Jewett Creek Integrated Farm Plan

prepared for:

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EXHIBITS

EXECUTIVE SUMMARY

The 294-acre Jewett Creek Farm, located in the Sacramento River floodplain in Tehama County, provides a unique opportunity to substantially improve the wildlife value within an integrated framework of agricultural and natural community land uses on privately-owned land. The Nature Conservancy's Sacramento River Project initiated this project as a case study to augment and add new tools for determining management recommendations for publicly and privately owned land in the Sacramento River floodplain where a balance between agriculture and wildlife habitat is desired.

The farm currently consists of a 4-acre house and shop area near the western edge of the property, and 236 acres in agricultural production. The entire farmed area is planted with varieties of English walnut, including Hartley, Serr, Chico, Vina, Howard and Chandler. The walnut trees vary in age from 3 to 23 years and from poor to fair condition. The Jewett Creek channel follows an abandoned channel of the Sacramento River through the property and has been cleared of all native riparian vegetation. The farm fields have been graded, terraced and their margins extended by filling the formerly broader creek channel. A band of native riparian forest and scrub occurs between the farm fields and the Sacramento River's current channel and provides habitat value for wildlife. However, some non-native pest plant species including black walnut, arundo and tamarisk have invaded this remaining native community and threaten to outcompete the native vegetation and degrade the wildlife habitat value.

A multi-disciplinary team including wildlife, riparian forest ecology, hydrology and agricultural experts developed the Integrated Farm Plan through a comprehensive scientific evaluation of the area and input from the public. The team evaluated the physical characteristics of the site including the current and historical native vegetation communities and agricultural operations to develop management and habitat restoration recommendations that optimize agricultural production and wildlife habitat value based on the conditions and locations most suitable to each.

Water saturation of the roots and previous management practices were determined to be the primary causes for poor crop production on this farm. Three areas, or terraces, defined by elevation, were identified as management units: a 40-acre upper terrace including three agricultural fields and the house and shop area above the 180-foot elevation contour; a 140-acre middle terrace including the most productive portions of the three agricultural fields in the center of the property above the 175-foot elevation contour; and a 114-acre low terrace that includes all of the existing native vegetation communities, the degraded Jewett Creek channel, and the agricultural fields below the 175-foot contour.

It was recommended that the middle and high terrace areas remain in agricultural production and the low terrace area be restored and managed for native riparian plant communities and high-quality wildlife habitat. Long-term ownership could be any combination of public and private interests as long as the management units are kept whole. Additionally, it was recommended that the creek's riparian forest be restored to re-establish high quality wildlife habitat in the area by connecting the riparian forest on the adjacent property with the forest along the Sacramento River. A final recommendation was to widen the Jewett Creek channel and increase culverts at the farm's access road to remove potential flooding of off-site properties.

The farm and conservation land configurations, land ownership and management recommendations, and other conclusions reached in this farm plan are unique to the Jewett Creek property. However, the science-based approach for determining the configurations and management recommendations can be applied elsewhere and are hoped to serve as a model for integrating sustainable agricultural land uses and wildlife habitat.

INTRODUCTION

PROJECT DESCRIPTION AND PURPOSE

The Jewett Creek Integrated Farm Plan is an agriculture and wildlife conservation plan for the Jewett Creek farm, located along the western flank of the Sacramento River, California's largest river system draining the northern half of California's agriculturally rich Great Central Valley and ultimately connecting to the Sacramento-San Joaquin Delta, San Francisco Bay and the Pacific Ocean. The 294-acre Jewett Creek Farm is located 2 miles south of the Woodson Bridge State Recreation Area in northern Tehama County (Exhibit 1). The purpose of the plan is to provide an optimal balance of economically viable agriculture and high-quality riparian wildlife habitat supported by the natural conditions and agricultural history of the site. The Jewett Creek Integrated Farm Plan is intended to serve as a tool to protect agricultural uses on the floodplain and restore riparian habitat. It can serve as an illustration of a science-based agricultural, conservation, and general land use planning process that is accessible to individuals or groups of public and private landowners, including individual farmers, land trusts and land managers.

The region surrounding the Jewett Creek Farm has been actively farmed since the area was converted to agriculture between the 1850s and 1970s. Prior to farming, the area was characterized by riparian woodland and valley oak woodland in extensive bands up to 3 or more miles wide and hundreds of miles long in the Sacramento River floodplain (Barbour et al. 1993).

Under the influence of the Sacramento River, which has dominated and shaped the landscape, an abundant and rich mixture of plants and wildlife flourished in these natural communities for thousands of years. However over 88% of riparian forests in the Central Valley have been converted to agriculture and other land uses over the past 150 years (Barbour et al. 1983). As a result, many species dependent on riparian habitats have become uncommon or rare and some, like the least Bell's vireo (*Vireo bellii pusillus*) are no longer found in the region. The building of Shasta Dam in 1945 allowed the cultivation with less risk of flooding of new, low floodplain sites closer to the river. However, the Jewett Creek Farm was not cleared for production agriculture until 1978. Flooding along the largely non-leveed reaches of the northern Sacramento River continues to occur with regularity in the low floodplain due to a combination of unregulated tributary influences and releases from Shasta Dam.

Rising management costs and diminishing commodity prices of farm products have combined to force many landowners to reevaluate the land use options for their marginal lands, such as those subject to frequent flooding. The historic loss of habitat and conversions of agricultural lands to housing and other land uses has resulted in increased value placed on protecting and restoring natural wildlife habitat and compatible farming or other land use practices (e.g., recreation, hunting) that are profitable and may lead to a diversified economy. The need for an integrated planning approach to developing and protecting agriculture, natural habitat, and other land uses is perhaps greatest on cultivated areas now considered marginal for farming.

GOALS AND OBJECTIVES

INTEGRATED FARM PLANNING PROCESS GOAL AND OBJECTIVES

The goal of integrated farm planning is to create a land use and management plan that results in optimal agricultural and wildlife conservation values for a given site that are compatible with land uses on neighboring properties. To meet this goal, the objectives of the integrated farm planning process are to determine the types and locations of a range of suitable crops and management practices, natural plant communities, and associated wildlife habitats that have high ecological and economic values, and that can be supported by the physical conditions and processes specific to the site. The potential of each site may be limited by the physical conditions, such as the flood frequency and duration, soils, and changing river patterns. The potential may also be limited by cultural conditions such as the specific farming history of the site. As a result, integrated agricultural and conservation plans will be uniquely adapted to each site.

JEWETT CREEK INTEGRATED FARM PLAN GOAL AND OBJECTIVES

The Nature Conservancy (TNC) Sacramento River Project goal for the Jewett Creek Farm is to maximize wildlife habitat values on the site while maintaining an economically viable farming operation. The following objectives apply:

Physical and biological study objectives

Determine the physical and biological conditions that exist on the property as they relate to agricultural and conservation land use objectives.

Conservation objectives

1) Determine the most suitable natural communities and associated wildlife habitats for farm fields and unfarmed areas (e.g., stream channel) on the property.

2) Determine the best agricultural and natural area configuration for optimizing and protecting wildlife habitat.

3) Determine exact locations and causes of degraded wildlife habitat, and identify potential enhancements to restore high quality habitat in those areas.

4) Provide a conceptual habitat restoration design to help secure funding for restoration work at the site.

5) Recommend land ownership approaches for the continued protection of natural habitat on the property.

Agricultural objectives

1) Recommend land ownership approaches for the continued protection of viable agricultural areas on the property.

2) Provide a minimum of 100 acres of total farm area on the site. This size is the minimum assumed to be profitable to prospective farmer lessees who operate other farms within the area.

3) Provide farm fields that are a minimum of 40 acres in size to enable efficient farm operations.

4) Determine the most economically and ecologically suitable crops for each farm field that can be supported by the conditions of the site.

"Good neighbor" objectives

1) Determine causes and management actions to alleviate flooding problems to neighbors' properties. Investigate past alterations to the Jewett Creek channel on the Jewett Creek farm site, including narrowing of the creek channel and installation of a culverted road.

2) Solicit neighborhood and stakeholder comments, concerns, and suggestions to improve the integrated farm plan, including consideration of possible off-site impacts and specific management actions to resolve them.

INTEGRATED FARM PLANNING PROCESS

The integrated farm planning process has been designed to determine the types and locations of suitable crops, plant communities, associated wildlife habitats, or other land uses that have high ecological and economic values, and that can be supported by the physical conditions and processes specific to the site. Because the physical conditions and agricultural history are unique to any given parcel, the resulting land use plans will be equally unique to each site. In some locations in which this planning process is used, the optimal plan may call for a largely agricultural use of the land, while in other locations the plan may call for a largely natural habitat function for the land. The proportion of each land use type will depend on the physical and other conditions of the site as well as the landowner's goals and objectives (e.g., conservation emphasis vs. agricultural or recreational emphasis).

The steps used for the integrated farm planning process are as follows:

1) Determine and compare historical and existing conditions.

   The conditions of the site may include physical, biological, cultural, and other components. The most important physical components to consider for a site along an active river system are generally the site's hydrology, geomorphology, and soil conditions and how they are shaped and affected by river processes. Biological components include the natural plant communities and associated wildlife habitat values. Cultural components include the agricultural, recreational, or other land uses and their economic values.

2) Coordinate with stakeholders to determine interests, issues, and concerns regarding the project.

   Stakeholders should include the primary individuals or groups who have a stake in the outcome of the project, including neighbors, resource agencies, site managers, and others. Coordinating with the stakeholders may help to identify and solve

unanticipated concerns, provide helpful new information, and result in a better site plan and better relationships among all stakeholders. It also demonstrates the landowner's willingness and desire to be a good neighbor.

3) Conduct an integration team meeting to determine the preliminary plan and identify data gaps.

   The integration team meeting may occur before the stakeholder meeting and, if needed, again afterwards. The purpose of the meeting is to discuss the analyses from each discipline (e.g., agricultural, biological, physical) and try to reach consensus on the optimal design options for the site. Ideally, there is more than one good option in order to allow flexibility for changing landowners, market conditions, and other factors.

4) Gather missing information and conduct further analyses.

   Further analyses may be needed to determine solutions that resolve issues raised by stakeholders, or to answer questions raised at the integration team meeting.

5) Refine the integrated farm plan design.

HISTORIC AND EXISTING CONDITIONS

SITE HISTORY

About two-thirds of the Jewett Creek Farm site was converted to pasture by 1938 or earlier (Exhibit 2). The upper terrace area west of Jewett Creek had been converted to orchard and/or row crops. However, the Jewett Creek channel and drainage channels along the eastern edge of the property remained forested. In the late 1970s the property was sold and in 1978 it was converted to walnut orchards. The remaining riparian forest and woodland areas, primarily occupying the Jewett Creek channel and eastern portions of the property, were removed and the natural topography of the site was altered to form the current terraced pattern and farm fields (Exhibit 3). A culverted farm road was installed across the creek channel at the center of the property (Exhibit 3). In 1999, The Nature Conservancy purchased the property as part of the Sacramento River Project and initiated efforts to determine appropriate conservation and agricultural land uses for the site, leading to the development of this integrated farm plan.

REGIONAL SETTING AND LAND USES

The Jewett Creek Farm exists within a geographic landscape that can be defined by ecological and cultural characteristics as well as the physical dynamics of the river itself. Conservation and farming at the Jewett Creek Farm must be considered within the larger context of human and natural processes. The Farm is located in rural Tehama County. Although the property is in an unincorporated area, it is within the Federal Emergency Management Agency (FEMA) 100-year floodplain and designated floodway. Floodway management is the responsibility of the Reclamation Board and the Tehama County Flood Control District.

The Farm is within the Sacramento River Conservation Area (SRCA) and eligible for participation in associated conservation and restoration programs. Within the SRCA between Red Bluff and Chico Landing, 41,855 acres, or 75% of the area, is in agricultural production while only 6,413 acres, or 12% of the area, remains as natural riparian communities. The Jewett Creek Farm is also located within an actively meandering reach of the Sacramento River and the Farm's agricultural fields east of Jewett Creek are within the SRCA Inner River Zone Guideline (Exhibit 10). This Zone is roughly equivalent to the 150 year meanderbelt of the river, discussed below under "Site Analysis-Physical Conditions."

The Jewett Creek Farm is bordered on three sides by privately owned farm operations, including nut crop (currently walnut) orchards and pasture. Additionally, four miles of land along this stretch of the river are in conservation ownership. Approximately 1,500 acres of natural and restored riparian habitats owned by the U.S. Fish & Wildlife Service (USFWS) and the State of California Wildlife Conservation Board (WCB) are directly across the river from the Farm.

Within a couple of miles of the property and in many other locations along the river between Red Bluff and Chico Landing are excellent examples of mixed riparian forest, valley oak riparian forest and woodland and cottonwood/willow riparian forest. However, most of these habitats are currently fragmented remnants of the historically extensive riparian forest. Numerous state agencies, federal agencies, and private interests are currently working to protect and restore a continuous riparian corridor (i.e., the inner river zone) between Red Bluff and Chico Landing.

SITE ANALYSIS

PHYSICAL CONDITIONS

METHODS

An analysis of the historical and existing conditions of the site and adjacent areas was conducted for landform, soil, and hydrological conditions. The landform and soils analyses were based on a review of the California State University at Chico study (Brown et al., 2000) and comparisons of 1950 topography (U.S. Geological Service 7.5-minute topographic map series, Vina quadrangle) and 1998 topography (Harris pers. comm.). River meander trends were analyzed by comparing the 1938 aerial photograph of the site with the 1999 aerial photograph. Hydrological analyses included a review of the California State University at Chico study, a frequency analysis of daily Sacramento River stage at the Vina gage (3 miles upstream of the site) to determine flooding and groundwater elevation patterns, a reconnaissance survey of the property and detailed survey of the Jewett Creek channel by Gus Yates on February 16, 2001, and simulation of water surface profiles in Jewett Creek using the HEC-RAS stream hydraulics software (U.S. Army Corps of Engineers 2001). Feedback and suggestions provided by participants in a stakeholder meeting and presentation held at the site on June 6, 2001 guided the scope and direction of refinements to the hydrological analyses in order to better assess the flooding concerns, their causes, and possible solutions.

GEOMORPHOLOGY AND SOILS

The Jewett Creek Farm is located in the active 150-year meander belt (i.e., where the river channel has meandered during the past 100 years, or is anticipated to be over the next 50 years) of the Sacramento River between Sacramento River Mile 215 and 216, according to USGS (Note: USACE uses a different river mile system). The geology of the site is characterized by sedimentary features associated with the Sacramento River. Major physiographic features of the Sacramento River corridor in the project region include floodplains, basins, terraces, active and remnant channels, and oxbow lakes. These features, together with the historic and current hydrology and dynamic meander pattern of the Sacramento River, provide for a diverse array of riparian plant communities and associated wildlife habitats along the river channel intermixed in a broad arable floodplain.

The site slopes gently to the east in three primary farm terraces (Exhibit 4). The highest terrace includes the three farm fields along the western border of the farm and abuts the Jewett Creek channel. The middle terrace includes the farm's three interior farm fields and was created on a historical point bar.

The lowest farm terrace includes the three farm fields along the eastern edge of the property's farmed area and was created on a former creek drainage channel and riverbank sand bar (Exhibits 2 and 4). East of the farmed area is the youngest and, with the exception of Jewett Creek, lowest elevation feature on the property, a sand and gravel bar that continues to build eastward over areas the river occupied only 60 years ago.

Jewett Creek joins the property from its origin in hills northwest of the property. The creek winds its way southward and defines the southern boundary of the property before joining the river near the southeastern property corner. The Jewett Creek reach on the property was the main river channel in the late 19th century and now defines the boundary of what was a river point bar a century ago. The current Sacramento River channel and remnant meander channel occupied by Jewett Creek were formed through an avulsive cut-off process that is typical of the Sacramento river in this portion of the Sacramento Valley.

The interior farm fields adjacent to the creek were created when the historic point bar and creek channel were graded. During the site alterations, the Jewett Creek channel was narrowed along several hundred feet upstream of the confluence with the Sacramento River. The creek was also moved from its historical course, near the northwestern corner of the property, where it now follows the squared off farm field (Exhibit 4). The farm fields adjacent to the creek all slope toward the creek over much of those fields.

Geologic units present on the site and the immediate vicinity of the farm include the Modesto Formation (Qm), Quaternary Alluvium (Qa), Meander Belt Deposits (Qmb)(last 100 years), and Historic Meander Belt Deposits (Qhms)(DWR 1998). These are characterized by mostly erodible alluvial deposits consisting of gravel, sand, silt, and clay.

The soils on the Jewett Creek Farm property are mostly described as Columbia series soils (i.e., Columbia fine sandy loam, loam, silt loam, and Columbia complex), with the high terrace farm fields on the western boundary of the property described as Zamora silt loam (Exhibit 5a and 5b). The Columbia soils are well-drained, neutral (pH) soils that are generally medium-textured to moderately coarse-textured and formed on recent floodplains of the Sacramento River (Gowans 1967). Soil studies on the site were conducted by the California State University at Chico in March-April 2000 (Brown et al., 2000). Gravel layers were found in 3 out of 6 bore sites in the historic point bar, at depths of 7, 11, and 14.5 feet. Fine to coarse-grained sand, sandy loam, and loamy sand layers were found in most bore sites, including approximately 20 locations throughout the Jewett Creek channel. However, no gravel layers were found in the Jewett Creek channel bore sites.

Indications of hydric soil conditions, such as those caused by frequent, long-duration high water tables were evident in many bore sites. These included soil mottling, which results from long periods of anaerobic (low-oxygen) conditions and saturated soils. There is some evidence of hydric soils conditions in the lower elevation farm fields as shallow as 7 to 8.5 feet below the ground surface, and possibly as shallow as 2 feet deep (e.g., Field 6, Exhibit 4) (Brown et al., 2000). Mottles were also evident throughout the Jewett Creek channel beginning at depths of 1.5 to 3 feet.

HYDROLOGY

The existing hydrology of the site is dominated by the Sacramento River and, to a much lesser degree, Jewett Creek. A California State University at Chico study of the property concluded that surface and subsurface hydrology at the site are closely linked to the stage (height) of the Sacramento River (Brown et al., 2000). The Jewett Creek channel on the property is typically dry during summer even if upstream segments of the channel have pools of standing water in them. The creek carries surface flow during and following storms, and becomes inundated with backwater from the Sacramento River in downstream areas (i.e., below the farm road) almost annually for 1 to 2 weeks, except during multi-year droughts. In years of normal or above normal precipitation, the river typically inundates the lower end of the Jewett Creek channel several times, with the upstream extent of inundation determined by the maximum river stage in each event. The entire property may get flooded at least once every 2 to 3 years, except for some of the highest areas located north of the farm road that bisects the property (Brown et al. 2000). However, during years of below-average rainfall, runoff from the Jewett Creek watershed may not generate flows that reach the Jewett Creek Farm.

Groundwater levels at the site also appear to approximately equal river stage, rising in winter and falling in summer (Brown et al., 2000). Assuming a level water table, the depth to the water table can be estimated by subtracting the river stage elevation from the land surface elevation. Groundwater levels in summer typically remain fairly steady at an elevation of about 158 feet, or 11-22 feet below the ground surface in the existing orchard areas on the site. The elevation, season and duration of high groundwater levels strongly influence the suitability of various crops and native plant species for the different farm units on the property. Exhibit 6 shows the probability in any year that Sacramento River stage will exceed a certain elevation continuously for the various durations indicated by the curves (1, 3, 7 and 30 days). Deciduous trees are especially sensitive to shallow groundwater in spring, after leaves have emerged and active growth has begun. Although high groundwater levels are more common in January and February, March is the month when high groundwater levels are most likely to impair growth or promote root disease.

At the lowest end of the existing orchard (elevation 169 feet), the water table will be less than 10 feet below the ground surface for 30 consecutive days 7 years out of 10, and will be at the ground surface for 7 days 1 year out of 4. At the 175-foot elevation, the March water table will be less than 10 feet below the ground surface for 7 consecutive days about 1 year in 3. It will be less than 15 feet below the ground surface for 30 consecutive days every other year, on average.

Extended periods of fairly high groundwater levels occurred every year during 1997-2000, although mostly during the midwinter months. The maximum 30-day groundwater elevation (i.e. the water table elevation that was equaled or exceeded for 30 continuous days) ranged from 162 to 169 feet (corresponding to a water table depth of 6-13 feet at a ground elevation of 175 feet), but the period of high groundwater extended into March in only two of those years. The extremely wet spring weather in 1998 – including an unusual storm in early June – resulted in two continuous weeks of groundwater levels of 162-171 feet in early June (or a depth to water of 4-13 feet at a ground elevation of 175 feet).

ANALYSIS OF FLOODING PROBLEMS

Neighboring property owners have indicated that Ohio Road has flooded frequently in recent years, preventing vehicles passage. They suspect the problem may be associated with alterations to the Jewett Creek Farm property by the previous landowner. To investigate potential causes and solutions, three HEC-RAS simulations were completed of a 10-year flood event (800 cfs) on Jewett Creek. The first simulation examined the flows when given the existing channel configuration and vegetation conditions. The second was a simulation with three channel geometry modifications: widening of a "pinch point" near the creek's confluence with the river that was created during the grading that created the current farm fields on the property; removal of the road berm and culvert crossing the creek; and realignment of the 90-degree bend in the channel near the northwest corner of the property to its natural diagonal course. The third simulation was similar to the second, but with the addition of dense riparian forest ($n = 0.150$) along both banks of the creek, and a slightly-vegetated ($n = 0.060$), approximately 25-foot-wide swath, along the low-flow channel.

Simulated water surface profiles along Jewett Creek for each of the three aforementioned simulations are shown in Exhibit 7. Under existing conditions, the artificially narrowed channel section, or "pinch point", near the Sacramento River confluence has the greatest effect on water levels downstream of the culverted road crossing. The road crossing creates a significant backwater effect that dominates the profile up to the upstream end of the property.

The simulated water surface profile following removal of the pinch point and culverted road crossing and restoration of the original creek alignment upstream of the road crossing (i.e. removal of the artificial 90-degree bend) is 0.5-6.0 feet lower than the profile under existing conditions. The largest decrease is along the creek segment between the upstream property boundary and the road crossing. Upstream of the northern property boundary, the water surface profile climbs steeply back up to the existing profile. This results from the abrupt transition from the small channel and very dense floodplain vegetation on the upstream parcel to a relatively large, straightened unvegetated channel with no flow obstructions on the study parcel. The simple assumptions used to represent each simulated channel condition in the model resulted in some numerical instability and a simulated hydraulic jump near the upstream property boundary. Thus, the details of the profile for the second simulation (modified channel before regrowth of riparian vegetation) may be incorrect. However, the dominant factor influencing the water surface profile on the upstream parcel is the small channel and high roughness along that parcel.

Following reestablishment of mature riparian vegetation along the modified channel (the third simulation), a relatively smooth profile results. The water surface elevation is the same as for the second simulation at the downstream end of the creek and becomes progressively higher upstream, reaching a maximum increase of 4-5 feet at the upstream property boundary. There is only a slight steepening of the profile as it transitions onto the upstream property, and all three profiles converge between the property boundary and Ohio Road. Thus, the channel modifications and revegetation would appear to have a negligible effect on flooding at Ohio Road.

The simulations evaluate the effects of high flows in Jewett Creek that occur independently of high river stages in the Sacramento River. In reality, large local runoff events almost always coincide with high river stages because major storms affect the entire region. The 10-year peak river stage at the site is approximately 181 feet (Brown et al., 2000), which is slightly higher than the creekbed elevation at the upstream property boundary. Thus, during most major flow events, Jewett Creek is submerged by the Sacramento River along the entire reach on the property, and channel modifications and revegetation would have little or no effect on flood stages along upstream reaches of the creek.

RECOMMENDATIONS

It does not appear likely from the analyses that either the “pinch point” near Jewett Creek’s confluence with the Sacramento River, nor the road crossing appear to be constraining flows and elevating creek levels substantially enough to affect creek levels on the upstream neighboring property. It is possible that the Sacramento River itself is causing flooding at Ohio Road, at least during 10-year or higher flood events. It does appear, however, that the “pinch point” and culverted crossing increased water surface elevations substantially on the

property. Widening the creek channel at the "pinch point" and adding culverts to the road crossing would enable more room to restore a riparian forest and offset effects of increased vegetation in the floodplain. However, adding additional culverts to the road crossing may not accomplish the desired effects of abating flooding on the upstream property if the flooding is primarily caused by the Sacramento River. Further study of the causes of flooding may be warranted, along with an analysis of the effects removing the roadway might have on restoration efforts, before actions are taken to add culverts. Realigning the channel near the northwest corner of the property would allow the creek to follow its natural course and would likely reduce maintenance costs related to repairing eroded areas along the corner of the orchard created when the creek was channelized.

During the stakeholder presentation and meeting held on June 6, 2001, a suggestion was made to reduce ponding that occurs on the neighboring property because of the slope of farm field 3-West. If feasible, the field should be regraded to slope toward Jewett Creek when the orchard is replanted or converted to natural habitat.

PLANT COMMUNITIES

METHODS

An analysis of the historical and existing conditions of the site and adjacent areas was conducted. This included an analysis of the natural plant communities that currently occur onsite and in the surrounding region, and an assessment of the communities that historically occurred. In addition, potential plant communities were determined for the farm field and non-farmed areas of the property based on the historical and current vegetation patterns and an analysis of the physical conditions that currently exist. The analysis was based on a review of existing information for the site, including a study of the property by the California State University at Chico (Brown et al., 2000); and comparisons between 1938 and 1999 aerial photographs of the site; and a survey of the property by EDAW biologist Ron Unger on February 16, 2000; and the feedback and suggestions provided by participants in the June 6, 2001 stakeholder meeting and presentation held at the site.

EXISTING PLANT COMMUNITIES

The Jewett Creek property includes remnant and new stands of mixed riparian forest, riparian scrub, willow scrub, and ruderal communities, as well as stands of invasive riparian scrub species. The natural communities total less than 20% of the total acreage of the property and are confined almost entirely to the eastern portion of the property immediately adjacent to the river. Following is a characterization of the plant communities that currently exist on and in the vicinity of the Jewett Creek property.

Mixed Riparian Forest

Mixed riparian forest occurs in a 300 to 600-foot wide strip along the eastern side of the property sandwiched between the sand bar and the lowest farm field terraces (Exhibit 8). The northern portion of this forested strip developed sometime within the past 60 years atop the sandbar that formed over areas occupied by the river channel in 1938 (Exhibit 4). The southern portion of this strip appears to be a continuously existing stand that was extant in 1938. A remnant strip of mixed riparian forest defines the southeastern border of the property and is interspersed with willow scrub and hedges of Himalayan blackberry (*Rubus procerus*) (Exhibit 8). The strip is all that remains of the late 1970s clearing of the Jewett Creek mixed riparian forest.

The mixed riparian forest on the property is the most woody species-rich plant community on the property and is characterized by a multistory canopy dominated by upper story species, including Fremont cottonwood (*Populus fremontii*), western sycamore (*Platanus racemosa*), and valley oak (*Quercus lobata*); mid story trees including California black walnut (*Juglans californica* var. *hindsii*), valley oak, box elder (*Acer negundo*), Goodding's black willow (*Salix gooddingii*); and understory vines, shrubs, grasses, and forbs, including Himalayan blackberry, native blackberry (*Rubus ursinus*), California wild grape (*Vitis californica*), and poison oak (*Toxicodendron diversilobum*). The upper canopy varies from about 40% to 80% closure and wild grape and occasional blackberry vines grow up though the forest canopy layers forming lianas in several places. Numerous other species occur, but do not dominate this plant community, including trees and shrubs such as Oregon ash (*Fraxinus latifolia*), white alder (*Alnus rhombifolia*), blue elderberry (*Sambucus mexicana*), arroyo willow (*Salix lasiolepis*), narrow-leaf willow (*Salix exigua*), coyote bush (*Baccharis pilularis*), mule fat (*Baccharis salicifolia*), and California wild rose (*Rosa californica*); and herbaceous species such as mugwort (*Artemisia douglasii*), poison oak, Dutchman's pipe (*Aristolochia californica*), wild cucumber (*Marah fabaceus*), virgin's bower (*Clematis ligusticifolia*), and Barbara's sedge (*Carex barbarea*).

Willow Scrub

Willow scrub, riparian scrub, and stands of invasive riparian scrub all occur interspersed in strips on the sand bar. Willow scrub is characterized by a dense shrub canopy that is dominated by narrow-leaf willow and contains lesser amounts of arroyo willow and coyote bush. Along the slough at the southeastern edge of the property, willow scrub grades into a

thicket formed of saplings of Fremont cottonwood, box elder, Goodding's black willow, western sycamore, and Oregon ash (Brown et al., 2000).

Riparian Scrub

The University of California at Chico study characterized the riparian scrub community occurring on the sand bar as widely-spaced individuals of narrow-leaf willow and arundo (*Arundo donax)*, and an understory of mugwort patches interspersed with invasive grasses including Johnsongrass (*Sorghum halepense*), Bermuda grass (*Cynodon dactylon*), and others (Brown et al., 2000). Riparian scrub also is typically characterized by other native shrubs and woody species, however these are apparently absent from the riparian scrub currently present at the site.

Arundo and Tamarisk Scrub

Approximately 10 acres of the native vegetation communities on the sand bar are heavily infested with invasive arundo and tamarisk (*Tamarix* sp.) (Exhibit 9). These invasives are found all along the eastern edge of the main mixed riparian forest as well as other areas of the sand bar. The area of greatest concentration is shown in Exhibit 4 (Brown et al., 2000). These invasive plants can outcompete native plants, preventing the establishment of native plant communities along the sand bar.

Ruderal

Ruderal (weedy herbaceous) vegetation occurs throughout the Jewett Creek channel where the mixed riparian forest previously existed. The ruderal vegetation is characterized by weedy grasses and forbs, including native species such as cocklebur (*Xanthium strumarium*), horseweed (*Conyza canadensis*), vervain (*Verbena bonariensis*), and various cattails (*Typha* spp.), tules (*Scirpus* spp.), and sedges (*Carex* spp.); and non-native species such as curly dock (*Rumex crispus*), nutsedge (*Cyperis eregrostis*), bull thistle (*Cirsium vulgare*), white sweetclover (*Melilotus albus*), Bermuda grass, and Johnsongrass.

Plant Communities in the Project Vicinity

Natural plant communities adjacent to the property or in the vicinity include an expansive stretch of mixed riparian forest and valley oak riparian forest on the eastern bank of the river across from the Jewett Creek Farm and narrow (< 100 feet wide), fragmented strips of mixed riparian forest along the eastern and western banks of the river north of the property (Exhibit 10). It is likely that willow scrub, riparian scrub, and invasive arundo and tamarisk scrub communities also occur in these areas.

North of the property, Jewett Creek is characterized by a mixed riparian forest and valley oak riparian forest that appear to have continuously existed since 1938 and earlier (Exhibits 2 and 4). The mixed riparian forest occurs adjacent to the creek channel and transitions to valley oak riparian forest east of the creek channel. The forests in this area appear to have expanded and filled in subsequent to the 1938 photograph.

Valley Oak Riparian Forest

The valley oak riparian forest is characterized by a multistory canopy and species composition similar to the mixed riparian forest. The primary distinctions are dominance by valley oaks and a smaller presence by species that dominate mixed riparian forest. The upper story canopy varies from 20% to 70% closure, with the more open areas often containing a grass-dominated understory.

PLANT COMMUNITY ANALYSIS

The Jewett Creek property was dominated for 100 to 200 years or more by mixed riparian forest and valley oak riparian forest over much of the property, as part of the cyclic successional vegetation pattern tied to the Sacramento River's dynamic shaping and reshaping of its floodplain. Along the Sacramento River, willow and riparian scrub communities transitioned into forested areas as the sand bar extended and the river meander adjacent to the property moved downstream and eastward. Widely spaced patches of valley oak riparian forest are visible in the 1938 aerial photograph. Also, along Jewett Creek just north of the property, valley oak forest continues to flourish (Exhibit 2). Historically, areas north, west, and south of the property were also dominated by valley oak riparian forest on the Columbia and Zamora soil series that characterize the estimated 100-year floodplain and Sacramento River Conservation Area (SRCA) boundary (Exhibit 5a). The valley oak riparian forest along Jewett Creek has filled in since the 1938 photograph was taken and is currently extending eastward (Exhibit 4). Areas west of the historic Sacramento River floodplain were likely to have once been characterized by valley oak savanna, based on the pattern visible in the 1938 photograph. On the property, mixed riparian forest historically dominated the Jewett Creek channel except for a narrow main channel. Mixed riparian forest transitioned to valley oak riparian forest in what are now farm fields 9, 3-West, and 3-East, located on Zamora silt loam soils with a high water-holding capacity. On the historic point bar, the mixed riparian forest likely occupied creek channels on the east side of the property in portions of what are now farm fields 6, 7, 10. Fields 1, 2, and 8, which occupy most of the historic point bar, were likely dominated by valley oak riparian forest that transitioned into mixed riparian forest along the Jewett Creek channel. The valley oak forest may have transitioned to a more sparsely-covered valley oak woodland on the higher (> 175 feet) elevation, less-frequently-flooded areas of the point bar, with vegetation gaps and patterns following meander point bar ridges and swales and the soil moisture limitations of underlying gravel deposits that have low

water-holding capacities. Remnant oak woodland fragments in an area otherwise characterized by grassland pasture are evident on the property and on the adjacent parcel to the north in the 1938 photograph. Presumably the site was not always dominated by grassland, but had been converted to pasture from oak woodland or forest sometime prior to the 1938 photograph (Exhibit 4).

Invasive weeds have invaded plant communities on the property and threaten to alter the structure and composition of the communities along with the habitat value to native wildlife species dependent on those communities. California black walnut has invaded the forest areas, primarily the valley oak riparian forest. The tree propagates from seeds borne of the California black walnut rootstock used in walnut orchards. The trees did not occur historically along the Sacramento River and are not considered native to the area. In fact, they are considered invasive along the river and appear to be outcompeting valley oaks and other species where they are colonizing. Arundo and tamarisk are extensively invading the sand bar areas and, to an as yet much lesser extent, the drainages on the property. Both species have the ability to dominate riparian woodland habitats and alter the erosion and depositional patterns of streams and rivers.

POTENTIAL VEGETATION COMMUNITIES

Table 1 includes potential plant communities, by farm field, that can be supported by the physical conditions of the site. Valley oak riparian forest can occur at all elevations and flooding frequencies on the property, excluding the Jewett Creek channel bottom. However, if soil moisture holding-capacity and groundwater table elevations are too low, valley oak riparian forest may not be supported at the higher elevations of the historic point bar. Therefore, in those areas above about 175 feet elevation on the middle (global change) terrace farm fields, the site conditions may be restricted to a less densely vegetated valley oak savanna. Valley oak riparian forest is expected to be sustainable on the higher terrace silt loam soils west of the Jewett Creek channel where deep fine-grained soils with fewer gravel layers are expected and high soil water holding capacities can sustain a denser number of oaks.

Mixed riparian forest can occur in frequently flooded, lower elevation areas of the property up to about 170+ feet, where groundwater tables often approach the surface. Mixed riparian forest also can occur within about 150 feet of the Jewett Creek channel as it had existed until it was cleared in the late 1970s. Riparian and willow scrub can occur at the same locations and under the same conditions as mixed riparian forest to which they often transition. They can also occur on the new sand bar areas. There are two types of grassland that can occur on the site. Native riparian pasture, dominated by creeping wildrye (*Leymus triticoides*), is estimated to be sustainable in mesic areas below about 170 feet elevation on the property, where the water table is often shallow well into the into the spring and summer growing season. Annual grassland, composed of non-native annual grasses and some native perennial

bunchgrasses, is likely to be sustainable on the site under the xeric summer and spring conditions that naturally occur above 175 feet elevation.

Table 1
POTENTIAL PLANT COMMUNITIES

Farm Field or Location	Estimated Elevation (feet)	Potential Plant Communities[1]	Comment or Recommendation
Field 9	175 - 180+	VORF, AG	
Field 3-West	180	VORF, AG	
Field 3-East	180	VORF, AG	
Field 8	175 - 180	VORF, VOS, AG	
Field 1	177 - 180+	VOS, AG	
Field 2	170 - 177	VORF, VOS, AG, RP	On this property, the 175 feet elevation line is the approximate division between VORF (or RP) and VOS (or AG) community types.
Field 7	170 - 175	MRF, VORF, RP, WS, RS	
Field 10	170 - 175	MRF, VORF, RP, WS, RS	
Field 6	170 - 175	MRF, VORF, RP, WS, RS	
Jewett Creek Channel	creekbed: 167 (@ Sac. River) to 180 (northern boundary), plus 2- 6 feet to top of bank	MRF, VORF, RP, WS, RS	
Riparian Forest (east side)	below 170	no change	Invasive non-native California black walnut, arundo, and tamarisk should be abated.
Sand Bar	below 170	no change	Invasive arundo and tamarisk should be abated.

[1] Plant Community Types:

AG = Annual Grassland
MRF = Mixed Riparian Forest
RS = Riparian Scrub
RP = Riparian Pasture
VORF = Valley Oak Riparian Forest
VOS = Valley Oak Savanna
WS = Willow Scrub

Restoration of the potential communities on the site would likely require irrigation during the first few years while trees and shrubs develop their root systems. Competition with weeds, the lack of an overstory canopy for shade, and permeable surface soils that quickly dry in spring all can combine to make it extremely challenging to establish new trees and shrubs without irrigation. It is possible that some frequently flooded, low elevation and downstream Jewett Creek channel areas with shallow water tables would undergo some natural restoration, or not require much or any irrigation for the establishment of new riparian plants. However, it is estimated that over much of the property, planting and irrigation would be needed as part of any restoration work.

AGRICULTURE

METHODS

An analysis of the historical and existing land uses of the site and adjacent areas was conducted. In addition, potential agricultural crops and land uses were determined for the farm field areas based on the historical and current land uses, suitability of crops for each field based on analysis of physical conditions that currently exist, maintenance problems and costs, and current and projected market prices. The analysis was based on a review of existing information for the site, including the existing farm crop plan and crop history; regional information provided by Fred Thomas on suitability parameters for crops under different flooding regimes; and comparisons between 1938 and 1999 aerial photographs; and knowledge of the regional and site history and crop suitability parameters and costs from Fred Thomas; and information provided by the current farmer on the property and other local farmers; and from the feedback and suggestions provided by participants in a stakeholder meeting and presentation held at the site on June 6, 2001.

EXISTING AGRICULTURAL SETTING

The existing farm includes nine farm fields in three terraces (Exhibit 4). There are three upper terrace fields, including field 9 (11 acres), field 3-West (10 acres), and field 3-East (10 acres); three middle terrace fields, including field 8 (39 acres), field 1 (40 acres), and field 2 (60 acres); and three lower terrace fields, including field 7 (20 acres), field 10 (10 acres), and field 6 (14 acres). All fields have been planted with English walnuts, but the varieties and ages of the trees vary. The youngest orchards are in field 9, with trees planted about 1997, and field 10, with trees planted about 1998. The varieties planted include Howard (fields 6, 7, 9, and 10), Hartley (fields 3-East, 3-West, and 8), Serr (fields 3-East and 3-West), Chico (fields 1 and 8), Vina (field 2), Howard (fields 6, 7, 9, and 10), and Chandler (fields 6, 7, and 10).

AGRICULTURAL ANALYSIS

The Jewett Creek Farm historically was used for cattle grazing until is was sold and converted to walnut orchards in 1978. Since the farm was purchased by The Nature Conservancy in 1999, the farming operation has been leased to a local custom farmer. As part of the land conversion to orchards, the site was graded into the current gently sloped and terraced farm fields. Farm fields 2, 6, and 8, which are adjacent to Jewett Creek, were formed when soil and fill material was presumably pushed into the edge of the formerly forested, broader creek channel. These farm fields slope toward the creek channel over part or all of those fields.

Overall, the Jewett Creek Farm is considered marginal for farming due to frequent, long-duration flooding, and a shallow depth to groundwater during winter and summer. Walnut crops are one of a few orchard crops that will feasibly grow under these conditions. These walnut orchards range from fair to good condition. Areas showing signs of disease, weakness, or mortality are visible in the 1999 aerial photograph of the farm, primarily in farm fields 2, 3-East, 6, and 7. If crops are in a weakened condition, they will not be as productive and economically viable, especially in a more competitive market with declining crop prices and rising maintenance costs. It is not always easy to determine the underlying causes for weakened crop areas. They may be caused by site conditions, management, or both. The current farm managers have determined that fields 3-West, 3-East, and 9 have a husk fly pest problem requiring extra pesticide to control. Orchard problems in farm fields 2, 6, and 7 are perhaps due to a combination of factors, including the walnut rootstock variety, the underlying gravel layers, soil substrate, past management practices, and hydrology. What is most evident in the aerial photograph, coupled with an analysis of the current topography, is that the weakened crop pattern falls primarily in areas below the 175 feet ground elevation (Exhibit 4).

In examining the hydrology analysis, it is evident that areas below the 175-foot elevation level are characterized by frequent, long-duration flooding, and a shallow depth to groundwater in both winter and summer. Crops have different tolerances for flooding and saturated soil conditions, and walnuts are one of a few tree crops that have relatively high tolerances. Walnut tolerances for surface water inundation vary depending on the rootstock, with Paradox roots being more tolerant of flooding than black walnut roots. Table 2 indicates maximum crop tolerances to surface inundation during the majority of winter and spring months in which river flooding may occur. The tolerance of crops to flooding varies based on the duration and time of year. During the winter months of December and January, when many of the temperate crops are dormant, they can withstand longer term inundation of up to 25 to 30 days. However, when the roots of these crops begin to grow in March, and soil oxygen is needed for metabolic activity, then inundation periods of greater than 7 days will usually cause disease or suffocation.

Disease and damaged tree crops occurs when inundation speeds the spread of phytophthora root rot (*Phytophthora* sp.), which is dispersed by the free water zoospores through groundwater.

Table 2
MAXIMUM CROP TOLERANCES TO SURFACE WATER INUNDATION [1]

Crop	Month	Days Inundated	Occurrence Frequency
Walnuts (Black walnut roots)	January	25	once in 5 years
	February	14	once in 3 years
	March	7	once in 3 years
	April	3	once in 3 years
Walnuts (Paradox roots)	January	30	once in 5 years
	February	18	once in 3 years
	March	8	once in 3 years
	April	4	once in 3 years
Prunes (Mariana roots)	January	25	once in 8 years
	February	12	once in 5 years
	March	4	once in 3 years
	April	3	once in 3 years
Pasture (Creeping wildrye)	January	25	once in 5 years
	February	15	once in 5 years
	March	10	once in 3 years
	April	8	once in 3 years
Pasture (Ryegrass and Orchardgrass)	January	20	once in 10 years
	February	14	once in 5 years
	March	10	once in 5 years
	April	7	once in 5 years
Alfalfa (Dormant)	January	18	once in 2 years
	February	12	once in 2 years
	March	5	once in 2 years
	April	3	once in 4 years

[1] Maximum surface water inundation is the level in which 100% of the soil is saturated. Exceeding these inundation periods and frequencies will lead to damage and, depending on the health and age of the crop, will lead to death of 10% of the crop.

Exceeding the inundation frequencies indicated in Table 2 will lead to disease and, depending on the health and age of the orchard, will cause death at the 10% level of the orchard.

To avoid inundation-related problems, the "preferred" rooting depth for walnut trees is about 10 feet in winter and 20 feet during summer. Prolonged inundation within those zones during the seasons indicated will typically result in a weakened crop over the years. While crop tolerances provided in Table 2 are indicated for inundation levels above the ground surface, they also can provide some measure for determining when shallow groundwater tables may begin to severely affect crops. Based on the hydrological analysis, areas below about 175 feet ground elevation are marginal for growing orchard crops, including walnuts, due to prolonged periods of inundation within the "preferred" rooting depth during the spring and summer growing season.

POTENTIAL AGRICULTURAL LAND USES

The Jewett Creek site is marginal for most types of farming except for walnuts and low intensity pasture. The preferred minimum farmable field is 40 acres although there are several smaller fields on the property. The size of the entire farm should be 100 acres or more in order to provide a farm sufficiently large to attract a custom farmer to manage it. There are four potentially viable crop options for the Jewett Creek Farm: walnuts, prunes, alfalfa, and pasture. Walnuts are the most profitable and flood-tolerant of the four options.

Because the farmers cannot select the time period of the unnatural inundation, and because the duration is regulated by the very long releases of flood waters from Shasta Dam, the only sustainable option is to only plant crops that have the best chance of not being killed by the high water and groundwater tables.

Table 3 contains a list of potential crops suitable for the conditions of each farm field. The key to sustainable and profitable farming in marginal sites with the hydrological conditions such as are present on the Jewett Creek property, is to plant the most water tolerant crops possible, minimize standing water on the site, and ensure the fields are well-drained.

Table 3
POTENTIAL CROP TYPES

Farm Field or Location	Estimated Elevation (feet)	Potential Crops[1]	Comment or Recommendation
Field 9	175 - 180+	Walnuts (Paradox rootstock), Prunes (Mariana rootstock), Alfalfa, Ryegrass Pasture	
Field 3-West	180	Walnuts (Paradox rootstock), Prunes (Mariana rootstock), Alfalfa, Ryegrass Pasture	
Field 3-East	180	Walnuts (Paradox rootstock), Prunes (Mariana rootstock), Alfalfa, Ryegrass Pasture	Walnuts may be unsuitable due to the husk fly pest in this field
Field 8	175 - 180	Walnuts (Paradox rootstock), Ryegrass Pasture	
Field 1	177 - 180+	Walnuts (Paradox rootstock), Ryegrass Pasture	
Field 2	170 - 177	Walnuts (Paradox rootstock), Riparian (creeping wildrye) Pasture	Walnuts are only marginally suitable in this farm field
Field 7	170 - 175	Walnuts (Paradox rootstock), Riparian (creeping wildrye) Pasture	Walnuts are only marginally suitable in this farm field
Field 10	170 - 175	Walnuts (Paradox rootstock), Riparian (creeping wildrye) Pasture	Walnuts are only marginally suitable in this farm field
Field 6	170 - 175	Walnuts (Paradox rootstock), Riparian (creeping wildrye) Pasture	Walnuts are only marginally suitable in this farm field

WILDLIFE

METHODS

A review of the historical and existing conditions of the site and adjacent areas was conducted, including an analysis of the natural and agricultural plant communities and associated wildlife species known or expected to occur historically and currently onsite and in the surrounding region. In addition, optimal potential wildlife habitat configurations were determined for the property, based on the potential plant communities and agricultural crops and land uses the site can currently support. The analysis also included consideration of feedback and suggestions provided by participants in a stakeholder meeting and presentation held at the site on June 6, 2001.

Birds were selected as the wildlife group on which to focus the analysis, partly because extensive research has been conducted on bird populations in natural and agricultural habitats in the Sacramento River region. Additionally, birds are considered good indicators of environmental health (RHJV 2000), and their status in a given area is often indicative of the value of that area to other wildlife species. The Point Reyes Bird Observatory (PRBO) has been monitoring Central Valley bird populations along the Sacramento River since 1993. Although "riparian" birds were the focus of the PRBO studies, the group of species considered under this category was relatively broad and included species that utilize other habitats to varying degrees (e.g., brown-headed cowbird, blue grosbeak, California quail, killdeer, lark sparrow, mourning dove, red-winged blackbird, and yellow-billed magpie). Results from PRBO research along the Sacramento River have highlighted important relationships between habitat types and riparian bird diversity and abundance. Bird "diversity" is a measure of the number of bird species relative to the total number of individuals of all bird species found in a given area. "Abundance" is the number of individuals of a given bird species.

Results from PRBO data and other information on bird populations in the Sacramento Valley were reviewed for correlations between different natural and agricultural habitats and their value to various bird species. This information was evaluated in conjunction with analyses of the plant communities and agricultural crops the site is capable of supporting. Through the analysis, optimal configurations of natural and agricultural habitats for enhancement of wildlife value were determined.

EXISTING WILDLIFE HABITATS

The highest quality wildlife habitat on the Jewett Creek property is currently provided by existing natural plant communities. Agricultural areas have some wildlife value, especially

when located adjacent to natural communities. Following is a characterization of the existing wildlife habitat conditions on and adjacent to the property.

Mixed Riparian Forest

Of the existing plant communities present on the site, mixed riparian forest is expected to support the highest diversity of wildlife, including birds, reptiles, amphibians, and mammals. The number of bird species is expected to be particularly high, and this habitat could support relatively large numbers of breeding birds. Bird species expected to occur in mixed riparian forest on the site include Bewick's wren (*Thryomanes bewickii*), black-headed grosbeak (*Pheucticus melanocephalus*), spotted towhee (*Pipilo maculatus*), tree swallow (*Tachycineta bicolor*), and western wood-pewee (*Contopus sordidulus*). A number of mammals, including gray fox (*Urocyon cinereoargenteus*), ringtail (*Bassariscus astutus*), and a variety of rodents, occur in riparian forest in the Sacramento Valley. These could occur on the site, though their number may be limited by the relatively small amount of riparian habitat on and adjacent to the site.

Valley Oak Riparian Forest

Valley oak riparian forest is expected to support a very similar variety and number of species as mixed riparian forest. Some cavity nesting birds and others that are associated with oak woodland, such as ash-throated flycatcher (*Myiarchus cinerascens*), Bullock's oriole (*Icterus bullockii*), oak titmouse (*Baeolophus inornatus*), and western kingbird (*Tyrannus verticalis*) could occur in larger numbers.

Willow and Riparian Scrub

Willow and riparian scrub supports many of the same wildlife species found in mixed riparian and valley oak riparian forests. Some of the birds mentioned above that require large trees for nesting are not expected to breed in willow and riparian scrub, but they can provide foraging habitat. Birds expected to nest in willow and riparian scrub include American goldfinch (*Carduelis tristis*), black-headed grosbeak, blue grosbeak (*Guiraca caerulea*), and lazuli bunting (*Passerina amoena*). Mammals that prefer dense shrub cover, such as Audubon's cottontail (*Sylvilagus auduboni*), can be particularly abundant in this type of habitat. Areas of willow or riparian scrub that are characterized by only one or a few shrub species are likely to have a lower diversity of wildlife species than scrub areas with a greater diversity of plants. Also, areas of scrub that are heavily infested with arundo or tamarisk are expected to have reduced wildlife habitat value, as described below.

Arundo and Tamarisk Scrub

These introduced and invasive species are known to support a much lower number of wildlife species than the native plant communities discussed above (RHJV 2000). Few bird species are likely to nest in this habitat, but it can provide suitable foraging habitat for a number of species.

Ruderal

Ruderal vegetation typically supports a relatively small number of wildlife species. Vegetation within the Jewett Creek channel could support bird species such as blue grosbeak, lazuli bunting, and common yellowthroat (*Geothlypis trichas*). Shorter vegetation upslope of the creek channel is likely to support several grassland species, including lark sparrow (*Chondestes grammacus*) and western meadowlark (*Sturnella neglecta*), which do not occur in the other habitats discussed above. In addition, dry ruderal areas can support larger number of reptiles and burrowing mammals, such as California ground squirrel (*Spermophilus beecheyi*).

Walnut Orchard

Overall, orchards and other agricultural crops typically support fewer wildlife species and individuals than natural vegetation. However, orchards can provide foraging habitat for a number of bird species and some birds nest in orchards. Walnuts, in particular, are often utilized by riparian birds if the orchard is located adjacent to riparian habitat. Walnuts on the site are likely to be utilized by several riparian bird species, such as black-headed grosbeak and western wood-pewee.

WILDLIFE HABITAT ANALYSIS

Given their proximity to the Sacramento River, the project site and adjacent areas were once dominated by riparian forest habitat. Historically, the riparian and valley oak forests of the Sacramento Valley supported a variety of wildlife species. However, dramatic declines of these habitats in the past century have, in turn, resulted in declines in wildlife species associated with them. Only a small fraction (2-5%) of the riparian habitat that was once present in the Central Valley is thought to remain (RHJV 2000). These losses have resulted from land conversions for development, flood control, gravel mining, agricultural, and other purposes. Loss of riparian habitat may be the most important cause of population declines of landbird species in western North America (DeSante and George 1994). Despite these losses, riparian habitat remains a critical feature for wildlife populations, and it has been identified as the most important habitat to landbird species in California (RHJV 2000).

Based on the plant communities that historically occurred on and adjacent to the project site, including riparian forest, oak woodland, and oak savannah, the site is likely to have supported a rich wildlife community. Conversion of natural plant communities on the project site and adjacent areas to agricultural crops and pastures presumably resulted in a reduction of a number of wildlife species and the number of individuals of each species utilizing the area. Such declining trends have been documented for a variety of bird species throughout the Sacramento Valley. A number of formerly common species have experienced substantial population declines and several species no longer occur in the region (Gaines 1974, Small et al. 2000).

Based on the PRBO research, the highest bird diversity along the Sacramento River occurs in valley oak riparian forest and mixed riparian forest. Moderate bird diversity occurs in valley oak savannah and riparian scrub, and the lowest diversity occurs in grassland, orchard, and pasture (Small et al. 2000). PRBO results also indicate that high bird diversity is correlated with the amount of riparian habitat within 500 meters of a given location. In other words, blocks of riparian habitat tend to have higher diversity than narrower, linear strips of habitat, even if the strips of habitat are of greater acreage than the blocks.

A critical component of riparian forest and mixed riparian oak woodland is structural diversity. A diverse understory provides important nesting habitat for many bird species, and the number of birds in a given area is expected to increase with increases in vegetation density, because the vegetation provides more potential nest sites (Martin 1988). In turn, the denser vegetation may make a nest more difficult for a predator to find and make it more likely for a nest to produce young.

Gradual boundaries between different vegetation types, often referred to as “soft” edges can also reduce predation levels, which are higher along “hard” edges (Suarez et al. 1997). For example, hedgerows of native shrubs can be utilized to create a softer edge along a riparian forest, when it occurs adjacent to agricultural fields. The importance of vegetation corridors linking otherwise separated patches of natural vegetation has also been highlighted as an important factor for bird populations (RHJV 2000). These corridors provide a means for relatively sedentary species to disperse. They can also be an important linkage between populations that would otherwise be isolated and can allow dispersal of species to previously uninhabited, though suitable patches of habitat.

Of the agricultural crops and land uses that can be supported by the site, orchards, and in particular, walnuts, are expected to be utilized by a higher diversity of birds (PRBO unpublished data). Although orchards tend to support a low diversity of bird species, they can provide habitat for a number of riparian birds when located adjacent to riparian habitat. This is particularly true for walnut orchards that are somewhat similar in canopy structure to mature riparian forest. Birds that require the features associated with riparian forest for

nesting are often able to utilize orchards for foraging purposes if they are located nearby, and some of these can utilize walnuts trees for nesting habitat as well.

POTENTIAL WILDLIFE HABITAT AND RECOMMENDATIONS

Table 4 contains an assessment of wildlife diversity expected for each of the potential plant communities and crop types suitable for the conditions present on the Jewett Creek Farm site. Based on the above analysis, recommendations have been developed regarding habitat types and configurations that would maximize the wildlife value of the site, while maintaining a viable agricultural component. Mixed riparian forest and valley oak riparian forest are recommended as the primary natural habitats that should be restored on the site. This conclusion is supported by a combination of factors, including the historic and current vegetation communities present on and adjacent to the site, the potential for the site to support these habitats, and the relationship between these habitats and bird diversity. Restoration of these forest habitats should occur adjacent to existing patches of similar habitat to increase the total amount within a given radius, and between existing patches to provide a movement corridor. Therefore, forest restoration would be most suitable along the eastern, southern, and western boundaries of the existing walnut orchards. Restoration along the southern and western boundaries would occur along the current Jewett Creek alignment. This would increase the width of the riparian patch that currently exists between the Sacramento River and the orchard, as well as create a riparian corridor connecting existing riparian forest along the river to the existing riparian forest along Jewett Creek immediately upstream from the project site.

Restored forest habitat should be structurally diverse, including a variety of understory species and groundcover components. Riparian scrub should be utilized to soften habitat edges where existing and restored forest is adjacent to other habitats, such as orchard and pasture. The selection of mixed riparian and valley oak riparian forest as natural vegetation communities to be restored on the site leads to walnuts as the most appropriate agricultural crop for areas adjacent to existing and restored forest. This configuration would maximize the value of the forest areas by providing adjacent orchards that could be utilized as foraging habitat by riparian birds.

Selection of grassland or pasture habitats could increase the overall diversity of birds on the site, by providing habitat for species such as western meadowlark and lark sparrow, which are not expected to occur in woodland and scrub habitats. However, grassland and pasture would also provide foraging habitat for brown-headed cowbirds (*Molothrus ater*). Cowbirds are obligate brood parasites, birds that do not build their own nests and must lay their eggs in the nests of other species. Cowbird parasitism can greatly reduce the productivity of host

Table 4
WILDLIFE HABITAT VALUES FOR POTENTIAL PLANT COMMUNITIES AND CROPS

Potential Plant Community or Crop	Overall Wildlife Diversity	Primary Bird Species Expected to Occur and/or Nest[1]
Potential Natural Plant Communities		
Mixed Riparian Forest	High	American goldfinch, ash-throated flycatcher, black-headed grosbeak, blue grosbeak, Bullock's oriole, common yellowthroat, spotted towhee, lazuli bunting, Nuttall's woodpecker, oak titmouse, western kingbird, western scrub-jay, western wood-peewee, tree swallow, lesser goldfinch, Bewick's wren, bushtit.
Valley Oak Riparian Forest	High	Similar species as mixed riparian forest. However, some cavity nesting birds and others associated with oak woodland, such as ash-throated flycatcher, Bullock's oriole, oak titmouse, and western kingbird, could occur in larger numbers.
Valley Oak Savanna	Moderate	American goldfinch, blue grosbeak, Bullock's oriole, lazuli bunting, oak titmouse, western kingbird, western scrub-jay, western wood-peewee, loggerhead shrike, bushtit, California quail.
Riparian Scrub	Moderate	American goldfinch, black-headed grosbeak, blue grosbeak, spotted towhee, lazuli bunting.
Willow Scrub	Low	Similar to riparian scrub, but the lower vegetation diversity results in less wildlife diversity.
Riparian Pasture	Low	Lark sparrow, brown-headed cowbird, western meadowlark, mourning dove, ring-necked pheasant, California quail, foraging raptors.
Annual Grassland	Low	Similar to riparian pasture, but drier and more sparse vegetation may support fewer nesting birds.
Potential Crops		
Walnuts	Moderate	American robin, American goldfinch, Nuttall's woodpecker, mourning dove, house finch, black-headed grosbeak, western wood-pewee.
Prunes	Low	American robin, American goldfinch, mourning dove, house finch, brewer's blackbird.
Riparian Pasture (creeping wildrye)	Low	Same as riparian pasture, above, in Plant Communities
Ryegrass Pasture	Low	Similar to riparian pasture.
Alfalfa	Low	Similar to riparian pasture.

[1] Species expected to occur in moderate to high numbers and/or nest in these habitats on the site.

populations, and PRBO results have documented high rates of cowbird parasitism along the Sacramento River (Small et al. 2000). Therefore, grassland and pasture are not recommended, because they could support larger numbers of cowbirds, which may result in increased parasitism rates and decreased productivity of songbirds in nearby woodland habitats.

Implementation of these recommendations would enhance the value of the site for numerous landbird species and are expected to benefit other wildlife, such as mammals, reptiles, and amphibians. As a result, however, the populations of some species that are considered pests in agricultural areas could also increase (e.g., California ground squirrel). If resulting increases are substantial, some pest control measures may need to be implemented. Common bird pests in orchards, such as yellow-billed magpie (*Pica nuttali*) and American crow (*Corvus brachyrhynchos*) are not expected to increase, because they are not dependent on riparian habitat and tend to be more common in areas dominated by orchards and grassland.

FARM DESIGN RECOMMENDATIONS

Exhibit 11 is the suggested farm design. It includes an evaluation of current agricultural land uses and potential natural plant community types for the Jewett Creek Farm, based on their suitability for the physical conditions of the site, their economic value, and their wildlife values. Upper terrace farm fields 3-West, 3-East, and 9 along the west side of the property would remain in agricultural use as nutcrops or pasture (Exhibit 11). Middle terrace fields 2 and 8 would remain in agricultural use (nutcrops or pasture) above the 175-foot elevation contour line, and would be converted to valley oak forest or savanna below that elevation, along the Jewett Creek channel. Middle terrace field 1, which is entirely above 175 feet in elevation, would remain completely in agricultural use. Lower terrace fields 7, 6, and 10, all below 175 feet in elevation, would be restored to mixed riparian forest over time. The Jewett Creek channel and floodplain would be widened to its estimated historical floodplain width of 150 feet along the southern reach where it was narrowed during creation of the farm fields. The 90-degree bend near the northwest corner of the property would be realigned to closely resemble its original alignment. The Jewett Creek channel and floodplain should be restored with mixed riparian forest and the existing mixed riparian forest and sand bar areas would remain unaltered except for the removal of invasive arundo and tamarisk.

In order to provide for a minimum of 100 total farmable acres on the property to be attractive to a custom farmer, all farm fields (and portions of farm fields) above 175 feet elevation would continue to be farmed.

Few farm fields that meet the minimum 40-acre suggested farm field size are present on the site. However, the middle terrace farm fields that would be reduced in size should be kept in a rectangular configuration and at a size that would still be viable for farming. The total area that would remain farmed, based on the concept plan, would be approximately 150 acres, exceeding the 100 acre minimum recommended.

Walnut orchards were chosen as the optimal suitable crop for the farm because they are currently the most economically viable crop, they are currently grown on the farm and they are expected to have the highest wildlife habitat value and require the least pesticide input. Other crops as recommended in Table 3 may eventually be more suitable to a prospective owner or custom farmer, however, based on economic or other reasons. In general, nutcrops or pasture are recommended for the farmed areas from an overall environmental and economic standpoint, with nutcrops as the preferred choice based on higher wildlife habitat values. The best configuration for locating orchards, strictly from the perspective of wildlife habitat value, would be adjacent to riparian forests, because the orchards could be utilized for foraging by nesting birds in those areas. In farm field 3-East in the upper terrace, where husk fly pest is a problem for walnuts, other crops may be chosen that would be more suitable. The choice of crops will depend largely on crop prices and the interests of those who will farm the property.

In general, areas considered unprofitable or only marginally profitable for farming, and potentially highly valuable as wildlife habitat, should be restored to natural communities. Approximately 72 acres of farm fields considered marginal for agricultural use are below 175 feet in elevation on the property, and should eventually be restored back to mixed riparian forest and valley oak riparian forest. These areas are considered marginal due to high maintenance costs, and a high level of crop failure likely related to the persistently high water table occurring at those ground elevations. The young walnut orchards in the low terrace areas should remain as orchards so long as the crop is profitable and the orchard is productive and healthy. Once the crop fails to be economically viable and/or healthy, the trees should be removed and mixed riparian forest should be restored.

Restoration of a mixed riparian forest in the low-elevation farm field would widen the existing forest and is one of the recommendations that would have the highest potential for increasing bird diversity on the property. This is because blocks of riparian habitat tend to have higher wildlife species diversity than narrower, linear strips of habitat. To provide the highest possible wildlife habitat value and further reduce the potential for predation, riparian forest areas should be restored to be structurally diverse and contain a high diversity of plant species. An herbaceous ground cover component in this community would enhance habitat for ground-nesting birds.

The Jewett Creek channel area could be restored with a mixed riparian forest grading into valley oak riparian forest along the upper banks, and connecting the existing riparian forest fragment north of the property with the forest on the east side of the property. The riparian forest corridor along the creek should be as broad as feasible, by restoring the widened creek channel and the marginal farm field areas below 175 feet elevation that were once part of the creek's floodplain. The creek channel should remain open enough to prevent stagnant water and mosquito breeding habitat. It should also be mowed or otherwise maintained while being restored to natural communities. To the extent possible, the maintenance should be conducted in a manner that allows Jewett Creek to define its own path and meander within a widened channel bottom.

The Jewett Creek riparian corridor, once restored would provide a movement and dispersal corridor, greatly increasing the wildlife habitat value on the property. The widened channel may also have some benefits in reducing offsite flooding which may be associated with the creek. Further offsite flooding reduction may be gained by installing more culverts at the road crossing or removing the bridge and creating a low water crossing.

To further enhance wildlife habitat value on the site, riparian or willow scrub, characterized by a variety of native woody shrub species, should be restored along the boundaries of the riparian forests and orchards or pasture. These "soft" edges can reduce predation levels, in comparison to "hard" edges that have no scrub hedge component.

Implementation of the integrated farm plan should follow a phased adaptive management approach. Fields designated for restoration may be restored using approaches ranging from active planting to natural restoration. To reduce agricultural pests, a transitional community (e.g., pasture) may be planted that enables fields to be restored to natural habitats. Monitoring of the results would provide feedback to determine follow up site work, planting, weed control, maintenance, supplemental irrigation, and other actions that should be applied in subsequent phases to ensure successful restoration. Monitoring of crop success may also give indication of conservation area management needs (e.g., pest control). Also, crop and natural plant community options and other management prescriptions may change over time, depending on physical and economic conditions. Therefore, the integrated farm plan goals and objectives and management prescriptions would be evaluated periodically to ensure they match the conditions at that time.

LAND OWNERSHIP AND MANAGEMENT RECOMMENDATIONS

The Farm Plan team recommends that TNC commence the management recommendations outlined in this Farm Plan. Restoration and improvement of the Jewett Creek channel and floodplain can begin immediately, although the walnuts in fields 6, 7, and 10 could be farmed

for their productive life prior to being restored to riparian habitat. Public funding sources for restoration on private lands is available from both state and federal programs including the California Department of Fish and Game's Wildlife Conservation Board Riparian Habitat Conservation program and the U.jS. Fish and Wildlife Service's Partners for Fish and Wildlife Program. Implementing the "good neighbor" improvements to facilitate drainage and access through the property should be an immediate priority and most can happen in conjunction with the Jewett Creek restoration work.

A number of land ownership alternatives are possible. In general, if the terrace units are not broken up and ownership fragmentation is kept to a minimum any combination fo public and private ownership is acceptable. Below is a list of acceptable land ownership alternatives in order of preference:

< The Model Farm: The preferred ownership model for the Jewett Creek Farm would have the entire property in single private farming interest ownership with appropriate agricultural and conservation easements in place.

< The second alterative would have the upper and lower terraces in single private ownership and the middle terrace under separate private farming interest ownership. The intent for the upper terrace is primarily residential with some agriculture and the lower terrace would be added on as a natural feature amenity. The middle terrace encompasses 140 acres in three fields each greater than 40 acres in size and the intent for the middle terrace is agricultural production. This alternative would require lot-line splits of the Assessor's parcels.

< The third alternative would have the upper and middle terraces in the same private ownership and the lower terrace in public ownership. The upper terrace fields and house are suitable as a residential and agricultural property in combination with the middle terrace fields. This alternative would require lot-line splits of the Assessor's parcels.

< A fourth alternative would have the upper and middle terraces in separate private interest ownerships and the lower terrace in public ownership. This alternative would require lot-line splits of the Assessor's parcels.

< A fifth alternative would place the upper and lower terraces in public, or non-governmental organization (NGO) ownership and the middle terrace in private farming interest ownership. This scenario might be likely if the site were determined to be appropriate for a research station. This alternative would require lot-line splits of the Assessor's parcels.

< A final alternative would have the entire property transferred to public ownership with the agricultural production leased to local farming interests. If this alternative were pursued long-term leases would be recommended to foster good management practices.

STAKEHOLDER COMMENTS AND REQUESTED ACTIONS

Comment No.	Comment, Concern, or Recommendation	Text Location or Response (section, table, exhibit)
1	Regrade or add drainage or different irrigation system (i.e., drip) to correct SW farm field (field 3-West and 3-East) problem of water flowing away from creek and/or ponding near neighbor's house.	"Physical Conditions Recommendations"
2	Delineate easternmost area as management field.	Table 1, Exhibit 4
3	What is private property in context of river process (hydro- and geomorphic)? Other agency effects from their management. [We understand this question to be: is adjacent public ownership going to affect this property, and if this becomes public, how will that affect adjacent landowners?]	There are no plans to add or remove levees, and the river is meandering away from the property. Therefore, there is no anticipated need to stabilize banks to protect neighboring properties. The restoration planning for the Jewett Creek channel should improve flooding affects from the creek on upstream neighbors.
4	Monitor SE confluence area (i.e., reach of Jewett Creek along southern fence line) to see if accretion causing flooding problems.	"Analysis of Flooding Problems"
5	DFG has programs to address habitat loss (especially valley oaks; suggest intermixing valley oak community in lower reaches with valley oak savannah in upper reaches).	"Farm Design Recommendations" and "Land Ownership and Management"
6	Process used to determine agriculture and conservation configuration is transferable to other sites. The site specific results are specific to only Jewett Creek.	"Integrated Farm Planning Process Goals and Objectives" and "Integrated Farm Planning Process"

Comment No.	Comment, Concern, or Recommendation	Text Location or Response (section, table, exhibit)
7	Defer conservation prescription for low-terrace orchard to future landowners, depending on conditions (e.g., economics of that time). Make provisions subject to management plan and objectives and re-visit regularly to see if prescription matches conditions at that time.	"Farm Design Recommendations"
8	This idea is a positive change from the traditional idea of making whole parcel/site riparian habitat.	
9	Consider/check historic and current river flows and periods based on changing management (e.g., for fish/Calfed).	Outside scope of work for this plan.
10	Contact Alan Fulton	Alan will be contacted as we move forward with restoration activities.
11	Address road and debris issue; consider creek (low water) crossing.	"Analysis of Flooding Problems" and "Farm Design Recommendations"
12	Open creek up (like north of ranch) for mosquito control and interim management (e.g., mow and maintain channel).	"Farm Design Recommendations"
13	Meanders in Jewett Creek (small creek) - let it remain "natural", define its own path. May define with more examination of creek.	"Farm Design Recommendations"
14	Address Paul Martin's access to NW ditch.	TNC will follow up with Paul to determine and resolve problem.
15	To provide to other owners:	
	S address game management	"Land Ownership and Management"
	S make economically viable	"Goals and Objectives"
	S why would owner want to do this (e.g., if economically viable); what value from riparian/conserving habitat?	"Land Ownership and Management"

Comment No.	Comment, Concern, or Recommendation	Text Location or Response (section, table, exhibit)
16	Consider natural transition community to reduce pests to agriculture.	"Farm Design Recommendations"
17	Put in larger landscape perspective to put change in perspective of landscape agricultural or natural conditions.	"Regional Setting and Land Uses"
18	Make sure future management of wildlands is possible in management plan (i.e., agricultural pests).	"Farm Design Recommendations" and "Land Ownership and Management"
19	Consider preliminary draft document to solicit comments and review - before regular release of document.	Distributed draft for review by stakeholders
20	Input from current lessee? And future user, based on their interest.	"Farm Design Recommendations"

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