

# ECOSYSTEM MANAGEMENT



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## INTRODUCTION - SUSTAINABILITY AND ECOSYSTEM MANAGEMENT

Ecosystem management is encouraged and implemented by agriculturists, communities, governments, businesses, academics and conservation organizations worldwide. However, ecosystem management can be challenging to comprehend and apply due to the intricacies and interactions among its interrelated processes. Ecosystem management for agriculture requires knowledge of ecosystem components and processes and how to optimize them to improve agricultural productivity and environmental quality.

An ecosystem is the complex of living organisms and the physical environment interacting and functioning together. Ecosystem components are inseparable and interrelated. Agricultural practices affect multiple aspects of the ecosystem and should be managed accordingly. Awareness of the interconnectivity of ecological, social, economic and institutional systems is fundamental to understanding how agriculture and landscapes relate. An ecosystem management approach acknowledges that people are part of and significantly impact ecosystem structure and processes, and depend on and must assume responsibility for their ecological, social and economic systems.

Four fundamental processes affect ecosystem dynamics and environmental quality — water cycle, mineral cycle, energy flow and community dynamics. Understanding the basics of each process can improve your approach to land stewardship and optimize agricultural productivity.

### Water Cycle

Water enters landscapes as rainfall and is stored either in the soil profile; as surface water in ponds, lakes and reservoirs; or as groundwater in aquifers. Water exits landscapes via runoff, evaporation, transpiration and deep percolation through the soil profile into aquifers. In natural and agricultural ecosystems, plants significantly influence water storage and movement. On-site water resources are increased by practices that limit runoff, and improve infiltration and the water-holding capacity of soils. Water use efficiency can be optimized by regular maintenance and monitoring of irrigation systems, and basing irrigation decisions on soil moisture, soil water-holding capacity and crop demand. These practices help ensure the supply and efficient use and cycling of water, as well as optimal crop productivity.

### Mineral Cycle

The mineral or nutrient cycle is the process by which key elements such as nitrogen (N), phosphorus (P), potassium (K) and other macro- and micronutrients move through the living (biotic) and nonliving (abiotic)

components of the ecosystem. Ideally, the mineral cycle involves a biologically active soil with adequate aeration and energy flow to sustain diverse organisms that exchange carbon, nitrogen and oxygen with the atmosphere. Implementing practices that prevent off-site nutrient losses (e.g., buffer strips and hedgerows) and increase nutrient cycling (e.g., cover cropping, compost additions and efficient fertilizer use) make farming operations efficient, productive and environmentally sound.

### Energy Flow

The living world runs on solar energy, and energy flow impacts ecosystem structure and functions. Through photosynthesis, plants capture and convert solar energy to chemical energy (carbohydrates) for their growth and development. Animals, in turn, depend on energy stored by plants. All life forms rely on energy flow; thus, so does every economy, nation and civilization. Agricultural practices impact energy flow. Executing practices that enhance energy flow helps optimize crop productivity and other ecosystem processes.

### Community Dynamics

A community is a subset of the living organisms in an ecosystem. Plant and animal communities constitute the highest levels. The animal community, for example, can be divided into soil microbial, insect, bird and related communities. Community dynamics, the most vital of the ecosystem processes, refers to how communities interact with each other and the physical environment. Optimal functioning of other processes depends on plants being present to convert sunlight to useable energy for animals. Biologically diverse communities are never static, as species composition, density, age structure and other factors change constantly. Biodiversity is a measure of the variety of plant and animal species in an ecosystem. A diverse assemblage of plants and animals enhances the functioning, stability and productivity of the ecosystem, which increases crop productivity and quality.

Because ecosystem management generally is implemented for and affects larger landscapes, the practices relevant to orchards in this module should be assessed at the whole-farm (not individual orchard/block) level. Practices pertinent to hulling/shelling or processing should be assessed at the facility level.

# Ecosystem Management

For this farm or facility, the following ecosystem management practices and approaches relevant to the general landscape were used:

Not familiar with this  
I haven't tried it  
I have tried it  
My current practice  
Not applicable

## GENERAL LANDSCAPE ISSUES

1	The name and basic characteristics of the ecological region (e.g., Sacramento Valley, Bay/Delta, Sierra Foothills or San Joaquin Valley) where the farm or facility is located were known.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
2	The watershed where the farm or facility is located was known.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
3	One (or more) member of the farm or facility was an active member in a local or regional water quality coalition.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4	One (or more) member of the farm or facility participated in a watershed stewardship planning group.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5	Other: _____				<input type="checkbox"/>	

We live and farm in a watershed...

A watershed is the area of land where all of the water that is under it, or drains off of it, ends up in the same place.

John Wesley Powell, scientist geographer, put it best when he said that a watershed is "... that area of land, a bounded hydrologic system, within which all living things are inextricably linked by their common water course and where, as humans settled, simple logic demanded that they become part of a community."\*

Watersheds come in all sizes and often cross county and state lines as well as property boundaries. Accordingly, it is important to remember that we live and farm in watersheds; and, thus, are accountable for protecting and wisely using water resources.

\*Adapted from: <http://water.epa.gov/type/watersheds/whatis.cfm>.

For this farm or facility, the following ecosystem management practices and approaches relevant to threatened or endangered species were used:

Not familiar with this  
I haven't tried it  
I have tried it  
My current practice  
Not applicable

## THREATENED OR ENDANGERED SPECIES

6	The threatened and/or endangered species that might inhabit the farm or facility grounds have been identified. <input type="checkbox"/> Yes. (Includes determination of none.) <input type="checkbox"/> No. (Skip to question 11.)					
7	The identified threatened and/or endangered species that might inhabit the farm or facility grounds have been documented.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8	Habitat for any threatened and/or endangered species that might inhabit the farm or facility property has been identified.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9	The farm or facility property was managed to protect and/or enhance habitat for threatened and/or endangered species (e.g., Safe Harbor Agreement).	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10	Other: _____				<input type="checkbox"/>	

**What is a Safe Harbor Agreement (SHA)?**

A Safe Harbor Agreement is a voluntary arrangement between non-federal landowners and the U.S. Fish and Wildlife Service or National Oceanic and Atmospheric Administration – Fisheries. Primarily, SHA promotes voluntary management of listed threatened and/or endangered species on non-federal property, while assuring landowners that no additional regulatory restrictions will be imposed. The agreements benefit both the targeted species and the landowners, who can farm without worry of additional regulations and associated fines or penalties from noncompliance.

For more details, see <http://www.fws.gov/midwest/endangered/permits/enhancement/sha/index.html>.

**Threatened and Endangered Species and Habitat in California**

The Federal and California Endangered Species Acts list about 360 plants and animals as threatened or endangered in California. About half of the listed species have approximately 80% of their habitat on private lands, according to a 1993 study by the Association for Biodiversity Information and The Nature Conservancy. Consequently, efforts by private landowners to conserve these species is crucial. Some state and federal programs provide landowners with incentives to implement conservation practices that benefit threatened or endangered species while protecting their interests in the land (e.g., Safe Harbor Agreements).

Information about threatened, endangered and rare species in California is available from the California Department of Fish and Wildlife Threatened and Endangered Species website ([https://www.dfg.ca.gov/wildlife/nongame/t\\_e\\_spp/](https://www.dfg.ca.gov/wildlife/nongame/t_e_spp/)). The information includes lists of common and scientific names, physical descriptions, associated habitat and status.

		Not familiar with this	I haven't tried it	I have tried it	My current practice	Not applicable
<p>For this farm or facility, the following ecosystem management practices and approaches relevant to biodiversity were used:</p>						
<b>PROMOTION OF BIODIVERSITY</b>						
11	The value (ecosystem services) of ensuring a high level of appropriate biodiversity (e.g., beneficial wildlife, plants and soil organisms; pollinators; and pest natural enemies) on the farm or facility property was understood. <input type="checkbox"/> Yes. <input type="checkbox"/> No. (Skip to question 18.)					
12	Farmed or landscaped areas were managed (e.g., cover crops, low/no tillage, additions of organic matter or landscape plantings) to increase appropriate biodiversity.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
13	Areas not farmed or landscaped were managed to increase appropriate biodiversity, including beneficial wildlife (e.g., by providing owl and songbird nest boxes, bat boxes or raptor perches).	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
14	Habitat features on the farm or facility property were connected by vegetated corridors and to adjacent properties to the extent feasible to provide connectivity for beneficial wildlife.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
15	Numbers and/or symptoms of desirable animals and plants on the farm or facility property were observed to determine impacts from management.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
16	Numbers and/or symptoms of desirable animals and plants on the farm or facility property were measured and recorded to determine impacts from management.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
17	Other: _____				<input type="checkbox"/>	

### Songbirds and Bats Are Insectivorous

Although many adult songbirds eat seeds, not insects, all adult songbirds feed insects to their young during the nesting season. Bats also consume insects when flying at night. Consequently, using nest and bat boxes to enhance songbird and bat populations can benefit agriculture. To encourage owls to occupy owl boxes, the boxes should be cleaned annually by removing nesting material from the previous year.

### What are ecosystem services?

Ecosystem services are the benefits to humans from the many resources and processes supplied by ecosystems. Services include reducing greenhouse gases, recycling nutrients, providing habitat for beneficial wildlife (some wildlife can pose food safety issues; see the Almond Board of California’s GAP) and regulating microclimate and local hydrological processes. In some cases, ecosystem services can include suppressing plant and animal pests via natural enemies, and buffering the off-site movement of sediment, nutrients and pesticides.

For this farm or facility, the following ecosystem management practices and approaches relevant to conservation easements were used:		Not familiar with this	I haven't tried it	I have tried it	My current practice	Not applicable
CONSERVATION OF EASEMENTS						
18	Some or all of the natural areas of the farm or facility property were protected by a natural resources conservation easement.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
19	Some area(s) or the entire farm was protected by an agricultural conservation easement.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
20	Other: _____				<input type="checkbox"/>	

### Conservation Easements

Natural resources conservation easements are legal agreements that allow landowners to donate or sell some “rights” on portions of their land to a public agency, land trust or conservation organization. In exchange, the landowner agrees to restrict development and farming in natural habitat, and ensures the easement land remains protected in perpetuity. A 1996 survey conducted by the National Wetlands Conservation Alliance found that the leading reasons landowners restored wetlands were to provide habitat for wildlife, leave something for future generations, and preserve natural beauty. Only 10% of the surveyed landowners restored wetlands solely for financial profit. This finding applies to habitats besides wetlands. Natural resources conservation easements can provide landowners with financial benefits for the protection, enhancement and restoration of natural environments on their properties. Moreover, many easement programs include payments for costs associated with habitat restoration and enhancement.

It is important to recognize and enhance the services that the ecosystem provides to benefit almond production and environmental quality.

Agricultural conservation easements have the explicit purpose of keeping farmland in production. They resemble natural resource conservation easements, but specifically preserve farmland for farming. Local opportunities may exist for one or both types of conservation easements. See <http://www.conservation.ca.gov/dlrp/cfcp/Pages/Index.aspx> for details.

Flowering shrubs and pollinators

Flowering shrubs can be a valuable alternative nutrition source for bees. In fact, a beekeeper reduced rental charges by thousands of dollars for a Firebaugh-area almond grower because the presence of these optional nutrition sources allowed hives to remain in the orchard for more of the season.

For this farm or facility, the following ecosystem management practices and approaches relevant to upland habitat maintenance and enhancement were used:

		Not familiar with this	I haven't tried it	I have tried it	My current practice	Not applicable
UPLAND HABITAT MAINTENANCE AND ENHANCEMENT						
21	Hedgerows of trees and/or shrubs were maintained on at least some edges of the farm or facility property.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
22	Hedgerows of flowering shrubs, such as coyote brush, were maintained along at least some edges of the farm or facility to provide alternative nutrition sources for native pollinators and pest natural enemies.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
23	Vegetation was maintained on the farm or facility that provides pollen and nectar sources for introduced pollinators before and/or after almond bloom.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
24	Vegetation such as grasses, trees or shrubs was maintained along roadsides, ditch-banks, headlands and/or irrigation canals (where feasible), to provide habitat for beneficial wildlife and slow and retain water and filter contaminants.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
25	Beneficial trees (besides almonds) that existed before farm or facility establishment have been maintained, and/or beneficial trees were planted after establishment, such as along roadsides, to provide habitat for beneficial wildlife.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
26	Other: _____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>



For this farm or facility, the following ecosystem management practices and approaches relevant to riparian and wetland habitat maintenance and enhancement were used:

Not familiar with this  
I haven't tried it  
I have tried it  
My current practice  
Not applicable

RIPARIAN AND WETLAND HABITAT MAINTENANCE AND ENHANCEMENT

27	Riparian habitat, swales, vernal pools or water courses were present on the farm or facility property. <input type="checkbox"/> Yes. <input type="checkbox"/> No. (Skip to question 35.)					
28	Swales were managed with setbacks to preserve them and prevent their rutting by equipment when the soil was wet.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
29	If vernal pools and/or water courses exist on the farm or facility property, setbacks were in place to minimize their disturbance.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
30	If water courses exist on the farm or facility property, their banks were maintained with resident non-woody vegetation (excluding noxious weeds).	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
31	If water courses exist on the farm or facility property, their banks were maintained with a mix of grasses, trees and shrubs.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
32	Dying trees (unless infested with damaging disease), snags and downed logs were maintained in riparian buffer areas to provide cover, forage and habitat for beneficial wildlife.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
33	If water courses exist on the farm or facility property, there was enough canopy cover to adequately shade the water course(s) and thus benefit its functions as habitat.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
34	Other: _____				<input type="checkbox"/>	

What is resident vegetation?

Resident vegetation is composed mostly of nonnative plants, including weeds. It is important to ensure that resident vegetation growing in riparian areas excludes noxious weeds. Regular monitoring and resultant control actions, when necessary, can prevent the establishment of noxious weeds.

Resident vegetation provides many of the same ecosystem services as native plants. However, if economically feasible to plant and/or maintain, native plants are preferred in buffer strips, hedgerows, etc., because they are adapted to the area.

**Ecosystem management plans and assistance**

An ecosystem management plan for your farm or facility is the vision to manage the living and nonliving components of your property to help ensure the long-term health, biodiversity and productivity of your operation and surrounding areas.

Plans should reflect the resource base managed (land boundaries and conditions, internal and external stakeholders, and available financial and human resources and equipment). Plans should include measurable goals and monitoring procedures for areas used and not used for production based on stakeholder shared values, forms of production/use, and the desired future landscape.

The NRCS has resources to help with natural resource conservation for agriculture. This includes guidance and funding for technology and implementing practices, and for doing surveys and management plans. For more details, see <http://www.ca.nrcs.usda.gov/programs/> or contact your local NRCS office.

For this farm or facility, the following ecosystem management practices and approaches relevant to ecosystem management planning were used:

		Not familiar with this	I haven't tried it	I have tried it	My current practice	Not applicable
<b>ECOSYSTEM MANAGEMENT PLANNING</b>						
35	An environmental survey and map of the farm or facility property has been completed and notes sensitive areas (e.g., swales, waterways, trees, habitat for endangered species and other features). <input type="checkbox"/> Yes. <input type="checkbox"/> No. (Skip questions 36-40.)					
36	An expert, such as staff from the USDA Natural Resources Conservation Service (NRCS), helped complete the survey.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
37	The map was used for pesticide use reporting.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
38	The map was used for ecosystem management planning.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
39	A written ecosystem/habitat management plan has been completed for the farm or facility that includes goals for production areas, goals for managing areas not used for farming or processing, and a monitoring protocol to measure improvement over time.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
40	Other: _____				<input type="checkbox"/>	

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