Delta Working Landscapes – Feasibility Report

September 2013

Introduction

This report addresses the feasibility of the Delta Working Landscapes program and the continuation of completing similar restoration activities. The intent is to provide baseline information regarding the different restoration practices and restoration planting techniques in order to guide future grant or land owner based restoration activities. Although no two restoration projects are the same, understanding the restoration practices and restoration planting techniques for working landscape projects can inform decisions about the feasibility of success for a particular circumstance.

Project Goals

The Delta Working Landscapes Program was designed to encourage public/private partnerships to implement practices that improve the quality of the Delta environment and sustain and enhance agriculture. The goals of the Working Landscapes projects are to:

1. Improve environmental quality of existing working landscapes.
2. To develop an educational mechanism and economic model to transfer environmentally friendly farming knowledge, techniques and practices to other farms.
3. To facilitate environmental compliance through overcoming disincentives and increasing incentives towards achieving these goals.
4. Coordinating a research program with the farmers to understand the social, economic, environmental and governmental policy impediments and incentives to performing conservation practices.

Project Objectives

The Delta Working Landscapes Program project objectives are to:

1. Create vegetated buffers on ditch banks and hedgerow plantings that improve water quality by reducing runoff of sediment and pesticides.
2. Create vegetated levees with native grasses, sedges and other low-growing species that will stem erosion, discourage burrowing animals and reduce weed growth.
3. Creating wildlife friendly habitats such as native grassland plantings, riparian forests and wetlands in areas uneconomical to farm.
4. Identifying farming practices that benefit wildlife and environmental values such as v-shaped ditches, interior berm construction, and conversion to permanent wetlands on marginal farm lands.

Restoration Practices and Planting Techniques

This report evaluates two critical elements to restoration projects 1) Restoration Practices and 2) Restoration Planting Techniques. Restoration planting techniques are methods in which restoration ecologists can utilize to develop Restoration Practices. Ideally, the restoration ecologist will utilize different planting techniques where appropriate to provide the most cost effective successful restoration project.

Habitat Friendly Agriculture

Vegetated Ditch Banks: Ditch banks are challenging sites for restoration. Ditch bank characteristics vary based on site conditions. In the Delta, soils near ditches tend to consist of heavy, clayey materials that seasonally vary from wet to very dry, and are often compacted. These sites also vary from barren, due to frequent use of herbicides, to extremely weedy. Certain techniques are suitable for ditch banks, while others are not. As ditch banks are generally steep, the use of mechanized equipment, such as tractors and seed drills, is not always feasible. Hand planting is therefore a preferred strategy. Before planting, weed control is recommended techniques include hand weeding, mowing , weed trimming and some sites may require the judicious use of herbicides. The size of container plants can vary: seedling plugs (generally 1" x 1" by 3" deep), tree bands (2 7/8 x 2 7/8 by 9" deep), to one gallon sized materials. The larger sized materials have better developed root systems and so they are more likely to survive in conditions of drought and weed competition. The preferred time of planting is mid to late fall after sufficient rainfall has wetted the soil to a depth of 6-8 inches. Planting is facilitated by the use of hand held, power augers. A two-person crew with one person digging holes and the other planting can expect to install 800-1000 plants per day. After planting comes the maintenance phase. Initial weeding with hoes to remove competing weeds, mowing or the selective use of broad-leaved herbicides (if only grasses are planted) is recommended. Several years of weeding is needed to ensure success of the project. Should drought conditions prevail, a not unlikely consequence of global climate change, then supplemental irrigation may be necessary.

Vegetated Waterside/Landside Levee Slopes: Levee slopes may be installed with certain plants, provided that they do not compromise flood control objectives. Concerns about vegetation are different for waterside conditions compared to landslide levee slopes. During flood events, it is imperative that the landslide of levees be visible for inspection of possible leaks. Low growing grassy vegetation is recommended for ease of visibility of levee conditions. For the waterside of levees, more robust vegetation can be tolerated for several reasons. Vegetation can help to resist the forces of erosion, so planting and establishing appropriate vegetation can be an asset. However, vegetation that is too large, such as cottonwood trees, can present a hazard should a tree fall and dislodge a portion of the levee slope. Small woody vegetation, small shrubs and robust grasses and forbs can be tolerated at the lower portion of the levee slope, a location that is beneficial to many species of wildlife. The upper 1/2 to 2/3 of the slope should be only planted with grasses and grass-like plants, however; this is to facilitate flood fighting during periods of high water. Several techniques are available for installation of plant materials. The waterside of the levee, as it is often steep, is not well-suited for mechanized equipment, such as tractors. Hand-planting techniques, as described above, are appropriate in these locations. The installation of well rooted materials is recommended. However, should willows be tolerated, the direct installation of 3-4 ft. long cuttings is appropriate. Supplemental irrigation, using overhead sprinklers, is often deployed to

insure survival of the plants. Ideally, newly re-contoured levee slopes are better suited for restoration as one is starting out with a relatively weed free environment. But the cleanliness of the site is also a function of certain pre-emptive actions to further reduce weed growth. This may involve the selective use of herbicides (provided that the soil does not become contaminated with pre- and post-emergent ingredients), disking and mowing. A good time of the year to spray is after fall rains have germinated weed seeds. At this time the site may be lightly disked or sprayed. More than one treatment can be implemented. The sowing of seeds, generally with a range drill, is generally the technique of choice. Range drills are used because they can bury the seeds at the appropriate depth of about 1 inch. After the seeds have germinated, and the seedling grasses are 6-8 inches tall, the judicious and careful application of a broad-leaved herbicide may be applied. Other techniques include mowing of the grasses to eliminate the growth of annual plants, especially exotic grasses, during the spring. This should be done before the alien grasses overtop the perennial species and before the former go to seed. This mowing regime (and occasionally supplemented with the use of broad-leaved herbicides) should be practiced not only during the establishment period but also as a permanent maintenance practice.

Wetlands

Restoration practices and techniques for development of semi-permanent and seasonal wetlands include a multitude of considerations. Considerations for Delta Working Landscape restoration projects generally included land owner desired wetland conditions, farmland type, crop type, soil type, hydric status, drainage status, water availability, distance to other native habitats, and other site specific circumstances. Overall, this information influences restoration design practices and implementation techniques.

Initial design for evaluating wetland restoration should take a watershed and a historical ecological approach whenever possible. This is not always possible due to specific site constraints, landowner desires, management capabilities and potential impacts on listed species and surrounding landowners.

In many instances current social and science based community partners are pushing for passive wetland systems that restore more of the historic conditions of the Delta. For the Delta this technique generally includes restoration of tidal connectivity, flood plain connectivity, seasonally flooded areas. However, this presents extreme challenges while trying to maintain a working landscape as these are large scale restoration practices.

For the Delta Working Landscapes restoration projects, managed wetlands were designed and built to provide a higher degree of habitat reliability and landowner risk reduction. To maintain the working landscapes Delta Working Landscapes restoration project focused on managed semi-permanent wetlands and managed seasonal wetlands.

Managed seasonal wetlands were designed and built to be managed as moist-soil wetland units. This type of wetland management promotes the germination of specific types of plants. Managed seasonal wetlands provide an abundance of plants that provide a high carbohydrate food source, necessary for the high energy demands of flight, for migratory waterfowl. Plant species such as crabgrass (*Digitaria spp*.), millet (*Echinochloa spp*.), smartweed (*Polyganum spp*.), and swamp timothy (*Heleochloa schoenoides*), etc. contain vital carbohydrates. Waterfowl and other migratory waterbirds utilize these food sources during wintering periods to replenish body fat consumed in migration flight.

Managed semi-permanent wetlands were designed and built to provide year round water with an interspersion of upland, emergent and open water habitat communities. Generally semi-permanent wetlands provided much need water in the late spring and summer months. Semi-permanent wetlands provide a host of benefits for a plethora of wildlife, and are especially utilized by waterfowl for brood-rearing, molting, loafing, foraging and predation avoidance.

Each of these wetland types contribute to various water-bird life cycle stages. There are multiple benefits and costs associated with each restoration practice. The restoration comparison table further elaborates on several of these factors, which may better inform the most appropriate restoration practice associated with the restoration projects goals.

Planting Techniques

Various techniques are deployed in habitat restoration, such as seeding, plug and larger container sized direct installation of plants.

Seeding for Native Grasses. The use of seeds in working landscapes restoration is best applied on sites that have been thoroughly cleaned and/or reconfigured. These restoration sites resemble a well-cared for agricultural field. Seeds can be successfully used but weed control is especially critical. Initial pre-planting weed control can consist of plowing, disking and roto-tilling to physical remove weeds. This approach can be supplemented with the careful use of herbicides. Contact herbicides are applied directly onto the weedy plants to be controlled. Pre- or post emergent herbicides may also be used, but these can negatively impact the planted grasses so caution is required. Once a field has been well prepared then seeds can be applied, especially with range drills that bury the seeds. The timing of planting is critical: generally fall planting after initial rains is the best time of the year as there would be sufficient warmth to foster seed germination. Mid winter planting can be problematic as native grasses do not readily germinate during the coldest months of the year. Once the grasses have germinated, then maintenance techniques are required to ensure success. Spring mowing to knock down invasive weeds is needed. Judicious use of broad-leaved herbicides may also be required. Long term maintenance of native grassland sites is required.

Planting Plugs. Many restoration professionals prefer planting small plugs, which are barely rooted juvenile plants. These can be successful installed on relatively clean sites using a dibble stick to create a planting hole. A good time to install these plants is between fall and winter rains. Planting too late in the spring does not provide sufficient time for the plants to become established.

Larger Container Stock. Well rooted and relatively more mature plants stand a better chance of survival than smaller plants. These plants may be installed in wetland or upland environments, and the plants involved may includes grasses, herbs, and woody plants. Since these materials are more expensive that seeds or plugs, their use is recommended for smaller acreages and/or more difficult sites. Tules and rushes can be planted along the wetted perimeters of wetland sites at nearly anytime of the year (provided there is sufficient moisture content). Upland sites using grasses and sedges should be installed during the cool, wet season. There is somewhat more latitude of the planting season than for the smaller plug plants, but late spring planting should still be avoided unless artificial irrigation is provided. Weeding of these sites is required through the establishment period. Planting of woody native species also involves larger

sized container plants. Power augers are often used to dig the planting hole. The use of landscape fabric to control weeds and the application of a temporary irrigation system is required. Generally 2-3 years of irrigation and weed control is necessary for plant establishment.

Passive Restoration. Typically, working landscape seasonal wetlands are designed and built to be managed as moist-soil wetland units. This type of wetland management promotes the germination of specific types of plants by drawing down a flooded wetland at specific times within the growing season, generally in Early, Mid or Late Spring. By managing water levels through the use of water control structures, the manager can promote a variety of plants that provide a high carbohydrate food source, necessary for the high energy demands of flight, for migratory waterfowl. This technique is considered a passive technique as no seed or installation costs are associated with seed production.

Plant species such as crabgrass (*Digitaria spp*.), millet (*Echinochloa spp*.), smartweed (*Polyganum spp*.), and swamp timothy (*Heleochloa schoenoides*), and other wetland species contain vital carbohydrates. Waterfowl utilize these food sources during wintering periods to replenish body fat consumed in migration flight. By winter flooding the vegetation and subsequent seed heads, the food source becomes available to ducks and geese, as well as a variety of other water-birds.

Comparison of Restoration Practices and Techniques

The restoration practices and techniques comparison table below identifies several of the ecosystems, restoration and land owner constraints and benefits identified within the Delta Working Landscape program (Table 1).

Table 1: Comparison of Restoration Practices

Restoration Practice	Waterbird Benefits	Other Biologic and Social Benefits	Short Term Maintenance Requirements	Long Term Maintenance Requirements	Implementation Cost
Semi-permanent Wetlands	Moderate to High	Moderate	Low-Moderate	Low to Moderate	High
Seasonal Wetlands	High	High	Moderate to High	Moderate to High	Moderate
Wildlife Friendly Flooded Agriculture	Moderate to High	Moderate	Low	Low	Low
Vegetated Ditch Banks	Moderate to High	High	Moderate	Low	Moderate
Native Grasslands	Low to Moderate	Moderate	Moderate to High	Low	Low
Hedgerows and Buffers (Herbaceous)	Low	Moderate to High	High	Low	Moderate to High

Although no two restoration projects are equal, the table attempts to evaluate the general nature of the restoration technique or practice based on the findings from the developed projects. Cost evaluations were

determined based on direct project costs, and vary considerably due to the economy of scale and site specific conditions.

Restoration planting techniques were evaluated for hedgerow, buffer strip and levee slope projects. However, the findings from these projects do cross over to other restoration practices such as seasonal wetland and semi-permanent planting techniques. The findings are summarized in the Restoration Planting Techniques table below (Table 2).

Table 2: Comparison of Planting Techniques

Restoration Planting Technique	Weed Competition	Versatility	Short Term Maintenance	Long Term Maintenance	Implementation Cost	Site Constraints And Limitations
Drill Seed	Low	Moderate	Moderate	Low	Low	Limited in Weedy conditions, compact, clayey soils. (Drill seeding more versatile if site is prepped)
Plug Planting	Moderate	Moderate	Moderate	Low	Moderate	Weedy conditions, poor soil.
Root Stock/ Container Plantings	High	High	Moderate	Low	High	Economic limitations
Passive	Low	Low	High	Moderate	Low	Depends on residual seed bank.

Low, moderate and high rankings were established for evaluation of Restoration Practices and Restoration Planting Techniques for each criterion. The comparisons are made with respects to each of the identified practices and do not financially or ecologically define ratings of low, moderate or high. As example, the high waterbird benefits of Seasonal Wetlands does not constitute a given population usage or duration of use per year or acre over that of the low waterbird benefits for Hedgerows and buffers. The logic is comparative, general observations made throughout the projects have lead us to believe that seasonal wetlands provide greater waterbird benefit than hedgerows or buffers strips.

Short term maintenance would typically be considered all maintenance activities required from project implementation to 3 years post project implementation. Long term maintenance would the required activities after the short term maintenance period. For further information about maintenance activities please refer to the Delta Working Landscapes – Vegetative Buffer and Wetland Habitat Management Guide dated September 2013.

Economic Considerations

When determining the feasibility of Working Landscape projects, cost is an important consideration. Costs that should be considered include project implementation and construction, short-term and long-term maintenance costs, and environmental compliance and permitting. When assessing feasibility, project costs should be considered in relation to the availability of funding assistance, economic incentives, and other benefits.

Project Implementation and Maintenance Costs

Costs for project implementation will vary significantly based on the type of restoration practice, site-specific conditions and preparation, and project design. Tables 1 and 2 identify the range of costs for various restoration practice and planting techniques. For the Working Landscapes projects, costs for buffer vegetated ditches, and levee slopes varied from $4.95-21.28 per linear foot. For wetland projects, cost between projects which ranged from approximately $1,200 per acre to over $12,000 per acre. Irrigation systems and wetland infrastructure contributed to the wide variation in costs across the same types of projects. For further information regarding implementation costs please refer to the Delta Working Landscapes – Cost Analysis Report, dated September 2013.

Due to the short time frame of this study, the costs associated with the short or long term maintenance of the restoration practices were not thoroughly evaluated; however, professional judgment through our years of coordinated restoration projects we have made some general assumption on the level of effort and costs associated with maintenance activities. It is important to understand that not all projects are the same and the Low, Moderate and High rankings for costs in Tables 1 and 2 not absolute.

Regulatory/Permitting Costs

Regulatory and permitting compliance and associated costs are also important feasibility considerations. Restoration practitioners as well as landowners have indicated that there could be high costs and level of effort associated with permitting and regulatory compliance for voluntary restoration like Working Landscape projects (CRAE 2010). Depending on the project, permitting costs can range in the thousands to tens of thousands of dollars (CRAE 2010).

For the Working Landscapes Program, environmental compliance and permitting was overcome by a California Environmental Quality Act categorical exemption and the utilization of other programmatic permits. Many of the project actions fell under agricultural exemptions and ongoing reclamation district operational permits.

There are a variety of web-based permitting assistance tools that are available to assist with identifying permitting requirements for Working Landscapes projects (CARCD 2009; CRAE 2010). Funding assistance may also be available to assist with project permitting (described further below).

Incentives and Assistance Programs

There are various funding and incentive programs available for Working Landscape projects that can significantly reduce implementation costs for landowners. Some programs also provide annual incentive payments, which may offset ongoing maintenance costs. An overview of major incentive programs is presented in Table 3.

Table 3: Incentive Programs for Working Landscape Projects

Program Name	Description	Incentive
Wildlife Habitat Incentive Program (WHIP)	Voluntary program for people who want to develop and improve wildlife habitat primarily on private land.	Up to 75% cost share for 5 to 10 years
Conservation Reserve Program (CRP)	Assistance to farmers and ranchers regarding soil, water and natural resources concerns and compliance with Federal, State and tribal laws.	Financial and technical assistance
Environmental Quality Incentives Program (EQIP)	Voluntary conservation program for farmers and ranchers to implement structural and management practices to improve environmental quality.	Financial and technical assistance, up to 75% cost share for 1 to 10 years
California Wetlands Reserve Program	Farmers can sell easement of lands for conversion to wetlands and riparian habitat, and may also benefit from sale of hunting rights.	Financial and technical assistance
California Landowner Incentive Program (LIP)	Assistance to private landowners to enhance and manage the region's three predominant historic habitat types: riparian, wetland, and native grassland.	Incentive payments for a 3 to 5 year contract range between $25/acre/year to $400/acre/year depending on the habitat type
Source: Riparian Habitat Joint Venture (2009); Department of Fish and Wildlife (2013)		

Research on creating additional regulatory and economic incentive programs for agriculture stewards to enhance the environmental benefits they provide, including payments for ecosystem services and conservation credits in California is ongoing (CRAE 2012).

Other Considerations

Barriers to environmental enhancement, especially establishing native plants, are a real concern and involve social/cultural considerations, lack of experience or knowledge about native plant and animal species, inherent incompatibilities between the needs of native species and crops, and potential health concerns.

Most cultivated landscapes are nearly monocultural in nature. The farm landscape consists of neat rows of well kept crops in which competing weeds are kept at bay through intensive cultivation techniques, including disking and the application of herbicides. From a practical standpoint, establishing native plants in the context of the widespread use of herbicides is fraught with problems of drift and impacts potential restoration efforts. This is not a friendly environment for native plant species. The dearth of native species may have, in part, a cultural explanation. To many farmers the unruly appearance of native species is suggestive of weeds. The presence of native species doesn't fit into the concept of neat and straight rows idealized by farmers. To a large extent the presence of native plant species in the Delta, when they occasionally can be found, is the result of benign neglect. The potential beneficial use of native species is a new concept for most farmers. Simply stating their benefits may not be convincing. Farmers may also believe that native species cause harm to crops. An example is the many methods of scaring birds away from cherries during the brief harvest season. In recent years, there have been increased food safety concerns and the potential health risks of having native species of animals (i.e., rabbits) in agricultural fields, the concerning being that some disease might spread from the animals to the crops.

Ecosystem Services and Benefit Outcomes

Working landscapes provide a broad-range of ecosystem services and benefits. A summary of the potential ecosystem benefits for vegetative buffers and seasonal and semi-permanent wetlands is presented in Table 4.

Wildlife friendly agriculture projects are intended to provide habitat for wildlife, improve water quality by reducing runoff of pesticides and sediment, enhance levee stability, and retard levee erosion. Wetland restoration practices provide waterfowl brooding habitat, a food source, and additional wetland functions and services which promote healthier waterbird populations. These benefits are not only qualitative, but can provide economic benefits as well, through improving the value of farmland and diversifying recreational opportunities.

Table 4: Ecosystems Functions and Services of Working Landscape Projects

ECOSYSTEM SERVICE	DESCRIPTION	POTENTIAL BENEFITS	
		Vegetative Buffers	**Seasonal and Semi-permanent Wetlands**
Provisional Services—Products obtained from ecosystems			
Food	Food and energy sources derived from plants, animals, and microbes	Allows for ongoing land cultivation for food production.	Seasonal wetlands provide food production of high carbohydrate plant food sources for a variety of wildlife. Semi-permanent wetlands promote aquatic invertebrate food sources for birds and may promote fish propagation under certain conditions.
Freshwater Water Supply	Storage or retention of fresh water and groundwater recharge	Provides improvements to water quality for water supplies.	Provides improvements to water quality for water supplies Increases groundwater recharge and promotes flood water attenuation for later release.
Fiber and Fuel	Wood and other biological materials that provide fiber for products or sources of energy	Vegetative buffers can produce woody materials.	Seasonal wetlands can produce highly productive cottonwood stands utilized in the pulp industry.
Biochemical Resources	Natural biota with a variety of medicinal uses	Native Americans have historically used several native plant species commonly found throughout the Delta for medicinal uses.	Native Americans have historically used several native plant species commonly found throughout the Delta for medicinal uses.
Genetic Materials	Generating or sustaining genes and genetic material for animal and plant breeding	Provides pollinator habitat and increases genetic diversity throughout the native plant community.	Without large expanses of habitat, wildlife breeding areas are diminished and subsequently reduce population sizes which reduces the gene pool with further propagates negative genetic mutations and reduces genetic diversity of wildlife. Semi-permanent wetlands are critical for the ongoing breeding of avian species within the Delta.

ECOSYSTEM SERVICE	DESCRIPTION	POTENTIAL BENEFITS	
		Vegetative Buffers	**Seasonal and Semi-permanent Wetlands**
Regulating Services—Benefits obtained from regulation of ecosystem processes			
Climate Regulation/Air Quality Maintenance	Provides climate regulation, including temperature, precipitation, and carbon capture; promotes resiliency and resistance to climate variability; contributes and/or extracts chemicals from the atmosphere	Uptake of CO_2, carbon sequestration, general air quality improvement.	Although no GHG protocol has been established for wetlands, research indicates that semi-permanent wetlands sequester atmospheric carbon, promote climate change resiliency and other climate regulation benefits.
Water Regulation	Regulation of hydrological flows, including flood flows and fluctuations in surface and groundwater	Plantings provide shade for ditches which can reduce evaporation and protect water quality and reduce diversion.	Provides for floodplain storage and attenuation of floodwater.
Water Purification and Waste Treatment	Filter impurities, contribute and/or extract chemicals into the atmosphere	Improves agricultural return water quality by filtration and sequestration of contaminants. Reduces herbicide use on restored areas.	Improves agricultural return water quality by filtration and sequestration of contaminants. Reduces herbicide use on restored areas.
Erosion Control/ Soil conservation	Promotes soil retention, reduces wind or water erosion, sedimentation and scouring, prevents landslides; retards subsidence	Reduces wind and water erosion of soil with vegetative cover and windbreaks; provides bank protection and increases slope stability.	Reduces water erosion of soil with vegetative cover; retards oxidation of peat and associated subsidence.
Biological Control	Affects the prevalence of ecosystem pests, pathogens and disease, and/or the spread of invasive species	Reduces noxious weeds.	Reduces noxious weeds.
Pollination	Promotes pollen transfer between plants, without which may plants cannot reproduce	Provides habitat for bees that pollinate crop plants.	Provides habitat for bees that pollinate crop plants.
Natural Hazard Regulation; Flood Attenuation	Provides regulation of natural hazards like wildfires, storm events and flooding; protects from or reduces damage caused by natural hazards	Provides windbreaks Reduces levee failure after flooding.	Seasonal and Semi-permanent wetlands provide additional storage and attenuation flood waters.

ECOSYSTEM SERVICE	DESCRIPTION	POTENTIAL BENEFITS	
		Vegetative Buffers	**Seasonal and Semi-permanent Wetlands**
Supporting Services—Services necessary for the production of all other ecosystem services			
Nutrient Dispersal and Cycling	Storage, internal cycling, processing, or acquisition of nutrients	Upland plants and wetland plants are an integral part of nutrient cycling.	Wetlands provide large amounts of nutrient cycling including the sequestration of atmospheric carbon.
Habitat Establishment / Provision	Establishment of habitat for resident and migratory species	Provides habitat for birds and other wildlife; attracts beneficial insects.	Provides habitat for birds and other wildlife; attracts beneficial insects.
Soil Formation	Processes that form soil, sustain soil fertility, or contribute to subsidence reversal	Provides organic matter for soil formation.	Provides organic matter for soil formation and retains floodwater sediments in wetlands May contribute to subsidence reversal.
Cultural Services—Nonmaterial benefits obtained from ecosystems			
Recreational	Provides for recreation opportunities like ecotourism, wildlife viewing, and hiking	Provides increases in birds and other wildlife for recreational enjoyment.	Provides increases in birds for recreational enjoyment.
Aesthetic	Provides for desirable conditions for sensory enjoyment of the environment like scenic views	Increases attractiveness of land for tourists, farm stand customers, and recreationists.	Increases attractiveness of land for tourists, farm stand customers, and recreationists.
Educational	Provides opportunities for formal and informal learning, including enhancement of scientific understanding	Provides for educational opportunities and contributes scientific knowledge for land conservation practices and environmental stewardship.	Provides for educational opportunities and contributes scientific knowledge for land conservation practices and environmental stewardship.
Sense of Place	Maintains or enhances unique or well-recognized features of the environmental that contribute to a sense of place	Enhances the aesthetics of agricultural and native landscapes which contribute to a sense of place in the Delta.	The long rich agricultural and hunting history within the Delta Community is well documented. By restoring wetlands and providing additional habitat and hunting opportunity contributes to a sense of place in the Delta.
Cultural Heritage	Maintains or enhances historically important landscapes or culturally significant species	Preserves productive agricultural landscapes which are important to the cultural heritage of the Delta.	Wetlands have been identified as culturally significant as well as containing culturally significant species.

ECOSYSTEM SERVICE	DESCRIPTION	POTENTIAL BENEFITS	
		Vegetative Buffers	**Seasonal and Semi-permanent Wetlands**
Source: UN Millennium Ecosystem Assessment (2005); Natural England Commissioned Report 102 (2012); Yolo County RCD (2012)			

Conclusion

The Delta Working Landscapes program has been a learning experience for the sponsors and contractors who implemented the grant. Hart Restoration, Inc. and Ducks Unlimited were each responsible for different aspects of the overall project. Hart was responsible for restorations, using native plant species, along the borders and edges of the property: ditches, levees and other borders of agricultural fields to improve various environmental parameters. Ducks Unlimited was responsible for within farm wetland development to enhance wildlife values. The projects differed in approaches, outcomes and lessons learned.

Vegetative Buffers: Ditches, Levees and Borders

1. Certain types of farming operations are more amenable to planting native plant species along ditches and levee slopes. Large scale open field commodity crops (such as corn and wheat) are less likely to be compatible with these environmental enhancements as broad herbicide application (sometimes done by airplane) is incompatible with native plant survival.

2. Vineyard sites seem to be more compatible with planting native species as herbicide application is done in a more controlled manner.

3. Success or failure seems to be related to the size, structure and management of the farming operation. Small family-run farms may not have the time or the financial resources to break away from farming operations to participate in environmental enhancement. Larger farms -- and presumably with more resources -- seem to have more resources to participate in environmental enhancements. More critically, larger farms often hire younger, college educated managers who value environmental improvements for its own sake.

4. The success and/or failure of this type of project will vary with inherent environmental conditions of soil types. Poor soil conditions, such as coarse sandy or fine clayey situations, are more difficult for plant growth. The most ideal environment is a well-balanced loam, which may be difficult to locate as most environments tend towards the clayey end of the soil spectrum. Extremely sandy conditions, in the Delta, are often the result of former dredging operations that pile sandy river bottom materials onto levee slopes. These materials are often derived from former hydraulic mining activities which brought course materials downstream from the gold mining regions downriver to the Delta. Extremely clayey soils are often the result of dredging from ditches; these materials are then placed on ditch and levee banks.

5. The success and/or failure of this type of project will vary with pre-existing types of vegetation. Extremely weedy conditions, especially sites with rank species of blackberry and other perennial plants, are not easily converted to native plant communities. First, several years of weed control (often through spraying of herbicides) is required to prepare the site for planting. If native plants are installed within a weedy community, then competition with the weedy species reduces the success of the intended species.

6. The success and/or failure of this type of project will vary with past and ongoing land management practices. In particular, sites with long histories of herbicide application make for difficult conditions for native plant establishment.

7. The success and/or failure of this type of project will vary with moisture availability. Planting of moisture loving plants along ditches can be very successful, while planting on dry slopes (with either too much sand or clay) will have problematic results. Another factor for planting success along ditches will also be somewhat dependent upon the timing and seasonality of water availability. The timing and amount of water available in ditch environments may not be ideal for plant establishment. These factors must be understood before planting is planned.

8. The timing of planting is critical. There is a narrow window of opportunity for success. This is in the middle of fall after sufficient rains, but not too late in the season as conditions dry out by mid spring. Therefore, large planting crews need to be able to plant within a 2-month period. Starting earlier or waiting for a latter date requires expensive pre-irrigation or post-irrigation.

9. Some general weeding or mowing is required to reduce weed competition. Planting into annual grass communities is more feasible than planting into coarser weed communities as the former can be more easily controlled through mowing. The presence of rank weed species requires hoeing or the application of herbicides which can be expensive or problematic for survival of the native plant species.

10. The most successful environment for ditch and levee slope environments will therefore include: 1) better quality soils (such as loams); 2) inherently cleaner sites with fewer rank and/or perennial weeds; annual grasses are the least problematic for planting success; 3) certain cropping environments, such as larger vineyards with farm managers who share these environmental goals.

11. The size of the planting materials influenced survival. The larger the plant, generally, the greater the likelihood of survival. The use of seeds is not recommended except for weed free and tilled sites; this is more likely to occur in conjunction with newly constructed landscapes, such as re-contoured levees or ditch banks.

12. Two out of the three years of this project were extremely dry. As global climate change will likely worsen conditions for plant survival, other measures, such as dedicated irrigation systems, will likely be needed.

Seasonal Wetlands

1. The rate and density of vegetation establishment for seasonal wetlands is variable whether using planting methods or passive methods. Spring draw downs and summer irrigations are the largest contributing factors in vegetation success.

2. It is more financially cost effective to develop larger restoration project due to the economy of scale. Subsequently, larger projects seem to provide greater avian habitat use.

3. The success of Seasonal Wetlands relies heavily on land owner/manager involvement. These types of projects require management effort to provide optimal habitat. When not managed correctly they provide minimal habitat opportunity.

4. Summer water is required for irrigations to maintain healthy vegetation growth, but requires close coordination with the local Mosquito Vector Control.

5. When managed correctly, seasonal wetlands provide the greatest habitat value to wintering waterfowl.

Semi-Permanent Wetlands

1. Landowners like these projects as they are visually appealing year round and require less management effort than Seasonal Wetlands.

2. Implementation of these projects typically cost more, due to greater excavation requirements.

3. Summer water is required to maintain surface water levels due to evaporation but requires less coordination with Mosquito Vector Control than seasonal wetlands.

4. These projects provide great habitat for multiple species of nesting and rearing birds.

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