California Department of Food and Agriculture
ENVIRONMENTAL FARMING ACT SCIENCE ADVISORY PANEL

MEETING AGENDA

January 31, 2014
10 AM to 4 PM

(Science Panel members only)
10 am to 1 pm
Farm Tour
Dixon Ridge Farms
5430 Putah Creek Road
Winters, CA 95694
530-795-4619

(Public meeting)
1 pm to 4 pm
USDA NRCS
Room 125, 430 G Street
Davis, CA 95616
530-792-5600

Call in information:
Please call 1-877-238-3859
Participant passcode - 3964856#

Jeff Dlott, PhD, Member and Chair
Mark Nechodom, PhD, Member — Don Cameron, Member
Mike Tollstrup, Member — Jocelyn Gretz, MSc, Member
Luana Kiger, MSc, Subject Matter Expert
Doug Parker, PhD, Subject Matter Expert

1.	Introductions	Jeff
2.	Updates • EFA SAP bi-annual report • Ecosystem Services Database • Regulatory form/permit project	Amrith
3.	California Economic Summit – Working Landscapes Team	Glenda Humiston James Gore
4.	Recognition System for Ecosystem Services - GEELA	Nilan Watmore
5.	Future Direction - projects • Demonstration projects	Amrith
6.	Next meeting and agenda topics	Jeff

Amrith Gunasekara, PhD, CDFA Liaison to the Science Panel

All meeting facilities are accessible to persons with disabilities. If you require reasonable accommodation as defined by the American with Disabilities Act, or if you have questions regarding this public meeting, please contact Amrith Gunasekara at (916) 654-0433.
More information at: http://cdfa.ca.gov/Meetings.html and http://www.cdfa.ca.gov/EnvironmentalStewardship/Meetings_Presentations.html

CALIFORNIA DEPARTMENT OF FOOD AND AGRICULTURE

Environmental Farming Act Science Advisory Panel

Bi-Annual Report (2011-2013)

Amrith Gunasekara, PhD
CDFA Liaison to the Science Panel
Science Advisor to the Secretary

December, 2013

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EXECUTIVE SUMMARY

In August 2011 the Secretary of the California Department of Food and Agriculture (CDFA), Karen Ross, organized the Environmental Farming Act Science Advisory Panel (Science Panel). The Science Panel is primarily tasked with (among other activities);

- Review data on the impact that agriculture has on the environment
- Recommend to appropriate state agencies data that the panel approves as scientifically valid
- Compile information on the net environmental impacts that agriculture creates for the environment
- Research, review, and comment on data upon which proposed environmental policies and regulatory programs are based to ensure that the environmental impacts of agricultural activities are accurately portrayed
- Identify incentives that may be provided to encourage agricultural practices with environmental benefits
- Assist government agencies to incorporate information on agriculture's net environmental benefits into environmental regulatory programs.

Over the past two years, the Science Panel has worked to establish several initiatives consistent with the primary tasks defined in the Environmental Farming Act (Sections 560-568 of the Food and Agricultural Code). There were several deliverables that were identified and achieved over the past two years. The deliverables include;

1. Establishing an Ecosystem Services definition for agriculture.

2. Creating and utilizing an Ecosystem Services Qualitative Assessment Model.

3. Initiating pilot projects to support market-based trading systems.

4. Securing funding for incentive-based Ecosystem Service projects.

5. Establishing an Ecosystem Services database.

Several deliverable have been completed while components of the specific deliverables are ongoing and in the process of being completed. This report provides an account of the activities related to these deliverables and discuss potential topics to be and covered at future EFA SAP meetings.

INTRODUCTION

In August 2011 the Secretary of the California Department of Food and Agriculture (CDFA), Karen Ross, organized the Environmental Farming Act Science Advisory Panel (Science Panel). The composition of the Science Panel and objectives are defined in the 1995 Cannella Environmental Farming Act. The Act[1] (Sections 560-568 of the Food and Agricultural Code) mandates the establishment of a Scientific Advisory Panel on Environmental Farming. The overall objective of the Science Panel is to advise and assist federal, state, and local government agencies on issues relating to air, water, and wildlife habitat at the interface of agriculture. The Science Panel is primarily tasked with (among other activities):

- Review data on the impact that agriculture has on the environment
- Recommend to appropriate state agencies data that the panel approves as scientifically valid
- Compile information on the net environmental impacts that agriculture creates for the environment
- Research, review, and comment on data upon which proposed environmental policies and regulatory programs are based to ensure that the environmental impacts of agricultural activities are accurately portrayed
- Identify incentives that may be provided to encourage agricultural practices with environmental benefits
- Assist government agencies to incorporate benefits into environmental regulatory programs.

This report is a summary of the work completed by the Science Panel over the last two years. The report also discusses the future direction and work to be completed by the Science Panel.

SCIENCE PANEL COMPOSITION

As described in the Act, the Science Panel is composed of five members who "shall be highly qualified and professionally active or engaged in the conduct of scientific research" (Section 568 (b) of the Food and Agricultural Code). The code specifies that three members be appointed by the Secretary of Agriculture, one member by the Secretary of the Environmental Protection Agency and one member by the Secretary of the Resources Agency. In accordance with these requirements, the following individuals serve as members of the panel. The past members of the consortium are also listed below. Two subject matter experts contribute to supporting the scientific research aspects of the Science Panel. The dates of service of the consortium members are also provided below.

- **Jeff Dlott, PhD** *(Chair and Member - SureHarvest)*

Dates of Service – August 2011 to present

- **Mike Tollstrup** *(Member – California Air Resources Board)*

Dates of Service – August 2011 to present

- **Mark Nechodom, PhD** *(Member – California Department of Conservation)*

Dates of Service – April 2012 to present

[1] http://www.cdfa.ca.gov/EnvironmentalStewardship/Cannella. html

- **Don Cameron** *(Member – Grower Terranova Ranch)*

Dates of Service – August 2011 to present

- **Jocelyn Gretz, MSc** *(Member – Grower Rio Farms)*

Dates of Service – October 2013 to present

- **Doug Parker, PhD** *(Subject Matter Expert – University of California)*

Dates of Service – October 2013 to present

- **Luana Kiger, MSc** *(Subject Matter Expert – USDA NRCS)*

Dates of Service – April 2012 to present

Past Members:

- **Ann Thrupp, PhD** (*Member – Grower Fetzer Vineyards*)

Dates of Service – August 2011 to September 2013

- **Louise Jackson, PhD** *(Subject Matter Expert – University of California)*

Dates of Service – August 2011 to September 2013

- **Daniel Mountjoy, PhD** *(Subject Matter Expert – USDA NRCS)*

Dates of Service – August 2011 to March 2012

- **Brian Leahy** *(Member – California Department of Conservation)*

Dates of Service – August 2011 to March 2012

MEETING STRUCTURE

The first public meeting of the Science Panel was held on November 7, 2011. This meeting primarily involved introductions, informing the members about the Act, and an opportunity for the Secretary to share her vision for the Science Panel. A CDFA Planting Seed Blog posted on November 2, 2011, informed stakeholders about the public meeting. The direction of the Science Panel and tasks to be completed were discussed in subsequent meetings. Two smaller workgroups were established to address specific issues. The smaller workgroups consisted of three members and one subject matter expert. The Chair of the Science Panel served on both smaller workgroups that were established. These workgroups (three members) did not have a quorum and therefore were designed to discuss issues and make recommendations to the larger Science Panel meetings where a quorum (four members) was used to move forward specific recommendations. The Evaluation Framework Workgroup created an Ecosystem Services Evaluation Tool for use in the department to show and easily communicate the multiple benefits afforded by agriculture. The Incentives Workgroup discussed potential measures to incentivize growers to implement management practices that provide multiple benefits including environmental benefits. Initial meetings of the Science Panel were dedicated to obtaining feedback from interested stakeholders, determining the direction and evaluating scale of work based on CDFA resources. At the November 7, 2011 meeting, the Science Panel agreed to focus on the topic of Ecosystem Services in agriculture. The Panel's first task was to develop a definition of Ecosystem Services and several supporting categories in relation to agriculture. Table 1 shows the 15 meetings held to date, the main topics and the outcomes from each meeting. All meetings were held in accordance with Bagley-Keene Open Meeting requirements, including posting of agendas and meeting binders to the CDFA public website ten days prior to the meeting.

Table 1. Issues discussed and outcomes from the 15 Science Panel meetings held since November 7, 2011.

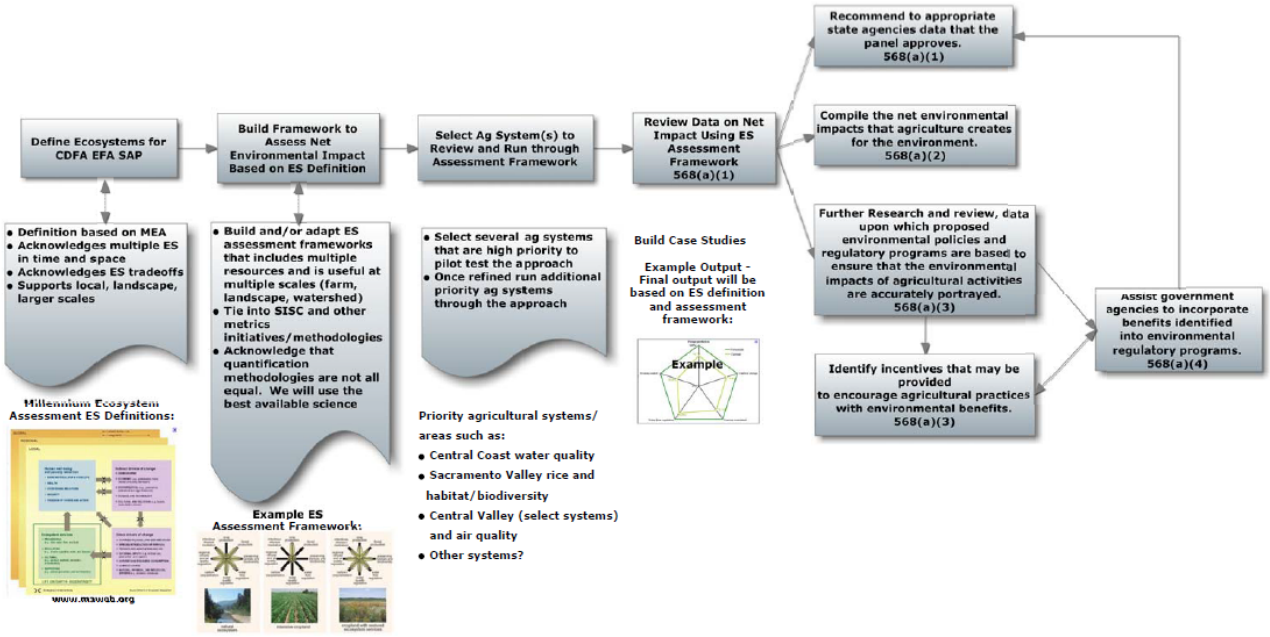
Meeting Date	Meeting Type	Main Topic	Outcomes
November 7, 2011	Main Science Panel	• Environmental Farming Act • Ecosystem Services • Future focus and direction • Bylaws	• Bylaws approved • Established working group for Ecosystem Services definition
January 23, 2012	Main Science Panel	• Ecosystem Services definition • Future focus and direction	• Ecosystem Service definition and categories proposed • Establishment of workgroups
February 23, 2012	Evaluation Framework Workgroup	• Evaluation frameworks	• Existing evaluation frameworks and tools studied and analyzed • Potential evaluation framework tool for use by CDFA proposed
March 1, 2012	Incentives workgroup	• Incentives for implementing ecosystem services	• Existing incentive programs presented and analyzed
April 23, 2012	Incentives workgroup	• Guest presentations on incentive programs	
May 18, 2012	Incentives workgroup	• Nitrogen management through nitrogen trading markets	• Established need for pilot projects
June 22, 2012	Evaluation Framework Workgroup	• Evaluation framework tool for CDFA	• Qualitative Assessment Model Version 1.0 proposed
September 20, 2012	Evaluation Framework Workgroup	• Evaluation framework tool for CDFA • Qualitative Assessment Model white paper document	• Qualitative Assessment Model Version 2.0 proposed • Qualitative Assessment Model White paper document
October 2, 2012	Incentives workgroup	• Funding of nitrogen management pilot projects	• Creation of white paper for establishing incentives and pilot projects
November 8, 2012	Main Science Panel	• Case studies analyzed using the Qualitative Assessment Model	• Four case studies evaluated with the Qualitative Assessment Model
December 14, 2012	Main Science Panel	• White paper for establishing incentives and pilot projects • Ecosystem Services Database	• White paper establishing incentives and pilot project approved • Ecosystem Services Database presented and approved
February 5, 2013	Main Science Panel	• Qualitative Assessment Model	

April 23, 2013	Main Science Panel	• Conservation Innovation Grant proposal • Qualitative Assessment Model	
July 1, 2013	Main Science Panel	• CIG grant proposal • Reward/Recognition system	• Submission of Conservation Innovation Grant

FOCUS

At the January 23, 2012 meeting, Chair of the Science Panel, Dr. Jeff Dlott presented an outline for future projects (Figure 1). According to this outline, the Science Panel would first work to define Ecosystem Services in agriculture using information presented in the scientific literature. The definition should also acknowledge the multiple Ecosystem Service benefits and tradeoffs (Column 1, Figure 1). Following the establishment of the definition, the Science Panel would focus on building a framework (e.g., tool) to assess the net environmental impacts from agriculture (Column 2, Figure 1); "build and or adapt ES assessment framework that includes multiple resources and is useful at multiple scales (farm, landscape, watershed)." Case studies would be run through the assessment model to visualize and effectively communicate to a wide audience the multiple benefits and improvements that can be made to agriculture from conservation practices and stewardship efforts (Figure 1, Column 4). There was recognition that the assessment framework might need to be refined based on the initial examination of specific case studies and this was recognized in Figure 1 (Column 3 and 4). The last row of Figure 1 indicated the need for pilot projects, compiling the net environmental impacts/benefits that agriculture provides for the environment and identifying incentives that may be provided to encourage agricultural practices with environmental benefits.

Figure 1. Outline of the proposed future direction and focus of the Science Panel approved at the January 23, 2012, meeting.



There are several deliverables that were produced over the past two years by the Science Panel. Each of these deliverables are described in more detail below. The deliverables include;

1. Ecosystem Services Definition
2. Ecosystem Services Qualitative Assessment Model
3. Pilot projects to support market-based trading systems
4. Secure funds for incentive-based Ecosystem Service projects
5. Ecosystem Service Database

1. Ecosystem Services Definition

Ecosystem Services is an ecological concept used to explain the multiple benefits people obtain from ecosystems. There are four different categories that help define the ecological definition of ecosystem services; provisioning services, regulatory services, support services and cultural services. The concept of ecosystem services has been used by some in the scientific community to understand the benefits to society from agriculture (Eigenbrod et al., 2011; Swinton, 2008). Historically, Ecosystem Services has been used successfully in agriculture to incentivize practices or conservation measures that are protective of natural resources and the environment. Examples include the World Wildlife Fund Payment of Environmental Services program[2] and Biophilia[3] Foundation easement sales to the State of Maryland for adaptive management of habitat practices in perpetuity. Dr. Ann Thrupp and Science Panel Subject Matter Expert, Dr. Louis Jackson, presented the concept of Ecosystem Services and its applicability to agricultural systems at the November 7, 2011 Science Panel meeting. Several supporting categories associated with ecosystem services were highlighted by Dr. Thrupp; Food-Fiber-Fuel production, soil structure and fertility, beneficial insects, climate/air regulation, biodiversity conservation, water provision and purification, and water and watershed conservation. These categories are supported by several scientific documents including the Millennium Ecosystem Assessment (MEA, 2005; Swinton et al., 2007; and Norgaard, 2009). The Science Panel focused on defining Ecosystem Services in agriculture as a primary initiative to effectively communicate with a wide audience about the multiple benefits provided by agriculture.

In addressing the initial task of defining Ecosystem Services in agriculture, the Science Panel consulted a wide array of scientific peer-reviewed resources. The intent was to formulate a definition that recognizes farmers and ranchers for their environmental and social stewardship efforts. At the January 23, 2012 meeting, an Ecosystem Services definition for agriculture with 13 different supporting categories was proposed. The work by Foley et al. (2005) was used as a foundational basis of establishing a definition and categories for Ecosystem Services in agriculture. Foley et al. (2005) provided a good visual diagram to emphasize the need for balancing agricultural production with environmental stewardship. Figure 2 (Foley et al., 2005) shows that in a natural system, many of the categories (e.g., water quality) are enhanced. Note that the green bubbles extend all the way to the end of the black bars for each ecosystem service category except crop production in the "natural ecosystem" image. These Ecosystem Service categories, except for crop production, become minimized in the middle diagram titled "intensive

[2] http://wwf.panda.org/what_we_do/where_we_work/black_sea_basin/danube_carpathian/our_solutions/green_public_funds/pes/

[3] http://www.biophiliafoundation.org/about-current-projects.html

cropland." Foley et al (2005) shows that both crop production and Ecosystem Services have to be maintained for future sustainability, although not to their maximum potential; green bubbles on top of black bars do not extend all the way to the end in the final graphic of Figure 2. Foley discusses the inability to maximize Ecosystem Services with crop production as inherent tradeoffs between maintaining ecological systems and food production.

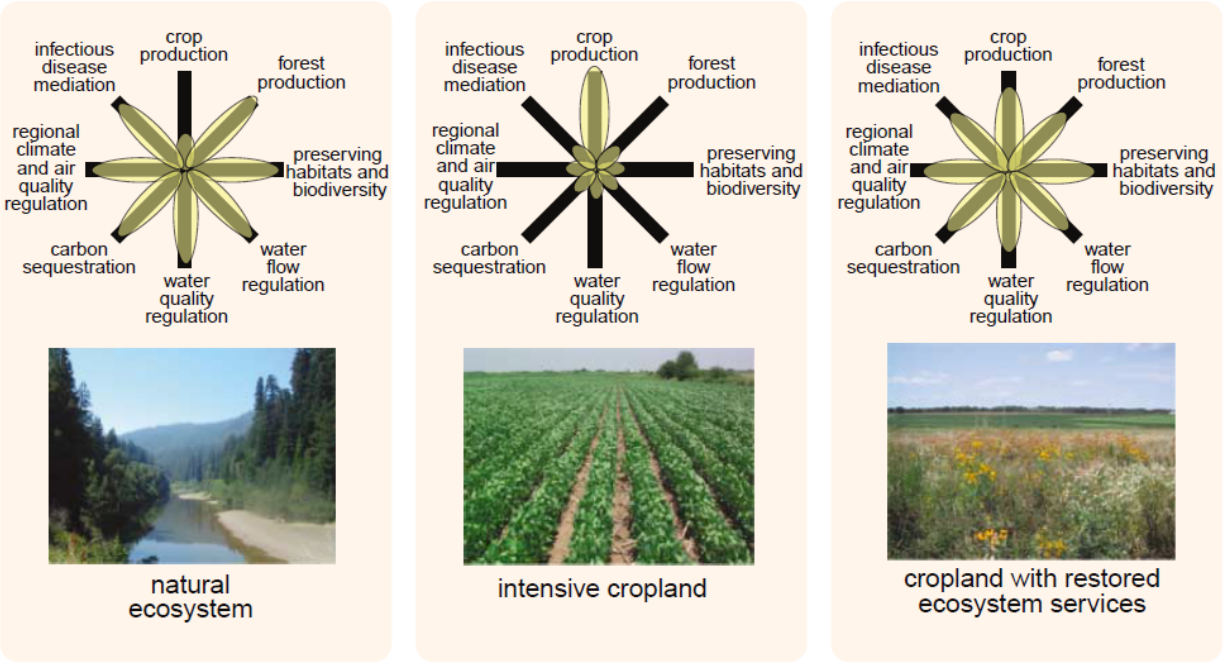


Figure 2. According to Foley et al, (2005), "Conceptual framework for comparing land use and trade-offs of ecosystem services. The provisioning of multiple ecosystem services under different land-use regimes can be illustrated with these simple ''flower'' diagrams, in which the condition of each ecosystem service is indicated along each axis. (In this qualitative illustration, the axes are not labeled or normalized with common units.) For purposes of illustration, we compare three hypothetical landscapes: a natural ecosystem (left), an intensively managed cropland (middle), and a cropland with restored ecosystem services (right). The natural ecosystems are able to support many ecosystem services at high levels, but not food production. The intensively managed cropland, however, is able to produce food in abundance (at least in the short run), at the cost of diminishing other ecosystem services. However, a middle ground—a cropland that is explicitly managed to maintain other ecosystem services—may be able to support a broader portfolio of ecosystem services."

Three separate definitions – a technical definition and two non-technical definitions - were originally proposed for consideration by the Science Panel (MEA, 2005; Daily, 1997; Costanza et al., 1997). The definition underwent multiple drafts, and ultimately the Science Panel defined Ecosystem Services as "the multiple benefits we gain from farming and ranching including crop and livestock production. In addition to valuable open space and wildlife habitat, the management decisions and conservation practices of farmers and ranchers also enhance environmental quality, provide recreational opportunities and offer social benefits." In addition to the definition, the Science Panel agreed on 13 different categories, including food, fiber and fuel production, for the Ecosystem Services in agriculture definition (MEA, 2005; Swinton et al., 2007; Zhang et al., 2007). The supporting categories established are wildlife habitats; nutrient cycling; food, fiber and fuel production; recreation and cultural; soil structure, formation and

fertility; biodiversity conservation; water cycling; atmospheric gas/climate regulation; water quality; pest control; and pollination services. Each category is described in more detail below. Please note that the three separate categories of food, fiber, and fuel have been listed as one category below.

Wildlife habitats (Costanza et al., 1997; Stallman, 2011; Jedlicka et al., 2011) - Provide habitats for resident and transient wildlife populations
Nutrient cycling (Costanza et al., 1997; Stallman, 2011; Sandhur et al., 2010) - Provide nutrient storage and cycling
Food, fiber, fuel production (Costanza et al., 1997; Stallman, 2011; Sandhur et al., 2010; Swinton et al., 2007) - Provide food, fiber, and fuel to sustain a growing global population
Recreation and cultural (Costanza et al., 1997; Stallman, 2011; Sandhur et al., 2010) - Provide opportunities for recreational activities
Soil structure, formation, and fertility (Stallman, 2011; Sandhur et al., 2010; Swinton et al., 2007; Dale and Polasky, 2007) - Provide opportunities for enhancing the soil system, promotes organic matter buildup/carbon sequestration, and prevents disturbances
Biodiversity conservation (Stallman, 2011; Swinton et al., 2007;) - Promote biodiversity
Water cycling (Stallman, 2011) - Maintain soil moisture and regulate water movement/cycling
Atmospheric gas/climate regulation (Sandhur et al., 2010) - Regulate atmospheric chemical composition.
Pest control (Sandhur et al., 2010; Jedlicka et al., 2011; Dale and Polasky, 2007) - Control pests and weeds by natural enemies and weed seed predators, respectively
Pollination services (Swinton et al., 2007) - Contribute to fruit, nut, and vegetable production
Water quality - Reduces salinity and organic/inorganic constituents in surface and ground water

2. Qualitative Assessment Model

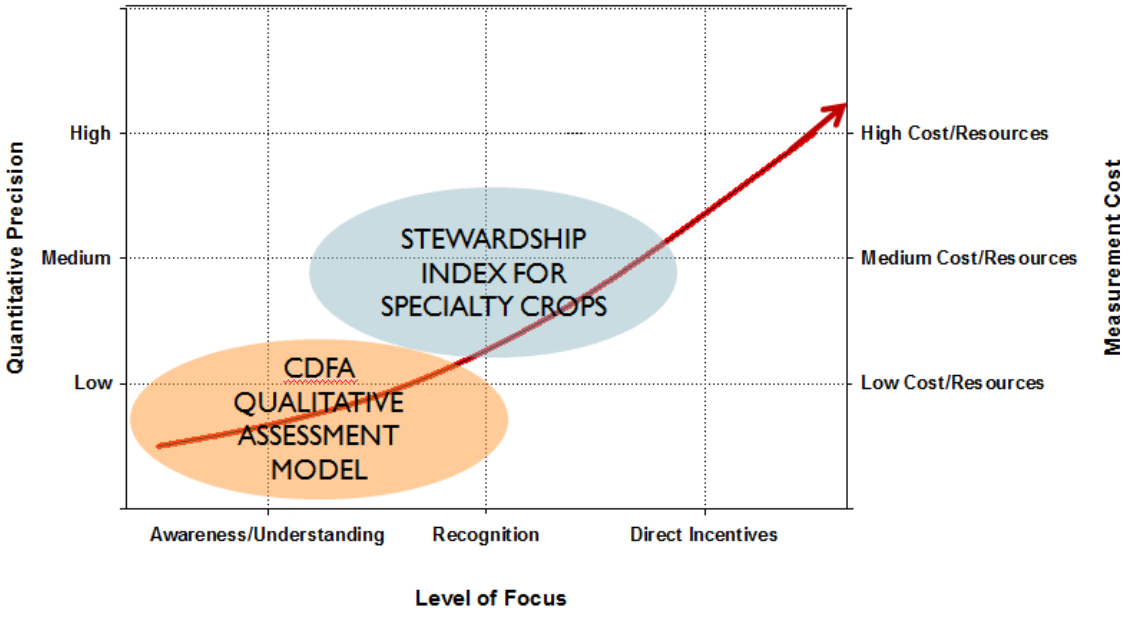
Developing an assessment framework required a review of the scientific literature and evaluation of existing frameworks. The Science Panel convened a workgroup titled Evaluation Framework Workgroup to discuss potential options for a framework tool. Several initial questions were posed at the February 23, 2012, meeting to guide in the development of the Ecosystem Services Assessment Framework. They included the potential use of numerical values, scale of assessment, use of the scientific methods to uphold assessment framework, potential for using statistical methods to quantify qualitative inferences and the need to not "reinvent the wheel". The Science Panel referenced Foley et al. (2005), who presented Ecosystem Services as a "flower" diagram with the different Ecosystem Services highlighted for different scenarios (e.g., cropland with restored ecosystem services compared to intensive cropping; Figure 2).

Several existing quantitative systems were analyzed including the Stewardship Index for Specialty Crops[4], Field to Market spider diagram sustainability calculator[5], BASF's Eco-Efficiency Analysis tool[6], the Environmental Defense Fund's environmental assessment tool, SureHarvest's Water Quality Self-Assessment system and several systems highlighted in the MEA report. The systems presented in the MEA used plus and minus symbols as an indication of

[4] http://www.stewardshipindex.org/
[5] http://www.fieldtomarket.org/
[6] http://www.basf.com/group/corporate/en/sustainability/eco-efficiency-analysis/what-is

negative and positive impacts on working lands, respectively. Several other systems used arrows as well as different color schemes to represent the environmentally positive and negative changes to Ecosystem Services across different scenarios (MEA, 2005). The Environmental Defense Fund uses a qualitative numerical scale from -2 to 2 to rate environmental impacts and improvements. Other assessment scales, such as the one proposed by Cooley and Olander (2012) use a numerical line or axis that is negative on one side and positive on the other with a zero in the center to evaluate the net environmental contribution of some management practices. The Science Panel agreed that the qualitative models and tools developed to date had been completed with extensive scientific merit, financial resources, and time. Based on the existing resources of the Science Panel and lack of an effective tool to assess, communicate and educate a wide audience about the multiple conservation and stewardship contributions from growers and ranchers, the members decided to focus on a qualitative (as opposed to quantitative) assessment tool. This tool would be called the CDFA Qualitative Assessment Model. The Science Panel agreed that there is a lot of work being invested in developing quantitative tools but communicative qualitative tools are also needed to ensure a wide audience becomes familiar with the concept of Ecosystem Services on working lands in California. Figure 3 was developed to highlight the level of this tool in relation to other more quantitative tools such as the Stewardship Index for Specialty Crops.

Figure 3. The proposed Qualitative Assessment Tool by CDFA will utilize existing resources (low) in the department to effectively communicate Ecosystem Services in agriculture with the focus of the tool being an awareness/understanding approach. The CDFA tool is different from more quantitative tools being developed such as the Stewardship Index for Specialty Crops.



An initial version (1.0) of the CDFA Qualitative Evaluation Tool was presented to the Science Panel for consideration at the February 23, 2012 meeting. The design was akin to a hub and spoke model where each spoke represented a different Ecosystem Service category established as part of the definition. Spokes were shaded if the services were provided. This model underwent

changes and became a circle with slices (e.g., pie chart). Each slice represented an Ecosystem Service category. A three-color scheme was introduced. The slices were red if the Ecosystem Service was impaired or degraded and green if the Ecosystem Service was provided. Orange represented neutral, meaning that the Ecosystem Service remained constant without being impacted or enhanced. The Qualitative Assessment Model worked effectively for case studies under a "before" and "after" implementation of conservation measures scenario. Management practices that contribute to the enhancement of the Ecosystem Service must meet the practice standards defined by the USDA California Natural Resources Conservation Services (NRCS). The NRCS issues protocols for each management practice that provide the purpose and description as well as criteria each practice must meet. If the farm or ranch is appropriately performing the management practices contributing to a certain Ecosystem Service, the represented category will be green to indicate enhancement by the conservation practice. Colors will change from red to orange, orange to green and potentially green to orange or red depending on the management practice and potential tradeoffs.

The CDFA Qualitative Assessment Model was approved, along with a white paper document (Appendix 1), at the September 23, 2012 meeting. Several case studies have been moved through the model since this meeting and posted on the CDFA Ecosystem Services Qualitative Assessment Model webpage; http://www.cdfa.ca.gov/EnvironmentalStewardship/qamodel.html. The tool will be used by CDFA to inform and educate a wide audience about the net social, economic, and environmental benefits, including tradeoffs, of implemented management practices.

3. White paper on pilot projects to support market-based trading systems

The Incentives Working Group, first convened on March 1, 2011, evaluated different incentive and award programs. These efforts are in response to the mandate that the department shall "provide incentives to farmers whose practices promote the well-being of ecosystems, air quality, and wildlife and their habitat" (Food and Agriculture Code Section 566 (a)). The Science Panel reviewed several incentive programs (e.g., American Carbon Registry, the Santa Rosa Resource Conservation Program Nutrient Offset Program, market-based trading system in the Chesapeake Bay and the Willamette Partnership in Oregon). Based on issues of current importance, the Science Panel decided to focus on nitrogen trading markets in the Central Valley as an incentive-based project. The Panel opted to pursue this topic through the design and implementation of a nitrogen fertilizer budget worksheets (NFBW) pilot project in combination with other conservation management practices (bundling of Ecosystem Services). The Science Panel established a white paper to further define this work. The white paper is included in this report as Appendix 2.

4. Funding for incentive-based Ecosystem Service projects

The Science Panel Incentive workgroup highlighted the importance of obtaining funding for pilot projects consistent with strategies outlined in the white paper document. A Conservation Innovation Grant (CIG) project proposal was developed. The CIG focused on NFBW and implementation of them in conjunction with other conservation management practices. The data collected would have been evaluated for the multiple environmental benefits from this combination or "bundling" of practices along with economic benefits. More specifically, the

project would involve analyzing existing NFBW templates, designing a new NFBW that would capture the multiple environmental benefits of nitrogen management, and implementing the NFBW with approximately 20 growers in the San Joaquin Valley, California. Local Resource Conservation Districts will assist in implementing the project with growers. The benefits from the "bundled" management practices would then be assessed qualitatively using the Qualitative Assessment Model. The information gathered could be validated using the Nitrogen Tracking Tool which has not yet being validated in California. The economic benefits of conservation practices will be evaluated as well, using the Ecosystem Valuation Toolkit developed by Earth Economics, and compared to the economic cost of implementing them, providing an overall economic analysis of environmental stewardship. The project is intended to last two years, and the Panel has applied for a federal grant to complement in-kind support and financing by CDFA's Fertilizer Research and Education Program (FREP). This project would provide vital data on nitrates that would lay the groundwork for the development of nitrogen trading markets, a long term goal of the Science Panel. The CIG summary application is included in this report as Appendix 3. The CIG application was not funded and the Science Panel is in the process of evaluating alternative funding sources for the project.

5. Ecosystem Service Database

Section 566 (b) of the Food and Agriculture Code notes that "The department may assist in the compilation of scientific evidence from public and private sources, including the scientific community, industry, conservation organizations, and federal, state, and local agencies identifying the net environmental impacts that agriculture creates for the environment. The department shall serve as the depository of this information and provide it to federal, state, and local governments, as needed." To address this mandate, CDFA designed a database to highlight the many benefits afforded from working lands in agriculture. The information contained in this database was collected from farm and ranch websites, on-line case studies and websites that were associated with environmental stewardship awards (e.g., Leopold award). The database is designed to show and communicate, to a wide audience, the many social and environmental benefits offered by farms and ranches in California, including food and fiber production. The goal was to build a database clearinghouse which highlights existing and ongoing efforts by farmers and ranchers who have implemented management practices that provide multiple environmental benefits or Ecosystem Services.

The purpose of the clearinghouse is twofold.

1. Help the department promote, to a large public audience including regulators, the multiple benefits or Ecosystem Services afforded by California agriculture using collected data/information
2. Assist growers, ranchers, and stakeholders who want to learn more about environmental stewardship practices implemented in California agriculture

The database can be queried by keyword and categories as well as through the interactive map. This database of nearly 400 farms and ranches is comprised predominately of farms growing specialty crops. There are approximately 300 specialty crop farms and 100 non-specialty crop growers. The database can be accessed from the following link;
http://apps.cdfa.ca.gov/EcosystemServices/
Appendix 4 provides several screenshots of the database, which is publicly available.

FUTURE DIRECTION

There are several ongoing activities associated with the initiatives discussed in this report that will continue over the next two years with guidance from the EFA SAP. They include (not listed in order of priority):

- Working with existing organizations that recognize and award growers for environmental stewardship to include CDFA and the Ecosystem Services Qualitative Assessment Model in their evaluation.
- Seeking partnerships to implement pilot projects
- Securing funding for pilot projects to gather fundamental data that will lead to establishing market-based trading systems
- Continue to make growers aware of the Ecosystem Services Database and maintain the database with the most current information available

Discussion on the potential future topics to be addressed by the EFA SAP was discussed in brief at the October 23, 2013, meeting. They included:

- Developing informational guidebooks for growers to explain how to qualitatively and quantitatively show the benefits of conservation measures and Ecosystem Services on working lands
- Explore tools for growers that will assist in quantifying the Ecosystem Service benefits of conservation measures
- Establish a grower community of Ecosystem Services in agriculture
- Study the potential of rewarding voluntary Ecosystem Service markets
- Create an effective pathway for providing growers with useful information and also obtaining feedback and existing needs from growers.

The further discussion of topics to be covered by EFA SAP will be discussed at upcoming meetings to be held in January 2014 and beyond. The next bi-annual report will be drafted, reviewed and released to growers and the public in December 2015.

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Appendix 1 – Qualitative Assessment Model White Paper

A QUALITATIVE ASSESSMENT MODEL FOR EVALUATING ECOSYSTEM SERVICES IN AGRICULTURE

CDFA ENVIRONMENTAL FARMING ACT SCIENCE ADVISORY PANEL

INTRODUCTION

California agriculture provides many social and financial benefits both nationally and internationally. Growers and ranchers use many innovative methods to balance food and fiber production with environmental stewardship. One example is the transition from flood irrigation of fields for crop production to micro-sprinkler or drip irrigation methods which has led to better plant nutrient management, and in many cases, water conservation. A qualitative assessment model is useful to illustrate the net environmental benefits from management practices, implemented by growers and ranchers, to enhance the environment.

For many years, growers and ranchers in California have voluntarily implemented management practices on their fields that enhance the environment. However, little has been done formally by CDFA, to promote, recognize and incentivize growers for their environmental stewardship efforts. The Environmental Farming Act Science Advisory Panel (EFA SAP), formed in August 2011 by the Secretary of CDFA, was established to document, study, recognize, and incentivize environmental stewardship efforts on farms and ranches.[1] The scientific panel established three specific objectives to meet this goal. They are:

1. Establish a definition for management practices that contributes to improving the net environmental quality of farms and ranchers
2. Create a qualitative and educational assessment model to effectively show and communicate the benefits of using management practices to enhance the environment on agricultural fields
3. Identify specific incentives to support pilot projects which will support, and potentially lead to the establishment of larger projects on farms and ranches

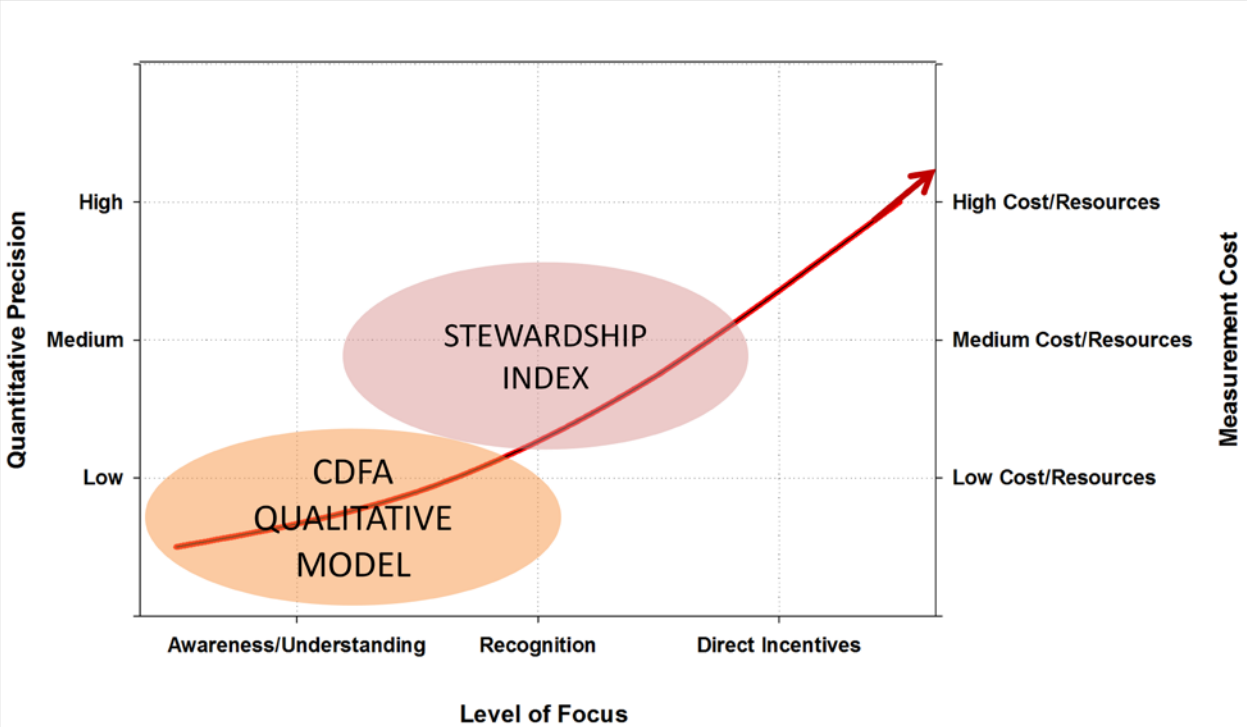
The first objective is complete.[2] EFA SAP recognized that management practices that contribute to improving the net environmental quality can be classified as Ecosystem Services. Ecosystem Services are defined as "the multiple benefits we gain from farming and ranching including crop and livestock production. In addition to maintaining valuable open space and wildlife habitat, the management decisions and conservation practices of farmers and ranchers also enhance environmental quality, provide recreational opportunities and offer social benefits." The definition is supported by several categories.[3] Objectives 2 and 3 involve the development of a qualitative assessment model and identifying monetary and non-monetary incentives to growers. These three objectives will help further the implementation of management practices to enhance the environment in agriculture. This document discusses the qualitative assessment model developed by CDFA with the assistance of the science panel, methods associated with it, and expected current and future use.

QUALITATIVE ASSESSMENT MODEL

A range of qualitative and quantitative assessment models have been developed to estimate the net environmental benefits of management practices implemented on farms and ranches. Examples include the Stewardship Index for Specialty Crops (http://www.stewardshipindex.org/), the Sustainable Winegrowing Program (http://www.sustainablewinegrowing.org/swpcertification.php), and Nitrogen Tracking Tool (http://nn.tarleton.edu/NTTWebARS/). These assessment models vary in their degree of precision (Figure 1). However, a qualitative assessment model that is formulated to specifically educate and promote awareness of management practices that contribute to the net environmental quality of a farm and ranch does not exist for California agriculture. EFA SAP has developed a qualitative

assessment model to communicate the benefits of management practices that contribute to the net environmental quality and potential social benefits of agricultural working landscape. The differences between the quantitative and qualitative assessment models are presented in Figure 1. Figure 1 shows that the level of quantitative precision and measurement cost associated with the CDFA qualitative assessment model is less than the quantitative Stewardship Index model. The CDFA qualitative assessment model is expected to be further developed through integration into more quantitative models such as the Sustainable Winegrowing Program. Any future developments in the model will result in new versions with a different level of quantitative precision. The intended audience, methodologies, and opportunities for use of the assessment model are provided below.

Figure 1. The relationship between the CDFA Qualitative model and more quantitative models such as the Stewardship Index for Specialty Crops.



AUDIENCE

The CDFA qualitative assessment model will be used to inform and educate a wide audience, including the general public, policy makers, regulators, farmers and ranchers, and other stakeholders about the net social, economic, and environmental benefits, including tradeoffs, of implemented management practices. This assessment model will be used primarily by CDFA to fulfill the objectives noted above.

METHODOLOGY

The assessment model uses categories, established as part of the Ecosystem Services definition (http://www.cdfa.ca.gov/EnvironmentalStewardship/Ecosystem Services.html) to show changes in an agricultural system. The different categories were identified in the process of developing the Ecosystem Services definition and support the definition; "the multiple benefits we gain from farming and ranching including crop and livestock production." The science panel and CDFA recognize that not all activities in agriculture have positive effects on the environment and may include tradeoffs. Tradeoffs are net negative impacts that occur for a specific category as a result of implementing a management practice in a different category. In general the category of Food will be green since agriculture is the main economic sector that provides this Ecosystem Service (e.g., fruit, vegetable and livestock production). The different

categories compiled as part of the definition and utilized in Figure 2 (visual representation of the CDFA qualitative assessment model) are listed below.

- Wildlife Habitats – Encourage resident and transient wildlife populations (Costanza et al., 1997; Stallman, 2011; Jedlicka et al., 2011).
  There are two subcategories that were identified for this category.
  - Terrestrial habitat benefits
  - Aquatic habitat benefits
- Nutrient Cycling - Food storage in soil for plant and microbial use (Costanza et al., 1997; Stallman, 2011; Sandhur et al., 2010)
- Food, fiber, fuel production - Sustains a growing population (Costanza et al., 1997; Stallman, 2011; Sandhur et al., 2010; Swinton et al., 2007)
- Recreational opportunities – Provides activities for society (Costanza et al., 1997; Stallman, 2011; Sandhur et al., 2010)
- Soil structure, formation, and fertility - Enhances the soil environment, promotes organic matter buildup and carbon sequestration, and prevent disturbances (Stallman, 2011; Sandhur et al., 2010; Swinton et al., 2007; Dale and Polasky, 2007)
- Biodiversity conservation (Stallman, 2011; Swinton et al., 2007).
  There are two subcategories that were identified for this category.
  - Terrestrial biodiversity
  - Aquatic biodiversity
- Water cycling - Maintains soil moisture and regulates water movement (Stallman, 2011)
- Atmospheric gas/climate regulation which maintains chemical composition (Sandhur et al., 2010)
- Water Quality - Reduces salinity and organic/inorganic constituents in surface and ground water
- Pest control – Alternative management practices use control pests and weeds. (Sandhur et al., 2010; Jedlicka et al., 2011; Dale and Polasky, 2007)
- Pollination services - Contributes to fruit, nut and vegetable production (Swinton et al., 2007; Kremen et al., 2004; Kremen et al., 2007)

Expert opinion and a peer review process will be used to establish directional color changes from red and orange to green (net positive impact) or from green to orange to red (net negative impact or tradeoff). Directional changes from one color to another color for the categories will be made by experts knowledgeable on ecosystem services and agriculture in CDFA. Color changes will be supported by scientific literature as well, when available and applicable.

The CDFA qualitative assessment model uses a three-color scheme to represent the status of each category associated with the Ecosystem Services definition. A detailed description of the color scheme is described in the caption of Figure 2. EFA SAP examined several potential options for this model. They include showing positive ecosystem services on working landscapes using a plus/minus scale (Millennium Ecosystem assessment, 2005 – page 19), a multidirectional arrow based system with a three color scheme (Millennium Ecosystem assessment, 2005 – page 16), and several other industry based assessment models such as Field to Market. The three color scheme for the CDFA assessment model, in combination with the categories, was chosen because the benefits of management practices on the net environmental quality of a farm or ranch can be easily communicated to broad audience.

There are several scenarios where the colors of the assessment model can change depending on the implemented practice. For example, the green status can change to orange first and then red if there is a net negative impact to a category as a result of a tradeoff.

OPPORTUNITIES FOR USE

The CDFA qualitative assessment model is intended to be used for two different scenarios:

1. A "before" and "after" scenario – in this scenario, using case studies of already completed conservation work, the "after" scenario will be developed first. The "after" scenario refers to a conservation practice that has been applied to a farm or ranch. The net environmental benefits to agriculture will be noted. Using this "after" scenario as a positive baseline, the "before" scenario can be established. This "before" scenario includes listing how the ecosystem services categories were impacted before the conservation measures were implemented on the working landscape. By creating a "before" and "after" scenario, a visual representation of the net environmental benefits can be clearly observed and understood.

2. Future projections scenario – in this scenario, the model is designed to establish what the current status of the working landscape is and then projecting into the future what the landscape will look like "if" specific practices were implemented. Using the future projection scenario with the qualitative model will help a broad audience understand the benefits of management practices that may need to occur to move the working landscape from the existing status, with potentially negative environmental impacts, to one that offers more net beneficial "Ecosystem Services" (previously defined).

The model example presented in Figure 2 uses a "before" and "after" scenario to highlight the net environmental benefits of management practices used to enhance water cycling, wildlife habitats (aquatic) and nutrient cycling categories. The case study used for this example is the Agricultural Water Enhancement Program; Northern San Joaquin River water Quality Project (AWEP, 2011). The case study describes how NRCS funds were used to improve the environmental quality of impaired waterways from sediment, nutrients, and pesticides. Specific irrigation and farming practices, such as micro-irrigation systems and tail water recirculation systems, were implemented on 5,229 acres by growers to meet requirements of the Central Valley Irrigated Lands Regulatory Program. The completed work resulted in two, of three, waterways meeting state standards for pesticides and toxicity. The assessment model shows the qualitative benefits of the management practices that improved the net environmental quality in Northern San Joaquin River waterways. Color changes from red to green are noted from the "before" to "after" scenarios in Figure 2 for water cycling as a result of micro-sprinkler irrigation which significantly reduce surface water runoff compared to furrow or flood irrigation, aquatic wildlife habitat improvements by meeting state regulatory requirements for pesticides in waterways, and nutrient cycling from the development of tail water recirculation systems and holding ponds.

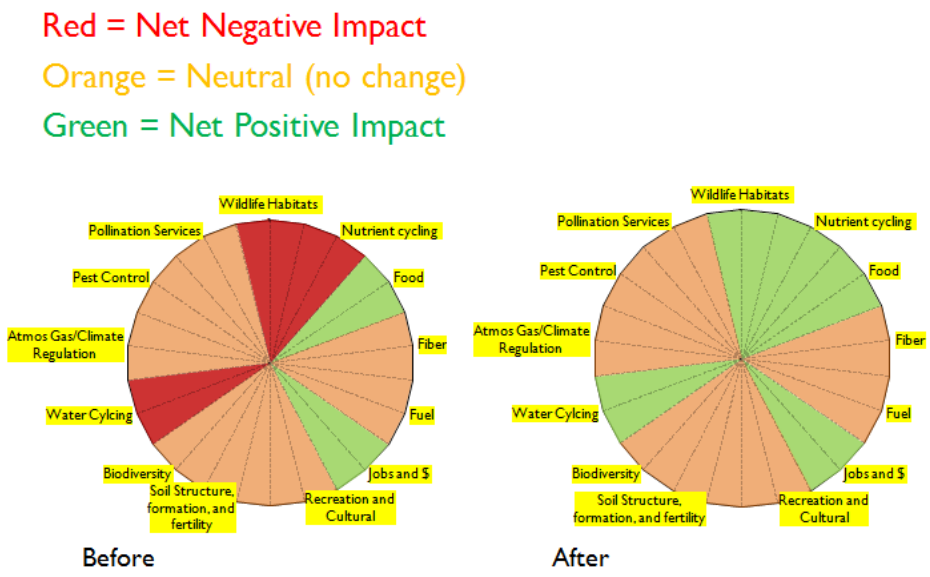


Figure 2. The qualitative assessment model developed by CDFA. The orange colored regions are net neutral status and can remain unchanged in each scenario or change to green as a result of applied conservation measures. Red color regions are net negative status of a category where the current environmental baseline is impacted or where ecosystem services have not been implemented. Green color regions are net positive impacts on the environmental quality of a farm or ranch.

Explanation boxes will be provided next to each category to describe the reason for a color change. Such descriptive explanations are designed to eliminate overly subjective assessments being made of an ecosystem service. Caution should be taken in moving a category from a specific color to another color. If there is insufficient justification for this transition, conservative predictions should be made in changing colors (e.g., red to orange as opposed to red to green change). Conservative measures should be used in all cases if uncertainty in the data/information exists.

A list of NRCS practices will be included as part of the CDFA qualitative assessment model. Referencing these practices and applying them to case studies or future scenarios will be beneficial. NRCS practices are the acceptable "standard" for conservation measures. They have been extensively vetted to show conservation benefits over time. Their use in agriculture and reference to the ecosystems services in the qualitative assessment model is extremely beneficial. With each change in category color, the identification and listing of specific NRCS practices will be useful.

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Appendix 2 – White paper report on pilot projects to support market-based trading systems

INTRODUCTION

The California Department of Food and Agriculture (CDFA) is in the process of establishing pilot projects to obtain quantitative information to support market-based trading systems that will enhance the overall net environmental quality of working lands. CDFA recognizes the many voluntary efforts made by growers and ranches to enhance the environment and the lack of sufficient incentives to further encourage on-farm conservation management practices.

The importance of establishing incentives for growers is described in the California Food and Agriculture code. The Cannella Environmental Farming Act of 1995 states that "many farmers engage in practices that contribute to the well-being of ecosystems, air quality, and wildlife and their habitat" [California Food and Agriculture Code 561 (b)]. The 1995 act also describes requirements for creating a Science Panel and the establishment of a program to "provide incentives to farmers who practices promote the well-being of ecosystems, air quality, and wildlife and their habitat."

The Environmental Farming Act Science Advisory Panel (Science Panel), organized in August 2011 by the Secretary of CDFA, is working towards developing a market-based trading system that will incentivize growers to implement management practices that contribute to the overall environmental quality of their working lands. However, the Science Panel recognizers there is a lack of basic information to move directly to the implementation stage of a market-based trading system. Therefore, several pilot projects, with three management practices in each, have been proposed.

The goals of the pilot projects are to gather basic information from implemented management practices over two to three years in the East San Joaquin Region of the Central Valley, California. The projects will focus on row and tree crops primarily. The information will be used to design a market-based trading system. This document discusses the pilot projects, including potential sources of funding.

PILOT PROJECTS

Direct investment in large scale agricultural projects to improve the overall net environmental quality of a working landscape is costly and coupled to substantial risk. For instance, there are numerous food safety concerns related to the co-management of food production and environmental habitats. Bringing certainty on this issue, through the scientific method and extensive documentation, will be beneficial to establishing wildlife ecosystem services on working lands. Pilot projects are designed to understand the practical feasibility, associated costs, and potential risk at a farm scale. Recent research work highlights the importance of pilot projects to understand the success of specific management practices on working landscapes. For example, Evans et al (2012) initiated seven pilot projects from 1995 to 2006 to demonstrate and evaluate alternative channel management strategies that might enhance water quality functions in North Carolina. The results show that nitrogen concentrations and transport were reduced by 20% to 70% with in-stream and constructed storm water wetlands. Pilot projects that have successful quantitative results can be used for larger "scaled-up" projects.

The department and science panel have highlighted three primary subject areas to be used in each pilot project . They are 1. Nitrogen management, 2. Native pollination services, and 3. Riparian habitats. More explanation on each subject area is provided below. Other subject areas will be visited once these two to three year pilot projects have been implemented in various locations beginning with the East San Joaquin region of the Central Valley, California.

1. Nitrogen Management

There have been recent scientific reports and numerous media reports that have highlighted surface and groundwater contamination by nitrates from nitrogen fertilizers used for food production (SBX2 1 report, 2012; Sobata et al., 2009; Warrick et al., 2005). These reports have suggested or identified that much of the contamination stems from agricultural use of synthetic and organic nitrogen fertilizers. Controlling nitrogen on irrigated agricultural lands is critical to limiting the amount of nitrate movement to groundwater systems which are often also used as drinking water sources in many communities (Hearing, 2012). A front end solution to reducing nitrates in groundwater is to have a nitrogen management plan. A nitrogen management plan helps growers balance and understand where their nitrogen is in their agricultural system (e.g., soil, water, or plant). The process helps growers apply nitrogen more effectively to optimize yields and reduce nitrates in water. These nitrogen management plans can also be effectively used to determine how much nitrogen can be potentially traded in a non-point source (e.g., irrigated farm) to point-source (e.g., wastewater treatment plant) nitrogen trading program. This fundamental information is required prior to establishment of any large scale nitrogen market-based trading program. The information will also benefit the design of non-monetary market systems such as a credit based trading system.

2. Native pollination services

California agriculture is dependent on pollination services. Many tree crops, such as almonds, require pollinators to establish sufficient, economically viable, yields. Recent declines in California bee populations are of concern (Michels, 2011). Bees are often trucked in from other states such as Florida to provide enough pollinators to ensure crop yields but have numerous issues associated with this process (Longstroth, 2012). Native pollinators and establishment of their habitats on agricultural fields have long-term sustainability benefits including reduced cost from importing bees from other states.

3. Riparian/wildlife habitats (including native plants)

Riparian/wildlife habitats including native grasses have been found to successfully reduce the movement on nitrogen and sediment in surface waters from the irrigation agricultural fields (Smiley et al., 2011; Lovell and Sullivan, 2006). Riparian grasses and intercropping might potentially reduce nitrogen movement beyond the crop root zone as well but more fundamental information is required. Riparian or wildlife habitat zones also offer numerous other benefits including habitats for beneficial insects, habitats for birds, biodiversity services, water cycling, and enhancement of on farm conservation measures (Henningsen and Best, 2005). Pilot projects on agricultural fields will highlight the many benefits of establishing riparian/wildlife habitat zones and also collect some basic quantitative information that can be used to support larger scale projects.

The implementation of these three management practices that provide ecosystem services on agricultural lands, together in combination at a pilot project site, will greatly improve and highlight quantitatively and qualitatively the overall environmental quality of working lands. There are also numerous direct benefits to agriculture as well (e.g., native pollinators). The quantitative data collected will support the establishment of these projects on a larger, potentially regional, scale on California's working lands. For measuring riparian/wildlife habitats, existing systems on working lands will be used since it would otherwise take two to three years to actually establish these zones before quantitative data could begin to be collected. By using existing systems, data can be collected immediately. There are several questions that would drive the collection of specific types of data. They include (but not limited to) questions such as;

- How much nitrogen can be prevented from surface runoff and by a riparian buffer at different stages of growth?
- How many bird/beneficial insect species can be expected by the introduction of a wildlife buffer and what are the reductions (if any) in crop pests?

- How much nitrogen can be reduced from a crop field without effecting yields or reduced yields by 5 or 10%? Are the reductions tradable and economical?
- How many native pollinators and habitat area is required to maintain effective pollination services for a specific crop?
- What are the cost and maintenance for implementing specific management practices (e.g., 100 feet of wildlife habitat) on working lands?

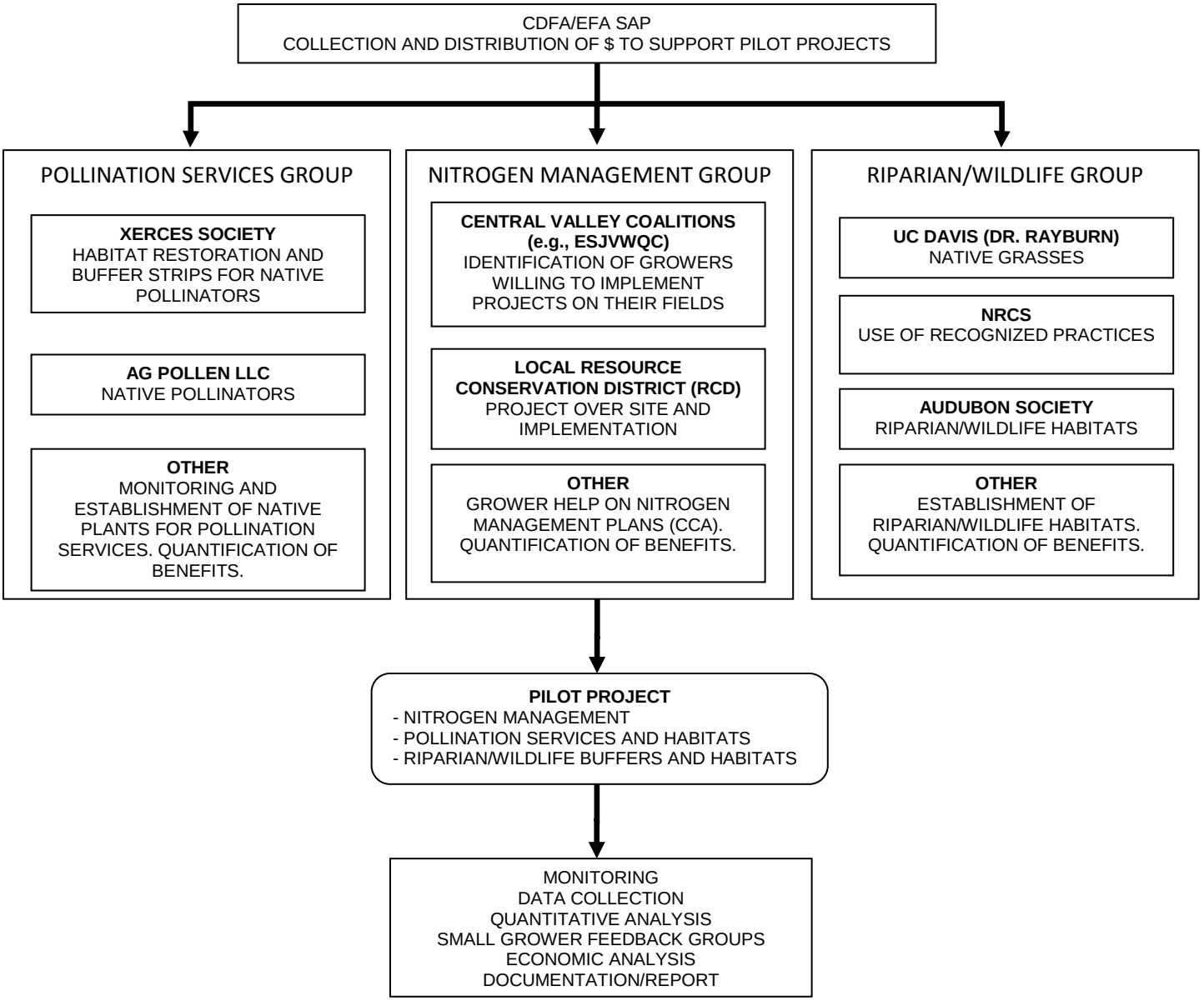
Establishment of the pilot projects

All pilot projects will be established using experts in each of the three primary subject areas described above. Many of these experts are with nonprofit organizations and UC/CSU education and extension services. Several of these organizations presented their work at the recent EFA SAP public meeting held on November 8, 2012. Presentation materials can be found on the CDFA Environmental Stewardship website; http://www.cdfa.ca.gov/EnvironmentalStewardship/Meetings_Presentations.html. The diagram below shows potential partners that can help establish pilot project on working lands. The diagram also shows how monetary dollars will support the activities of the pilot projects.

FUNDING

The department and EFA SAP are currently seeking funds to establish pilot projects in partnership with groups described in the diagram above (and potentially other gropus). Additional partners will be identified once some initial funds have been secured. Growers will also be identified through the Central Valley coalitions once initial funds have been secured. Cost sharing will be a priority between the partners and growers and will be built into the structure of establishing the pilot projects. Several examples of funding have been identified below.

- Federal funds – Specialty Crop Block Grant Program – Concept proposal completed and submitted by CDFA on 12/7/12 ($400,000).
- Agricultural associations – TBD (need to distribute document)
- Environmental associations – TBD (need to distribute document)
- NRCS CIG – Concept Proposal due by March 15, 2013 (need to distribute document)
- State agencies – TBD (need to distribute document)



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Appendix 3 - Funding for incentive-based Ecosystem Service projects

2) Project executive summary

This project will qualitatively and quantitatively examine the many Ecosystem Service benefits of bundling together nitrogen fertilizer budget worksheets (NFBW) and other conservation management practices (e.g., hedgerows) on farms of different sizes in California's agriculturally intensive San Joaquin Valley. Ecosystem Services have been defined by the California Department of Food and Agriculture (CDFA) Environmental Farming Act Science Advisory Panel as "the multiple benefits we obtain from farming". The multiple Ecosystem Service benefits from nested or multiple conservation management practices have not been qualitatively evaluated nor quantified in California. This project will explore the benefits of using NFBW as an in-season grower tool to effectively capture the multiple benefits provided by nitrogen management and hedgerows.

The project methodology will involve the following;

- analyzing existing NFBW templates for their potential to capture the multiple Ecosystem Services afforded by bundling conservation practices when supplemented with nitrogen management;
- designing a NFBW to more effectively capture the multiple benefits of nitrogen management and to also quantify the effects of multiple conservation practices;
- implementing NFBW with approximately 20 growers in the San Joaquin Valley, California, to monitor, capture, and document existing conservation practices such as cover cropping;
- qualitatively assessing the benefits from the multiple "bundled" management practices;
- quantitatively assessing the benefits from the multiple "bundled" management practices;
- evaluating the economic benefits of the multiple Ecosystem Services provided by working lands.

In addition to progress reports and other funding agency requirements, the deliverables of this project include qualitative and quantitative information on the Ecosystem Services delivered by using multiple management practices on a farm or single field, demonstrating the applicability of NFBW as an important in-season tool for plant nutrient needs, using NFBW to collect information on other conservation management practices, and validating the information collected in the NFBW using the nitrogen tracking tool (NTT) to develop nitrogen trading environmental markets.

This two-year project has a total budget of $1,062,202. More than half (53%) of the total budget is provided by in-kind support and CDFA Fertilizer Research and Education Program (FREP) cash-match contributions. The in-kind contribution from project collaborators and CDFA is $308,306 for the duration of the project. The CDFA FREP cash-match total is $254,026 for the duration of the project. Financial assistance of $499,870 is requested from the NRCS Conservation Innovation Grant program.

Several collaborators will assist CDFA in the implementation and completion of this project. They include California Association of Resource Conservation Districts, California Farm Bureau Federation, Almond Board of California, the Central Valley Regional Water Quality Control

Board, University of California Agricultural Extension Services and the Institute for Water Resources, Xerces Society, Western Growers, Earth Economics, and California Audubon Society.

3) Project description
Ecosystem Service Benefits from Bundled Management Practice in the San Joaquin Valley, California

a) Project background
Agriculture is an important economic and food production sector in the San Joaquin Valley, California. The counties within this region produce more food than any other comparably sized region in the world. The agricultural commodities produced in this region include perennial tree crops, vineyards, citrus, annual vegetable crops, and concentrated dairies. However, nitrates from nitrogen fertilizer use in agriculture have negatively impacted groundwater quality in this region. The groundwater is used by nearby communities as a primary source for drinking water, among other beneficial uses. Recent scientific reports by the University of California have noted that agriculture is the largest contributor to nitrates in groundwater in this region, primarily from nitrogen fertilizer use. At present, discussions are taking place between State environmental agencies (e.g., State Water Board, Regional Water Quality Control Boards, Cal Environmental Protection Agency) on the importance of nitrogen management budget worksheets on farms. Therefore, there is a need to demonstrate and quantify the effectiveness of nitrogen management practices, along with other conservation measures such as efficient irrigation, to avoid, control, and trap nutrient losses from farms. Nitrogen fertilizer budget worksheets (NFBW) are an on-farm grower tool that has the potential to capture information to effectively quantify and understand the distribution of nitrogen on farms, as well as to provide foundational information for the development of environmental markets for nitrogen.

The NFBW can also be used as a fundamental grower in-season tool for the monitoring and quantifying of nested or bundled management practice benefits. These benefits can be classified as Ecosystem Services. Ecosystem Services have been defined by the CDFA Environmental Farming Act Science Advisory Panel as “the multiple benefits we obtain from farming”. These benefits have been organized into 13 different categories including food production, nutrient cycling, soil health, water quality, biodiversity conservation, and creation of wildlife habitats among others (http://www.cdfa .ca.gov /EnvironmentalStewardship/Ecosystem Services.html). Use of NFBW in qualitatively and quantitatively assessing the Ecosystem Services of multiple or bundled conservation measures is feasible since it can take into account numerous conservation management practices that have been implemented at the farm level. This project will use quantitative and qualitative tools to 1) determine whether the existing NFBW adequately consider multiple conservation measures implemented on farms to address nitrogen management and other conservation measures already implemented by growers and 2) design a NFBW that considers multiple conservation management practices to highlight the Ecosystem Service benefits of using more than one practice at the same time on a farm or field.

Hedgerows offer numerous benefits and growers have used their own resources and NRCS EQIP dollars to install many miles of this conservation practice in the San Joaquin Valley. In addition to being habitat for wildlife and native pollinators, if designed effectively, they also contribute to

limiting surface water nitrogen movement off working lands, providing additional and diverse forage for managed pollinators like honey and solitary bees, and improving soil health. This bundled approach is more effective from a conservation and Ecosystem Services perspective but little has been done in California to qualitatively and quantitatively assess the multiple benefits from multiple conservation measures.

There is a high probability of success for this project based on review of scientific literature and from discussions in the CDFA Environmental Farming Act Science Advisory Panel. The scientific literature, on the benefits of multiple conservation practices, is used as a foundational component in the CDFA Qualitative Assessment Model (QAM) that was developed using input from the Science Panel. This model has been used to evaluate various projects involving multiple conservation practices. For example, the QAM was used to evaluate the USDA NRCS Agricultural Water Enhancement Program Northern San Joaquin River Water Quality Project. In this project, several different management practices were used in conjunction (e.g., tail water recovery system, irrigation system improvements) to achieve water quality improvements in the San Joaquin River. The management practices implemented to improve surface water quality in the San Joaquin River also provided numerous other benefits including enhanced aquatic wildlife habitats as a result of water quality improvements, enhanced nutrient cycling through effective on-farm water cycling, and improved water management through implementation of micro-irrigation systems. This project is designed to qualitatively and quantitatively examine the many Ecosystem Service benefits of on-the-ground "bundled" conservation practices on farms in California.

The results and deliverables of this project can be utilized in other States with diverse crop production commodities such as Florida and New York. Many States use the national NRCS practice code 590 for nutrient management, but designing NFBW for local agronomic conditions, especially for states with diverse agricultural production, will be useful. Unique NFBW that consider bundled conservation measures, highlighting the benefits of Ecosystem Services, will enhance the agricultural systems and provide environmental benefits.

b) Project objectives

The objective of this project is to qualitatively and quantitatively examine the many Ecosystem Service benefits of bundling together NFBW and on-the-ground conservation practices (e.g., hedgerows) on farms in the California's San Joaquin Valley. This project will explore the potential for using NFBW as an in-season grower tool to effectively capture the multiple benefits from nitrogen management and hedgerows already implemented on farms.

This project is innovative since NFBW have not been used before to support and highlight the many Ecosystem Services offered through nitrogen management along with existing on-farm conservation measures. For example, according to the California NRCS practice standard 590 on nutrient management, the plan calls for establishing perennial vegetative cover in all areas of concentrated flow, optional installation and maintenance of vegetative filter strips and riparian buffers in conjunction with other conservation practices in order to reduce the amount of sediment and nutrients from reaching surface and groundwater, and that irrigated fields should use irrigation scheduling strategies with the intent of minimizing leaching. These criteria specified in standard practice 590, and several others, have multiple Ecosystem Services benefits

when considering the CDFA Ecosystem Services definition and categories (http://www. cdfa.ca.gov /EnvironmentalStewardship/Ecosystem Services.html). The Ecosystem Services of vegetative covers, including hedgerows that provide wildlife habitats for native pollinators and birds, help with the development of soil structure and health, enhanced biodiversity and pollination rates on working lands, and improved water quality/cycling. The findings from this project have the potential to be widely used and applied since they would be beneficial to growers to understand their nitrogen distribution on-farm and to recognize the many other conservation benefits or Ecosystem Services offered from bundling management practices.

c) Project methods

To achieve the objectives, several action measures - followed by specific methodologies - will be initiated. They include;

1. Collection and analysis of existing NFBW templates

Several existing NFBW will be collected and analyzed for their ability to provide and influence different Ecosystem Services using the qualitative QAM.

2. Design of a NFBW to effectively capture the benefits for nitrogen management and to also capture and quantify other conservation practices

CDFA and its collaborators will design a NFBW that can effectively account for nitrogen management and include other Ecosystem Service benefits. The bundled management practices considered to highlight multiple Ecosystem Services including nitrogen management, benefits of hedgerows (riparian/wildlife buffers) and pollination services. Project partners are currently involved in a five year national study linking habitat quality and quantity to the delivery of pollination service, the results of which will tie directly to qualitative assessments of pollinator habitat quality, as outlined in this proposal. A template for a NFBW will be critically evaluated by several subject-matter experts to determine improvements to the worksheet document prior to implementation.

3. Implementation of the NFBW with approximately 20 growers in the San Joaquin valley, California.

CDFA has determined that conservationists and agronomists from the local Resource Conservation Districts (RCDs) will be ideal candidates to lead the on-the-ground effort of this project. They will be responsible for implementing the NFBW in close coordination with growers, monitoring, capturing, and documenting existing conservation practices such as cover crops and hedgerows, and providing that information to other collaborators of the project for quantifying and qualitatively assessing the benefits of bundled conservation practices on grower fields. Growers who have already implemented conservation practices such as hedgerows for wildlife habitat will be ideal participants for this project. Several miles of hedgerows for wildlife habitat have been already implemented in the San Joaquin valley using NRCS EQIP cost share funds. However, the benefits of these hedgerows and how to bundle these services with nitrogen management have not been quantified or determined. Several other collaborators on this project will help identify growers in the San Joaquin valley who already implemented conservation management practices related to wildlife habitat and pollination services in agricultural fields. The collaborators include the Almond Board of California, California Farm

Bureau Federation, Western Growers, and the California Association of RCDs. The California Association of RCDs has recently initiated a project to engage growers in this region in considering and evaluating the numerous benefits from bundled conservation measures including nitrogen management. These efforts are critical since the concept of Ecosystem Services is a relatively new discussion topic to growers in California.

4. Monitor, capture, and document nitrogen management information including benefits from already implemented conservation practices.

Conservationists and agronomists from the local RCDs will monitor, capture, and document basic information in coordination with growers in the San Joaquin Valley, California. For example, a NFBW requires collecting information on nitrogen distribution in fields as well as querying the grower about on-farm management practices such as cover crop use. The information is used to complete the NFBW as well as provide additional information on existing conservation measures (e.g., hedgerows). The information will be used by other project collaborators to qualitatively and quantitatively evaluate the multiple benefits or Ecosystem Services of bundled conservation measures.

5. Qualitatively assess the benefits from the multiple "bundled" practices

CDFA will use the recently developed QAM to visually show the many Ecosystem Service benefits of using NFBW and also the benefits of bundling NFBW with other NRCS conservation management practices implemented on farms in the San Joaquin Valley of California. Initial examination of different scenarios using the QAM has shown that multiple Ecosystem Services are enhanced when using more than one management practice. For example, some of the Ecosystem Service categories enhanced by considering hedgerows on agricultural fields include benefits to wildlife habitats, biodiversity conservation, water quality, nutrient cycling, pollination services and soil health. Many farmers, including those that can be categorized as early innovators, in the San Joaquin Valley California, have already implemented native pollination management practices (e.g., hedgerows) to enhance the overall environmental quality of their working land.

6. Quantitatively assess the benefits from the multiple "bundled" practices

At present, there is no California-based information available to support environmental trading markets between point-source and non-point emitters although some pilot projects have been initiated to test a trading system. This project will use information captured in the NFBW to test and validate the NTT. The NTT has not been applied, tested, and calibrated for farms in the San Joaquin Valley of California. NFBW can be an effective in-season grower tool to evaluate nitrogen management and also help determine how much nitrogen can be reduced through effective utilization and application of nitrogen fertilizing materials. It is also a necessary component of a viable nitrogen trading market. There is evidence in other states that such trading markets are providing an incentive to growers to optimize nutrient use. Management practices used to optimize nutrient use contribute to protecting water ways from nutrients. Establishment of trading markets for nitrogen is a long-term vision of the Science Panel. The Science Panel has noted that some fundamental information is needed to move the discussions to pilot projects for

initiating environmental trading markets. NFBW, used in concert with the NTT, offer a method to evaluate and gather this fundamental information.

7. Evaluate economic benefits of the multiple Ecosystem Services

The value of the management practices as an Ecosystem Service will be evaluated using the Ecosystem Valuation Toolkit (EVT) developed by Earth Economics. The EVT provides spatially explicit monetary assessment of benefits beyond food, fiber, fuel to include up to 23 Ecosystem Services including habitat, pollination, and water filtration and supply. This kind of valuation can be used to understand and communicate the economic importance of our farms to the local/regional economy, beyond traditional agro-economics, to a wide audience including other regional growers. The economic value of these services will be compared to the cost of implementing the management practices which will provide an overall economic analysis of the bundled services. This evaluation along with the NTT analysis is consistent with the economics funding area for consideration titled “Projects designed to stimulate the development of environmental markets”.

d) Location and size of project

The project will be implemented on approximately 20 tree and field crop farms in the San Joaquin Valley (part of the Central Valley), California. There is a diversity of crops grown in this region (e.g., grapes, almonds, cotton, citrus, tomatoes). The diversity of crops is supported by diverse farm sizes ranging from under 100 acres to over 500 acres. Diverse population groups can be found involved with agriculture in the region (e.g., Latino, Hmong). To the extent possible, growers from different ethnic backgrounds will be recruited for this project. This project will also identify several different farm sizes under different cropping conditions for the implementation of this project. Focusing this project in this region is important because it is the State's leading agricultural producer. Several counties comprise the San Joaquin valley. They include Kings, Fresno, Kern, Merced, and Stanislaus counties and portions of Madera, San Luis Obispo, and Tulare counties. The figure below shows the geographic location of this region. This region also has impaired water systems where nitrate levels from nitrogen fertilizer application to agricultural crops are of concern.

f) Project action plan and timeline

ID	TASK	START DATE
1	Organize collaborators meeting	9/3/2013
2	Hold collaborator meetings to discuss roles and responsibilities	9/17/2013
3	Collect, analysis, design and develop NFBW	10/7/2013
4	Obtain critical review of designed NFBW	12/9/2013
5	Identify 20 growers for project participation	9/17/2013
6	Coordinate with grower for NFBW implementation	11/4/2013
7	Implement NFBW in collaboration with growers	1/1/2014
8	Evaluate nitrogen distribution and management practices on farm	1/1/2014
9	Monitor, capture, and document benefits of hedgerows, including bee diversity and abundance, for Ecosystem Services	1/1/2014
10	Use CDFA QAM to evaluate Ecosystem Service benefits from using multiple or bundled conservation measures (Year 1)	10/29/2014
11	Use CDFA QAM to evaluate Ecosystem Service benefits from using multiple or bundled conservation measures (Year 2)	10/27/2015
12	Calibrate NTT using captured information from NFBW	2/23/2015
13	Determine potential for nitrogen trading markets	10/29/2015
14	Evaluate economic benefits using EVT	11/3/2014
15	Compile semi-annual report	7/30/2014
16	Compile final report	7/8/2015
17	Develop fact sheet and other outreach documentation	7/7/2015
18	Grower outreach and education meeting 1	9/8/2015
19	Grower outreach and education meeting 2	10/14/2015
20	Grower outreach and education meeting 3	11/23/2015
21	Public outreach efforts	10/14/2015

g) Project management

Personnel from CDFA's FREP program and Executive Office will lead project administrative and coordination functions. CDFA, a State governmental organization, will also maintain close coordination and regular meetings with collaborators of this project at all levels of work. Project implementation, monitoring, capturing of on-farm information will be completed by conservationists and agronomists with the local RCDs. These personnel from the RCDs have existing relationships with local growers through partnerships on projects such as EQIP. Therefore, the personnel from the RCDs will be responsible for working with growers to implement the NFBW and gather on-farm conservation practice information. Several other collaborators on this project (e.g., California Farm Bureau Federation, Almond Board of California, Western Growers) will help identify growers that can be part of this project. Several associations will provide consultation services. For example, Audubon California will carry out vegetation monitoring twice annually, in order to document the diversity and abundance of annual and perennial plants which provide food, shelter, and nest sites for a diversity of wildlife. Audubon California will also assess the carbon storage capacity of hedgerows. Similar training and advice on pollinator habitat assessment and qualitative assessment of bee abundance and diversity will be provided by experts from the Xerces Society. The table below provides a more detailed list of collaborator role and responsibilities.

Key project personnel	**Role and responsibilities**
Doug West Ph.D CDFA – Environmental Scientist Dr. West will serve as project lead.	Responsible for managing all administrative aspects of the project including coordinating with project collaborators and consultants. Other responsibilities include ensuring timely completion of project activities, writing performance reports, maintaining financial transactions, distributing information to pertinent project collaborators, and organizing regular meetings for those involved in this project. The project lead will participate in NRCS CIG events for the duration of this project.
Amrith Gunasekara Ph.D CDFA – Science Advisor Dr. Gunasekara will provide technical agronomic and environmental science expertise for this project.	Responsibilities include gathering existing NFBW templates, providing technical guidance and design on NFBW to ensure they can capture multiple conservation practices as bundled services, and evaluate information using the NTT and CDFA Qualitative Assessment Model.
Karen Buhr CARCD – Executive Director Ms. Buhr leads the California Association of Resource Conservation Districts.	Activities include organizing training through workshops to educate potential participants and lay the groundwork for an effective project, build a network of diverse farmers that are informed about bundled Ecosystem Services and able to participate in this project, and initiate and implement all farm-level activities to facilitate successful completion of this project.
Doug Parker Ph.D University of California (UC)	Activities include serving as liaison and coordinator for UC Agricultural and Natural Resources technical

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Institute for Water Resources - Director	agronomic and scientific support for the project, provide access to UC Extension Specialist and Farm Advisors and assist with outreach for the project. These extension specialists have agronomic expertise and grower information that are critical aspects of this project. Dr. Parker has considerable experience on the economics and potential implementation of environmental markets and will provide direction and advice.
Mace Vaughan Xerces Society – Pollinator Director	The Xerces Society has been engaged in activities involving native pollinators and pollinator habitat projects in California since 2002. Experts from the society will provide training for on-the-ground collaborators of this project to use existing tools to assess pollinator habitat and document bee abundance and diversity.
Hank Giclas Western Growers – Senior Vice President	Western Growers is an association that will contribute to this project by identifying and recruiting cooperating farms/growers, identify and quantify the extent of EQIP practices employed by grower members, and communicate project information, findings, and other pertinent information to growers as part of the project outreach effort.
Jennifer Harrison-Cox Earth Economics – Managing Director Jonathan Kochmer MSc. Earth Economics – Research Director Earth Economics will provide 0.1 FTE or $21,425 in in-kind contributions, for the project duration, in the form of volunteer time for this project (not included in the project budget).	Earth Economics will serve as a collaborator in the collection, classification and standardization of economic data on pollination services, hedgerows and wildlife habitats, as bundled conservation practices, for use in the Ecosystem Valuation Toolkit (EST). Other activities include conducting a full Ecosystem Services Valuation (ESV) analysis of the San Joaquin Valley and summarizing findings in a user-friendly report for EQIP eligible producers, policy makers, and the public.
Valerie Calegari Audubon California – Conservation Project Director	Restoration professionals from Audubon California will identify growers in the San Joaquin Valley who have carried out on-farm habitat restoration efforts. They will carry out vegetation monitoring twice annually in these hedgerows and riparian plantings, in order to document the diversity and abundance of annual and perennial plants which provide food, shelter, and nest sites for a diversity of wildlife. Audubon California will also assess the carbon storage capacity of hedgerows and riparian plantings through an evaluation of the quantity of the above- and below-ground plant material.

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Danny Merkley California Farm Bureau Federation – Water Resources Director	Many growers in the San Joaquin region are members of the Farm Bureau. The Farm Bureau will contribute to this project by identifying corporative growers with different farm sizes to participate in this project. Other activities include participating in project collaborator meetings and assisting with information distribution to growers.
Robert Curtis Almond Board of California Gabriele Ludwig Ph.D Almond Board of California	The project will be implemented in a region with large almond production (over 575,000 acres in 2012). The Almond Board of California will contribute to this project by providing agronomic advice, on both nitrogen budgeting in almonds and on pollination services and management of alternate forages, and by identifying corporative growers to participate in this project. Other activities include participating in project collaborator meetings and assisting with information distribution to growers. This includes publicizing the project and extending results through several print and electronic media and at the Annual Almond Conferences.
Joe Karkoski Central Valley Regional Water Quality Control Board (CVRWQCB) – Supervisor	Staff will participate in project collaborator meetings, provide feedback on project activities as it relates to CVRWQCB irrigated lands regulations, and assist with outreach activities as needed.

h) Project deliverables

Successful completion of this project will lead to several important deliverables that will be applicable to agriculture in other regions of California and other States as well. They are:

1. Qualitatively assess the Ecosystem Services resulting from the deployment of bundled management practices.
2. Quantify the Ecosystem Services from using bundled management practices on working lands in the San Joaquin Valley, California.
3. Demonstrate the applicability and use of NFBW as an important in-season tool for determining plant nutrient needs and collecting information on multiple management practices.
4. Evaluate the information collected in the NFBW with use of the NTT to develop nitrogen trading environmental markets.

Semi-annual reports will be provided to the funding agency and made public to effectively show the progress of the work described in this proposal. The project lead or Science Advisor from CDFA will attend NRCS CIG events during the period of the grant to highlight the work and provide updates on work progress. A final report will be completed and provided to the funding agency upon completion of the project. This report will also be available for public access to maintain transparency. The final report will be completed in coordination with the project collaborators. Several fact sheets will be developed to explain the work proposed here during and after completion of the project.

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i) Benefits of results expected and transferability

This project will show the many Ecosystem Service benefits of bundling together NFBW and on-the-ground conservation practices (e.g., hedgerows) on farms in the California's San Joaquin Valley. There are several social and environmental benefits of this work. They are described below.

Benefits to the environment

This project examines the multiple environmental benefits or Ecosystem Services afforded by bundling conservation practices together, in this case, nitrogen management and already established habitats for wildlife, biodiversity and native pollination services such as hedgerows. Therefore, the primary environmental benefits include less groundwater nitrate pollution by efficiently managing nitrogen applied to soil for crop uptake and recognizing the importance of hedgerows for wildlife and pollination services on working farm lands that are often devoid of such zones. There are several environmental benefits of this work. They include:

- highlighting the importance of different components of a NFBW that accounts for other conservation management practices such as cover crops and effective irrigation methods which promote Ecosystem Services such as soil health and water cycling, respectively;
- determining how nitrogen from croplands in California can be used in a trading market which balances the overall use of nitrogen on a regional scale;
- understanding how to effectively capture and communicate, though quantitative and qualitative tools, the multiple Ecosystem Services afforded by growers who used nitrogen management practices along with other bundled conservation practices to enhance the overall environmental standing of their farm; and
- increasing the number of native plant species, birds, and native pollinators providing biodiversity which can potentially lead to several other indirect environmental benefits such as resilience against invasive plant and animal pests and less reliance on imported bees for pollination services.

Benefits to society

Ecosystem Services have been defined by the Science Panel as the "the multiple benefits we gain from farming and ranching including crop and livestock production. In addition to valuable open space and wildlife habitat, the management decisions and conservation practices of farmers and ranchers also enhance environmental quality, provide recreational opportunities and offer social benefits." (http://www.cdfa.ca.gov/EnvironmentalStewardship/EcosystemServices.html). The use of conservation practices on farms greatly enhances Ecosystem Services which include social benefits such as jobs, food production, and recreational opportunities. There are several social benefits of this work. They include:

- effectively emphasizing and communicating to the public and growers the many benefits to society when considering the environmental and Ecosystem Service benefits of multiple conservation measures on working agricultural lands (e.g., improved water quality);

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- highlighting economic contributions from growers and EQIP funding for implementing conservation practices to enhance the land thereby providing sustainable working lands for future food production;
- demonstrating regulatory certainty, mandated by society (e.g., right to clean drinking water), using grower (NFBW) and Ecosystem Service tools (CDFA QAM and EVT);
- applying the outcomes of this project to other regions of the country to promote environmental stewardship on agricultural farms on a larger regional scale;
- using the NFBW to potentially increase food production and yields by optimized and efficient use of nitrogen fertilizer application for crop uptake;
- evaluating native pollination services for sustainable food production in the future in light of recent declines in bee colonies ; and
- ensuring the benefits, through qualitative and quantitative analysis, of using multiple conservation methods on farm to maintain clean drinking water supplies under irrigated agricultural land in the San Joaquin Valley, California.

The results and deliverables of this project can be transferred to and utilized in other States with diverse crop production commodities such as Florida and New York. Many States use the national practice code 590 for nutrient and nitrogen management but designing NFBW for local agronomic conditions, especially for States with diverse agricultural production, will be useful. Unique NFBW that consider bundled conservation measures, highlighting the benefits of Ecosystem Services, will enhance agricultural system and environmental benefits at the same time.

This project utilizes collaborative partnerships, coordinated funding and in-kind support, and leveraged Federal investment in environmental evaluation of conservation practices in conjunction with agricultural production to provide unique opportunities to address environmental concerns at the source while maintaining economic agricultural viability in California.

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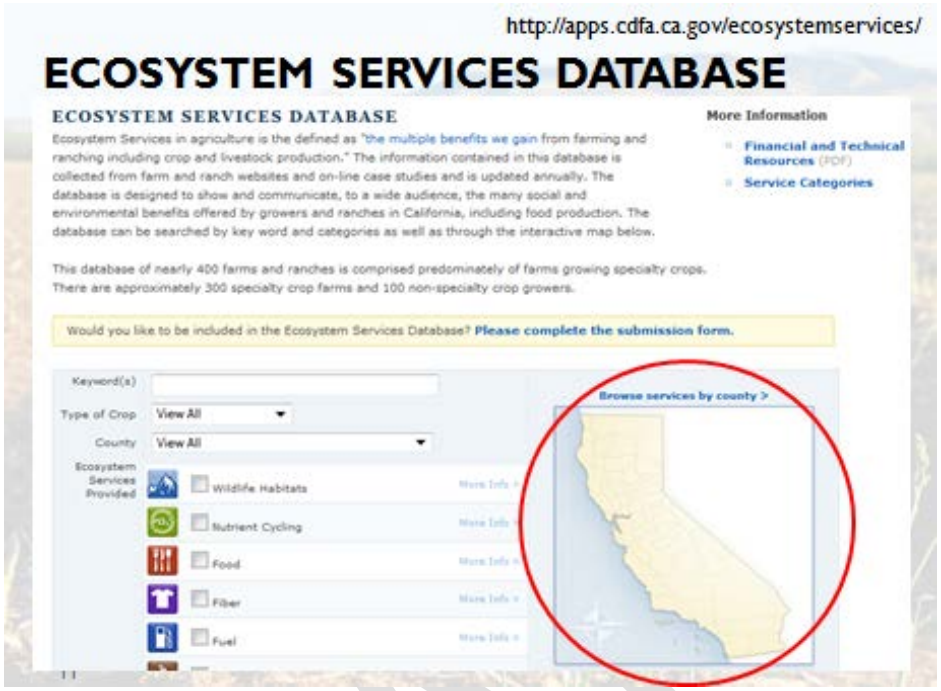
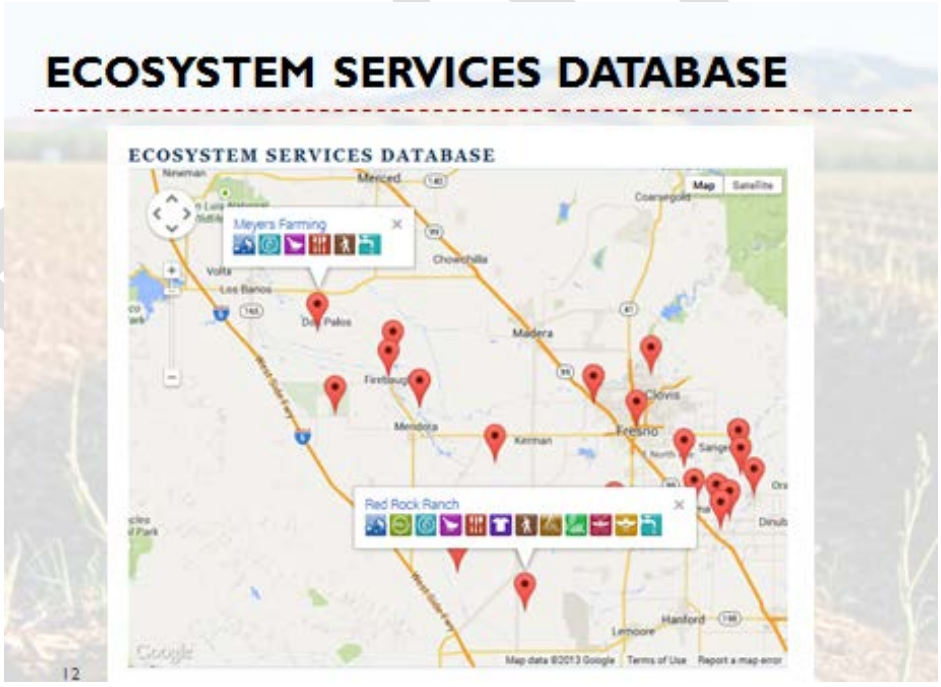
Appendix 4 - Ecosystem Service Database





ECOSYSTEM SERVICES DATABASE

Meyers Farming

Services Description

Almond farmer Marvin Meyers is concerned about the natural resources and environment surrounding his orchards. He constructed an underground water storage aquifer that holds up to 35,000 acre feet of water. Flood water and purchased water are deposited into the aquifer. In addition, he created a wildlife refuge using native plants, which provides habitat for hawks, rabbits, and lizards. He hosts school tours of the refuge as well.

Case Study Website

http://plantingseedsblog.cdfa.ca.gov/wordpress/?p=2322

Location

Firebaugh

Crop Type

tree crops

Crops

almonds

Size

3,500 acres

County

- ✓ Wildlife Habitats
- ☐ Nutrient Cycling
- ✓ Food
- ☐ Fiber
- ☐ Fuel
- ✓ Recreation and Cultural
- ☐ Soil Structure Formation and Fertility
- ✓ Biodiversity Conservation
- ✓ Water Cycling
- ☐ Atmospheric Gas and Climate Regulation
- ✓ Water Quality
- ☐ Pest Control
- ☐ Pollination Services

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ECOSYSTEM SERVICES DATABASE

CDFA Home > Ecosystem Services Database > Services > Wildlife Habitat

WILDLIFE HABITAT

Provide habitats for resident and transient wildlife populations

Suitable habitats provide a combination of food, water, shelter and space arranged to meet the needs of resident and transient wildlife. Restoring riparian areas and planting perennial vegetation within an agricultural landscape can help support wildlife.

Below are practices that contribute to wildlife habitat.

- Alley Cropping (PDF)
- Brush Management (PDF)
- Herbaceous Weed Control (PDF)
- Conservation Cover (PDF)
- Windbreak/Shelterbelt Establishment (PDF)
- Silvopasture Establishment (PDF)
- Woody Residue Treatment (PDF)
- Field Border (PDF)
- Riparian Herbaceous Cover (PDF)
- Riparian Forest Buffer (PDF)
- Stream Habitat Improvement & Management (PDF)
- Aquatic Organism Passage (PDF)
- Hedgerow Planting (PDF)
- Access Control (PDF)
- Forage Harvest Management (PDF)
- Drainage Water Management (PDF)
- Access Road (PDF)

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http://apps.cdfa.ca.gov/ecosystemservices/