Chapter 5. Overview of the Implications and Concerns of Agricultural Land Retirement in the San Joaquin Valley, California

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This chapter is a synopsis of the results acquired from work at the Land Retirement Demonstration Project (LRDP) study sites over a 5-year period. The key points of the results of the various studies are summarized. The knowledge acquired will be used to address concerns associated with land retirement that were not a focus of the studies.

The LRDP Tranquillity site is representative of conditions encountered on most drainage impacted areas of the San Joaquin Valley, including a high percentage of those lands targeted for retirement by district and federal programs. The predominant soil type at the site is Tranquillity clay which is the most extensive soil type mapped by the Natural Resources Conservation Service (NRCS) on the lower alluvial fan and basin rim landforms in the western San Joaquin Valley. Accordingly, the information presented in this report is applicable to the entire region.

The 5-year studies clearly show that retiring land from irrigated agriculture results in numerous physical and biological benefits. Some of these include declining groundwater and a declining salinity and selenium in surface soils. Land retirement provides important habitat for a wide variety of wildlife and has the potential to contribute to the recovery of sensitive species. Selenium levels in biota from retired lands indicate that there is a low risk of contamination in this terrestrial environment, despite the relatively high (but declining) level of selenium in the system. Surface ponding of water did not occur and would not likely contribute to the bio-accumulation of selenium. A high number of agriculturally beneficial insects were found on retired lands, whereas the predicted increase in the abundance and diversity of agricultural pests has not occurred. Land retirement did not result in a decrease of selenium concentrations in groundwater.

Standard restoration techniques applied to the study plots were somewhat successful in establishing native shrubs and a limited variety of native annual plants. However, in general those techniques were relatively ineffective at establishing a diverse community of native flora. Appropriate restoration

techniques are currently being developed and recommendations will be made in the near future.

The data set obtained from these studies is unique in that it describes the wildlife community existing on lands dominated by non-native species. No other wildlife studies or monitoring efforts in the central San Joaquin Valley of this duration or scope exist. The data provide insights into the value of land retirement and of habitat restoration to wildlife. The results obtained and the restoration techniques being developed can be applied to meet a variety of management objectives on large blocks of retired lands, including the recovery of threatened and endangered species.

5.1. Declining Groundwater

The water table response observed during groundwater monitoring supports the conceptual and numerical models that predicted a declining shallow water table in response to land retirement. Prior to land retirement, percolation of applied irrigation water was the primary source of groundwater recharge that sustained the high water table. Without irrigation, groundwater recharge has been greatly reduced and the shallow water table has steadily receded from the land surface.

5.2. Selenium in Groundwater

The high concentrations of salinity and selenium in the shallow groundwater found in Coast Range deposits at the site are a result of leaching under irrigated conditions and evaporation from the shallow water. Land retirement resulted in an increase in depth to groundwater, but did not substantially change the selenium concentrations in groundwater. Critical to the well being of biota is that the access to this contaminated groundwater is very limited because of the declining water table after cessation of irrigation.

5.3. Selenium in Soil

Soils of the predominant type at the site contain moderately elevated concentrations of selenium (average 1.0 mg/kg) when compared to the common range (0.1-1.4 mg/kg) for Western U.S. and San Joaquin Valley soils. Total selenium concentrations, soluble selenium concentrations, and salinity in the top 30 cm (1 foot) of surface soil showed a decreasing trend over the 5 years of monitoring. The decreasing selenium and salinity trends in the surface soil indicate that an upflux of salt and selenium from capillary rise and evaporation of shallow groundwater at the soil surface is minimal.

5.4. Selenium Concentrations in Biota

A risk assessment for the biota in this terrestrial system was not an objective of the LRDP. However, the levels of selenium concentrations observed in extensive monitoring of soil, groundwater, and biota indicate a low risk to wildlife. Whereas high selenium levels in groundwater could present a potential risk to biota, the exposure pathway is limited because the depth to groundwater increased to greater than 2.1 m (7 feet). Mean selenium levels in biota are within the range typically found in biota occurring on non-seleniferous soils in the western United States and are generally below performance standards set for the project by the U.S. Fish and Wildlife Service (FWS 1999). Furthermore, selenium levels in biota are generally an order of magnitude less than found at Kesterson National Wildlife Refuge. Although the risk to wildlife from selenium exposure is limited, a few samples contained relatively high levels of selenium and we recommend that land retirement be integrated with a comprehensive selenium monitoring program.

The generally low levels of selenium in biota may be a result of very little available water during the study period. The potential bio-availability and bio-accumulation of selenium is reduced because dry, upland environments, rather than aquatic or wetland environments, dominate the system. This is supported by the higher selenium levels that were found in common and widespread species collected from irrigated lands compared to those collected from non-irrigated lands.

5.5. Surface Water Ponding

Due to dry climatic and soil conditions during the study, surface water ponding did not last for more than 30 days at the site. Monitoring of precipitation during the study period suggests that the precipitation threshold to cause ponding of surface water is in excess of 5 cm (2 inches) of rainfall per month. The extensive network of dessication cracks in the Tranquillity clay soils greatly inhibits the formation of surface water ponds. Should surface water ponding occur during very wet periods, it is likely that selenium concentrations in the ponded water would remain below 5 parts per billion (ppb) (the aquatic life criteria) given the surface soil selenium concentrations.

5.6. Wildlife Abundance, Diversity, and Recovery of Sensitive Species

Results of the Habitat Restoration Study (HRS) demonstrate that retired lands provide habitat for a wide variety of wildlife, even in the absence of highly successful restoration. Over a 5-year period, we identified 101 families within 21 orders of invertebrates, 1 species of amphibian, 4 species of reptiles, 48 species of

birds, and 8 species of small mammals, 1 species of canid (coyote), 2 species of mustelids (skunk and long-tailed weasel), and 2 domesticated species (cat and dog) that utilize the Tranquillity study site. Nine species of birds used the study area as breeding habitat and 12 species of sensitive birds were using the study area. Although this is an impressive list of species, we would have expected a greater diversity of wildlife and a greater degree of emigration had there been suitable wildlife habitat in the immediate vicinity.

The successful restoration of retired lands would provide increased vegetative diversity and result in an even greater diversity and abundance of wildlife. To maximize benefits for wildlife and to preclude retired lands from becoming infested with weeds and pests, appropriate habitat restoration must be conducted. Land uses, such as grazing and dryland farming, can be compatible with this effort. Creating topography, or berms, in the retired agricultural, laser-leveled landscape has benefits for plants and animals.

Land retirement and restoration, if properly implemented, monitored, and managed, would contribute to listed plant and animal species recovery. These lands could provide connecting linkages and corridors between existing habitat areas or large areas of contiguous blocks of land that would provide habitat for new core populations. The recovery of threatened and endangered animal species does not necessarily require a fully restored San Joaquin Valley ecosystem. Many rare upland species seem to be dependent upon an appropriate vegetative structure, rather than a highly diverse, fully functional native plant community. Habitat for rare species may be simplified and more easily established and managed than a diverse, native upland plant community. A diverse, native ecosystem, however, will provide the numerous benefits inherent in a totally functional ecosystem.

Providing the appropriate habitat for these species will require phases of implementation and successive management. Open spaces with low vegetation densities and heights are required for many listed species, while others require dense shrub cover. Phased restoration may or may not be immediately compatible with some sensitive species. Similarly, neither a single restoration prescription nor a single plant community would meet all species needs. Accordingly, a matrix of land uses, restoration strategies, plant communities, and management techniques is preferred. The LRDP data collected and the ongoing trials provide the basis for an implementation plan for the listed species recovery on retired agricultural lands.

5.7. Restoration Challenges and Techniques

Appropriate restoration must accompany land retirement or lands will largely become weed- and pest-infested fields. Without restoration, retired lands would require extensive and continuous management to reduce negative impacts to active agricultural practices on neighboring lands. Soil conditions that

historically existed on the site were seasonally dynamic, with successive periods of flooding and drying. Decades of intensive agricultural use greatly affected soil characteristics, depleted the native plant seed bank, reduced topographic relief, and promoted the dominance of introduced weeds. These historic conditions greatly increased the challenges associated with establishing native upland plant communities on the study site.

Specific challenges to successful restoration include competition from invasive species, lack of sufficient quantities and varieties of local native plant seed, inadequate seed delivery methods, and insufficient knowledge of germination, propagation, harvesting, and seed cleaning techniques. Inconsistent and inadequate precipitation affected plant survivorship and decreased restoration success.

Despite the immense challenges associated with restoration of retired farmlands, we successfully established plant cover to stabilize soils, to provide for wildlife habitat, and to establish native wildlife. The establishment of native plant species on the site was more difficult than originally envisioned. As a result of the significant expenditure of effort and resources for this demonstration project, the information obtained provides a valuable foundation to develop practical restoration strategies.

Weed suppression is the primary challenge in the restoration of these lands. Initially, a barley crop was planted on many portions of the demonstration project to control weeds and prevent soil erosion. Barley persisted for several years without the need to replant, but insufficient rainfall and seed production required some reseeding in subsequent years. Barley was excellent at controlling weeds and is an excellent cover crop or nurse crop, but it must be maintained. Despite the use of barley to help control weeds, only intensive and repeated weed suppression has successfully reduced weed loads and allowed natives to persist. These efforts have been costly and labor intensive. Numerous experimental techniques including herbicide use, establishing cover crops, flaming, mowing, discing, pre-irrigating, solarization, and manual weeding have been explored for weed eradication techniques. None have provided effective long-term results. The team is continuing research in an attempt to develop efficient techniques for weed control that would be applicable for large-scale land retirement.

The observed succession of weed species as seen on the HRS plots, fallowed lands and reserves is tumbling saltweed (*Atriplex argentea)*, mustards, and finally non-native Mediterranean grasses. The general weed succession after fallowing appears to start with nearly 100 percent cover of ***A. argentea*** that begins to decline after 4-5 years. Each year, ***A. argentea*** dies and forms a skeleton that can carry for miles in a stiff wind. The skeleton eventually begins to break down but the process can takes years and in the meantime it makes a dense cover layer of dead and dry vegetation. The mustards begin to grow underneath these skeletons in the second year; ***A. argentea*** itself does not reproduce under them. These continue as co-dominant plants through the third and fourth years. After four or

five years, Mediterranean grasses begin to establish, ultimately becoming the climax community. This pattern of succession must be overcome for native plant restoration to be effective.

No source of native plant seed is available in sufficient amounts to perform significant restoration in the San Joaquin Valley. The majority of plant species occurring in the targeted upland habitats are no longer found in the vicinity of the project site (within 80 km or 50 miles). Consequently, local ecotypes of native plants are largely absent or exceedingly rare and seed is extremely limited. The prime sources for seed have been Ecological Reserves and small, isolated remnants of habitat existing along roadsides. Seed from 100 species of native plants collected from the project vicinity were planted in the on-site native plant nursery. The nursery provides the seed used in the research trials and restoration activities.

Information on appropriate seed delivery techniques, germination, propagation, harvesting, and seed cleaning techniques is non-existent or insufficient for a majority of the targeted native species. The seed imprinter that was used in the initial restoration effort proved to be less effective on heavy clay soils than other seed delivery techniques. Valuable information on seed production is being generated through research in the native plant nursery and through partnership with the NRCS Plant Materials Center in Lockeford, California. Numerous research trials have been implemented and are ongoing (Appendix 3). Through these trials, we are exploring a variety of techniques to address the challenges encountered and to expand their applications to large-scale restoration.

Of the native species used in the work to date, the shrubs have proven to be easier to establish and maintain than winter and summer annuals. Shrubs survive better long-term against weeds, seem to be less susceptible to competition from weeds, and set seed better than annuals. The deep root system of established shrubs allows them to persist through drought conditions. Winter annuals cease to grow when overtopped by weeds and, without weed control, they quickly expire. Soil moisture is reduced by weeds causing a lack of germination in summer annuals. Drought exacerbates the competition between natives and weeds. Weed suppression will alleviate this competition for soil moisture and enhance success of annuals.

The restoration of a fully functioning ecosystem is much more involved than the successful planting of a few native species. A simplified ecosystem will tend to degrade to a weedy landscape. Even in many of the Ecological Reserves where the ecosystem has been degraded, intensive management is required to maintain the native floral diversity. Successful restoration must include a high diversity of sustainable populations of plants and animals.

5.8. Agricultural Pests

Although there have been some instances of agricultural pest outbreaks and weeds which required control measures, there were no indications that the HRS lands supported greater pest densities than did surrounding retired and fallowed lands or agricultural lands. Predatory insects were common on the site, which has likely kept the potential for pest infestation to a minimum. Agriculturally beneficial species were much more common and widespread on the site, especially in restored areas.

A few weed and insect pests are worthy of mention. Russian thistle is an invasive weed that has a high potential to become established on retired farmlands and adjacent agricultural fields. It is fairly widespread on the site, but has been present only in small patches and in low abundance. Both its distribution and abundance on the site decreased over the five-year study period. London rocket and black mustard are not generally considered agricultural pests, but they provide prime habitat for false chinch bugs and lygus bugs. There were two serious infestations of false chinch bugs. These infestations were regionally widespread, not restricted to the study site, and not influenced by land retirement or restoration activities. Lygus bugs were widespread on the study site, but they were not encountered in any great abundance. Few beet leafhoppers were observed. Predatory insects likely controlled their numbers.

5.9. Recommendation

Based upon the findings presented in this report and experiences gained during this 5-year project, the Land Retirement Team and the Endangered Species Recovery Program fully support land retirement. We believe that land retirement has the potential to solve a variety of drainage issues, including drainage reduction, and improved reliability of water supply. Restoration can improve the overall ecosystem function by improving air quality, reducing weed loads, creating wildlife habitat, and assisting with recovery of sensitive species. Land retirement is compatible with a variety of land uses including grazing, dryland farming, and enhanced recreational opportunities. Land retirement is expected to benefit adjacent farming operations by improving water quality, improving air quality through dust abatement, increasing abundance and diversity of invertebrate pollinators and predators.

These benefits are justification for the continuation and expansion of retiring drainage impacted lands, continued research of restoration techniques, and restoration of selected parcels of retired lands in the San Joaquin Valley.

The project objectives and associated performance criteria established by the USFWS have been met. Many of these criteria were based upon the premise that if met, retired lands could qualify for consideration of inclusion in the federal National Wildlife Refuge system. The retired lands at Tranquillity and Atwell

Island clearly meet the established criteria. The BLM recognized the potential value of the Atwell Island site and manages and restores the retired agricultural lands to meet wildlife values, including those of sensitive species. The Land Retirement Team and the Endangered Species Recovery program encourage the FWS to consider acquiring and managing the Tranquilllity site in a similar manner.