Project Title:

Integrating Science into Decisions: Climate Change/Land Use Change Scenarios and Outreach for Habitat Threat Assessments on California Rangelands

Proposal by:

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Scope & Budget:

Location: CA LCC-Wide
Duration in months: 12
Requested Funding: $101,628.17
Leveraged Funding: $226,374

Briefly summarize the goals of the project, what products will result, and how the products support decision-making and conservation delivery for natural resource management within the CA LCC.

Through a multi-stakeholder partnership, we propose to develop integrated climate change/land use change scenarios for the Central Valley and Chaparral and Oak Woodland eco-regions, and disseminate information about future potential threats to high priority conservation areas within the California Rangeland Conservation Coalition (CRCC) study area, which includes the foothills around the Central Valley and most of the southern Inner Coast Range. Products will include: 1) three spatially-explicit integrated scenarios from years 2000 – 2100 consistent with three Intergovernmental Panel on Climate Change greenhouse gas emission scenarios – A2, B1, and A1B, 2) an assessment of potential threats to three ecosystem services – wildlife habitat, water availability, and carbon sequestration – within CRCC high priority conservation areas under each scenario, 3) an economic analysis of these scenarios to quantify economic costs and benefits and identify where ecosystem services can be optimized, 4) a web-based visualization tool for resource managers to view and compare scenarios in a map format, and 5) an outreach program through the Defenders of Wildlife that will target the CRCC network of more than 100 partner organizations to communicate how results can be applied to conservation and land management decisions. Overall, this project will aid conservation of California rangelands by identifying future integrated threats of climate change and land use change, and will quantify two main co-benefits of rangeland conservation – water supply and carbon sequestration. Products will 1) help local planners make zoning decisions that limit impacts to ecosystem services, 2) help Federal and state agencies design effective conservation plans that are robust to climate change and land use change impacts, and 3) help water districts assess potential changes to water supply and guide their land acquisition and outreach to landowners on practices to maximize watershed function.

For continuing 2010 CA LCC projects, describe the accomplishments and outcomes to date, why additional funds are needed, and what this proposal will add to the project.

NEW PROJECT

Identify which National LCC Performance Measure(s), if any, your project addresses.

1. A risk and vulnerability assessment developed or refined for priority species and habitats. 4. A biological planning and conservation design project developed in response to climate change.

List Partners

USGS Western Geographic Science Center (WGSC) Defenders of Wildlife USGS Center for Science, Decisions, and Resource Management USGS California Water Science Center

Briefly describe how the project team (main PIs) provides the range of experience, expertise, and organizational capacity needed to accomplish the project. List recent and current projects (names, time-periods, PI time commitments, and total budgets). Also attach 1 page CVs for the principle investigator and/or project leaders per below under additional information.

Kristin Byrd (USGS Western Geographic Science Center) has expertise in spatial analysis, remote sensing, and modeling urban and exurban growth. As a post-doctoral researcher at U.C. Berkeley she investigated the role of conservation easements in controlling development threats and influencing fire management. Her research was published in Landscape and Urban Planning (Byrd, K. B., A. R. Rissman, and A. M. Merenlender. 2009. Impacts of conservation easements for threat abatement and fire management in a rural oak woodland landscape. Landscape and Urban Planning 92:106-116). Kristin is also Principal Investigator of a 3-year project titled, Advanced Remote Sensing to Quantify Temperate Peatland Capacity for Belowground Carbon Capture, funded by the NASA ROSES New Investigator Program in Earth Sciences. Kristin completed a Ph.D. and post-doctoral research at U.C. Berkeley in the Department of Environmental Science, Policy and Management. Christopher Soulard (USGS Western Geographic Science Center) has been employed with the USGS since 2002. As a physical scientist with the Western Geographic Science Center, Chris' research has focused on multi-temporal change analysis in the Western United States using Landsat imagery and aerial photography. Chris primarily works on the Land Cover Trends Project, a national effort focused on understanding the rates, trends, causes, and consequences of contemporary U.S. land use and land cover change between 1973 and 2000. In 2010, Chris expanded Land Cover Trends research to help develop spatially explicit land use and land cover change and models based on future climate scenarios. These models are being used by the USGS LandCarbon Project to produce carbon and greenhouse gas estimates. Frank Casey (USGS Center for Science, Decisions and Resource Management) is the Ecosystem Services Theme Lead at the USGS Science and Decisions Center. Dr. Casey has experience in the market and non-market valuation of ecosystem services, including those services associated with California rangelands located in the California Landscape Conservation Cooperative. He has also developed expertise in the development and implementation a comprehensive system of public and private land owner economic incentives at the federal and state level for wildlife habitat and biodiversity conservation, including the estimation of ecosystem service benefits and the application of ecosystem service markets to wildlife habitat and other resources. Dr. Casey has provided policy assistance to the conservation community and relevant government agencies in selecting and implementing economic incentives for the conservation and protection of wildlife habitat and biodiversity. Relevant publications include Flexible Incentives for the Adoption of Environmental Technologies and Agriculture (Kluwer Academic Press) and Defender of Wildlife reports entitled Incentives for Biodiversity Conservation: An Ecological and Economic Assessment and An Economic Analysis of the Benefits of Habitat Conservation on California Rangelands. One of Dr. Casey's publications in the area of ecosystem services as co-author is the article "An assessment of market-based approaches to providing ecosystem services on agricultural lands", published in Ecological Economics (2007). He has a PhD in Food and Resource Economics from the University of Florida and an MS in Agricultural Economics from Cornell University. Lorraine Flint and Alan Flint (USGS California Water Science Center) have expertise in downscaling climate data for application to regional water balance models to calculate the hydrologic response of watersheds and landscapes to current and future climates at very fine spatial scales. They have developed approaches for establishing impacts of future climate on stream temperature, water availability, and vegetation. Relevant ongoing projects include climate change and hydrology investigations for the

State of California, including regional studies in the Sierra Nevada, Klamath River, Central Valley, and Russian River basins, evaluating impacts of climate change on wolverine and waterbird habitats, springtime snowmelt, runoff and recharge, and distribution of vegetation. Pelayo Alvarez (Defenders of Wildlife) oversees research and outreach activities for the California Rangeland Conservation Coalition. He coordinates stakeholder meetings, field trips, conferences on a variety of topics including, conservation, ecology, ecosystems services and he also manages the Coalition's website. Pelayo has given presentations providing technical information to diverse groups including landowner organizations, land trusts, resource conservation districts, federal, state and local agencies, research institutions and legislators. The U.S. Geological Survey brings extensive organizational capacity to this project. Highly experienced teams across the country have spent over ten years researching nation-wide land use/land cover (LULC) change (Land Cover Trends Project http://landcovertrends.usgs.gov/). The USGS is now developing scenarios of LULC change for the nation out to 2100 through the LandCarbon project (http://www.usgs.gov/global_change/carbon/default.asp). The USGS offices have excellent remote sensing hardware, software, and expertise. Software includes several licenses for Earth Resource Mapper (ERMapper 8.2), ERDAS Imagine 9.2, ArcGIS 9.3 and ArcGIS Server 9.3, ArcGIS 10.0, IDL and ENVI. Other software includes SAS and STATA statistical software and FORE-SCE growth modeling software. Recent and Current Projects: Kristin Byrd Title: Advanced Remote Sensing to Quantify Temperate Peatland Capacity for Belowground Carbon Capture Source of Funding: NASA ROSES New Investigator Program in Earth Science Total Award Amount: $346,333 Award Period: January 2011 – December 2013 Person-months per year devoted to project: 3 Title: LandCarbon: Wetlands Project Plan Source of Funding: The USGS Landcarbon Project Total Award Amount: $55,613 Award Period: January 2011 – December 2012 Person-months per year devoted to project: 3 Christopher E. Soulard Title: USGS Land Cover Trends Project Source of Funding: USGS Land Cover Trends Total Award Amount: $72,012 Award Period: October 2010 – September 2011 Person-months per year devoted to project: 3 Title: Can mammals mediate climatically-induced vegetation transitions in alpine ecosystems of the western United States? Source of Funding: National Climate Change and Wildlife Science Center Total Award Amount: $22,364 Award Period: October 2010 – September 2011 Person-months per year devoted to project: 2 Frank Casey has been in his USGS position for 5 months and does not yet have any recently or currently funded projects. Lorraine Flint Title: Sierra Snowmelt Source of Funding: California Department of Water Resources Total Award Amount: $360K Award Period: 2008-2012 Person-months per year devoted to project: 2 Title: Russian River Climate Change Source of Funding: Sonoma County Water Agency Total Award Amount: $420K Award Period: 2009-2012 Person-months per year devoted to project: 2 Title: Adapting to Climate Change: "State of the Science" for North Bay Watersheds Source of Funding: North Bay Watershed Assn. Total Award Amount: $60K Award Period: 2010-2011 Person-months per year devoted to project: 1 Title: Impact of climate change on future suitability of the Sierra Nevada for wolverines Source of Funding: USGS Biologic Resource Discipline Total Award Amount: $75K Award Period: 2010-2011 Person-months per year devoted to project: 1 Title: Influence of Climate Change on Sediment Transport in the Sacramento Valley Watershed Source of Funding: Calfed Total Award Amount: $366K Award Period: 2011-2013 Person-months per year devoted to project: 2 Title: Klamath River Basin Characterization Model Source of Funding: USGS Western Region Total Award Amount: $200K Award Period: 2009-2011 Person-months per year devoted to project: 2 Pelayo Alvaraz Title: An Economic Analysis of the Benefits of Habitat Conservation on California Rangelands Total Award Amount: $50,000 Award Period: April 2008 – April 2009 Title: The Feasibility of Ecosystem Service Payments and Markets for California Rangeland Resource Enhancement Total Award Amount: $75,000 Award Period: Sept. 2009 – May 2011 Person-months per year devoted to project: 3 Title: Investigating the Feasibility of Water Quality Markets for California Rangelands Source of Funding: Compton Foundation Total Award Amount: $20,000 Award Period: December 2009 – July 2011 Person-months per year devoted to project: 2 Title: Establishing Protocols for a Potential Water Quantity Market-Trading Program within the San Francisco Bay Area Source of Funding: Bechtel Foundation Total Award Amount: $25,000 Award Period: January 2011 – September 2011 Person-months per year devoted to project: 2

Project Description: This project will aid conservation of wildlife habitat on California rangelands by 1) identifying future integrated threats of climate change and land use change, and 2) quantifying two main co-benefits of rangeland conservation – water supply and carbon sequestration. Through a multi-stakeholder partnership, we propose to develop integrated climate change/land use change scenarios for the Central Valley and Chaparral and Oak Woodland eco-regions, and disseminate information about future potential threats to wildlife conservation within the California Rangeland Conservation Coalition (CRCC) focus area. By means of scenario analysis we will assess potential threats to three ecosystem services – wildlife habitat, water availability, and carbon sequestration – and conduct an economic analysis to quantify economic costs and benefits and identify where ecosystem services can be optimized. To develop scenarios we will leverage two USGS efforts – the national LandCarbon land use change scenarios and an ensemble of downscaled California climate projections and related hydrologic data on climatic water deficit, runoff and recharge. Both these efforts are based on consistent storylines of the Intergovernmental Panel on Climate Change (IPCC) Special Report on Emission Scenarios (SRES). Our spatially-explicit scenarios will be developed for three IPCC scenarios and will have consistent spatial resolution, spatial extent and time frame. The spatial extent will also match the high priority conservation focus area map in use by the CRCC (Figure 1). A web-based visualization tool will provide access to maps of climate change/land use change generated by scenario and decade out to 2100 as well as maps that identify potential consequences to three rangeland ecosystem services for each scenario. An outreach program through the Defenders of Wildlife will target the CRCC network of more than 100 partner organizations to communicate how results can be applied to conservation and land management decisions.

CA LCC Priorities Addressed: We will address the following CA LCC priorities: 1) Developing models that characterize habitat response to projected change under alternative climate/economic/planning scenarios; 2) Future scenario planning at eco-regional scales; and 3) Development of an open access information retrieval system. We will develop future integrated scenarios of climate and land use change for the Central Valley and Chaparral and Oak Woodland eco-regions. Through analysis of our integrated scenarios, we will assess risk of direct habitat loss on rangelands, change in water storage on rangelands, and shifts in major vegetation types on rangelands, which are critical to supporting multiple threatened and endangered species. A web-based visualization tool displaying scenarios in map format will aid local planners with zoning decisions related to protection of ecosystem services on rangeland. Federal and state agencies will be able to design more effective conservation plans that are robust to climate change and land use change impacts. Water districts will be able to assess future impacts to water supply and plan actions such as land acquisition and outreach to landowners in order to maximize watershed function.

CA LCC Criteria Addressed:

1) Applicability to conservation and adaptation decisions. Partners within the CRCC are seeking guidance on how future threats of climate change and land use change may impact the viability of a ranching landscape within the Central Valley and surrounding foothills. Especially with reduced support from the Williamson Act due to state budget cuts, landowners are seeking additional incentives for maintaining ranching operations. Identification of the benefits of rangelands, such as wildlife habitat, water supply and carbon sequestration, will provide further justification for their conservation. Overall results from this project will help the CRCC raise awareness of the importance of private rangelands in the provision of ecosystem services, and will increase the efficiency of conservation efforts.

2) Ecological or ecosystem responses to climate change. Results will show the magnitude and location of climate- and development-driven threats to habitats within rangelands under alternative scenarios. By integrating projections of land use change with hydrologic data on climatic water deficit, runoff and recharge, we will model potential shifts in major vegetation types and water availability on rangelands, both key components of wildlife habitat.

3) Breadth of understanding. This project integrates socioeconomic, climate and hydrologic data to assess changes to wildlife habitat, water availability, and carbon sequestration on rangeland.

4) Accessibility. We will develop a web-based visualization tool and an outreach campaign to provide managers access to data and results. Our data will also be made available via the proposed Climate Adaptation Commons website.

5) Scope/transferability. Rangelands threatened by future development and climate change dominate the

western U.S and so issues addressed in this project are applicable elsewhere. The national LandCarbon scenario methodology can be applied to other LCCs. In other LCCs downscaled climate data produced by the National Climate Change and Wildlife Science Center will be available to integrate with LandCarbon land use change scenario data.

6) Partnership/leveraging. This is a multi-partner project that includes geographers, biologists, hydrologists, and economists. It builds a new collaboration between the USGS and Defenders of Wildlife, and has secured in-kind support in the amount of $226,374.

7) Timeliness and urgency. Grassland and shrub land in the Central Valley decreased by 2000 km^2 over 27 years and is expected to decline significantly in the future. Information is needed now to plan for climate and land use change at the eco-region scale.

Approach and Scope of Work

Background and project objectives: There are over 11 million acres of grasslands in the Central Valley and the interior Coast Range, most of which are privately owned and managed as rangelands for livestock production. These ranches provide some of the best habitats for freshwater fish, wintering birds and waterfowl, invertebrates and mammals, including 75 species listed as threatened or endangered under the Endangered Species Act (Jantz et al. 2007). In addition to biodiversity conservation, ranches generate multiple ecosystem services, defined as human benefits provided by natural ecosystems, that carry considerable economic value, including livestock production, drinking and irrigation water, and carbon sequestration (Maczko and Hidinger 2008). Quantifying ecosystem services on ranches is critical to biodiversity conservation, because economic incentives for maintaining these services will benefit co-located threatened or endangered species. Grasslands are located in some of the state's fastest-growing counties and are under severe threat from conversion and development. California lost 105,000 acres of grazing lands to urbanization between 1990 and 2004 and it could lose 750,000 acres more by 2040 (Kroeger et al. 2010). In addition climate change further stresses grasslands by potentially altering water availability (Grantham et al. 2010) and distribution of species (Crimmins et al. 2011). Maintaining a ranching landscape holds great potential for biodiversity conservation in the California LCC region, as these privately-owned rangelands are the last remnants of open space providing corridors for wildlife to migrate and adapt to climate change. Ranchers, managers, conservationists and decision makers need science-based tools to maximize the provision of ecosystem services, which includes maintenance of biodiversity, from rangelands in light of integrated climate change/land cover change threats.

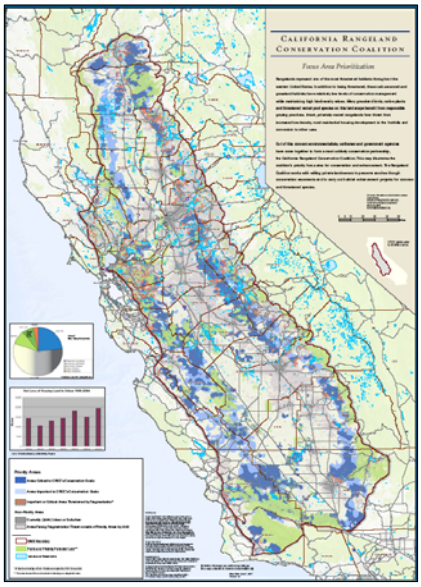
To help managers make effective decisions at the local level, we will develop scenarios in map format to prioritize conservation areas that maximize three critical ecosystem services: 1) provision of wildlife habitat to support biodiversity; 2) provision of fresh water supplies; and 3) sequestration of carbon. Climate scenarios derived from greenhouse gas emission storylines first need to be matched with logically consistent land use/land cover maps to form the basis for integrated assessments and long-term policies (Bierwagen et al. 2010). To do this, we propose to merge two significant USGS research efforts – the national LandCarbon land use change scenarios and California downscaled climate data – to assess future integrated threats to California rangelands. Both these efforts were developed under consistent storylines of the Intergovernmental Panel on Climate Change (IPCC) Special Report on Emission Scenarios (SRES). Our spatially-explicit scenarios will be developed for three IPCC scenarios (A2, B1, and A1B) and will have consistent spatial resolution (270 meters), spatial extent (EPA Level III Central Valley and Chaparral and Oak Woodland eco-regions) and time frame (year 2000 – 2100). The spatial extent will also match the high priority conservation focus area map in use by the California Rangeland Conservation Coalition (Figure 1).

Development of land use change scenarios: The USGS LandCarbon Project is a national assessment of ecosystem carbon stocks, carbon sequestration, and greenhouse-gas fluxes under present conditions and future scenarios. To assess future carbon sequestration potential, the LandCarbon team has developed multiple national land use change scenarios based on IPCC SRES greenhouse gas emission scenarios (Nakicenovic et al. 2000). To develop land use change scenarios that are logically consistent with greenhouse gas emission scenarios, the LandCarbon team used the Integrated Model to Assess the Global Environment (IMAGE) (Strengers et al., 2004), which translates the SRES storylines, greenhouse gas emission and population projections, into changes in land cover, including forest, agriculture, grassland and developed land. The IMAGE model generates demand, or the area of land required for each land cover class, in 5 year intervals from 1975-2100 on a national scale. National estimates are converted into regional estimates for Level III eco-regions (including the Central Valley and

Chaparral and Oak Woodland) based on USGS Land Cover Trends data on land cover change from 1973 to 2000 (Loveland et al. 2002), as well as expert knowledge. Land Cover Trends data for 2010 will be used to validate this scenario-generation effort. After the IMAGE model has generated the demand, the USGS uses a probabilistic growth model, FORE-SCE, (FORecasting SCEnarios of future land cover) to model the distribution of each land cover type across a landscape (Sohl and Sayler, 2008). We plan to further downscale land use change scenarios for the Central Valley and Chaparral and Oak Woodland eco-regions that correspond with SRES storylines A2, B1, and A1B, as downscaled climate data consistent with these scenarios are presently available. These scenarios are described in Stengers et al. (2004) as:

- A2: higher population growth, regional economic growth, dispersed development patterns, and greater deforestation
- B1: lower population growth, reduced greenhouse gas emissions, and economic changes toward a service and information economy
- A1B: rapid economic growth, increasing population that peaks in mid-century then declines, and rapid introduction of new and more efficient technologies.

As part of this California LCC project, we will downscale the LandCarbon-derived "Developed" class into multiple development classes representing different densities of residential and commercial land use, including exurban development using county-level zoning, demographic and economic data. The distribution of these development classes will be modeled in FORE-SCE for the time horizon of years 2000 – 2100 at a scale of 270 meters. Probability of occurrence for each development class will be determined from data and from workshops with land owners and resource managers to identify regions where development is most likely. Model results will be validated with 2010 Land Cover Trends data and comparison with other growth modeling efforts throughout California. We will distinguish high density development from low density housing, or exurban development, because exurban growth is expanding rapidly and is a threat to rangelands (Theobald 2005).



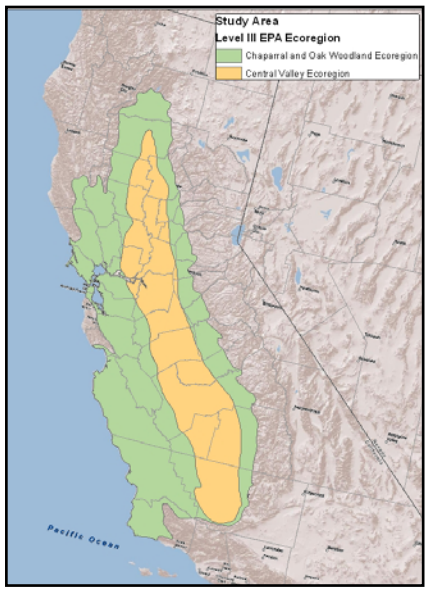


Figure 1. On the left is the California Rangeland Conservation Coalition (CRCC) Focus Area Map that identifies high priority conservation areas. The map on the right displays the boundaries of the EPA Level III eco-regions: Central Valley and Chaparral and Oak Woodland, which cover essentially all of the CRCC focus area. We will develop integrated climate change/land use change scenarios for these eco-regions for IPCC greenhouse gas emission scenarios A2, B1, and AB1 to assess future threats to wildlife habitat, water availability and carbon sequestration in high priority conservation areas.

Integrating land use change data with downscaled climate data: An ensemble of 23 statistically downscaled global climate models for three emissions scenarios, A2, B1, and A1B, will be analyzed to provide representative future climate projections for California. These representative projections will be downscaled to 270 meter spatial resolution for monthly estimates of precipitation, maximum and minimum air temperature for application to the Basin Characterization Model (BCM), a regional water balance model. The BCM relies on a rigorous calculation of potential evapotranspiration using solar radiation and topographic shading to provide the energy forcings to calculate changes in snowpack, snowmelt, soil moisture, climatic water deficit, recharge, and runoff for all 270 meter grid cells.

Consequences for wildlife habitat: High priority conservation areas are identified in the California Rangeland Conservation Coalition Focus Area Map (Figure 1). High priority areas represent sites with high biodiversity and high present-day development threat. The integrated climate change/land use change model results will be

overlaid with the map of high priority conservation areas to determine which high priority regions are at greater risk from development, land conversion, and climate change within each scenario. This future threat information can be used for long-term planning of wildlife corridors and to identify shifting conservation priorities with time. A subset of high priority conservation areas identified through this threat analysis will be selected for additional analysis of change to two major ecosystem services: water availability and carbon sequestration.

Consequences for water availability: For each integrated climate change/land use change scenario, water availability will be established for conservation priority areas in watersheds on the basis of recharge and runoff calculated in the BCM. For a given scenario and time period, modeled development patterns in a watershed will be used to modify runoff and recharge calculations to establish changes in water availability on the basis of changes in land use. Conversion of grazing land to agriculture is expected to occur over large areas also; however modeling change in water availability due to agricultural conversion is far more complex than modeling change due to urbanization, and will be beyond the scope of this one-year project. Currently the CRCC identifies priority conservation areas based on high biodiversity and threat from development. Therefore we will limit our modeling of water availability to watersheds where urbanization is the primary land use change.

Consequences for carbon sequestration: For each integrated climate change/land use change scenario, we will estimate changes in potential carbon sequestration within high priority conservation areas. First, we will use climatic water deficit to model a bioclimatic distribution for major vegetation types, including grassland, shrubland, and forest. Climatic water deficit (CWD) is calculated in the BCM as potential evapotranspiration minus actual evapotranspiration, which is a function of change in soil moisture storage, and represents an annual stress index that correlates with the distribution of vegetation across the landscape. This variable will be used to define distinct bioclimatic distributions for major vegetation types within the Central Valley and Chaparral Oak Woodlands eco-regions on the basis of current climatic conditions and will be calculated for future climatic conditions to project potential changes in vegetation types.

Second, through the LandCarbon project, land use change projections based on selected IPCC scenarios will be integrated with a biogeochemical model to identify how land change will influence carbon storage capacity. Biogeochemical modeling will be conducted using the General Ensemble Modeling System (GEMS), which was developed by the USGS to provide spatially explicit biogeochemical simulations over large areas (Liu et al. 2004). The modeled bioclimatic distributions of vegetation types combined with modeled land use data will serve as input to the GEMS model in order to develop carbon sequestration estimates for high priority conservation areas across all scenarios.

Analysis of potential economic impacts on California rangelands: Employing the results of the various climate change/land use change scenarios, a preliminary economic impact (cost and benefits) analysis will consist of three stages. Stage one will focus on the *identification* of the types of ecosystem services that will be impacted by climate change/land use change, and their overall economic importance. These services will be aligned with three outcomes addressed by identifying which climate change/land use change scenarios optimize, in bio-physical terms, the supporting services related to biodiversity conservation, water availability, and carbon sequestration.

Stage two activities will be centered on reporting, *based on secondary published materials*, what the provisional magnitudes of the economic costs and benefits of each climate change/land use scenario will entail. For example, the combined effects of a dryer climate and increased ex-urban development may decrease the amount of forage and water available for livestock production, thereby increasing the costs of production and forcing some abandonment of rangeland, with negative impacts on biodiversity conservation. We will be able to identify some of the tradeoffs of prioritizing one ecosystem service (carbon sequestration vs. biodiversity conservation) over another. As part of Stage two, we will review the suitability of various economic impact models (InVest, Habitat Benefits Toolbox, etc.) that could be employed to provide more precise measures of economic impacts of the scenarios produced.

Stage three of the economic analysis will consist of a discussion of the economic incentive mechanisms and policies that could be adopted and applied to maintain the viability and increase the effectiveness of rangelands within the CA LCC to conserve and enhance at risk habitats and species. The potential of both market (e.g. payment for ecosystem services) and non-market incentive mechanisms (institutional change) will be explored. The cumulative input from Stages one through three will be an analysis of the economic dimensions of climate change impacts on wildlife habitat for land managers, policy makers, conservation organizations and landowners to consider in making land use decisions.

Development of a web-based visualization tool: In order to provide an opportunity for users to view model results and compare scenarios, a Google-maps web application will be designed based on the format of the USGS Puget Sound Ecosystem Portfolio Model website (http://geography.wr.usgs.gov/pugetSound/index.html). WebGIS applications are practical tools for an audience to view and compare spatial data without the need for specialized GIS software. This website will be designed for planners, land owners and resource managers working in the CRCC focus area, and will allow users to compare and contrast results at the data point scale or the regional scale across three scenarios simultaneously. The web application will provide maps that identify potential consequences to three rangeland ecosystem services for each scenario, and where these services could be maximized. In addition, our data will be standardized and made available via the proposed Climate Adaptation Commons, which will provide a venue for sharing data with the public via the web.

Outreach campaign: An education and outreach campaign will be implemented by Defenders of Wildlife to help stakeholders integrate results into land management decisions. A series of workshops and meetings will be held to help managers and decision-makers use the information generated by the project and discuss other potential applications of the knowledge gained. Target audience will include the California Rangeland Conservation Coalition network of more than 100 partner organizations that include land owners, land managers from state, federal and local agencies, researchers and conservation organizations among others. The Coalition carries out an extensive outreach campaign that includes an Annual Summit, a series of field trips, presentations a website and a bi-monthly electronic newsletter. All these existing tools will be used to ensure wide dissemination of results. Individual organizations will be encouraged to contribute to the dissemination of results to the many ranchers, land managers and decision makers who would benefit from this project.

Products/Data Sharing: This project will result in the following products and deliverables. These data and products will be distributed to the CRCC network of more than 100 partner organizations via an outreach campaign organized by the Defenders of Wildlife. Data will also be available via a USGS WebGIS website and the proposed Climate Adaptation Commons website. Products and timeline are: **1) February 2012**: Integrated climate change/land use change modeling results for IPCC greenhouse gas emission scenarios A2, B1, A1B; **2) February 2012**: Selection of key CRCC high priority conservation areas for detailed ecosystem services analysis; **3) May 2012**: Modeling of changes in water availability (stream flow, recharge) due to urbanization in high priority conservation areas for each scenario; **4) May 2012**: Modeling of carbon sequestration potential in high priority conservation areas for each scenario; **5) June 2012**: Analysis of ecosystem services (water, carbon, and habitat) tradeoffs and economic impacts for each scenario; **6) August 2012**: Development of WebGIS products; **7) Ongoing**: Outreach campaign involving workshops, meetings, etc., with California Rangeland Conservation Coalition members, public and private resource managers, and land owners to disseminate project results and provide assistance in integrating results into land management.

Measuring Results: This project will produce two types of data: maps displaying potential changes in rangeland ecosystem services, and economic impact data. Maps of climate change/land use change will be generated by IPCC scenario and decade out to 2100 and will be accessible via a web-based visualization tool and the proposed Climate Adaptations Commons website. The web tool will also provide maps that identify potential consequences to three rangeland ecosystem services for each scenario. These maps will help Federal and state agencies develop conservation plans robust to future climate change and land use change threats, and will help local planners identify areas where zoning decisions could assist protection of ecosystem services.

The economic analysis will generate material that will assist policy makers and ranchers set priorities for conservation actions. Economic impact data for the various climate change/land use scenarios will be available for outreach efforts to agency personnel, conservation organization and ranch land owners. Recommendations related to the private landowner participation in conserving biodiversity in the light of climate change will be provided to inform policy makers and natural resource management agencies of the types of incentives mechanisms that may be the most effective.

The Defenders of Wildlife will distribute this information and data through an outreach campaign directed the California Rangeland Conservation Coalition network of more than 100 partner organizations that include land owners, land managers from state, federal and local agencies, researchers and conservation organizations. Outreach programs will be designed to help stakeholders integrate results into land planning and management decisions.

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Theobald, D.M. 2005. Landscape patterns of exurban growth in the USA from 1980 to 2020. Ecology and Society 10(1).

Project Title: Integrating Science into Decisions: Climate Change/Land Use Change Scenarios and Outreach for Habitat Threat Assessments on California Rangelands

Contact: Kristin Byrd, USGS Western Geographic Science Center, kbyrd@usgs.gov, 650-329-4279

California Landscape Conservation Cooperative 2012 Proposal Budgets

Product: Development of Land Use Change Model Results
USGS Western Geographic Science Center

Budget Categories	CA LCC Request	Partner(s) Contribution(s) (monetary)	Partner(s) Contribution(s) (non-monetary value/in-kind)	**Total**
Salaries	$ 45,478.64	$ -	$ 51,360.00	$ 96,838.64
Supplies	$ -	$ -	$ -	$ -
Overhead	$ 22,284.53	$ -	$ -	$ 22,284.53
Equipment	$ -	$ -	$ -	$ -
Other (specify)	$ -	$ -	$ -	$ -
Sub-Total	$ 67,763.17	$ -	$ 51,360.00	$ 119,123.17

Product: Integration of Land Use Change Model Results with Downscaled Climate Data
USGS California Water Science Center

Budget Categories	CA LCC Request	Partner(s) Contribution(s) (monetary)	Partner(s) Contribution(s) (non-monetary value/in-kind)	**Total**
Salaries	$ 8,500.00	$ -	$ 123,000.00	$ 131,500.00
Supplies	$ -	$ -	$ -	$ -
Overhead	$ 4,165.00	$ -	$ -	$ 4,165.00
Equipment	$ -	$ -	$ -	$ -
Other (specify)	$ -	$ -	$ -	$ -
Sub-Total	$ 12,665.00	$ -	$ 123,000.00	$ 135,665.00

Product: Economic Impacts of Integrated ClimateChange /Land Use Change Scenarios
USGS Center for Science, Decisions and Resource Management

Budget Categories	CA LCC Request	Partner(s) Contribution(s) (monetary)	Partner(s) Contribution(s) (non-monetary value/in-kind)	**Total**
Salaries	$ 8,100.00	$ -	$ 25,678.00	$ 33,778.00
Supplies	$ -	$ -	$ -	$ -
Overhead	$ 1,900.00	$ -	$ -	$ 1,900.00
Equipment	$ -	$ -	$ -	$ -
Other (specify)	$ -	$ -	$ 1,336.00	$ 1,336.00
Sub-Total	$ 10,000.00	$ -	$ 27,014.00	$ 37,014.00

Product: Outreach Campaign
Defenders of Wildlife

Budget Categories	CA LCC Request	Partner(s) Contribution(s) (monetary)	Partner(s) Contribution(s) (non-monetary value/in-kind)	**Total**
Salaries	$ 7,000.00	$ -	$ 25,000.00	$ 32,000.00
Supplies		$ -	$ -	$ -
Overhead	$ 1,200.00	$ -	$ -	$ 1,200.00
Equipment	$ -	$ -	$ -	$ -
Other (specify)	$ 3,000.00	$ -	$ -	$ 3,000.00
Sub-Total	$ 11,200.00	$ -	$ 25,000.00	$ 36,200.00

Total Budget for FY 2012

Budget Categories	CA LCC Request	Partner(s) Contribution(s) (monetary)	Partner(s) Contribution(s) (non-monetary value/in-kind)	**Total**
Salaries	$ 69,078.64	$ -	$ 225,038.00	$ 294,116.64
Supplies		$ -	$ -	$ -
Overhead	$ 29,549.53	$ -	$ -	$ 29,549.53
Equipment	$ -	$ -	$ -	$ -
Other (specify)	$ 3,000.00	$ -	$ 1,336.00	$ 4,336.00
Total	$ 101,628.17	$ -	$ 226,374.00	$ 328,002.17

Other:

Other Budget Categories:
USGS Center for Science, Decisions and Resource Management: $1336 in-kind for travel
Defenders of Wildlife: $3000 for workshops

Description of in-kind services:
USGS Western Geographic Science Center:
$51,360: Calculation of land use demands for each scenario
USGS California Water Science Center
$25,000: Downscaling climate projections and model development
$60,000: Historical climate and hydrologic analyses
$38,000: Future ensemble projections of climate and hydrology
USGS Center for Science, Decisions and Resource Management
$1336: Travel
$25,678: Salary
Defenders of Wildlife
$25,000: NRCS-Cooperative Agreement California Rangeland Coalition

EDMUND G. BROWN Jr., Governor
NATURAL RESOURCES AGENCY
DEPARTMENT OF FISH AND GAME
WILDLIFE CONSERVATION BOARD
1807 13th Street, Suite 103
Sacramento, California 95811-7137
www.wcb.ca.gov
(916) 445-8448
Fax (916) 323-0280

April 8, 2011

Ms. Rebecca Fris, Research Coordinator
California Landscape Conservation Cooperative
Suite 2007, Modoc Hall
3020 State University Drive East
Sacramento, California 95819

Dear Ms. Fris:

I am writing this letter in support of the request for funding from the USGS Western Geographic Science Center and Defenders of Wildlife. Completion of the research proposal titled *Integrating Science into Decisions: Land Use Scenarios and Outreach for Habitat Threat Assessments on Central Valley Ranch Land* will provide a vital tool for the management and preservation of important rangeland and oak woodland habitat in California.

The Wildlife Conservation Board (WCB) has a long history of working with the USGS, Defenders of Wildlife and the California Rangeland Conservation Coalition. The WCB is dedicated to the protection of natural resources. These organizations have played an important role as partners implementing projects designed to integrate working landscapes and the habitat needs of numerous fish and wildlife species. The research products proposed in this request will facilitate our efforts to preserve these critical landscapes and help address potential threats due to climate change impacts.

As science continues to evolve and help explain climate change impacts to our natural resources, it is even more critical this information is provided to the stewards of our working landscapes. Working with the California Rangeland Conservation Coalition will further ensure quality information is made available to landowners who have for generations provided the quality stewardship and management of our working landscapes.

In closing, I encourage your support of this request and thank you in advance for your consideration.

Sincerely,

John P. Donnelly
Executive Director

The Nature Conservancy
Protecting nature. Preserving life.™

Sacramento Field Office
2015 J Street, Suite 103
Sacramento, California 95811

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nature.org/california

April 11, 2011

Rebecca Fris, Research Coordinator
California Landscape Conservation Cooperative
Suite 2007, Modoc Hall
3020 State University Drive East
Sacramento, CA 95819

RE: Support for funding "Integrating Science into Decisions: Land Use Scenarios and Outreach for Habitat Threat Assessments on Central Valley Ranch Land" proposal

Dear Ms. Fris:

The Nature Conservancy applauds the proposal put forth by the U.S. Geological Survey Western Geographic Science Center and Defenders of Wildlife, "Integrating Science into Decisions: Land Use Scenarios and Outreach for Habitat Threat Assessments on Central Valley Ranch Land" (proposal), and supports funding for the project.

The Conservancy is a global, non-profit organization dedicated to the conservation of biodiversity. We seek to achieve our mission through science-based planning and implementation of conservation strategies that provide for the needs of people and nature. We believe the proposal will be an important step in increasing our knowledge base and will complement existing work that has been done to help preserve ecologically valuable rangelands in California's Central Valley.

Please do not hesitate to contact me should you have any questions regarding our support for the proposal. I can be reached at (916) 449-2850, ext. 4124.

Sincerely,

Pablo Garza
Associate Director, State Policy & External Affairs
The Nature Conservancy

cc: Pelayo Alvarez, Defenders of Wildlife

CALIFORNIA
RANGELAND
Trust

April 11, 2011

Ms. Rebecca Fris, Research Coordinator
California Landscape Conservation Cooperative
Suite 2007, Modoc Hall
3020 State University Drive East
Sacramento, CA 95819

Dear Ms. Fris:

We write in support of the proposal entitled, "Integrating Science into Decisions: Land Use Scenarios and Outreach for Habitat Threat Assessments on Central Valley Ranch Land" submitted by Dr. Kristyn Byrd from the United States Geological Survey to the California Landscape Conservation Cooperative. This proposal is in response to the CLLC's 2011 Request for Applications.

The California Rangeland Trust works to conserve the open space, natural habitat and stewardship of California's ranches. We currently have forever protected over 230,000 acres of California's working ranchlands. Rangelands in the Central Valley of California provide a multitude of ecosystem services including watershed health, wildlife habitat and climate change mitigation. Measuring the impacts of climate and land use changes on ecosystem services in the Central Valley is essential in the development of cost-effective programs that protect lands from conversion and help management decisions in the face of climate change.

In addition, science-based data will help us prioritize our investments in conservation to ensure an efficient use of resources. We are confident that this team has the expertise to carry out the research described in the proposal and the outreach needed to share the results of this project with a broad group of stakeholders.

Thank you for your strong consideration of the Byrd proposal. Should you have any questions or if we can provide any further information, please feel free to contact me.

Sincerely,

Michael M. Delbar
Chief Operating Officer

1225 H Street Sacramento, California 95814 Telephone 916.444.2096 Facsimile 916.329.3488 www.rangelandtrust.org

KRISTIN B. BYRD

U.S. Geological Survey, 345 Middlefield Road, MS-531, Menlo Park, CA 94025
Email: kbyrd@usgs.gov; Phone: 650-329-4279

EDUCATION

PhD **University of California, Berkeley**, 2005, Environmental Science, Policy, and Management (ESPM)
Maggi Kelly (chair), Adina Merenlender, Alex Horne, dissertation committee

MA **San Francisco State University**, 1998, Ecology and Systematics

BS **Cornell University, College of Agriculture and Life Sciences**, 1993, Environmental Science

PROFESSIONAL EXPERIENCE

Physical Scientist, U.S. Geological Survey — *Feb. 2009 – Present*
Western Geographic Science Center, Menlo Park, CA

GIS Coordinator, California Academy of Sciences, San Francisco, CA — *Jan. 2007 – Dec. 2008*

Post–Doctoral Researcher, ESPM Department, U.C. Berkeley, Berkeley, CA — *Jan. 2006 – Dec. 2006*
P.I. Adina Merenlender, in partnership with The Nature Conservancy

Wetlands Bio-Technician, Point Reyes National Seashore, CA (summer position) — *May 2001 – Sept. 2001*

Senior Staff Biologist, URS Corporation, Oakland, CA — *April 1998 – March 2001*

Fellow, United Nations Economic Commission for Africa (UNECA) — *Oct. 1994 – July 1995*
Natural Resources Division, Addis Ababa, Ethiopia

Natural Resources Interpreter, Yosemite National Park, CA (internship) — *June 1994 – Sept. 1994*

Environmental Analyst, Energetics, Inc., Columbia, MD — *June 1993 – June 1994*

PUBLICATIONS

Byrd, K. B., A. R. Rissman, and A. M. Merenlender. 2009. Impacts of conservation easements for threat abatement and fire management in a rural oak woodland landscape. *Landscape and Urban Planning* 92:106-116.

Byrd, K. B. 2009. Remote sensing and spatial analysis of watershed and estuarine processes for conservation planning in Elkhorn Slough, Monterey County, California, pp. 495-520 *In* X. Yang (ed.). *Remote Sensing and Geospatial Technologies for Coastal Ecosystem Assessment and Management*. Springer-Verlag Berlin Heidelberg.

Byrd, K. B., N. M. Kelly and A. M. Merenlender. 2007. Temporal and spatial relationships between watershed land use and salt marsh disturbance in a Pacific estuary. *Environmental Management* 39(1):98-112.

Byrd, K. B. and N. M. Kelly. 2006. Salt marsh vegetation response to edaphic and topographical changes from upland sedimentation in a Pacific estuary. *Wetlands* 26(3):813-829.

Byrd, K. B., N. M. Kelly, and E. Van Dyke. 2004. Decadal changes in a Pacific estuary: a multi-source remote sensing approach for historical ecology. *GIScience and Remote Sensing* 41(4):347-370.

Byrd, K. B., V. T. Parker, D. R. Vogler, and K. W. Cullings. 2000. The influence of clear-cutting on ectomycorrhizal fungus diversity in a lodgepole pine (*Pinus contorta*) stand, Yellowstone National Park, Wyoming, and Gallatin National Forest, Montana. *Canadian Journal of Botany* 78(2):149-156.

AWARDS, GRANTS AND FELLOWSHIPS

- NASA New Investigator Award in Earth Sciences; $265,788 — 2010
  Advanced Remote Sensing to Quantify Temperate Peatland Capacity for Belowground Carbon Capture
- Estuarine Conservation Research Award — 2004
  Elkhorn Slough National Estuarine Research Reserve and the Elkhorn Slough Foundation
- U.C. Center for Water Resources Grant, with P.I. N. Maggi Kelly — 2002 – 2004
  Linking upland landcover change with wetland structure in Elkhorn Slough, CA; $56,000
- U.C. Marine Council Coastal Environmental Quality Graduate Fellowship — 2002
  Agriculture in the watershed and its impact on the structure of salt marshes in Elkhorn Slough – use of remote sensing for historical change detection; $25,000
- U.C. Marine Council Coastal Environmental Quality Graduate Research Support — 2002 – 2003
  Agriculture in the watershed and its impact on the structure of salt marshes in Elkhorn Slough – use of remote sensing for historical change detection; $17,500
- ESPM Departmental Fellowship, U.C. Berkeley — 2000 – 2001
- U.S. Dept. of Education Graduate Assistance in Areas of National Need Fellowship — 1995 – 1997
  Support for M.A. at San Francisco State University

Christopher E. Soulard
(650) 329-4317
csoulard@usgs.gov

U.S. Geological Survey
Western Geographic Science Center
Pacific Geographic Science Team
345 Middlefield Road, MS-531
Menlo Park, CA 94025

Education:

M.A., Geography, San Jose State University, 2005; B.A., Geography, University of California, Santa Barbara, CA, 2003; B.A., Environmental Studies, University of California, Santa Barbara, CA, 2003

Experience/Research Areas:

Employed as a physical scientist with the USGS since 2002. Research has focused on multi-temporal change analysis in the Western United States using Landsat imagery and aerial photography. Extensive knowledge of ENVI, ERDAS Imagine, and ESRI software platforms.

Selected Publications:

Sleeter, B.M., Wilson, T.S., Soulard, C.E., and Liu, J., 2010, Estimation of Late Twentieth Century Land-Cover Change in California, Environmental Management and Assessment DOI 10.1007/s10661-010-1385-8.

Wood, N., and Soulard, C., 2009, Variations in population exposure and sensitivity to lahar hazards from Mount Rainier, Washington, Journal of Volcanology and Geothermal Research 188, 367–378.

Soulard, Christopher E., and Raumann, Christian G., 2008, Historical orthoimagery of the Lake Tahoe Basin: U.S. Geological Survey Data Series 376 [http://pubs.usgs.gov/ds/376/].

Coons, Tom, Soulard, Christopher E., and Knowles, Noah, 2008, High-resolution digital terrain models of the Sacramento/San Joaquin Delta Region, California: U.S. Geological Survey, Data Series 359 [http://pubs.usgs.gov/ds/359/].

Soulard, Christopher E., Raumann, Christian G., and Wilson, Tamara S., 2007, Land-cover trends of the Southern California Mountains ecoregion: U.S. Geological Survey Scientific Investigations Report 2007-5235 [http://pubs.usgs.gov/sir/2007/5235/].

Raumann, Christian G., and Soulard, Christopher E., 2007, Land-cover trends of the Sierra Nevada Ecoregion, 1973-2000: U.S. Geological Survey Scientific Investigations Report 2007-5011 [http://pubs.usgs.gov/sir/2007/5011/].

Soulard, Christopher E., 2006, Land-cover trends of the Central Basin and Range ecoregion: U.S. Geological Survey Scientific Investigations Report 2006-5288 [http://pubs.usgs.gov/sir/2006/5288/].

Peterson, David, Smith, Richard, Stewart, Iris, Knowles, Noah, Soulard, Chris, and Hager, Stephen, 2005, Snowmelt discharge characteristics Sierra Nevada, California: U.S. Geological Survey Scientific Investigations Report 2005-5056 [http://pubs.usgs.gov/sir/2005/5056/]

Selected Presentations:

Forney, William M., Soulard, Christopher E., and Chickadel, Christopher (2011) Multi-Scaled Modeling of Shade Provided to Lower Klamath River Basin by Vegetation and Geomorphology. Poster presentation at the USGS Pacific Northwest Science Conference.

Soulard, Christopher E., Esque, Todd, Bedford, David, and Bond, Sandra (2010). Fire in the Mojave Desert: The role of microtopography on floral reestablishment following fire. Poster presentation at the American Geophysical Union Fall Meeting.

Soulard, Christopher E. and Sleeter, Benjamin M. (2010). Land Cover Trends: Carbon Storage in the Basin-and-Range Ecoregions. Poster presentation at the Workshop on Natural Resource Needs Related to Climate Change in the Great Basin and Mojave Desert: Research, Adaptation, Mitigation.

Soulard, Christopher E. (2010). Remote Sensing Classification Methods and the USGS Land Cover Trends Project, guest lecture at San Jose State University (Geography 182).

Soulard, Christopher E. (2009). Land-cover trends in the forested ecoregions of California: Sierra Nevada and Southern California Mountains. Poster Presentation at the Association of American Geographers Annual Meeting.

LORRAINE E. FLINT
U.S. Geological Survey, California Water Science Center, Sacramento, CA 95819-6129; Phone (916) 278-3223, email: lflint@usgs.gov

Education: PhD 2002, Oregon State University (Soil Physics), MS 1985, Oregon State University (Forest Soils), BS 1979, Humboldt State University (Wildlife Biology)

Positions: 2001-present: Research Hydrologist, U.S. Geological Survey, California Water Science Center, Sacramento, CA.; 1986-2001: Hydrologist, Project Chief, Yucca Mountain Project, Matrix-Hydrologic Properties; 1982-1985: Research Assistant, Dept. of Soil Science, Oregon State University

Scientific Presentations: Authored/coauthored over 100 national and international presentations, including about 15 in the last 2 years on downscaling climate change scenarios to fine-scale spatial resolution and using them in regional hydrologic models for analyses on historical and future environmental and ecological conditions.

Publications: Published over 65 peer-reviewed journal articles, book chapters, and USGS reports.

Research Direction: Current research involves downscaling future climate projections to ecologically relevant scales (1-km to 30-m) and using that as input to a regional scale hydrologic model with the same scale output. The research provides precipitation, min and max air temperature, soil moisture, potential and actual evapotranspiration, solar radiation, climatic water deficit, snow accumulation, snow melt, sublimation, recharge, and runoff. Projects are being conducted throughout the western US for analyses of water availability, flow and transport, snowmelt processes, and ecosystem change, with particular attention to the California, the Sierra Nevada, and the SF Bay Area.

Relevant Publications:

Flint, L.E. and Flint, A.L., Downscaling climate change scenarios for ecologic applications: USGS approved, in journal review.

Flint, A.L., Flint, L.E., Curtis, J.A., and Buesch, D.C., 2010, A Preliminary Water Balance Model for the Tigris and Euphrates River System: USGS Open-File Report.

Flint, L.E., and Flint, A.L., 2008, Regional analysis of ground-water recharge, in Stonestrom, D.A., Constantz, J., Ferré, T.P.A., and Leake, S.A., eds., Ground-water recharge in the arid and semiarid southwestern United States: US Geological Survey Professional Paper 1703, p. 29-59.

Flint, L.E and Flint, A.L., 2008, A basin-scale approach to estimating stream temperatures of tributaries to the Lower Klamath River, California, J. of Environmental Quality 37:57-68.

Flint, A.L. and Flint, L.E., 2008, Modeling soil moisture processes and recharge under a melting snowpack: 7:350-357 Vadose Zone J.

Flint, A.L., and Flint, L.E., 2007, Application of the basin characterization model to estimate in-place recharge and runoff potential in the Basin and Range carbonate-rock aquifer system, White Pine County, Nevada, and adjacent areas in Nevada and Utah: USGS SIR 2007-5099, 20 p.

Flint, A.L., Flint, L.E., Hevesi, J.A., and Blainey, J.M., 2004, Fundamental concepts of recharge in the Desert Southwest: a regional modeling perspective, in *Groundwater Recharge in a Desert Environment: The Southwestern United States,* edited by J.F. Hogan, F.M. Phillips, and B.R. Scanlon, Water Science and Applications Series, vol. 9, AGU, Washington, D.C., 159-184.

Curriculum Vitae

Frank Casey, Ph.D.

2010-Present: United States Geological Survey, Ecosystem Services Theme Lead, Science and Decisions Center. Responsibilities include incorporation of ecosystem services and their valuation (including market mechanisms) in adaptive management research and planning for resource conservation on both public and private lands using a structured decision making approach. Dr. Casey has initiated a bi-monthly seminar series on economic valuation of ecosystem services, participates in several in-house and external steering committees, and is active in developing a role for the SDC in applying ecosystem services concepts and valuation in the context of the Landscape Conservation Cooperatives.

1999- 2010: Senior Director, Conservation Economics and Finance Program, Defenders of Wildlife. Responsibilities included (1) development and implementation a comprehensive system of public and private land owner economic incentives at the federal and state level for wildlife habitat and biodiversity conservation. This included developing a sub-program in the estimation of ecosystem service benefits and the application of ecosystem service markets to wildlife habitat and other resources; (2) policy assistance to the wildlife community, Congress, and relevant government agencies in selecting and implementing economic incentives for the conservation and protection of wildlife habitat and biodiversity; (3) leading an internal Defenders of Wildlife working group to review, analyze, develop and promote specific changes to the conservation title of Farm Bill legislation for biodiversity conservation; (4) economic conceptualization and program implementation for (a) a national performance-based resource conservation incentive program, and (b) full cost-benefit valuation of natural lands and habitat for at risk species, including ecosystem services. Dr. Casey was the founding director of the Conservation Economics and Finance Program.

Dr. Casey is an agricultural and natural resources economist whose areas of expertise include financial and institutional incentive mechanisms for resource conservation, developing economic policy alternatives for habitat conservation by private landowners, including ecosystem service payments and markets, the economics of wildlife habitat and biodiversity conservation, soil fertility, and water allocation, the economics of regulation and technology adoption, and natural resource conflict resolution. He is lead editor for a book entitled, *Flexible Incentives for the Adoption of Environmental Technologies and Agriculture* and authored a recent a report entitled *Incentives for Biodiversity Conservation: An Ecological and Economic Assessment.* One of Dr. Casey's most recent publications in the area of ecosystem services as co-author is an article "An assessment of market-based approaches to providing ecosystem services on agricultural lands", published in *Ecological Economics* (December 15, 2007). He has a PhD in Food and Resource Economics from the University of Florida and an MS in Agricultural Economics from Cornell University.

PELAYO ALVAREZ
Conservation Program Director
California Rangeland Conservation Coalition
Defender of Wildlife
1303 J St. Suite 270
Sacramento CA 95814.
Phone: 916-313-5800
E-mail: palvarez@defenders.org

Education

Ph.D. Ecology, (Agroecology) UC Davis, June 2008.
M.S. Animal Science, Oklahoma State University, Stillwater, OK, August 1997.
B.S. Veterinary Medicine, with minor in Animal Production and Economics, Universidad de Leon (Spain), March 1993.

Work Experience

Conservation Program Director, Defenders of Wildlife**,** Sacramento, California. Co-director of the California Rangeland Conservation Coalition. Responsible for the coordination of the research, outreach and steering committees.

Analyst/Industry Liaison, Center for Animal Disease Modeling and Surveillance, UC Davis, Davis, California. Liaison with livestock associations, government agencies and other academic institutions to collect data for animal disease models. Outreach and media and industry relations.

Community Liaison, John Muir Institute of the Environment, Davis, California, March 2005-June 2006. Liaison between a community and an NGO in a community-based riparian restoration project. Community development. Indoor and outdoor experiential education. Field trips.

Consultant, The World Bank, Washington DC, August 1997-July 1999.
Media relations. Design and implementation of outreach campaigns in agriculture and environmental issues. Budget management. International travel.

Projects Assistant, The Nature Conservancy, Arlington, VA, September 1999-December 1999.
Database management. IT helpdesk.

Areas of Interest

Rangeland conservation, rangeland ecology, ecosystem services, wildlife conservation on private land, sustainable agriculture.