre" for each study area acre. Although these costs and benefits are averaged over an entire zip code or watershed unit, in the case studies presented below, we have a spatial treatment footprint and will demonstrate the application at the finest scale possible, that is, of evaluating individual projects. From both of these examples, we can see that as the BLM partners become familiar with GIS, or as the BLM adjusts its grant tracking system to include spatial footprints (see Section 5.5 Next Steps), it should be possible to track costs and benefits of fuel treatments on different slopes and across different land cover types. We will discuss further implications of adjusting the BLM grant monitoring system in Section 5.5 Next Steps.

CASE STUDIES

Within the three study counties, two specific case studies were selected to clarify how the total economic value approach developed in this study could be applied to assess the cost-effectiveness of Community Assistance and Hazardous Fuel Programs in California. The study sites were selected after discussion with BLM team members from the California State Office. The sites are Petrolia in Humboldt county and Morongo Valley in San Bernardino County, both considered within the Wildland/Urban Interface (WUI). These case study sites were selected because the BLM has created a spatial foot print for the actual treatment and sphere of influence. An additional 1.5 mile "buffer" was added to each treatment site because of the Healthy Forest Restoration Act's call for vegetative buffers to protect communities[17]. The Healthy Forest Restoration Act (HR 1904) requires that 50% of the funds expended upon HFRA projects are within the WUI and municipal watersheds surrounding private homes and communities. In this Act, the WUI is defined as a 1.5 mile radius around communities; however communities can define their own WUI by completing a 'community fire plan.'

The Petrolia mechanical thinning project was selected as a case study for Humboldt County. The title of the project is the Prosper Ridge Neighborhood Fuels Reduction & Safety Project (05BLM0079) and is being implemented by the Mattole Restoration Council to protect Petrolia, a Community at Risk. The 1.5 mile buffer around the treatment area contains a range of land cover types, including open water, hardwoods, mixed forest, conifers, grasses and riparian forest, as well as a number of structures, most of which are located along the coast. The treatment itself is located between 1 and 3 miles from the coast and consists of a number of thin "arms" which appear to sinuously follow ridgelines between drainages. The project covered 85 acres and was conducted in 2005,

[17] 1.5 mile buffer is relevant because when NEPA analysis is required, the study needs to include only the proposed action and no action alternative for projects within 1.5 miles of an at-risk community or in the WUI as defined in the Community Wildfire Protection Plan (CWWP).

in conjunction with the Mattole Restoration Council. As table # below shows, the direct costs (excluding admin) of this treatment project was $332 per acre for a total one-time cost of $28,188.

The Morongo Valley chipping and biomass removal project was selected as a case study for San Bernardino County. The project (03BLM0051) was implemented by the Morongo Valley Fire Safe Council in 2003 to protect Morongo Valley, a Community of Interest. The 1.5 mile buffer around the treatment area contained a range of cover types and has a large urbanized center surrounded by some BLM ownership. The Morongo Valley chipping and biomass removal portions of the project covered 40 acres and 35 acres respectively. The footprint of this treatment was significantly larger than the Petrolia example as the Morongo Valley treatment acres are not contiguous. These types of treatments are designed to work in areas of highest need (as defined by the Fire Safe Council) to protect the larger community and, as a result, the project and sphere of influence is spread over a larger geographic area. The direct costs (excluding admin) of this project was $914 per acre for a total of $69,432.

The community of Petrolia has a population (census year 2000) of 291 with nearly an even gender split (males: 151, females: 140). The community is located at 122 feet and has a land area of 80.9 square miles. Its median resident age is 47 years old and the median household income: $ 27,857 (year 2000). The median house value in 2000 was $11350. The races of Petrolia can be characterized as White Non-Hispanic (95.9%), Hispanic (3.1%), other race (0%) American Indian (2.4%), two or more races (1.4%) and Black (0.3%)[18]. 54% of the population over 25 has never been married, 45% are currently married and 21.7% are either separated or divorced. 8% of the population is widowed. As for the education of residents, 29% have a Bachelor's degree or higher. One percent of the community is unemployed but 27.5% of the community is below the poverty line. The mean travel time to work is 43.9 minutes.

There are three small towns in the Mattole basin: Whitethorn in the headwaters region; Honeydew near the center of the basin; and Petrolia near the mouth. The Mattole River basin encompasses approximately 296 square miles, primarily in Humboldt County, of the Northern California Coast Range. The total Mattole basin resident population in the year 2000 census was estimated at about 1,200 people. The Mattole has a Mediterranean climate characterized by cool wet winters with high runoff, and dry warm summers with greatly reduced flows. Most precipitation falls as rain. Along the coast, average air temperatures range from 46 to 56 degrees F. Further inland, annual air temperatures are much more varied, ranging from below freezing in winter to over 100 degrees in summer. Mattole basin receives one of the highest annual amounts of rainfall in California averaging 81 inches. Average rainfall near the coast in Petrolia is about 60 inches per year and well over 100 inches per year falls near the center of the basin in Honeydew.

The towns of Petrolia, Ettersburg, Whitethorn, and Honeydew are all listed in the California Fire Plan as being in a high wildfire threat area and that some or all of the

[18] Total can be greater than 100% because Hispanics could be counted in other races.

threat comes from federal lands (http://firesafecouncil.org/fireplanindex.html, May 2002). The Mattole Valley/Prosper Ridge area and the Shelter Cove subdivisions, which extend to the watershed boundary, are identified in the CDF Humboldt/Del Norte Ranger Unit Fire Management Plan as being two of the highest risk areas in the County. Ninety percent of the Northern Subbasin's total population lives within three miles of the population centers of Petrolia or Honeydew, which are both near the southern boundary of this subbasin.

The community of Morongo Valley has a population (census year 2000) of 1,929 with an even gender split (males: 965, females: 964). The community is located at 2,538 feet and has a land area of 7.7 square miles. Its median resident age is 41 years old and the median household income: $36,357 (year 2000). The median house value in 2000 was $73,700. The races of Morongo Valley can be characterized as White Non-Hispanic (86.9%), Hispanic (9.3%), Other race (3.4%) American Indian (2.5%) , two or more races (2.1%) and Black (0.8%)[19]. Of the White Non-Hispanic, the ancestries of the residents are German (21.1%), United States (12.8%), English (12.3%), Dutch (10.1%), Irish (9.4%), Polish (4.8%). 21.2% of the population over 25 were never married, 49.1% are currently married and 21.7% are either separated or divorced. 8% of the population is widowed. Nearly 5% of Morongo Valley are foreign born (3.2% Europe, 1.0% Asia). As for the education of residents, 91% of them have completed High school or higher education with 12% completing a Bachelor's degree or higher and 5% finishing a graduate or professional degree. 5.1% of the community is unemployed. The mean travel time to work is 32 minutes.

On June 22, 2005, at about 1:00 pm, a fire erupted in a private residence on Paradise Road in Morongo Valley, California. Due to high temperatures, low humidity, and high winds, the fire quickly spread to surrounding homes and brush. Big Morongo Canyon Preserve, approximately 2 miles due east, was directly in the path of the flames which destroyed 6 homes and the BMCP historic barn, and ultimately consumed 3022 acres of vegetation, most of which was on the Preserve. On August 30, 2005, economists have estimated that a fire in Palm Springs (of 5,000 acres) has cost taxpayers a total of $1,700,000 strictly for suppression costs and this figure continues to rise as they consider other market and non-market goods and services. These results are consistent with the 2003 Old, Grand Prix and Padua Wildfire Complex which found that suppression costs accounted for 5% of the total expenditures which does not include ecosystem goods and services values (Dunn 2005). With its baseline ESV figures, the BLM can add to the accounting of the true costs of this Morongo Valley fire.

Both communities provide an excellent example of the usefulness of the NaturalAssets™ Information System to evaluate the general cost effectiveness of BLM treatments for protecting communities and their environmental goods and services in California. Using the Total Economic Value (TEV) framework discussed in this study, the project team was able to identify and measure both the non-market, ecosystem service values *and* the market-based value of protected structures (i.e., homes) associated with hazardous fuels

[19] Total can be greater than 100% because Hispanics could be counted in other races.

treatment. When compared with the actual costs of treatment for mechanical thinning and chipped/biomass utilization in Petrolia and Morongo Valley respectively, these data can be used to evaluate the net social economic benefit associated with treatments on-the-ground (see Table 22).

Table 22: Cost Effectiveness of Treatment in Two Communities*

Project Community	**Petrolia**	**Morongo Valley**
Project Type	Mechanical thinning	Chipped/biomass utilization
Acres treated	85	76
Total acres within Buffer	10,478.91	17,992.69
Project Cost	$28,188	$69,432
Project Costs per acre	$332	$937
Market Value of Protected Structures	$2,073,213	$107,494,431
Non-Market Ecosystem Service Values	$4,570,692	$379,680
Total Economic Value	$6,643,905	$107,874,111
Total Economic Value per acre	$634	$5,995
Net Benefit per acre	**$302**	**$5,058**

* All dollar values are standardized to $2004 equivalents

As the data in Table 22 demonstrates, purely from the total economic value perspective, both fire treatments considered in this case study appear to be cost-effective. When both the non-market and market-based values of protected structures, goods and services within the 1.5 mile buffer zone are taken into consideration, there appears to be a net economic benefit for each community. For instance, in the case of Petrolia, the data show that treatment project costs were $332 per acre, yet the total economic value of market and non-market goods and services within the protected buffer zone yield approximately $634 per acre, resulting in a net benefit of $302 per acre. In the case of Morongo Valley, while the costs of treatment were somewhat higher at $937 per acre, the total economic value of the protected area is also considerably higher resulting in a net benefit of $5,058 per acre.

What the case study data also show is that the source of economic value differs considerably for each community. In the case of Petrolia, it appears that non-market ecosystem service values contribute approximately twice as much to the total economic value of the protected buffer as market-based values. As a result, if one were to 'leave out' the non-market component of total value in the cost-effectiveness estimate, the end result would have been quite different: the total economic value would have been only $197 per acre, resulting in a net cost of $135 per acre for treatment. On the other hand, in Morongo Valley, the market-based value of homes and structures appear to far outweigh the non-market goods and services associated with the protected buffer zone, so that the

net cost effectiveness of treatment would remain the same regardless of the non-market benefits.

With available time and resources, the approach used in this case study comparison could effectively be expanded to include all communities in the Hazardous Fuels Program throughout California. Given the nature of value transferability, the baseline non-market valuation information provided by the NaturalAssets™ Information System could be linked to other land cover types affected by treatment programs throughout California and once this information is coupled with market-based value estimates, the total economic value can be estimated and compared to treatment costs. The end result would provide the possibility for a rigorous assessment of total social benefits associated with every BLM fire treatment project implemented in California. In sum, the information summarized in this case study effectively answers recent calls by policy makers to better account for the full social costs and benefits associated with environmental programs (National Research Council 2004). Armed with such information, it appears that more informed decisions can be made in the future about protecting the natural and built assets that matter most to the people in the Wildland/Urban Interface.

Treatment Costs and Suppression Costs

It is of primary importance to determine whether or not the current level of fuel treatment is cost-effective. If total treatment costs exceed total suppression cost-savings, then too much area is being treated. But, if suppression cost-savings outweigh treatment costs, then not enough area is receiving treatment. In the second case, increasing the area treated would result in cost-savings and would improve cost-effectiveness. Choosing a cost-effective fire and fuels management strategy requires an examination of available treatment methods and the suppression cost-savings of fuel load reductions.

The fire season of 2000 heightened awareness of wildland fire and fuels management across the United States. The fires of 2000 that blazed across the western United States burned over 8.4 million acres and an estimated $1.6 billion was spent on fire suppression. These figures are very conservative as they rarely consider expenditures by public, private and non-profit sectors as well as market and non-market economic costs. Examples of these would include: the damage to the resource being protected, value of personal and commercial property lost, losses due to closure of airports, schools, businesses, recreation areas, loss of tourism revenues, displacement of workers, increase in health costs due to smoke exposure, the opportunity cost of the investment in fire suppression activities, etc. When all of those impacts are taken into consideration, the true cost of the impact of the event can reach remarkable totals; as demonstrated by the USFS's preliminary estimate of $1.2 billion accounting for the impacts of the 2003 Old, Grand Prix and Padua Wildfire Complex, which does not include ecosystem goods and services values (Dunn 2005).

As we have demonstrated in our analysis, treatment costs vary from location to location (Table 21). These variations makes sense according to the costs of doing business being

linked to median housing prices. California's median selling price, as reported by the California Association of Realtors has increased 20.1 percent over the home selling price for August of 2004. These housing trends are undoubtedly contributing to the differences in costs of treatment and using the 2004-2005 grant reporting NFPORS system, we have determined that these treatment costs will vary from year to year (Table 23).

Table 23 : Comparison of Treatment Costs by Administrative Unit for 2004 and 2005 BLM FY

Internal vs External	Treatment Category	Treatment Type	2004 Rx Costs	2004 Acres	2004 Cost/ Acre	2005 Rx Costs	2005 Acres	2005 Cost/ Acre
External	Fire	Broadcast Burn	4500	1700	3	15250	200	76
		Hand Pile Burn	84651	284	298	87686	377	233
	Fire Total		89151	1984		102936	577	
	Mechanical	Biomass Removal	101882	316	322			
		Chipping	812932	3453	235	215367	1848	117
		Crushing	31000	831	37			
		Hand Pile	74751	283	264	128462	860	149
		Lop and Scatter	8000	20	400	22769	125	182
		Machine Pile	15000	75	200	16463	128	129
		Mastication/Mowing	18500	114	162	27163	392	69
		Thinning	207223	278	745	725711	2790	260
	Mechanical Total		1269288	5370		1135935	6143	
	Other	Biological				60800	342	178
		Chemical	4250	8	531			
		Grazing	0	0				
		Seeding				5040	20	252
	Other Total		4250	8		65840	362	
External Total			1362689	7362		1304711	7082	
			2004			2005		
Internal	Fire	Broadcast Burn	114000	1738	66	485156	6434	75
		Hand Pile Burn	268600	1155	233	203350	1832	111
		Machine Pile Burn				25000	200	125
	Fire Total		382600	2893		713506	8466	
	Mechanical	Biomass Removal	43000	38	1132	137867	453	304
		Chipping	183850	211	871	258400	404	640
		Crushing	30000	50	600			
		Hand Pile	430500	649	663	711000	1619	439
		Lop and Scatter	36000	25	1440	138333	606	228
		Machine Pile	85000	180	472	20000	175	114
		Mastication/Mowing	162000	650	249	766500	1222	627
		Thinning	168000	310	542	124500	1521	82
	Mechanical Total		1138350	2113		2156600	6000	
Internal Total			1520950	5006		2870106	14466	
Grand Total (Both internal &external projects)			2883639	12368		4174817	21548	

Source: Table generated from the NFPORS database. Data from 2004-2005

Table 23 compares the treatment costs simply from 2004 to 2005 broken down by treatment types and whether this was a project implemented by BLM itself (internal projects perform by its field offices) or those implemented through grants (external projects performed by the BLM's local partners/grant recipients). This table demonstrates the variability in each of these treatments from year to year and also between those projects administered internally and through BLM local partners. What is perplexing about this table is that in all cases, except broadcast burning and mastication/mowing

(internal projects), the per acre costs of treatment has decreased from 2004 to 2005 while we know that the cost of living has increased. With median housing and gas prices escalating to all-time highs, why would we see an overall decreasing trend in treatment costs? Is this trend accurate? Are there hidden costs that made business more costly in 2004 that are no longer tracked in the NFPORS system for 2005? Or, more importantly, is the BLM and its local partners getting more efficient at implementing fuel treatments?

In order to answer these questions, we need more consistency in data collection and a longer duration to evaluate the BLM fuel treatment trends. Each year the BLM has the opportunity to track its internal and external projects using a grant reporting system that is designed to monitor the cost-effectiveness of fuel treatments. Currently, comparing the 2004 and 2005 data, we can see that the BLM has increased both the expenditures and numbers of acres being treated by the BLM field offices. With these internal projects, fire is the treatment of choice with 8,466 planned acres in 2005. In both 2004 and 2005, fire made up 58% of all BLM's treated internal acres. The costs of these fire treatments varied from $66/acre for broadcast burning to $233/acre for handpiling and burning. From 2004 to 2005, the numbers of acres treated internally has increased nearly threefold while the external projects by the BLM's local partners (i.e. grant recipients) has remained at the same level. These external projects favor mechanical treatments with chipping and thinning as the treatment of choice in 2004 and 2005, respectively. Although some trends are apparent in Table 23, we would hesitate to speculate that external projects are more expensive than internal ones because of the hidden costs of performing NEPA and CEQA. The BLM internal projects often have permanent staff members contributing to NEPA which may or may not have valued in these costs.

Initially, we planned to use historical data on suppression costs on units with and without fuel treatments to determine the cost-savings associated with the relevant treatment. However, given limited financial resources, data availability and data inconsistencies during the study period (2002-2004), this was not possible. At this point, there is only anecdotal evidence of suppression cost savings following fuel treatments. In the absence of empirical evidence, treatment cost estimates from fire management officers and suppression cost estimates from the National Fire Management Analysis System (NFMAS) provided an alternative data set for analysis.

The National Fire Management Analysis System (NFMAS) estimates suppression costs according to fuel model classifications. Based on the degree to which a treatment changes the fuel model, NFMAS estimates can be used to calculate the suppression cost-savings of fuel treatments. For example, given a 1-acre unit that is classified as a fire behavior fuel model 8, the NFMAS suppression cost per acre estimate is $5339. If the probability of ignition is 6%, then the expected suppression cost on the 1-acre unit is $320.34. Fuel treatment X, which costs $50 per acre, will change the fuel model from 8 to 9. The NFMAS suppression cost per acre given a fuel model 9 is $3427 per acre and given a similar 6% probability of ignition, the total cost of fire management with treatment is $255.62. In this example the suppression cost-savings generated from treatment is positive, $64.72, and treating the unit minimizes the expected cost of fire management.

We recommend that the BLM integrate into their evaluation system a mechanism for interpreting how their (and their partners) fuel treatments are changing fuels models.

5.3 Behavior Changes from Community Outreach Efforts

One central objective of wildfire management is to minimize the sum of fire losses and costs. That objective applies to prevention and pre-suppression as much as to fire fighting. Prevention and fuels management are (or ought to be) equal partners with suppression in the management of fires to reduce as much as possible the negative impacts on people's lives and their social and economic systems. However, currently our thinking is dominated by suppression even in the case of defensible space design and promotion. As presently conceived, defensible space is a collection of actions, including vegetation management around structures, that will provide a safe place to defend the structure and reduce the vulnerability of the structure to ignition. Defensible space includes other elements, of course, such as signing, adequate roads, and water supplies, and all are to be provided in an effort to defend individual structures easily, safely, and more effectively. If defensible space were widely adopted, fewer resources from perimeter control would be reassigned to structural defense, allowing quicker containment of the fire.

The unexpressed assumption of this viewpoint is that the values at risk are contained in the structure and that the landscape is expendable. The actual facts are very different.

Recent studies have revealed that Southern California residents considered the protection of the landscape more important than protection of the structures. A recent study by the US Forest Service on the 2003 Old, Grand Prix and Padua Wildfire Complex found that suppression costs only accounted for 5% of the $1.2 billion in total expenditures which does not include ecosystem goods and services values (Dunn 2005). It is in this context that we may revisit hazard mitigation systems and approaches that are seen to be more effective in tempering uncontrolled fires, more beneficial to local ecosystems and more cost efficient in the long term.

Traditionally, those who work with urban-wildland intermix residents were told that if the landscape is lost, people will not want to live in the area anymore. Of the respondents to our survey, 64% of them have experienced wildfire on their properties. The majority of these experiences have been in the last year (35%) and in the last five years (52%) with the remaining experiences taking place over five years ago (13%). Despite the frequency of experiencing fire firsthand, only 55% of the phone survey respondents demonstrated a concern for their property[20]. Our findings are consistent with earlier sociological studies (Gardner et al 1987; Gardner and Cortner 1988; Cortner et al 1990) which found that the majority of homeowners surveyed did not believe the wildland fire situation to be serious.

[20] This result was NOT significant to the 0.5 level.

It can be inferred by this study (and similar surveys in California by Beebe and Omi 1993; Gardner and Cortner 1988) that impacted communities express low awareness of the fire hazard and a belief that fire will not reoccur in the area. Although California is in a well documented fire prone Mediterranean climate in which its residents often experience fires, the public perception is still that the fire risk is "not on my property" and "not in my backyard". Our findings indicated that recent wildfire survivors tend to discount future wildfire risk because they are convinced that fire won't strike twice in the same place. The resultant slow rate of adoption of wildfire defenses by people living in the Wildland/Urban Interface is not the result of lack of knowledge, motivation, or skepticism about the effectiveness of defensible space. Instead, a number of barriers have resulted from perceptions of defensible space. Defensible space does not have a clear relative advantage compared to alternatives; it is perceived to be somewhat complex, and has the potential to conflict with important values or established methodologies. Increasing the rate of adoption and use of wildfire defenses in the Wildland/Urban Interface requires fire prevention officers to be conscious of perceived barriers and work to remove or mitigate those barriers.

Despite these overall trends, we are optimistic about those that are concerned about wildfires on their properties and within their communities. These respondents are taking action or have already taken action. From our survey, we found that 36% of the respondents have taken some actions after the wildfire to better protect themselves from future wildfires. An additional 51% indicated that they had already taken action. Perhaps the consistent outreach efforts of the federal agencies (and their local partners) are starting to influence their behaviors. The majority of these actions were initiated as a result of an outreach effort (albeit many could not remember which agency or department the effort came from). The focal point of these actions was to defend the structure and reduce the vulnerability of the structure to ignition.

This survey also found that 62% of those respondents know what the term "community at risk" means. This high percentage of awareness of this term shows that the outreach efforts are reaching those that want to hear the message, that being, there is a risk of fire in almost every Californian community. Those that have experienced wildfires and understand the threat to their structure are demonstrating a change in their behavior. Fire prevention is more than information and education aimed at reducing the numbers of fire starts. That is part of prevention - a very important part - but fire prevention works best when supported by three legs: information and education, enforcement, and engineering, and integrated with suppression and fuels management. Understanding the terms "Communities at Risk" and "Wildland/Urban Interface" and taking actions to change the defensible space around one's homes only addresses a portion of this triad. We need to work with whole neighborhoods and settlements instead of targeting only individual property owners to develop and implement a coordinated set of wildfire defense preparations. From our phone survey results, it is clear that there is still much work to be done in the State.

The blending of understanding and information about elements that are important (the successes, the failures, its perspectives and key factors) should be considered at the wider state-wide program scale. In order to identify the "system" elements that enable (or

prevent) communities to take part in raising awareness and taking action for themselves, the broader aspects of the Community Assistance Program level must be evaluated at the program level. This evaluation would include the policies, laws, macro-economic intentions (and their implementation) which effect BLM's Community Assistance Program. A review of these elements from beyond the community level is needed to support the points for discussion, lobbying and advocacy with stakeholders at the local and national levels. This improved understanding at the wider system scale should also create the opportunity to identify where, and perhaps how, communities can be connected through to the other levels of organization (such as Western Governors Association, the state-wide Fire Safe Councils, etc.). This assumes that these organizational levels are appropriate for the BLM's Community Assistance Program. The same system wide evaluation could be performed of the Fire Districts in the RFA Program to determine the system elements that make the RFA program more (or less) cost effective than retaining money at the federal level or placing it in the BLM's CAHFPs.

5.4 Reporting System Recommendations

There is a need for the BLM to request that all grant recipients report on their sphere of influence in a similar fashion. In order to use the total economic value approach effectively to compare and contrast individual fuel mitigation treatments (and their actual efficacy on the landscape), we suggest linkages with fire risk models like FARSITE and FLAMAP. For resource managers and fire management officers to use this decision management system, the BLM needs to change its grant tracking to require three new data inputs. The first is the treatment footprint , the second is the sphere of influence (or protection footprint), and third is the probability of fire under the treatment scenario. The last two inputs would have to be generated by a wildfire simulation model. This will allow the field offices and the grant managers to track, compare and contrast, the different fuel treatment options at a local and regional level and better quantify the benefits from them.

As communities continue to develop CWPPs (under the HFRA), the BLM and other agencies will be able to allocate their federal dollars to specific fuel treatments based upon weighing the potential benefits from a treatment against cost. Specifically, the fire models would produce a baseline wildfire damage probability under a no-treatment scenario. The amount and probability of damages to both structures and environmental assets could then be compared to the predicted amount and probability of damages under alternative treatment scenarios, net of treatment cost. Treatment scenarios can range from shaded fuel breaks, strategically placed land area treatments (SPLATS), or the break up of fuel continuity around individual communities and homes. Well designed treatments should result in lower burn probabilities as well as fewer burned acres when a simulated fire does occur. Because these models are spatially explicit, the predicted fire perimeters can be overlain on our baseline ESV and structure maps to estimate what the extent of damage would be under each scenario. For each scenario, including the baseline, then,

the cost of treatment (zero in the case of the baseline) can be compared to the probability of fire multiplied by the estimated damage from each fire. This can be a valuable tool for communities in the Urban/Wildland Interface, as they engage in wildfire protection planning. On a state-wide level, grant applications can be evaluated based upon their net benefits to society.

Outreach projects should have a realistic target number for performing the outreach and should have monitoring systems in place to measure the efficacy of the effort. We have suggested four different types of evaluation:

1) Formative evaluation usually takes place during the planning phase of a communications project and provides information on the strengths and weakness of materials or initiative strategies.
2) Process evaluation takes place during the implementation phase of the outreach project and is used to assess whether the grant recipient(s) has conducted the tasks, procedures, and activities as originally planned.
3) Impact evaluation is used to determine the short-term effects of the program on the target audience(s), such as an increase in their knowledge and awareness levels or changes in attitudes or behaviors.
4) Outcome evaluation assesses the long-term results of the program, such as a decrease in numbers of acres burned in a particular watershed.

Currently of all of the grants disbursed during the three year study period, only three of them performed surveys to see if they achieved the anticipated results. We recommend that the BLM and its local partners consider developing a monitoring and evaluation system for purely the outreach effort[21]. We are available to help with this process and have some ideas on how to adapt rapid appraisal techniques to evaluate projects in a cost-efficient manner (Ganz et al 2003). This evaluation system designed should be based upon a target audience and reported in terms of population and the numbers of homes and parcels affected. As in the grant reports from 2004, these preferred metrics will allow for the quarterly and annual reports to serve as process and impact evaluations of the outreach effort. Had there been this kind of information for the entire three year study period, we would have been able to perform an assessment of the efficacy of the program. Under the Sacramento Regional Foundation, the reporting system was not nearly as focused as it is now under the State's Fire Safe Council so we suggest that the BLM continue to use the State Council to serve as the clearing house for its grants.

Irrespective of the type of grant (supporting fuels treatment project, planning, education or outreach), grant recipients need to focus and report on similar metrics, i.e. typically focused on the number of acres treated, the number of miles of fuel break, or some other geographic unit. Although these continue to be good metrics to quantify the expenditures on a per unit basis, the BLM should also encourage its local partners to assess how many homes and community members are protected by the project. This would assist in future

[21] For building an appropriate Monitoring and Evaluation System for its Community Assistance Program, we recommend that the BLM refer to "Measures of Success : Designing, Managing, and Monitoring Conservation and Development Projects" by Richard Margoluis and Nick Salafsky

efforts to do a cost-benefit comparison of its programs. If the grant reporting system of 2004 and 2005 is in place for another year, we anticipate that there will be consistency in reporting and enough data from the grant recipients to perform the desired assessment of generating a cost-benefit ratio. In order to do this cost-benefit analysis for these grants, the BLM would also need to make sure that the $ values in their reporting system uses the same 2004 non-discounted standard that we used for generating the ESV estimates (or converts these reported values prior to performing such an analysis).

5.5 Next Steps

In evaluating the CA BLM Community Assistance and Hazardous Fuel Programs, we have come up with a list of potential next steps that would enable the agency to further assess the efficacy of their programs and to integrate the lessons learned from this assessment into future monitoring and evaluation systems.

We have identified a number of areas for future research and analysis in the realms of ecosystem service valuation and decision support in California. First, it is critical to improve the quality of spatial and valuation data. This would involve expanding the NaturalAssets ™ Information System land cover typology to include more precise land cover classes (e.g. breaking down forest type by successional stage), broadening the typology to include classes that may not be present in the three study areas, and adding valuation studies to our database estimate values for the resulting new land cover classes. We also hope to develop applications that will automate the creation of landcover datasets that incorporate the Natural Assets™ typology utilizing publicly available data. Finally, we hope to develop an automated approach for incorporating data from short term and long term monitoring projects.

Further, we hope to develop a decision support system integrating a series of automated modules. Ideally, this system would integrate existing fire models, such as FARSITE, and would allow for the calculation of probabilities of fire damage under current and alternative scenarios. Scenarios could include different types of vegetative treatments, different estimated suppression responses and different development patterns. The predicted damage from each fire scenario could then be estimated by calculating loss to market values, like structures, timber, and crops, as well as ecosystem services. Calculating market values is simply a matter of obtaining the necessary data. The Natural Assets™ Information System would be used to calculate the opportunity cost of the lost ecosystem service values. Utilizing these estimates of forgone benefits in the event of fire, the probabilities of occurrence, and the costs of treatments under each scenario, we can then test the cost effectiveness of each treatment type.

The next steps are broken down into three major categories as they relate to this assessment:

Ecosystem Goods and Services

1. Further refine the NaturalAssets™ information system and broadened the literature review to reflect more ecosystem goods and services.
2. Perform a similar analysis for the entire State of California.
3. Integrate the ESV layer that we have generated for these three counties (or a state-wide effort) into the NFPORS system so that all federal agencies can have the benefit of this planning layer.
4. Re-evaluate the baseline assessment in two years time within the three counties to see if there has been a change in ecosystem goods and services based upon the most up to date land cover data.
5. Request that grant recipients submit a map of the project's footprint or sphere of influence. If this is done using GIS, request that the original datafile of the footprint of sphere of influence is also submitted. For those that do not have this capability, request that grant recipients send a USGS quad with their project's treatment footprint and sphere of influence.
6. Build a decision support system integrating existing fire models, such as FARSITE that would allow for the calculation of probabilities of fire damage under current and alternative fuel management scenarios.

Economics

1. Perform a full scale, state-wide cost-benefit analysis and/or a full costs accounting.
2. Generate true costs of hazardous fuel treatment for fire, mechanical and "other" under the State's various land cover types (perhaps even build in site specific information such as slopes and distance to roads, etc.)
3. Use the same 2004 non-discounted standard that we have used for generating the ESV estimates for future comparisons.
4. Continue to use the 2004 grant reporting system and encourage grant recipients (and the State's Fire Safe Council acting as coordinator) to be diligent in completing the metrics that are needed to perform a cost comparison between sites and between fiscal years.
5. For fuel treatments, determine the level of change in fuel model classifications so that BLM can estimate suppression costs according to the National Fire Management Analysis System (NFMAS).

6. Input BLM 2002 project's direct treatment costs into the NFPORS system

Phone Survey

1. Development of statewide evaluation system for CAHFPs and rapid appraisal tools for individual project to better assess the efficacy of these programs.
2. Perform an evaluation of the CAHFPs (with this assistance of BLM's local partners) with an emphasis on the "system" elements that enable (or potentially prevent) communities to take part in raising awareness and taking action for themselves. This could be done in a workshop venue with key stakeholder groups.
3. Perform a state-wide survey using this survey instrument (or a similarly designed one). This would serve as the BLM's baseline state-wide impact evaluation.
4. Repeat the existing phone survey in these three counties after a period of time (probably two to three fiscal periods) as an impact evaluation of BLM's Community Assistance Program. Use the existing phone survey results as the baseline. Utilize the lessons-learned from this assessment to streamline phone survey instrument.
5. In the event that such a phone survey was repeated for BLM, ensure that there is an ability to do call-backs to those respondents that clearly would prefer to speak Spanish.
6. Determine whether there is a potential to respond directly to survey participants requests. Several respondents gave suggestions as to how they felt the best outreach could be performed but this information tends to get lost during the analysis.
7. Streamline the demographic questions to ask only those that are absolutely necessary or find alternative ways to generate the same information (such as using zip codes and census information to generate demographics).

Marketing of the BLM CAHFP and its Cost Effectiveness at the National Level

1. Disseminate the Executive Summary of this report.
2. Post the Executive Summary of this report on CA BLM website
3. Distribute hard copies of this report to the CA field offices (especially those that manage projects within the three study counties).
4. Distribute a hard copy of this report to the Fire Safe Council
5. Turn the two case studies of Petrolia and Morongo Valley into a scientific paper for presentation at the next IAWF conference on Fuels Management: How to Measure Success" in March 2006.
6. Present the findings of this assessment at the BLM Fire Leadership Team Meeting in December 2005.

7. Create a one page marketing slick for the California CAHFPs with mention of this assessment and its findings. Disseminate to all federal agencies, grant recipients and local partners.

5.6 Conclusions

Quantifying effectiveness of fire mitigation treatments is a challenge as there is no accepted system of measurement. We have provided the California Bureau of Land Management with an alternative perspective to viewing their standard metrics of numbers of acres treated and treatment costs per acre. In order to see a shift in the dominant paradigm of what is efficient and not efficient, the BLM has had the foresight to include of the economic benefits of ecosystem goods and services associated when evaluating the cost-effectiveness of their fuel treatments. Although limited to the counties of San Bernardino, Napa and Humboldt counties, the BLM has received a baseline accounting of these values in three heterogeneous landscapes that are representative and transferable with other parts of the State. Obviously, major differences exist between study counties and the areas for which we consider them representative. California contains many unique features that are irreplaceable. Nevertheless, because the value transfer method used in this study uses the relationship between general land cover types and estimated economic values, the estimates presented in this report are transferable to many other parts of the State.

The net benefits to society are captured in a total estimated value associated with each land cover type. In this assessment, the market values of structures have been included and we recommend the inclusion of other market values in future uses of the proposed cost-effectiveness analysis. Irrespective of the kind of fuel hazard reduction treatment performed (and the costs associated with them), by accounting for these market and non-market assets, there is a net benefit to society.

When both the non-market and market-based values of protected structures, goods and services are taken into consideration, the case study site of Petrolia demonstrated that although treatment project costs were $332 per acre the total economic value of market and non-market goods and services within the protected buffer zone yield approximately $634 per acre, resulting in a net benefit of $302 per acre. In the case of Morongo Valley, while the costs of treatment are somewhat higher at $937 per acre, the total economic value of the protected area is also considerably higher resulting in a net benefit of $5,058 per acre.

Had ESVs been excluded from BLM's analysis of total value in these two case studies, the end results would have been quite different: the total economic value in Petrolia would have been only $197 per acre, resulting in a net social cost of $135 per acre for treatment. On the other hand, in Morongo Valley, the market-based value of homes and structures appear to far outweigh the non-market goods and services associated with the protected buffer zone, so that the net cost effectiveness of treatment would remain the same regardless of the non-market benefits. The end result would provide the possibility

for a rigorous assessment of total social benefits associated with every BLM fire treatment project implemented in California. In sum, the information summarized in these report effectively answers recent calls by policy makers to better account for the full social costs and benefits associated with environmental programs (National Research Council 2004). Armed with such information, the BLM will be able to make informed decisions about protecting the natural and built assets that matter most to the people in the Wildland/Urban Interface.

Equally important in this assessment was our attempts to depict changes in behaviors from BLM's outreach activities. Using a phone survey instrument to depict these changes, we completed 432 (12.74%) surveys out of 3390 calls initiated. Similar trends were found in all the three counties. Fortunately, the scale of this assessment allows for some general depictions of California residents:

- The public perception is still that the fire risk is "not on my property" and "not in my backyard".
- The majority of homeowners surveyed, despite having experience wildfires recently, did not believe the wildland fire situation to be serious.
- Those that are concerned about wildland fire are taking actions. Many of these actions are well-planned, well-orchestrated and in collaboration with other local stakeholders.
- Most Californians are receiving the outreach messages on the need to take actions to defend their structure and reduce the vulnerability of the structure to ignition. A number of barriers still exist from misperceptions of what defensible space means and why it is necessary.
- Ecosystem goods and services are valued highly by Californians. In fact, some Southern California residents (surveyed by other studies) considered the protection of the landscape more important than protection of the structures. This reinforces the need to include this report's ESV estimates in future mitigation planning efforts.
- There is a need to work with whole neighborhoods and settlements instead of targeting only individual property owners. Homeowner associations and the smaller Fire Safe Councils are existing social structures of this appropriate scale.
- Although California residents seem are educated and well informed, the need for outreach and extension is still there.
- There is a need to perform an independent assessment purely on the agency's community assistance at the state-wide program scale to evaluate its successes, failures, its perspectives and key obstacles.
- An opportunity exists to create a rapid appraisal technique so that the BLM grant recipients are able to effectively track the efficacy of their outreach program.
- Working at a local level, through joint management initiatives (with partners like the Fire Safe Councils, homeowner associations), has many inherent benefits that

are not captured by a cost effectiveness or traditional cost-benefit analysis. For instance, the capacity-building component of funding a local partner to perform planning activities will never fully be recognized in monetary terms. It is equally rare to pick up these behavioral changes in a well designed phone survey. To date, as many social scientists will attest, capacity building is a difficult social phenomenon to measure.

There is economic evidence in this report to support the continued use of fuels treatments for cost-effective wildland fire hazard reduction. However, in spite of this evidence and the management goals put forth in the 1995 Federal Wildland Fire Policy, treatment costs have not increased in the period FY2004 to FY2005 but have in fact decreased. Including estimates of the full range of social and ecological benefits of hazardous fuel treatments suggests that increasing the treatment level to include higher cost treatment methods would result in increases in net benefits. We have provided the BLM with a tool to quantify the full benefits of hazardous fuel treatments, particularly nonmarket benefits, beyond the typical metric of reduced suppression costs.

Although capacity building and collaboration is difficult to measure, it is clear that the BLM's Community Assistance and Hazardous Fuel Programs can create opportunities for improving understanding among local communities, federal and state resource management agencies and commercial enterprises. Successful community-based approaches are in the best interest of everyone hoping to eliminate unwanted fire. In California, there is a growing consensus, among people who believe that both people and valuable ecosystems are at risk from present courses of action, that the most promising approaches to wildland fire management lie in such joint management initiatives. This report has documented both the monetary benefits to society and potential behavioral changes by working through these joint management initiatives.

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Appendix A. Glossary of Common Terms

Benefits Transfer: Economic valuation approach in which estimates obtained in one context are used to estimate economic values in a different context This approach is widely used in policy settings because of its relative efficiency and low cost, but has limitations because value estimates are context-specific and must be carefully used and interpreted. Also referred to as *value-transfer*.

Contingent Valuation: Economic valuation technique based on the stated preference of respondents to a survey regarding how much they would be willing to pay for specified benefits of an environmental good or service. CV is designed to circumvent the absence of markets by presenting consumers with hypothetical markets in which they have the opportunity to 'buy' the good or service in question. A detailed description of the good or service is provided along with details about how it will be provided.

Cultural Services: The non-material benefits that people obtain from ecosystems through cognitive development, recreation opportunities, aesthetic experiences and spiritual or cultural enrichment.

Direct Use Value: In the total economic value framework (see below), the benefits derived from the goods and services provided by an ecosystem that are used directly by an economic agent. These include consumptive uses (e.g., harvesting timber) and nonconsumptive uses (e.g., enjoying scenic views). Agents are often physically present in an ecosystem to receive direct use value. Compare to *indirect use value*.

Ecosystem Function(s): An intrinsic ecosystem characteristic related to the set of conditions and processes whereby an ecosystem maintains its integrity (e.g., primary productivity, food chain, nutrient cycles). Ecosystem functions include such processes such as nutrient cycling, biomass production and decomposition. See also *supporting services* for related discussion.

Ecosystem Services: The benefits people obtain from ecosystems. These include provisioning services such as food and water; regulating services such as flood control and waste assimilation; supporting services such as nutrient cycling; and cultural services such as recreational or aesthetic benefits.

Existence Value: The value that an economic agent places on knowing that a resource exists, even if they will never directly use that resource (also commonly referred to as *passive use value* or *conservation value*).

Geographic Information System (GIS): A computerized system organizing data sets through a geographical referencing of all data included in its collections. A GIS allows the spatial display and analysis of information.

Hedonic Price Methods: Economic valuation methods that use statistical techniques to break down the market price paid for goods and services into the implicit prices for each

of their attributes, including environmental attributes such as access to a nice view or clean water. For example, the price of a home may be broken down to see how much the buyers were willing to pay for a home in a neighborhood with cleaner air.

Indirect Use Value: The benefits derived from the goods and services provided by an ecosystem that are used indirectly by an economic agent. For example, an agent at some distance from an ecosystem may derive benefits from drinking water that has veen purified as it passed through the ecosystem. Compare to *direct use value.*

Intrinsic Value: The value of something in and of itself, irrespective of its utility to another economic agent.

Option Value: The Value of preserving the option to use services in the future either by oneself (option value) or by others including heirs (bequest value). Quasi option value represents the value of avoiding irreversible decisions until new information reveals whether certain ecosystem services have values that society is currently not aware of.

Provisioning Services: The products obtained from ecosystems, including, for example, genetic resources, food, fiber, and raw materials.

Raster Data: A type of GIS data that describes the characteristics of a geographic area using a continuous grid, with each cell, or pixel, assigned a value.
Regulating Services: The benefits obtained from the regulation of ecosystem processes, including, for example the regulation of climate and water cycles.

Replacement Cost: A method for valuing the ecological services by estimating the cost of replacing the service or treating the damages arising from the loss of the service. For example the presence of a wetland may reduce the cost of municipal water treatment for drinking water because the wetland system filters and removes pollutants. The cost of water treatment can thus be used as a proxy for the value of waste treatment provided by the wetland. Given that the method is extremely sensitive to the market conditions under which cost assumptions are being made, however, this method should be used with great caution.

Supporting Services: Ecosystem services that are necessary for the production of all other ecosystem services. Examples include biomass production, nutrient cycling and provisioning of habitat.

Total Economic Value Framework: The presumption of this framework is that people can hold multiple values for an ecosystem. A widely used taxonomic framework to disaggregate the components of economic value, including *direct* and *indirect use value*, *option value*, *quasi-option value* and *existence* value. A TEV approach is necessary to ensure that double counting of values does not occur when multiple valuation methods are used such as in the case of *benefits transfer*.

Travel Cost Methods: Economic valuation techniques that use observed costs to travel to a destination to derive demand functions for that destination, often based on the environmental quality of the site. Developed primarily to value the recreational uses of protected areas.

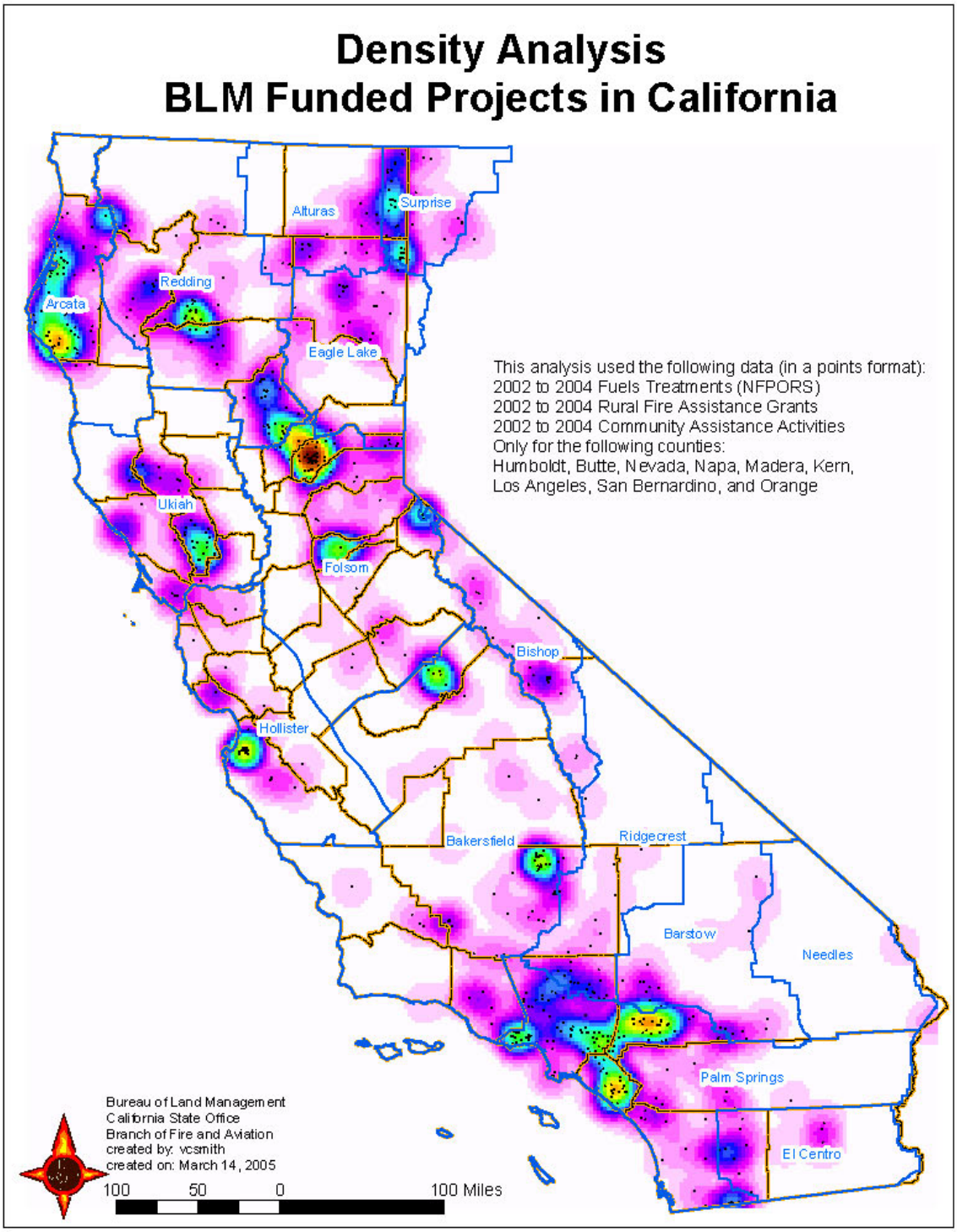
Union: a geoprocessing step in which two overlapping polygon geographies are combined to the full extent of both

Valuation: The process of expressing a value for a particular good or service in terms of something that can be quantified through economic methods.

Value Transfer: See *benefits transfer*.

Vector Data: a type of GIS data that uses points, lines and polygons to represent geographic features.

Appendix B. BLM Projects Evaluation Criteria and Density Analysis Map



2002 BLM Funded Project Details

2002 #	$	FSC/Other Proposer	Location	Pop/Homes.	Ownership	Expenditure Use	Program Objective	Evaluation Criteria
DJ15		Butte Co.	Paradise, Berry Creek, Yankee Hill, Cohasset	60,000	USFS, BLM,Pvt	Ex Dir FSC	res defensible space	homes lost
DJ183		Butte Co.	Carbon Canyon			Brochure		none listed
DJ17		Butte Co.	Cohasset	1,500		Evac Plan	Evacuation Plans	Res response to Plans
DJ19		Del Norte	County	28,500/4950	pvt.	Questionaire Survey	Create FSC	
DJ99		Diablo FSC	Alameda/Contra Costa Counties	2.4 million	pvt, Military/Nat Labs	Ex. Coord.	Admin, workshop, media	Increase Defensible Space
DJ 20		Diablo FSC	Alameda/Contra Costa Counties	2.4 million	pvt, Military/Nat Labs	Dev res workshops		FireSafety,Inc. Def. Space
DJ 81		10 FSC	Eastern Madera County	26000/16000	fed/pvt	find funding/devWorkPlan		
DJ21		East.SierraFSC	Inyo-Mono Counties/19 Communities	25,000	fed/pvt	Admin	Admin	incr. Members,FSC, funds
DJ22		East.SierraFSC	Inyo-Mono Counties/19 Communities	25,001	fed/pvt	Equip for Presentations	admin, reduce fuels/educ	Incr. In def. Space, escape routes
DJ77		Lassen	Day/LassenBench	375/200homes	fed/pvt/tribal	Equip For Fuels Reduction	Equip, Admin	Incr. Acres, escape rounts
DJ23		SFSC	state-wide	statewide	all	Amin	Support local FSCs	
DJ24		SFSC	state-wide	statewide	all	Amin	Support local FSCs	
DJ26		Nev. Co FSC	Nev. County	39000 homes	all	Brochures	Summer Comm. Outreach	#brochures distri, incr. In homes with def.Space
DJ07		Marin FSC	Marin Co.	240,000	pvt	computer, software	use of laptop by board/community groups	
DJ02		Marin FSC	Marin Co.	240,001	pvt	Ex. Coord.	admin	# Public Outreach efforts
DJ27		San Mateo FSC	San Mateo County		pvt	Brochures	Educ. Outreach	
DJ97		Sonoma FSC	Sonoma County	50,000-45,000 homes	pvt	audio/visul equip	Educ. Outreach	#presentations
DJ84		LA Co.	Topanga, Hidden Hills, Agoura Hills, Malibu, Westlake					
DJ82		El Dorado FSC	El Dorado Co	68,500	pvt	office/admin suport	permanent office	
DJ28		Orange County	Orange County		pvt	landscape planting/maint	educ	# guides used by landscapers/nurseries
DJ30	67500	Hiwy168FSC	Fresno - Shaver Lake	15,000	USFS, pvt	Fire Safe Coordinator	Admin	incr educ programs/1-2new fuel proj/annual
DJ31		Hiwy168FSC	Fresno - Shaver Lake	15,000	USFS, pvt	Fire Safe Coordinator	equip for fuel proj	incr educ programs/1-2new fuel proj/annual
DJ32		Janesville FSC	Lassen Co.	1500 homes	pvt	Seniors/handicapped fuels reduction		# tons reduced fuel-reduce fire intensity
DJ33		Janesville FSC	Lassen Co.	1500 homes	pvt	fuel reduction projects		# tons reduced fuel-reduce fire intensity
DJ36		Susanville	Lassen Co.	1500 homes	pvt	fuel reduction projects	fuel reduction projects	# tons reduced fuel-reduce fire intensity
DJ34		KernRiverFSC	Kern Co	25,000	pvt, federal	Coordinator/educ/fuelreduc	interagencyLiason	add 2 communities/mo
DJ37		Lytle CreekCny	San Bernardino	385 homes, 1000pop	pvt	brochures	educ	3 residences creating defensibvle space
DJ38		Lytle CreekCny	San Bernardino	386 homes, 1000pop	pvt	Insurance	Admin	
DJ40		Lytle CreekCny	San Bernardino	387 homes, 1000pop	pvt	manual of procedures		
DD03		Mariposa FSC	Mariposa Co.	6613 Homes, 90%hi risk	USFS,BLM,Tribal,Pvt	Cood., Mailer, office, CPA	Outreach/Admin	#requests for brochures; Risk Surveys
DJ43		Mococ FSC	Modoc Co.	6300 pop	USFS, BLM,Pvt, NatPark	brochures, fair booths, present.	Outreach effort	#events/brochures/presentations
DJ44		City of Monrovia	City of Monrovia (adjacent to LA Nat. Forest	750 homes	USFS, pvt	Goats for fuel reduction	fuel reduction projects	volume of fuel removed
DJ85	48000	MorongoValley FSC	Morongo Valley	5000pop	USFS, BLM, pvt	FSCAdvocate/Grants	fuel reduction projects	#grants&volume of fuel reduced
DJ74		MosquitoVol.FD	Mosquito	520homes, 1400pop	USFS, pvt	project plannin/fuelsreduction,educ		volume of fuel removed
DJ45		Mt. Veeder FSC	Mt. Veeder (Napa Co.)	600 homes	BLM, pvt	mailed Fire Prev Brochures/Presentations		#homeowners participating
DJ96		Mt. CommunitiesFSC	San Jacinto Mtns. Communities	1200homes, 3360pop.	USFS, StateLands,pvt	Coordinator/educ/fuelreduc	Admin, Educ. Outreach	fuel reduction & defensible space incr.
DJ46		Mt.Rim FSC	W/in San Bernardino N.F.	30,000yr.roundpop	USFS, pvt	Fund Office, Travel forWorkshops,etc.	Admin	Fuel Reduction
DJ48		Mt.Rim FSC	W/in San Bernardino N.F.	30,000yr.roundpop	USFS, pvt	Brochures, mailings	Educ. Outreach	Fuel Reduction
DJ49		Mt.Rim FSC	W/in San Bernardino N.F.	30,000yr.roundpop	USFS, pvt	1 mile Fuel Break	fuel reduction projects	Fuel Reduction
DJ51		Mt.Rim FSC	Arrowhead CommunityW/in San Bernardino N.F.	16000pop,45000tourists	USFS, pvt	Fuel Reduction Contractors	fuel reduction projects	Fuel Reduction
DJ52		Mt.Rim FSC	Lake Green Valley Lake	1000pop, 3000 tourists	USFS, pvt	Fuel Reduction Contractors	fuel reduction projects	Fuel Reduction
DJ53		Mt.Rim FSC	Running Springs/ Arrowber Communities	6000paop, 8-10,000 toursis	USFS, pvt	Fuel Reduction Contractors	fuel reduction projects	Fuel Reduction
DJ54		Mt.Rim FSC	Lake Crestline	5000pop, 20000tourists	USFS, pvt	Fuel Reduction Contractors	fuel reduction projects	Fuel Reduction
DJ55		Mt.Rim FSC	San Jacinto Mtns. Communities	30,000yr.roundpop	USFS, pvt	12 page color Supplement	fuel reduction projects	citizens participatitng
DJ56		Mt.Rim FSC	San Jacinto Mtns. Communities	30,000yr.roundpop	USFS, pvt	Brochures, PwPt., presentations	Ecuc. Outroach.	Area Field Survey of homes
DJ92		North Fork	North Fork	11337pop	USFS, pvt, tribal	Admin,chipper,educ,projects	Educ/fuel reduct. Proj.	#requests/fuelloadingreductionprojects
DJ58		Ojai FSC	Ojai (Los Padres NF)	20000res;8000busemploy	USFS, pvt	Expand fuel proj/markets	Educ/fuel reduct. Proj./users	#tonsbiomasscollected/#&type of end users
DJ73		PineMtnClubHomeowners	Kern Co	5000pop,2000 homes	USFS, pvt	Complete Community Plan	Planning	Response to the plan by community
DJ61		MtPinos/FrazierPark	Kern Co.	10000pop, 6500homes	USFS, pvt	Organize FSC	Admin	Creation of FSC
DJ62	12000	PlacerCoFireSafeAlliance	Eastern Placer Co.	102892pop	USFS, pvt,BLM,StParks	Tabloid Magazine onFire	Educ	#distributed
DJ63		PlacerCoFireSafeAlliance	Eastern Placer Co.	102892pop	USFS, pvt,BLM,StParks	Exec coordinator	Admin	
DJ64		PlacerCoFireSafeAlliance	Eastern Placer Co.	102892pop	USFS, pvt	FIreInspections/educ	FireInspect/Educ	#inspections
DD06		PlumasCo. FSC	Plumas Co.	21000pop, 1700restargeted	USFS, pvt,BLM,StParks	Coord.&GIS Map For Co use	Dev GIS Assessment	#residencesparticipating
DJ98		PlumasCo. FSC	Plumas Co.	21000pop	USFS, pvt,BLM,StParks	HazFuelAssessment	Dev HFA	Used by Co in Allocating $
DJ65		PlumasCo. FSC	Plumas Co.	21000pop	USFS, pvt,BLM,StParks	Educ material & distribution	Educ. Outreach	#people attending/contacting
DJ66	64856	SYRCD	Siskiyou Co.	45000pop, 15000homes	USFS, pvt	Coord to establ FSC	Admin	
DJ80	6830	So Lake FSC	Lake Co	11000pop, 5100 homes	pvt	Continue Educ &chipper Prog	Educ. Outreach/Fuel Proj	#citizens contacted/attendees at workshops
DJ86	12700	So Lake FSC	Lake Co	11000pop, 5100 homes	pvt	Expand&extendEduc efforts	Educ. Outreach/Fuel Proj	#citizens contacted/attendees at workshops
DJ67		SWRuversudeCoFSC	Riverside County	250,000+pop	USFS,BLM,BIA,pvt	Maintain FireSafe Demon	Educ	
DJ68		SWRuversudeCoFSC	Riverside County	250,000+pop	USFS,BLM,BIA,pvt	fund FSC	Adm	
DD04		SWRuversudeCoFSC	Riverside County	targeted30000pop	USFS,BLM,BIA,pvt	Educ Outreach	Educ Outreach	#responses/requests/contacts
DJ90	33000	SunflowerCRMP	West of Red Bluff		pvt	plan,construct20milefuelbreak	Fuel Break	miles of fuel break constructed
DJ95		Tahoe FSC	Tahoe	55000pop	usfs, pvt	Coordinator	Admin	#fuel oading reduction projects, pvt., & public
DD05		Trinity CO. FSC	Trinity Co	13000pop	USFS, BLM, pvt	Educ/fuel Projects	Educ/Fuel projects	dev 20 opage fire nespape rinsert/#fuel reduction proj.
DJ70		Glendale& Whiting Woods	Cities of Glendale & Whiting Woods	200,000+pop	USFS, pvt	Coord,FirePlan, inspections	Admin, inspections	Completion of Fire Plan
DJ72		Glendale& Whiting Woods	Cities of Glendale & Whiting Woods	200,000+pop	USFS, pvt	Educ. Material	Educ Outreach	Dev, & publication of fiere safe materials

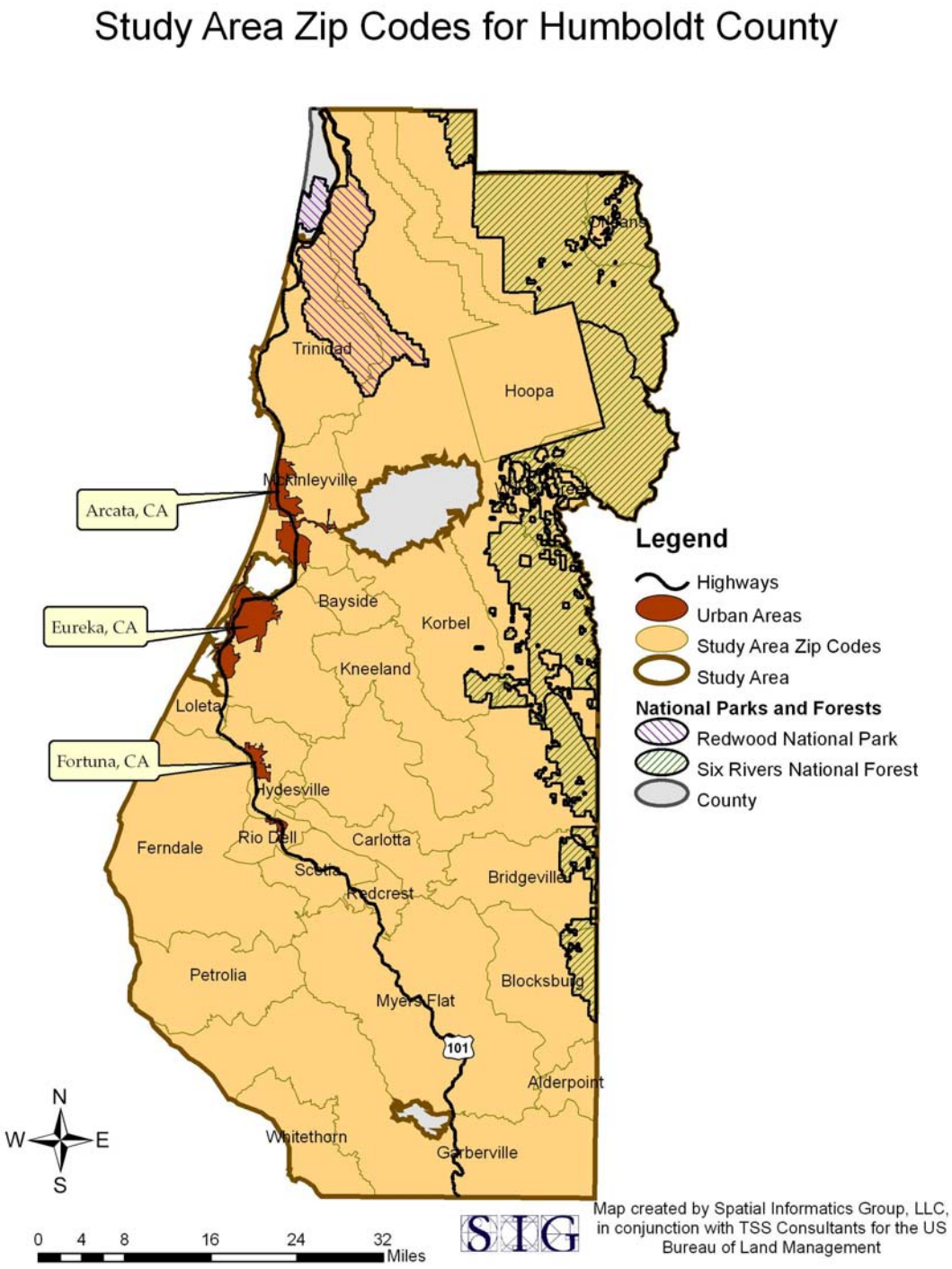
2003 BLM Funded Project Details

2003 #	$	FSC/Other Proposer	Location	Pop/Homes.	Ownership	Expenditure Use	Program Objective	Evaluation Criteria
DD61	36000	Alpine EMS	Alpine Co near Woodfords			Fuel Reduction	Fuel Reduction	150'fuel break around devlopment
DD62	52000	Amador FSC	Amador Co	Sen citizens	pvt	Fuel Reduction	Fuel Reduction	Fuel reduction and defensible space around homes
DD63	55000	Amador FSC	Volcano/Pioneer areas		pvt, USFS	Fuel Reduction	Fuel Reduction	Fuel reduction and defensible space around homes
DD64	18941	S.BernardinoNFAssn	Big Bear Valley	22000pop	pvt, USFS	Create FSC	Admin	
DD66	47740	Calif FSC	California	35million	pvt,fed,state,local	Hold meetings	Admin	
DD67	23100	Calif FSC	California	35million	pvt,fed,state,local	Web Site funding	Admin	
DD69		Circle Oaks	Napa Co.	182 homes	pvt	Fuel treatment/Educ	FuelReduct/Educ	100acres greenbelt/5.6iles road clearance/newsletter/brochure outreach
DD71	31171	CottonwoodCreekWatGrp	Cottonwood	7960pop	pvt	Educ outreach/planning	Educ outreach	
DD73	64988	Diablo Fire Safe Council	Oakland		pvt	Dev Fire Plan/sp. Projects	Admin, planning	Fire Plan/fuel projects
DD75	61747	Eastern Madera FSC	Madera Co		pvt, USFS, BIA	Coord/IdentifyseniorFuelProjects	Admin/Fuel Projects	Fuel Reduced
DD76	76840	Eastern Madera FSC	Madera Co		pvt, USFS, BIA	Educ outreach/planning	Educ/Admin	Two Community Fire Plans, presentations
DD77	56969	El Dorado Co FSC	El Dorado		pvt, USFS	Continue funding Coord for Fire Plan	Admin	Dev Fire Plan
DD78	25600	El Dorado Co FSC	El Dorado		pvt, USFS	Expand Chipper Program	Fuel Reduction	Fuel Reduction/disposal
DD22	312000	Nev Co FSC	Nevada Co		pvt, USFS	Equip for Dropoff Grinding Center	Fuel Reduction	Fuel Reduction/disposal
DD79	180420	Nev Co FSC	Nevada Co		pvt, USFS	Contract for fuel reduction around homes	Fuel Reduction	Fuel Reduction/disposal
DD80	168900	Greater San Diego RCD	San Diego Co		pvt, USFS	Coord/continue RCD programs	Admin/Fuel Projects	#fuel acreage/vol removed
DD82	30000	Fire Safe Marin, inc.	Marin Co.		pvt, state parks	fuel loading reduction	Fuel Reduction	Fire break and fuel reduction projects
DD83	23050	Ft Ross VFD	Sonoma Co.		pvt	fuel loading reduction	Fuel Reduction	Fire break and fuel reduction projects
DD84	36000	Greater Laguna CoastFSC	Laguna Beach	300homes	pvt	Community Fuel Chipping/disposal	Fuel Reduction	Fuel reduced/educ demon projects
DD87	15000	Hiway 168 FSC	Fresno Co		pvt, USFS	Educ outreach/planning	Educ	20-30%increase in res fuel reduction;10-15%decrease in visitor related fires
DD88	21638	Inter-Canyon League FSC	San Diego Co		pvt, USFS	Fuel Reduction	Fuel Reduction/educ	Increase fuel cleared from 200-250 tons
DD89	112500	Kern River Valley Revit. Inc	Kern County		pvt, USFS	Mechanically treat 80 acres of fuel	Fuel Reduction	80 acres of fuel reduction
DD91	1300	Lakeland Village VFC	San Diego Co	5500 homes	pvt, USFS	Brochure mailing to homeowners	Educ Outreach	#homeowner mailings
DD92	33800	Lytle Creek FSC	San Bernardino Co	1000 pop 385 homes	pvt, USFS	Continue funding FSC	Admin	
DD93	54450	Lytle Creek FSC	San Bernardino Co	1001 pop 385 homes	pvt, USFS	Continue funding Chipper program	Volume fuel chipped	
DD94	96000	Malibu Lakeside Community	LA Co.	1000+pop, 300homes	pvt, USFS	Educ/Fuel Reduction projects	Educ/Fuel Reduction	
DD95	52738	Marin Country Club Homeowners	Marin Co.	88 homes	pvt	Fuel Reduction	Fuel Reduction/educ	1 and1/2 miles 30"shaded fuel break
DD96	53445	Novato Fire District	Indian Valley-Marin Co.	376 homes	pvt	Fuel Reduction	Fuel Reduction/educ	Denfensible space 30' fuel break around homes
DD97	96000	Mariposa Co. FSC	GreeleyHill	544 homes	pvt, BLM, USFS	Fuel Reduction	Fuel Reduction/educ	1.25 miles fuel break
DD98	76005	Matole Restoration Council	Humboldt Co	70 pop	BLM, USFS, pvt	Fuel Reduction	Fuel Reduction/educ	54 acres treated, part of fuel break
DL2	38905	Matole Restoration Council	Humboldt Co		BLM, USFS, pvt	Fuel Reduction	Fuel Reduction/educ	20 acres treated
DL4	65000	Monterey FSC	Monterey Co		pvt, USFS	Fuel Reduction	Fuel Reduction	extends fuel breaks/defensible zones
DL5	90000	Monterey FSC	Monterey Co		pvt, USFS	Fire Planning	Fire Planning	Fire Plan/fuel projects
DL6	30000	Monterey FSC	Monterey Co		pvt, USFfed agencies	Smoke Mgt of prescibed burning	Weather Forecasts	
DL7	85072	Morongo Valley CSD	Riverside Co	minimum 100 parcels	pvt	Purchase chipper for fuel loading reduction	Vol fuel removed	
DL8	150000	Idyllwild	Idyllwild	250 parcels	pvt, USFS	Fuel Treatment	Fuel Treatment	200 acres treated
DL9	45000	Mountain Area Safety Task Force	Crestline		pvt, USFS	Fuel Treatment	Fuel Treatment	Extend fuel break 1 mile
DL13	34200	Ojai FSC	Ojai Valley		pvt, USFS	Fuel Treatment	Fuel Treatment	20+tons fuel removed
DL14	56081	Arcata Econ Dev. Corp	Orleans community		pvt, USFS, Karuk Tribe	Fuel Treatment	Fuel Treatment	80 acres fuel reduction
DL15	73600	Butte Co FSC	Paradise		pvt	Fuel Treatment	Fuel Treatment	65 acres fuel reduction
DL16	40000	Pine Mtn. Club Owners Assn	Pin Mtn. Community		pvt	Fuel Treatment	Fuel Treatment	
DL17	50000	Plumas Corp	Plumas FSC		pvt, BLM, USFS	Continue funding FSC	Admin	
DL18	34738	Salmon River Restoration Council	Sawyers Bar		pvt, USFS	Educ/Plan/Fuel Reduction projects	Reduction	
DL19	50000	Community Foundation for San Benito Co	Hollister		pvt	Fuel treatment/Educ	Fuel treatment/Educ	
DL20	100000	Mtn. Area Safety Task Force	Arrowhead		pvt, USFS	Fuel treatment/Educ	Fuel treatment/Educ	reach 23000 residents; fuel reduction on 1000+ lots
DL21	11600	S. Bernardino NF Assn	San Bernardino Co		pvt, USFS	Educ	Educ	
DL22	24000	SLO Co Community FSC	SLO Co		pvt, USFS	continue FSC funding	Admin	
DL23	48000	SLO Co Community FSC	SLO Co		pvt, USFS	Educ Build Demo fire safe house on Fairgrounds	Educ	
DL24	28000	Diablo Fire Safe Council	Santa Clara Co		pvt	Fire Planning	Fire Planning	
DL25	20500	Diablo Fire Safe Council	Santa Clara Co		pvt	Educ outreach	Educ outreach	
DL26	34000	Santo Cruz RCD	Santa Cruz Co		pvt	Restore fuel break/Educ publication	break/Educ	
DL28	3700	So Coast RCD	Murrieta, Riverside Co		pvt, USFS, BLM	Educ Firesafe Demo Garden	Garden	
DL29	4584	SW Riverside Co FSC	Riverside Co		pvt, USFS, BLM	Educ./ workshops	Educ./ workshops	
DL30	12000	So Coast RCD	Murrieta, Riverside Co		pvt, USFS, BLM	Fund Fire safe efforts	Admin	
DL31	52640	Sunflower CRMP	Shasta Co		pvt, USFS, BLM	Expand fuel break, prescribed burn	Expand fuel break, prescribed burn	9 miles fuel break/1000acres prescribed burn
DL32	75000	Trinity Co RCD	Trinity Co		pvt, USFS, BLM	Fuel Reduction	Fuel Reduction	75 acres fuel reduction
DL33		West Co Fire Safe Group	Sonoma Co.		pvt	Fuel Reduction/educ	Fuel Reduction/educ	
DL34	19077	Western Shasta RCD	Shasta Co		pvt	fund fFSC	fund fFSC	
DL35	28375	City of Glendale	Cities of Glendale/WhitingWoods		pvt, USFS	coord, fuel projects	coord, fuel projects	
DL37	99020	Butte Co FSC	Concow,YankeeHill, Paradise		pvt, BLM, USFS	Extend fuel break	Extend fuel break	1/2 mile fuel break
DL90	18000	West Lake RCD	Lake Co		pvt, BLM, USFS	Educ Outreach	Educ Outreach	

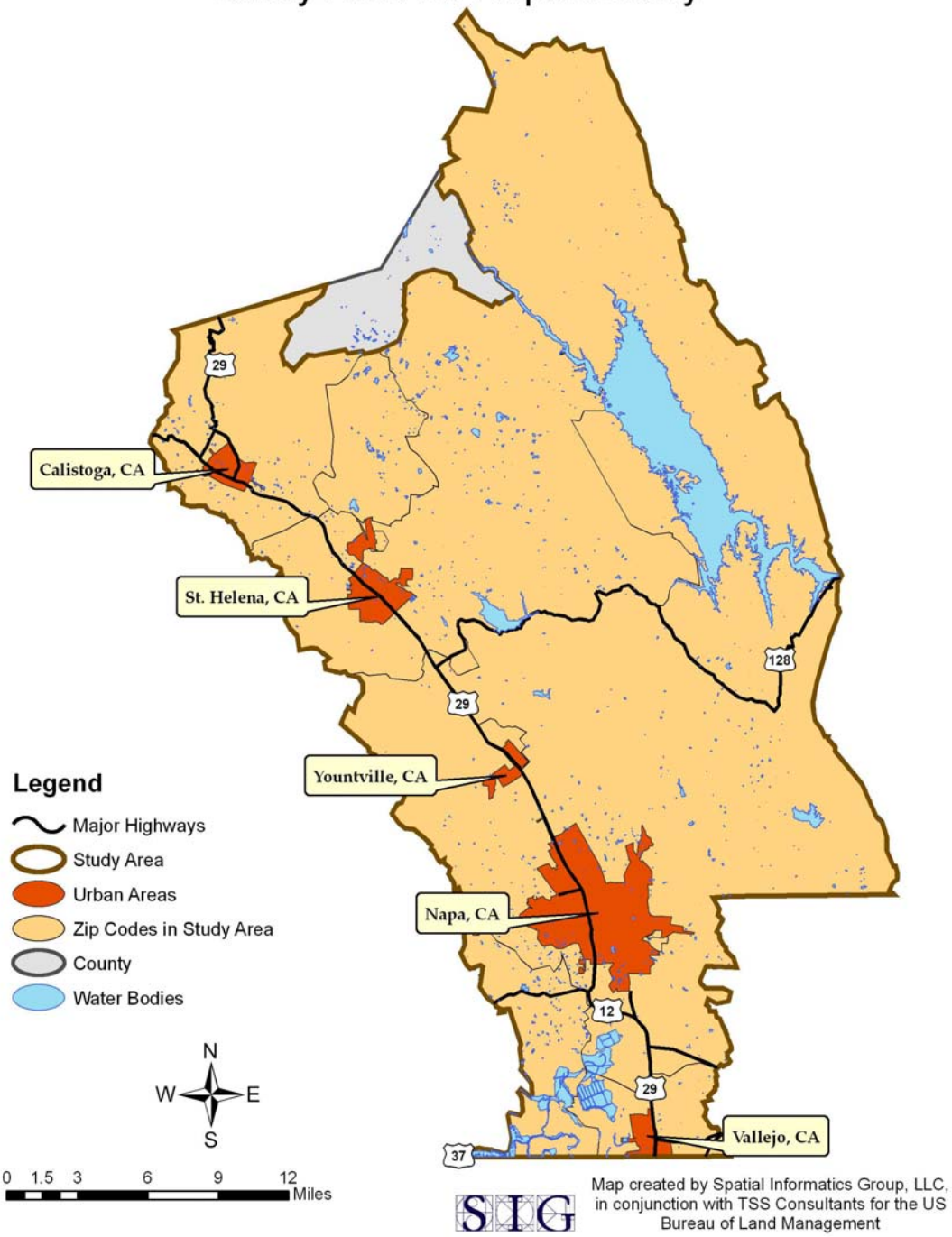
2004 BLM Funded Project Details

2004 #	$	FSC/Other Proposer	Location	Pop/Homes.	Ownership	Expenditure Use	Program Objective	Evaluation Criteria
DL50	25000	Alpine Co Em Med Services	Alpine Co	400homes/bus	pvt, USFS	Support FSC/Educ	Admin/Educ	
DL51	65000	Amador FSC	Amador Co		BLM, USFS, Tribal	Fuel Reduction	Fuel Reduction	
DL52	60000	Amador FSC	Amador Co		BLM, USFS, Tribal	Fuel Reduction	Fuel Reduction	264 acres fule reduction
DL55	15484	S Bernardino NF Assn	S. Bernardino Co	22000pop	USFS, pvt	Fuel Reduction	Fuel Reduction	
DL56	159340	North Valley Community Found	Butte Co		pvt, USFS	Fuel Reduction/Educ	Fuel Reduction/Educ	Increased Fuel Reduction
DL57	100000	Circle Oaks Homeowners Assn	Napa Co	182 homes, 156lots	pvt, USFS	Fuel Reduc, inspections/educ	Fuel Reduc, inspections/educ	roadway clearance 5.6 miles, curbside chipper program, multiple
OO16	76840	Madera Co FSC	Eastern Madera Co		pvt, USFS	Educ,plans, fuel reduction	Educ,plans, fuel reduction	workshops/presentations, 2 new community fire
DL61	61747	Madera Co FSC	Eastern Madera Co		pvt, USFS	Fuel Reduc Proj	Fuel Reduc Proj	750 prev removed fuel chipped
DL62	106500	El Dorado FSC	El Dorado Co		pvt, USFS	Fuel Reduction/Educ	Fuel Reduction/Educ	Fuel Reduced
DL63	180420	Nevada Co FSC	Nevada Co		pvt, USFS	Fuel Reduction	Fuel Reduction	removed.
DL64	39320	Nevada Co FSC	Nevada Co-Owl Creek		pvt, USFS	Fuel Break expansion	Fund	Fund
DL65	189100	SEED	City of Auburn		pvt,BLM, BurRecl	Fuel Break expansion	Fuel Break expansion	
OO24	43000	High Sierra RCD	Yuba FSC		BLM, pvt	coord for Yuba FSC	Admin/Educ	
OO25	77500	Hiway 168 FSC	Fresno Co		USFS, pvt	Coord for FSC	Admin/Educ	
DL68	250000	Kern River Valley Revitalization,Inc	Kern Co		USFS, pvt	Shaded Fuel Break	Fuel Reduction	break
DL69	32300	Lytle Creek FSC	S. Bernardino Co	1000 pop 385 homes	USFS, BLM, pvt	fund FSC	Admin/Educ	
DL70	96000	Mariposa FSC	Mariposa Co		pvt,USFS, SF water&power	Shaded Fuel Break	Fuel Reduction	1.25miles or 100 acres of shaded fuel break
DL71	13890	Tahoe FSC	Rubicon, MeeksBay,Tahoma	2900 pvt. Parcels, 675 public	USFS, pvt	Inspect 1000 parcels	Fuel Reduction	w/fuel reduction as appropriate
DL72	65000	Monterey FSC	Monterey Co		USFS, BLM, pvt	Fuel Reduction Projects	Fuel Reduction	
OO36	55000	Mt. Rim FSC	S Bernardino Co		USFS, pvt	Support FSC/Educ	Admin/Educ	
DL74	16000	Mt. Area Task Force	Lake Arrowhead		USFS, pvt	Chipper program/Educ	Fuel Reduction/Educ	lots, 15 acres
DL76	20500	Mt. Area Task Force	Green Valley Lake		USFS, pvt	reduc	Fuel Reduction	15acres fuel reduction
OO40	150000	North Fork Rancheria	Madera Co		Tribal, pvt	Implement Fuel Plan	Fuel Reduction/educ	
OO41	31500	Ojai Valley	Ojai		pvt. USFS	projects	Fuel Reduction	20+tons fuel reduction
OO44	50000	Plumas Corp	Plumas Co.		pvt. USFS	fund Plumas FSC	Admin/Educ	
DL78	34738	Salmon Riv. Rest. Council	Sawyers Bar		pvt. USFS	Fie Safe Planning	Planning	
DL80	100000	S. Bernardino FSC	S. Bernardino Co		pvt. USFS	Educ, fuel reduction	Educ, fuel reduction	mailers/fuel reduction on up to 1200 lots
DL82	28000	SLO FSC	S. Luis Obispo Co.		pvt. USFS	brochures	Educ	
OO51	25500	Diablo FSC	S. Clara Co		pvt	Educ Outreach	Multiple educ scenarios	
OO52	58850	Shasta Valley RC	Shasta Co		pvt, USFS	Coord/educ/form FSC's		
No #		Siskiyou FSC	Siskiyou Co		pvt, USFS	Create new community FSC;Educ	Admin/educ	community FSC's/ 4 Fuel project proposals
OO53	85838	Tahoe RCD	Tahoe		pvt, USFS	FSC/administrator	Admin	
OO54	45000	Tinity County RCD	Trinity Co		pvt, USFS	continue FSC funding	Admin	
OO56	15257	Western Shasta RCD	Shasta Co		pvt., USFS	continue FSC funding	Admin	

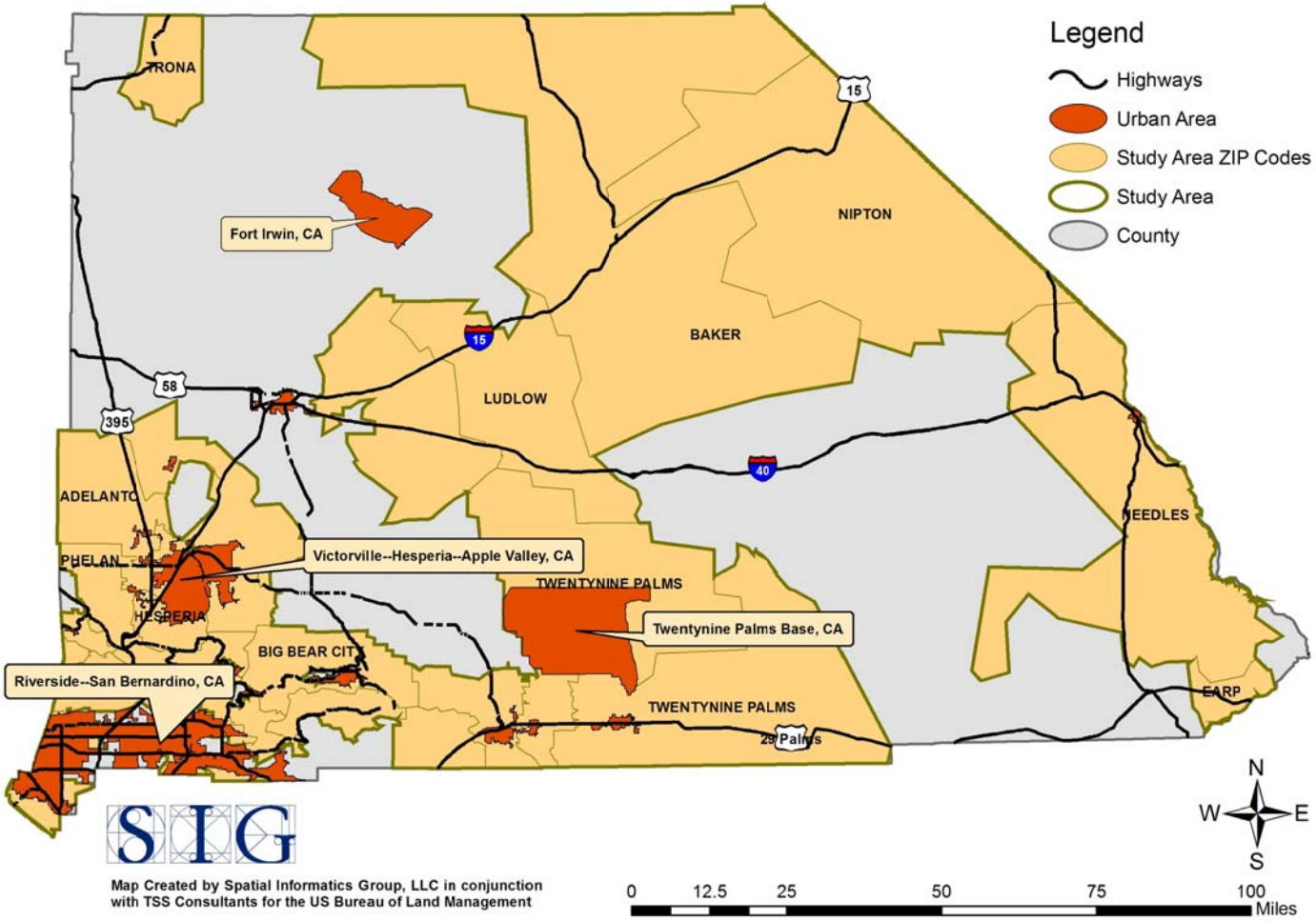
Appendix C. Study Area Maps



Study Area for Napa County

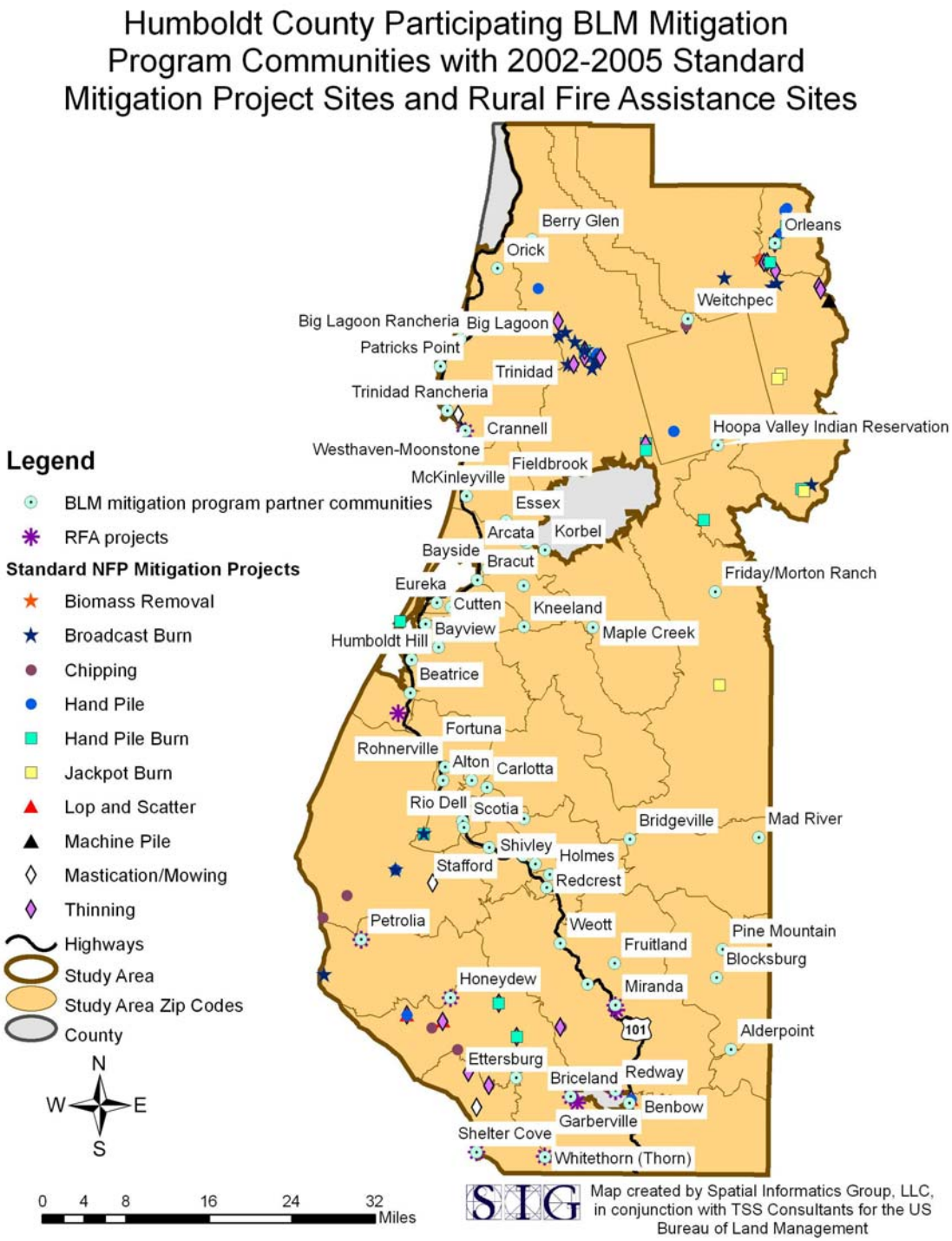


Study Area by Zip Codes for San Bernardino County

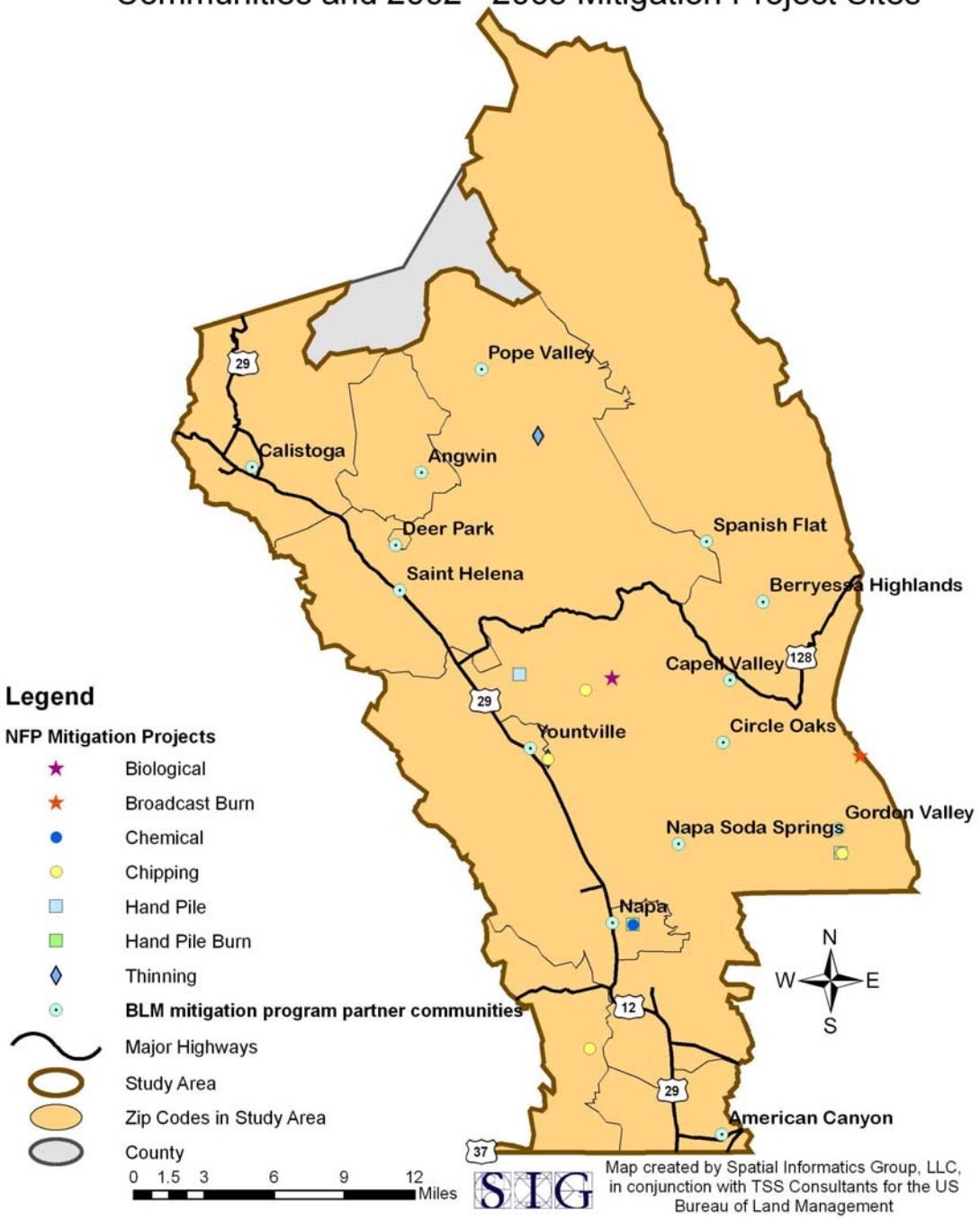


Map Created by Spatial Informatics Group, LLC in conjunction with TSS Consultants for the US Bureau of Land Management

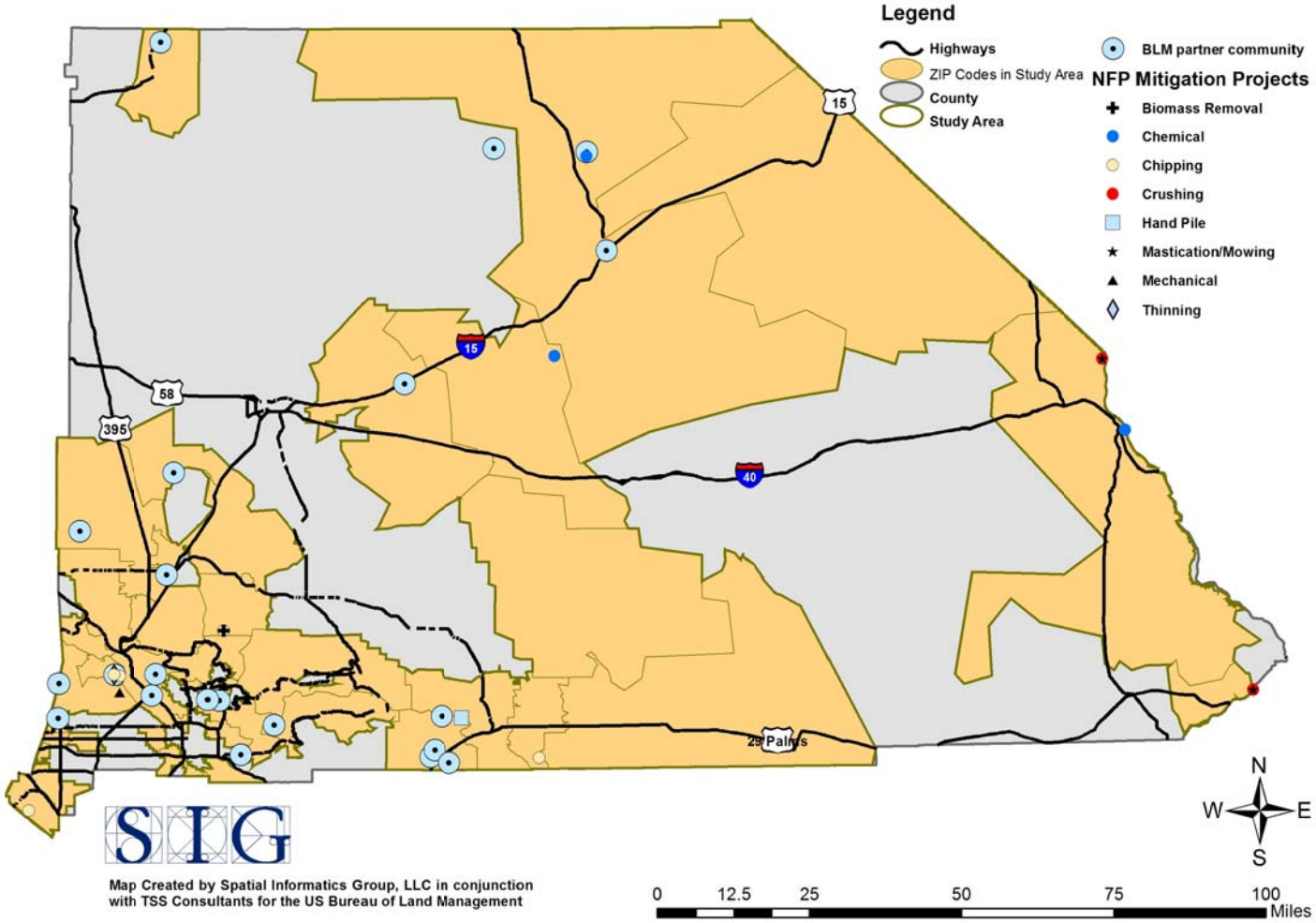
Appendix D. BLM Project Site and Mitigation Community Maps



Napa County Participating BLM Mitigation Program Communities and 2002 - 2005 Mitigation Project Sites

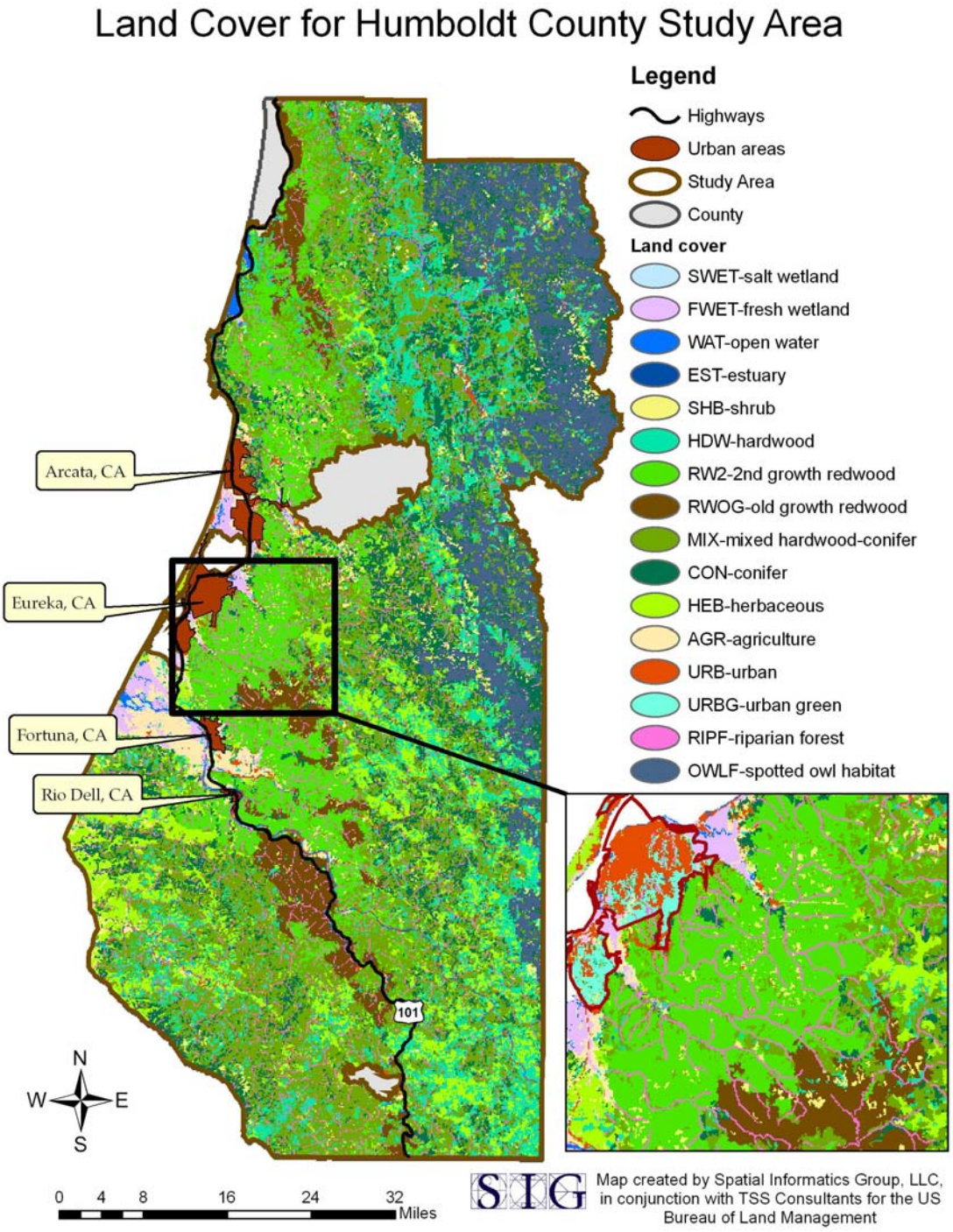


San Bernardino County Participating BLM Mitigation Communities and 2002 - 2005 Standard Mitigation Project Sites

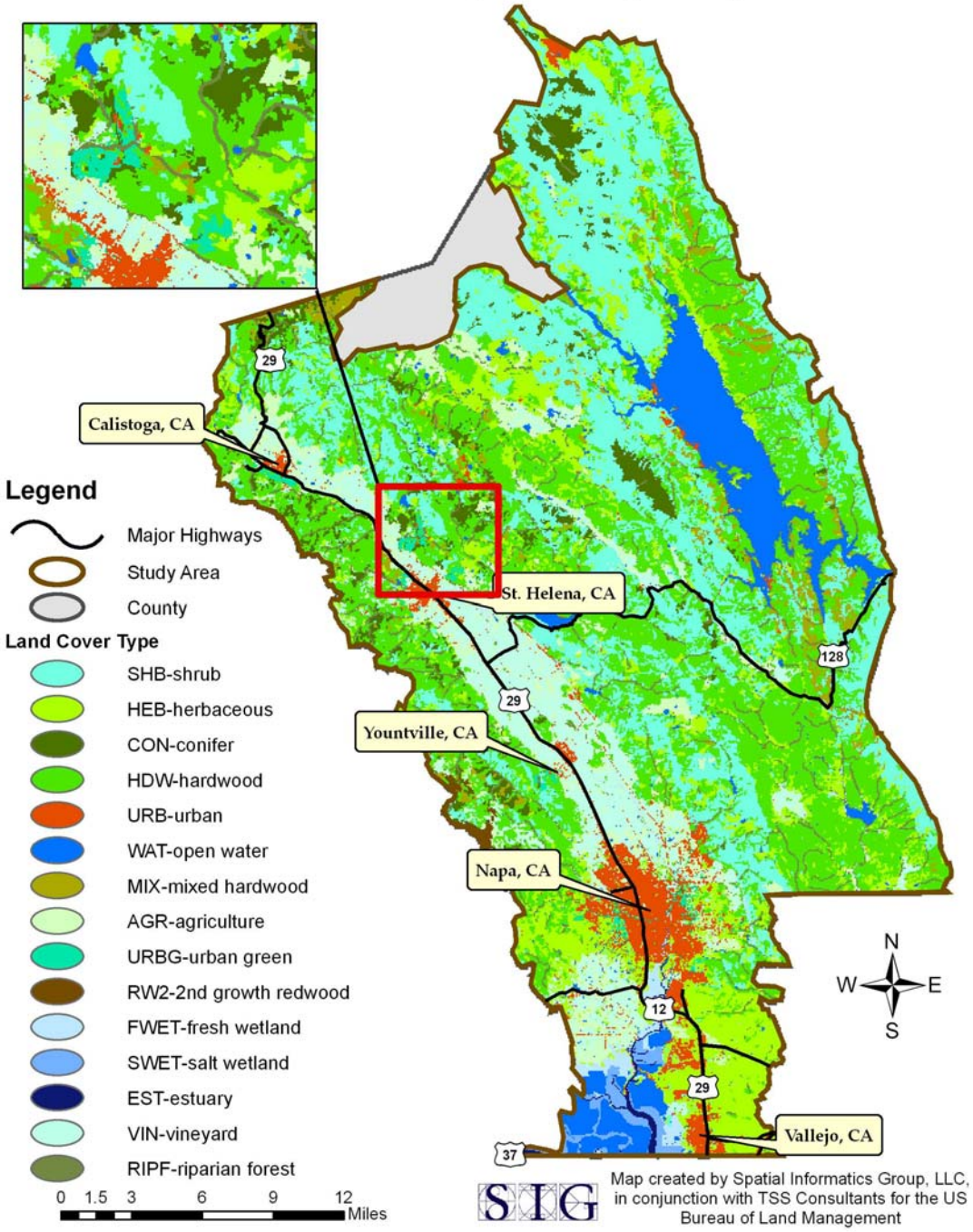


Map Created by Spatial Informatics Group, LLC in conjunction with TSS Consultants for the US Bureau of Land Management

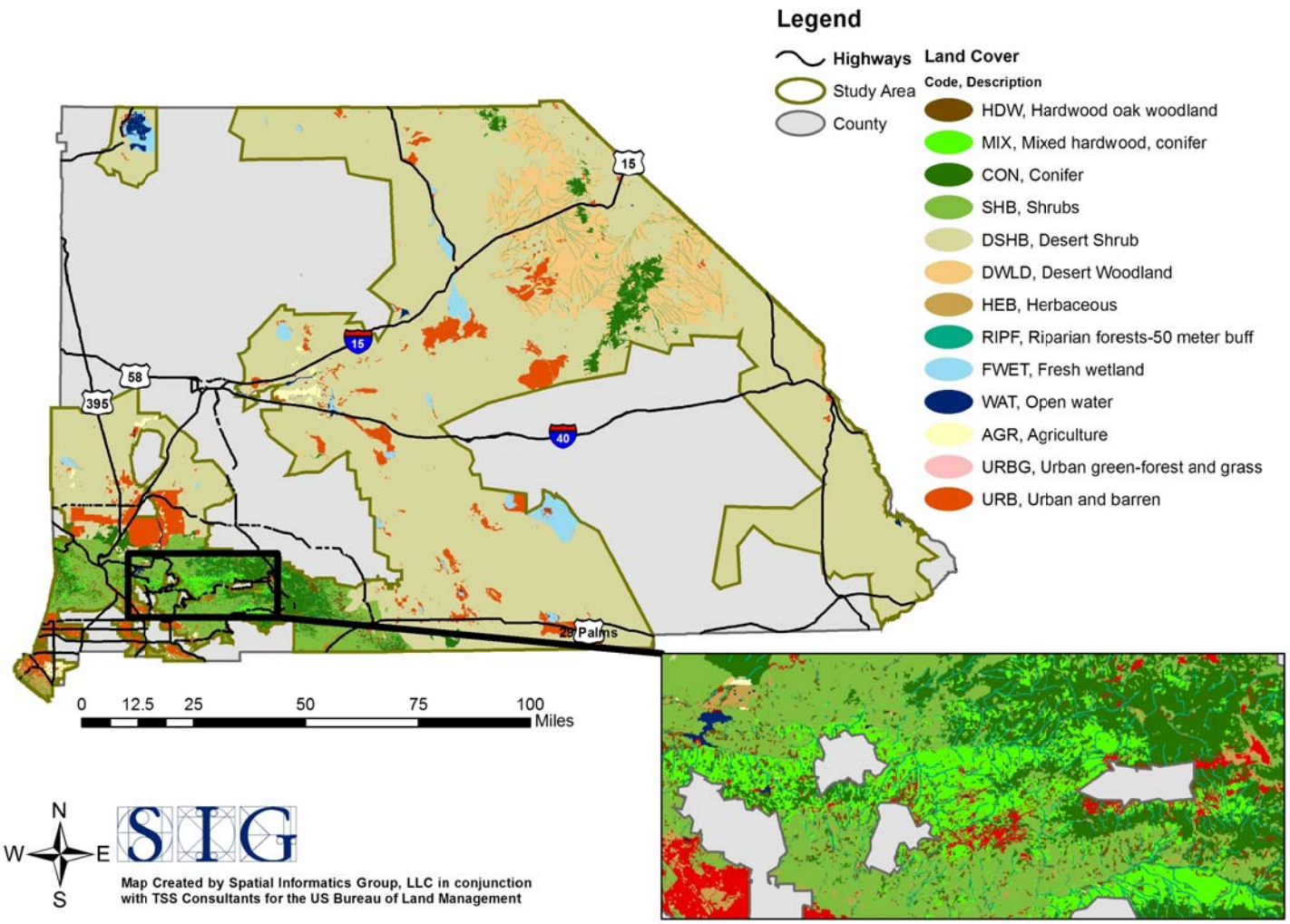
Appendix E. Land Cover Maps



Land Cover for Napa County Study Area



Land Cover for San Bernardino County Study Area



Appendix F. ESV Tables

Table 1: ESV Estimates (in thousands $USD) by Land Cover and Zip Code for Humboldt County Study Areas

		ECOSYSTEM SERVICE VALUES														MARKET VAL.
Zip Code	Community Name	AGR	CON	EST	FWET	HDW	MIX	OWLF	RIPF	RW2	RWOG	SWET	URBG	WAT	total	Structures
00050	Six Rivers Ntl Forest	1.8	12,247.4	0.0	63.2	3,063.8	13,358.2	47,487.9	15,384.2	497.0	40.5	0.0	0.0	1,436.2	93,580.1	1,648.2
00054	Six Rivers Ntl Forest	216.8	19,130.3	0.0	984.6	11,816.4	41,480.0	23,457.0	76,072.0	17,694.6	9,736.8	0.0	0.0	1,239.5	201,828.1	17,480.0
95501	Eureka	35.9	2.6	0.0	1,513.0	6.1	6.8	0.0	240.6	0.1	0.0	32.6	862.1	641.6	3,341.3	791,062.5
95503	Eureka	1,813.4	529.6	0.0	17,004.4	124.0	1,631.9	0.0	20,488.0	11,681.8	2,942.1	50.6	7,667.0	1,502.6	65,435.3	737,010.8
95511	Alderpoint	0.0	378.1	0.0	2.0	1,062.0	1,308.6	0.0	2,017.8	0.0	0.0	0.0	0.0	517.2	5,285.6	4,093.8
95514	Blocksburg	6.7	3,015.0	0.0	4.0	2,906.0	6,564.0	3,056.3	11,457.1	0.0	0.0	0.0	0.0	1,683.7	28,692.6	5,551.1
95519	Mckinleyville	1,712.6	1,110.0	0.0	1,714.5	124.3	1,592.6	0.0	9,597.5	4,874.7	0.0	134.4	3,994.6	889.1	25,744.3	568,656.6
95521	Arcata	3,091.9	140.9	0.0	26,303.6	63.7	512.9	0.0	2,885.8	1,212.3	0.0	291.0	3,086.2	2,568.2	40,156.6	687,373.5
95524	Bayside	147.2	382.1	0.0	178.8	82.7	2,379.8	0.0	5,924.4	2,704.7	0.0	19.0	26.2	91.8	11,936.7	71,936.8
95526	Bridgeville	0.0	3,787.0	0.0	0.0	2,358.2	7,495.4	2,621.4	12,005.4	0.0	0.0	0.0	0.0	348.5	28,615.8	9,886.2
95528	Carlotta	498.9	711.7	0.0	104.7	144.2	1,657.1	0.0	7,783.1	4,088.7	1,770.1	0.0	0.0	906.7	17,665.1	24,751.7
95534	Cutten	39.5	2.3	0.0	6.9	1.3	8.1	0.0	37.2	0.0	0.0	0.0	401.0	0.0	496.3	46,339.5
95536	Ferndale	12,474.5	7,559.3	0.0	27,058.1	1,679.4	13,466.3	0.0	26,499.4	783.7	24.6	1,421.4	0.0	4,615.3	95,582.1	132,812.3
95537	Fields Landing	0.0	1.6	0.0	0.0	2.6	2.7	0.0	0.0	3.8	0.0	0.0	522.6	0.0	533.4	48,079.8
95540	Fortuna	3,917.9	340.0	0.0	2,133.2	234.1	733.7	0.0	5,856.3	3,545.0	192.1	0.0	1,075.0	1,339.8	19,367.2	489,163.7
95542	Garberville	270.7	5,832.0	0.0	4.9	6,238.6	31,024.5	0.0	43,004.9	786.0	1,231.6	0.0	0.0	1,598.4	89,991.6	118,069.9
95546	Hoopa	438.4	10,805.2	0.0	83.9	5,312.8	15,616.7	11.9	27,955.4	599.9	253.5	0.0	0.0	6,453.4	67,531.1	13,829.9
95547	Hydesville	2,270.3	46.3	0.0	682.4	32.3	87.3	0.0	471.6	104.9	0.0	0.0	0.0	132.2	3,827.3	44,075.0
95549	Kneeland	113.8	2,309.9	0.0	0.0	2,177.5	8,369.5	0.0	15,127.0	2,137.8	414.0	0.0	0.0	119.2	30,768.7	13,860.1
95550	Korbel	575.5	9,407.5	0.0	0.0	542.0	8,098.7	1,195.4	21,989.1	2,037.5	0.0	0.0	0.0	496.3	44,342.0	7,411.5
95551	Loleta	3,968.2	71.5	10.1	25,156.0	124.0	48.9	0.0	348.2	0.0	0.0	1,290.3	0.0	4,081.9	35,099.2	35,209.1
95554	Myers Flat	199.6	3,684.0	0.0	13.8	3,925.8	26,508.2	0.0	45,319.4	4,206.2	10,391.5	0.0	0.0	3,597.3	97,845.9	111,536.2
95556	Orleans	63.5	930.4	0.0	67.2	370.7	1,154.4	7,258.0	2,365.9	0.0	0.0	0.0	0.0	822.0	13,032.1	11,308.5
95558	Petrolia	649.6	1,497.0	0.0	0.0	2,296.9	9,445.5	0.0	14,127.6	0.0	0.0	0.0	0.0	1,416.6	29,433.4	15,780.1
95562	Rio Dell	323.7	246.4	0.0	498.7	37.6	294.1	0.0	3,742.8	2,560.2	183.9	0.0	537.7	1,343.0	9,768.3	98,278.1
95564	Samoa	1.0	0.0	0.0	769.3	1.3	4.2	0.0	7.9	0.0	0.0	40.3	169.0	177.2	1,170.1	34,989.3
95565	Scotia	370.7	298.9	0.0	29.6	113.0	696.6	0.0	6,401.5	3,766.1	3,538.6	0.0	0.0	1,302.0	16,517.0	3,876.2
95569	Redcrest	539.4	205.3	0.0	0.0	18.2	230.3	0.0	3,454.8	1,803.1	1,028.2	0.0	0.0	1,220.6	8,499.9	7,123.9
95570	Trinidad	650.4	2,114.1	0.0	869.1	1,138.3	7,222.6	0.0	21,478.7	10,919.9	3,123.8	4.9	0.0	7,961.2	55,483.0	106,831.3
95573	Willow Creek	173.4	1,160.7	0.0	0.0	1,259.9	2,367.3	4,329.6	4,269.8	0.0	0.0	0.0	0.0	1,715.6	15,276.3	64,400.0
95589	Whitethorn	37.1	2,159.5	0.0	0.0	1,224.5	6,646.1	0.0	11,120.8	24.3	0.0	0.0	0.0	230.6	21,442.8	54,298.1

Table 2: ESV Estimates (in thousands $USD) by Land Cover and Zip Code for Napa County Study Areas

Zip Code	Community Name	ECOSYSTEM SERVICE VALUES													MARKET VAL.	
		AGR	CON	EST	FWET	HDW	MIX	RIPF	RW2	SWET	URBG	VIN	WAT	total	VIN-market val	Struc Val
94508	Angwin	925.9	351.7	0.0	0.0	1164.2	113.3	2783.4	0.0	0.0	2.9	233.8	866.8	6442.0	35514.2	264769.6
94515	Calistoga	3510.0	842.1	0.0	0.0	2262.6	519.2	5754.4	0.0	0.0	662.6	3064.3	385.1	17000.3	15778.9	579039.0
94558	Napa	9346.4	2178.9	468.7	10406.3	16044.4	2725.9	37552.3	414.4	1459.1	1721.9	16557.4	62605.1	161480.8	2565151.0	5696380.1
94559	Napa	2768.1	15.0	1021.1	5351.8	193.9	36.0	763.0	0.0	4535.0	229.0	2993.2	13721.5	31627.5	562216.4	1552990.0
94574	Saint Helena	6615.9	2191.7	0.0	929.3	5426.2	507.4	12709.5	0.0	0.0	1292.1	7550.0	5972.4	43194.5	244709.9	1530792.1
94576	Deer Park	0.0	6.7	0.0	0.0	28.7	8.8	163.0	0.0	0.0	187.7	0.0	0.7	395.6	26.7	18939.0
94589	Vallejo	11.9	7.6	1158.5	2888.2	28.5	0.8	253.0	0.0	2415.6	2.3	170.6	3396.4	10333.5	139161.3	1136809.3
94599	Yountville	120.5	19.9	0.0	1.7	61.1	0.0	81.9	0.0	0.0	1.5	506.5	0.0	793.3	0.0	177622.9

Table 3: ESV Estimates (in thousands $USD) by Land Cover and Zip Code for San Bernadino County Study Areas

		ECOSYSTEM SERVICE VALUES														MARKET VAL.
Zip Code	Community Name	AGR	CON	DSHB	DWLD	FWET	HDW	HEB	MIX	RIPF	SHB	URB	URBG	WAT	total	Structures
91709	CHINO HILLS	$ 442	$ -	$ -	$ -	$ -	$ 332	$ -	$ 12	$ 2,127	$ -	$ -	$ 119	$ 82	$ 3,114	$ 4,103,121
91710	CHINO	$ 9,836	$ -	$ -	$ -	$ -	$ 46	$ -	$ 1	$ 389	$ -	$ -	$ -	$ 173	$ 10,445	$ 3,774,678
91730	RANCHO CUCAMONGA	$ 349	$ -	$ -	$ -	$ -	$ 2	$ -	$ 26	$ -	$ -	$ -	$ -	$ 4	$ 381	$ 2,843,538
91759	MT BALDY	$ 15	$ 3,089	$ -	$ -	$ -	$ 795	$ -	$ 2,148	$ 11,192	$ -	$ -	$ -	$ -	$ 17,239	$ 18,846
91763	MONTCLAIR	$ 20	$ -	$ -	$ -	$ -	$ -	$ -	$ 4	$ 9	$ -	$ -	$ -	$ -	$ 33	$ 1,351,923
91784	UPLAND	$ 75	$ -	$ -	$ -	$ -	$ 3	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 77	$ 1,715,200
91786	UPLAND	$ 21	$ -	$ -	$ -	$ -	$ -	$ -	$ 11	$ 9	$ -	$ -	$ -	$ -	$ 41	$ 2,160,104
92242	EARP	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 324	$ 324	$ 53
92252	JOSHUA TREE	$ -	$ 892	$ -	$ -	$ 2,627	$ 73	$ -	$ -	$ 1,259	$ -	$ -	$ -	$ 25	$ 4,877	$ 124,155
92256	MORONGO VALLEY	$ -	$ 5,409	$ -	$ -	$ -	$ 239	$ -	$ 233	$ 7,704	$ -	$ -	$ -	$ 10	$ 13,594	$ 47,013
92277	TWENTYNINE PALMS	$ 50	$ 1,951	$ -	$ -	$ 190,040	$ -	$ -	$ -	$ 1,829	$ -	$ -	$ -	$ 2,045	$ 195,915	$ 410,030
92278	TWENTYNINE PALMS	$ -	$ -	$ -	$ -	$ 42,680	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 30	$ 42,710	$ -
92284	YUCCA VALLEY	$ -	$ 5,015	$ -	$ -	$ -	$ 1,407	$ -	$ 260	$ 11,572	$ -	$ -	$ -	$ 13	$ 18,267	$ 390,247
92301	ADELANTO	$ 1,318	$ -	$ -	$ -	$ 14,318	$ -	$ -	$ -	$ 488	$ -	$ -	$ -	$ 69	$ 16,193	$ 522,842
92305	ANGELUS OAKS	$ 28	$ 8,956	$ -	$ -	$ -	$ 568	$ -	$ 3,971	$ 19,608	$ -	$ -	$ -	$ 78	$ 33,209	$ 23,812
92307	APPLE VALLEY	$ 153	$ -	$ -	$ -	$ 2,310	$ -	$ -	$ -	$ 428	$ -	$ -	$ -	$ 43	$ 2,934	$ 1,523,781
92308	APPLE VALLEY	$ 1,431	$ 595	$ -	$ -	$ 709	$ 100	$ -	$ 2	$ 1,630	$ -	$ -	$ -	$ 4,298	$ 8,766	$ 1,084,553
92309	BAKER	$ 29	$ 8,683	$ -	$ -	$ 128,156	$ -	$ -	$ -	$ 28,120	$ -	$ -	$ -	$ 2,583	$ 167,570	$ 13,575
92314	BIG BEAR CITY	$ -	$ 27,104	$ -	$ -	$ 57	$ 629	$ -	$ 9,390	$ 48,098	$ -	$ -	$ 42	$ 224	$ 85,544	$ 1,641,114
92321	CEDAR GLEN	$ -	$ 111	$ -	$ -	$ -	$ 21	$ -	$ 305	$ 488	$ -	$ -	$ 19	$ 10	$ 954	$ 197,828
92324	COLTON	$ 298	$ -	$ -	$ -	$ -	$ 9	$ -	$ 8	$ 115	$ -	$ -	$ -	$ 10	$ 440	$ 1,387,192
92325	CRESTLINE	$ -	$ 413	$ -	$ -	$ -	$ 44	$ -	$ 840	$ 522	$ -	$ -	$ 28	$ 266	$ 2,113	$ 134,022
92338	LUDLOW	$ -	$ -	$ -	$ -	$ 5,726	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,793	$ 7,519	$ 3,703
92342	HELENDALE	$ 3,427	$ -	$ -	$ -	$ 210	$ -	$ -	$ -	$ 1,237	$ -	$ -	$ -	$ 944	$ 5,819	$ 190,805
92345	HESPERIA	$ 605	$ 5,570	$ -	$ -	$ 14	$ 91	$ -	$ -	$ 3,495	$ -	$ -	$ -	$ 615	$ 10,389	$ 2,314,550
92346	HIGHLAND	$ 447	$ -	$ -	$ -	$ -	$ 12	$ -	$ -	$ 183	$ -	$ -	$ -	$ 23	$ 665	$ 1,414,281
92358	LYTLE CREEK	$ 34	$ 768	$ -	$ -	$ -	$ 147	$ -	$ 455	$ 1,755	$ -	$ -	$ -	$ 18	$ 3,177	$ 26,574
92359	MENTONE	$ 1,019	$ 148	$ -	$ -	$ -	$ 373	$ -	$ 633	$ 4,252	$ -	$ -	$ -	$ -	$ 6,425	$ 244,600
92363	NEEDLES	$ -	$ -	$ -	$ -	$ 4	$ -	$ -	$ -	$ 1,200	$ -	$ -	$ -	$ 6,953	$ 8,158	$ 132,493
92364	NIPTON	$ -	$ 20,859	$ -	$ -	$ 176	$ -	$ -	$ -	$ 130,603	$ -	$ -	$ -	$ 505	$ 152,143	$ 20,498
92365	NEWBERRY SPRINGS	$ 13,686	$ 142	$ -	$ -	$ 39,751	$ 38	$ -	$ -	$ 1,384	$ -	$ -	$ -	$ 14,860	$ 69,861	$ 104,696
92371	PHELAN	$ 106	$ 1,389	$ -	$ -	$ -	$ 100	$ -	$ -	$ 1,905	$ -	$ -	$ -	$ 5	$ 3,505	$ 360,419
92373	REDLANDS	$ 1,338	$ -	$ -	$ -	$ -	$ 14	$ -	$ 16	$ 180	$ -	$ -	$ 6	$ -	$ 1,553	$ 1,775,667
92376	RIALTO	$ 131	$ -	$ -	$ -	$ -	$ 0	$ -	$ 5	$ -	$ -	$ -	$ -	$ -	$ 136	$ 1,731,918
92392	VICTORVILLE	$ -	$ 25	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 25	$ 1,458,428
92394	VICTORVILLE	$ 117	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 403	$ -	$ -	$ -	$ 35	$ 554	$ 519,141
92397	WRIGHTWOOD	$ 3	$ 1,431	$ -	$ -	$ -	$ 332	$ -	$ 896	$ 2,475	$ -	$ -	$ -	$ 14	$ 5,150	$ 132,736
92405	SAN BERNARDINO	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 9	$ -	$ -	$ -	$ -	$ -	$ 9	$ 482,372
92407	SAN BERNARDINO	$ 149	$ 1,236	$ -	$ -	$ -	$ 1,214	$ -	$ 4,054	$ 14,591	$ -	$ -	$ 63	$ 3,081	$ 24,388	$ 1,364,230
93562	TRONA	$ -	$ -	$ -	$ -	$ 78,756	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 41,704	$ 120,460	$ 28,631

Table 4: Estimated Value (in thousands $USD) of Ecosystem Services by Land Cover Class for Humboldt County Study Areas

ECOSYSTEM SERVICE	AGR	CON	EST	FWET	HDW	MIX	OWLF	RIPF	RW2	RWOG	SWET	URBG	WAT
Aesthetic & Recreational*	1,004	50,157	1	37,203	7,303	116,232	37,889	133,168	42,636	16,762	2,176	15,490	7,175
Cultural and Spiritual	28,528	-	6	-	-	-	-	-	-	-	-	-	-
Disturbance prevention	-	-	-	-	-	-	-	115,564	-	-	1	-	-
Gas & Climate regulation	-	-	-	-	-	-	-	-	-	-	452	2,705	-
Gas & Climate regulation (CO2)	-	8,177	-	-	9,224	20,105	18,234	-	6,354	7,458	-	-	-
Habitat Refugium (Not Spotted Owl)*	500	31,773	3	119	31,944	73,628	25,960	104,409	27,008	10,618	134	-	-
Habitat Refugium (Spotted Owl)	-	-	-	-	-	-	7,381	-	-	-	-	-	-
Pollination	321	-	-	-	-	-	-	-	-	-	-	-	-
Soil formation	227	-	-	-	-	-	-	-	-	-	-	-	-
Soil retention	-	-	-	-	-	-	-	14,444	-	-	-	-	-
Waste treatment	-	-	-	40,278	-	-	-	516	-	-	1,148	-	-
Water regulation	3,991	-	-	10,947	-	-	-	-	-	-	-	45	476
Water supply	-	-	0	16,593	-	-	-	49,149	-	-	242	-	42,916

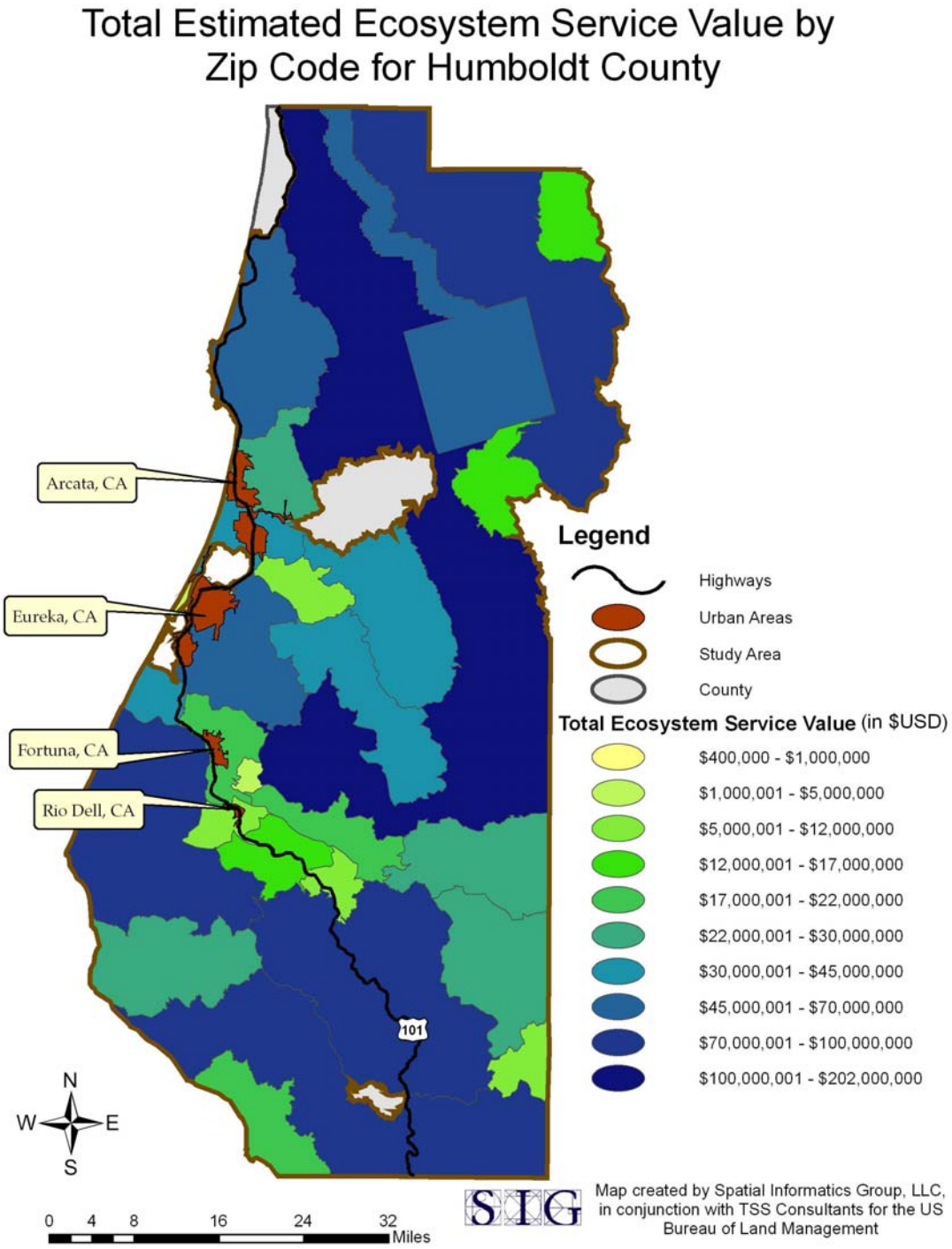
Table 5: Estimated Value (in thousands $USD) of Ecosystem Services by Land Cover Class for Napa County Study Areas

ECOSYSTEM SERVICE	AGR	CON	EST	FWET	HDW	MIX	OWLF	RIPF	RW2	RWOG	SWET	URBG	VIN	WAT
Aesthetic & Recreational*	677	3,125	141	6,927	3,798	11,878	2,002	19,169	232	20,917	5,565	3,482	903	7,649
Cultural and Spiritual	19,226	-	1,627	-	-	-	-	-	-	-	-	-	25,644	-
Disturbance prevention	-	-	-	-	-	-	-	16,635	-	-	3	-	-	-
Gas & Climate regulation	-	-	-	-	-	-	-	-	-	-	1,156	608	-	-
Gas & Climate regulation (CO2)	-	509	-	-	4,798	2,055	963	-	35	9,306	-	-	-	-
Habitat Refugium (Not Spotted Owl)*	337	1,979	825	22	16,614	7,524	1,372	15,029	147	13,250	344	-	449	-
Habitat Refugium (Spotted Owl)	-	-	-	-	-	-	390	-	-	-	-	-	-	-
Pollination	216	-	-	-	-	-	-	-	-	-	-	-	289	-
Soil formation	153	-	-	-	-	-	-	-	-	-	-	-	204	-
Soil retention	-	-	-	-	-	-	-	2,079	-	-	-	-	-	-
Waste treatment	-	-	-	7,500	-	-	-	74	-	-	2,937	-	-	-
Water regulation	2,690	-	-	2,038	-	-	-	-	-	-	-	10	3,587	507
Water supply	-	-	55	3,090	-	-	-	7,075	-	-	619	-	-	45,755

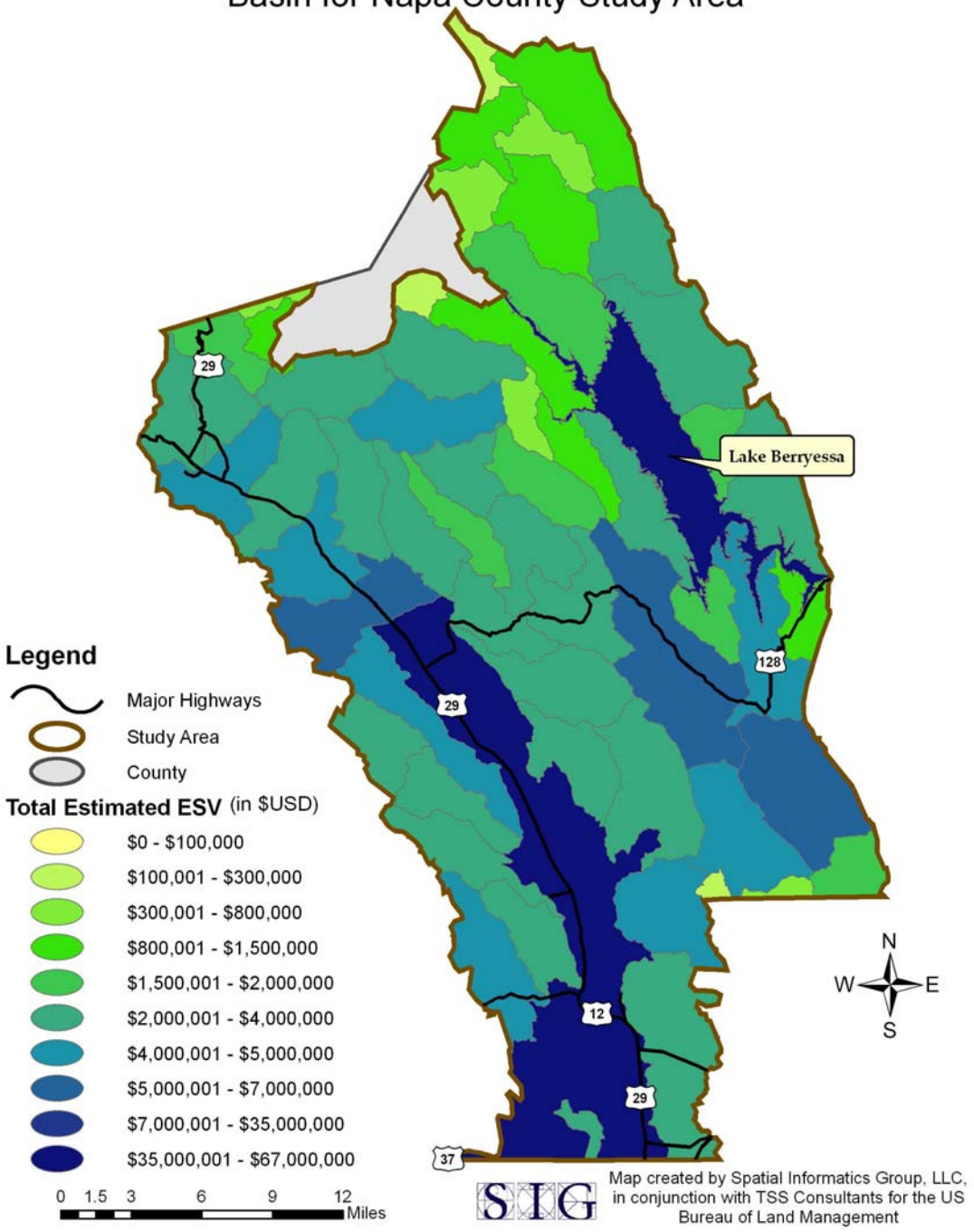
Table 6: Estimated Value (in thousands $USD) of Ecosystem Services by Land Cover Class for San Bernadino County Study Areas

Ecosystem Service	AGR	CON	DSHB	DWLD	FWET	HDW	HEB	MIX	RIPF	SHB	URB	URBG	WAT
Aesthetic & Recreational*	$ 1,020	$ 52,205	$ -	$ -	$ 178,880	$ -	$ 923	$ 12,889	$ 95,507	$ -	$ -	$ 234	$ 11,470
Cultural and Spiritual	$ 28,984	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Disturbance prevention	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 82,881	$ -	$ -	$ -	$ -
Gas & Climate regulation	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 41	$ -
Gas & Climate regulation (CO2)	$ -	$ 8,511	$ -	$ -	$ -	$ -	$ 1,166	$ 2,229	$ -	$ -	$ -	$ -	$ -
Habitat Refugium (Not Spotted Owl)*	$ 508	$ 33,070	$ -	$ -	$ 574	$ -	$ 4,037	$ 8,164	$ 74,881	$ -	$ -	$ -	$ -
Pollination	$ 326	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Soil formation	$ 231	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -
Soil retention	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 10,359	$ -	$ -	$ -	$ -
Waste treatment	$ -	$ -	$ -	$ -	$ 193,664	$ -	$ -	$ -	$ 370	$ -	$ -	$ -	$ -
Water regulation	$ 4,055	$ -	$ -	$ -	$ 52,633	$ -	$ -	$ -	$ -	$ -	$ -	$ 1	$ 760
Water supply	$ -	$ -	$ -	$ -	$ 79,784	$ -	$ -	$ -	$ 35,249	$ -	$ -	$ -	$ 68,609

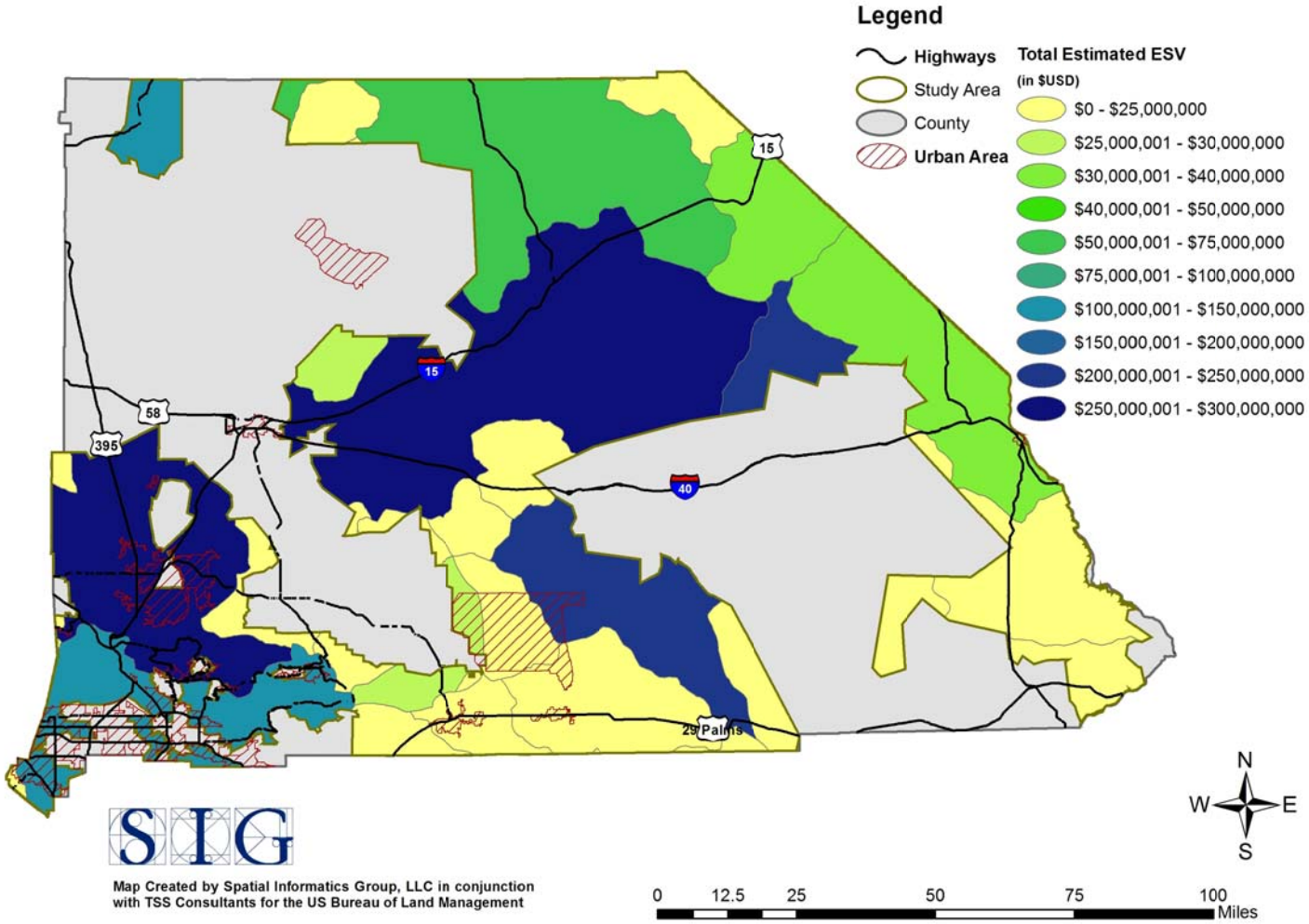
Appendix G. Total Ecosystem Service Value Estimate Maps by Watershed



Total Estimated Ecosystem Service Value by Tributary Basin for Napa County Study Area



Total Estimated Ecosystem Service Value by Watershed Hydrologic Unit for San Bernardino County Study Area



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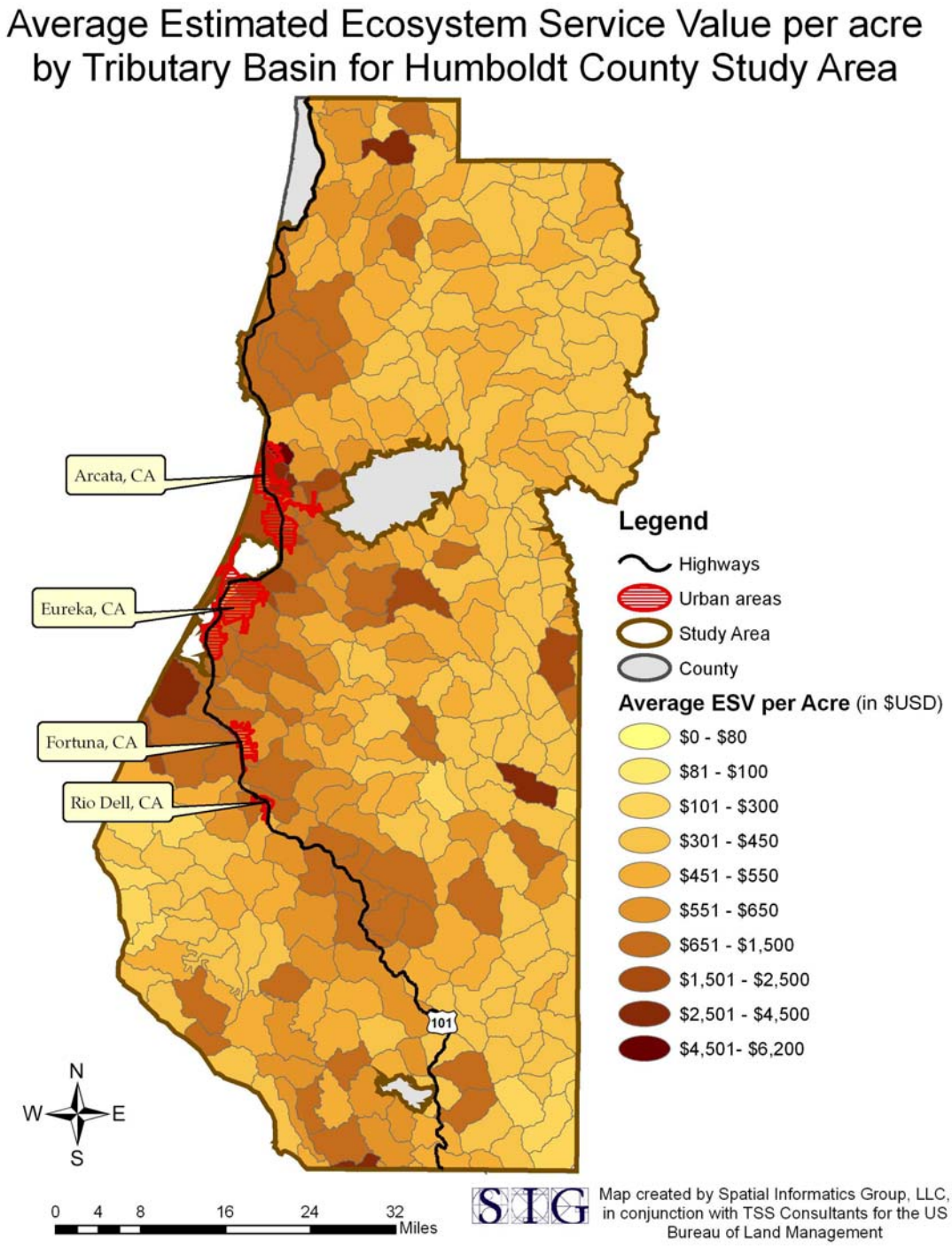
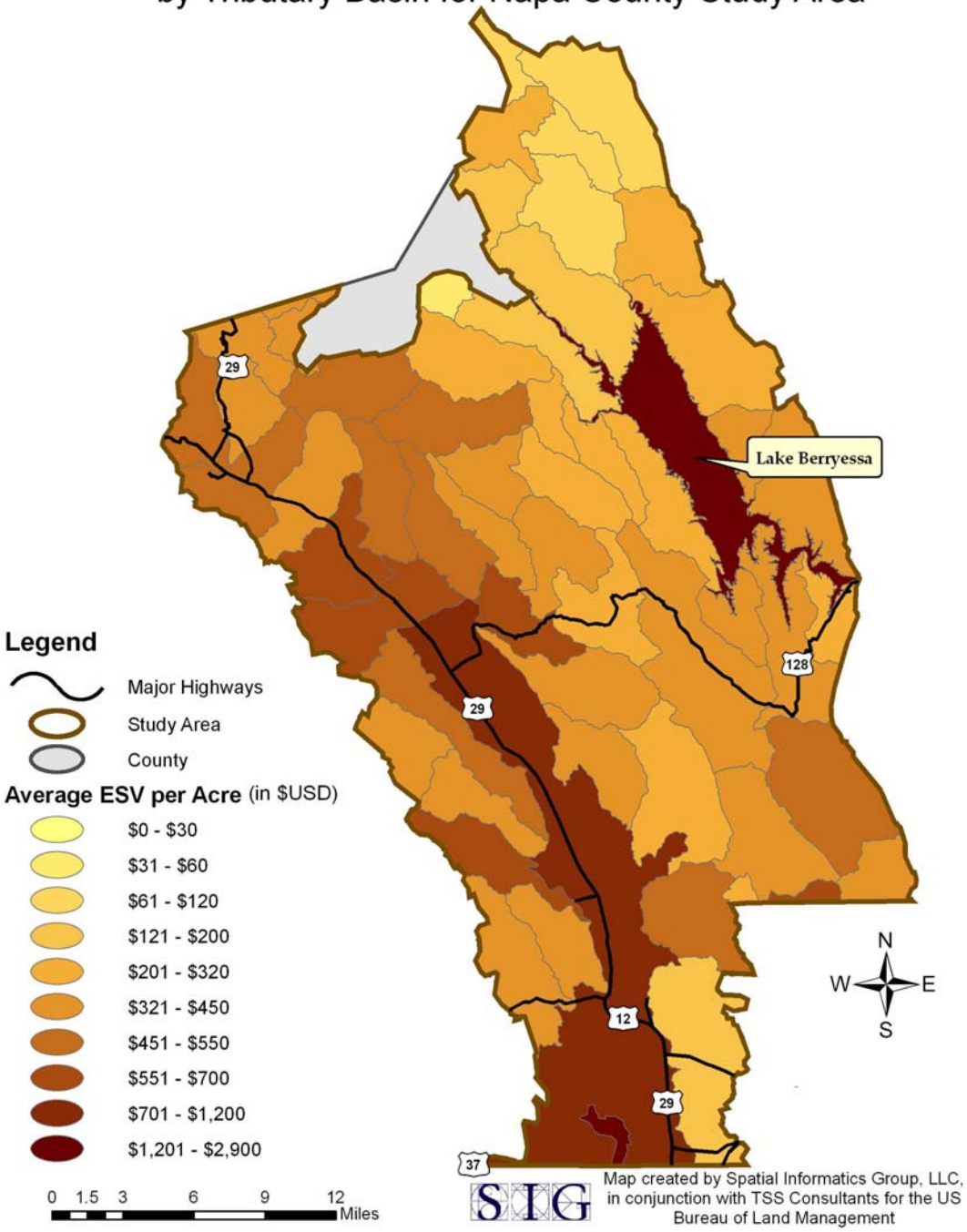
Map Created by Spatial Informatics Group, LLC in conjunction with TSS Consultants for the US Bureau of Land Management

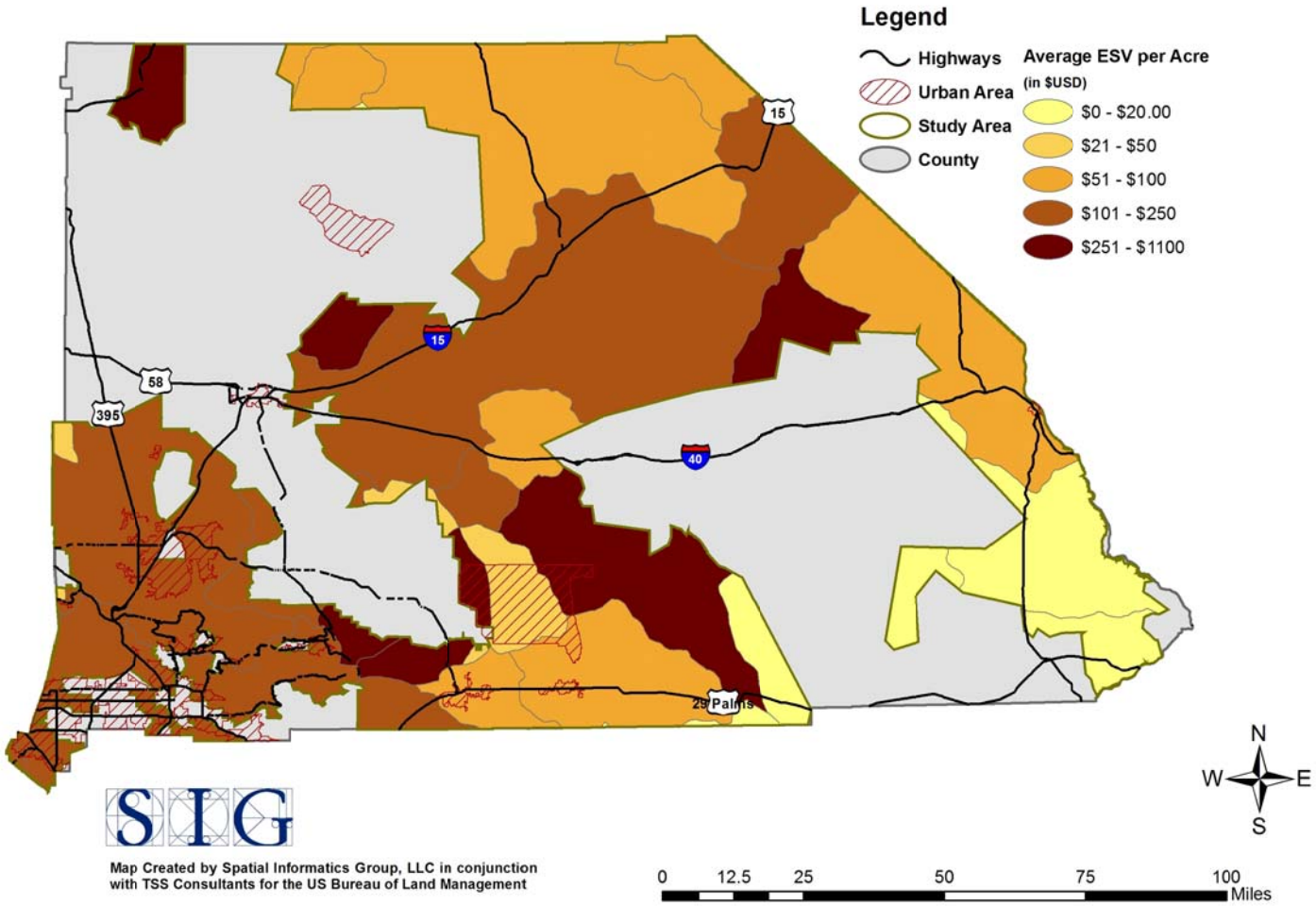
Appendix H. Average Ecosystem Service Value Estimate per Acre Maps by Watershed



Average Estimated Ecosystem Service Value per Acre by Tributary Basin for Napa County Study Area

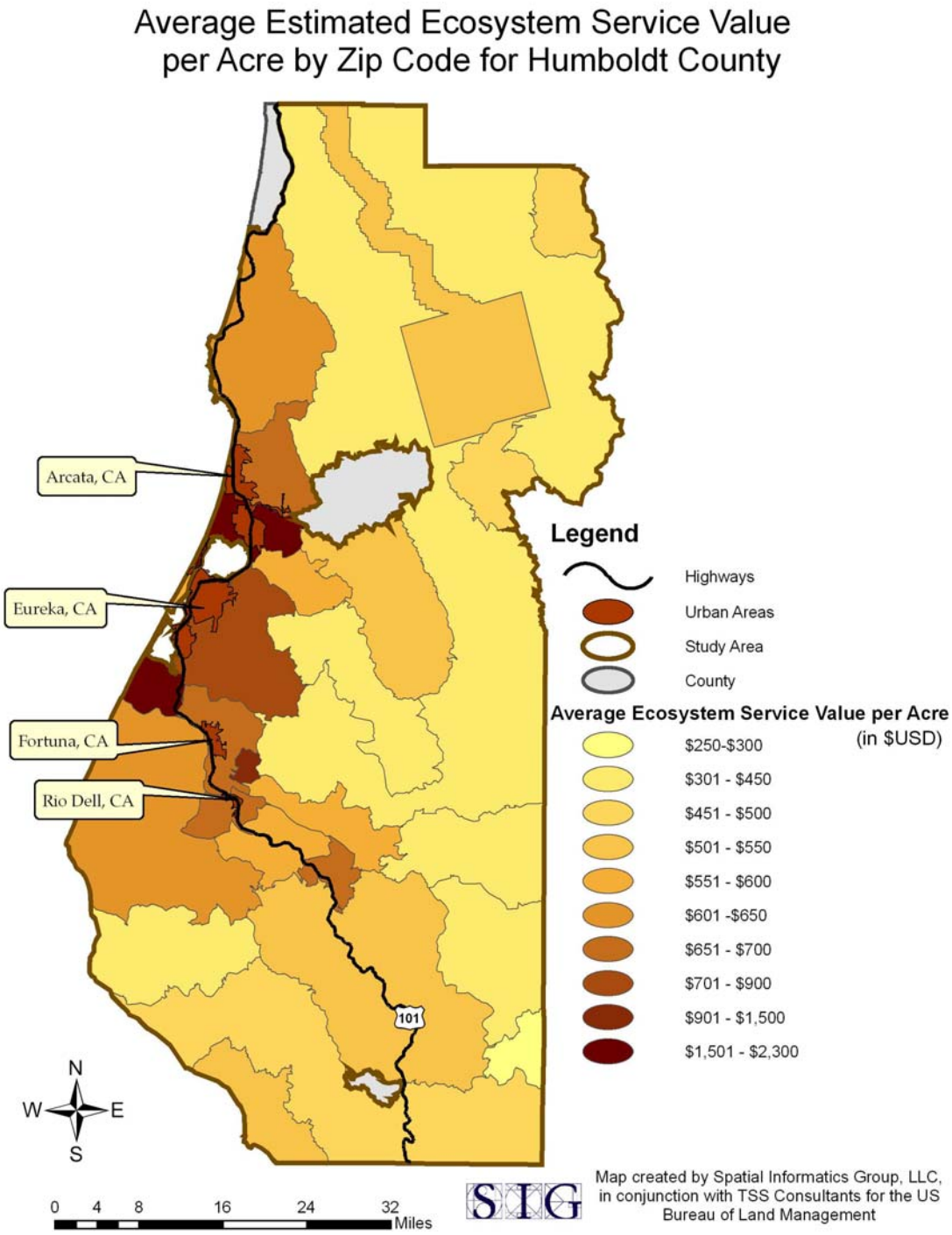


Average Estimated Ecosystem Service Value pre Acre by Watershed Hydrologic Unit for San Bernardino County Study Area

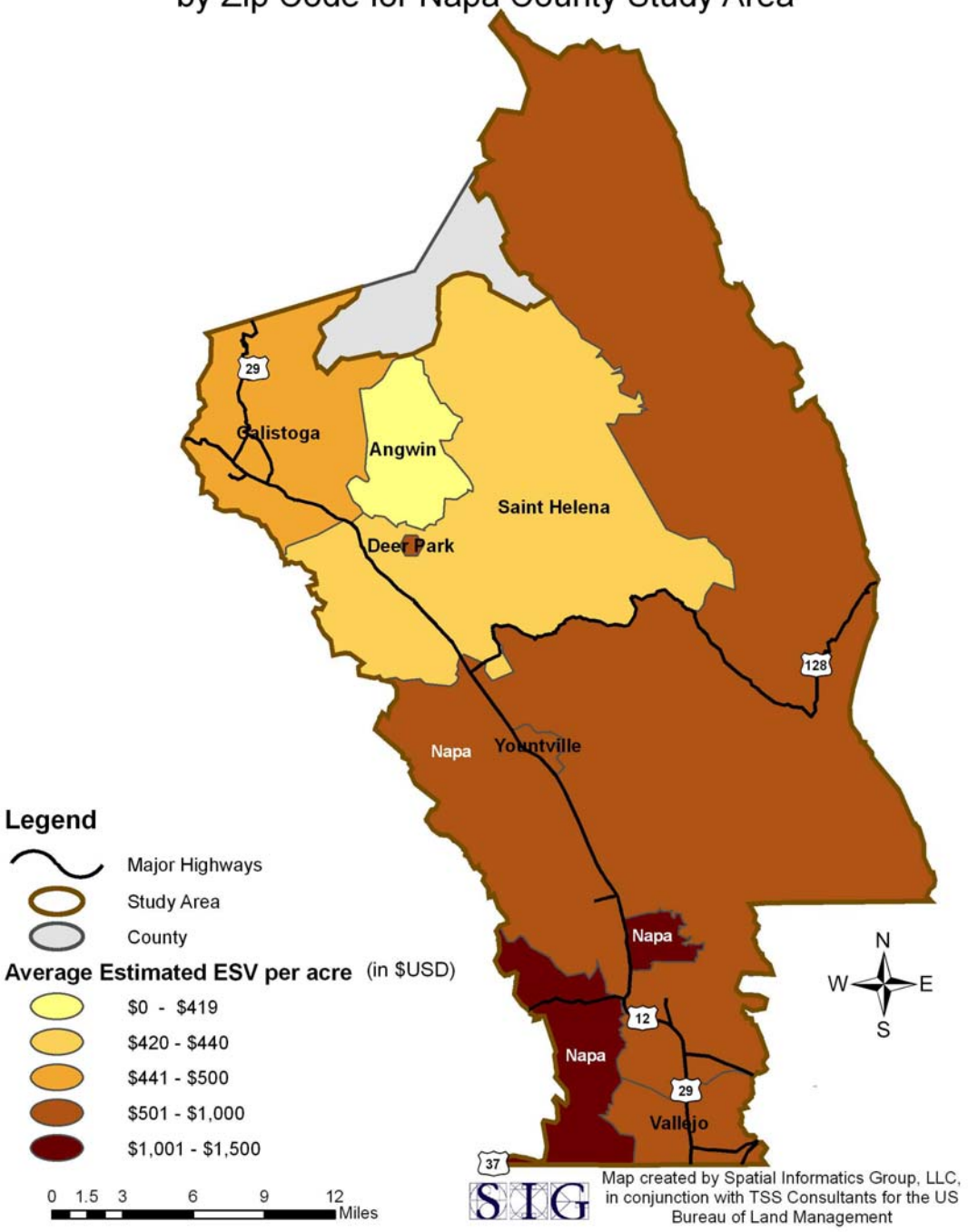


Map Created by Spatial Informatics Group, LLC in conjunction with TSS Consultants for the US Bureau of Land Management

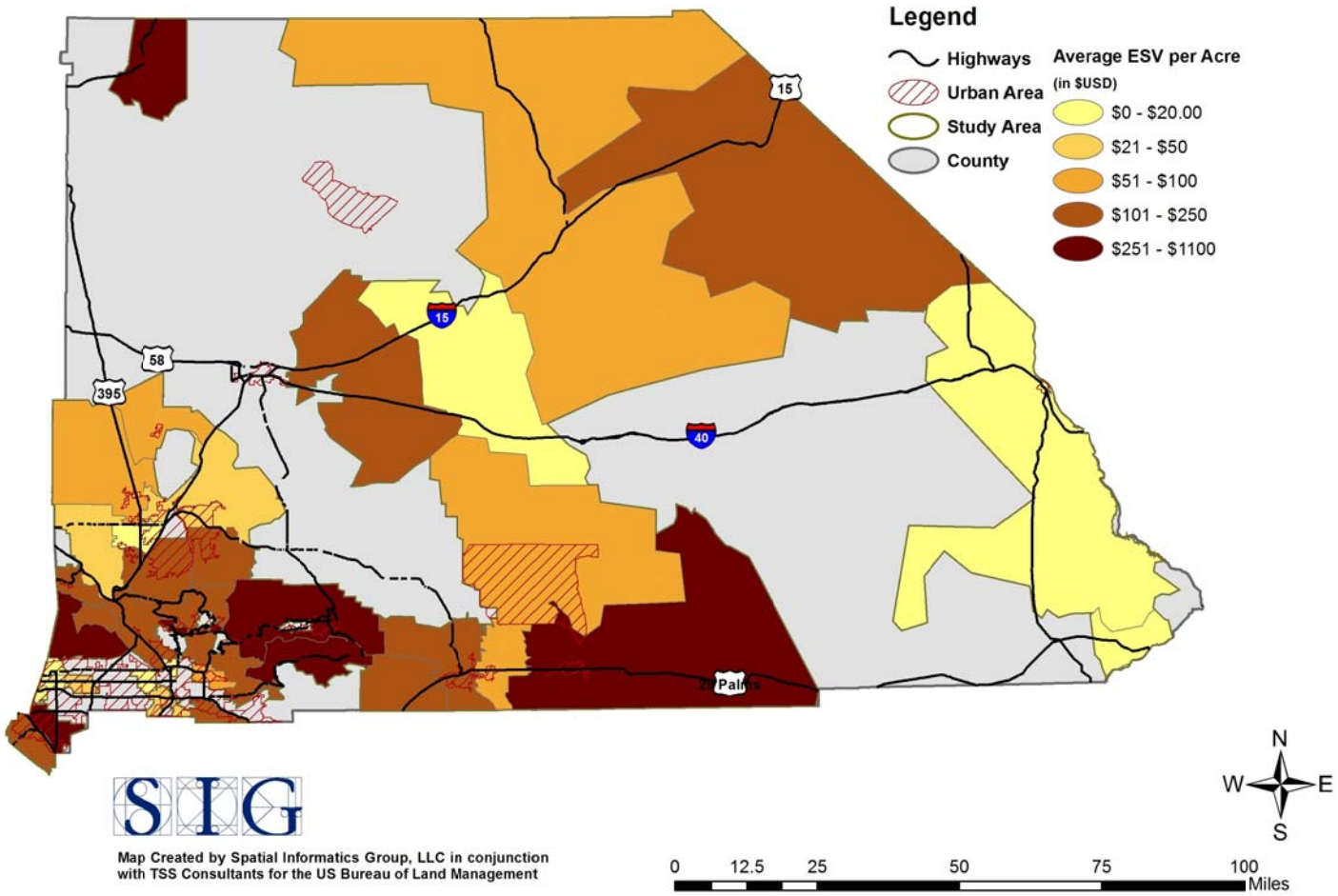
Appendix I. Average (per-Acre) Ecosystem Service Value Estimate Maps by Zip Code



Average Estimated Ecosystem Service Value per Acre by Zip Code for Napa County Study Area



Average Estimated Ecosystem Service Value per Acre by Zip Code for San Bernardino County Study Area



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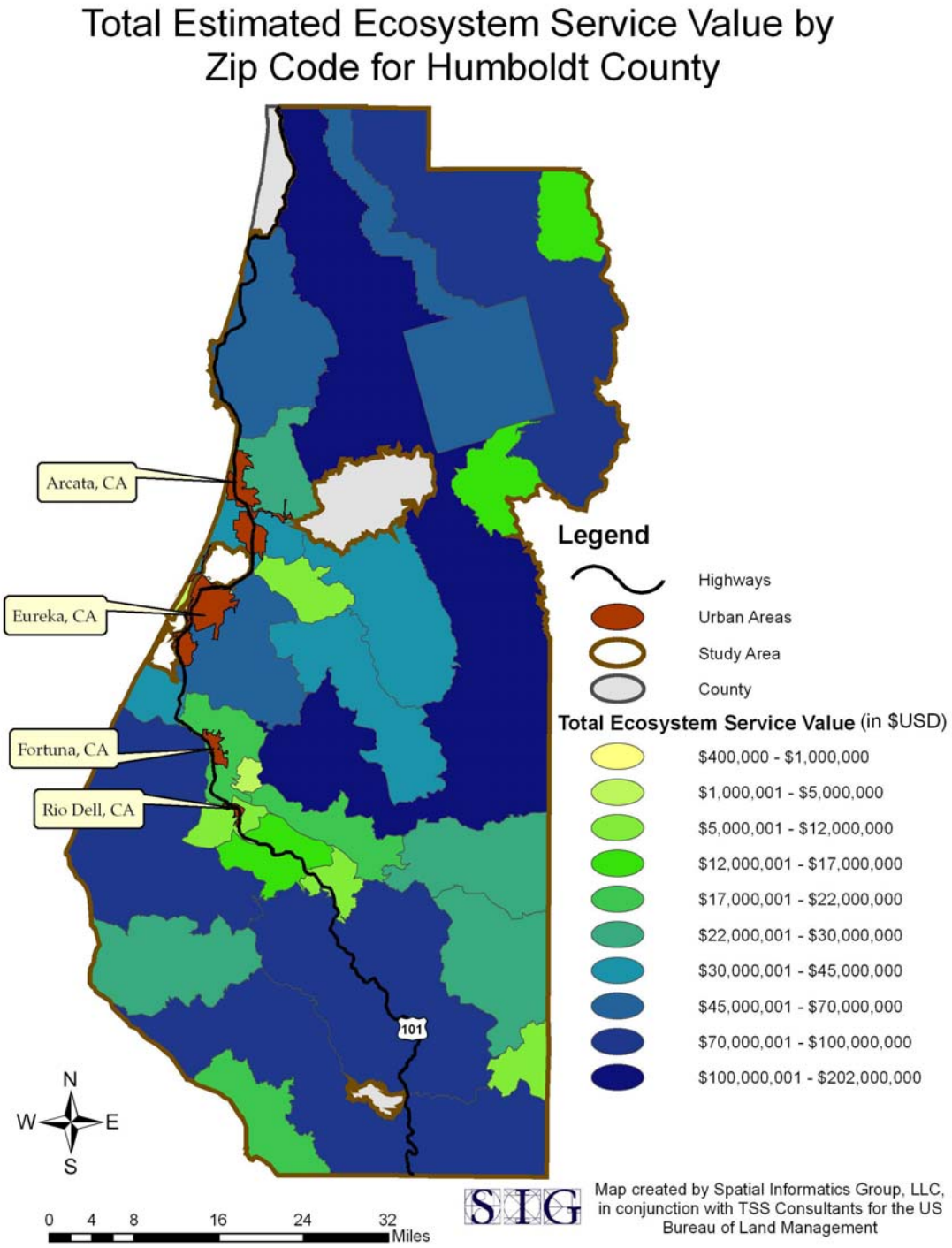
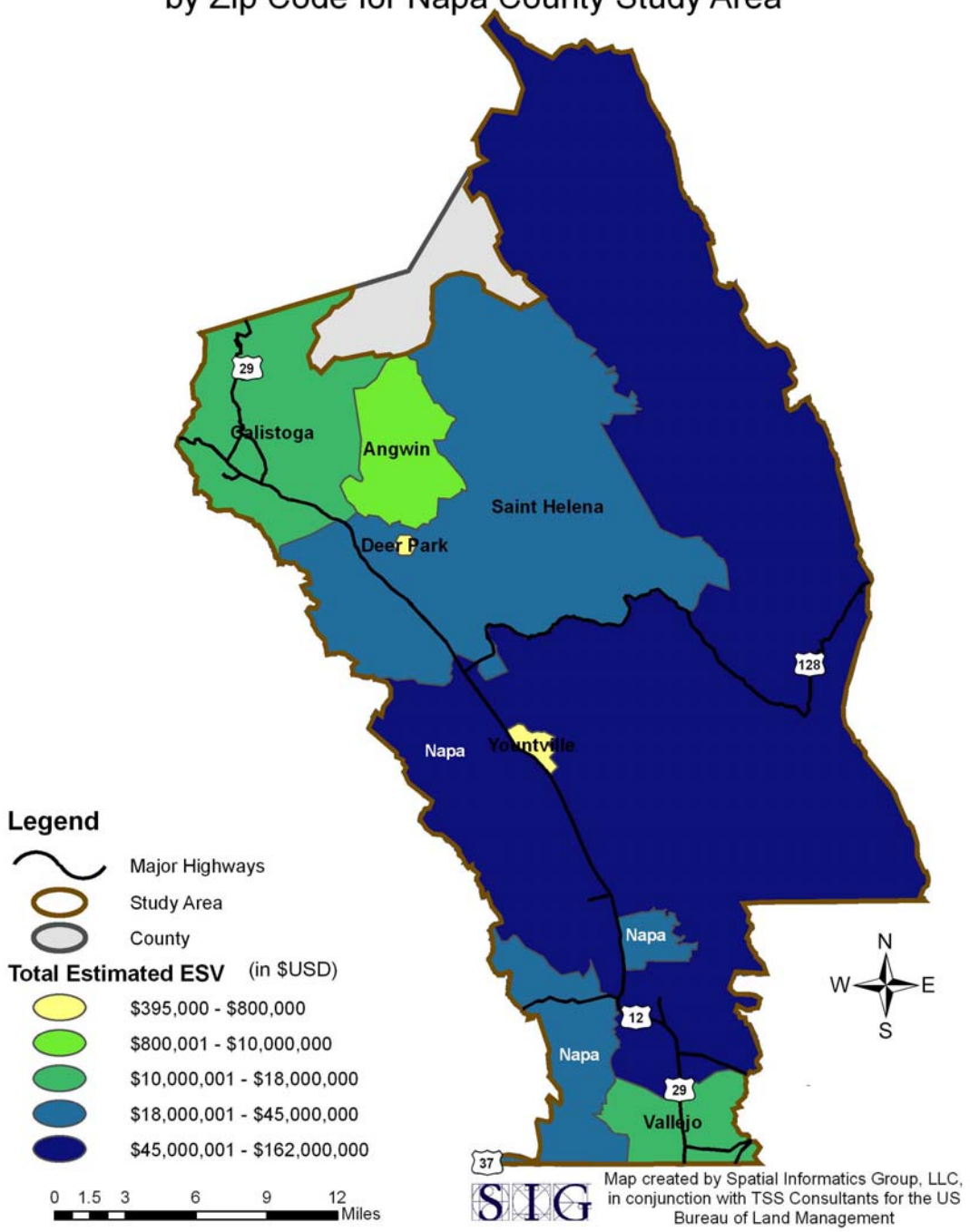
Map Created by Spatial Informatics Group, LLC in conjunction with TSS Consultants for the US Bureau of Land Management

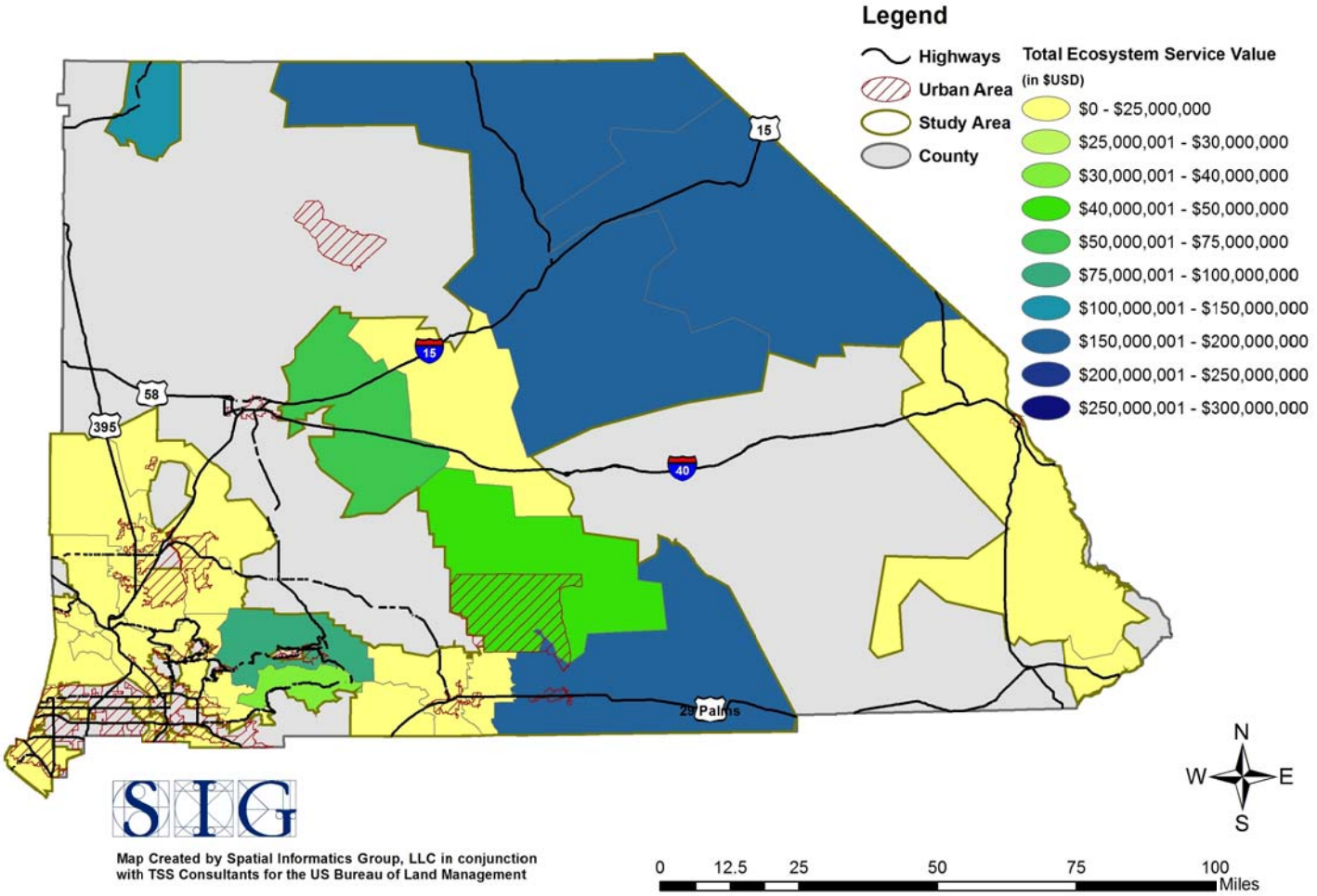
Appendix J. Total Ecosystem Service Value Estimate Maps by Zip Code



Total Estimated Ecosystem Service Value by Zip Code for Napa County Study Area



Total Estimated Ecosystem Service Value by Zip Code for San Bernardino County Study Area



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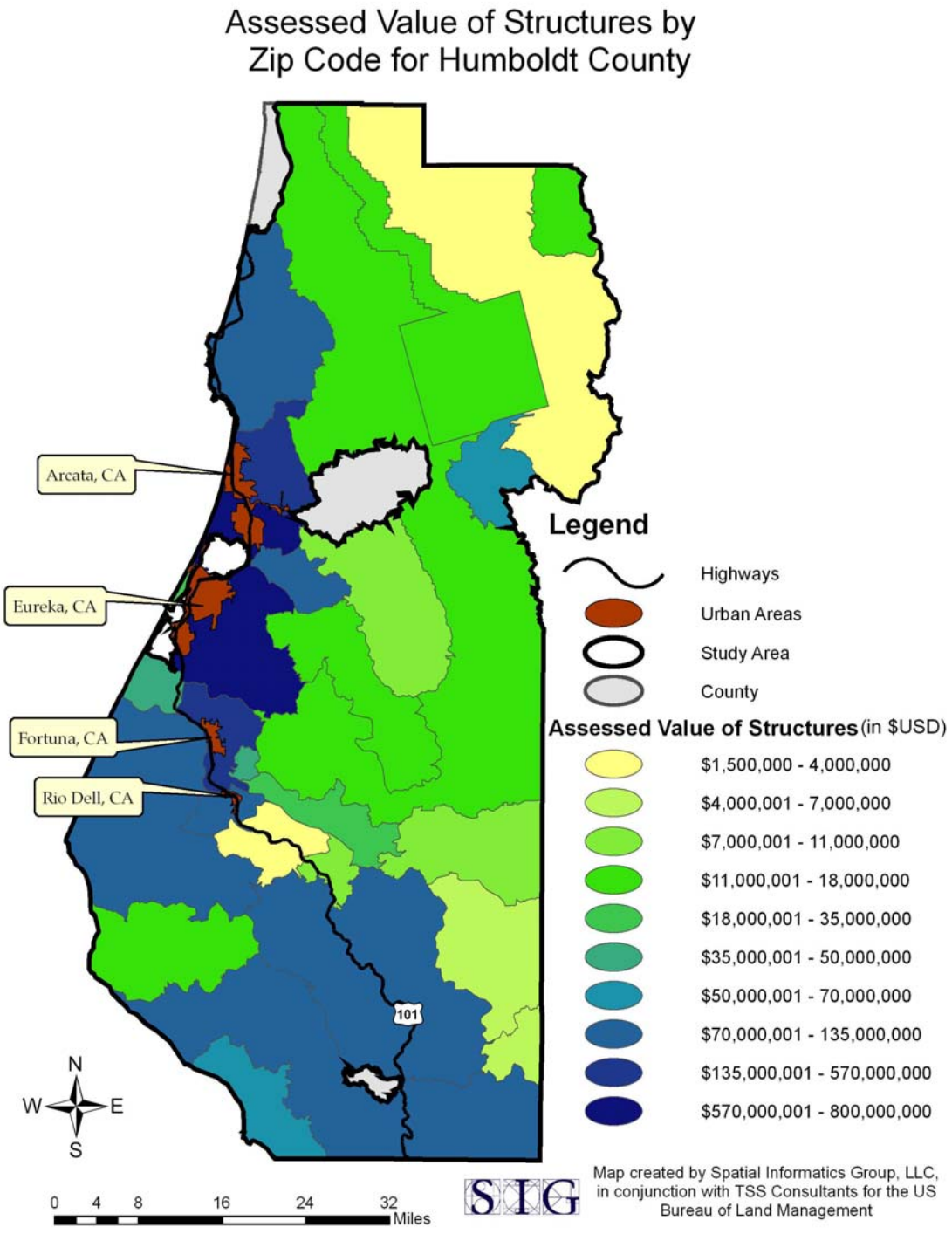
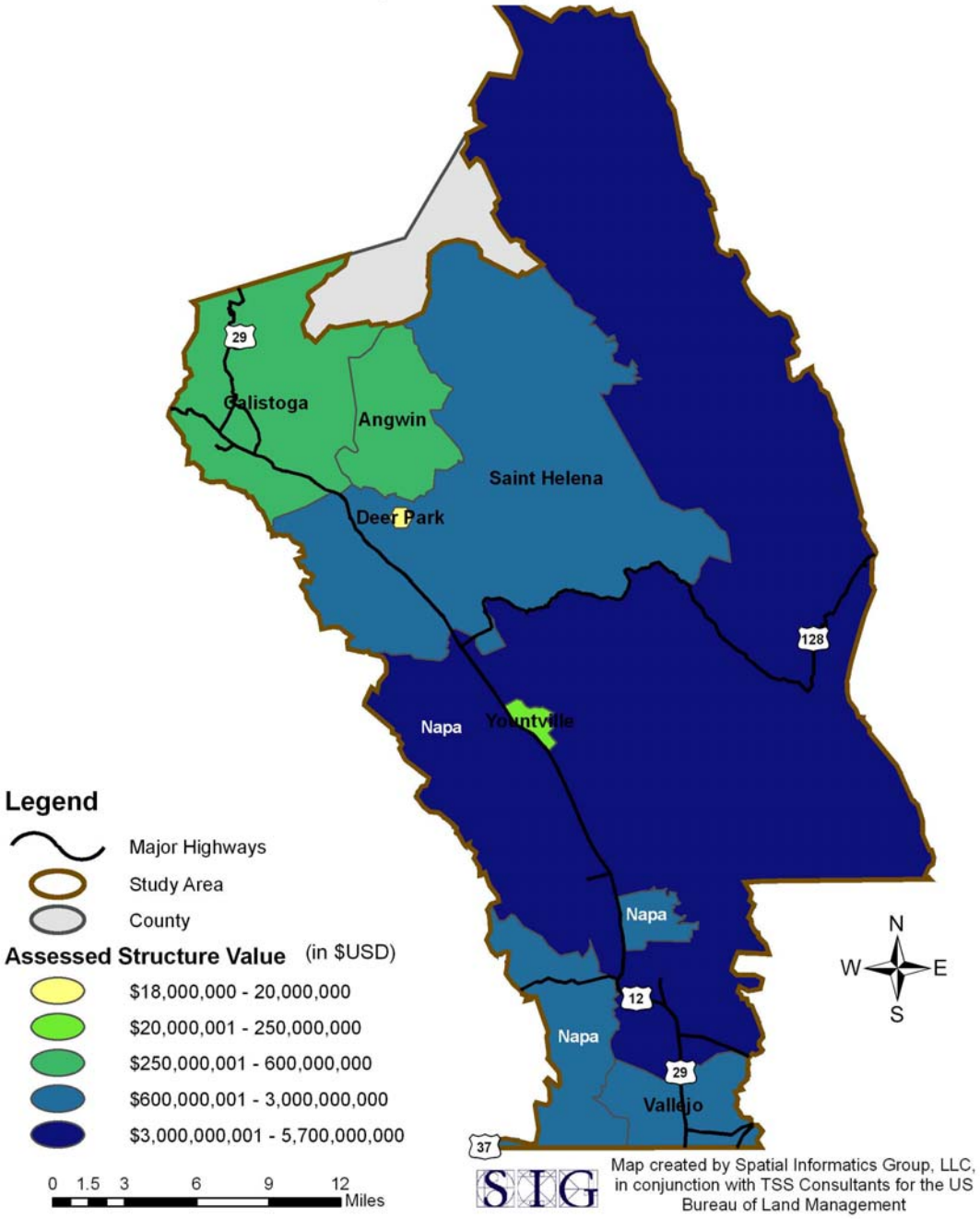
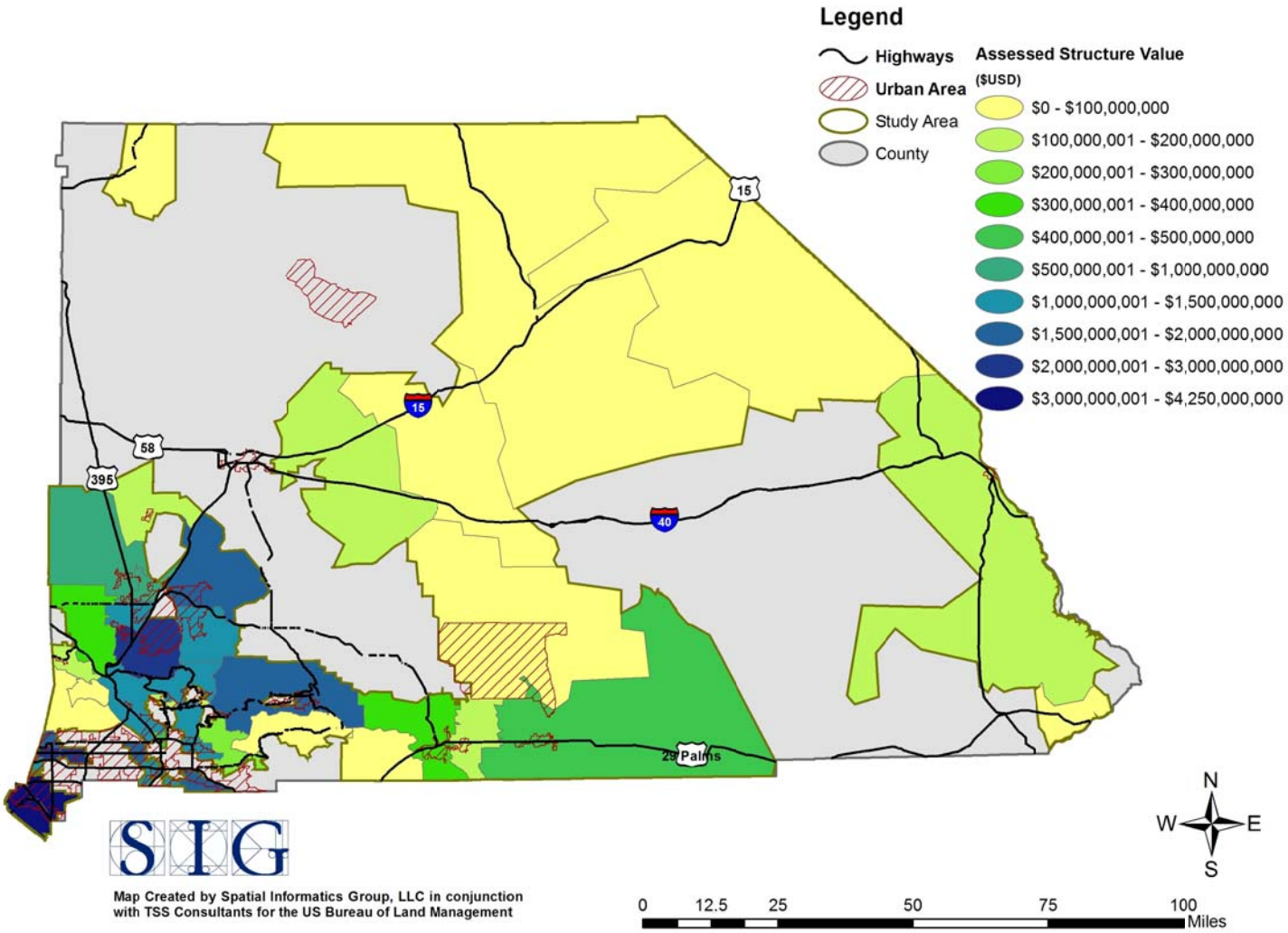
Appendix K. Assessed Structure Value Maps by Zip Code



Assessed Value of Structures by Zip Code for Napa County Study Area



Assessed Value of Structure by Zip for San Bernardino County Study Area



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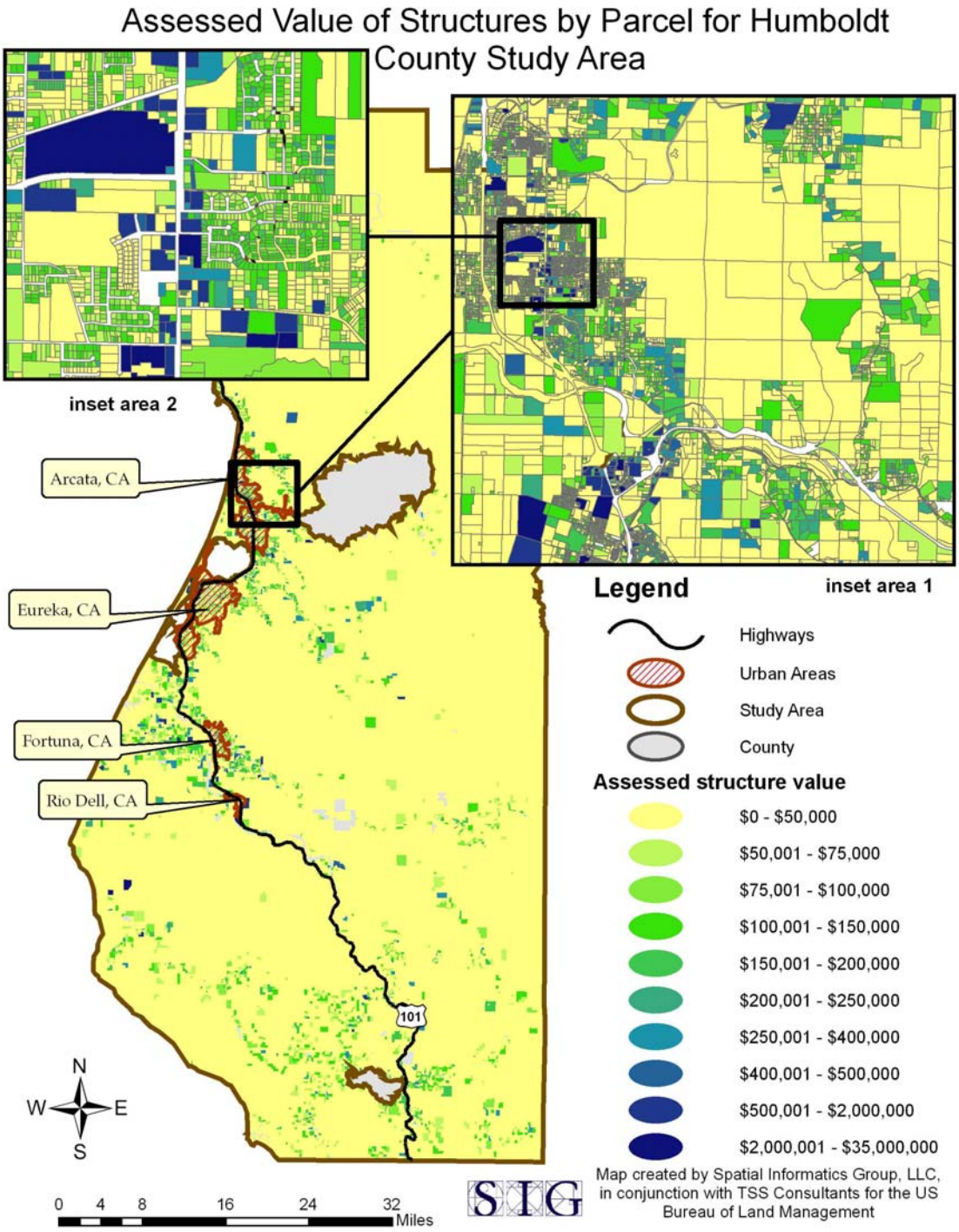
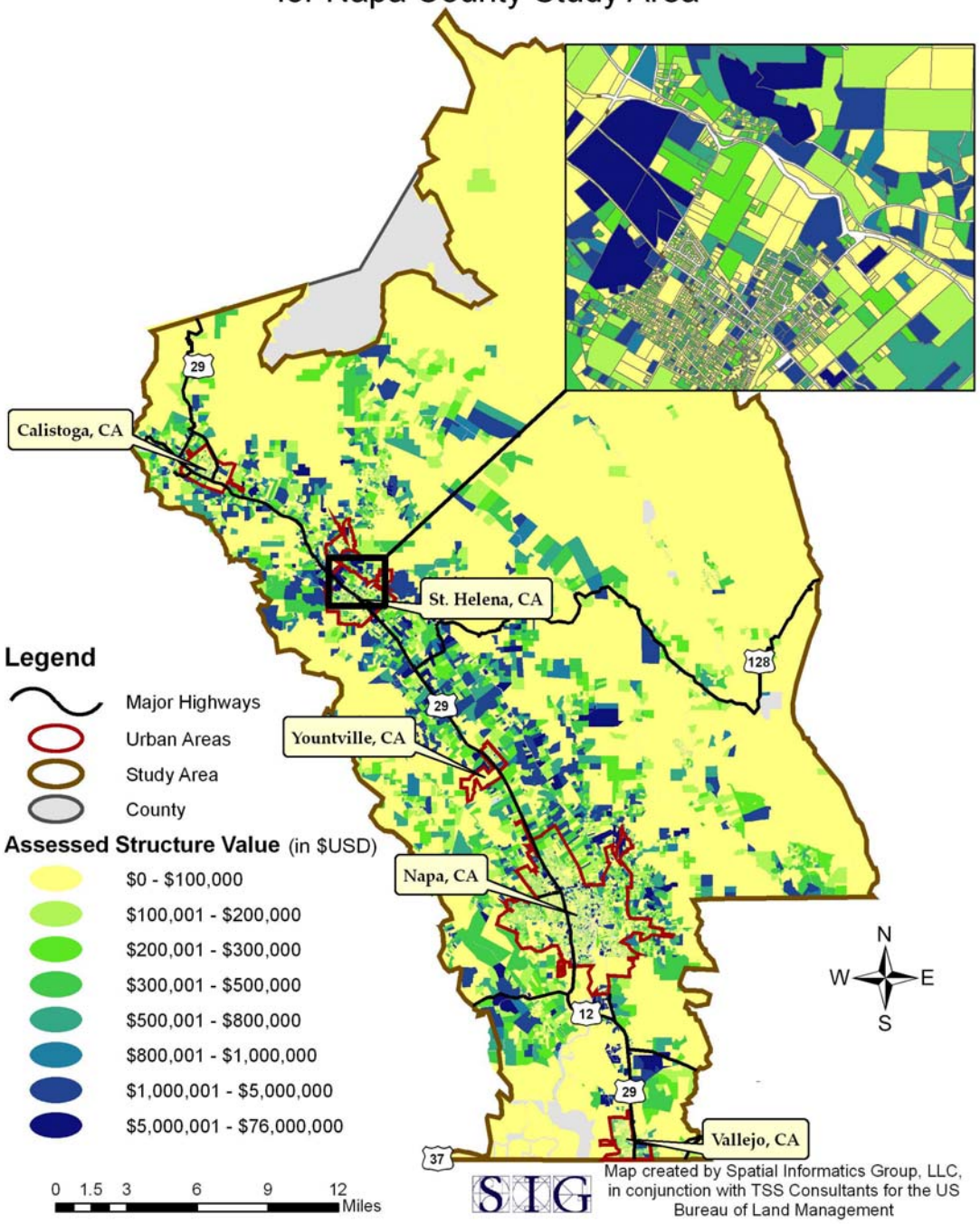
Map Created by Spatial Informatics Group, LLC in conjunction with TSS Consultants for the US Bureau of Land Management

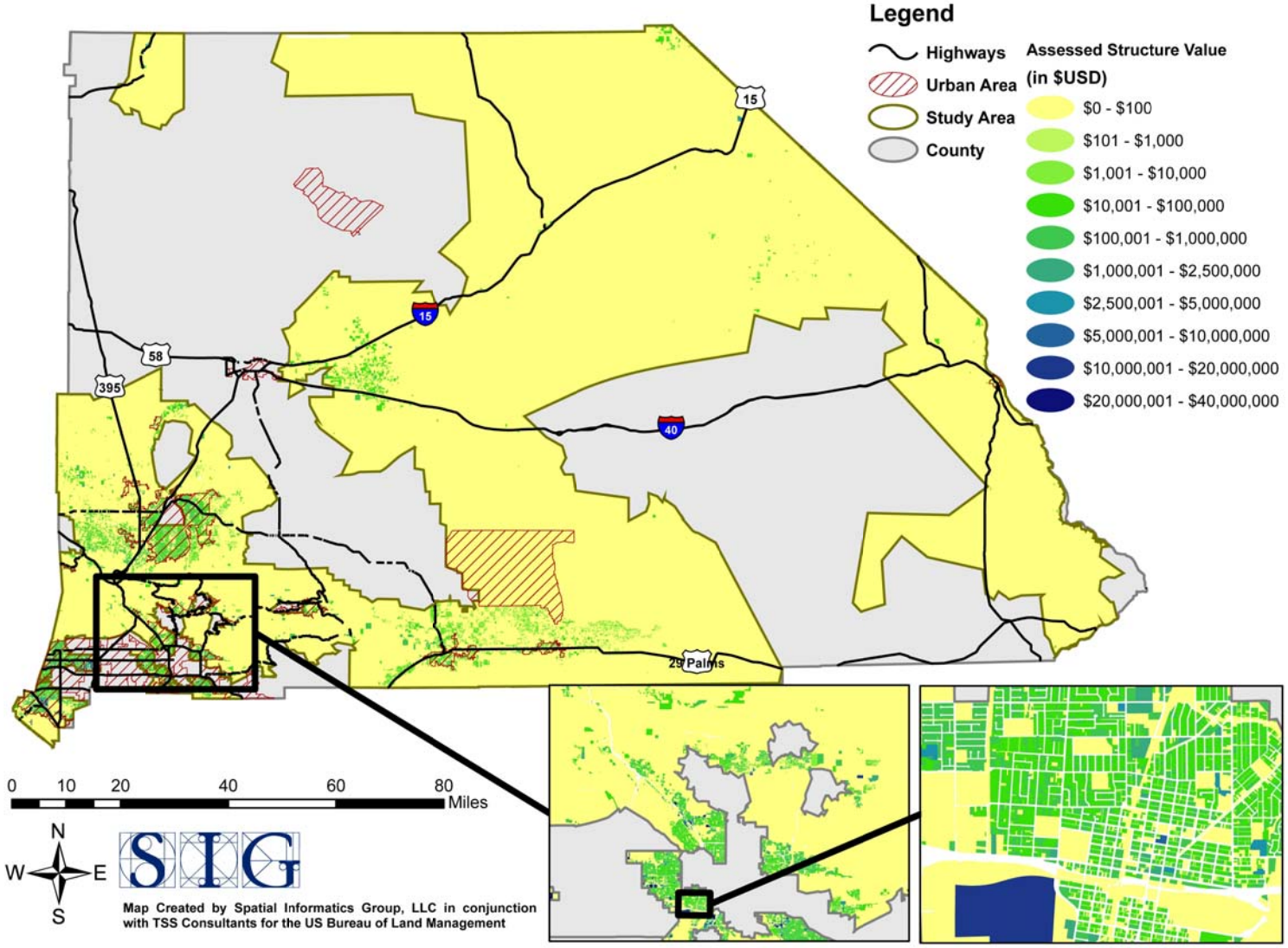
Appendix L. Assessed Structure Value Maps by Tax Parcel



Assessed Structure Value by Parcel for Napa County Study Area



Assessed Value of Structures by Parcel for San Bernardino County Study Area



Appendix M. Phone Survey Instrument

F Name
L Name
Address
Phone Nu
County
MSA
Income
Home $
Quit

Hello, this is Amy Allis. May I please speak to the head of the household? (AFTER REACHING THE APPROPRIATE RESPONDENT SAY...)

Let me start off by mentioning that I am not a telemarketer or trying to get any money from you.

The U.S. Bureau of Land Management has asked us to help determine the effectiveness of its Fire Safe educational outreach program that was conducted in your area. As you probably know, California is facing a growing wild fire problem that threatens trees, the environment and people living in wild land areas.

We have some questions that should only take a few minutes of your time. Your answers would very helpful in determining whether the public is receiving the appropriate fire safety information.

Q01 1) Do you own or rent any property in an area where wildfire is a concern?

Q02 2) Which of the following best describes your wildland property/properties?

Q03 3) How long have you occupied the wildland area property (if own more than one, the one owned longest)?

Q04 4) Is this property adjacent to federal lands?

Q05 5) Which agency owns the federal lands adjacent to you? c. Other:

Q06 6) In meeting your clearance requirements on your property, does this require clearing the adjacent federal lands?

Q07 7) Has the adjacent federal property owner cooperated in clearing their lands to protect your property under the state and local clearance requirements?

Q08 8) What does the term "community at risk" mean to you?

Q09 9) What does the term "urban wildland interface" mean to you?

Q10 10) During the last 3 years, do you recall receiving any information, such as public service messages, literature, or attended workshops on how to protect you from wildfires?

Q11 11) What kind(s) of information did you receive? i. Other:

Q12 12) If the information came from a fire agency or official, do you recall which fire agency? f. Other:

Q13 13) After receiving the information, did you take any action to protect you or your home from future wildfires?

Q14 14) What action(s) did you take (LET RESPONDENT ANSWER, THEN MATCH TO CHOICES BELOW)? i. Other:

Q15 15) Have you experienced wildfires in the area(s) of your home, second home, business or undeveloped property?

Q16 16) If so when?

Q17 17) Did you take any actions after the wildfire to better protect yourself from future wildfires?

F Name
L Name
Address
Phone Nu
County
MSA
Income
Home $
Quit

Hello, this is Amy Allis. May I please speak to the head of the household? (AFTER REACHING THE APPROPRIATE RESPONDENT SAY...)

Let me start off by mentioning that I am not a telemarketer or trying to get any money from you.

The U.S. Bureau of Land Management has asked us to help determine the effectiveness of its Fire Safe educational outreach program that was conducted in your area. As you probably know, California is facing a growing wild fire problem that threatens trees, the environment and people living in wild land areas.

We have some questions that should only take a few minutes of your time. Your answers would very helpful in determining whether the public is receiving the appropriate fire safety information.

Q18 18) What actions did you take to make you and your property more Fire Safe (LET RESPONDENT ANSWER, THEN MATCH TO CHOICES BELOW)? i. Other:

Q19 19) Do you want additional information or technical assistance on how to better protect you, your home or your property from wildfires?

Q20 20) What types of information or assistance would help make you or your property more Fire Safe? d. Other:

21) Do you have any suggestions for better communicating with home or landowners in your area?

Q22 0 22) On a scale of 1-10, with 10 being the highest rating, how safe from wildfire do you think you are?

23) Do you have any other suggestions or comments?

(DEMOGRAPHIC INFORMATION)
In order to determine what sectors of the population might require more fire safe education, I have some demographic information I'd like to ask. This information will be kept strictly confidential.

Q24 24) Are you Male or Female?

Q25 25) What is your age?

Q26 26) What is the highest level of education you have completed?

Q27 27) Would you say your annual household income is...

Q28 28) Do you own or rent your residence?

Q29 29) What is your current marital status?

Q30 30) What is your race?

Appendix N. Phone Survey Statistical Analysis

Question	Humboldt	Napa	San Bernardino	Combined	Expected	County x Category	All Counties	All Counties w/o last choice
1) Do you own or rent any property in an area where wildfire is a concern?						Degrees of freedom: 2	chi-square = 216.	chi-square = 3.39
Yes	70	32	130	232	142.3333333	Chi-square = 1.6245789792304	degrees of freedom = 2	degrees of freedom = 1
No	60	19	115	194	213	For significance at the .05 level, chi-square should be greater than or equal to 5.99.	probability = 0.000	probability = 0.066
Don't Know		1		1		The distribution is not significant. *p* is less than or equal to 1.		
2) Which one of the following best describes your wildland property/properties? (CHOOSE ONE)								
a Primary Home	58	31	119	208	58	Degrees of freedom: 6	chi-square = 519.	
b Second Home	6		10	16		Chi-square = 11.6509649347905	degrees of freedom = 3	
c Undeveloped Property	5	1	1	7		For significance at the .05 level, chi-square should be greater than or equal to 12.59.	probability = 0.000	
d A Business	1			1		The distribution is not significant. *p* is less than or equal to 0.10		
3) How long have you owned or occupied this property (from the previous question)?								
a Less than 1 year		1	6	7	57.5		chi-square = 114.	
b 1 to 3 years	5	3	29	37			degrees of freedom = 3	
c 3 to 10 years	23	10	37	70			probability = 0.000	
d 10 plus years	41	18	57	116				
4) Is this property adjacent to federal lands?								
Yes	13	1	33	47	77		chi-square = 148.	
No	53	25	85	163			degrees of freedom = 2	
Don't Know	4	6	11	21			probability = 0.000	
5) Which agency owns the federal lands adjacent to you?								
a US Forest Service	7		19	26	12			chi-square = 11.3
b Bureau of Land Management	2	1	6	9	15.33333333			degrees of freedom = 2
c Other	3		8	11				probability = 0.004
d Don't Know (DON'T READ THIS CHOICE)	1	1		2				
6) In meeting your clearance requirements on your property, does this require clearing the adjacent federal lands?								
Yes	2		9	11	25		chi-square = 15.7	
No	12	1	26	39			degrees of freedom = 1	
							probability = 0.000	
7) Has the adjacent federal property owner cooperated in clearing their lands to protect your property under the state's clearance requirements of 100 feet?								
Yes	1		7	8	5.666666667			chi-square = 0.692
No	2		3	5	6.5			degrees of freedom = 1
Don't Know	4			4				probability = 0.405
8) What does the term community at risk mean to you? (DON'T READ. a if close, else b)								
a A community or home that is threatened by wildfire	39	21	82	142	115		chi-square = 12.7	
b Don't know	31	11	46	88			degrees of freedom = 1	
							probability = 0.000	
9) What does the term urban wildland interface mean to you? (DON'T READ. a if close, else b)								
a A home in a forest area that is threatened by wildfire	10	4	27	41	115.5		chi-square = 96.1	
b Don't know	60	28	102	190			degrees of freedom = 1	
							probability = 0.000	
10) During the last 3 years, do you recall receiving any information, such as public service messages, literature, or attended workshops on how to protect you from wildfires?								
Yes	39	18	87	144	115		chi-square = 14.6	
No	30	13	43	86			degrees of freedom = 1	
							probability = 0.000	

Question	Humboldt	Napa	San Bernardino	Combined	Expected	County x Category	All Counties	All Counties w/o last choice
11) What kind(s) of information did you receive? (LET RESPONDENT ANSWER, THEN TYPE								
a Literature from a Fire Agency or Official	8	7	21	36	22.77777778	Degrees of freedom: 16	chi-square = 107.	chi-square = 99.9
b Literature in the Mail	11	5	39	55	20	Chi-square = 28.4662556707967	degrees of freedom = 7	degrees of freedom = 6
c Literature from School	1			1		*p* is less than or equal to 0.05.	probability = 0.000	probability = 0.000
d Attended Workshop	7		16	23		The distribution is significant.		
e Public Service Announcement on Radio	3	2	4	9				
f Public Service Announcement on TV	5	2	8	15				
g Newspaper	7	2	11	20				
h Internet		1		1				
i Other	4	4	37	45				
12) If the information came from a fire agency or official, do you recall which fire agency(s)? (SKIP IF NOT, OTHERWISE TYPE LETTERS)								
a U.S. Bureau of Land Management	1	1	5	7	20.42857143	Degrees of freedom: 10	chi-square = 33.4	chi-square = 32.4
b U.S. Forest Service	2	3	11	16	20.83333333	Chi-square = 25.8961910851297	degrees of freedom = 6	degrees of freedom = 5
c California Department of Forestry and Fire Protection	6	2	2	10		*p* is less than or equal to 0.01.	probability = 0.000	probability = 0.000
d County Fire Agency or Fire District	9	6	17	32		The distribution is significant.		
e Fire Safe Council	3	1	31	35				
f Other	2	4	19	25				
g Don't Know or Don't Recall (DON'T READ THIS CHOICE)	2		16	18				
13) After receiving the information, did you take any action to protect you or your home from future								
Yes	14	7	58	79	46.66666667		chi-square = 51.6	
No	5	1	4	10			degrees of freedom = 2	
Had already taken action	19	8	24	51			probability = 0.000	
14) What action(s) did you take? (LET RESPONDENT ANSWER, THEN TYPE LETTERS)								
a Discussed with family, friends or neighbors, what could be done for potential fire problems		1		1	32.22222222	Degrees of freedom: 16	chi-square = 369.	
b Developed a formal or informal plan for dealing with future fire threats		1	1	2		Chi-square = 21.393127753304	degrees of freedom = 8	
c Obtained assistance from fire agencies or others on what you can do to protect you and your			1	1		*p* is less than or equal to 0.05.	probability = 0.000	
d Worked with Homeowners Association or other neighborhood group to develop a plan for imp				0		The distribution is significant.		
e Removed vegetation from around home or other structures	24	14	69	107				
f Removed vegetation from driveway or roads accessing your property	2	4	63	69				
g Removed vegetation from other areas	6	2	49	57				
h Installed water supplies or other related equipment	4	2	7	13				
i Other	1	1	38	40				
15) Have you experienced wildfires in the area(s) of your home, second home, business or undeveloped property?								
Yes	37	11	97	145	113		chi-square = 18.1	
No	32	21	28	81			degrees of freedom = 1	
							probability = 0.000	
16) If so when?								
a During the last year	7	7	38	52	49		chi-square = 33.4	
b During the last five years	18	1	57	76			degrees of freedom = 2	
c More than 5+ years	12	3	4	19			probability = 0.000	
17) Did you take any actions after the wildfire to better protect yourself from future wildfires?								
Yes	17	2	32	51	47.33333333		chi-square = 30.1	
No	7	1	11	19			degrees of freedom = 2	
Had already taken action	14	8	50	72			probability = 0.000	

Question	Humboldt	Napa	San Bernardino	Combined	Expected	County x Category	All Counties	All Counties w/o last choice
18) What actions did you take to make you and your property more Fire Safe? (LET RESPONDENT ANSWER, THEN TYPE LETTERS)								
a Discussed with family, friends or neighbors, what could be done for potential fire problems			2	2	34	Degrees of freedom: 16	chi-square = 288.	
b Developed a formal or informal plan for dealing with future fire threats			2	2		Chi-square = 39.5197962917642	degrees of freedom = 8	
c Obtained assistance from fire agencies or others on what you can do to protect you and your			1	1		*p* is less than or equal to 0.001.	probability = 0.000	
d Worked with Homeowners Association or other neighborhood group to develop a plan for imp	1		1	2		The distribution is significant.		
e Removed vegetation from around home or other structures	14	8	70	92				
f Removed vegetation from driveway or roads accessing your property	2	1	66	69				
g Removed vegetation from other areas	4	1	57	62				
h Installed water supplies or other related equipment	9	3	15	27				
i Other	2	2	45	49				
19) Would additional information or technical assistance on how to better protect you, your home or your property from wildfires be useful?								
Yes	35	11	43	89	113.5		chi-square = 10.6	
No	33	21	84	138			degrees of freedom = 1	
							probability = 0.001	
20) What types of information or assistance would help make you or your property more Fire Safe? (LET RESPONDENT ANSWER, THEN TYPE LETTERS)								
a Fire Prevention Inspection by fire official	4	3	5	12	29		chi-square = 19.4	
b Instructions on what to do in case of a wildfire	11	7	20	38			degrees of freedom = 3	
c Assistance in developing a Fire Safe Plan for your home, business or property	6	6	12	24			probability = 0.000	
d Other	16	4	22	42				
21) Do you have any suggestions for better communicating with home or landowners in your area?								
22) On a scale of 1-10, with 10 the safest, how safe from a wildfire do you think your property is?								
1	4	2	1	7	22.1		chi-square = 138.	
2	2	1	2	5			degrees of freedom = 9	
3	5	1	3	9			probability = 0.000	
4	3	2	2	7				
5	17	3	18	38				
6	6	1	6	13				
7	12	7	17	36				
8	15	8	39	62				
9	2	3	19	24				
10	3	2	15	20				

Question	Humboldt	Napa	San Bernardino	Combined	Expected	County x Category	All Counties	All Counties w/o last choice
22a) On the same scale, how safe from a wildfire do you think your community is?								
1	4	3		7	21		chi-square = 89.8	
2	2	3	6	11			degrees of freedom = 9	
3	8		6	14			probability = 0.000	
4	10	4	8	22				
5	20	5	29	54				
6	6	2	13	21				
7	11	4	22	37				
8	2	3	15	20				
9	3	3	10	16				
10	3	3	2	8				
23) Do you have any other suggestions or comments?								
(DEMOGRAPHIC INFORMATION)								
and now a few Demographic questions to see if we're reaching everyone we need to...								
24) Male or Female? (DON'T ASK, TAKE BEST GUESS)								
a Male	56	21	96	173	138.6666667		chi-square = 219.	
b Female	68	31	142	241			degrees of freedom = 2	
c decline to answer	1		1	2			probability = 0.000	
25) Which of the following age groups do you fall under...?								
a 18-21	1	2	6	9	52.375			chi-square = 292.
b 22-25	4	2	5	11	55.71428571			degrees of freedom = 6
c 26-30	3		9	12				probability = 0.000
d 31-40	8	9	27	44				
e 41-50	23	7	55	85				
f 51-60	33	10	38	81				
g 61 or over	49	21	78	148				
h decline to answer	7		22	29				
26) What is the highest level of education you have completed?								
a Less than High School	6	2	12	20	46.33333333			chi-square = 206.
b High School/GED	33	11	50	94	47.875			degrees of freedom = 7
c Some College	29	6	57	92				probability = 0.000
d 2-Year College Degree (Associates)	18	6	22	46				
e 4-Year College Degree (BA, BS)	24	14	44	82				
f Master's Degree	9	10	21	40				
g Doctoral Degree	1	2	2	5				
h Professional Degree (MD, JD)			4	4				
i decline to answer	8		26	34				

Question	Humboldt	Napa	San Bernardino	Combined	Expected	County x Category	All Counties	All Counties w/o last choice
27) Would you say your annual household income is between...								
a Less than $10,000	7	1	10	18	59.28571429			chi-square = 63.3
b $10,000 to $20,000	28	1	22	51	51.16666667			degrees of freedom = 5
c $20,000 to $40,000	29	6	47	82				probability = 0.000
d $40,000 to $75,000	26	10	44	80				
e $75,000 to $100,000	7	5	28	40				
f More than $100,000	7	5	24	36				
g decline to answer	23	24	61	108				
28) Do you own or rent your residence?								
a Own	91	39	173	303	103.75			chi-square = 397.
b Rent	28	8	29	65	124.6666667			degrees of freedom = 2
c Live with relative	1	1	4	6				probability = 0.000
d decline to answer	7	1	33	41				
29) What is your current marital status?								
a Single, Never Married	31	11	42	84	69.5			chi-square = 327.
b Married	56	34	114	204	74.6			degrees of freedom = 4
c Separated	2		7	9				probability = 0.000
d Divorced	8	1	12	21				
e Widowed	17	5	33	55				
f decline to answer	13	1	30	44				
30) Which of the following best describes your primary race?								
a White	106	47	158	311	69.16666667			chi-square = 0.104E+04
b African-American	1		2	3	70.2			degrees of freedom = 4
c Hispanic	4	5	16	25				probability = 0.000
d Asian-Pacific Islander			3	3				
e Native American	2		7	9				
f decline to answer	14	1	49	64				