CALFED Ecosystem Restoration Program

Research and Restoration External Review

Response to Summarized Review Questions and Comments

Wetland Response to Modified Hydrology With Respect to Salinity Management'

Response to technical comments provided by:

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General Review

Problem/Goals

Reviewer Questions:

1). Does a network of salinity and temperature gauges already exist across the site as part of an existing study?

Project Team Response:

Until this project was initiated there was no systematic collection of continuous flow and EC data at any of the project locations. Previous projects were conducted in North Grassland Water District and in the San Luis NWR in which a system of stations were built and continue to operate. Thanks to a cost-share contribution from USBR additional instrumentation was acquired to cover the additional four study units required for a minimum biological monitoring sample size of 12. Web enabled data loggers are in the process of installation at the inlets and outlets of the twelve study sites. The 24 stations monitoring 670 wetland acres collecting water depth, electro conductivity, temperature, and flow data are currently available to the public at

http://www.ysieconet.com/public/WebUI/Default.aspx?hidCustomerID=99

2). How is monitoring being related to any water and salt balance modeling for the site? Is there adequate characterization of sources, sinks and flow paths?

Current monitoring is the first step to developing detailed water and salt balances. Modeling of these wetland cells will proceed hand-in-hand with the monitoring. Two salinity balance models have been constructed by Quinn and Hanna (2004, 2005) to simulate seasonal wetland hydrology. The first WETMANSIM attempts a monthly flow and salinity balance using gross monthly deliveries and average monthly evapotranspiration rates. These were performed on the scale of individual wetland refuge units and for the northern Division of Grassland Water District. The second model was a daily mass balance model of the inflows and outflows to the Northern Division of GWD. Current monitoring station design is state-of-the-art - the system is being used as a showcase for the western United States by the commercial hardware vendor. Additional hydrologic components include a weather station to measure moist soil plant ET (Bowen ratio). There are plans to also monitor groundwater elevations at the various monitoring sites.

3). How does delayed drawdown result in increased wetland salinity?

Project Team Response:

The lengthened inundation period of the delayed drawdown increases the potential evapoconcentration of salts within each wetland unit. During unusually warm spring months the rate of evapoconcentration of salts can be quite high resulting in EC concentrations above 4000 uS/cm in some instances, depending on the quality of the supply water and the factors affecting wetland evaporation that include area of emergent vegetation, wind velocity and temperature.

4). Is there literature to support the premise that an increase in soil salinity decreases swamp timothy production?

Project Team Response:

Although soil salinity effects on seed production of some waterfowl food plants was established by Mall (1969) in the Suisun Marsh, soil salinity effects on seed productivity have not been established for swamp timothy *Crypsis schoenoides* in managed seasonal freshwater wetlands of the Central Valley. As a component of a collaborative sister project, a green house based M.S. project from UC Merced is investigating the salinity tolerances of swamp timothy *Crypsis schoenoides*. By mimicking field conditions such as site specific soil type, soil salinity, water quality, hydrologic variables, and thermal units will enable the comparison of field observations as they pertain to swamp timothy seed production.

5). How is surface water salinity to be related to salinity in root zone?

Project Team Response:

The dynamics of soil salinity are complex. Typically the near surface groundwater will be highly correlated with the surface water impounded above it. However this is not always the case. After drawdown high water tables close to the soil surface may be subjected to high rates of evaporation and evapotranspiration and if high water tables are sustained well into the late spring and early summer can result in soil solution EC concentrations much higher than the quality of the surface ponded water. The quality of the source water, initial soil salinity prior to flood-up and the rate of infiltration and effect of emergent wetland vegetation all can have an effect on soil salinity. These processes are poorly understood in wetland soils.

Soil salinity maps are being created for all 12 study ponds as a component of a sister project. EM meter calibration soil core samples will be taken at the 6" and 12" depths throughout the study sites. A UC Merced swamp timothy salinity tolerance greenhouse study previously mentioned will also analyze soil core samples from areas where comprehensive biological vegetation assessments are also taking place.

Reviewer Comments:

1) A limitation of the project will be whether the weather and hydrologic conditions during the project will span a great enough variability to allow wetland drawdown guidelines to be developed. Even if the weather and hydrologic conditions do not give the project this ability, the results of the study can be used to formulate new trials during critical weather and hydrologic conditions.

Project Team Response:

We recognize the limitations of the 3-year duration of the study. Ideally, this study would continue for longer and we hope to pursue further funding for the continuation of the collaborative monitoring of the wetland's responses to this modified hydrology beyond the three year study duration proposed here. However, given the limited source of funds available and the immediate need to evaluate effects of delayed drawdown on wetland productivity for waterbird management, we felt that an initial 3-year duration was a prudent and cautious initial undertaking. Results from this study will serve to evaluate short-term influences and will provide the necessary framework to develop new trials during critical weather and hydrologic conditions, as the reviewer recognized.

2). Hypotheses could be better stated as:

1. Delaying drawdown date does not increase salinity.

2. An increase in wetland salinity does not decrease swamp timothy production.

3. A decline in swamp timothy production does not influence bird use.

Project Team Response:

We agree with this alternate phrasing of our hypotheses (effectively stating our hypotheses as null hypotheses rather than as alternate hypotheses, as in the proposal). We suggest a slight further modification as follows:

1. Delaying drawdown date does not increase salinity.

*An increase in salinity does not alter wetland habitat composition or distribution

2. An increase in wetland salinity does not decrease swamp timothy production.

[•] 3. A decline in swamp timothy production does not influence bird use. *A modified delayed drawdown does not influence bird use.

Approach

Reviewer Questions:

1). Will the wetland units be chosen randomly?

Project Team Response:

Our experimental design is a paired treatment design. Hence, each set of pairs was chosen and matched as closely as possible for:

- Wetland history consistent with swamp timothy production management (the proposed hydrologic shift directly affects swamp timothy managed habitats in critically dry years).
- Paired sites with the same yet independent water sources and drainage capabilities (this is important from logistical and water quality monitoring perspectives).
- Similar size, micro-topography, habitat composition, soil type, and water quality within paired wetland units.

The treatment allocated to each pair was then chosen randomly. We considered alternate designs whereby treatments were assigned randomly to all 12 sites, but this did not provide similar levels of statistical power. Moreover, with a limited number of wetland units to manipulate, a simple random selection of (unmatched) sites for each treatment could have confounded geographic/site variation in soil types, hydrology, etc. By using a matched pairs design, extraneous variables are controlled as much as possible within paired sites, and hence, by testing for difference among paired treatment-control sites, we are able to more powerfully evaluate treatment effects. We contracted with statistical consultants at UCD (Statistical Consulting Services, Dept. of Math and Statistics) to develop the study design that would best allow us to control for among-site variation while testing the main effect of delayed drawdown.

It is important to recognize that this study represents a one of a few ongoing efforts to implement true adaptive management (i.e., learning while managing). These sites are actively managed wetland units for which the Department of Fish & Game has a specific management mandate. To meet this mandate, the number of activities that can be undertaken while still meeting the prescribed management goals are necessarily limited. True adaptive management will always present some logistical constraints (i.e., we can not design the study purely based on the needs of an ideal experimental "greenhouse" design). In return, the information gained is directly useful and can be immediately incorporated into updated management actions. One of the important strengths of the present study is that it establishes a process to learn actively about alternative management actions at a sufficiently large spatial scale (whole wetland units located throughout the Grasslands region), while continuing to manage these units to meet public and wildlife needs. Undertaking such an effort (while running the risk of reducing the guality of some of these sites in order to learn) is a significant development for CDF&G and its partners. The study has been designed to provide the greatest analytical power, while maintaining and respecting the primary management objectives for these sites.

2). The use of high resolution aerial photography and image segmentation techniques to map habitat are inadequately explained. When will the imagery be acquired, how will it be interpreted and by who?

Project Team Response:

A pilot effort during the summer dry season of 2005 established that methods of in field wetland habitat monitoring to be excessively labor intensive due to the need for ecotone delineation and layer postprocessing consistent with Tatu et al. (1999). These methods also introduced a tremendous amount of technician-based habitat delineation biases, and provided low resolution for monitoring habitat distribution due to GPS device inaccuracy. A method of rapid assessment, monitoring and quantification of wetland habitat communities on a year to year basis is necessary, consistent with Wiens and Parker (1995) and Shuford et al. (1999).

Imagery acquisition from HJW Geospatial aircraft imagery has been and will continue to be acquired as a cost-shared component of one of the sister projects. HJW has provided 6" image resolution with RG and NIR bands. Orthorectification using ground control targets will also be performed by HJW. RMS ERROR X=0.747; Y=1.089; X = 0.1138 and Y =

0.1659 meets NMAS 1":200' mapping standards. Images are acquired twice annually, and are scheduled throughout the duration of the project. Initial yearly images are taken just prior to irrigation. Although irrigation timing is normally 4 weeks post draw down, it is dictated by a set of physiological and environmental criteria commonly used among wetland managers. The second set of images are acquired approximately 4 weeks post irrigation. This will allow for differential species maturation and in turn provide differential spectral properties within and across wetland annual habitats. (López-Granados etal., 2005)

Imagery classification processing will be accomplished using maximum likelihood pixel-based, applied to polygon-objects. This pixel-based maximum likelihood classifier creates one signature for each ground truth point, then records the data into a small number of classes at the end of the process. Using the majority of pixels in each polygon, assign each polygon a value. These methods have been modified from methods developed in the North Division of the Grassland Water District by specialists from LBNL employing industry standard methods per se Lillesand, T. and R. Kiefer (2000).

Collaborative ground-truthing efforts involving representatives from DWR, CDFG, GWD, LBNL, UC Merced, and UC Davis will continue to conduct vegetation assessment surveys across wetland habitat types potentially affected by a change in the normal timothy-managed hydrologic schedule. This project is employing sub-inch resolution Nikon Surveying Total Stations to map habitat polygon boundaries or ecotones. Polygons mapped to sub-inch accuracy in a subset of wetland habitat polygons enables the seasonal monitoring of changes in habitat distributions, outside the resolution of our remote monitoring methods. This sub-inch mapping and monitoring effort will also act as a proxy for the calculation of segmentation error, and ultimately the resolution of the remote monitoring. Classification and segmentation data will be continuously collected and accessed throughout the ground-truthing, and vegetation monitoring efforts over the study duration. Spectral properties of high-resolution aerial photography coupled with the comprehensive vegetation assessment and ground-truthing effort, will enable the accurate remote classification and segmentation of wetland vegetation classes in swamp timothy managed wetlands within the Grassland Ecological Area.

3). What is the purpose of collecting moist core samples? Consider that a core sample will have seeds/cysts from years prior to the proposed experiment, so how is this of value to assessing impacts of delayed draw-down?

Project Team Response:

Until this study, the standard method used to assess seed production in moist-soil managed wetlands has been via core-sampling. (Fredrickson

and Taylor 1982, Gray et al. 1999a, b, c, Laubhan and Fredrickson 1992, Sherfy and Kirkpatrick 1999, Smith et al. 2004, Naylor et al. 2005. References given below). A major rationale for such an approach was that it is the only method available to assess seed availability after flood-up, during the period of high bird use. Previous workers have recognized the potential for core-samples to include seeds/cysts from previous years, although it is thought that the bias is low given (1) high rates of depletion by foraging birds and other predators, and (2) high decomposition for many seeds, including swamp timothy. Cores are limited to the top 1-2 inches of substrate to further minimize bias due to the seed bank. Nonetheless, in the present study, we have proposed using two approaches to safe-guard against the concerns raised; (1) traditional wet soil core method utilized by Naylor et al. (2005), and (2) a less processing intensive aboveground clipping approach. By doing so, we will be able to directly compare our results with those of other studies and will be able to assess the extent to which other studies using core-sampling may yield biased estimates.

The sampling design is for clipped vegetation samples to be taken at locations near to those targeted for wet soil cores to facilitate a direct comparison between the two methodologies. A favorable comparison of productivity estimates between the methods would permit the less time intensive and greater data acquisition potential of the clipping method to be adopted. The moist soil core sampling will be isolated to the swamp timothy effective germination zone depth of 2" consistent with findings of Leck, Simpson, (1987).

- Fredrickson, L. H., and T. S. Taylor. 1982. Management of seasonally flooded impoundments for wildlife. United States Fish and Wildlife Service Resource Publication 148.
- Gray, M. J., R. M. Kaminski, and G. Weerakkody. 1999a. Predicting seed yield of moist-soil plants. Journal of Wildlife Managagement 63:1261-1268.
- Gray, M. J., R. M. Kaminski, and M. G. Brasher. 1999b. A new method to predict seed yield of moist-soil plants. Journal of Wildlife Management 63:1269-1272.
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- Laubhan, M. K., and L. H. Fredrickson. 1992. Estimating seed production of common plants in seasonally flooded wetlands. Journal of Wildlife Management 56:329-337.
- Sherfy, M. H., and R. L. Kirkpatrick. 1999. Additional regression equations for predicting seed yield of moist-soil plants. Wetlands 19:709-714.

- Smith, L. M., D. A. Haukos, and R. M. Prather. 2004. Avian response to vegetative pattern in playa wetlands during winter. Wildlife Society Bulletin 32:474-480.
- 4). Will whole plants be clipped, or only seed parts?

Entire plants will be clipped at ground level utilizing a modified sampler. Collected clipped vegetation samples will be marked by collection date, wetland field, and sample point location. Samples will be separated into component tissues (leaf, stem, and reproductive components), placed in separate sub-bags, dried to constant weight and weighed to 0.0001g accuracy. Reproductive structures will separated using dissecting microscopes and an illumination system. Data collected will include total sample dry mass, leaf tissue dry mass, stem tissue dry mass, and reproductive tissue dry mass.

5). Water depth is one of the key factors which influences waterbird use, both the species of birds and their relative abundance. How will water depth be measured? Will water depths be consistent between treatments within a block? Among blocks?

Project Team Response:

A calibrated pressure sensor will collect real time water depth measurements at the drainage water control structures of all ponds. In addition, as a cost share component of the proposed project California Waterfowl Association has agreed to map the micro topography of all 12 study ponds to sub-inch accuracy. These elevations will then be correlated to the real time depth measurements to calculate a mean pond depths at any given time through the hydrologic period. These data will be utilized as covariates for the avian usage data during analysis.

CDFG water managers are responsible for keeping consistent water depths within a block at the drainage sites control structures, although ponds will vary slightly in micro-topography across blocks. Within paired blocks, ponds share common micro-topographic characteristics with relatively flat basin expansions that sustain similar water depths when inundated.

6). Will mechanical manipulation (discing/mowing) will be consistent between treatments and among blocks?

In an effort to maximize the utility of the study to wetland managers, and to minimize study related influences on normal best management practices, mechanical management will continue to be done on a normal basis. Efforts will be made to be consistent within paired sites, subject to management needs. Further, we will document and map all mechanical management occurring within the study sites. Mechanically managed areas can then be later removed from the total area for analysis if necessary; alternatively the type and area of mechanical management can be used as covariates. Concise maps of mechanically managed areas will allow us to document cumulative effects of mechanical management as they pertain to habitat composition, density, distribution and ultimately swamp timothy seed production.

7). Since it is already established that waterfowl rely on swamp timothy seed food resources in the Grasslands, is it necessary to assess waterbird response to changes in seed yield considering the conservation ramifications to waterbird resources would be clear without documenting any bird response?

Project Team Response:

We agree that, by assessing swamp timothy production, we will be able to evaluate the conservation implications to waterbirds. Moreover, due to significant depletion and decomposition of swamp timothy by the end of hunt season, a direct correlation of bird use to swamp timothy seed productivity would be difficult to assess. However, concerns about any potential impact of delayed drawdown ultimately relate to how bird use will be affected (ostensibly via changes in the food resource). Accordingly, we believe it is imperative that we undertake an assessment of avian usage patterns in relation to the proposed hydrology manipulations. To improve the utility of such comparisons, we have modified the avian monitoring methods of this project to more accurately assess waterbird responses during the late winter/spring inundation period. In addition to monitoring the six pairs of swamp timothy managed cells we will also monitor six wetlands managed for watergrass due to their similarity to the delayed hydrologic schedule of the swamp timothy managed wetlands. Waterbird monitoring of six swamp timothy control wetlands, six swamp timothy treatment wetlands, and six normally managed watergrass wetlands will provide a more robust comparison of bird habitat use in relation to normal wetland hydrology and the proposed modified hydrology.

Avian surveys for the proposed study will enumerate the number of birds of each species, water depths, electroconductivity, temperature, time, and weather. Fields will be surveyed weekly by walking the perimeter of each field using 10 x 25 binoculars. Larger fields require stopping points in areas where the observer has concealing cover. We will utilize Nikon 82mm ED field scopes minimizing disturbances and increasing identification and quantification accuracy. Each field will be surveyed once per week; surveying three fields per day. Each field within a pair is surveyed on a separate day as part of a rotational schedule to avoid probable pseudo replication by bird movement between the fields during a survey. Surveys will be conducted between sunrise and four hours after sunrise and each fields survey time will be alternated weekly (early, mid, late morning) to minimize time biases (Taft, O. and S. Haig, 2005).

In addition to the site-specific surveys described above, we further propose to integrate previous Waterbird Habitat Use Project (WHUP) surveys and data within the context of the modified hydrology study. By doing so, we will be able to interpret avian response to the modified hydrology in a broader context (as recommended by one reviewer). In effect, the WHUP survey data from traditionally managed swamp timothy and watergrass wetlands provide critical baseline information to which we can then compare waterbird response to the modified hydrology.

From 2000 through 2004, waterbird surveys were conducted on 40 fields adjacent to our study sites, as part of the WHUP conducted by CDFG. The proposed goal of WHUP was to assess waterbird use of differently managed wetlands. Five variables were considered for each survey, including: moist soil management type, water depth, variability of water depth, date, and wildlife area locality. Five wetland management types were considered, including, swamp timothy, watergrass, swamp timothy/watergrass, swamp timothy/smartweed, watergrass/smartweed, and combination fields composed of swamp timothy/ watergrass/ smartweed. Each field was surveyed once per month during the late winter and early spring.

8). Will the hunted units be paired with hunted units, and non-hunted units paired with non-hunted units? This is an important consideration, because sanctuaries typically have far greater waterfowl use than hunted areas and this can influence waterfowl use in both sanctuaries and hunted areas during the post-hunting wintering/spring staging period.

Project Team Response:

All study units are within hunted zones. We fully recognize the potential influence associated with public use and distribution of sanctuaries during the hunting season. This would be of concern if some sites were hunted and others were not (or if this varied among treatment and control units). However, such a bias will not affect our results since all study units are managed for public hunting; bird use should reflect normal utilization patterns for these units. Moreover, by pairing treated and control sites, variation in waterbird use of sites caused by public use and the distribution of nearby sanctuaries will be standardized within blocks. To further reduce the influence of hunting and availability of sanctuaries on measure of avian response, we will focus survey efforts on post-season water bird use (from the end of hunting season to drawdown).

9). How will the proponents separate the responses of drawdown from the other factors that may affect swamp timothy production, including such things as soil salinity, weather factors and others?

Project Team Response:

The study is designed with the intent that factors other than drawdown date, such as soil salinity, habitat composition, micro-topography, microclimate, and water quality would be consistent within pairs, justifying the paired block design. Additionally, we will document these variables for use as covariates in the analysis of swamp timothy seed production. The collaborative efforts of the project partners are currently providing soil salinity maps, habitat composition maps, micro-topographic maps, and collecting Bowen ratio weather station data and water quality data.

Reviewer Comments:

1). If wetland blocks are adjacent to one another, the proponents are likely to run into problems of spatial non-independence, especially with waterbird use, e.g., what's happening in the treatment wetland (delayed drawdown) may influence use of the control (traditional drawdown date), or vice versa.

Project Team Response:

We agree. For example, when the control field is drawn down it is very likely that birds will move to the next available water source. This is true even if the fields are not adjacent. It is for this reason that the focus of our study is on seed production (primary response variable), rather than waterbird use, which is likely to be highly variable (please see our comments on avian survey methods above, where we provide more detail on how we will conduct the avian monitoring component of the study).

To evaluate spatial non-independence we will also monitor six adjacent units managed for watergrass with similar drawdown dates to the experimental timothy cells to compare waterbird responses across other available remaining habitat.

To minimize pseudo-replication between fields during surveys, each field within a pair will surveyed on a separate day as part of a rotational schedule. The time of day for each field survey will also follow a rotational schedule so that usage will not reflect a specific time of day on specific fields. 2). Agreements should be made with State Wildlife Area Managers and managers of private duck clubs to eliminate all unnecessary visits to the study sites during the waterbird survey period.

Project Team Response:

Public site visits will be reduced dramatically due to monitoring beginning at the end of waterfowl hunt season. It is a priority of the wetland area managers to minimize any unnecessary visits, including management staff and the public, to the study sites to minimize further disturbance.

Feasibility

Reviewer Comments:

1). The likelihood of success will depend strongly on the ability to use statistics to separate out changes and what they are related to, as well as the ability of the on-the-ground manager to communicate and receive timely guidance from those providing the statistical expertise.

Project Team Response:

Statistical consultation will continue to be a cost-share contribution from UC Davis. Wetland managers will continue to work directly with UC Davis statisticians, graduate students and project advisors to insure design related consistency and direction. We have designed the study to yield the maximum statistical power, given the logistic constraints on the number of wetland units (12) available for manipulation. It is important to recognize the large scale of this project and to realize that experimental manipulation of 6 sets of paired whole-wetland units is a considerable contribution and undertaking– this is not a small scale, garden-plot comparison. Accordingly, we anticipate that the results will reflect the range of variation that exists in wetland productivity and so will have direct validity and utility to wetland mangers (i.e., we are evaluating the effects of the treatment at a scale that is realistic and relevant to on-the-ground management).

Project Performance.

Reviewer Comments:

1). Performance measures in this proposal appear to be limited to reports describing monitoring and a final report integrating the assessment. It is recommended that an external review process be incorporated in to the schedule and deliverables.

An external pier review process will be incorporated in the tasks and deliverables as a component of the Master's thesis work from UC Davis. Further peer review could be developed if desired or required.

Expected Products/Outcomes.

Reviewer Questions:

1). Will there be a final report published for the scientific community?

Project Team Response:

Yes. This project will produce multiple peer-reviewed publications from Masters level thesis work from UC Davis and UC Merced. (This was not well explained in the proposal). We anticipate 3-6 manuscripts resulting from this work to be submitted to per-reviewed scientific journals. Similar work conducted at UC Davis has yielded 4 manuscripts from a single M.S. thesis, with several other manuscripts in development. Additional peer-reviewed publications will derive from the collaborative sister projects associated with this study.

Reviewer Comments:

1). One of the expected outcomes of the project is to provide insight into the methods of remote sensing technologies that can be used in making impacts to the aquatic biota in the wetland. The previously funded CALFED projects were suppose to develop the procedures for remote sensing techniques. This project should not attempt to duplicate this effort, only concentrate on on-the-ground data which other specialists in other projects can use to validate the remote sensing techniques.

Project Team Response:

Intensive ground-truthing, vegetation assessment efforts are currently being conducted by teams from UC Davis, CDFG, DWR, and LBNL. In the field, spatial monitoring will take place in a statistically robust subset of habitat polygons to not only monitor slight changes undetectable by remote assessment methodologies, but also to assign segmentation, classification, and registration errors associated with the remote assessment and monitoring methods. In addition to the vegetation surveys associated with the ground truthing efforts, we will also conduct comprehensive vegetative quadrat surveys monitoring species composition, distribution, habitat structural characteristics and respective species densities. 2). Articles providing project overview, results, and restoration/management implications in "Valley Habitats (Ducks Unlimited) and "California Waterfowl" (California Waterfowl Association) would provide additional outreach to the duck hunting landowner constituency.

Project Team Response:

We agree and will pursue these venues to provide information and outreach in addition to a final report and peer-reviewed journal articles. We will also maintain regular updates of the project progress on UC Davis and associated web-sites.

Specific Review

Additional Studies

Reviewer Questions:

1). One factor that is missing from the project is how the delayed (thus moving into warmer weather) drawdown impacts the algal loads leaving the wetland areas. At present initial modeling of the San Joaquin River shows that nutrients and algal loads leaving the Upper basin areas such as the Grassland sub-basin are a major contributor to the loadings to the Stockton Deep Water Channel. Will this project, or any of its 'sister' projects looking the mechanical hydrology in the area be collecting data on algal loads in wetland discharges?

Project Team Response:

The largest DO sags in the River and in the Ship Channel occur in the fall not during spring drawdown. Hence the wetland areas are not responsible for algae induced impacts during this period. However during fall flood-up nutrients, oxidized and mineralized during the summer months are brought into solution. These nutrients may stimulate algal growth in the River. However, at present, we have insufficient data to explore this causality.

Reviewer Comments:

1). Additional studies should focus on invertebrate production/biomass.

Project Team Response:

We recognize the value and need for such studies. Invertebrate sampling is extremely time and labor intensive and was viewed as being beyond the capability of the present project, although highly desirable. We are working with CSU Fresno to develop funding to incorporate an invertebrate component to the study. Invertebrates are a highly important food source for many waterbirds, and have been noted to increase in importance at the end of the winter and into spring (Bolduc, F and D. Afton, 2004). Investigations would assess differences in invertebrate biomass concordant with the avian use surveys in control and treatment swamp timothy managed cells as well as normal watergrass managed cells.

2). It would be important to collect waterbird use data throughout the managed wetland hydro-period (late-summer/fall flood-up to spring draw-down) so that the full impacts of delayed draw-down to wintering waterfowl may be assessed. (This considering that disturbance and water depth is critical to waterbird use: so high quality wetland habitat may not receive high waterbird use if disturbance is high and/or water depths too great for dabbling ducks, shorebirds, and wading birds access food and prey items).

Project Team Response:

Waterfowl hunting season spans from late October to the beginning of February. As a component of the pilot study for the purposed project we collected weekly avian usage baseline data across all paired sites from the beginning of waterfowl season to drawdown. We observed dramatically lower waterfowl usage throughout waterfowl season, despite conducting surveys on non hunt days. We believe this was due to the disturbance from the previous days hunt, and that the birds had likely chosen non-hunt areas as sanctuary during these months. For this reason, and the extreme disturbance factors influencing site specific usage we will not survey during the hunting months. Avian monitoring surveys will run from the end of waterfowl hunting season in early February, to the end of the drawdown periods in mid-March (control) and mid-April (treatment).

3). While swamp timothy is an important wetland food plant, there are many other important wetland waterfowl food plants, including native species. It would be useful to assess habitat use by waterbirds in other types of wetlands adjacent to the swamp timothy experimental cells. This will show whether other managed or natural wetland types compensate for decreased swamp timothy wetland habitat quality.

Project Team Response:

As describe above, we will monitor six adjacent watergrass managed fields in addition to the twelve swamp timothy managed cells to not only evaluate any compensation that may occur (due to reduction in swamp timothy wetland productivity) but also to allow the simultaneous comparison of avian response to normal and delayed hydrology as it pertains to available habitat. In addition, we will integrate the avian surveys with the more extensive WHUP surveys to provide a broader comparative assessment of avian response to management changes. 4). The continued promotion of swamp timothy (an exotic plant) management may be in direct conflict with the CALFED Ecosystem Restoration Program's goals for ecosystem and native species recovery.

Project Team Response:

It is important to note that this study does not "promote" swamp timothy management – i.e., it is not designed to evaluate different management techniques to improve or maximize swamp timothy production. Rather, the study is designed to evaluate the impacts of a proposed change in hydrology management (as desired to reduce salt and boron discharge into the San Joaquin river at certain times of year) on <u>current</u>, existing management activities. The study seeks simply to determine whether such changes in hydrology would have a deleterious effect on the capability of these wetlands, <u>as currently managed</u>, to provide high quality habitat for waterbirds. It would seem imprudent and irresponsible <u>not</u> to consider such effects.

The 180,000 acre Grassland area constitutes the largest contiguous wetlands left in California. The most abundant moist soil plant managed and selected for in the Grassland Wetlands is swamp timothy. Wetlands managed for swamp timothy constitute approximately one third of all the managed wetlands with in the Grassland Ecological Area including State Wildlife Areas and National Wildlife Refuges. Previous research has demonstrated swamp timothy to be an important energetic component of waterfowl diets (seeds are high in protein and carbohydrates); and an important detrital component to enhance to invertebrate production.

The grassland ecological area is a significant waterfowl wintering area supporting peak waterfowl populations in excess of one million, as well as an important fall and spring migration stopover site for shorebirds, with peak numbers of more than 200,000 shorebirds observed. In 1991, the Western Hemisphere Shorebird Reserve Network recognized the Grasslands as an Internationally Significant Shorebird Site. It has also been designated as a Globally Important Bird Area by the American Bird Conservancy and the National Audubon Society. In 2005, the Area has been designated a Wetlands of International Importance under The Convention on Wetlands of International Importance, making it one of 22 Ramsar sites in the United States. Accordingly, we view it as essential that efforts be undertaken to evaluate rigorously any proposed changes in hydrology (or other) management that could impact the ability of the grassland ecological area to provide critical habitat for the large numbers of birds and other wildlife that depend upon this region.