Waterfowl Impacts of the Proposed Conservation Measure 2 for the Yolo Bypass – An effects analysis tool

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1 Executive Summary

This project is the result of initial Bay Delta Conservation Plan's Conservation Measure 2 Yolo Bypass Fishery Enhancement Planning Team meetings held during the summer and fall of 2011 to discuss the biological needs of fish species and how alteration of flood duration and frequency could affect current land uses within the Bypass. From these meetings it became clear that there was a gap in information to determine the effects from Conservation Measure 2 on other key species and habitats that benefit from the current operation of the Yolo Bypass, waterfowl in particular. Many of land uses in the Bypass provide habitat for waterfowl, notably the Yolo Bypass Wildlife Area and many private hunt clubs. These stakeholders requested that any changes to flood management in the Yolo Bypass be examined with consideration for the effects on waterfowl, among other effects. This study is an effort to describe the main drivers of waterfowl and associated recreational use in the Yolo Bypass and report on the successful development of a tool that can evaluate effects on these resources and uses due to implementation of future flood management scenarios as part of Conservation Measure 2.

2 Background

Conservation Measure 2 proposes to increase fish habitat functions and values within the Yolo Bypass through the activation of floodplain processes by increasing the frequency, duration, and amount of flooding over the Fremont Weir between November and April. In order to refine what operational scenario the Measure might operate and how the effects of that scenario on waterfowl may either be minimized or off-set, this project designed a tool that can model the effects on waterfowl and their habitat resulting from a change in Yolo Bypass flood management. Waterfowl habitat for the purpose of this project is defined as managed seasonal wetlands and winter flooded rice fields. Potential flood flows through the future operation of a gate or passive notch in the Weir have yet to be determined; however, current estimates are for allowing flows of up to an additional 6,000 cubic feet per second (cfs) in certain situations. This is the boundary condition that was used in developing the evaluation tool and is integral to the proof of concept examples as described in this report. Future scenario runs may vary the magnitude, duration and frequency of new flooding in the Bypass and their effects can nonetheless be quantified with this tool.

Wetlands and their management at Yolo Bypass Wildlife Area was the focus for the development of this tool considering that the majority of wetlands located within the Bypass are situated within its borders. Additional waterfowl habitat is also present on private hunt clubs and on winter flooded rice fields on both the Wildlife Area and private farmland throughout the Bypass.

3 Main Drivers

The four main drivers of effects on waterfowl from increased flooding in the Yolo Bypass include the changes to recreational use, loss of farming and hunting income, reductions in foraging habitat and the loss of wetland seed production due to later spring draw down. Each of these drivers is described in detail in the following sections.

3.1 Recreation/Hunt Use

The Yolo Bypass Wildlife Area (YBWA) is a popular waterfowl hunting and bird watching area with bird numbers peaking in February. It is open to the public most days except during certain Bypass flooding instances. Current procedure regulating public access at the YBWA during floods is to close the entire area soon after water overtops the Fremont Weir. Even relatively small overtoppings can inundate public access infrastructure in certain portions of the YBWA. This infrastructure is not currently capable of limiting access to only non-flooded areas, hence closing the entire area for the duration of the flood. In order to understand the relationship between the magnitude of a flood and the number of days of closure, this study used the record of Fremont Weir overtopping events and matched it chronologically with the record of YBWA closures as a metric for effects on recreation. Since there is not a direct tally of YBWA closures, the last 13 years of hunt records were examined to record the days that hunting was closed on the wildlife area. Figure 1 shows the number of days of Fremont Weir overtopping and the subsequent YBWA closures.

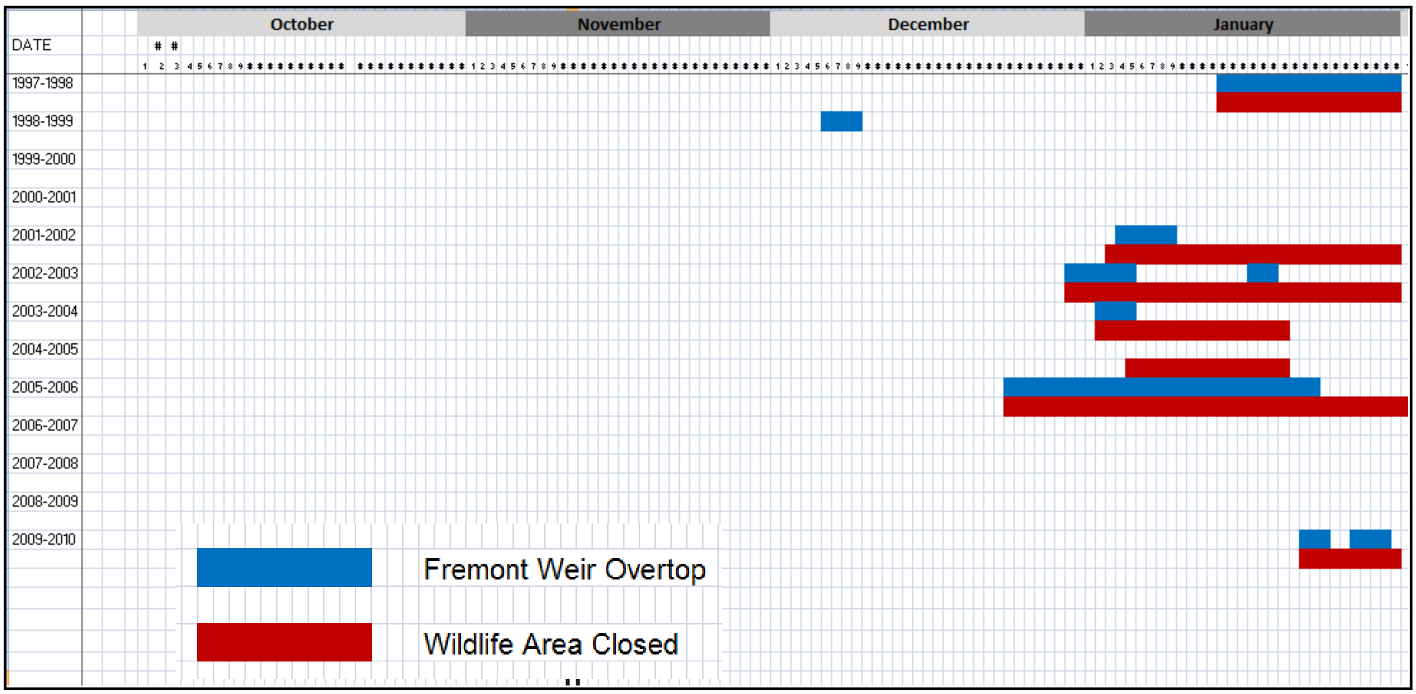

Figure 1. Dates of Fremont Weir overtopping and closure dates for the Yolo Bypass Wildlife Area

For future scenarios, the current baseline closures could be compared with new flooding due to changes in the operating of the Fremont Weir. Future scenarios would be expressed as their effect on the increase or decrease in the number of possible waterfowl hunt days each year. This has the potential to affect both public hunting opportunities on the YBWA and private hunt opportunities on duck clubs and rice fields. If the number of flooded days reach an undefined threshold, private ducks club members may lose interest in maintaining their wetland habitat if there aren't enough hunting days to make it worth their investment. This topic could be further examined when future scenarios are compared.

Over the 13 year record, the YBWA averaged 14 days of closures during the course of a hunting season, which lasts for roughly 100 days between the middle of October through the end of January. In the thirteen seasons, seven years had weir overtopping events. Several flooding events were examined in an effort to understand the time needed for the YBWA to dry sufficiently before opening back up to the public. The first event was the December 1998 event and was unique in that it was the only overtopping event that did not cause any closures. Further inspection revealed that this event had a maximum flow of 1,650 cfs, which is small enough to be fully contained in the flow channel of the Toe Drain and not flood the wildlife area.

The next unique closure event examined was the late December event in 2004. For this occurrence, the Fremont Weir did not overtop yet the YBWA was closed for two and a half weeks. It is suspected that this closure was due to flooding caused by west side tributaries. Since there are no gauging stations on many of the west side tributaries, we looked at local precipitation data to see if a large storm affected the western part of Yolo County to a much higher degree than the remainder of the Sacramento Valley upstream of the Bypass. The Berryessa precipitation station shown in Figure 2 totaled over six inches of rain in late December. An examination of stations farther up the Central Valley showed significantly less rainfall. This corroborated the premise that this occurrence captured the type of event when the Fremont Weir is not spilling, but the west side tributaries are flowing high enough that they can independently flood the YBWA and downstream duck clubs.

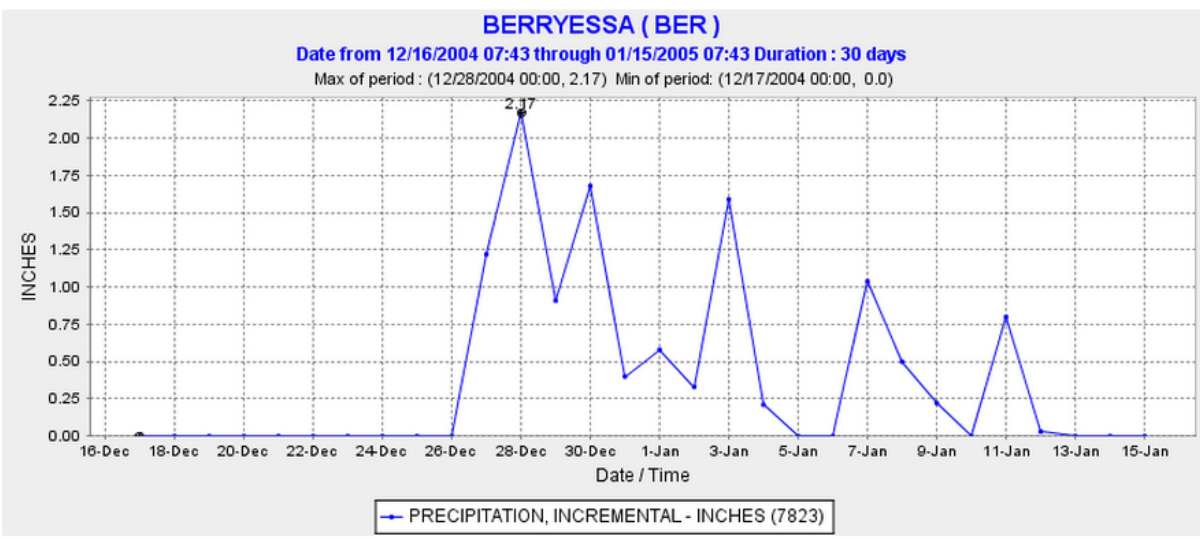

Figure 2. Precipitation at the Berryessa station from 12/16/2004 – 1/15/2005 (CDEC, 2012)

The third event that was examined was the January 2004 event that lasted less than five days and had a peak flow of 3,000 cfs over the Fremont Weir. This flow is in the lower range of the proposed notch flow events currently proposed by Conservation Measure 2. This event closed the YBWA for two weeks. Another larger overtopping event in January 2002 peaked at 35,000 cfs and the YBWA closure lasted for three weeks.   Although it is a very small sampling of years, the record establishes a drying time window for the YBWA to reopen after a flood is between two and three weeks with current operating procedures. It may be possible to change the way the YBWA closes and have partial closures in order to accommodate managed flood events. However, any changes would be needed to be developed and approved by the Department of Fish and Game with respect to YBWA Management Plan.

3.2 Income Loss

The landowners in the Bypass may experience several types of income loss due to the proposed Conservation Measure 2, which could have ramifications on waterfowl habitat management. Yolo County recently completed an agricultural impact analysis that monetized the direct loss of income from farming operations and the indirect effects on the local economy (Howitt et al., 2012) from a potential Bypass flooding scenario. In the County's analysis, they examined a series of dates that represent the last day in a season for the overtopping of Fremont Weir and the resulting effects on crop planting. The study documents significant agricultural income losses from a flooding scenario that lasts past a March 24 overtopping date. For many crops, including rice, to be grown at all in the Bypass, flooding needs to end by April 10 for the east side and April 24 for the west side due to differential drying times.

In addition to the agricultural losses on growers and the local economy, the YBWA depends on income from agricultural leases including rice, grazing and other crops to support annual management and operational costs. This income is significant as it is greater than the annual appropriations from the Department of Fish and Game. Although Yolo County's study monetized potential private agricultural losses in the Bypass as a result of Conservation Measure 2, it did not specifically describe how the YBWA's wetlands could be affected by losing the agricultural lease income.

Other sources of potential income losses supporting wetland management as a result of Conservation Measure 2 may include waterfowl hunter expenditures for reservations at the YBWA or membership fees at private duck clubs.   On the YBWA, increased duration and frequency of flood events can close the area to the public thereby reducing hunter access fees. On private wetlands that are managed as duck hunting clubs, there is a potential loss to property value since this value is primarily derived from the amount and quality of hunting opportunities available each year. With more flooding the annual maintenance costs may increase while the hunt days decrease. This will effectively increase the cost per day of hunting.

3.3 Deep Winter Flooding

One of the potential impacts of an increase in winter flooding due to Conservation Measure 2 is that the Bypass may be covered in deep water that precludes dabbling ducks from foraging. This guild of waterfowl prefer to forage in very shallowly flooded seasonal wetlands, but can feed in relatively deeper areas by upending as shown in Figure 3. Due to their physiology, they are limited to foraging in water depths of less than 18 inches (Nelson, 2012; Fredrickson, 1982) with preferred foraging depths less than

10 inches. This is in contrast to the diving duck guild that dives or swims to their food sources in water deeper than 18 inches. The population objectives for dabbling ducks and diving ducks in the Central Valley are shown in Figure 4; this figure also shows the corresponding dabbler species-level population objectives (CVJV, 2006).

Figure 3. Upending dabbling ducks have a limit to the depth of water that allows foraging (Garg, 2007)

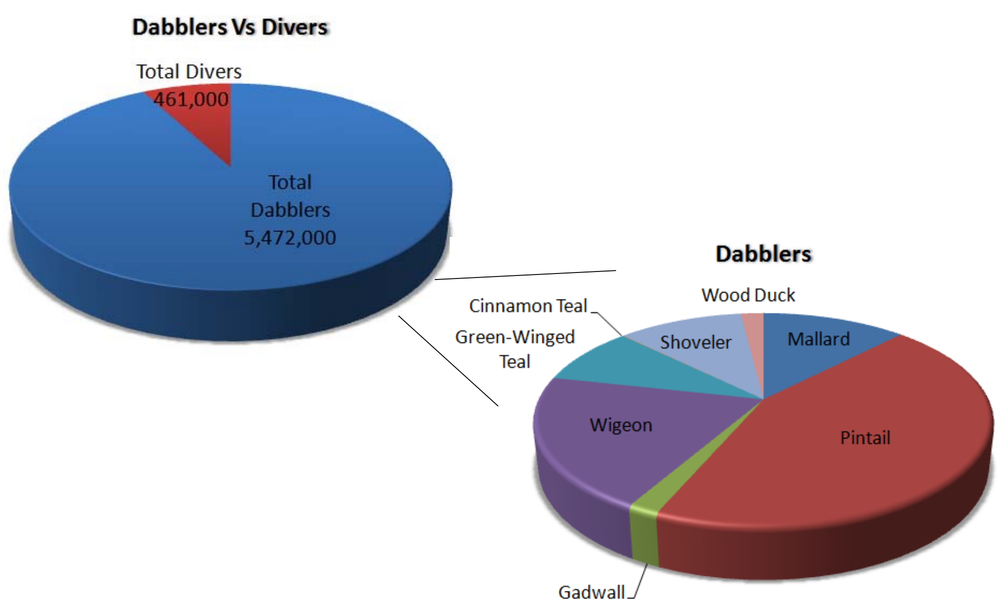

Figure 4. Dabbling duck population objectives for the Central Valley (CVJV, 2006)

The Central Valley Joint Venture's (CVJV) dabbling duck population objectives were developed for each of the major 'basins' within the Central Valley, including the Yolo Basin. To incorporate the effects of Conservation Measure 2 on dabbling ducks, a series of linked models were used as shown in Figure 5. Land cover was combined with the MIKE21 2-D flood model results and input into the BypassDepth (BDepth) GIS model. This GIS model separates the depth of each land cover class into a dry, managed, shallow or deep water category. These outputs are then used in the TRUEMET model for the Yolo Basin in combination with the Basin's waterfowl population objectives. Final output of this progression is food supply and food demand curves that show how changes in flooding affect the carrying capacity of the waterfowl population in the Yolo Basin, including the Yolo Bypass.

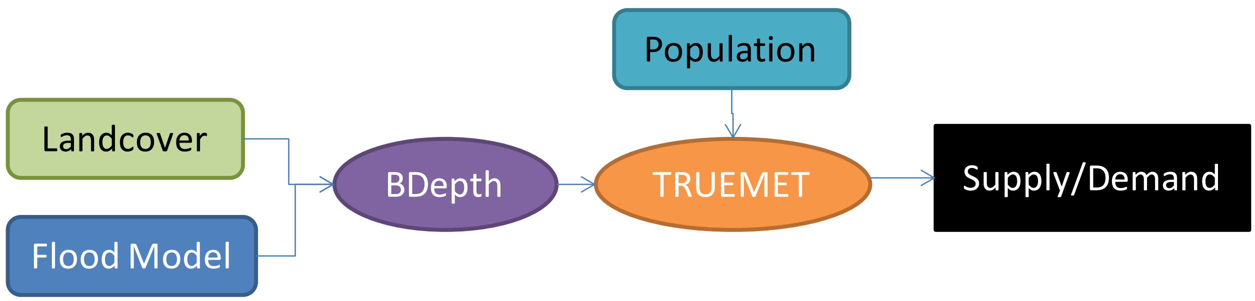

Figure 5. Data inputs and models used in the modeling of the loss of winter foraging habitat

In order to assess the future impact on the available waterfowl foraging habitat in the Yolo Bypass, the 2011 land cover, including the spatial extent of wetlands, in the Bypass was mapped. This effort was aimed at capturing the large areas of wetlands that were restored after the previous mapping effort in 1999. Additionally, the total amount of winter flooded rice base, the other key waterfowl food in the Bypass, was mapped with the assumption that only two-thirds of the rice base is planted in a normal year either due to flooding conditions or the rotation of the ground to fallow every third year. The current conditions are shown in Figure 6.

For the initial run of the BypassDepth model a high end flood flow boundary condition of 6,000 cfs from a proposed notch and additional inputs from west side tributaries (CBEC, 2010) was chosen from the Mike21 model output. This was the largest flow scenario outlined in the document and suitable for demonstrating proof of concept for the evaluation tool. The BypassDepth output is shown in map format in Figure 7.

The second set of output from the BypassDepth model is a land use specific analysis of the dry, managed, shallow and deeply flooded land in the Yolo Bypass. Each category defines the water depth or absence of it on a specific land use. Dry areas are defined as fields that receive no delivered water and are upslope of the example flood. Managed areas are wetlands or rice shallowly inundated in the fall to encourage waterfowl use and/or rice stubble decomposition. Water on these areas is managed to depths preferred by dabbling ducks. Shallow water areas include both managed and unmanaged locations that remain below the 18 inch depth threshold for dabbling ducks to continue to forage. Deep water areas are locations that were inundated by flood waters to depths deeper than 18 inches.

The top chart in Figure 8 shows the initial condition and land use acreages in the Bypass in a dry year, defined as a year with no overtopping of the Fremont Weir. In this example wetlands and rice fields are managed for water depths that promote waterfowl foraging. During a subsequent flood event of 6,000 cfs, the lower chart in Figure 8 shows the extent of the land uses outside of the flood extent as dry or managed water, and the areas inside the floodwater extent as shallow water or deep water. Following the wetland land use through this example from the top chart to the bottom chart, in the initial conditions is all managed water. In this example when the Bypass floods (lower chart), approximately 55% of the wetlands are deeply flooded and the remaining wetlands are split between being shallowly flooded by the new floodwater and those wetlands outside the flood flows that stay as managed wetlands. In relation to foraging potential and food availability, the managed and the shallow categories are equally weighted and available to foraging dabbling ducks.

The next step in the analysis, as shown in Figure 5, is taking the output from the BypassDepth model and inputting it into the TRUEMET model. The other site-specific input into TRUEMET is the waterfowl population objectives for Yolo Basin. The waterfowl population objectives are taken from the CVJV's Implementation Plan (CVJV, 2006). The objectives in Figure 9 are given at two week intervals throughout the winter season with peak waterfowl use in February. The Yolo Bypass is completely contained in the CVJV's Yolo Basin. The Bypass forms the entire east portion of the Yolo Basin as shown in the Figure 10. The inset map shows the Yolo Basin in relation to the other eight planning basins of the Central Valley. The Yolo Basin also contains roughly half of the valley portions of Yolo County and Solano County.

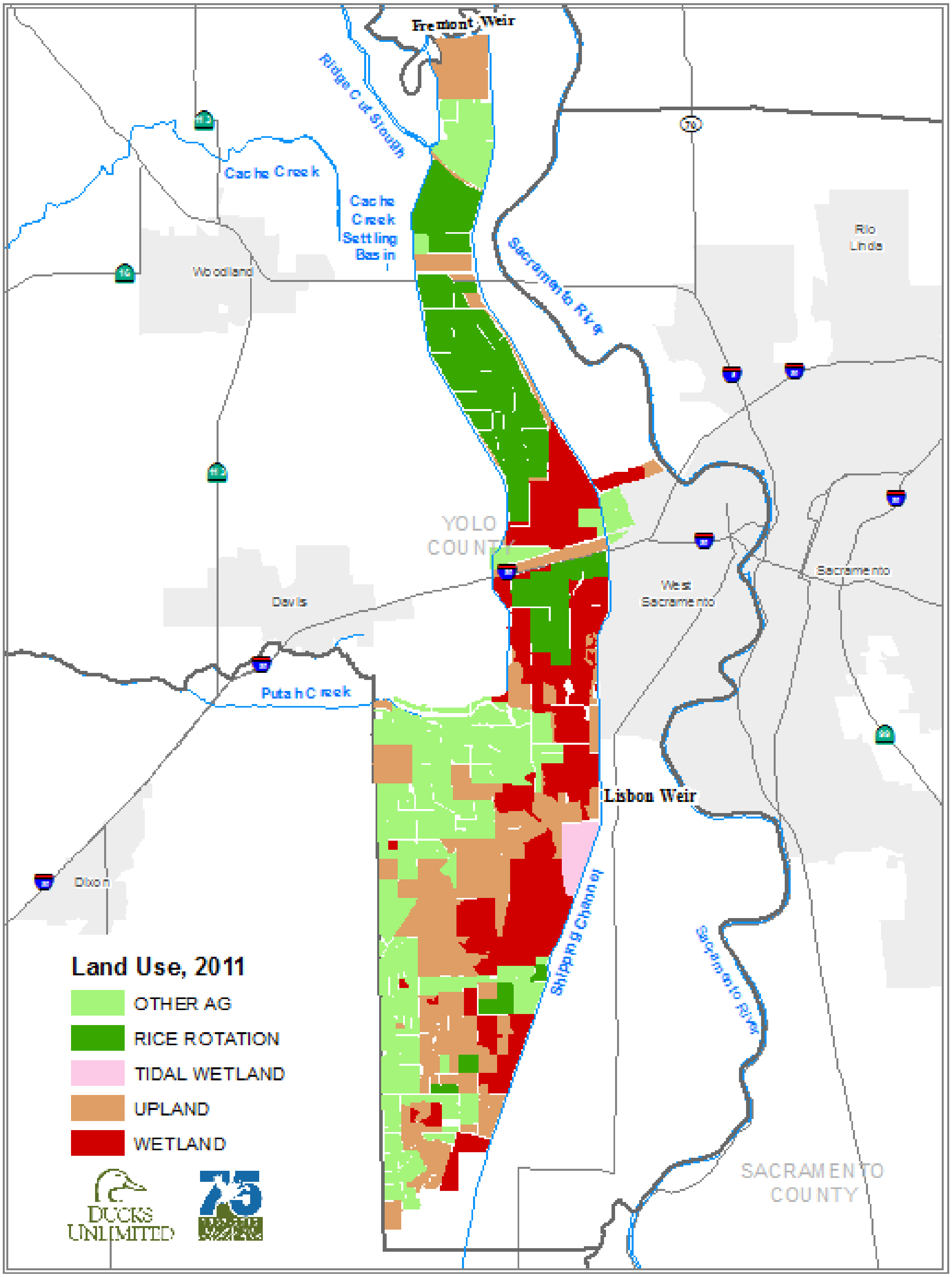

Figure 6. Updated wetland base in the Yolo Bypass, 2011

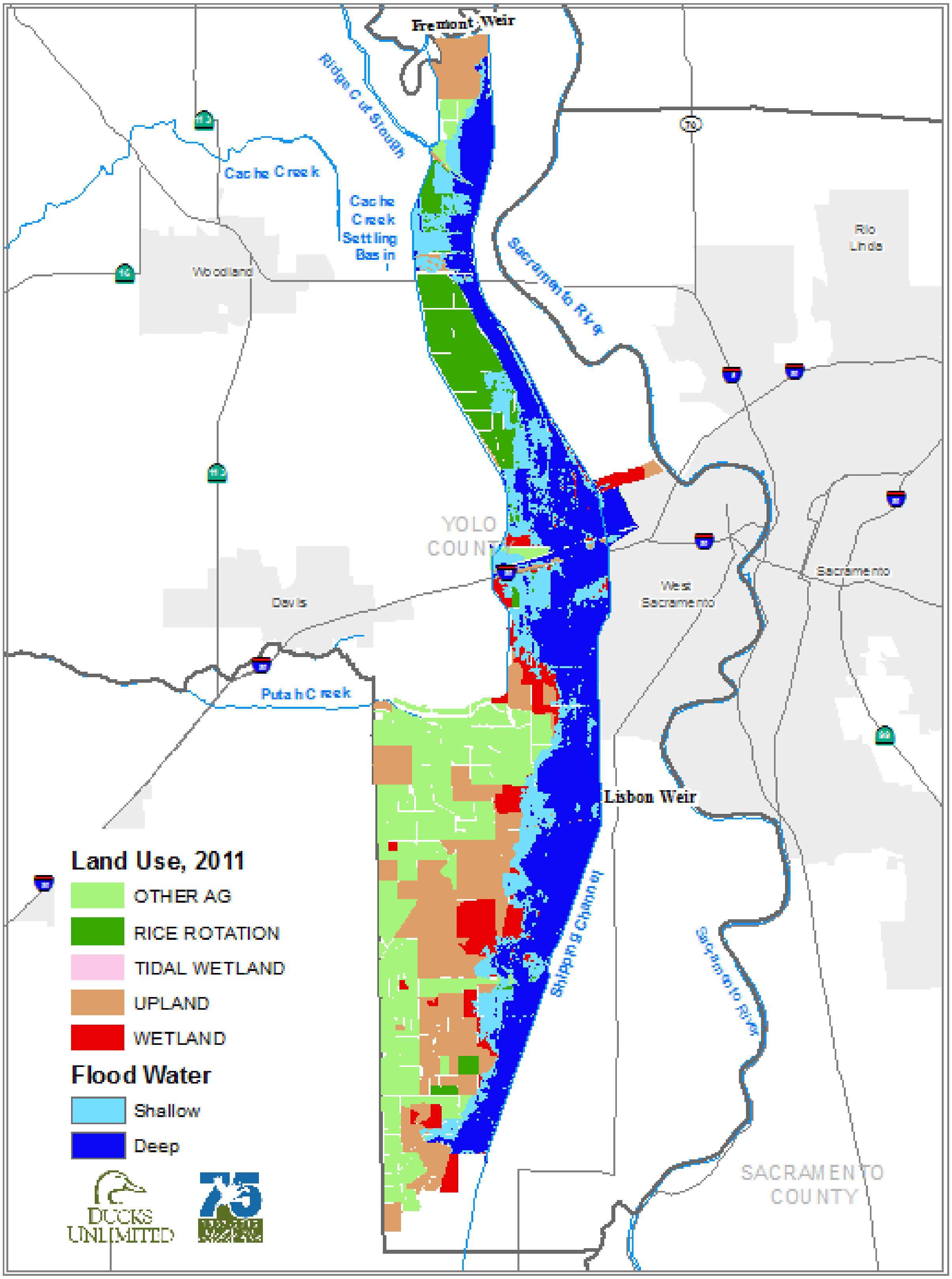

Figure 7. Map of the BypassDepth model output with Yolo Bypass land use showing most wetlands deeply flooded

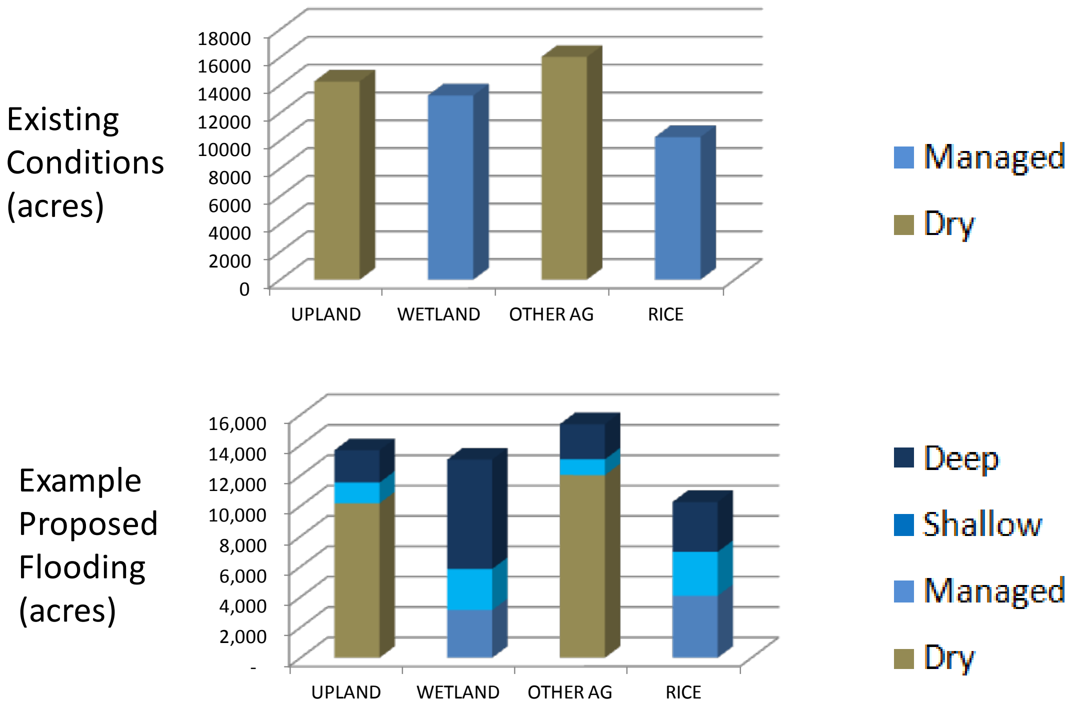

Figure 8. The Bypass Depth model initial conditions and example proposed flooding by land use

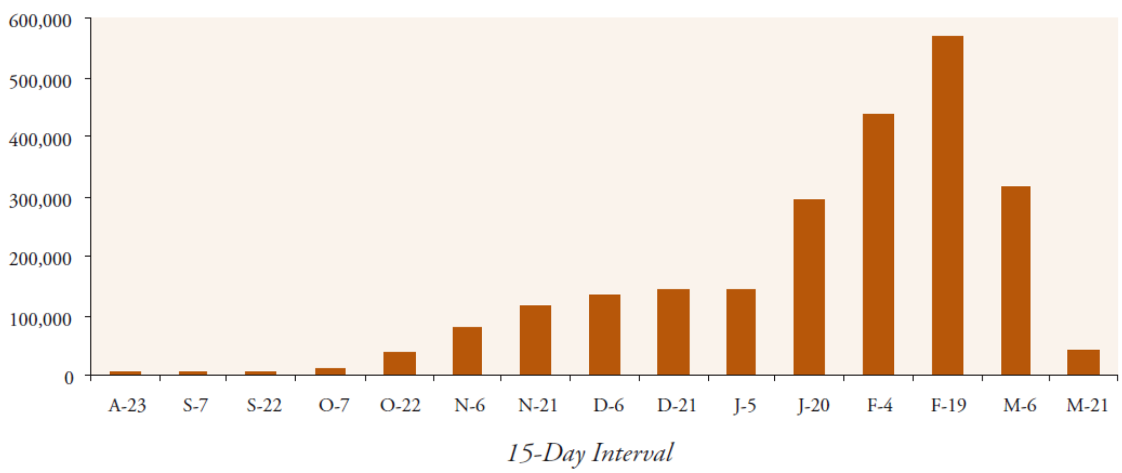

Figure 9. Population of ducks by 15 day interval for the Yolo Basin (CVJV, 2006)

Most of the waterfowl use in the Central Valley occurs in the non-breeding winter season and consists primarily of foraging to survive winter and to accumulate bodily reserves in preparation for spring migration and the breeding season. Adequate winter foraging habitat is important to increase waterfowl survival during winter, migration and to increase breeding season success. Ducks Unlimited collaborated with the CVJV to develop a bioenergetic model, TRUEMET, to establish habitat conservation objectives based on providing sufficient foraging habitat food resources to support waterfowl populations at goal levels for each of the nine basins of the Central Valley. TRUEMET is a daily ration model that calculates a waterfowl population energy demand curve and compares it to a curve for the available true metabolizable energy supplies from different food sources. The energetic demand curve is how the model expresses the daily caloric needs of waterfowl population. The available food supply curve is calculated in two week time steps throughout the winter as the supply of food resources is depleted from foraging and decomposition.

The major food supplies for ducks in the Yolo Basin are seasonal wetlands, winter-flooded rice and harvested corn fields. Previous runs of the TRUEMENT model for the Yolo Basin in the 2006 CVJV Implementation Plan were based on data now out dated and do not reflect the current Bypass land use. In addition, three sources of crop data were used to estimate the existing agricultural food sources for the remainder of the Basin. Rice acres were extracted for the last 15 years from the Yolo County Agricultural Commissioner's annual crop reports. The second source was the Department of Water Resources Land Use Survey available in GIS format that allows for the geographic separation of rice inside the Yolo Basin as opposed to the entire county. Figure 11 shows that approximately half of the rice grown in the County is inside the Yolo Basin. The third source of rice information was the new GIS rice base layer for 2009 produced by Ducks Unlimited. This layer showed a slight drop in rice within the basin while the county trend was for more rice acres. With the dramatic fluctuations in rice acreage over the past 15 years, this analysis uses a conservative value as shown as the dashed line the Figure 11.

Corn was shown to be an even more unstable food source when its acreage was plotted over the same time period. During the past 15 years, corn has been as high as 65,000 acres in the Yolo County and Solano County and as low as 6,000 acres. Based on GIS analysis of two time periods of DWR Land Use Survey data, the corn in the basin can be between 45% and 70% of the corn in Solano County and Yolo County. For this example run, half of the corn acreage in 2009 was used as an input in the TRUEMET model.

The TRUEMET model run in Figure 13 uses the updated 2011 current conditions in the Yolo Basin. Over the course of the winter season the resulting supply and demand curves show a food supply curve that is initially high, but is consumed over the course of the season to a point in March where the birds deplete the food resource just as they leave for their migration northward. This existing conditions run is for a dry year when the Fremont Weir is not overtopped.

To test the model's robustness, two additional boundary conditions were run to test how the Basin's carrying capacity responded. The first was an overtopping event that lasted the month of January. The second was a winter-long flood that lasted from November 15 – April 15.

The January flow condition assumed the full proposed 6,000 cfs flow from a notch as well as west side tributary inputs from the MIKE21 model. This example uses the output from the BypassDepth model and holds that depth for four weeks. Figure 14 shows the decrease in food supply during January. In February the Bypass flood water levels would drop and all wetland seed and rice grain resources would again be available to foraging waterfowl. Since all remaining food resources would be available when bird populations peak in mid-February, the Basin's food supply would last into March, near the same longevity as the current conditions example.

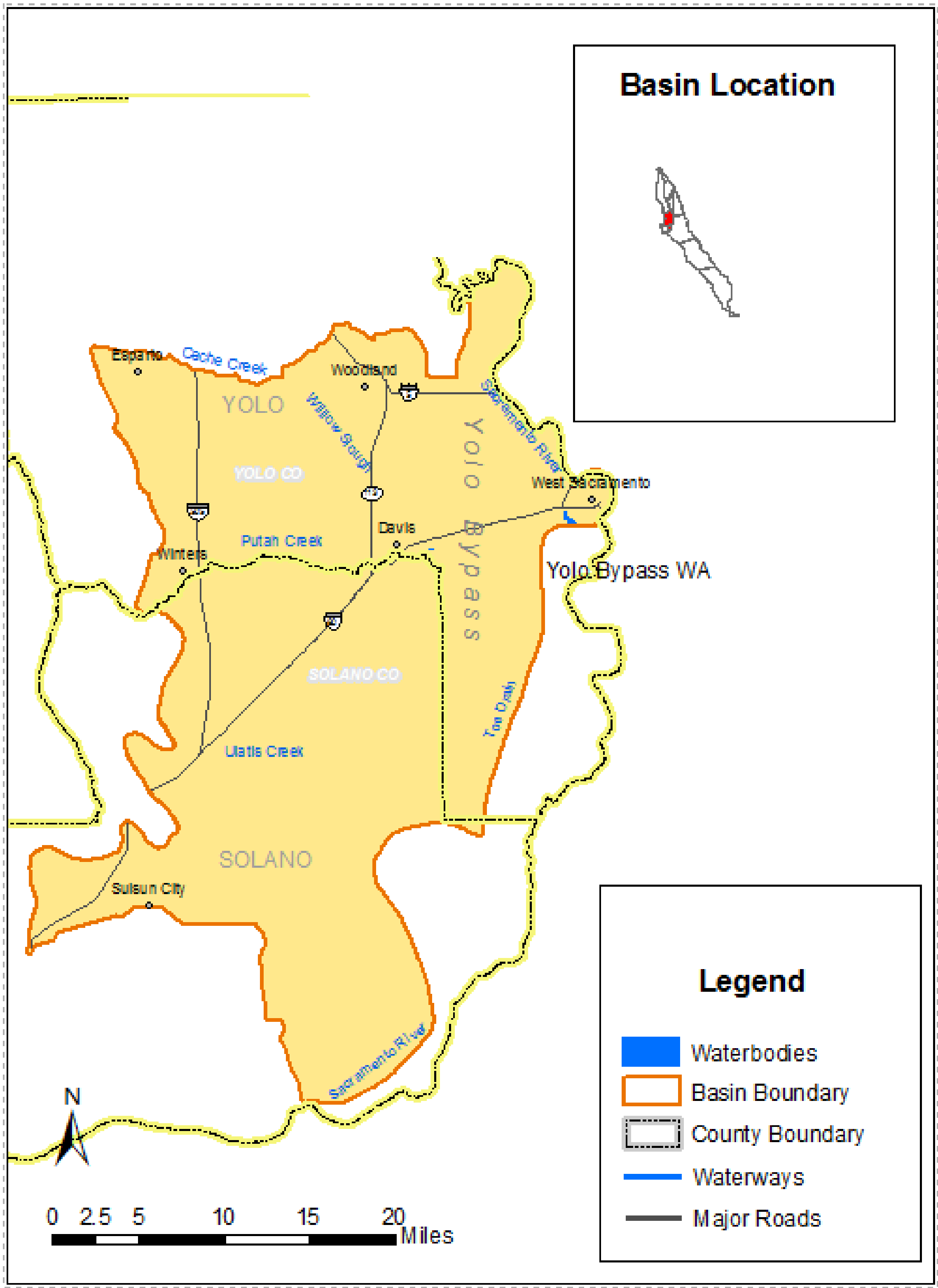

Figure 10. Map of the Yolo Basin including the Yolo Bypass

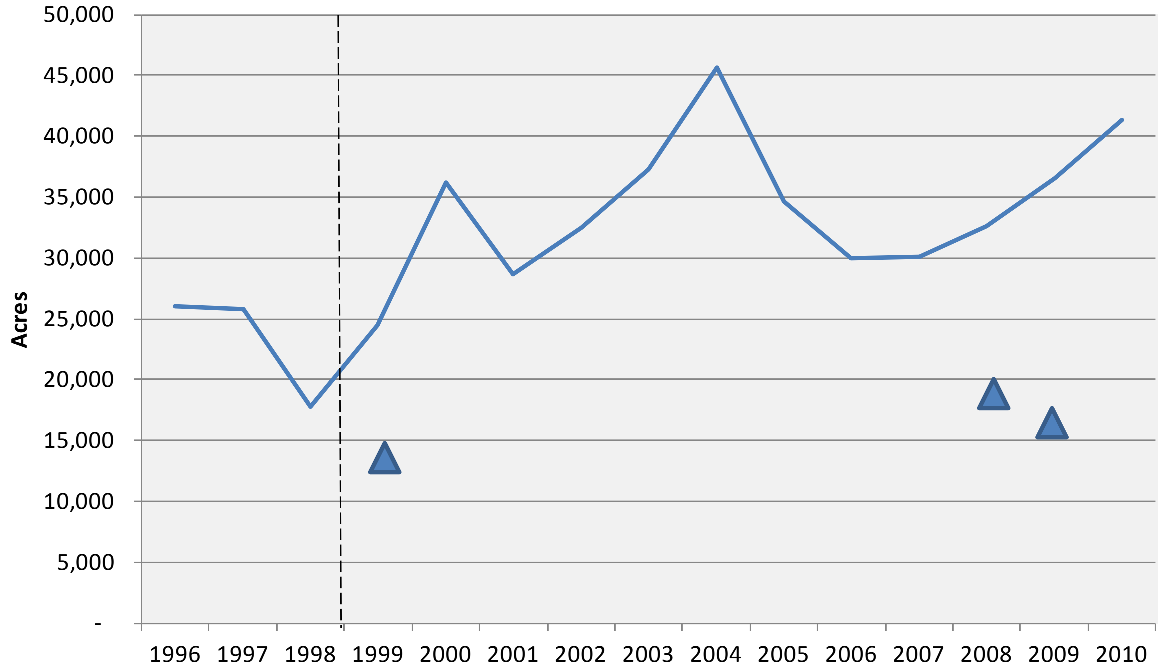

Figure 11. Rice acreage in Yolo County and Yolo Basin

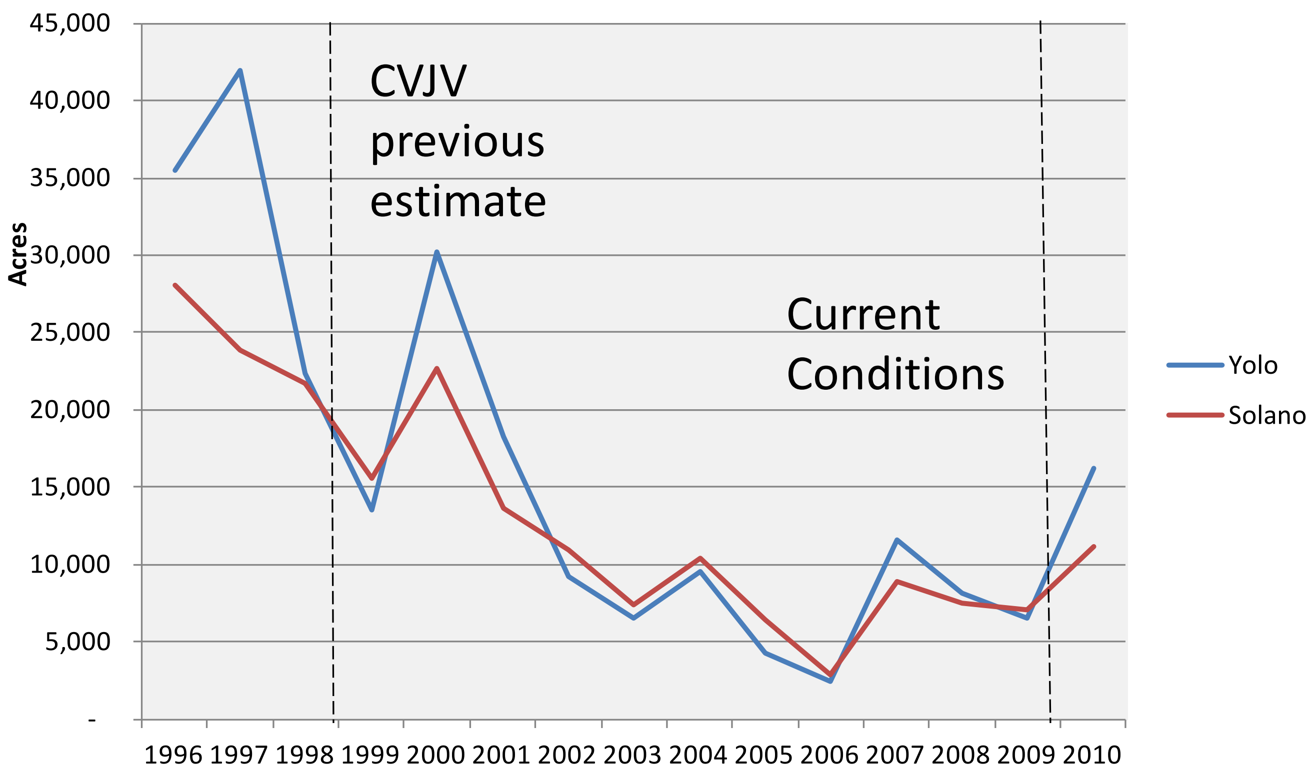

Figure 12. Corn acreage in the two counties that are part of the Yolo Basin

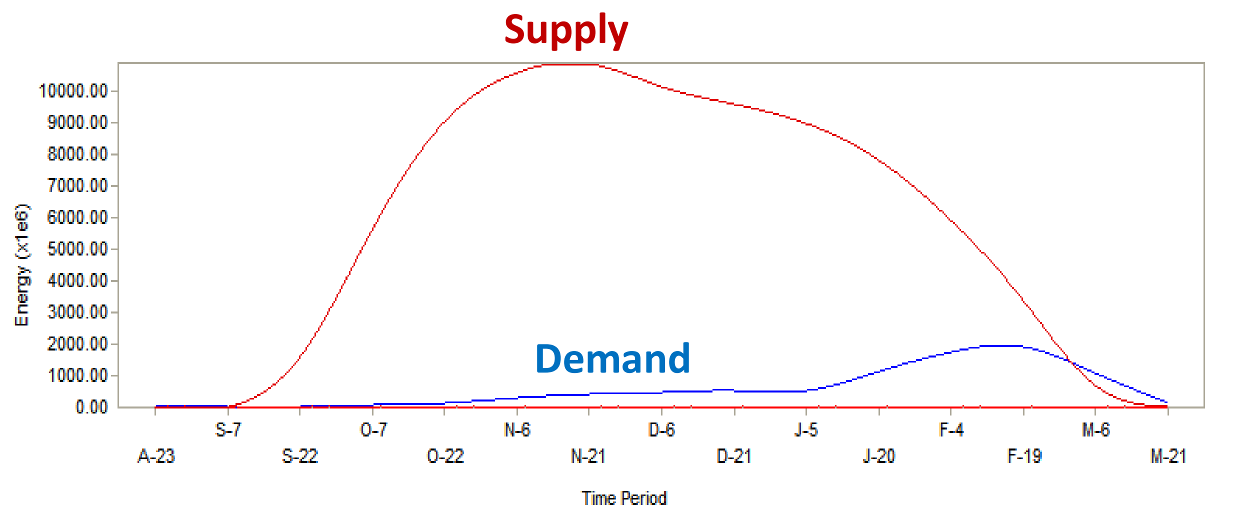

Figure 13. TRUEMET model output for the existing conditions for a dry year in the Yolo Basin

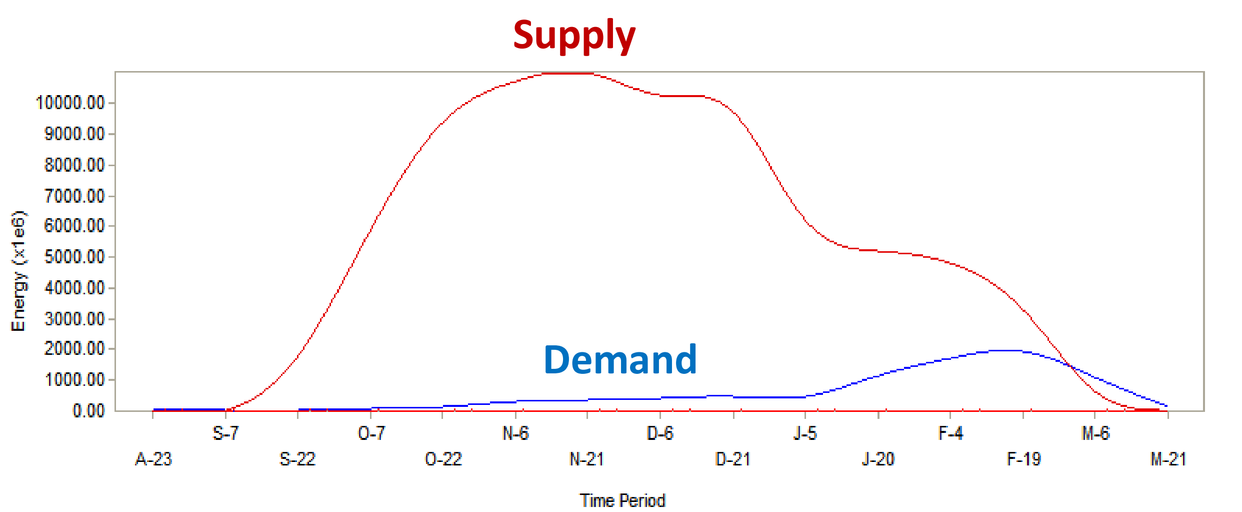

Figure 14. Example TRUEMET run with a January 6,000 cfs notch event and west side tributaries

The second boundary condition run was a winter-long flood event of the same magnitude, 6,000 cfs with west side tributaries. This flood event would start November 15 and end April 15. Even with much of the Yolo Bypass under deep water in the early- to mid-winter, waterfowl have enough food supplies from agricultural sources to maintain population objectives. The carrying capacity of the Basin crashes, as shown in Figure 15, in February when the food supply is depleted. This is at the same time as waterfowl population would be at their highest and food demand is approaching its highest. Another effect of flooding through spring in the Bypass may be a reduction of wetland plant seed production the following year. This potential effect is examined as the fourth driver of the model in the next section.

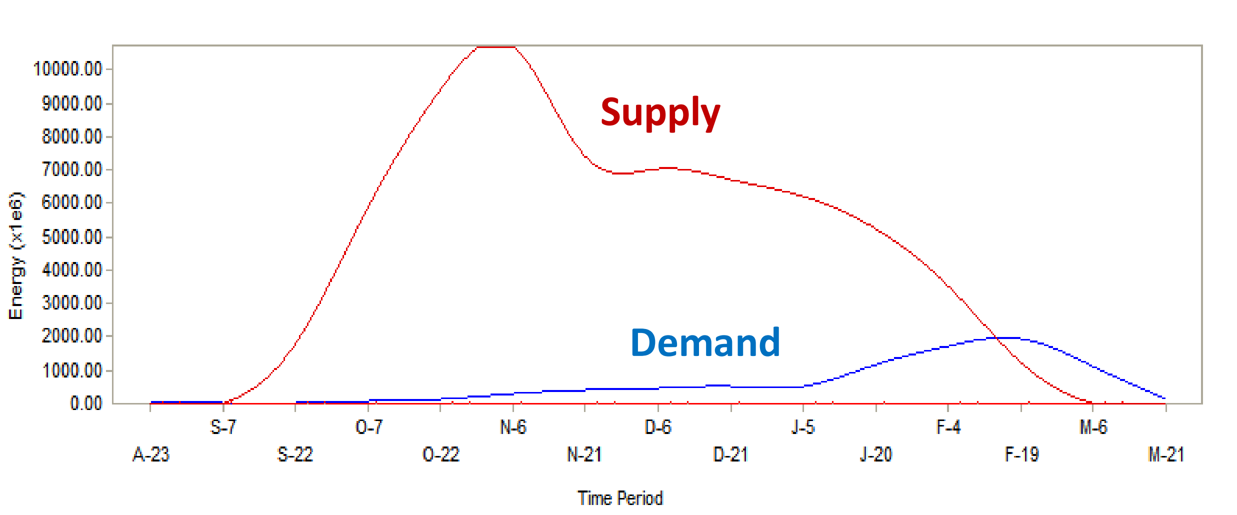

Figure 15. Example of TRUEMET run with a winter long 6,000 cfs notch event and west side tributaries

3.4 Spring Seed Production Loss

The CVJV calibrated the TRUEMET model by measuring energetic values and overall production of seasonal wetland plant seeds in the Central Valley. Different seasonal wetland areas in the Valley are managed for certain wetland plants. Interviews with wetland managers at the YBWA and Bypass private duck clubs were conducted to determine the types of wetland vegetation grown and their timing of seasonal wetland spring draw down. On the YBWA, swamp timothy is the primary plant grown in the seasonal wetlands. This plant provides high seed yield and energy, and is low enough in height to provide the open sheet water habitat that is preferred by dabbling ducks.

Current seasonal wetland water management practices include pulling the water control structure boards on about half of their wetland cells in advance of a pending flood event before floodwaters arrive. This prevents infrastructure damage on some water control structures from the high volumes of flowing water. After the higher water from the flood recedes and some high elevation roadways are exposed, managers try to access the wildlife area as soon as they are able to put the boards back into the drainage structures to retain water within the managed ponds for shallow inundation as the high flood water recedes. These wetlands are topped off with a last supply of delivered water in February then allowing for a slow evaporation of the ponds beginning in March. Wildlife managers monitor the germination rate of swamp timothy along the pond borders. When it reaches a certain threshold during the first two weeks of April, the water is drained rapidly to promote maximum growth.

On the private ducks clubs in the Yolo Bypass, the main vegetation favored by wetland managers is a mix of watergrass and smart weed. These species attract a diverse array of dabbling duck species and provide some vegetative cover preferred by mallards, a highly favored ducks species by hunters. These plants have a much different water management regime. With the hunting season ending in late January, some clubs partially drop their water levels in mid-February to concentrate the water and the invertebrates. Full draw down occurs one month later in mid-March and is a slow process lasting 2-3 weeks. To promote maximum production of wetland seeds and weed control, land managers perform early season irrigation by flooding the wetland unit and holding stable water levels for 2-4 weeks in May.

Overall, late season draw downs in managed wetlands can contribute to annual weed dominance rather than target waterfowl plants (Meeks, 1969). This effect has been documented for swamp timothy in two studies in the Central Valley (Rahilly et al., 2010 and Naylor, 1999). In the Rahilly study, a two year experiment was conducted that documented the effects on swamp timothy seed production by delaying draw down by 4-6 weeks. In this study, seed production was not significantly affected after one year; however, after two spring seasons of delayed draw down there was a 25-30% drop in seed production. Since the study only covered two years, it is unknown how many seasons it would take for seed production to rebound when a wetland is returned to a normal spring draw down schedule. In an effort to put delayed spring draw downs in the context of the Yolo Bypass, the historical record of the Fremont Weir overtopping in late March was examined in Figure 18. In the last 40 years, only one time period had flooding extended into March in two consecutive years, 1973-74 and 1974-75. This was prior to the establishment of the YBWA.

No known studies document the effect of delayed draw down on watergrass. An examination of the literature on watergrass germination yielded that watergrass can germinate soon after the draining of a seasonal wetland in March, April or May. Although many private duck clubs in the Bypass drain their watergrass wetlands in March, they may be able to drain later and still get maximum seed production. Interviews with pubic area wetland managers farther up the Sacramento Valley on this topic acknowledged that some wetland managers can hold water through early May and not experience noticeable seed loss. Any changes in the water management by private duck clubs in the Yolo Bypass to accommodate later spring flooding may have other costs associated with it since many of these areas do not have on-site managers.

To model the effect of seed production loss in the Yolo Bypass from delayed draw down, the land use basemap with 6,000 cfs flooding was examined to quantify which wetlands are directly affected by the flooding footprint and which wetlands are indirectly affected by being adjacent to flooding. Wetlands abutting a flooded area would have their drains already full. Since the outflow control structures would be below the water surface level in the drainage canals, there would not be any down slope elevation gradient to drain the water from the wetland unit. In this boundary condition example the vast majority of the wetlands are either directly under the floodwaters or adjacent to the flooded footprint and would not be able to drain in time for normal seed germination, as shown in Figure 16. Further topographic analysis would be necessary to exactly determine which fields would not be inundated yet unable to drain.

In the TRUEMET seed loss model run, the seasonal wetlands that grow swamp timothy have a 25% reduced food value following two years of delayed draw down. The resulting supply and demand curves are shown in Figure 17. Although the supply loss is observed for much of the winter season, its impact on the basin's carrying capacity is only significant in February when the waterfowl population peaks and the food resource is completely depleted.

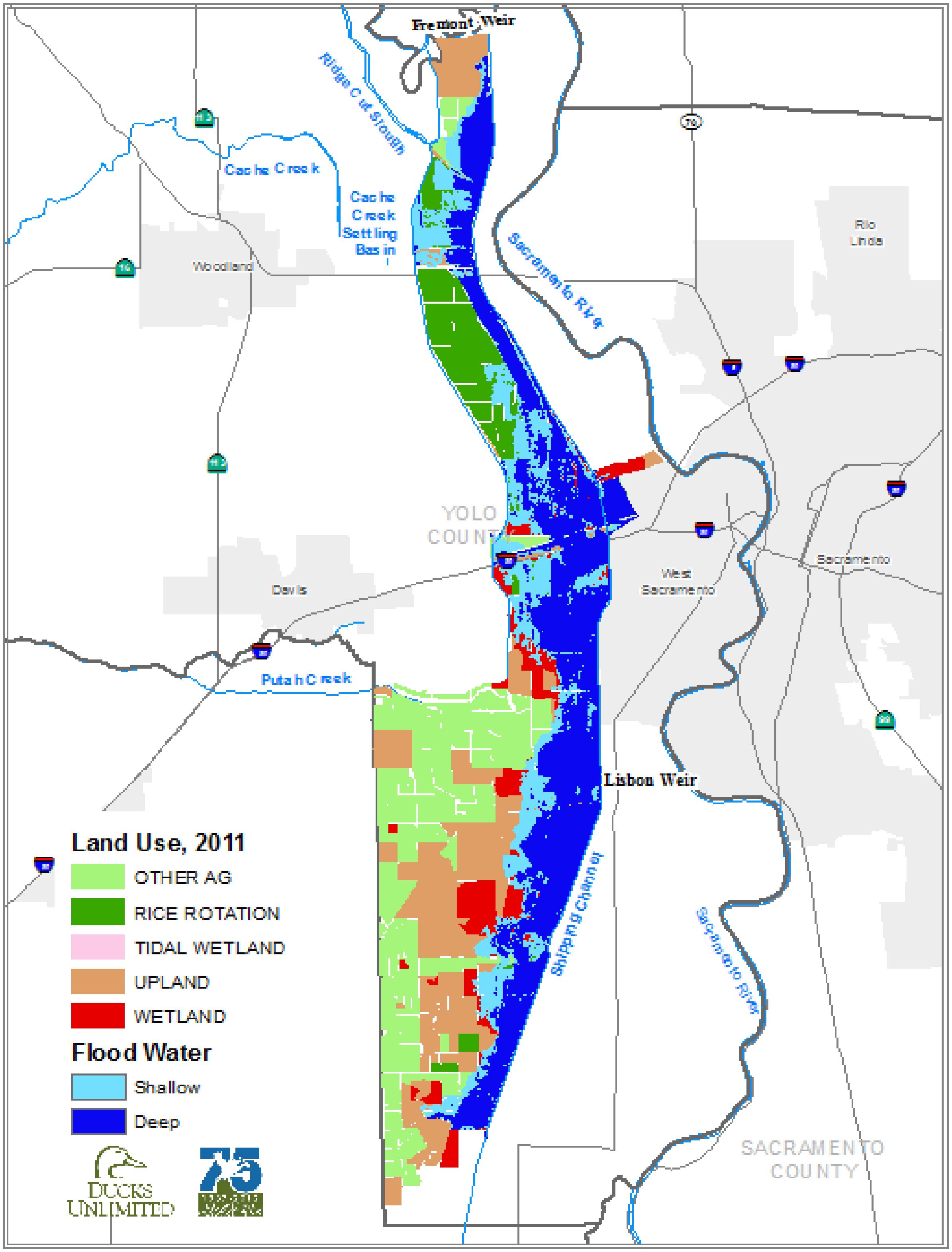

Figure 16. Direct and indirect wetlands affected by late spring draw down

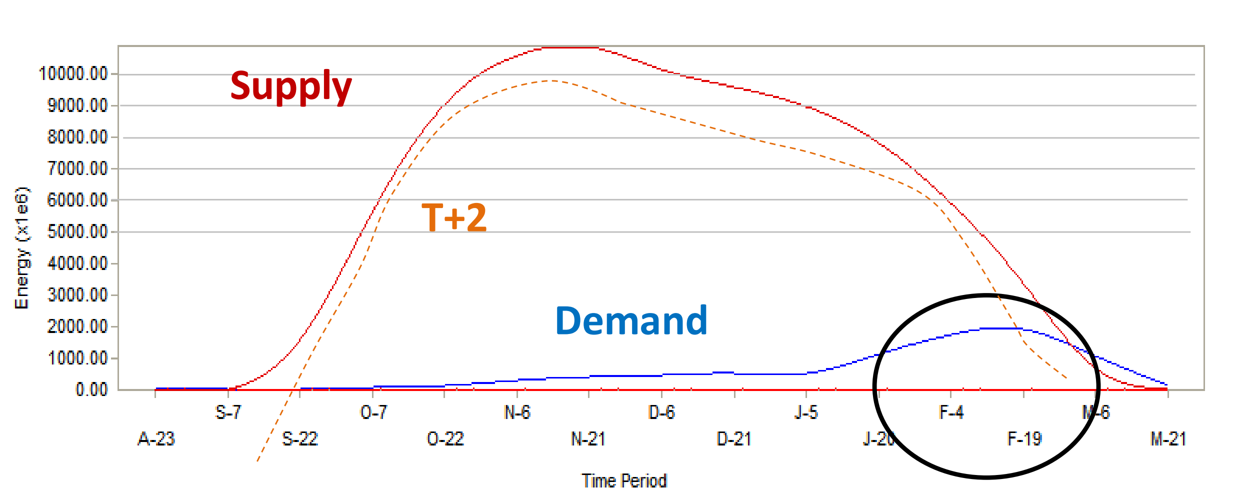

Figure 17. TRUEMET supply and demand curves for current conditions and for delayed draw down plus two.

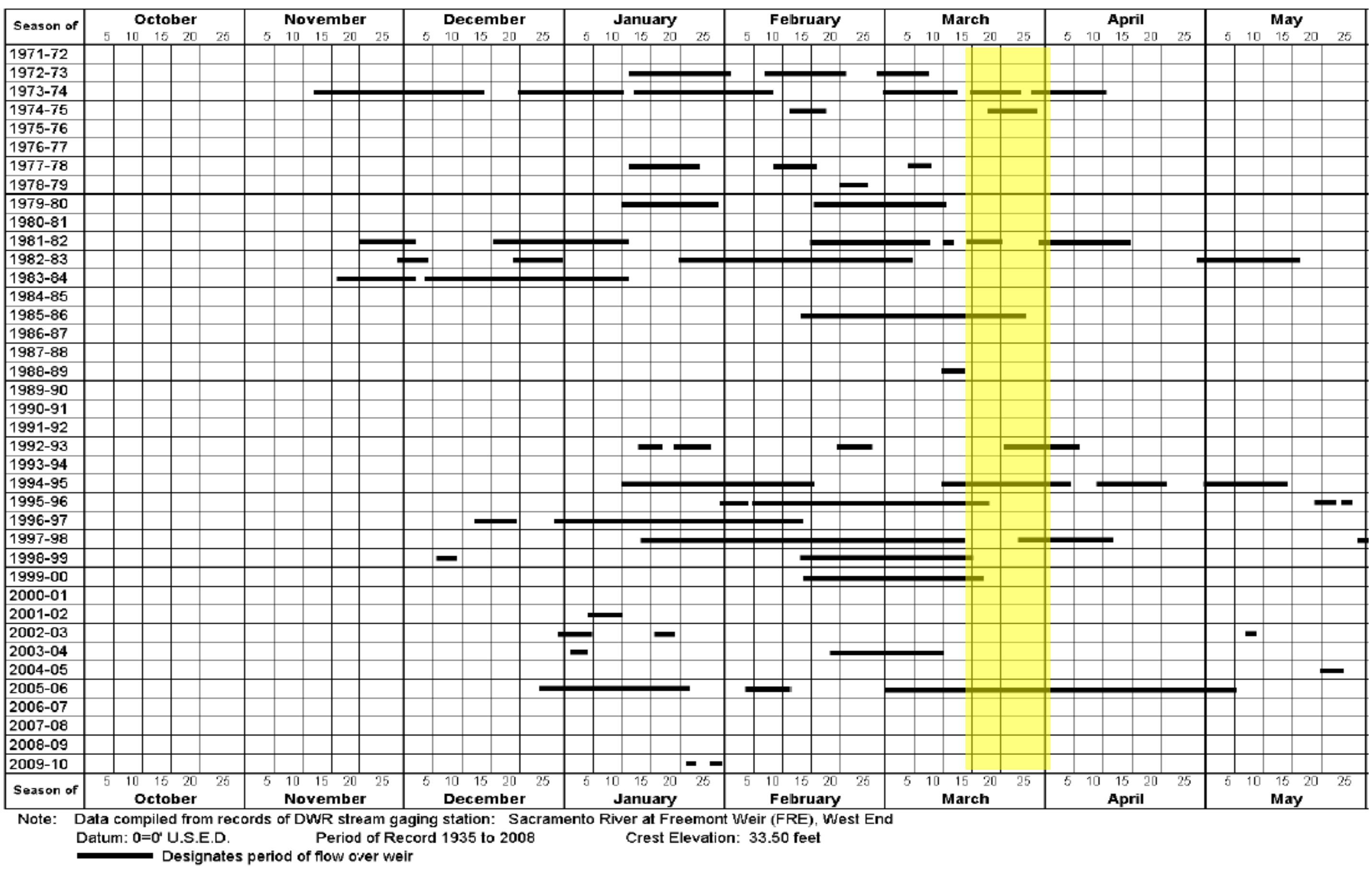

Figure 18. Fremont Weir overtopping dates 1971-2010 with late March highlighted

4 Waterfowl Breeding

Although the changes to Yolo Bypass operations are not expected to significantly affect waterfowl during the breeding time period, the study authors wanted to briefly review the annual breeding chronology of locally nesting waterfowl. In the Yolo Bypass nesting season starts in late March. Nest initiation peaks in late April and can continue into early June. Birds use their nests approximately 50 days for egg laying, incubation and hatching (G. Yarris, personal communication, March 6th, 2012). Waterfowl typically nest near water in grasslands or seasonally dry wetlands. In the May breeding population surveys flown by the Department of Fish and Game, the one aerial transect that covers a portion of the Yolo Bypass has consistently counted high values of mallard breeding pairs. Further discussions would be needed to translate these counts into basin wide breeding numbers. Based on this breeding chronology, breeding is not expected to be significantly impacted if the Fremont Weir notch flooding finished by the end of March. One scenario that would have major impact on nest success is if a dry early spring is followed by a late flood event. This timing would allow waterfowl to establish nests in April and then inundate these nests in late April or May. Depending on how late a flood arrives in the spring, some birds may renest later in the spring.

5 Conclusions

The study's goal was to develop a modeling tool that can be employed to evaluate potential effects on waterfowl from increased duration and frequency of flooding within the Yolo Bypass from Conservation Measure 2. The developed tool incorporates topographic and land use data sets with MIKE21 projected flood depths and extent from a 6,000 cfs event. This tool links the resultant loss of waterfowl foraging habitat from deep flooding to the TRUEMET model so a reduction in waterfowl carrying capacity can be calculated as an effect. The two boundary conditions of a month long and winter long flood event demonstrate proof of concept that all variations of potential flooding scenarios in Conservation Measure 2 and associated effects on waterfowl can be evaluated with this tool.

Additionally, the following conclusions became apparent in the development of the evaluation tool.

- The most sensitive time of the year for waterfowl populations in relation to Conservation Measure 2 is in February when the waterfowl numbers are highest and the food supply is the lowest. This is a critical time period as birds need enough fat reserves to migrate north to their breeding grounds.
- Controlled floods on the order of the notch flooding examples in early and mid-winter temporarily removes food supply from waterfowl populations, but does not impact the annual carrying capacity of the Yolo Basin.
- Consecutive year flooding after mid-March would significantly decrease the seed production of wetland plants and fully deplete food resources at the peak of the annual waterfowl numbers.
- The financial sustainability of the YBWA depends on the agricultural income from some of its leased property. New management of the floodway may require the replacement of this income stream.

- Hunters who use the YBWA or private waterfowl hunt clubs in the Bypass current lose approximately two weeks of hunting opportunities according to the baseline flooding regime. One measure of impact for future scenarios is how they change the number of available hunt days. Changes in infrastructure may allow the YBWA to partially close due to managed flooding and lessen the effect on hunting opportunities.
- Elevation data on the west side tributaries is needed to improve the MIKE21 flood model to more accurately depict the extent and depth of flooding in the Bypass.
- Flood events that continue into April have the potential to substantially impact breeding waterfowl in the Yolo Bypass.

6 Next Steps

Several steps are needed to improve the accuracy of the modeling effort and to support the establishment of Conservation Measure 2 and quantify its impact on waterfowl populations and waterfowl habitats in the Yolo Bypass. The first step is a more comprehensive review and calibration on the MIKE21 2-D flood model. Current model documentation states that the water depth in some areas of the Bypass may differ by as much as one foot from the modeled water depths. With a foraging threshold of 18 inches for dabbling ducks, it is important that some of the uncertainty in water depth be minimized. Yolo County is currently reviewing the Mike21 model and this effort should be supported.

A portion of the errors in the Mike21 model is model assumptions of the west side tributaries. Currently, two west side tributaries are not properly modeled and are falsely assumed to enter the Bypass on the east side as proper bathymetry is not available for their channels. The elevation data should be collected and Mike21 should be rerun to show more accurate water extents for each flooding scenario.

A major uncertainty in the modeling of future flooding scenarios on waterfowl populations is the impact of a delayed spring draw down on seed production by wetland plants in subsequent years. Current studies show significant losses can occur with multiple years of delayed draw down, but it is unknown how quickly or slowly seed production can rebound in wetland plants when spring draw down is returned. Any pilot studies to study changes in the operation of Yolo Bypass should include a seed-head study to examine the potential effects of flooding on spring seed production.

The example 6,000 cfs flood flow analyzed in this report is from the MIKE21 model as reviewed in CBEC, 2010. In May, 2012 the CBEC modeling group revised their flood model and produced a new flooding footprints and depths. Future runs of this waterfowl effects analysis tool will use the updated flood model data.

Conservation Measure 2 flooding scenarios are not currently identified. Specific flood scenarios including magnitude, duration and frequency need to be refined so that the waterfowl effects can be quantified. Future scenario runs of this tool will quantify each of the 4 main drivers in relation to the impact over baseline conditions.

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